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FRONTIERS IN CHEMICAL, BIOLOGICAL AND PHARMACEUTICAL SCIENCES VOLUME I

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Title: **FRONTIERS IN CHEMICAL, BIOLOGICAL AND PHARMACEUTICAL SCIENCES (VOLUME-I)**

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PREFACE

The evolutionary theory of the living universe places a significant emphasis on the fields of chemical and biological research. A significant amount of work has gone into this book, Frontiers in Chemical, Biological and Pharmaceutical Sciences: An Approach towards Qualitative and Quantitative Studies and Applications, by a variety of authors in the field to offer new research methodologies, their applications, and practical encouragements for chemical sciences and biological science. Application of biological organisms, ethnomedicine used in various human disorders, biological activity of Indian medicinal plants, ethnobotanical study, Ecofriendly energy, Transplastomic plants, Role of Sacred Groves in Biodiversity Conservation, Medicinal Property Rich Plants Comphora, and Different Traditional Parts in India its application is some of the various themes in the book. It includes environmental science topics such as the impact of harmful chemicals on the environment. Additionally mentioned were pharmacognosy points such as Euphorbiaceae's pharmacological properties. It covers subjects such as phytochemistry, biochemistry, and the active components of Indian medicinal herbs. Inorganic Metal Oxide-Polymer Nanocomposites for near Infra-Red, Qsar: A Useful Tool of Computational Chemistry for Designing New Drug and Predicting Their Biological Activities, and other topics in chemical science such as organic and inorganic are discussed. Additionally, it covers computational and medicinal chemistry there. This book serves as a bridge between the chemical sciences and other disciplines, opening the door for new study in the relevant field. The experiments outlined in the boom chapters are ones that every student of chemistry should carry out. They also make a great starting point for a course on qualitative and quantitative analysis. This book will be very helpful to all academics, researchers, and students working in the subjects of chemistry, biology, physics, materials science, and engineering, among other fields.

This book with valuable book chapters from eminent scientists, academicians, and researchers will surely be a part of almost information for the coming new research taken by the researchers in the field of chemical sciences and other disciplines in the future.

Editors:

Dr. Bassa Satyannarayana

Mr. Mukul Machhindra Barawnt

TABLE OF CONTENT

Chapter 1

ISOLATION AND STRUCTURE ELUCIDATION OF NOVEL OLIGOSACCHARIDE 'ASOSE' FROM COW MILK

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ABSTRACT
Milk is a fantastic source of well-balanced nutrients and also demonstrates a variety of biological activities. The development of the immune system in both adults and newborns is attributed to oligosaccharide, a naturally occurring carbohydrate found in milk. Milk provides number of novel oligosaccharides depending on the nature of their origin and to which mammals the milk belongs. These oligosaccharides have shown a range of biological activities, including anti-tumor, anti-cancer, anti-complementary, hypoglycemic, anti-inflammatory, and anticoagulant properties, as well as antiviral, immunostimulant, and immunological activity. In order to achieve this, bulk Cow milk was procured and processed using Kobata and Ginsburg method, which was then followed by gel filtration, HPLC, and column chromatography, leading to the extraction of a novel oligosaccharide called Asose. Chemical transformations, chemical degradation, NMR of neutral and acetylated oligosaccharide (^{1}H, ^{13}C and 2D COSY, TOCSY and HSQC), and mass spectrometry were used to clarify the structure of isolated oligosaccharides.

GlcNAc–β–(1→3)GalNAc–β–(1→6)Gal–β–(1→4)Glc

KEYWORDS: Bovine milk, milk oligosaccharide, 2D NMR

INTRODUCTION

All mammal species make milk to provide nutrition and immunological protection to newborn mammals.[1, 2] The key components of milk include lipids, proteins, fats, immunoglobins, and carbohydrates.[3, 4] One of the important bioactive components of milk, oligosaccharides have a major impact on prebiotic activity, anti-adhesion activity, anti-inflammatory activity, glycome modifying action, and brain and central nervous system development.[5, 6] Different milk sources, including those from cows, buffaloes, people, mares, goats, yaks, and donkeys, have yielded a number of milk oligosaccharides that contain significant concentrations of bioactive oligosaccharides and exhibit a variety of biological activities, including antitumor, anticancer, antigenic, Immuno stimulant, and others.[7, 8] The adherence of calf enterotoxic E. Coli strains is reduced by the oligosaccharides in cow milk.[9] Buffalo milk oligosaccharides have also been tested for their capacity to promote the host's non-specific immune tolerance to parasite infections.[10] Mare's milk has demonstrated anti-oxidant, lipid-lowering, and post-heparin lipolytic activity. They also support cellular immune response as seen in vitro in terms of cellular proliferation and reactive oxidative burst, which has also been interpreted as an activation of innate immune defense mechanism.[10] The fat-like compounds that help with the transmission of specific nerve impulses and the control of blood pressure are abundant in Mare's milk.[11] The formation of the gangliosides in the developing calves' brains was significantly influenced by the elephant milk oligosaccharide fraction, which contained a high ratio of sialyl oligosaccharides.[12] The N-

acetylneuraminlactose sulphate oligosaccharide, which predominates in dog milk and is crucial for the nourishment of rat pups. Infant health advantages from camel milk oligosaccharides, which contain sialyl oligosaccharides and thus sialic acid, include the encouragement of infant brain development. Sheep milk is a rich source of fucosylated oligosaccharides, which have distinct biological effects.[13] For example, human milk's powerful innate immune system is made up of 1, 2-linked fucosylated oligosaccharides conjugated with other families of oligosaccharides. Goat milk oligosaccharides exhibit anti-inflammatory properties in rats with trinitrobenzenesulfonic (T) acid-induced colitis and may be helpful in the treatment of inflammatory bowel disease.[14] Non-specific and specific immunological resistance can be stimulated by donkey milk oligosaccharides. Human milk oligosaccharides can be thought of as prebiotics since they are metabolized by particular bifidobacteria strains and so aid in the development of distinctive healthy gut Microbiota in newborns while they are breastfed.[15] According to ancient texts, cow milk is essential for human life. Dhanvantri, an old Indian physician, confirmed that it guards against leucoderma and heart conditions. Black cow milk's medicinal value has been discussed in Ayurveda, and the Rig-Veda claims that cow milk is Amrita, protecting humans from disease and having both curative and preventative properties.

Keeping in mind the biological activities of milk oligosaccharide. We selected cow's milk because milk oligosaccharide has a wide range of biological activities according to its composition. Cow milk was collected in bulk and processed using a Kobata and Ginsburg's method before being subjected to a variety of chromatographic procedures, including gel filtration, TLC, CC, HPLC, and others, which led to the isolation of a new milk oligosaccharide called Arose (D). The data obtained from spectroscopic methods such as NMR (^{1}H, ^{13}C, COSY, TOCSY, and HSQC), mass spectrometry, and chemical degradation and transformation were used to elucidate the structures of pure milk oligosaccharides.

MATERIAL AND METHOD

GENERAL PROCEDURE

A PERKIN-ELMER 241 automated polarimeter in a 1 cm tube was used to measure optical rotations. On a Bruker AM 300 FT NMR spectrometer, novel oligosaccharide 'Asose' ^{1}H and ^{13}C NMR spectra were recorded in D_2O and the spectra of acetylated oligosaccharide 'Asose' ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ at 25^0C.A MICROMASS QUATTRO II triple quadrupole mass spectrometer was used to record the electrospray mass spectra. The sample was injected into the ESI source at a rate of 5ul per minute using a syringe pump after being dissolved in appropriate solvents such as water, acetonitrile, or methanol. The cone voltage was 40 V, while the ESI capillary voltage was set at 3.5 KV. The spectra were collected in 6s scans and the printouts are averaged spectra of 6-8 scans. The elemental analyzer CARLO-ELBA 1108 was used to record the C, H, and N analyses. The sugars were visualized on paper chromatography using acetyl acetone and p-dimethyl amino benzaldehyde reagents and on TLC using a 50% aqueous H_2SO_4 reagent. Silica gel G (SRL) and CC silica gel (SRL, 60–120 mesh) were used as the absorbent for TLC. Paper chromatography was performed on Whatman No.1 filter paper using a solvent system ethyl acetate-pyridine (2:1) saturated with H_2O. In gel permeation chromatography, Sephadex G - 25 (PHARMACIA) was used. With the help of a CT 60e (HETO) lyophilizer and a cooling centrifuged Remi instrument C-23 JJRCI 763, the compound was freeze-dried. A reverse phase HPLC system with Perkin Elmer 250 solvent delivery system, 235 diode array detector, and G.P. 100 printer plotter was used to test the homogeneity of the compounds. Authentic samples of glucosamine, galactosamine, galactose, glucose, fucose, and sialic acid were purchased from Aldrich Chemicals.

ISOLATION OF COW MILK OLIGOSACCHARIDE BY KOBATA AND GINSBERG METHOD[16]

A cow's milk was collected in 10 liters, and it was then isolated using the Kobata and Ginsberg technique. In order to use this technique, milk was kept at -20°C and centrifuged at 4°C for 15 minutes at 5000 rpm.

By filtering through a glass wool column in the cold, the solidified lipid layer was eliminated. A final ethanol concentration of 70% was added to the clean filtrate, and the resultant solution was then allowed to left overnight at 0°C. After centrifuging the white precipitate, which was mostly made of lactose and protein, it was twice washed with 70% ethanol at 0°C. A crude oligosaccharide combination was produced by combining the supernatant and washings, filtering them through a micro filter, and then lyophilizing them. The lyophilized sample responded well to the Morgan-Elson test and the thiobarbituric acid assay, indicating that sialic acid and N-acetyl sugars were present in the oligosaccharide mixture. This mixture of oligosaccharides that had been lyophilized was further purified using fractionation on Sephadex G-25 chromatography with glass triple-distilled water as the eluant and a flow rate of 3 ml/m. The presence of neutral sugar was analyzed in each fraction using the phenol sulphuric acid reagent.

ACETYLATION OF COW MILK OLIGOSACCHARIDE MIXTURE

At 60^0C, 10.5 gm of a crude oligosaccharide mixture was acetylated with 12 ml each of pyridine and acetic anhydride, and the mixture was stirred overnight. Furthermore, the mixture was evaporated at a lower pressure, and the viscous residue was taken in 250 ml of $CHCl_3$ and rinsed with 25 ml of water. The acetylated mixture (12 gm) was obtained when the organic layer was dried over anhydrous Na_2SO_4, filtered, and evaporated to dryness. The acetylation converted the free sugars into their nonpolar acetyl derivatives, which were resolved well on thin layer chromatography (TLC), giving eight spots: A, B, C, D, E, F and G. Compounds were ultimately separated by column chromatography over silica gel (60-120 mesh) using hexane: $CHCl_3$ and MeOH: $CHCl_3$ as eluents.

PURIFICATION OF ACETYLATED MILK OLIGOSACCHARIDE ON SILICA GEL COLUMN

By using column chromatography, the separation of the acetylated products (10 gm) was purified. The silica was used in the ratio of 1:100 using various proportions of Hexane CHCl3, CHCl3, CHCl3: MeOH mixture which was resolved into twelve fractions namely I(250 mg), II(90 mg), III(162 mg), IV(2.10 gm), V(2.00 gm), VI(1.75 gm), VII(125 mg), VIII(284 mg), IX(715 mg), X(184 mg) and XI(2.22 gm) respectively. These fractions had a combination of two to three distinct compounds. One chromatographically pure compound G (51 mg) was isolated using repeated column chromatography of fraction VIII.

DEACETYLATION OF COMPOUND

Compound G (51 mg) that had been acetylated was deacetylated in a hydrolysis flask with a stopper using 20 ml of acetone and 20 ml of NH_3. The compound was recovered in the aqueous phase after 24 hours of ammonia removal under reduced pressure, equal volumes of $CHCl_3$ and water were added, and the compound was then deacetylated oligosaccharide Asose (35 mg) obtained from the water layer by freeze drying.

DESCRIPTION OF ISOLATED COMPOUND ASOSE

^{1}H NMR: δ in D_2O (ppm)

δ5.27(d,1H J= 3.8Hz), δ4.66(d,1H J=8.6 Hz), δ4.51(d,1H J= 7.6Hz), δ4.44(d,1H J=7.2Hz), δ4.06(t,1H J=4.8 Hz), δ3.91(d,1H J=2.7Hz), δ3.28(t,1H J=8.7Hz), δ3.22(t,1H J=8.5Hz), δ1.95(s,3H $NHCOCH_3$), δ1.87(s,3H $NHCOCH_3$).

^{13}C NMR: δ in D_2O (ppm)

δ102.2, δ101.2, δ91.4, δ89.6, δ76.8, δ76.0, δ 75.9, δ74.6, δ 73.7, δ73.2, δ72.8, δ72.4, δ71.8, δ71.2, δ70.9, δ70.7, δ 69.8, δ 69.6, δ 69.3, δ 69.2, δ 66.8, δ 61.9, δ61.7, δ 61.0

FAB-MS

787, 771, 710, 747, 724, 679, 659, 637, 634, 619, 617, 577, 517, 475, 426, 403, 391, 373, 331, 289, 229, 221, 169, 137.

RESULTS AND DISCUSSION

The presence of normal and amino sugars in Compound G $C_{28}H_{48}O_{21}N_2$ was confirmed by positive results from the Morgan-Elson[17] and Phenol Sulphuric Acid tests[10]. Four signals for five anomeric protons were seen in the ^1H NMR spectra of D_2O at 300 MHz, suggesting that the compound G may be a tetrasaccharide in its reducing form at δ5.27(1H), δ4.66(1H), δ4.51(1H), and δ4.44(2H). Further support for it came from the presence of four signals for the five anomeric carbons at δ101.4 (2C), δ101. (1C), δ91.7.4 (1C), and δ89.2 (1C) in the ^{13}C NMR spectra of acetylated F. Compound G has four monosaccharide units, which have been given the convenient names S_1, S_2, S_3, and S_4 starting from the reducing end. The paper chromatography revealed three spots after the acid hydrolysis of compound G, which was recognized as Glc, Gal, GalNAc and GlcNAc by paper chromatography using authentic materials. Methylglucosidation of G by MeOH/H^+ followed by its acid hydrolysis led to the isolation of α and β–methyl glucoside, Gal, GlcNAc, and GalNAc which suggested the presence of glucose at the reducing end in the oligosaccharide. The reducing and free nature of glucose was further supported by the presence of two anomeric proton signals as doublets and their coupling constants, for α and β Glc at δ5.27(1H) (J= 3.8Hz) and δ4.66 (1H) (J= 8.6 Hz) respectively. The ^1H NMR spectrum of compound G also showed the presence of lactosyl moiety at the reducing terminal indicated by the presence of two anomeric protons doublet resonating at δ4.44 (1H) (J=8.0 Hz), 4.66 (1H) (J=8.6Hz) for Gal and Glc residues respectively, along with the H-2 proton signals of β-Glc as structural reporter group for lactosyl moiety, appearing as a triplet at δ 3.28, (J=8.7Hz). Further, the ^1H NMR spectrum showed another anomeric proton signal appearing as a doublet at δ4.44 (1H) (J=8.0 Hz) and one signal of three protons at δ 2.09 one for NHAc group, which confirmed the presence of only GalNHAc unit in the compound G. Presence of another anomeric proton doublet at δ4.51 (1H) (J=7.6 Hz) and one triplet for H-2 proton at δ 3.22 (1H) (J=8.5 Hz) showed that the fourth monosaccharide in G is unsubstituted β-GlcNHAc (S_4) moiety which could be present at the nonreducing end of the tetrasaccharide. The compound G was also demonstrated by the absence of the downfield chemical shifted H-4 proton resonance of β-Gal (S_2), which appeared as a doublet at 3.91 (J=2.7 Hz), in contrast to the upfield chemical shifted β-GalNAc anomeric proton, which indicates that β-Gal (S_2) is not substituted at C-3 by a GalNHAc (S_3) moiety. This implies that the β-GalNAc in compound G is 1-6 linked to Gal, which was further confirmed by the the^1H-^1H connectivity in the HOMOCOSY spectrum of the acetylated compound G, anomeric proton confirmed that another anomeric proton doublet at 4.51 (J=7.6Hz) was due to presence of unit suggesting the spectrum presence of Lactosyl moiety into compound Asose. The ^1H NMR spectrum, which showed two additional anomeric proton signals as a doublet at δ4.44 (1H) (J=7.2 Hz) and δ4.51 (1H) (J=7.6 Hz), as well as two singlets of three protons at δ1.95 and δ1.87 that were assigned to two NHAc groups, further supported the presence of one GalNAc and one GlcNAc moiety in the compound Asose. The large coupling constant (7.2 Hz) of the anomeric proton of GalNAc indicated that GlcNAc (S-3) unit was β linked to S_2 of lactosyl moiety by β glycosidic linkage. The fourth anomeric proton which appeared at δ4.51 (7.6 Hz) as a doublet confirmed the presence of another GlcNHAc moiety in the Asose. The linkage between S_3 and S_4 was established on the basis of the presence of GalNAc H-3 proton of S_3, appearing as a triplet in the region δ3.97 which indicates that GalNAc (S_3) was substituted at 3- position by another β-GlcNAc (S_4), which was the fourth monosaccharide present at the non-reducing end of the tetrasaccharide. The large coupling constant of 7.6 Hz of anomeric proton implies that it was also linked by a β glycosidic linkage to S-3 of tetrasaccharide. All the ^1H NMR assignments for structural reporter protons of monosaccharide units of compound Asose were confirmed by the HOMOCOSY spectrum. The chemical shifts of the anomeric carbons of compound Asose at δ89.4 (1C, α-Glc), 91.4 (1C, β-Glc), 101.2 (1C, β-Gal) and 102.4 (2C, β-GlcNAc, β-GlcNAc) present

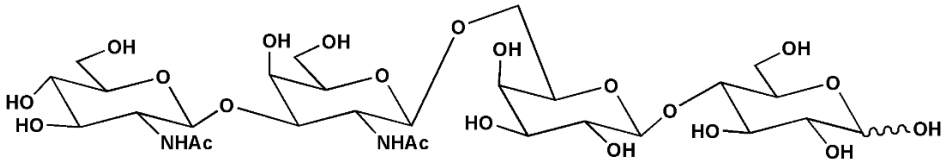
in the ^{13}C NMR spectrum are in accordance with the anomeric carbon values of Glc, Gal, β-GalNAc and GlcNAc.

The ^{1}H NMR spectra of the acetylated compound Asose, which contained twelve singlets of methyl protons of acetyl groups in addition to the signals of ring protons and anomeric protons present in acetate, further supported the compound's tetrasaccharide nature.

HSQC spectrum of acetylated compound Asose confirmed anomeric assignments in ^{1}H and ^{13}C NMR spectra of the compound by showing the ^{1}H and ^{13}C cross peaks of α-Glc (δ6.24× δ89.6) and β-Glc (δ5.56×91.4). It also contains a cross peak of one β-Gal, β-GalNAc, and β-GlcNAc moieties at δ4.62× δ101.2 (1C), 4.45× δ102.2 (1C), 4.56× δ102.2 (1C) respectively. It also showed the presence of three cross peaks for four glycosidically linked carbons at δ3.94×δ72.4, δ3.78× δ73.2, δ3.83× δ74.6. Based on the pattern of the chemical shift of ^{1}H, ^{13}C, HOMOCOSY, TOCSY, and HSQC experiments, it was interpreted that the compound Asose was a tetrasaccharide having a structure.

GlcNAc–β–(1→3)**GalNAc**–β–(1→6)**Gal**–β–(1→4)**Glc**

The FAB mass spectrum of Asose helped in substantiating the sequence of monosaccharide units in it. The highest mass ion peaks were recorded at m/z 771 and m/z 787 which were due to $[M+Na]^+$ and $[M+K]^+$ confirming the molecular weight of Asose as 748. The mass ion at m/z 748 further fragmented to give fragment ion at m/z 566[S_1-S_2-S_3], which was produced by cleavage of the glycosidic bond at N-acetylglucosamine residues at the non-reducing terminal of the tetrasaccharide i.e. M-S_4 indicating the presence of GlcNAc (S_4) at the nonreducing end. The subsequent loss of a $NHCOCH_3$ from fragment ion at m/z 566 [S_1-S_2-S_3] leading to an ion at m/z 508 confirms the presence of another amino sugar in the tetrasaccharide. It was further supported by the formation of mass ion peaks at m/z 774[810-$2H_2O$], 714[774-CH_2OHCHO], 656[714-$NHCOCH_3$], 625[656-CH_2OH], 583[625-CH_2=C=O], 523[583-CH_2OHCHO], 465[523-$NHCOCH_3$], 430[465-H_2O-OH], 413[430-OH], 329[413-$2CH_2$=C=O], 192[329-CH_2OHCHO-CH_2=C=O-H_2O-OH]. The pseudomolecular mass ion fragment at m/z $[M+K]^+$ further fragmented to produce mass ion m/z 583 and m/z 345 by the successive loss of one GalNAc and one GlcNAc residues, confirming the presence of one GalNAc and one GlcNAc units in the tetrasaccharide. Similarly pseudomolecular mass ion fragment at m/z 771 $[M+Na]^+$ fragmented to give mass ion fragment at m/z 406(S_3-S_4) and m/z 365 (S_1-S_2)which were assigned to the two disaccharide units produced predominantly by cleavage of the glycosidic bond between S_2 and S_3 at N-acetylglucosamine residues which further confirmed that the one GalNAc and one GlcNAc (S_3& S_4) residues were glycosidically linked and lactosyl moiety was present at the reducing terminal of the tetrasaccharide. This fragmentation pathway confirmed the sequence of monosaccharides in the oligosaccharide. It was further supported by the formation of mass ion peaks at m/z 345 [406- CH_2OH-CHOH], 329[365-$2H_2O$], 329[406- CH_2OHCHO-OH], 279[345-$2CH_3CO$]. The FAB mass spectrum of compound Asose also contained other mass ion peaks at m/z 742[771-CHO], 686[M-$2CH_2OH$], 632 [M-$2NHCOCH_3$], 614[632-H_2O], 583[614-CH_2OH], 566[810-GlcNAc-H_2O], 465[686-GlcNAc-H_2O], 430[465-H_2O-OH], 244 [465-GlcNAc-H_2O], 209[244-H_2O-OH], 167[209-CH_2=C=O], 149[180-CH_2OH], 107[149-CH_2=C=O] and many other fragment ion peak are obtained from the further fragmentation of various fragment ions. On the basis of results obtained from physico-chemical techniques and chemical transformation, the structure of compound Asose was determined as-



Asose

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Chapter
2

POLYMER SCIENCE AND TECHNOLOGY – AN OVERVIEW

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ABSTRACT

Polymer science is concerned with the composition and properties of a large number of substances classed as "polymers", which include rubbers, plastics, and fibers. The science of chemistry concerns itself with the composition of matter and with the changes that it undergoes to the layman, the methods and processes of chemistry appear quite baffling and difficult to comprehend. Yet these are essentially based on a simple, logical development of knowledge about the substances which comprise our physical world. In present, polymer has become an integral part of human life. Due to its structures and properties, it has entered into almost all area of requirements, such as construction, transport, agriculture, education and information technology. The subject of polymer chemistry will be developed from the type of first principles comprehensible to anyone. In present study; preparation, properties and application of Polycarbonate and Polyaniline in detailed.

KEYWORDS: Polymers, Monomer, Polycarbonate, Polyaniline, Macromolecules.

INTRODUCTION

Molecules are compounds that are made of more than one type of atom. An example of a small molecule is water it contains three atomstwoof hydrogen and one of oxygen. Polymers are very large molecules compared to water. That's correct! Polymers are large molecules composed of repeating subunits called monomers. These monomers are connected together through chemical bonds, forming a long chain-like structure. The term "polymer" originates from the Greek words "poly," meaning many, and "mer," meaning part or segment, which accurately reflects their composition.

The size of a polymer molecule can vary greatly, typically ranging from 10,000 to 100,000 atoms per molecule. Due to their large size, polymers are often referred to as macromolecules. In fact, some polymers can consist of hundreds of thousands or even millions of atoms.

To put the size scale difference into perspective, imagine a polymer chain as a piece of cooked spaghetti, which is long and flexible. On the other hand, envision one water molecule as a single crystal of salt, which is tiny and compact. The contrast between these two examples demonstrates the significant disparity in size between a small molecule like water and a polymer macromolecule.

In terms of molecular weight, water has a molecular weight of approximately 18 grams per mole, which corresponds to the combined weight of one mole of water molecules. In contrast, a polymer macromolecule can have a molecular weight ranging from 2,000 grams per mole to millions of grams per mole, depending on its size and structure.

Overall, polymers are fascinating substances that exhibit a wide range of properties and are essential in various fields, including materials science, chemistry, and biology. Any of a group of substances, either organic or inorganic, referred to as polymers, are made up of very big molecules, or macromolecules,

which are variations of simpler chemical compounds, or monomers. Many components in living creatures are polymers, such as proteins, cellulose, and nucleic acids. Furthermore, they are the foundation of minerals such as diamond, quartz, and feldspar, as well as man-made materials such as concrete, glass, paper, plastics, and rubbers. The term polymer refers to an undetermined number of monomer units. When the number of monomers is exceedingly big, the compound is referred to as a high polymer. Polymers are not limited to monomers that have the same chemical composition, molecular weight, or structure. Some natural polymers are made up of only one type of monomer. Most natural and manufactured polymers, on the other hand, are composed of two or more different types of monomers; these polymers are referred to as copolymers. Because of their small size, polymers exhibit unique behaviour and features.

The big molecules become entangled with one another, similar to how a single strand of cooked spaghetti becomes entangled with other strands of spaghetti in a bowl of pasta. The lengthy polymer chains intertwine and become entangled with one another. A bowl of cooked spaghetti (without the sauce) is an appropriate analogy for this situation. Because the strands of spaghetti are knotted together, it is extremely difficult to separate one piece of spaghetti from the remaining portions. Polymer molecules are also organised in this manner. This structure confers remarkable features on polymers, such as resistance to breakage. Small molecules, on the other hand, like water, do not tend to entangle with one another; each molecule is unique and different from the other. In present study; preparation, properties and application of Polycarbonate and Polyaniline in detailed. A toxicity test method developed by the authors has been used to evaluate a large number of materials for toxicity of off-gases evolved under specified test conditions [1-11].

Molecular weight distribution and melt flow are given in reference [12]. Reproducibility of results on this material was reported earlier [13].

EXPERIMENT

Polymers are macromolecules that are composed of repeating structural units called monomers. Polymers can be classified into two broad categories depending on the process of decomposition.

BIODEGRADABLEPOLYMERS

Biodegradable polymers are those polymers that can be degraded or decomposed under aerobic or anaerobic conditions, as a result of the action of microorganisms or enzymes such as bacteria and fungi. Some common examples of biodegradable

Polymers include Polyesters, polyamides, and polyurethanes. These polymers are used in packaging, medical implants, and other applications requiring minimal environmental impact.

Examples

There are numerous biodegradable polymers. Given below are a few most common biodegradable polymers:

PHBV

1. Poly β-hydroxybutyrate – co-β-hydroxy valerate (PHBV) is produced by the combination of 3-hydroxybutanoic acid and 3-hydroxypentanoic acid, and the monomer units are connected by ester bonds.

2. It breaks down into carbon dioxide and water.

It is brittle and is used to create pharmaceuticals, bottles, orthopaedic materials, and other products.

3. Polyglycolic Acid (PGA) is a kind of polyglycolic acid. It is made by chain polymerizing cyclic dimers of glycolic acid.

4. It is the most basic linear aliphatic polymer and is utilised in drug delivery, orthopaedic procedures such as screws and nails, and other applications.

NYLON-2 AND NYLON-6

1. Glycine and aminocaproic acid are used to make.
2. It is used to make toothbrush bristles and musical instrument strings.

NON-BIODEGRADABLE POLYMERS

Non-Biodegradable Polymers are those polymers that are made up of synthetic materials and cannot be broken down by decomposition. These polymers remain in the environment for long periods of time. Such polymers cause negative impacts on the environment and human health. They are a major cause of pollution and cause damage to the ecosystem.

Examples of non-biodegradable

Polystyrene, Polyvinylchloride (PVC), polymers include Polyethyleneterephthalate (PET), Polypropylene, etc.

Some examples of non-biodegradable polymers include:

POLYETHENE

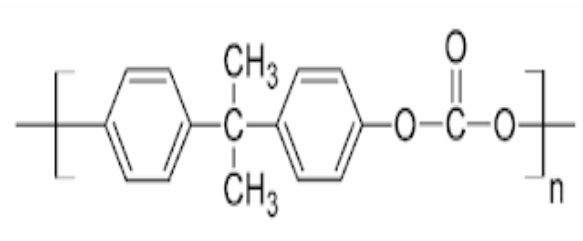
It has very high strength and lubricity. It is used in orthopedic implants and catheters. It can be classified further into three types:

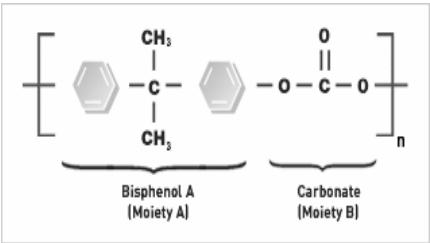
(a) Linearhigh-density polyethylene (HDPE)
(b) Branchedlow-density polyethylene (LDPE)
(c) Ultra-high molecular weight polyethylene (UHMWPE)

STRUCTURE, PREPARATION, PROPERTIES AND APPLICATIONS OF POLYCARBONATES

It is widely used for bullet-proof windows and safety or crash helmets. The most popular example of polycarbonates is Lexan, which is a high-performance tough thermoplastic polymer with organic functional groups linked together by carbonate groups (-O-(C=O)-O-). Polycarbonates have high impact resistance and are produced by condensation of diphenyl carbonate or carbonyl chloride and Bisphenol-A.

STRUCTURE OF POLYCARBONATE

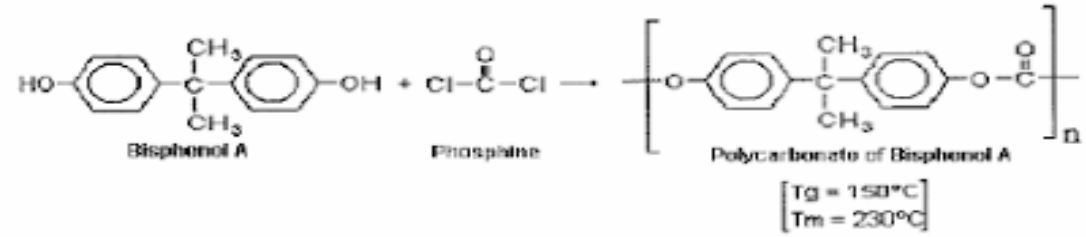




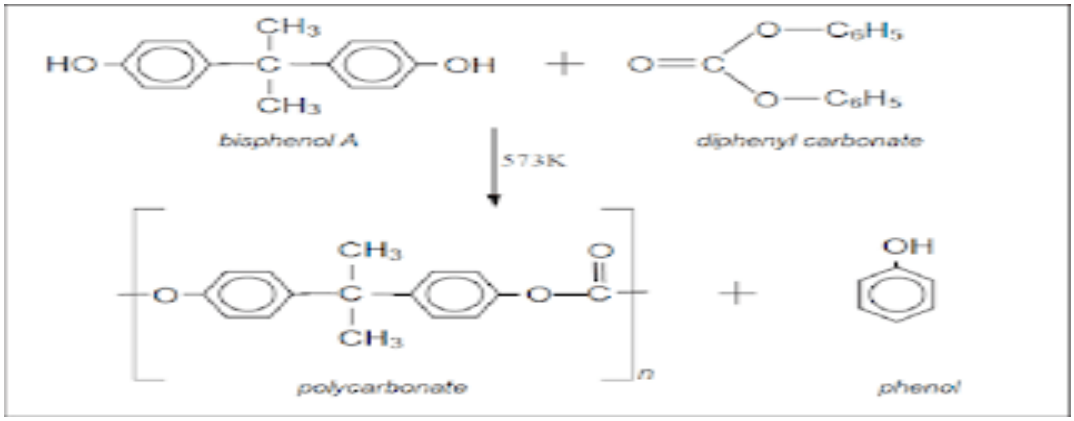
PREPARATION OF POLYCARBONATE

Condensation polymerization of either diphenyl carbonate or carbonyl chloride with Bisphenol A results in polycarbonate.

(a) Condensation polymerization of Bisphenol-A and carbonyl chloride to produce polycarbonate: The polymer is typically created by the reaction of Bisphenol-A and carbonyl dichloride, also known as (phosgene) carbonyl chloride, in a basic solution. The polymerization occurs at the interface between the aqueous and organic layers with the aid of an amine-based catalyst.



(b) Making Polycarbonate without the use of carbonyl chloride (Phosgene), an exceedingly toxic gas: Polycarbonate can also be created without carbonyl chloride by condensation polymerizing Bisphenol-A with diphenyl carbonate.



PROPERTIES OF POLYCARBONATE

1. Due to its great strength, polycarbonate is resistant to impact and breakage. The polymer is tensile even at temperatures as low as -20 °C and up to 140 °C.
2. Polycarbonate is a very transparent plastic with over 90% light transmission, comparable to glass.
3. Polycarbonate has outstanding optical qualities with a refractive index of 1.584.
4. Polycarbonate demonstrates strong chemical resistance to alcohols, diluted acids, and aliphatic hydrocarbons.
5. Polycarbonates have strong heat resistance and are thermally stable up to 135 °C. By using flame retardants that alter the qualities of the material, their heat resistance can also be increased.

APPLICATIONS OF POLYCARBONATES

1. Electrical products including refrigerators, air conditioners, coffee makers, food mixers, etc. are made of polycarbonate.
2. Polycarbonates are also employed as the ideal substitute for glass in bulletproof windows, shelters, and skylights.
3. Polycarbonate is utilised in a variety of medical applications, including blood filters, haemodialysis membranes, drug delivery systems, surgical equipment, and more.
4. It is employed in situations where it will come into direct contact with food and beverages due to its heat resistance and shatter resistance. Reusable food storage containers made of polycarbonate help keep food fresh, shield it from contamination, and are easily utilised in a refrigerator or microwave.

ADVANTAGES OF USING POLYCARBONATES

1. High transparency, light-transmitting properties as well as glass
2. High strength even at -20 degree sCelsius
3. Stable mechanical properties upto 140 Celsius
4. It is inherently flame retardant
5. Suitable electrical insulation properties
6. Good abrasion resistance

DISADVANTAGES OF POLYCARBONATESUSES

A. Weak against aromatic and open hydrocarbons

B. Exposed to water above 60 degrees does not last long

C. It needs to be dried before the process

D. Low fatigue resistance

CONDUCTING POLYMERS

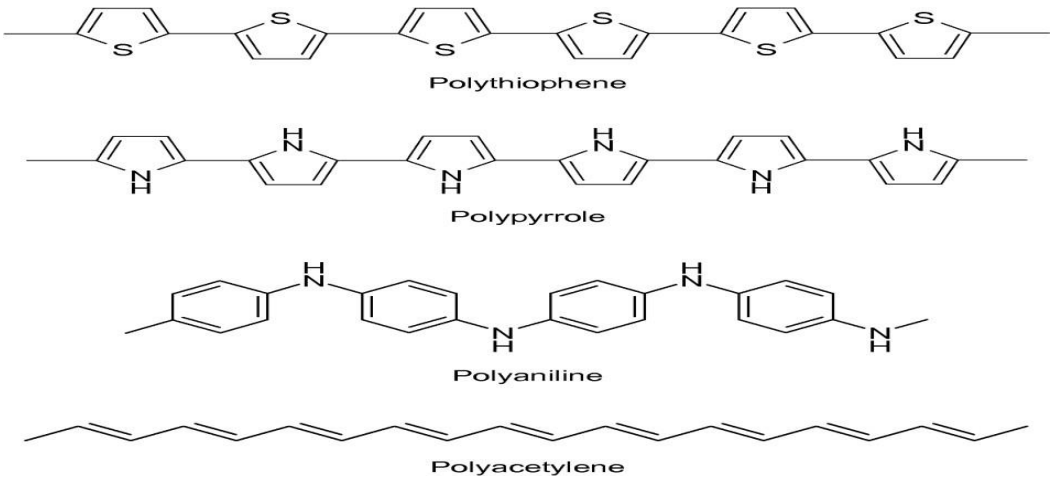
Organic polymers that conduct electricity are known as conducting polymers. Until 1970, all organic polymers were employed as insulators in electrical, electronic, and other applications due to their outstanding insulation qualities.

Thus, organic polymers with conductivity of the order of conductors are now referred to as "conducting polymers." Conducting polymers are divided into two types:

1. Polymers that conduct extrinsically; 2. Polymers that Conduct Intrinsically

Examples:

1. Polyaniline
2. Polythiophene:
3. Trans-Polyacetylene
4. Polythiophene



STRUCTURE PROPERTIES, PREPARATION, AND APPLICATIONS OF POLYANILINE POLYANILINE

Polyaniline is a typical phenylene based polymer having a flexible-NH-group flanked on either side by a phenylenering. The various physico-chemical properties of polyaniline are due to the presence of -NH-group.

SYNTHESIS OF POLYANILINE

Polymerization mechanism: It involves three steps

- Initiation
- Propagation
- Termination

Initiation:

Reactant: Aniline

Initiator: Ammonium persulphate (APS)

1. Aniline reacts with Initiator
2. Initiator oxidizes aniline and forms anilium free radical.

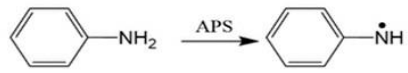
Propagation:

Anilium free radical in acidic medium undergoes substitution reaction at the paraposition of aniline and forms a dimer which again reacts with APS and leads to the formation of another free radical.

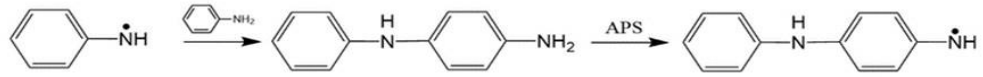
Termination:

Free radical again couples with fresh aniline to form Polyaniline.

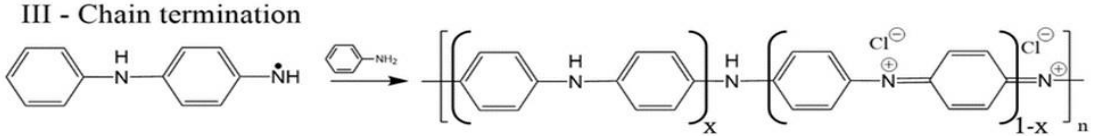
I - Induction



II - Chain elongation



III - Chain termination



CHEMICAL OXIDATION POLYMERIZATION

a) PANI is synthesized in an aqueous environment utilizing hydrochloric acid (HCl) or sulfuric acid (H_2SO_4) as a dopant and ammonium persulfate (APS) as an oxidant.

b) Take two beakers containing 50ml of 1.0 MHCl. To the first beaker add 5g of APS (oxidizing agent) and 2ml of aniline is added to the second beaker.

c) Slowly transfer APS into aniline containing beaker by maintaining the temperature almost to 0^0c with constant stirring.

d) Polyaniline formed is washed several times with distilled water.

e) Finally washed with acetone and dried at 60 ^{0}c.

APPLICATIONS:

a) In antistatic materials and a selectrode materials in rechargeable batteries.

b) In light emitting diodes and display devices.

c) As conductive track on printed circuit boards (Polyaniline).

d) A sesisters for lithography (emeraldine base).

e) In information storage devices.

f) As humidity sensors, gas sensors, radiation sensors.

g) In electro-chromic display windows.

h) In fuel cells as electro-catalytic materials.

i) As membrane for gas separation.

CONCLUSION

This particular sample of Bisphenol A polycarbonate appears to be a satisfactory reference material with good reproducibility over along period of time. Certain plastics, like this polycarbonate sample, may be better reference materials than typical cellulosic materials. Finally, the subject's polycarbonate and polyaniline are fully discussed.

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Chapter 3

EFFECT OF MULCHING ON SOIL AND CROP PRODUCTION

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ABSTRACT

As the population is continuously rising now there is a need to adopt some means to enhance agricultural growth and it can be done through conservation farming. Mulching has become an important practice in modern agriculture due to benefits such as reduced weed, moisture conservation, and reduction of certain insect pests, higher crop yields, increase in soil temperature, and more efficient use of soil nutrients. Mulching is an important practice in modern agriculture. Mulch reduces the application of chemical fertilizer and herbicide, weed control and also it maintains the soil temperature.

KEYWORDS: Agricultural growth, Mulching, Soil, Crop Production.

INTRODUCTION

The word mulch has been probably derived from the German word "molsch" means soft to decay, which apparently referred to the use of straw and leaves by gardeners as a spread over the ground as mulch (Jacks *et al.*, 1955). A thin plastic film is placed over the ground, with holes punched at regular intervals to plant the seeds, or it is placed directly on plants in early stages of growth. The main functions of plastic mulches are to prevent soil moisture evaporation, reduce seeding and tillage, inhibits weed growth, and prevents erosion. Colourless films can be used, each with specific advantages and disadvantages over the other. Black film inhibits weed growth but does not transmit light to heat the soil and clear films transmit light and heat the soil but promote weed growth. In mulching, the waste of crops, straw, husk and dry leaves are used to cover the empty spaces, which controls soil erosion and nutrient erosion by creating a cover on the empty spaces. In hilly areas cover crops and mulch has specific importance in fruit orchards. Along with organic farming methods, mulching plastics are used more due to increase in the production of vegetables and fruits etc. The material spread on an area of land is called Mulch. Mulching has many purposes, some of which are important

ADVANTAGES OF MULCHING

- Helpful in soil moisture conservation and temperature control
- Reduces soil erosion by wind and water
- Provides a favourable environment for plant growth
- improves productivity
- Mulching increases the fertility and health of the land.
- inhibits the growth of weeds

Mulching can be permanent, such as bark chips, or temporary, such as thin plastic sheets. Plastic film or membrane is used as mulch; it is also called plastic mulching. It is cheap, easily available and available in all thickness and colors. Among different mulching techniques plastic film mulching increases soil surface temperature by influencing the heat balance and thus increased the soil temperature and it also positively influenced the crop emergence (Aniekwe *et al.*, 2004). Plastic is available in different colors like transparent, yellow, black, and red. Mostly black and silver colored plastic is used. It is beneficial to use

this colored plastic for temperature control, pest control and more production The black polyethylene mulch maintained high soil water contents compared to the control (no mulch) and the bare soil treatments (Li *et al.*, 2001).

PLASTIC FILM SELECTION

Plastic film should always be selected according to the need of farming like weed control, lowering and raising of soil temperature and disease control etc. Generally, 90-120 cm wide mulch should be selected so that agricultural work can be done easily. The thickness of the mulch is generally according to the type of crop and its duration.

HOW TO USE MULCHING

Many materials are used as mulches which are used to retain soil moisture, regulate soil temperature, suppress weed growth, and also for aesthetics. They are planted on the surface of the soil. Plastic mulch is most efficient when used in conjunction with drip irrigation. A drip tube can be applied on the soil surface under the mulch or buried two inches to three inches beneath the soil surface.

LAYING PLASTIC MULCH

Mulching plastic is done in the same way as planting seeds and planting trees. Before laying the mulching plastic, good plowing of the land is necessary. After plowing, a 1 meter wide bed is to be made. Unnecessary things like stone, wood etc. are removed from the prepared bed so that the plastic mulch does not burst. Now the drip pipe line is laid in the upper part of the bed. Let's start laying plastic over the drip line. After laying the plastic, soil is covered in both the outer edges. In the upper part of the bed make holes at fixed distance of -1 feet. Selected plants or seeds are planted in a certain place by adding compost manure, in this way, with regular care, the production will definitely be better and more. The decomposition of organic residues under plastic mulch adds organic acids to the soil resulting in low soil pH, which may increase the bioavailability of micronutrients (Mn, Zn, Cu, and Fe). This was also evident from the increased Fe and Zn content in soil under plastic mulch (Tislade *et al.*, 1990).

PRECAUTIONS

1. Remove unnecessary things like stones, wood etc. from the prepared bed so that the mulch does not burst.
2. Mulching plastic should be of good quality.
3. Plastic must be fitted correctly.
4. The soil should be well covered in the edge part.
5. Good seeds and plants prepared in nursery/green house should be selected and used.
6. Pesticides should be sprayed on the plants as per requirement.

In the present time along with production health consciousness demand for crops has increased. Under plastic mulch, soil properties like soil temperature, moisture content, and bulk density nutrient improved. Even though it has many advantages, high initial cost, removal and disposal of plastic materials are some of the limitations experienced by the farmers. To overcome these limitations photo and biodegradable

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Chapter 4

MOLECULAR DOCKING STUDIES FOR THE ASSESSMENT OF WOUND HEALING ACTIVITY OF PHYTOCONSTITUENTS IN *SIDA ACUTA*

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ABSTRACT

The healing process after an injury is one of the most important and complicated processes. During the healing process, the skin passes through a number of different stages. The plant *Sida Acuta* exhibits a variety of biological properties, including those that are antibacterial, antimicrobial, antifungal, antioxidant, and wound healing. Secondary metabolites such alkaloids, flavonoids, steroids, coumarins, and others may be found in it. The wound healing proteins PDB ID:1YXO, 3V18, and 4G8R were used in the molecular docking investigations of *Sida Acuta*, which were carried out with the assistance of Argus lab 4.0.1 and Auto dock tools 1.5.7. The components have a productive interaction with the protein responsible for wound healing. Constituents such as stigmasterol, taraxasterone, and campesterol demonstrate the highest binding affinity because of this, in contrast to the usual drugs mupirocin and nitrofurazone. The present study thus provides significant information of the ingredients of *Sida Acuta*, which would promote contact with their receptors engaged in the wound healing process, further facilitating the formulation of the molecule for our proper usage.

KEYWORDS: Docking, *Sida Acuta,* Wound Healing, Software's

INTRODUCTION

The loss of dermal integrity leads to wound development, which may be caused by any kind of physical or thermal injury to the subcutaneous tissue. In general, a wound is a disruption to the normal anatomical structure and function. This can be as simple as a break in the epithelial integrity of the skin, or it can be more severe, extending into the subcutaneous tissues and causing damage to structures such as tendons, muscles, vessels, nerves, parenchymal organs, and even bone (1-3). Wounds can range in severity from a simple break in the epithelial integrity of the skin to severe damage to the structures of the Acute and chronic wounds are the two classifications that may be applied to wounds. Surgical wounds, bites, burns, small cuts, and abrasions are all examples of acute skin injuries, all of which are caused by external injury to healthy skin. They repair themselves and that continue regularly by following a timely and orderly healing route, and the time period of healing typically spans from five to ten days, or within thirty days. On the other hand, chronic wounds are created by endogenous processes in conjunction with a state that makes them more likely to occur. Compromised tissue perfusion, such as an impaired arterial supply or impaired venous drainage, and metabolic disorders, such as diabetes mellitus, are examples of pathophysiology abnormalities that may predispose to the formation of chronic wounds such as leg

ulcers, foot ulcers, and pressure sores (4-8). These pathophysiology abnormalities can increase the risk of developing chronic wounds. The process of healing wounds is a dynamic and complicated one that involves cellular, humoral, and molecular factors. The normal process of cutaneous wound healing is a temporal process that involves a complex series of overlapping events. These events can be divided into the following stages: hemorrhage, formation of fibrin clot, inflammatory response, re-epithelialization, formation of granulation tissue, angiogenic response, connective tissue contraction, and remodeling. The process of wound healing is a complex one that requires coordinated interactions between a variety of immunological and biological systems. Chronic wounds are the only significant cause of people, and these wounds may lead to an increased risk of bacterial invasion as a consequence of certain variables and metabolic illnesses. Chronic wounds are the only major cause of people (9-11). Therefore, nonhealing wounds are characterized by extended inflammation, inadequate re epithelialization, and impaired matrix remodeling. Additionally, there is an interaction between bacteria existing in a wound and a patient, so it is also a cause of the condition. Some of the bacterial species, including staphylococcus aureus, pseudomonas aeruginosa, and beta-hemolytic streptococci, may be isolated from wounds that are clinically infected as well as those that are not clinically infected. Because of its ability to predict the binding conformation of protein and ligand, molecular docking is one of the most commonly used methods in structure-based drug design. Because of this, the results from in silico studies could be used to find out relevant information before in vitro and in vivo studies are conducted. The research that is being done in this area right now focuses almost entirely on investigating the in-silico methods for the creation of fresh synthesized compounds that have increased therapeutic efficacy but lower toxicity. The purpose of the current study was to design and carry out docking studies for chemical constituents of *Sida Acuta* (Taraxasterone, Quindoline, Ferulic acid, Sinapic acid, Syringic acid, hentriacontane, Gallic acid, Chlorogenic acid, Myricetin, Stigmasterol, Campesterol, Cryptolepine, Scopoletin) with three different proteins (1YXO, 3V18, 4 1.5.7. The treatment of a wide variety of diseases by indigenous people often involves the usage of *Sida Acuta*. Saponosides, coumarins, steroids, tannins, polyphenols, and steroids are all components of this compound. In traditional medical practice, every component of this plant is used. This plant is involved in a wide variety of pharmacological processes. Research on the wound-healing potential of this plant has already been carried out with rats by Akilandeswari *et al.* The purpose of this investigation was to investigate whether the molecules are effective in promoting the healing of wounds (12).

MATERIALS AND METHOD

Structures:

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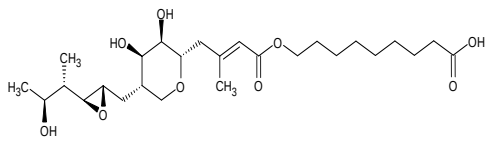
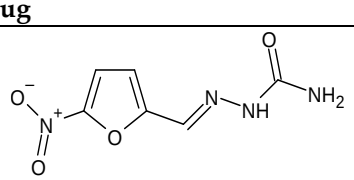
<tr><td> 
Mupirocin</td><td> 
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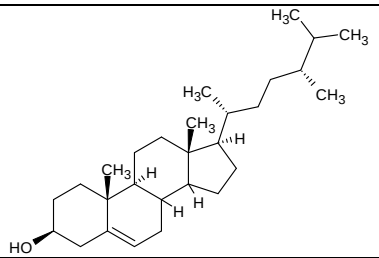
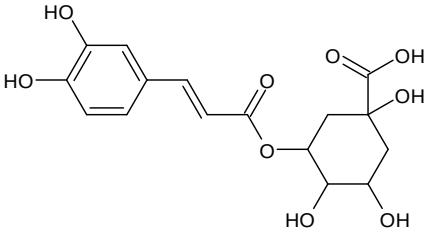
<tr><td>  </td><td>  </td></tr>
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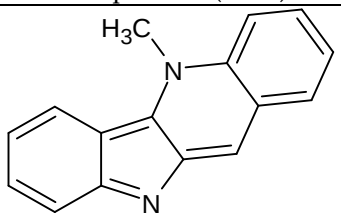
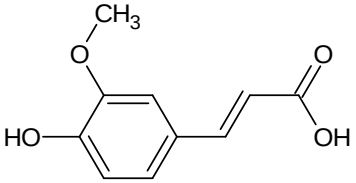
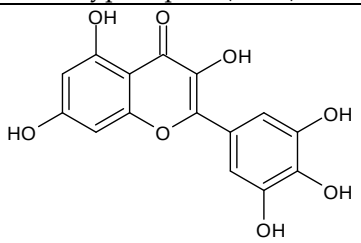
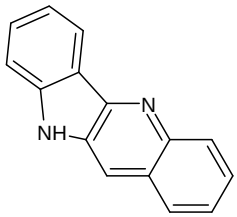
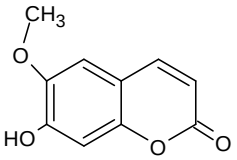
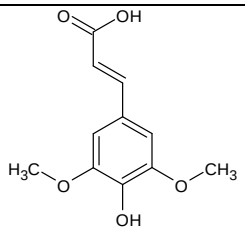
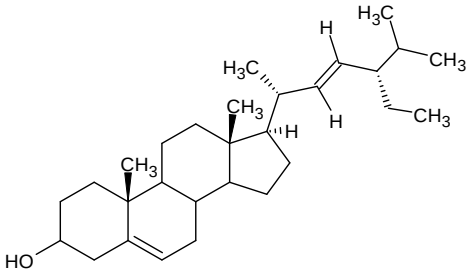
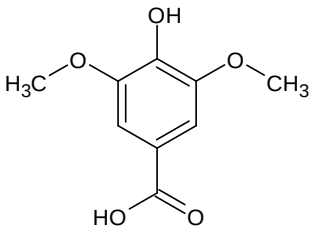
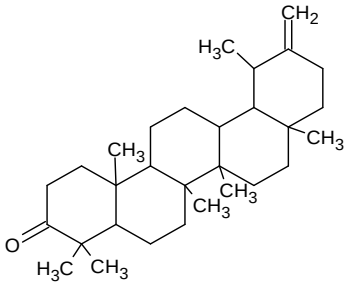
Campesterol (SA-1)	Chlorogenic acid (SA-2)
 Cryptolepine (SA-3)	 Ferulic acid (SA-4)
 Myricetin (SA-5)	 Quindoline (SA-6)
 Scopoletin (SA-7)	 Sinapic acid (SA-8)
 Stigmasterol (SA-9)	 Syringic acid (SA-10)
 Taraxasterone (SA-11)	

WOUND HEALING PROTEINS

- 1YXO (Crystal Structure of pyridoxal phosphate biosynthetic protein PdxA PA0593).
- 3V18 (Structure of the Phosphatidylinositol-specific phospholipase C from Staphylococcus aureus).
- 4G8R (Crystal Structure of a novel small molecule in activator bound to plasminogen activator inhibitor-1).

METHODOLOGY

DOCKING PROCEDURE

Steps involved in docking by using Argus lab:

1. Protein preparation
2. Selection of active site
3. Ligand preparation
4. Docking procedure
5. Visualization/ Interpretation of Docking

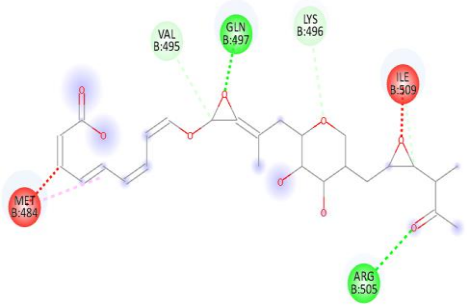
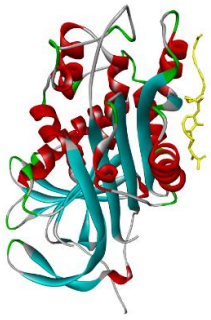
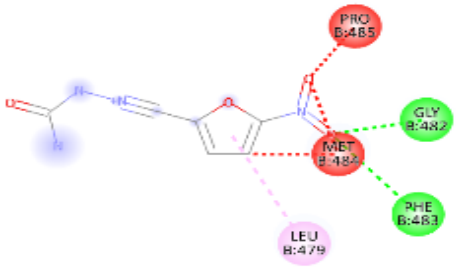
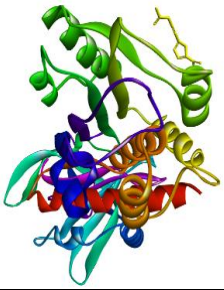
Steps involved in docking by using Auto dock tools:

1. Create a new folder
2. Preparation of Protein and Ligand
3. Configuration file
4. Command prompt
5. Analysis and Interpretation

RESULTS AND DISCUSSION

The binding affinity of the standard drug with wound healing proteins by using Argus lab 4.0.1 (Table 1) and Auto dock tools 1.5.7 (Table 3) and followed by the binding affinity of *Sida Acuta* with woud healing proteins by using above mentioned software's (Table 2 & 4) were enumerated below

Table 1: Binding affinity of standard drug by Argus lab 4.0.1

S. No.	Standard drug	Capture		Final energy
		2D	3D	
4G8R				
1.	Mupirocin			-9.23565 kcal/mol
2.	Nitrofurazone			-6.91681 kcal/mol

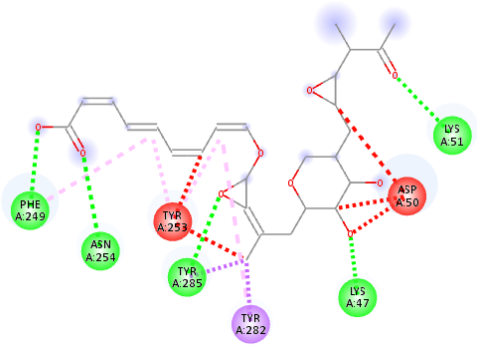
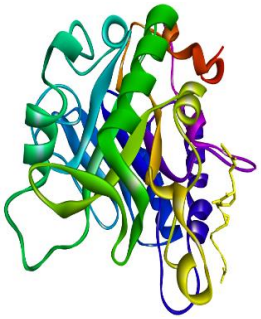
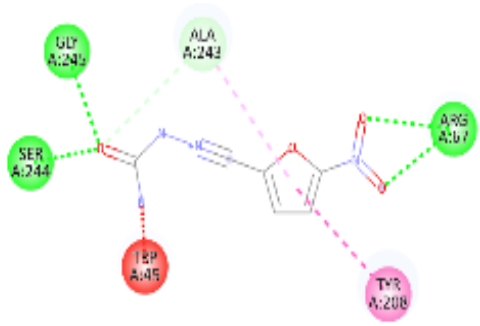
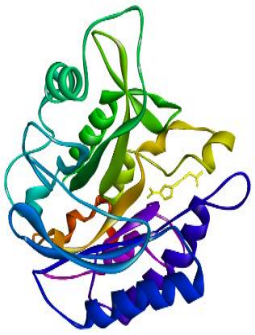
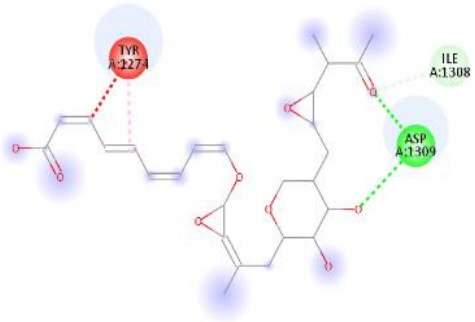
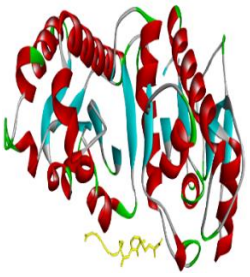
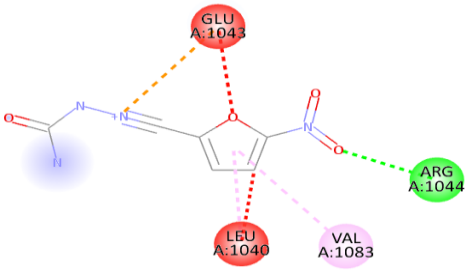
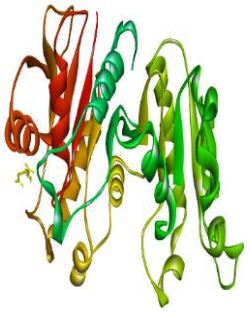
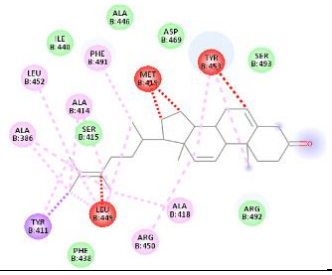
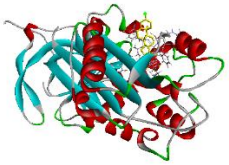
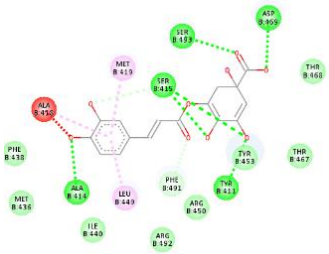
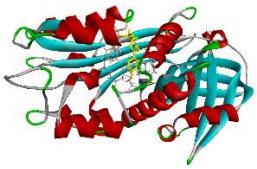
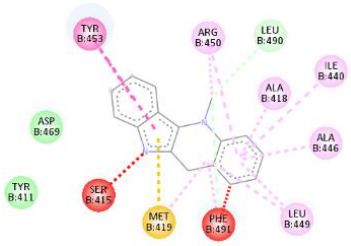
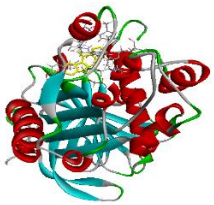
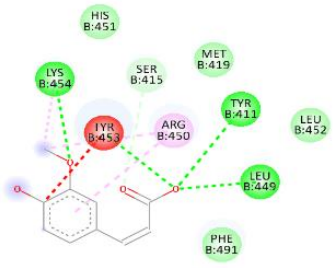
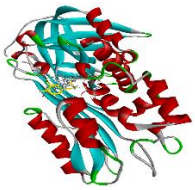
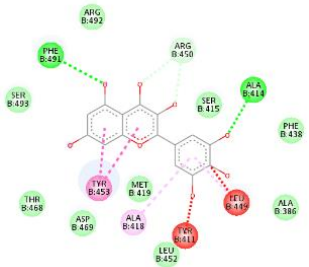
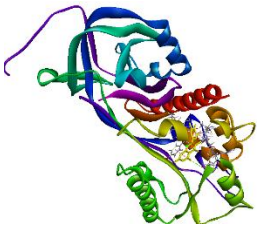
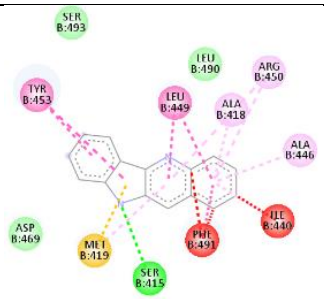
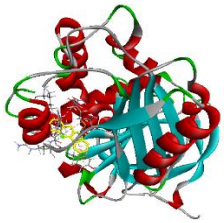
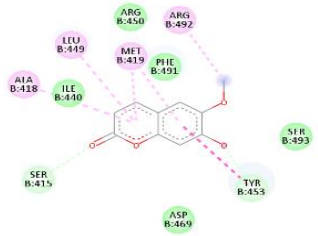
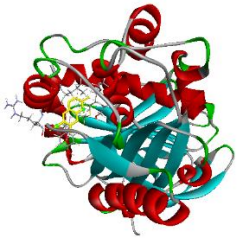
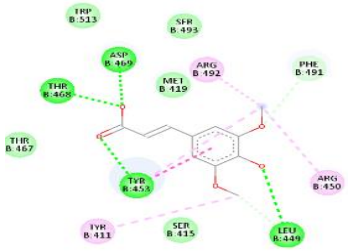
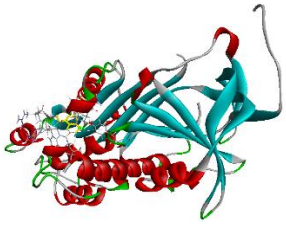
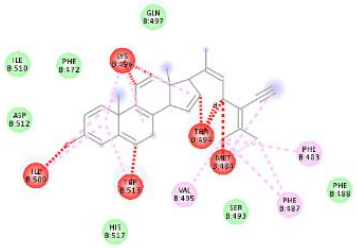
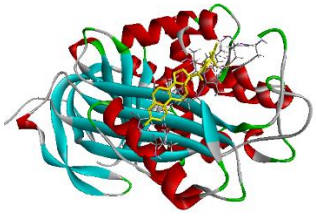
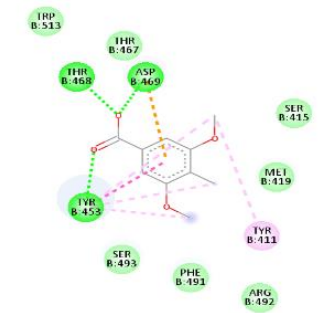
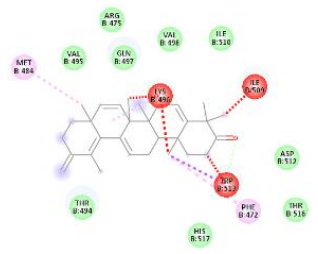
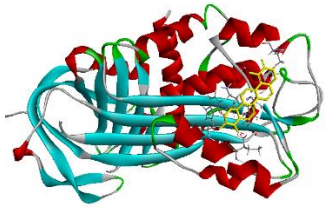
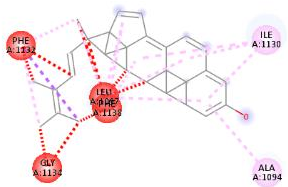
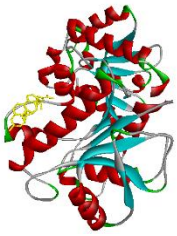
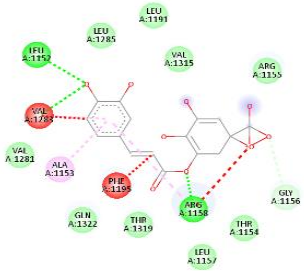
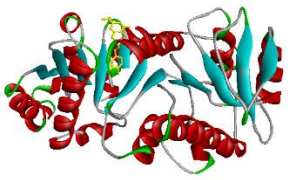
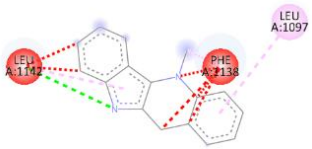
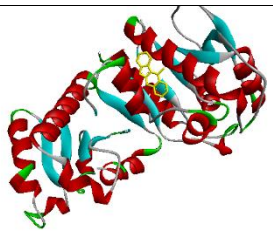
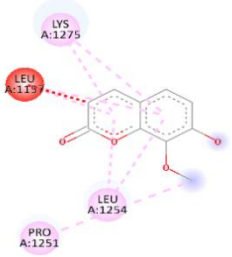
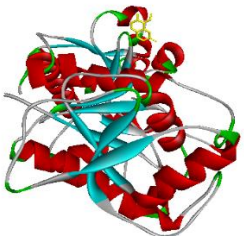
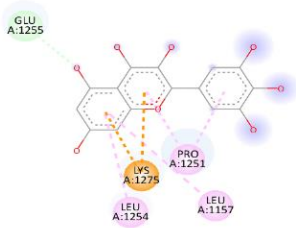
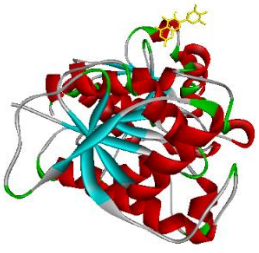
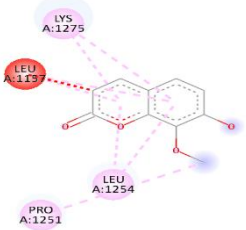
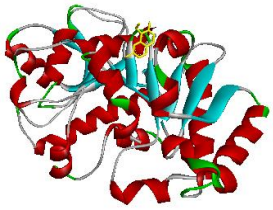
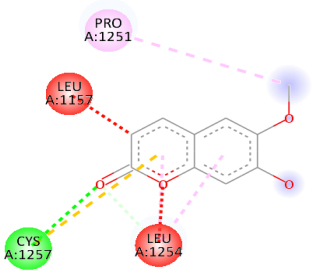
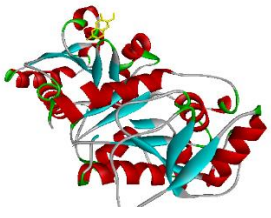
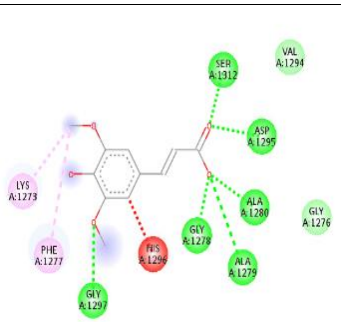
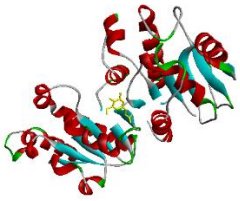
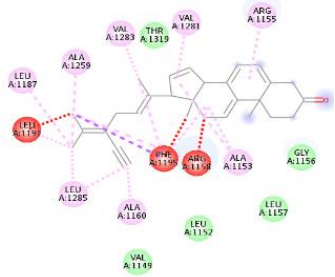
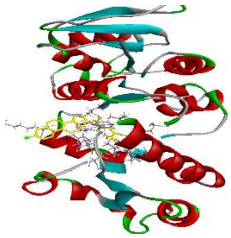
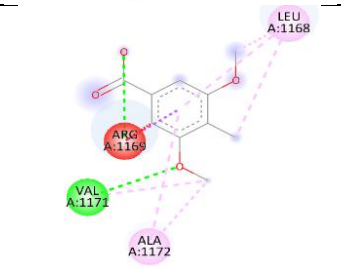
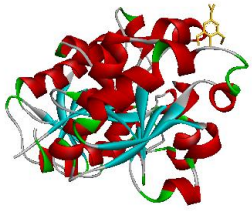
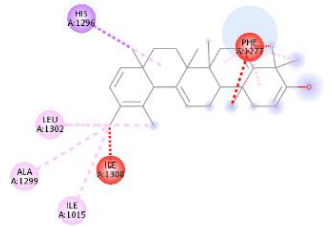
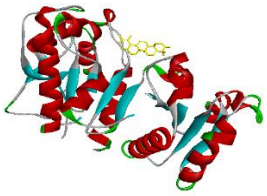
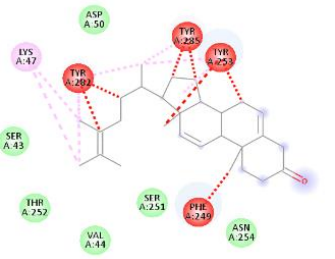
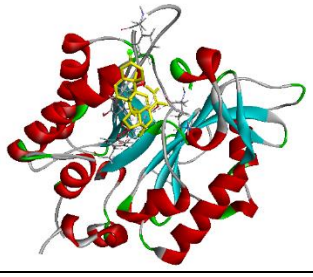
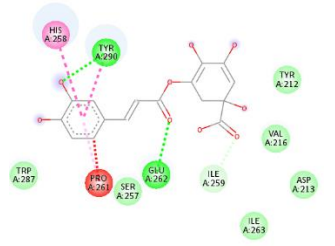
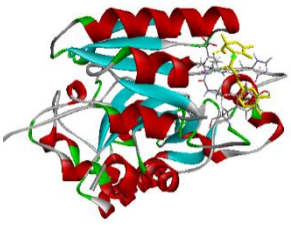
3V18				
1.	Mupirocin			-10.3793 kcal/mol
2.	Nitrofurazone			-7.01352 kcal/mol
1YXO				
1.	Mupirocin			-9.85249 kcal/mol
2.	Nitrofurazone			-6.57333 kcal/mol

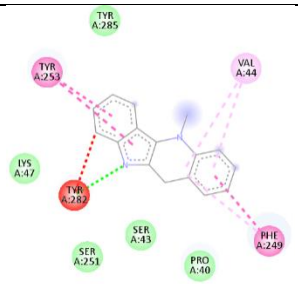
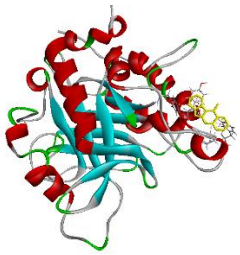
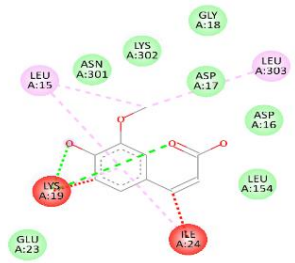
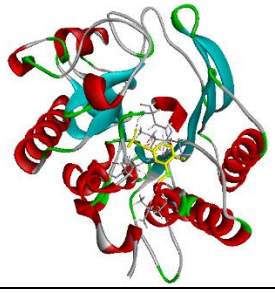
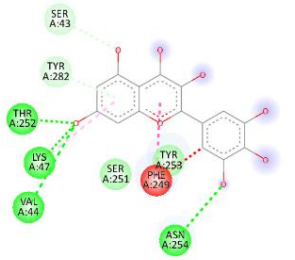
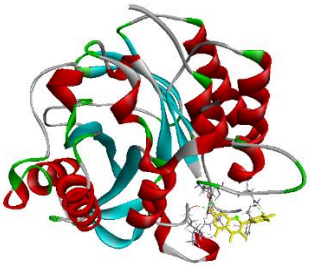
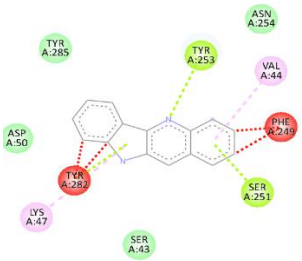
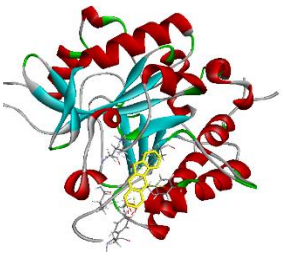
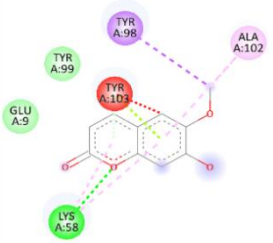
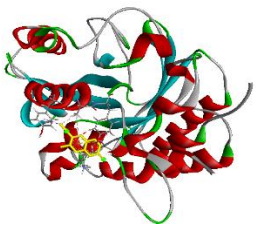
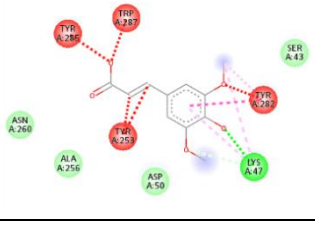
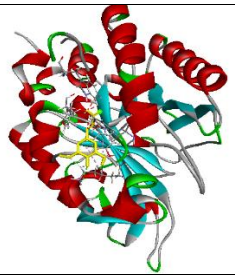
Table 2: Binding affinity of *Sida Acuta*by Argus lab 4.0.1

S. No.	Chemical constituent	Capture		Final energy
		2D	3D	
4G8R				
1.	SA-1			-16.0316 Kcal/mol
2.	SA-2			-8.5761 Kcal/mol
3.	SA-3			-9.5184 Kcal/mol
4.	SA-4			-8.2295 Kcal/mol
5.	SA-5			-6.9877 Kcal/mol

6.	SA-6			-9.6371 Kcal/mol
7.	SA-7			-7.2418 Kcal/mol
8.	SA-8			-7.5879 Kcal/mol
9.	SA-9			-14.3211 Kcal/mol
10.	SA-10			-7.7324 Kcal/mol
11.	SA-11			-11.7813 Kcal/mol
1YXO				

1.	SA-1			-13.436 Kcal/mol
2.	SA-2			-8.3998 Kcal/mol
3.	SA-3			-9.1579 Kcal/mol
4.	SA-4			-8.6396 Kcal/mol
5.	SA-5			-7.1249 Kcal/mol
6.	SA-6			-9.6467 Kcal/mol
7.	SA-7			-7.8031 Kcal/mol

8.	SA-8			-8.1937 Kcal/mol
9.	SA-9			-13.8273 Kcal/mol
10.	SA-10			-6.9380 Kcal/mol
11.	SA-11			-12.025 Kcal/mol
3V18				
1.	SA-1			-13.2849 Kcal/mol
2.	SA-2			-9.0270 Kcal/mol

3.	SA-3			-9.0027 Kcal/mol
4.	SA-4			-7.9161 Kcal/mol
5.	SA-5			-6.3828 Kcal/mol
6.	SA-6			-9.6028 Kcal/mol
7.	SA-7			-7.2512 Kcal/mol
8.	SA-8			-7.723 Kcal/mol

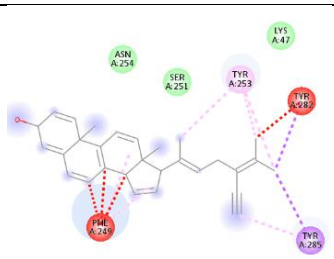
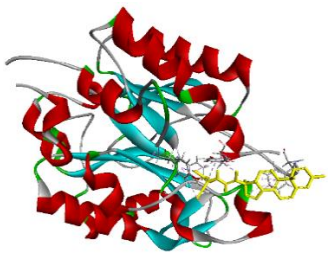
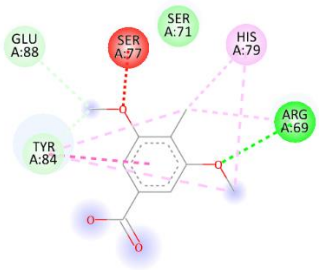
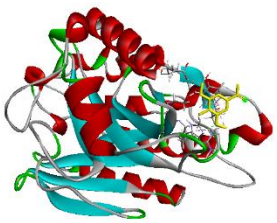
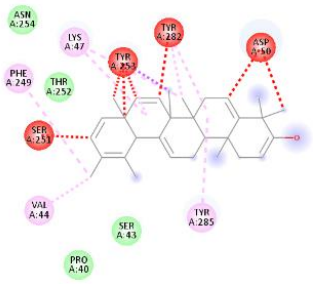
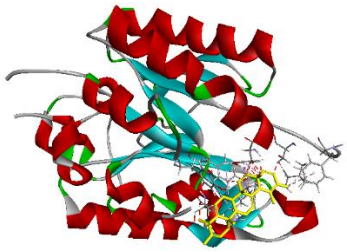
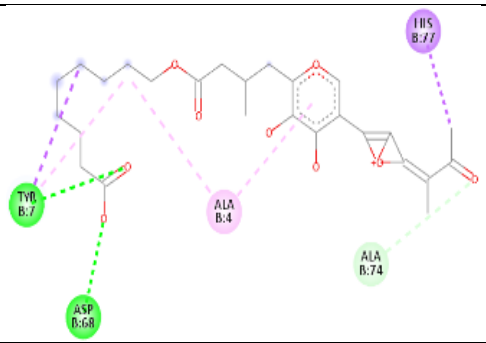
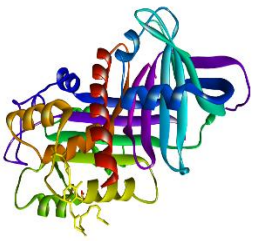
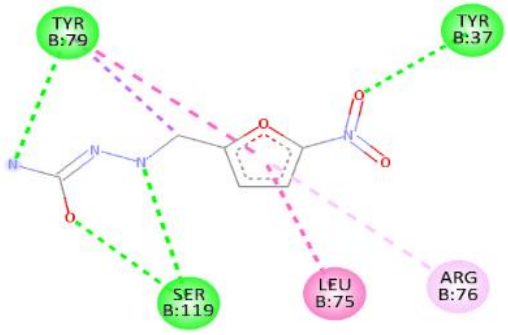
9.	SA-9			-13.2245 Kcal/mol
10.	SA-10			-7.2369 Kcal/mol
11.	SA-11			-12.7736 Kcal/mol

Table 3: Binding affinity of standard drug by Auto dock tools 1.5.7

S. No	Standard drug	Capture		Final energy
		2D	3D	
4G8R				
1.	Mupirocin			-4.3 kcal/mol
2.	Nitrofurazone			-5.9 kcal/mol

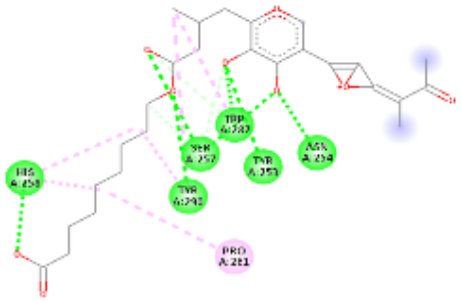
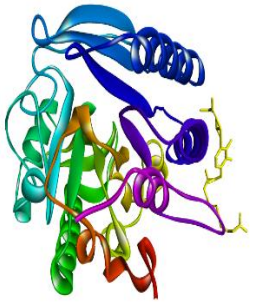
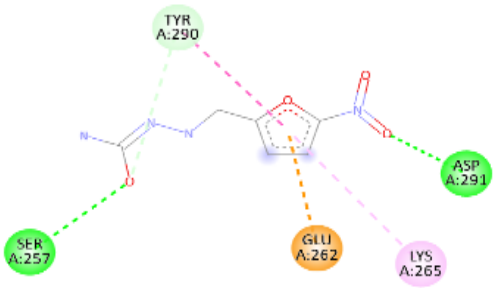
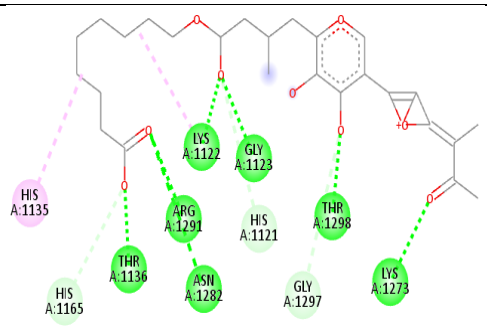
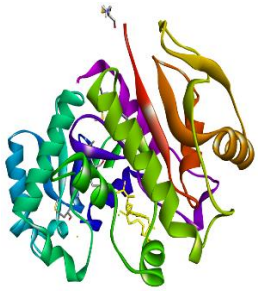
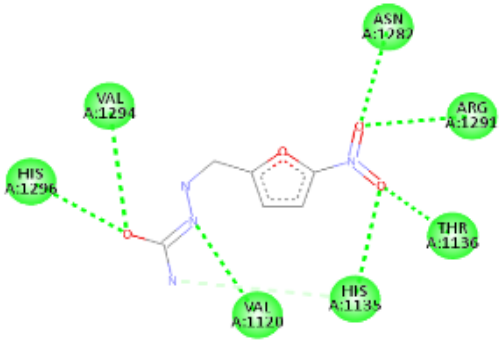
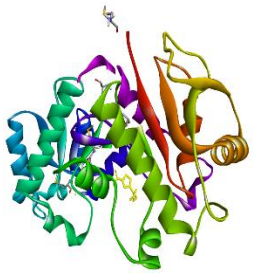
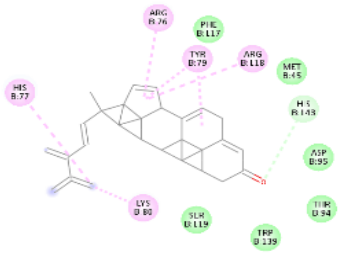
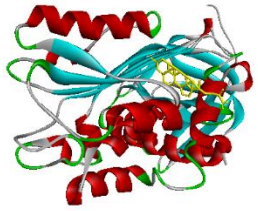
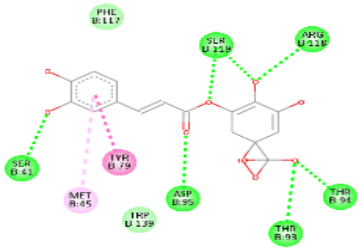
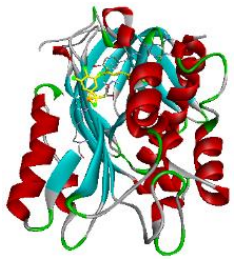
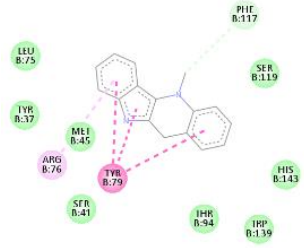
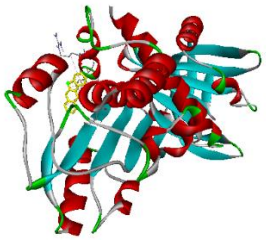
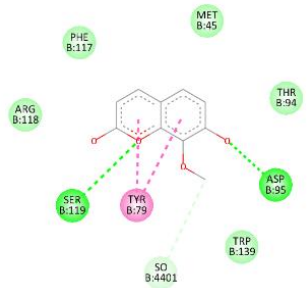
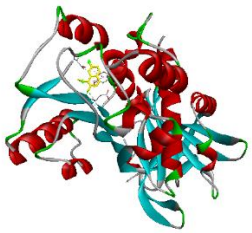
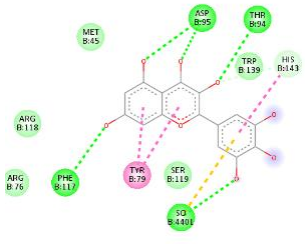
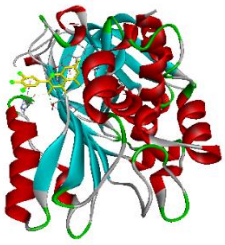
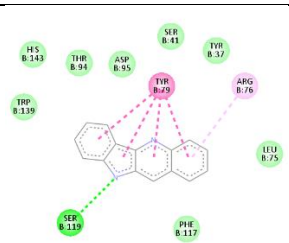
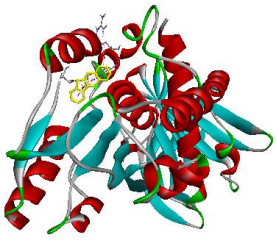
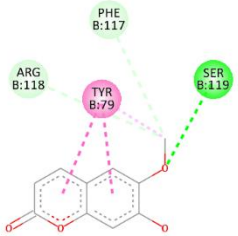
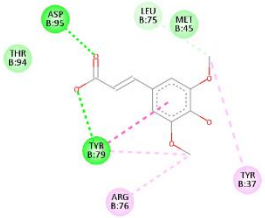
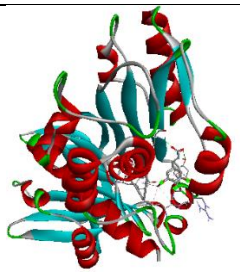
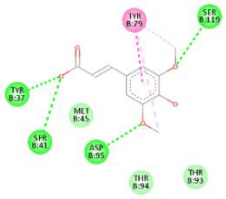
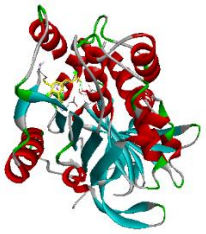
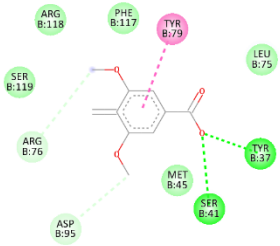
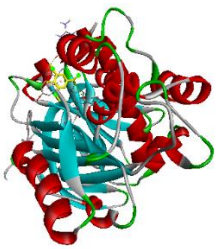
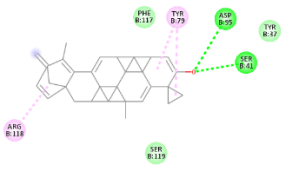
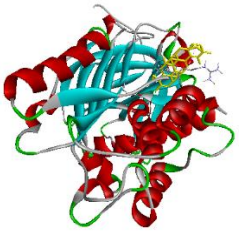
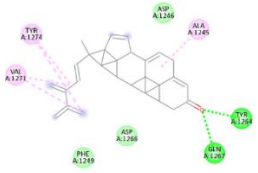
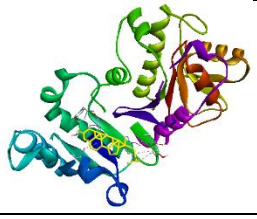
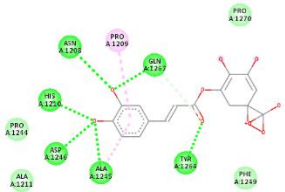
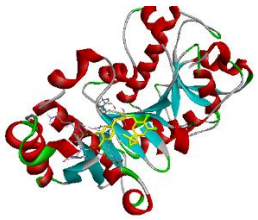
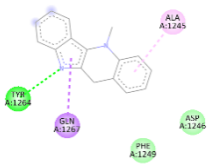
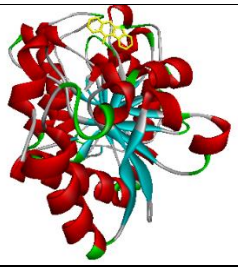
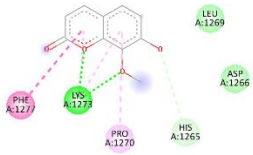
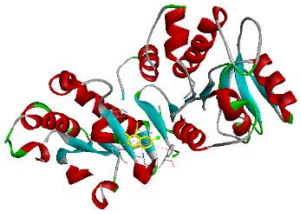
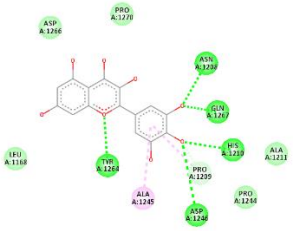
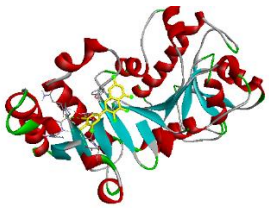
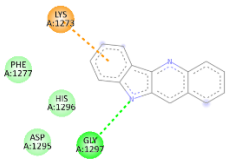
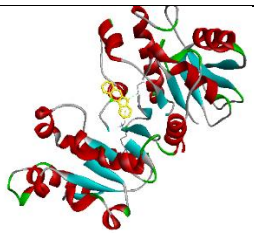
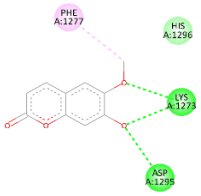
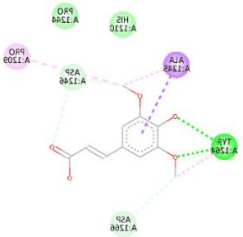
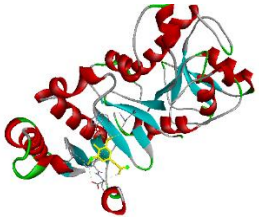
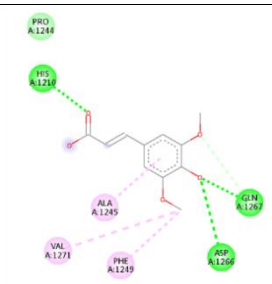
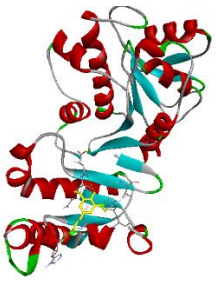
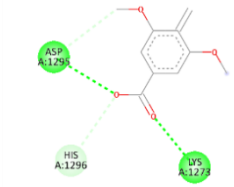
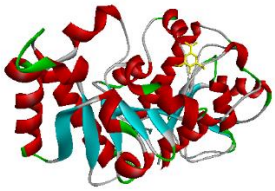
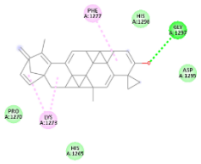
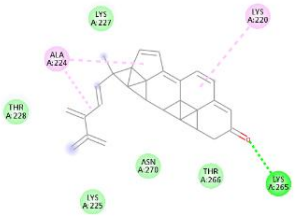
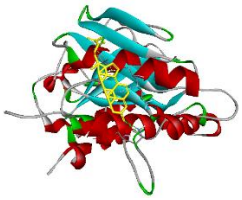
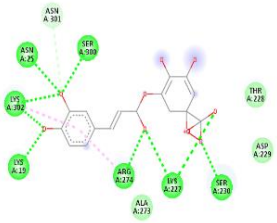
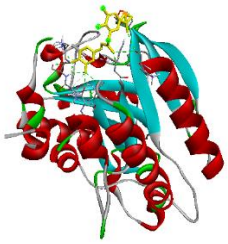
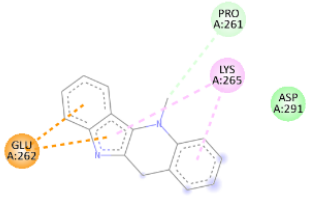
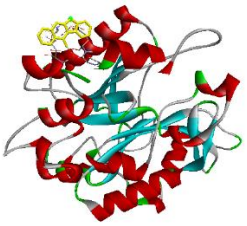
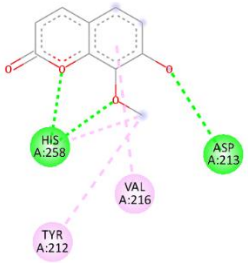
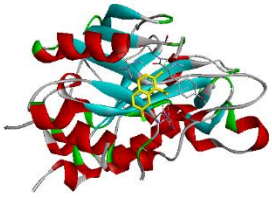
3V18				
1.	Mupirocin			-6.0 kcal/mol
2.	Nitrofurazone			-4.8 kcal/mol
1YXO				
1.	Mupirocin			-6.6 kcal/mol
2.	Nitrofurazone			-6.0 kcal/mol

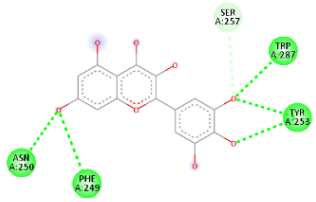
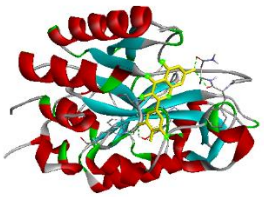
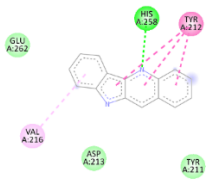
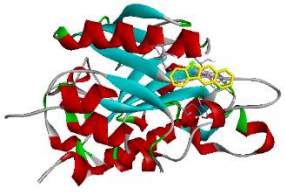
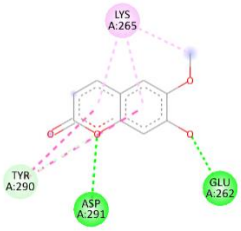
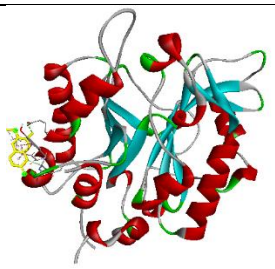
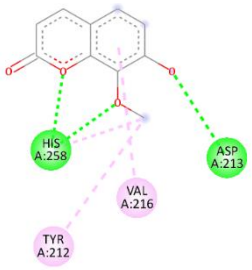
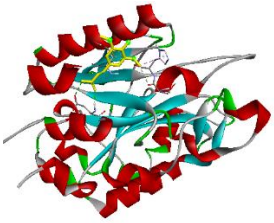
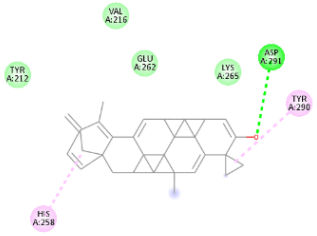
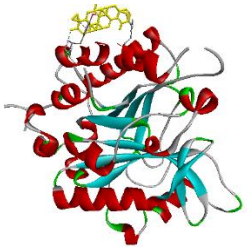
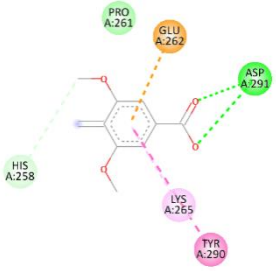
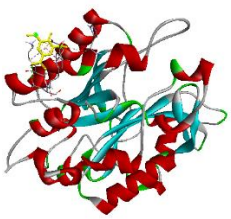
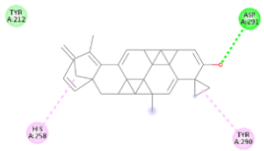
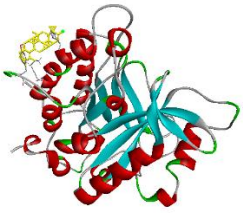
Table 4: Binding affinity of *Sida Acuta*by Auto dock tools 1.5.7

S. No.	Chemical constituent	Capture		Final energy
		2D	3D	
4G8R				
1.	SA-1			-10.9 kcal/mol
2.	SA-2			-8.9 kcal/mol
3.	SA-3			-8.4 kcal/mol
4.	SA-4			-6.6 kcal/mol
5.	SA-5			-8.8 kcal/mol

6.	SA-6			-8.3 kcal/mol
7.	SA-7			-6.8 kcal/mol
8.	SA-8			-6.7 kcal/mol
9.	SA-9			-6.7 kcal/mol
10.	SA-10			-6.1 kcal/mol
11.	SA-11			-13.4 kcal/mol
1YXO				
1.	SA-1			-8.1 kcal/mol

2.	SA-2			-6.6 kcal/mol
3.	SA-3			-5.3 kcal/mol
4.	SA-4			-4.8 kcal/mol
5.	SA-5			-5.5 kcal/mol
6.	SA-6			-5.4 kcal/mol
7.	SA-7			-4.7 kcal/mol
8.	SA-8			-4.8 kcal/mol

9.	SA-9			-4.8 kcal/mol
10.	SA-10			-3.9 kcal/mol
11.	SA-11			-10.0 kcal/mol
3V18				
1.	SA-1			-7.2 kcal/mol
2.	SA-2			-7.4 kcal/mol
3.	SA-3			-6.2 kcal/mol
4.	SA-4			-5.0 kcal/mol

5.	SA-5			-6.2 kcal/mol
6.	SA-6			-6.2 kcal/mol
7.	SA-7			-4.7 kcal/mol
8.	SA-8			-4.7 kcal/mol
9.	SA-9			-8.5 kcal/mol
10.	SA-10			-4.4 kcal/mol
11.	SA-11			-8.5 kcal/mol

In this study, the phytoconstituents of *Sida Acuta* were examined to establish whether or not they have the capability of accelerating the natural process of wound healing. This was performed by analyzing the binding impact of the phytoconstituents using Auto dock tools 1.5.7 and Argus lab 4.0.1 with several proteins (4G8R, 1YXO, and 3V18), all of which play a unique role in the process of wound healing. The results of this analysis were positive. The root-mean-square deviation (RMSD) as well as the binding affinity score were used in order to provide predictions about the best possible interactions that may take place between proteins and phytoconstituents. The protein known as 4G8R plasminogen activator inhibitor type I, commonly known as plasminogen, is a zymogen for the enzyme known as plasmin, which is the principal enzyme responsible for breaking down fibrin clots. Plasminogen and the receptors that bind to it are the factors that are responsible for controlling the inflammatory phase of the wound healing process. Proteins with the sequences 1YXO and 3V18 are exclusively associated with the pathogens Staphylococcus aureus and Pseudomonas aeruginosa, respectively. They do this by generating endotoxins, which leads to a rise in levels of proinflammatory cytokines including IL-1 and TNF-. The progression of this process is what makes wounds become chronic. If there is an extreme inflammatory response, the process of healing will take much more time. Wound healing activity will be created as a result of the suppression of these microorganisms. The result obtained from Argus lab 4.0.1 (Table 5) and Auto dock tools 1.5.7 (Table 6) in the respective wound healing proteins along with standard drug and *Sida Acuta.*

Table 5: The results obtained from Argus lab 4.0.1

Plant name	Protein name	Standard	Phyto constituents having best affinity compared with standard drug		
Sida Acuta	4G8R	Mupirocin	Campesterol,	Chlorogenicacid, Cryptolepine, Quindoline	Syringic acid
		Nitrofurazone	Campesterol	Myricetin	-
	3V18	Mupirocin	Campesterol, Stigmosterol	Quindoline	Chlorogenic acid, Cryptolepine
		Nitrofurazone	Stigmosterol, Campesterol	Scopoletin, Syringic acid	Myricetin
	1YXO	Mupirocin	Campesterol, Stigmosterol	Quindoline, Ferulic acid, Cryptolepine	Myricetin, Syringic acid
		Nitrofurazone	Campesterol, Stigmosterol	Syirngic acid	-

Table 6: The results obtained from Auto dock tools 1.5.7

Plant name	Protein name	Standard	Phyto constituents having best affinity compared with standard drug		
Sida Acuta	4G8R	Mupirocin	Taraxasterone, campesterol	-	-
		Nitrofurazone	Campesterol, Taraxasterone	-	-
	3V18	Mupirocine	Taraxasterone Stigmosterol	Cryptolepine, Myricetin, Quindoline	Syringic acid
		Nitrofurazone	Stigmosterol, Taraxasterone	Sinapic acid, Scopoletine	Syringic acid
	1YXO	Mupirocine	Campesterol, Taraxasterone	Chlorogenic acid	Cryptolepine, Quindoline
		Nitrofurazone	Campesterol, Taraxasterone	Chlorogenic acid	Cryptolepine, Quindoline

CONCLUSION

Within the realm of structurally-based pharmacological activity, one of the most important factors is the interaction between the ligand and the protein. These results were compared with those obtained using a conventional topical antibacterial treatment (mupirocin, nitrofurazone), along with three different proteins. The purpose of these docking tests was to determine whether plants can heal wounds using Auto dock and Argus lab by (1YXO, 3V18, 4G8R). Considering the findings of the current research, it is possible to draw the conclusion that certain chemical components of *Sida Acuta*, specifically campesterol, chlorogenic acid, cryptolepine, ferulic acid, myricetin, quindoline, scopoletin, sinapic acid, stigmasterol, syringic acid, and taraxasterone, have the ability to promote the healing of wounds. These chemical components are listed in the order that they appear in the plant. The results of the study indicate that the *Sida Acuta* has an activity that is helpful in the treatment of wounds since it is anti-bacterial, anti-fungal, and anti-inflammatory.

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Chapter 5

STUDIES ON PHYTOCHEMICAL STANDARIZATION OF SOLANUM INCANUM L. – MEDICINAL HERB

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ABSTRACT

The plant materials selected for the present investigation is *Solanum incanum* L. is belonging to the family Solanaceae and it is commonly called garden egg family. *S. incanum* L. leaves were collected from wild habitats in and around of Nagalur of Thanjavur district, Tamil Nadu. The healthy leaves were collected, dried, extracted for qualitative and quantitative analysis. In qualitative analysis the phytochemicals such as alkaloids, phenols, tannin, carbohydrate, cardial glycosides, flavonoids, quinines, proteins, amino acid and saponins and quantitative analysis flavonoids and phenols were tested in two different solvents aqueous and ethyl acetate. Among these two solvents, aqueous leaves extract has maximum numbers of phytochemical and in quantitative analysis of flavonoids and phenols were highly present in ethyl acetate leaves extract and this result justifies the plant having an important role in drug designing in medical field.

KEYWORDS: *Solanum incanum* L, Medicinal Herb, Phytochemical, Alkaloids.

INTRODUCTION

India has a rich heritage of knowledge in plant based drug for use in preventive as well as curative therapies (Rain and Nath 2005). About 6000 plants in India these plants are used in traditional, folk and herbal medicines (Dubery *et al.,* 2004). The worldwide share of plant extract used as medicines for treating of human and livestock ailments is still massive (Prasad and Tyagi, 2015). Research findings also support the idea that many plants are used in the treatment of various diseases whose symptoms might involve microbial infection leading to the discovery of novel bioactive compounds (Thankman, 2003; Narendra *et al.,* 2009; Sequeira *et al.,* 2009).

Medicinal plants are used to maintain and promote healthy life, prevent disease and cure ailments (Lakshman, 2012). Each medicinal plant species has its own nutrient composition besides having pharmacologically important secondary metabolites. These nutrients are essential for the physiological functions of human body (Novak and Haslberger, 2000).

Medicinal plants play a crucial role in the search for alternative antimicrobial components. According to the World Health Organization, it is estimated that around 80% of the earth's population use some form of herbal medicine in their health care, where natural products are a preferable option than synthetic ones. The literature indicates that medicinal plants have secondary compounds that are of great importance in human life in terms of acting as antioxidants, anti-inflammatory, and being involved in the

modulation of detoxification enzymes, the stimulation of the immune system, the modulation of steroid metabolism and antimicrobial effects (Alamri and Moustafa, 2012).

Herbal medicine is the oldest and most tried and tested from of medicine. In a sense it forms the basis of all medicine. It is the original medicine, the mother of all remedies used today. It has been used by all cultures for centuries and is still the main from of medical treatment. Majority of people in the world like to use an herbal medicine, especially those who cannot afford expensive drugs (McKenna, 1996).

The Solanaceae is an important family in the angiosperms (Bremer *et al.,* 2003), and it includes 91 genera and an estimated 2450 species with great variation in habit, morphology, and ecology (Mabberley, 2008), and the family is compared to other families ranked as third in economic importance and is surveyed as a source of many morphologically different domesticated crop species beneficial to human health, diet, beauty, and ornamental use (Sekara *et al.,* 2007).

S. torvum (leaf, stem, and fruits) extracts showed antibacterial and antifungal activities (Bari *et al.,* 2010). S. surattense whole plant extracts take part in the antibacterial activity (Patil *et al.,* 2009). The leaf, fruit, and seed extracts of S. nigrum were Analysed and presence of phytochemicals have more potential in antibacterial activity (Khizar *et al.,* 2014; Dalal, 2016). The present study was analysed, the phytochemical and estimate the qualitative analysis of phenols and flavonoids.

MATERIALS AND METHODS

The plant materials selected for the present investigation is *Solanum incanum* (L.) is belonging to the family Solanaceae. Leaves of *S. incanum* were select and collected from wild habitats in and around of Nagalur of Thanjavur district, Tamil Nadu. The healthy leaves were collected, shade dried for one week and used for the extraction and analysis.

S. incanum, commonly called as bitter garden egg belongs to the family Solanaceae. It is a shrub, growing 13 m high. The leaves are simple, ovate, elliptic, 2.5 -12 cm long and 2.5 -8 cm wide. The fruit is fleshy, less than three cm. in diameter on wild plants but larger in cultivated forms. The fruit is spherical, green, often striped with white, turning yellow to orange-brown then ripe (Denston, 1951).

Plant leaves were air dried, powdered and soaked in solvents like methanol, hydro alcohol, petroleum ether, chloroform, ethyl acetate and distilled water. The extracts were subjected for the analysis of various phytochemicals present in the dried samples of *Solanum incanum*. The procedure for screening of phytochemical though preliminary screening was followed by using standard manual 'phytochemical methods' by Harbone (1973). The test was carried out for the presence and absence of alkaloids, flavonoids, phenols, aminoacid and protein, saponins, sterols, tannins, quinones, cardiac glycosides and. The chemicals and reagent used in the above test were freshly prepared in our laboratory. The presence and absence of phytochemical in the different extract of *S. incanum* recorded in notebook as + or – respectively. Total phenolic and flavonoids content of the leaf extract *S. incanum* were studied according to Folinciocalteu method described by Thangaraj *et al.,* (2016).

RESULTS AND DISCUSSION

In the present study, leaf extracts of *S. incanum* analyzed for the presence and absence of phytochemicals like, alkaloids, flavonoids, phenols, amino acids, saponins, sterols, tannin, and quinone, using methanol, chloroform, petroleum ether and aqueous extracts. Among these phytochemicals all phytochemicals are present in the aqueous solvent. In the ethyl acetate Alkaloids, Phenols, Tannins, Carbohydrates, Cardial glycosides, were present and Flavonoids, Quinones, Proteins, Amino acid and Saponins were absent. The results of the qualitative analysis of phytochemicals present in the leaf extracts of the two solvents of *S. incanum* are presented in Table 1. Alkaloids and tannins are presents in the plants have amazing effects on humans and this has led to the development of powerful pain killer medications, and these are used

for healing wounds, varicose ulcers, hemorrhoids, frost-bite and burns (Kam and Liew, 2002, Lgboko, 1983 and Maiduyi 1983).

The biological functions of flavonoids are treated to include allergies, inflammation, platelets aggregation, microbes, ulcer and tumour (Okwu and Okwu 2004). Steroids, resins and saponins are taking part in pharmacological activities of the plant and phenolic compounds have antimicrobial properties and useful for the treatment of hyperglycaemia (Olaleye, 2007, Malinow, *et al.,* 1997).

Phytochemical analysis of *S. incanum* fruits ethanol extract tested positive for alkaloids, flavonoids, tannins, glycosides, saponins, and steroids in the plant (Sahle and Okbatinase. 2017). In addition, the identified phytochemicals have been reported previously in the fruits extract of Solanum nigrum (Mazher *et al.,* 2016) and ethanolic extract of S. melongena (Imo *et al.,* 2020) which are examples of plants belonging to family Solanaceae. In ethanolic fruit extract of *S. incanum* where presence of phytochemicals is used to control the plant can be used to control plants pests and pathogens. Phenols for example, from their simple structure they penetrate the microorganisms resulting to considerable damage to the cell metabolism (Seed, 2014). On the other hand, flavonoids inhibit synthesis of nucleic acid, alter the permeability of membrane, and inhibit the function of cytoplasmic membrane among other effects (Cheng *et al.,* 2014). Similarly, alkaloids inhibit synthesis of nucleic acid and tannins destroy bacterial membrane and deter biofilm formation by its bacteriostatic properties (Roy *et al.,* 2018). It could then be considered from chemical composition of *S. incanum*, its ability to affect pests and pathogens.

The quantitative analysis of total phenolic content of leaf extract of ethyl acetate (110.5±0.166mg GAE/g), Aqueous (4.94± 0.419mg GAE/g) and the total flavonoids of leaf extract of ethyl acetate (110.33±0.166) mg GAE/g), aqueous (4.77±0.41mg GAE/g) in Table 2. for their pharmacological activities.

In the sample, the total phenolic content was calculated from regression equation of the calibration curve ($Y = 0.0098x + 0.0177$; $R2 = 0.9967$). The total phenolic content in ethanol fruits extract was found to be 84.997 ± 0.2 mg/g of the dried sample. Comparing their work from other literature, (Mongalo *et al.,* 2018) a total phenolic content (TPC) of 490.7 ± 0.02 mg/g GAE in S. panduriforme. Ghosal & Mandal (2018) reported a total phenolic content of 2.306 ± 0.37 mg/g in fruits extract of *S. incanum*. This was 41 times lower compared to the TPC reported in this study. Aryal *et al.,* (2019) found the TPC to be 97.96 ± 0.62 mg GAE/ g dry extract weight of S. nigrum fruits extract which was slightly higher compared to the one reported in the current study.

The TFC content of the plant extract was found to be 20.536 ± 0.2 mg/g of dried sample. In a survey of various review, (Mongalo *et al.,* 2018) reported a total flavonoid content (TPC) of 23.91 ± 0.91 mg/g QE dry weight of aqueous extract of S. panduriforme. These were slightly higher compared to the results of this study. In another study by Ghosal & Mandal (2012) the total flavonoids content of methanolic fruits extract of *S. incanum* was 0.207 ± 0.09 mg/g QE dry weight. This was very much lower compared to the TFC reported in this study. Similarly, (Nwanna *et al.,* 2014) reported low TFC content of 1.50 ± 0.17 mg QE/g of *S. incanum* aqueous fruits extract.

The same results were studied on *F. carica* (Oliveira *et al.,* 2009, Gibernau 1997) and *S. incanum* (Asaolu 2003, Waithaka *et al.,* 2019) respectively. However, Desta and Haftom had reported finding contrary to the present study in which they detected terpenoid in extract of *S. incanum* (Sbhatu and Abraha 2020). In the present investigation, *S. incanum* leaves extract has a rich source phytochemical and it justifies the plant having an essential role in medicine.

Table 1: Qualitative phytochemical analysis of leaf extracts of *Solanum incanum*

Phytochemicals	Solvents used	
	Ethyl acetate	Aqueous
Alkaloids	+	+
Phenols	+	+
Flavonoids	-	+
Tannins	+	+
Quinones	-	+
Carbohydrates	+	+
Proteins	-	+
Amino acid	-	+
Cardial glycosides	+	+
Saponins	-	+

+: Presence of phytochemical -: Absence of phytochemical

Table 2: Test for Phenols and Flavonoids in *Solanum incanum* L.

S.No	Evolution Test	Ethyl acetate	Aqueous
1	Phenol	110.5±0.166	4.94±0.419
2	Flavonoids	110.33±0.116	4.77±0.41

Fig.1: Alkaloids

Fig.2: Flavanoids

Fig.3: Flavonoids

Fig.4: Tannins

Fig.5: Quinones

Fig.6: Carbohydrates

Fig.7: Proteins

Fig.8: Amino acid

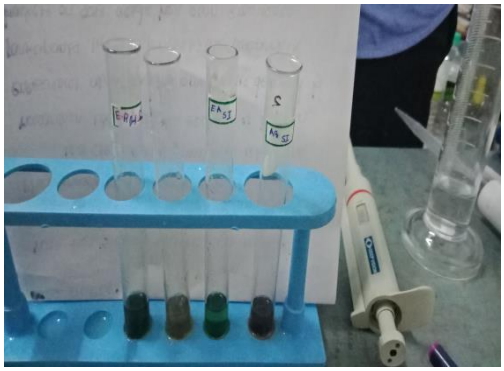

Fig.9: Cardial glycosides

Fig.10: Saponins

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Chapter 6

FORMULATION DEVELOPMENT AND EVALUATION OF ONDANSETRON HYDROCHLORIDE ORAL DISPERSIBLE TABLETS BY USING KYRON T 314

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ABSTRACT

The antiemetic drug ondansetron hydrochloride is administered to cancer chemotherapy patients to reduce their risk of experiencing nausea and vomiting. The purpose of this research was to formulate Ondansetron hydrochloride oral dispersible tablets (ODT) using Kyron T 314 as a novel super disintegrant chemically is (Polacrilin potassium) and to compare its efficacy to that of other standard super disintegrants tested at the same concentration. These tablets were made using a direct compression process and a variety of disintegrants (Kyron T 314, sodium starch glycolate, cross carmalose sodium, cross povidone). The produced tablets were tested for many qualities after compression, including their outward appearance, thickness, hardness, weight fluctuation, friability, in vitro dispersion, water absorption ratio, disintegration test, fineness of the dispersion, drug content, and in vitro dissolution. All formulations (F- I to F- IV) were found to have pre compression and post compression values that were within the Indian Pharmacopeial criteria. Based on in-vitro drug release (98.00 ±2.08%) and rapid disintegration time (12±1.52) after 10 minutes, formulation F-I was deemed the best formulation. Stability testing showed that formulation F I was unaffected by three months of storage at 25±2°C, 60% 5% RH and 40±2°C, 75% 5% RH. The research confirmed that the formulated F I with Kyron T 314 was an effective super disintegrant and used for intended purpose of medicament.

KEYWORDS: Ondansetron HCl, Oro-dispersible tablets, Kyron T 314.

INTRODUCTION

As its name suggests, ondansetron only inhibits the 5-HT3 receptors. Due to its ability to block the 5-HT3 receptor, which is present in both the central nervous system (the medullary chemo receptor zone) and the periphery, the drug has an antiemetic effect. Oral dispersible tablets rapidly dissolve the solid into a suspension or solution when placed in the mouth, and this occurs even in the presence of minimal bio-fluid [1-3]. Dissolving tablets have many names, including rapimelts, oro-dispersibles, rapiquicks, rapimelts, rapimelts, porous tablets, mouth dissolving tablets, and quick-dissolving tablets. Oral fast dissolving tablets are defined by the Food and Drug Administration as "a solid dosage form containing medicinal substances that disintegrates rapidly, usually within a matter of seconds when placed upon the tongue." Dissolution character was compared to that of other commercial super disintegrants at the same concentration, and KYRON T 314, a novel Cross-linked polymer of Polycarboxylic acids, was used to prepare the tablets via direct compression [4-6]. Formulations F-I and F-IV, both of which include Kyron

T-314 (Polacrillin Potassium) and Cross povidone as super disintegrant, were found to have the best results in this study. Despite this, Kyron T-314 (Polacrillin Potassium) offers the quickest release of the medication.

MATERIALS AND METHODS

MATERIALS

MetroChem API Pvt. Ltd. in Hyderabad, India was the source for our supply of ondansetron hydrochloride. A shipment of Kyron T-314 was obtained from Corel Pharma Chem in Ahmedabad. The ingredients of Crosspovidone, Crosscarmellose sodium, and sodium starch glycolate were all purchased from Fourrts (India) Laboratories Pvt Limited in Chennai. Ingredients with a strawberry flavour were purchased from IFF India Pvt. Ltd. in Chennai. Fourrts (India) Laboratories Pvt Limited, Chennai, was also sourced for the purchase of iron oxide. The mannitol we used was procured from Himedia Laboratories Pvt Limited in Mumbai. Yarrow Chem Product in Mumbai was where we got our supply of microcrystalline cellulose from. Isochem Laboratories in Kochi is where we got our supply of magnesium stearate. Spectrum Reagents & Chemicals in Kochi, India, was the source of our talc.

METHODOLOGY

PREFORMULATION STUDIES

For these essential dosage forms to be developed, the drug molecule must first possess certain essential chemical, physical, and pharmacological properties.

ORGANOLEPTIC PROPERTIES

The colour of Ondansetron HCl was evaluated by placing a small amount on a piece of butter paper and observing it in bright light. Taste and smell tests were conducted by placing a small amount of ondansetron HCl on the tongue.

SOLUBILITY

Sonication of water, methanol, and ethanol at room temperature dissolved ondansetron HCl.

FT IR STUDIES

Infrared (IR) spectroscopy involved the use of a Fourier transform infrared (FTIR) spectrophotometer to record spectra of the pure drug, physical mixture, and optimised formulations. The Shimadzu-IR Affinity I Spectrophotometer was used for the research. Dispersing the samples in KBr and pressing them into discs or pellets. These IR spectra were recorded by inserting pellets into the optical path. Resolution was 1 cm over a scanning range of 4000 cm^{-1} [7].

PRECOMPRESSION PARAMETERS

In order to determine the precompression parameter, we have used the angle of repose, bulk density, tapped density, compressibility index, and hausner's ratio. The outcomes for these parameters were satisfactory and within the canonical text.

Prototype formulation of Ondansetron hydrochloride ODT: To create Ondansetron hydrochloride ODT, four different formulations (FI-F IV) were made using the direct compression method and the ingredients listed in Table 1.

DIRECT COMPRESSION METHOD

Sieving: The active component was strained using a No. 40 filter. All of the remaining components listed in the recipe were sieved individually.

Dry mixing: All of the ingredients, including the active one, were placed in a plastic bag and thoroughly combined in a dry mixing process that lasted 10 minutes [8-9].

Lubrication: The powder was combined with magnesium stearate, which had been sifted through a #60 filter, in a plastic bag for 5 minutes to provide a consistent lubricant. Compression The tablet mixture was then crushed into tablets using a 16-station rotating tablet press with 11mm-diameter punches [10].

POST COMPRESSION PARAMETERS

General appearance: the tablet shouldn't have any flaws such as cracks, depressions, pinholes, etc. The tablets' hue and sheen should be consistent over their whole surface. The tablets need to have a glossy exterior. To check for surface cracks, depression, and pinholes, a biconvex lens was used for an exterior examination of the tablets.

Hardness test: A tablet's hardness may be determined by measuring its resistance to pressure or weight. Crushing strength is another name for it. Select 5-10 tablets at random from the created batch, crush them using the hardness tester, and calculate the mean and standard deviation [11-12]. A hardness tester is a tool used to measure an object's hardness (Monsanto). Measured in kilograms per square centimeter, the hardness value was.

Thickness: Twenty tablets were chosen at random to have their thickness measured using a digital Vernier calliper. The average and standard deviation of the thickness measurements were computed. The mm measurements were used to indicate the thickness.

Friability: Friability refers to the degree to which a tablet breaks under physical stress, such as that experienced during packing, transit, etc. The friability of a sample of 6 tablets was determined by spinning them at 25 revolutions per minute for 4 minutes in a Roche friabilator. Measure the total weight of 6 pills both before and after the procedure to determine the percentage of weight reduction. Here is the weight loss percentage formula [13].

Weight variation test: Twenty tablets of each formulation were weighed using an electronic scale to determine weight variation. The average weight was then computed, and the weights of individual tablets were compared to the average. No more than two weights may vary from the mean by more than the allowed deviation in weight, and no weights may vary by more than twice the allowed variation in weight.

Assay: The assay included weighing and finely powdering ten pills from each batch. A volume of 100 ml of phosphate buffer pH 6.8 was used to dissolve a quantity of ondansetron hydrochloride powder corresponding to 4 mg, and the resulting solution was filtered using Whatmann filter paper before being further diluted to a volume of 10 ml using 0.4 ml of the filtered solution. It was determined that the drug concentration in the solution was 248nm by utilizing a UV visible spectrophotometer [14].

***In vitro* dispersion time**: The amount of time needed for the tablet to disperse in vitro was measured by placing it in a tiny petri dish with 10ml of water.

Water absorption ratio and wetting time: Wetting time, or the amount of time it takes for a tablet to become completely saturated with water, was determined by subjecting it to a standard technique. A sheet of tissue paper was folded in half and set in a 6ml water-filled petri dish that was 6.5cm in diameter. When the tissue paper was fully saturated, a tablet that had been previously weighed was put on top. Wetting time was measured by keeping track of how long it took for water to penetrate the tablet's outer layer. Once the pill was moist, it was put on a scale to be measured.

Disintegration test: The disintegration test was conducted at 37±2 degrees Celsius. After placing a tablet into each tube of the disintegration apparatus, we filled a one-liter beaker with 900 millilitres of distilled water and set the tablet rack of the disintegration device in the beaker. We discarded the disc. Time was recorded until there was no longer any detectable tablet mass in the device.

***In vitro* dissolution studies**: The orodispersible tablets of ondansetron hydrochloride underwent in vitro dissolve testing using a USP type 1 dissolution device (basket). The temperature was kept at 37°C0.5°C, and a volume of 500 ml of dissolving media (0.1M HCl) was utilised. The rate of rotation of the basket has been set at 50 revolutions per minute. Each dissolving container contained one pill. To keep the volume of the dissolving media at 500 ml, we took 5 ml samples from each jar every 2 minutes for the first 10

minutes and replaced the sample liquid with fresh 0.1M HCl. The quantity of Ondansetron HCl released from the orodispersible tablets was then measured spectrophotometrically at 310 nm against a blank of 0.1M HCl [15].

Fineness of dispersion: To assess the fineness of dispersion, we dissolved two tablets in 100 ml of water and stirred the mixture until the pills were fully dissolved. The acquired smooth dispersion was then sieved through a screen having a nominal mesh size of 710 nm (Sieve #21).

Table 1: Composition of Ondansetron hydrochloride ODT

Ingredients	Working formula (mg)			
	Formulation code			
	F – I	F – II	F – III	F – IV
Ondansetron HCl	4	4	4	4
Mannitol	3	3	3	3
Kyron T 314	15	--	--	--
Sodium starch glycolate	--	15	--	--
Cross carmellose sodium	--	--	15	--
Cross povidone	--	--	--	15
Strawberry flavor	1.5	1.5	1.5	1.5
Iron oxide yellow	0.5	0.5	0.5	0.5
Micro crystalline cellulose	270	270	270	270
Magnesium stearate	3	3	3	3
Talc	3	3	3	3
Total weight	300	300	300	300

RESULTS

PRECOMPRESSION PARAMETERS

Table 2: Precompression parameter results

Formulation code	Angle of repose	Bulk density g/cm^3	Tapped density g/cm^3	Compressibility index (%)	Hausner's ratio
F- I	25º31′	0.3170	0.3840	17.4	1.210
F - II	27º74′	0.3476	0.4294	19.04	1.235
F - III	26º68′	0.3173	0.3842	17.41	1.211
F - IV	25º09′	0.3571	0.4410	19.00	1.234

POST COMPRESSION PARAMETERS

Table 3: Post compression parameter Results

Formulation code	Thickness (mm)	Hardness (kg/cm2)	Weight variation (mg)	Friability (%)
F- I	4.026±0.0152	5.00±0.37	300.02±3.66	0.68
F- II	4.023±0.0152	4.57±0.25	295.11±4.85	0.63
F- III	4.020±0.010	4.92±0.33	296.17±4.69	0.65
F - IV	4.023±0.015	4.45±0.38	297.11±3.71	0.66

Table 4: Evaluation of Ondansetronhydrochloride Oro-dispersible tablets

Formulation Code	Disintegration (sec)	Water absorption ration	Wetting time (sec)	In vitro dispersion time (sec)	Fineness of dispersion	Assay (%)
F I	12±1.52	95.34±0.57	56	27±1.52	Passed	99.29%
F II	30±2.08	86.45±0.39	104	39±1.52	Passed	98.28%
F III	15±2.51	90.57±0.24	102	31±1.52	Passed	95.00%
F IV	13±1.52	92.27±0.21	58	29±2.51	Passed	94.25%

Table 5: Percentage drug release of Ondansetronhydrochloride Oro-dispersible tablets

Time (sec)	Percentage drug release (%)			
	Formulation Code			
	F I	F II	F III	F IV
2	79.41±1.91	52.32±0.87	64.46±1.01	72.75±1.76
4	85.05±1.90	62.43±0.71	69.30±0.68	79.54±1.21
6	89.62±2.77	70.21±2.91	73.78±1.75	85.05±1.79
8	94.80±1.81	77.40±2.69	83.54±1.71	89.32±3.01
10	98.00±2.08	90.00±1.52	92.42±1.47	95.85±2.03

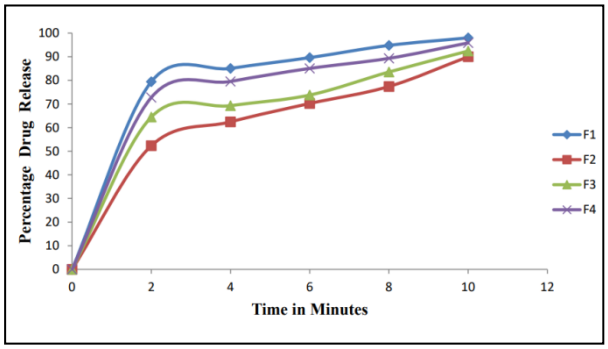

Figure 1: In vitro drug release of the Ondansetron HCl Oro-dispersible tablets

DISCUSSION

Some examples of micromeritic qualities tested on powder blends are angle of repose, bulk density, tapped density, compressibility index, and Hausner's ratio. Table 2 displays the findings. Excellent flow properties were observed for all formulations tested, with Formulation I having an angle of repose of 25°31' and the remaining formulations having angles of repose ranging from 25°09' to 27°74'. Compressibility index is from 17.40% to 19.04%; bulk density is between 0.3170 and 0.3571 g/cm3; tapped density is between 0.3840 and 0.4410 g/cm3; and Hausner's ratio is between 1.210 and 1.235. As may be seen from the above, Formulation-I has favourable flow qualities and acceptable other micromeritic features.

The pills were measured, and their thickness came out to be between 4.020 and 4.026 millimetres (mm). The recipes are all under the same thickness. Tablet hardness was assessed to be between 4.45 to 5.00 kg/cm2, indicating that the tablets are sufficiently hard and have adequate mechanical strength. We found no significant weight variation across all ondansetron hydrochloride oral rapid dissolving tablet formulations. Ondansetron hydrochloride oro-dispersible tablets display friability percentage values of

less than 1%, which is acceptable. So, the pills were (Tab 3) all deemed to be sufficiently non-friable. The evaluation studies of Ondansetron HCl given in Table 4.

Measurements of absorption of Ondansetron hydrochloride oro dispersible tablets in phosphate buffer 6.8 for up to 10 minutes. Manitol diluents were utilised to create formulations F-I (Kyron T-314), F-II (Sodium starch glycolate), F-III (Cross carmellose sodium), and F-IV (Cross povidone). The % drug release (Tab 5) was determined after 10 minutes for formulations F-I, F-II, F-III, and F-IV to be 98.00±2.08%, 90.00±1.52%, 92.42±1.47%, and 95.85±2.03%, respectively. Tolerable in vitro dissolution rates are set at a minimum of 80% drug release after 10 minutes (Fig 1). Testing for solubility in vitro showed that each formulation was effective. Higher dissolving rates were observed in fractions I and IV as a result of the quicker disintegration and finer particle dispersion that followed disintegration with Kyron T-314 and Cross povidone as super disintegrant. Formulation F-I, prepared with Kyron T-314 as super disintegrant, exhibits greater drug release because of the super disintegrant's direct compressible vehicle's (Micro Crystalline Cellulose) highly porous structure, which permits faster water uptake, faster disintegration, easy breakdown of the particles, and rapid dissolution. When compared against Cross Povidone, Cross carmellose sodium, and Sodium starch glycolate, Kyron T-314 was shown to be the most effective at accelerating the dissolving time. In terms of the aforementioned fast disintegration time, wetting time, in vitro dispersion time, and dissolving profile, Formulation I was judged to be the optimum formulation.

CONCLUSION

According to the results of this study, the most effective formulations are F-I and F-IV, both of which use Kyron T-314 (Polacrillin Potassium) and Cross povidone as the super disintegrant. Even so, Kyron T-314 (Polacrillin Potassium) offers the quickest release of the drug. Researchers discovered that tablets of oral dispersible Ondansetron HCl may be successfully formulated using the direct compression method and several super disintegrants at the same dosage. Formulation F-I was created to alleviate cytotoxic-induced nausea and vomiting. It includes the super disintegrant Kyron T-314 (PolacrPotassium), which may improve dissolving rate, administration ease, patient compliance, and therapeutic effectiveness. According to the findings, the most efficient formulation was F-I, which used Kyron T-314 as the super disintegrant.

LIST OF ABBREVIATIONS

- ODT – Oral Disintegrating Tablet
- API – Active Pharmaceutical Ingredient
- F – Formulation
- 5 HT3 – 5 Hydroxy Tryptamine 3 receptor
- FTIR – Fourier Transform Infrared Spectrophotometer
- IR – Infrared Spectroscopy

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Chapter 7

DIETARY BENEFITS OF SILKWORMS- A BIOTECHNOLOGY STRATEGY TO MEET AGRICULTURAL NEEDS

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ABSTRACT

Silk was one of the major materials traded between countries and had varied usage in the life of man in this century. One of the unique properties of sericulture is high employment potential and low capital investment, quick and high returns. It acts as a bridge between agriculture and industry at the same time. For centuries, the silkworm which is being exploited and domesticated under the patronage of man. Even though the production level has increased to a great extent recently, but there exists a wide gap between actual yield obtained in the farmer's field and the potential level of production along with the existing modern technology. By replacing outdated procedures for growing mulberries and raising silkworms, the field of sericulture has undergone changes that make it possible to apply and embrace new, improved factor, techniques, methods, and know-how that will increase cocoon yield and production. There are numerous significant roles for ascorbic acid in animal bodies. It is a potent antioxidant that guards against protein, lipid, and membrane oxidative damage. Ascorbic acid's antioxidant activity reduces reactive oxygen species and oxidative pressure, which improves the midgut's ability to absorb nutrients. Utilizing ascorbic acid (Vitamin C) improved silkworm productivity and resulted in an overabundance of silk in the sericulture industry.

KEYWORDS: Sericulture. Mulberry, Vitamin C

INTRODUCTION

Sericulture is an ancient method of raising silk-producing insects for natural silk production. The Greek word "Sericos" (which means "silk") and the English word "culture" (which means "rearing") are the roots of the word "sericulture." Sericulture is crucial for improving the socioeconomic conditions of rural Indian people. It is a significant cash crop and agro-based rural sector that contributes significantly to the economies of only a few emerging nations.

This Queen of Textiles has never been defeated, and silk's enchantment is what makes it possible. It is a natural fibre that is secreted by silkworms and represents comfort, luxury, elegance, and class. (Chandra 1997). Over 30,000 species of spiders are known to make silk. The silk made from Lepidoptera insects is the most well-known type. The non-mulberry silk worms, often known as the other silk worms used for commercial purposes, are *Antheraea myltita* (Tropical Tasar), *Antheraea proylei* (Temperate Tasar), *Antheraea pernyi* (Chinese Tasar), *Antheraea yamami* (Japanese Tasar), *Antheraea assamensis* (Muga) and *Philosamia ricinni* (Eri).

Silk has lost all of its untamed characteristics as a result of centuries of exploitation and continued domestication, and it now resembles a biological machine. It now requires constant care and attention to survive because it has grown to be incredibly fragile and sensitive.

HISTORY OF SERICULTURE

Hoshomin, the Chinese monarch, is regarded as being the first person to introduce sericulture to China. According to historians, under Kanishka's rule in 58 BC, silk was traded from India to Rome. Since it

offers advantages over other textile fibres in terms of features like durability, gloss, and low weight, silk holds a special position in the social and cultural lives of Indians. It is referred to as the "Queen of Textiles" as a result of this. After the country gained independence, the sericulture industry flourished as an agro-industry, providing employment to 3.5 million people in the nation. However, after 1928, the sericulture industry demonstrated a decline in its production due to the fierce competition from advanced sericulture countries such as Japan, China, and European countries.

SERICULTURE FOR RURAL DEVELOPMENT

An important part of India's rural economy is played by sericulture, the industry that produces silk. The wealthy class is the main consumer of silk products, and all the intermediaries—farmers, reelers, twisters, weavers, and traders—share in the value of the finished fabric. The majority of the market, according to Chandra (1997), belongs to cocoon farmers (54.60%), who are followed by traders (17.80%), twisters (8.70%), and reelers (6.60%). Sericulture has recently overtaken agriculture as the most significant rural business because of a few intrinsic benefits, including a short gestation period and regular, consistent yields all year round. The business has recently developed into a significant cash crop in rural India because of the use of modern technologies in mulberry farming and silkworm breeding among Seri culturists. As a labor-intensive sector, sericulture has employed over 85.10 lakh people in its various stages, including mulberry cultivation, silkworm rearing, seed generation, and other post-cocoon operations including reeling, twisting, coloring, and finishing. Sericulture also generates foreign exchange earnings of Rs. 2093.42 Crores (Central Silk Board Bangalore 2016-17), in addition to providing jobs.

WORLD RAW SILK PRODUCTION

Table 1: GLOBAL SILK PRODUCTION (IN METRIC TONNES)

Country	2012	2013	2014	2015	2016
Bangladesh	42.50	43	44.5	44	44
Brazil	614	550	560	600	650
Bulgaria	8.5	8.5	8	8	9
China	126000	130000	146000	170000	158400
Colombia	0.6	0.6	0.5	0.5	0
Egypt	0.7	0.7	0.82	0.83	1.2
India	23679	26480	28708	28523	30348
Indonesia	20	16	10	8	4
Iran	123	123	110	120	125
Japan	30	30	30	30	30
North Korea	300	300	320	350	365
South Korea	1.5	1.6	1.2	1	1
Philippines	0.89	1	1.1	1.2	1.82
Syria	0.5	0.7	0.5	0.3	0.25
Thailand	655	680	692	698	712
Tunisia	3.95	4	4	3	2
Tunney	22	25	32	30	32
Uzbekistan	940	980	1100	1200	1256
Vietnam	18	18	15	5	6
Madagascar	18	18	15	5	6
Total	152845.64	159737.10	178057.62	202072.83	192692.45

In 2016, there were around 192692.45MT of raw silk produced worldwide. China and India account for most of the global trade. China produces the rawest silk, accounting for 158400 MT, or 82.20% of the world's total production of silk, followed by India, which produces 30348 MT, or 15.74% of the raw silk. (Table 1)

SERICULTURE IN INDIA

28,472 MT of raw silk were produced in India as a whole in 2016. In India, sericulture has experienced remarkable expansion during the past 50 years. India is still the world's top silk producer and holds the distinction of producing all four types of natural silk. Around 60,000 communities across the subcontinent practice sericulture, although it is mainly focused in south India, where three states—Karnataka, Andhra Pradesh, and Tamil Nadu—raised nearly 90% of the mulberry silk while providing the remaining 10%. Although there is a growing knowledge among rearers about the new technologies, rearers in south India still employ their traditional methods and tools (Table 2)

Table 2: SILK PRODUCTIONS IN INDIA (IN METRIC TONNES)

State	2012-13	2013-14	2014-15	2015-16
Karnataka	8219	8574	9645	9823
Andhra Pradesh	6550	6912	6485	5086
Telangana	Nil	Nil	101	116
Tamil Nadu	1185	1120	1602	1898
Kerala	6	4	7	9
Maharashtra	97	122	221	274
Uttar Pradesh	157	188	236	249
Madhya Pradesh	190	195	248	214
Chhattisgarh	391	391	234	261
West Bengal	2070	2079	2500	2391
Bihar	22	52	53	67
Jharkhand	1090	2003	1946	2284
Odisha	104	53	98	117
Jammu & Kashmir	145	136	138	127
Himachal Pradesh	23	25	30	32
Uttarakhand	17	22	29	30
Haryana	0.13	0.13	0.3	0.6
Punjab	5	4	4	0.8
Assam & Bodoland	2068	2766	3222	3325
Arunachal Pradesh & Manipur	418	487	516	522
Meghalaya	517	644	656	857
Mizoram	40	44	50	64
Nagaland	324	606	619	631
Sikkim	3	0.20	8	6
Tripura	15	40	48	52
Total	23,679	26,480	28,,708	28,472

YIELD GAP, IMPROVED TECHNOLOGIES AND CONSTRAINTS

Though output has improved, there is currently an imbalance between expected and actual yield, which is a problem that worries everyone. According to the general consensus, farmers are unable to completely

use all of their resources in order to produce a high yield for a variety of reasons. Indian silk becomes prohibitively expensive as a result of the higher production cost. Therefore, in order to narrow the gaps in the yields that can be achieved, it is crucial to assess the severity of the gaps and consider whether it is possible to break current restrictions.

The disparity between expected and actual farm yields is referred to as the "yield gap." Potential yield is the yield that could be obtained at the experimental station using the current best technologies. Actual farm yield refers to the yield that farmers actually realize that whereas potential farm yield is the yield obtained in the test plots in the farmer's field.

Sericulture has seen an important technological transformation in India over the past few years. In India, sericulture has entered a new phase as a result of these changes. These innovative technologies have proven to be superior to conventional approaches. The adoption of such a technique is consequently thought to contribute to the socioeconomic advancement of the nation (Figure 1).

Adopting the suggested rearing technology also increased the rearers' revenue. However, a lot of people are hesitant to embrace modern technology. Economic, technological, social, and other variables could be to blame for this. On this basis, it is crucial to look into the things that make the adoption process difficult. Therefore, a study is suggested to look at acceptance levels, adoption barriers, and the effects of adopting better sericulture technologies.

A. Shoot rearing **B. Chawki rearing** **C. Seperate rearing house** **D. High cost rearing house**

Figure 1: New technologies in silkworm rearing

SUPPLEMENTATION OF VITAMIN C

Silk production is directly related to larval growth on mulberry since sericulture depends on raising silkworms on mulberry leaves. Mulberry leaves undergo quality and quantity changes as a result of weather factors and agricultural practises. Incorporating additional nutrients, such as vitamins, into mulberry leaves is one alternate method for enhancing larval feeding. Numerous research have been conducted to determine how vitamin-enriched mulberry leaves affect economic features, biological parameters, and biochemical parameters.

ASCORBIC ACID (Vitamin C)

Because it is highly vulnerable to deterioration, especially when in solution and exposed to light, oxygen, and free radicals, ascorbic acid exhibits a unique behaviour. Ito (1961) noted a connection between ascorbic acid administration and silkworm growth. The first and second instar larvae's delayed growth and development were caused by ascorbic acid being absent from their diet. Mulberry leaves contain sufficient Vitamin C, and the ascorbic acid concentration of developing larvae depends on the intake of this vitamin.

Numerous techniques were explored to increase silk production, and one of them was vitamin C supplementation, which offers a lot of potential for raising the silkworm's economic indicators. A vast range of dietary supplements, including tablets, capsules, liquid forms, crystalline powder, and more, include vitamin C (ascorbic acid). In the diet of silkworms and other polyphagous insects, ascorbic acid is a crucial vitamin (Ito and Arai, 1965; Kaur and Srivastava, 1995). Since ascorbic acid is most likely not

produced by the silkworm (Ito and Arai 1965), it must be consumed by food or exogenous supplementation. According to research by Babu *et al.* (1992), Chauhan and Singh (1992), and Prasad (2004), adding vitamin C to mulberry leaves enhances the silkworm's economic features.

L-ascorbic acid (vitamin C) has always been considered to be essential for *Bombyx mori's* growth and development. In fact, ascorbic acid may be produced by insects and is found in great quantities in mulberry leaves (Lowri 1964), the sole source of nutrition for the silkworm.

The amount of vitamin C in mulberry leaves largely depends on the seasonal and climatic conditions (with a peak in late spring or at the start of summer in temperate climates) as well as where the leaves are located on the shoot (with a peak near the branch insertion). Additionally, the ascorbic acid level of the mulberry leaves is impacted by the variety of mulberries chosen. Even when shielded from direct sunshine, leaf preservation reduces ascorbic acid concentration by at least 20% in a 24-hour period.

Although it is challenging to determine the precise amount of ascorbic acid consumed by silkworm larvae fed fresh mulberry leaves, researchers have been able to confirm the significance of L-ascorbic acid for silkworm physiology on the basis of historical experiments conducted by Ito, (1961).

CONCLUSION

About 7.56 million people in India's rural and semi-urban areas depend on the sericulture sector for their livelihood. Despite strong competition from synthetic fibres, natural silk has become the most popular textile fibre because of its noble qualities. In order to transmit wealth from the wealthy to the less fortunate sections of society, sericulture is crucial to the Indian economy. Modern sericulture technology has moved away from traditional procedures and techniques in favour of creative ones, and old types have been replaced by high yielding ones. Supplemental nutrition may contain sugars, proteins, vitamins, minerals, and amino acids.

Supplemental nutrition may contain sugars, proteins, vitamins, minerals, and amino acids. Mulberry leaves and additional nutrients added together produce a larger yield since the health and nutrition of the larvae are the major factors that influence how much superior quality silk can be produced. It has been discovered that adding supplements of some of these elements to the silkworm's regular diet will accelerate its growth. More than any other vitamin, synthetic Vitamin C supplementation to mulberry leaves has been used to enhance the economic parameters in the silkworm.

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Chapter
8

BIODIVERSITY OF MEDICINAL PLANTS

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ABSTRACT

The biodiversity is a complex, interdependent web, in which each member plays an important role, drawing and contributing in ways that may not even be visible to the eye. The relationship between humans and nature has changed dramatically over the last few years. The biodiversity refers to the variability of life on earth. It is vast array of life of the earth, today faces crisis of historic proportions. The development, urbanization, pollution and diseases have wreaking havoc on the tree of life. It can be conserved in the following ways: In-situ Conservation Ex-situ Conservation. Man and Biosphere Reserve Program of UNESCO. Globally, there are 686 biosphere reserves in 122 countries, including twenty Tran's boundary sites. There is total eleven biosphere reserves of India which have been recognized internationally under Man and Biosphere Reserve program. In the world twelve mega diversity centers in the India is one of important centre. The world consists eighteen biodiversity hot spot in the India two are present one is Western Ghats and another is eastern Himalaya. India having 25 biotic provinces with 16 major forest types and about 200 sub types. It also consists 15 Agro climatic zones, the medicinal plants occurs in Himalayan to marine and desert to rain forest ecosystem. India has contributed seven percentage share of world biodiversity.

The World Health Origination has documented 21,000 plant species used around world as medicinal purpose. In the India about 2500 plant species has used in indigenous system of medicine. The Red data book recorded 427 medicinal plants as endangered species in India, in which 28 are, consider extinct, 124 endangered, 81 rare and 34 unknowns. In the world about 80% people in developing countries depend on the traditional medicine; about 85% medicine has derived from plants according to World Health Origination. In the Western medicine about 57% of top most prescribed prescription drugs has extracted from natural source. The plants and animals evolved over millions of years. The chemical study of plants is less studied; it is source of inspiration in quest to new drugs. The traditional knowledge contains plant taxonomy with vernacular name. The plant related 27,440 unique phyto-chemicals found in modern research. The biodiversity is important part for the human life and also plants and animal life.

KEYWORDS: Biodiversity, Biosphere, Ecosystem, Red data book and Traditional system etc.

INTRODUCTION

The biodiversity has pyramid in which exquisitely adapted living organism brings stone. These delicately placed stone hold our world steady; the biodiversity is more than forest and wildlife it encompasses all variety and variability of living organism. The species alter habitat by drawing more nutrient and moisture than native species further invite virulent pathogens. In the world about 1.2 million species has described the earth consist 8.7 million eukaryotic species on the earth 86% land species and 91% ocean species not described. The fresh water habitat is only 0.01% the water cover less than one percentage earth surface but helps 10% animal and 1/3 vertebrates. On the earth about 215,644 plants and 953,434

animal species occurs the ocean covered 8,600 plants, 171,082 animal, 1087 fungi, 652 bacteria, 8,118 protozoa and 4,859 chromista species. The human has depended on plants for food about 30,000 wild and 7,000 cultivated plant species provides food. The marine animal and fishes provide about twenty percentage protein. In medicine top 150 drugs about 118 has made from chemical derived from the plant and fungi species of the world. The biodiversity is important part of human health, the extract of plants, and lesser extent animals are critical to treat infection, disease and other illness. The Greek, Chinese, Egyptian, Indian and Roman healer in ancient time used molds to treat inflammation, wounds, boils and infections. In 1920 Sir Alexander has proven this link between mold and antibacterial properties by discovering penicillin. The active component salicylic acid has isolated from the plants bud in 1839, the Bayer Company obtain synthetic derivative acetylsalicylic acid and called as aspirin from plant. In the world about 6,000 languages has spoken in which more used by indigenous peoples and its half culture has threatened with extinction. The traditional knowledge section contains the plant taxonomy, including its vernacular names. The human population has grown and expand into new geographic area, so many human communities contact with wild and domestic animals. The animals also play important role in human lives like food, food, fiber, livelihood, sports, and travel. These close contact with animals has disadvantage it provides more opportunities for diseases which has passes in animals and peoples.

The plants also a close related part of human it used in diets, medicine, furniture, textile, for making home and other more uses. The plant is our live part but highly industrialized society people not more depend on plants. In the environment it has very important so we ensure to care for them for continue this long relationship. The food is necessary part of human life the cereal grains made breads it eaten by human, in the cereal's rye, wheat, maize and millets like many grains used. The seeds like ground nut, sunflower, sesame, soybean and mustered has used to making oil for the coking purpose. The plants juice or sap used for produce sweet syrup like date palm and maple, the sugar also made from sugarcane and beetroot. The rice like cereals feed to the world, the fruit and vegetables are plant products which has used daily in food. The herb and spices help to flavor the food the human also used many spices and condiments in his life. The cotton like plants also important in oil production and also in making clothes it gives fiber which has used all over the world. The flax plant also gives linen the wood fiber given cellulose it used in manufacture of viscose. The plant also important in hygiene care the plant oil used to create soap like palm oil, coconut oil, almond oil, sandal oil and neem oil. The shampoo also made from different plant ingredients like ritha, amala, onion, lemon, citrus and aloe vera. The toothpaste has used by people in daily which also made from different plant products like amla, acacia, mint and meshwak in the cosmetics also different plants used like aloe vera, almond, haldi, sandal, citrus, apple, avocados and papaya. The plants oil also used by human for the protecting of the hairs in which, coconut oil, onion oil, almond oil, jasmine oil, hibiscus oil and different plant oil used. The hair dyes like henna the color obtained from black walnut, oak galls and ground coffee beans also used. The plants flower also used to give fragrant for the talcum powder, the flower also used in scents and perfumes in which mostly roses, sandal and jasmine like many flowers used.

The plants also used for making homes inside and outside parts it also used making different types of home furniture. The wood used in making framework, doors, windows, roofs and skirting boards, the soft wood used for kitchen cabinets, chairs and tables. The floor coverings can be made from wood, cork, coconut fiber and jute, the plants ingredients are vital for both wallpaper and household paint. The linseed, soya beans, pine resin and wood pulp are all used. The plant also used for writing and drawing paper, inks, paints, pencils, and erasers are just a few of the items we use to draw and write with that are made from plants and plant extracts. The tea coffee like plants has used in the beverages. The plant also protects human health they have natural healing properties so that it used from many years ago. In the

modern period also, many based medicines used by the humans like the leaves of the foxglove contain a substance that is used to treat heart conditions. The many plant derivatives are used in their natural states, such as evening primrose oil, echinacea, castor oil, aloe vera, ginseng, chamomile and garlic. Plants are also used in the production of bandages, antiseptics and plasters. In the urban area plant based medicine used as home remedy for it many herbs, shrubs and trees different parts are used. The plant a part tuber is swollen and fleshy structure occurs below the ground, it has roots or stem origin. The crocus and African potato has medicinal properties. The wood of shrub or trees has also used in medicinal like quasia and sandalwood. The bark of tree trunk has also useful as medicine quinine, oak, pepper and willow. The fleshy structure consists numerous layers of leaf base or scales known as bulb which has used as medicine like onion and garlic. The essential oil extracted by steam distillation process used in medicine like camphor and peppermint oils. The fatty acids also used in medicine which has made from castor oil and safflower oil. The flower also a part of medicine clove, chamomile and saffron flower used as medicine preparation. The gums are solid mixture of polysaccharides which also used in medicine. The fruits have also part of medicine dried fresh fruits used in medicine preparation. The leaf of herb, shrub or tree has used in medicine which has fresh or dried like fresh leaves adathoda, mango, neem dried leaves of tobacco, dathura. The roots of plants also part of medicine like ginseng, nerium, neem and mango which has used as fresh or dried from. The resins are mixture of essential oil and terpenes which extracted from special cell or ducts and used in medicine. The ginger turmeric like rhizomes used as fresh or dried in the medicine. The seed of plants also part of medicine the different plants seed used in the medicine. The plants every part is useful for human being but they become careless to save them. The plant and animals are wealth of every nation it is protected by protecting the biodiversity of that nation.

OBJECTIVES

1. To study biodiversity of medicinal plants
2. To study the role of biodiversity in living world
3. To study development and status of biodiversity on the earth
4. To aware young generation about biodiversity conservation

ANALYSIS AND RESULTS

The biodiversity has come from biological diversity which has referred to variety of life on earth all its level from gene to ecosystem. It also encompasses the evolutionary ecological and cultural process that sustains the life. The biodiversity includes about eight million species of plants and animals. The ecosystem has its home and shows genetic diversity in them.

THE BIODIVERSITY AND ITS STATUS

The biodiversity has complex independent web in which each member important role, also draw and contribute in this way it not visible to the eye. The food eaten, air breathes and water drink and weather that makes our planet habitable all come from nature. The biodiversity has foundation of all life of land and water below. It effects on human health providing clean air and water, nutritious foods, scientific understanding and medicine sources, natural disease resistance, and climate change mitigation. The negative consequences produce life affection occurs when change or remove any element of web. The term biological diversity has used in 1980 by Thomas Lovejoy in the scientific community book. The term biodiversity used by Rosen W.G., it has shown two type of conservation one is in-situ and other is ex-situ conservation of biodiversity. The in-situ conservation of biodiversity is the conservation of species occurs within their natural habitat. In it natural ecosystem protected and maintained, the biosphere, national park and wildlife sanctuaries are its examples. The ex-situ conservation of biodiversity involves the breeding and maintain of endangered species in artificial ecosystem like zoos, botanical gardens,

nurseries, gene bank, cryopreservation and germplasm conservation. In this place less competition for food, water and space occur in organisms.

The global biodiversity has measure of planet earth biodiversity which state that the total variability of life forms. On the earth about 99% all species lived it estimated to be extinct. The earth ranges species currently two million to one trillion in which 1.74 million has database and 80% yet not described. The biodiversity plotted with richness of geographical area with referenced to temporal scale. The biodiversity has taxonomic or species, ecological, morphological and genetic diversity types. In taxonomic diversity number of species, genera and family assessed type. In the insects there is about 10-30 million species, 5-10 million bacteria species, 1.5 million fungi species, one million mites and protists. The Terry Erwin published global species richness in 1982 has thirty million. In these extrapolating number of beetles found in species of tropical tree. He identified 1200 beetles species, 163 found that type of trees, he given 50,000 describe tropical tree species. The biodiversity of loss includes worldwide extinct of different species with local reduction or loss of certain species in habitat result in loss of biological diversity. This phenomenon is temporary or permanent depend on environmental degradation it leads loss is reversible by ecological restoration or resilience. The current global extinction results in biodiversity crisis driven by human activity it pushes beyond planetary boundaries and prove irreversible.

The biodiversity cornerstone of development and loss threaten many hard won development grains. The biodiversity blunts impact of other crises like climate change and conflict on development it is wealth of nation and community of within nation as produce job and gross domestic products. The value of biodiversity depend verity of living organisms also include service provided by healthy ecosystem. In which wild pollination, marine fisheries food provision and timber of native forest consist. The biodiversity considers as planets wealth it is cornerstone of development and its loss threaten many hard won development grains. The forest loss has sinks carbon loss also accelerate climate change; the Amazon forest used five percentage annual carbon emissions. The mangroves also powerful natural infrastructure it act as bio-shield and prevent erosion and absorb storm surges. It is important habitat for fish and sequesters four times more carbon than rainforests. When it becomes degraded, there are severe climate, social, and economic consequences. The loss of nature is also closely connected to climate change. The climate change need strong, vibrant and healthy oceans for absorb carbon dioxide to fight with. In India for the biodiversity protection and fight with climate change there is 14 biosphere, 914 national parks, 448 wildlife sanctuaries, 19 wetlands with five Ramsagar sites, 15 mangroves, five world heritage sites and four coral reefs. It also consists scared groves, ethno-biological reverse and natural monuments which help to conserve biodiversity with its respective regions.

BIODIVERSITY LEGISLATION

The biodiversity has important aspects of today's world so that it has it has separate polices and regulation for its protection. In India there no separate laws or polices about the medicinal plants protection there is only laws about the biodiversity. Some laws formulated by government of India which has protect the biodiversity and forest of the India.

- The forest Act, 1927
- The wildlife (protection) Act, 1972 and wildlife (protection) Amendment Act, 1991
- The forest conservation Act, 1980
- The environment protection Act, 1986
- The national forest policy Act, 1988
- The national biodiversity Act, 2002
- The scheduled tribes and other traditional forest dwellers Act, 2006

These all laws and different polices helps to protect the biodiversity of the India.

THE FOREST AND ITS STATUS

The earth land surface remnant habitat and forest cover 2.5% area in the world there is 36 areas known as hotspots. It supports more than half of world's land species as endemics which species not found no place else in which 43% of birds, mammal, reptile, and amphibian species. The earth covers about 71% marine water it has average depth 3.8 km. The oceans and sea make vast majority of volume of biosphere and by far most extensive main ecosystem type. In the world about 2-3% water is non-saline two third in which has locked away as ice and one third as ground water in upper layer of earth crust. The freshwater occurs in lake, rivers and wetlands and hold vanishingly small volume remain water, and these support the global biodiversity. In the fresh water about 40% more than 25,000 species of fishes isolated water system.

The earths around third surface have covered by the forest with close canopy forest accounts 4-5 billion hectors of lands. The Food and Agriculture Organization the global forest assessment 2020 has shown the world having 4.06 billion hectors area it is 31% total land area. The world forest has more than one third cover primary forest naturally regenerate forest with native species and not visible indication of human activity. The world's more than 54% covered by only five countries Brazil, Canada, China, Russia and United states in which Russia has cover 815 million hectors largest area and other four cover about 100 million hectors area. The Gabon an African country has cover 0.58% of world forest cover it has largest forest to land ratio of any country 91.3%. The forest ecosystem is one of critical component of biodiversity it bio diverse than another ecosystem. In the modern age deforestation has occur more in the period of 2015 to 2020 the rate of deforestation is ten million hectors per year. The global tree search database existence 60,082 tree species, in which half are only member of ten families. In the world about 58% all tree species are single country endemics, the plant world as known only 391,000 species of vascular plants in which 945 has flowering plants. The 21% species has threatened by extinction and 60% found in tropical forest. The fungi have 144,000 species which has named and classified about 93% fungal species currently unknown to science. According to International Union for conservation of nature (2019) the forest has provides 70,000 vertebrates species, the amphibians have 5,000 which has 80% to all known species. The bird has 7,500 species it is 75% all birds and more than 3,700 mammals which is 68% to all species. The invertebrate species describe about 1.3 million many are existing with estimate ranging five to ten million species. In the global 18% forest area have more than 700 million hectors legally established as protected areas like national parks, conservation area and game reserves. In the world South Africa has largest protected area which is 31%, and the Europe is cover lowest area. The five to ten percentage area of world covered by glaciers, 19% is barren land, dry salt flats, beaches, sand dunes and exposed rocks. In the world about 1.6 billion people depend on forest for their food and other necessities. The forest provides oxygen, shelter, jobs, water, nourishment and fuel. The deforestation has serious consequence on health of human. The agriculture and forest and other land use contribute 22% of global emission in which half are from deforestation and land conservation. The forest is second largest carbon store house on the earth after the ocean. It has absorbed 2.4 billion metric tons of carbon in each year. The forest also provides sustainable environment for the millions of animals for its survival. The forest also serves as water shed region, it protects streams and rivers passing through forest from suns radiation and drying. The forest is very important it act as repository for the biodiversity genes, it diverse range of plant and animal life from in distinct forest setting area. The plant also regulates atmospheric temperature by evapo-transpiration and provide environment breeze and climate stabilizer.

THE MEDICINAL PLANTS AND ITS STATUS

The medicinal plants have classified in the period 460-380 BC by Hippocrates which has known as father of the medicine. He classifies herbs basis of their essential qualities of hot and cold moist and dry developed a diagnosis and prognosis using herbs. In the medicine world morphine is first drug which isolated from the plant it identified by Frederich Sertrner. The salicin is active ingredient of willow bark tree which synthesize in 1852. It has modified by Drug Company Bayer in 1899 it modified into milder form of acetyl salicylic acid. The 40% drugs of Western region have derived from the plants. In the United States best twenty selling prescription drugs are derived from seed surrounded beautiful woody cone plants. The bark of willows has given us acetylsalicylic acid, which led to the creation of aspirin, the commonly used painkiller. The medicinal plants are poisonous and nonpoisonous the poisonous plants affect entire spectrums of organ system some plant contain several toxic ingredients it affects different system of body. The toxic ingredients occur in roots, stem, bark, leaves, flower, fruit and seed of plants. In medicinal plants majority are herbal plants about 880 herbs has well distributed in different life forms the herbs population is 41% in which grasses also included. The shrubs are 17%, climbers 16% and trees are 26%. The species of medicinal plants distributed across different bio-geographic zones. In the India Himalayan and Trans Himalayan zone including North East India about 18% species confined, while around 4% is restricted to Western Ghats and 0.5% is found only in the desert zone. The rest of all 77% species have a wide range of distribution across the other bio-geographic zones of the country. In the world also many countries have shown occurrence of different medicinal plants species which has used in health medicinal system. The data of some countries are as follows which has shown the plant species occurred in country and in which medicinal important species and its percentage.

Table 1: The occurrence of plant species and medicinal plants of some countries in the world

Sr. No.	Country	Plant species	Medicinal plant species	Percentage
01	China	26092	4941	18.9%
02	India	15000	3000	20.0%
03	Indonesia	22500	1000	04.4%
04	Malaysia	15500	1200	07.7%
05	Nepal	6963	700	10.0%
06	Pakistan	4950	300	06.1%
07	Philippines	8931	850	09.5%
08	Sri Lanka	3314	550	16.8%
09	Thailand	11625	1800	15.5%
10	USA	21641	2564	11.8%
11	Vietnam	10500	1800	17.1%
12	Average	1366	1700	12.5%
13	World	422000	52885	-

(Source- Shippman *et al.,* 2002)

The plant has consisted different chemical constituents so some are safe and while are toxic. The plant used as drug has long history the opium has first known drug from the plant source. The plant is significant part of the traditional medicine system and herbal medicine system. After the extraction of opium drug several important drugs derived from the plants like taxol, morphine, quinine and comptothecin. The plants consist alkaloids, pro-anthocyanins, triterpeniod, saponins, tannins, vitamins, volatile oils, bitter, glycosides, phenols, flavonoids, minerals, and polysaccharides. On the earth surface several plants biodiversity found which has used for prevention and treatment of human and livestock

diseases. The plants have secondary metabolites which have important in health cure. The nature was fundamental for people's survival and well-being, the plants provide basic support system on earth from food, clothing, shelter, medicine, and breath of life. The important gift of plants is discovery and utilization of psychoactive plants.

The medicinal plants are source of molecules which has medicinal properties due to natural compounds. The plants used for curing human diseases and plays important role in healing due to the presence of phyto chemical constituents. The World Health Organization states that 80% of global population still relies on the plants drugs. In the modern period he drugs discovery from natural source has involve multifaceted approach combining botanical, biological, phytochemical, and molecular techniques. Today the medicinal plant has exfoliation the decline of biodiversity due to result of global population, industrialization, deforestation, over exploitation of natural resources, pollution and it changes the global climate.

CONCLUSION

The biodiversity describes the variety of life on Earth, including the eight million plant and animal species on the planet, the ecosystems that house them, and the genetic diversity among them. It has a complex, interdependent web, in which each member plays an important role, drawing and contributing in ways that may not even be visible to the eye. The abundant foods we eat, the air we breathe, the water we drink and the weather that makes our planet habitable all. The oceans occupy more than 70% of the Earth's surface and 95% of the biosphere. The plant provides us with food, fiber, shelter, fuel and medicine. The life on earth only depends on plants which have real wealth of every nation; it used from the early civilization as source of medicine of all types diseases. It also occupies important place in modern and traditional medicine in all over the world. The biodiversity provides us sustainable benefits to meet immediate human needs such as clean, consistent water flow, protected from flood and storms and stable climate. The lack of clean water, fewer fish in the sea means less food for our survival, lack of forest resources such as food or plants for medicine. It has dangerous impact of biodiversity loss occur in the future. In the world due to different environmental effect many new diseases have come in focus the modern medical science not able to provide everyone but plant depend medicine has used by many people in the world. The human activity shows impact on the plant life so the medicinal plants species also decreases day by day. The protection of biodiversity also protects the flora and fauna of that place and help for future of human life.

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Chapter 9

EFFICIENT PRODUCTION ADVANTAGES OF USING HAPLOIDS AND POLYPLOIDS

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ABSTRACT

The technology of introducing genetic variation by using cell culture has been termed, somaclonal and genetoclonal variation. In wheat, rice corn, tobacco, abot 90 per cent of the pollen plants derived through another culture are haploid, or homozygous diploid, whereas the residual to percent are heteroploids and ancuploids Through another culture of inbred wheat cultivars we have directly obtained many aneuploid plants in wheat, including nullisomics, monosomics, spontaneous aberrations in chromosomes and telocentrics. (Seguí-Simarro, 2010). These results illustrate genetic variants may be produced without the involvement of hybridization. Anther culture can solve some problems in genetic studies and plant breeding. The advantages of using pollen plants in crop improvement include.

KEYWORDS: Production, Haploids, Polyhaploids, Variation and Advantages

INTRODUCTION

The possession of haploid and doubled haploid plants on which both dominant and recessive characters would be expressed, considerably shortens the process of selection for desirable characters. Varius types of recombinants of hybrid (F_1) gamete could be fully expressed at homozygous plant level. (Watts *et al.,* 2018). It is significantly evident when distant hybrids were used for anther culture. Recently anther culture with three F_1 hybrids of hexaploid triticale and common wheat was carried out (Sestili & Ficcadenti, 1996). More than 900 green plants were obrained and 588 of them were cytologically analyzed. (Daniel Hartl, 2011 and Murty, 1973). The F_1 hybrids between hexaploid triticale and common wheat have the chromosome constitution of AABBDR. There was DR mixed genome, two sets of univalent DR, each of which at meiosis will distribute into daughter cells in one of the seven possible ways, and thus result in diversified chromosome constitutions.

TECHNIQUES

To use pollen haploids in crop improvement, the characteristics of anther culture and haploidy like pollen plants must be understood. Anther culture can solve some problems in genetic studies and plant breeding. (Fig .2) The advantages of using pollen plants in crop improvement include (Fig. 1).

1. Gametoclonal variation
2. Plant level genetre analysis and
3. Recombinants as well as variants and new forms
4. Rapid achievement of homozygosity

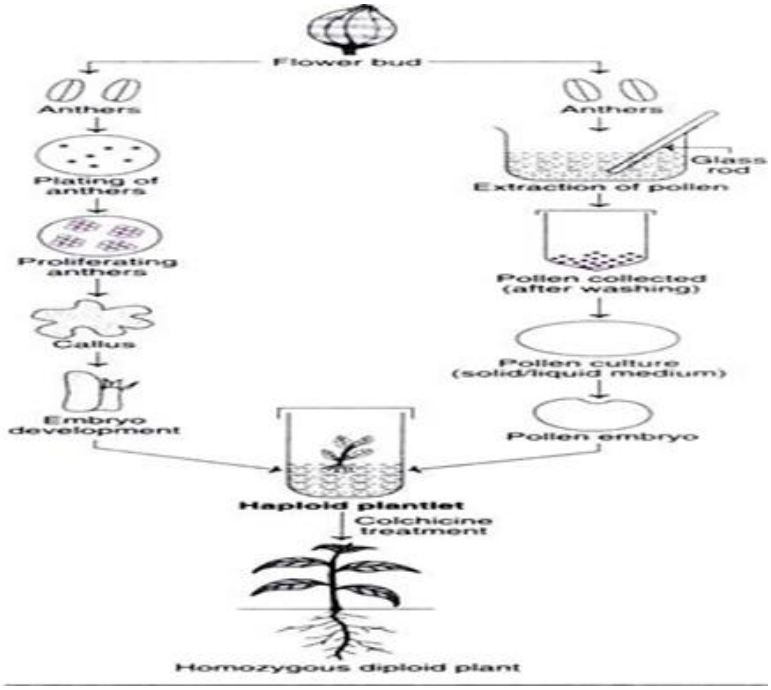

Figure 1: Anther culture

GAMETOCLONAL VARIATION

Recently it has been recognized that this method of introducing genetic changes could be used to develop new variants for plantbreeding and genetics. Pollen derived rice plants sometimes showed homozygous and sometimes heterozygous mutations. Jump up to. Tuguo Tateoka (May 1975). If all the variation prexised in the micropores (Pollen) all mutants would be homozygous (Rieger *et al.,* 1976). The heterozygous mutants must originate from the process of both gamete formation and regeneration of pollen plants. Experimental data also indicated that the frequency of aneuploid plants developed from a variety without the involvement of tissue culture is much lower than that of pollen derived plants As such the variation observed must have occurred during the culture phase. In wheat the first culture duration that is the in vitro do- differentiation stage of pollen is an important period.

PLANT LEVEL GAMETE ANALYSIS

If pollen grains of F1 hybrids are induced into pollen plants by anther culture, the haploid plants (H1) show various phenotypes of both parents. Diversity of pollen progeny has been observed in experiments with rice, wheat and tobacco. The gametes formed by meiosis are expected to contain 14 to 28 chromosomes (Darlington, (Cyril Dean) 1937). Through culture of anthers from F1 hybrids, pollen plants with chromosome numbers ranging from 17 to 27, and the corresponding diploid after spontaneous chromosome doubling were obtained. Giemsa banding analysis of 12 pollen plants derived from the Rosner x Kedong 58 F1 hybrid showed that they comprised in different numerical constitutions, of rye chromosome with wheat chromosomes of the D genome that is the chromosome of mixed or coexisted in these pollen derived plants. Theoretically, the type of pollen derived plants were the same as the types of chromosome composition formed by F1 hybrid meiosis.

RECOMBINANT VARIANTS AND NEW FORMS

The research system in our laboratory is being established for transferring genes from Triticale, Agropyron into wheat cultivars through anther culture, and producing the alien chromosome anumber variants simultaneously. The following figure shows that the most common system is to use F1 hybrids as the parental material for haploid production, there by fixing the new

products of recombination between the parental genotypes at the earliest possible opportunity. Chromosome breaks and reunions are likely to occur during anther culture. Anther culture can be used to enhance the frequency of the exchange required in sexual hybrids for introgressing desirable alien genes, that is, the variants might be obtained, also new substitution, addition and translocation lines can be obtained. The research system in our laboratory is being established for transferring genes from Triticale, Agropyron into wheat cultivars through anther culture, and producing the alien chromosome anumber variants simultaneously (Fig. 2).

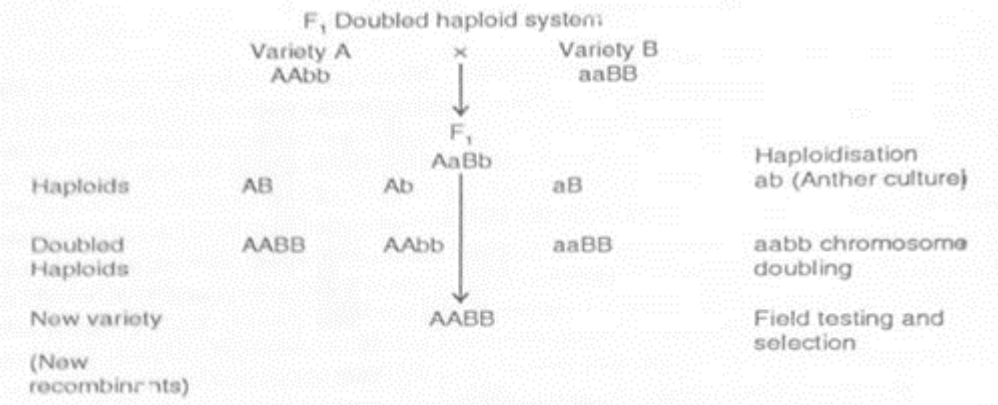

Figure 2: Agropyron into wheat cultivars through anther culture

RAPID ACHIEVEMENT OF HOMOZYGOSITY

In some cases, the haploid breeding may reduce the time needed for developing a new variety by three to four generations. For example, it only took five years to develop the varieties of rice Hua Yu No. 1 and No. 2 from the initial hybridization to release of the new varieties. Table-1. Three kinds of breeding methods of anther culture, bulk and pedigree were used to develop the four varieties.

Table 1: Development of Jinghua No.1

Year	Description	Generation	Year consumed
1976	Hybridization Lorrin 18 x (5238-035) x Hong hang No. 4 Anther culture		
1977	Chromosome doubling		
1978	Evaluation of lines	F1	
1978	Trial test, multiplication of trial test,	H2	6 years
1979	Regional seeds test, performance test	H2	
1971	multiplication of seeds		
1980	Trial test, Regional Test	H3	
1981	Performance test multiplication of seeds	H4	
1982	Nomination of Jinuhua No.1	H5	

Anther culture, might be taken as an approach to create new forms, as the case of (2n = 48) and A16 (2n = 16) which are relatively stable forms containing three plants of rye characters somes resistant to powdery mildew and setting seeds normally.

Rice aneuploids were obtained from 1715 pollen clones having a mean frequency of 10.2 percent in anther culture. Among the aneuploids obtained, the frequency of primary trisomics ranged from 5.4 percent to 6.7 percent, tetrasomics from 1.1. to 1.7 percent, monosomics from 0.9 to 1.3 percent, multisomics from 0.5 to 1 percent and double trisomics from 0.5 to 0.7 percent. The chromosome complements of anecuploids were identified by panchytene analysis of the absolute length of the extra chromosomes. Pollen clonal aneuploids showed a different range of variation in agronomic characters when compared to dihaploids from the same origin.

In anther culture of wheat and Triticale combined with irradiation, many variants and mutants were observed. The institute of application atomic energy. By irradiating anthers with gamma rays (100 KR) prior to inoculation, it was found that phenotypic frequency of haploids could be increased up to 55 percent whereas nly 14.3 percent in control where anthers were not irradiated. The variations related to may characteristics such as plant height, spike shape, and grain shape and colour and size.

APPLICATION OF POLLEN DERIVED DOUBLED HAPLOIDS

In applied research doubled haploids have been regarded as a possible means of rapidly producing true breeding lines. Madlung, A (2012). Theoretical treatment identified there important aspects to consider when deciding whether to use haploids in recurrent selection breeding programme (Snustad & Simmons, 2012).

1. The length of the selection cycle using doubled haploids versus segregating diploids and the number of fertile doubled haploids that can be produced and evaluated per cycle of selection.
2. The type of gene action (additive or dominant) involved in the determination of the character being selected and whether the character is influenced by environment. If the dominance affects phenotype more, then more the haploid system should be.
3. The length of the selection cycle using double haploids versus segregating diploids.

The benefits of doubled haploids for plant improvement include the rapid achievement of thomozygosity and in consequence the rapid incorporation of new genes into breeding materials and the increase of selection efficiency.

CHINESE SCIENTISTS HAVE EXTENSIVELY USED THIS TECHNIQUE IN PLANT BREEDING SUCH AS:

1. Establishment of haploid and dihaploid cell lines of pollen plants in maize and wheat.
2. Developing asexual line of rubber and popular of pollen plants.
3. Developing mutants resistant to diseases in tobacco, wheat and other crops.
4. Developing and releasing many new varieties of rice, wheat, pepper and maize inbred lines of pollen plants.
5. Transferring desirable allen chromosome or gene into cultivars.
6. Integration of haploidplant production with conventional breeding.
7. Production of pollen derived aneuploid and heteroploid plants.

RELEASE OF NEW VARIETIES

Many Agronomically important traits like the yield are polygenically controlled. In such cases, one cycle of recombination is insufficient. If linkages between genes are present, then not all the variation potentially available in a cross will be released. For overcoming these disadvantages, developed a method comprising one cycle of anther culture followed by sexual hybridization between different genotypes of anther derived plants and another cycle of anther culture of the selected sequal hybrids (Otto, 2007; Mable, 2004). By using this method some polygenic traits have been successfully improved. An example is the release of the cold resistant rice variety named Hua Han Zao. A method combining anther culture with composite crossing has been developed to break linkages between genes. A winter wheat variety, Jighua No. 1 with desirable characteristics has been released through this procedure

RICE

Certain institutions, such as Crop Institute of Chinese Academy of Agricultural Sciences (Beijing) using anther culture technique has released a batch of rice varieties. For example, Zhonghua No. 8 and No. 9 and Zhonghua 10. Three kinds of breeding methods, anther culture, bulk an nd pedigree were used to develop those varieties. Eighty rice varieties and strains have been developed through anther culture in China. In the early period around 1975, some rice varieties derived from pollen were released. For example, Hau Yu No. 1, Xin Xiu and Huttan Zao. At present, a standard anther culture procedure is used, to produce double haploid lines from F1 sexual crosses. Among them the duration needed for anther culture is less, i.e., only 4 generations. These varieties have high yield (7500 kg/ha) and resistance to bacterial leaf blight, blast, tyello dwarf, common dwarf and brown plant hoppers. One line-shan-Hua 369, derived from hybrid rice Shan You No. 2 showed a yield increase from 4.4 to 11.4 percent and possessed desirable characters with early maturity, high protein content from 10 to 12 percent, cold tolerance at these edling stage and uniformity at the heading and maturing stages. It has been tried out and applied in the field production.

DEVELOPMENT OF RESEARCH HIGHLIGHTS

HYBRIDIZATION

Dihaploids of Indica x Japanica crosses were successfully raised through anther culture in rice Antrogenic embryoids were developed from five cross combinations exhibiting variations. An evaluatin of anther derived lines of pomniunder field conditions indicated a considerable reduction in the duration (12.15 days) and stature of the plants A comparison of 7 anther derived cultures of cross vaigal xCo 40 indicated the supremacy of lines 433A – R5 and 433 – R6 in registering higher fields of 5.40 and 5.32 t/ha against 5.22 t/ha in the case of check, i.e. co. 40. The culture 4.3R1 was found to be resistant to blast and moderately resistant to rice tungro virus and leaf blight.

Two rice hybrids viz. Zs 97A/IR50 (115 days) and Er-Jiu-nan-IA/co. 40 (145days developed at Coimbatore have recorded an estimated grain yield of 4 t/ha respectively.

WHEAT

The new winter wheat Jinghua No. 1 is the best example of anther cultures, potential in plant breeding programmes. Jinghua No. 2 and No.3 have also been developed by anther culture. Jinghua no. 3 has good grain quality and a high protein content of 17 per cent. In 1985, the first doubled haploid variety Florin obtained by anther culture was registered in France. F1 hybrid anthers of winter type wheat were used as donor tissue for development of new strain Jingdan 2288 by anther culture. This new variety has large spikes and plenty of grains, vigorous, tillering, stripe rust and powdery mi8ldew resistance, short stem and resistance to lodging.

PEPPER

This variety possesses desirable characters with short stature, early maturity (7 – 10 days earlier than the control) desirable fruit colour and size, good quality, resistant to disease and tolerant to heat. Its yield can be from 10 to 58 per cent higher than that of the control.

MAIZE INBRED LINES

The tassel shape and ear type are most like 525. The resistance to drought is moderate and has cold tolerance and early vigour. The lines resistance to *Helminthosporium turcicum* and *H. maydis* are like C103. The lines were uniform for all agronomic traits. In the 2nd year Qun Hua was crossed with elite lines. Yield trials were conducted with controls Qundan 105 and Qundan 16 and yield data was tested.

DESIRABLE ALIEN CHROMOSOME OR GENE INTO CULTIVARS

Breeding of high yielding rice varieties with high resistance to blast in rice growing region of North China has traditionally been done by backcross, which is time consuming. However, the successful introduction of the resistant gene P1-Z in Toride No. 2 into a high yielding Chinese variety Jinxi 17 through

hybridization and anther culture was made. Two new cultivars Zhonghus No. 8 and Zhongua No. 9 with high yield potential, superior quality and good resistance to rice blast were developed. It took only 2 years through anther culture.

MUTANTS RESISTANCE TO DISEASE IN TOBACCO, WHEAT AND OTHER CROPS

It is important in crop improvement to screen mutants with resistance to disease. The selection of mutants which are easily evaluated at haploid level can be carried out by test tube methods. Now tobacco mutant resistant to black shank disease has been obtained. Lines resistant to wheat scab (Fusariun graminearum) were obtained from a susceptible variety. Similar screening techniques were adopted in rice to screen for blast resistance.

ASEXUAL LINE OF RUBBER TREE AND POPULAR OF POLLEN PLANTS

A peculiar merit of pollen plant in breeding is manifested in popular. Have obtained six-pollen derived popular stocks. Comprising 150 plants at the age of eight to nine years, some of them were observed to be disease resistant. Pollen plants can improve varieties of rubber tree (Chenetal, 1984) have obtained a pollen rubber tree taller than 6 metres, by asexual propagation. Several clones of pollen rubber trees were tasted.

HAPLOID AND DIPLOID CELL LINES OF POLLEN PLANTS IN MAIZE AND WHEAT

Through anther culture and tissue culture, both haploid an diploid somatic celllines have been established is maize and in wheat. The corn cell lines have been maintained for more than 7 years, with ability of differentiation into grenplants. These cell lines may represent a very useful system for both cytogenetical and molecular studies and for screening mutants with desirable characters.

PLANT PRODUCITON WITH CONVENTIONAL BREEDING

In this way the difficulty of selection using multiple crosss was overcome. Therefore, the anther culture has not only increased the efficiency of selection using multiple crosses, but also significantly reduced the time needed to develop new varieties. Six strains of rice have been selected from pollen plants derived from F1 anther culture of the hybrid rice variety Shan Youy No. 2. They are named as Shan, Hau, No. 7706, 78-1, 791, 792. Researchers have attempted to use these strains to replace the F1 hybrid variety and save the trouble of producing hybrid seed. Using the conventional crossing method combined anther culture with multiple crosses and selected the variety Hua Han zaao and other new strains such as strain 77001. In this way the difficulty of selection using multiple crosss was overcome. Therefore, the anther culture has not only increased the efficiency of selection using multiple crosses, but also significantly reduced the time needed to develop new varieties.

POLLEN DERIVED ANEUPLOID AND HETEROPLOID PLANTS

(a) The heteroploids are obtained through anther culture due to chromosome variations. These heteroploids are used for genetic investigation and plant breeding. Variability of polle derived plants. Cultured cells of both animal and plants characterized by instability of chromosome number and structure. The phenomin expressed in regenerated pollen derived plants

(b) They are meiosis, endomitosis spindle fusion, nuclear fusion and endo reduplication. If the initial unnucleate microspore is not a haploid because of somemeioticabnormally, the derived embryo and pollen derived plants will express this abnormal chromosome constitution. Fusion of nucleus during early nuclear divisions of the pollen grain is also possible and callus with doubled chromosome number amy be formed in this way and nonhaploid or spontaneous doubled haploids may be produced. In some species e.g., *N. tabacum*, the initial division of the vegetative nucleus is preceded by degeneration of the cytoplasmic organelles. As a result endomitosis may lead to a diploid restitution nucleus. Table-2 &Table-3 Thus, doubled dihaploids are produced. Ultimately heteroploids are produced.

Table 2: Species from which pollen derived plants first obtained in China

Year	Species	Reference
1971	*Capsicum annum*	wang *et al.* (1973)
	Triticale	Sun *et al.,* (1973)
	Triticum aestivum	Ouyand *et al.,* (1973)
1973	*Beta vulgaris* *(2n = 4x = 36)*	institute of sugar beet and sugar crops (1978)
1975	*Zea mays*	Institute of Genetics (1975)
1977	*Hevea brasillensis*	Chen *et al.,* (1978)
1978	*Sorghum vulgare*	Zhou, (1978)
1979	*Saccharum sinensis*	Chen et al, (1979)
	Linum usitatisimun	Sun, (1979)
1980	*Glycime max*	Vin *et al.,* (1980)
181	*Vitis vinefera*	Zhou and Li, (1981)

Table 3: Some Agriculture and tree species in which haploid callus (C) embryos (E) or plants (P) have been obtained by the culture of excised anthers/pollen

Crop species	Nature of haploids	Reference
Archis species Beta vultaris	E.P C.P	Bajan *et al.,* (1981) Atanassove (1973)
Brassica hirta	C.E.P	Bajaj and Mohapatra (1990)
Brassica juncea	C.E.P	George and Rao (1982)
Brassica napus	C.E.P	Swanson *et al.,* (1987)
Brassica oleracea	C.E.P	Orton and Browers (1985)
Cajous cajan	C.E	Bajaj *et al.* (1980 b)
Capsicum annum	C.P	Xuo et al (1973)
Cicer arietinum	C.E	Bajaj and Gosal (1987)
Gosypium species	C.E	Bajaj (1982)
Helianthus annus	C.P	Bohorova et al (19845)
Hordeun vulgare	C.E.P	Clapham (1973)
Coffea Arabica	C.E.P	Xuo *et al.* (1973)
Cyamopsis tetragonoloba	E	Bahah and Gosal (1988)
Haven brasillensis	C.E.P	Chen et al (1979)
Oryza sativa	C.E.P	Mercy and Zapata (1987)
Pennistum americanum	C.P	Bai-Dang Ha and Penes (1982)
Phaseolus aerecis	E.C	Bajaj and Singh (1980)
Solamin tuberosum	C.E.P	Wang et al, (1973)
Triticum aestivum	C.E.P	Wang et al (1973)
Sea mays	C.E.P	Petolino and Thompson (1987)

CONCLUSION

The above abnormal phenomena are occurring during early stages of pollen development *in vitro.* Distinct features of doubled haploids and he access to them, now allow using them in genetically studies and breeding both gamete formation and regenerate of pollen plants. Through anther culture these different genotypes of gametes might be fixed in a short time. Thus, by regeneration of doubled haploids it is possible to create variants and recombinants.

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Chapter
10

HEAVY METAL STUDY & TECHNIQUES IN BRIEF

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ABSTRACT

Farming is major tradition in most of the area in the world, most part of these areas are considered to be contaminated with heavy metals such as Cu, Zn, Cd, Pb, Ni, Hg and many more. Metal contamination mostly occurs due to industries, sewage and sludge, vehicular emission and pesticides fertilizers etc. Heavy metal contamination leads to pollution in food chain leading to disturbances and also degradation of soil quality. Heavy metals are harmful in nature and poses serious threat to urban population. Studies have been done to evaluate the effect of heavy metals on the biomass as well as microbial population in soil, plant and water. It is suggested that heavy metals have impacts on soil microbial communities. Microorganisms have been suggested to be the most indicative agent in soil ecosystem disturbances as heavy metal accumulation changes the physicochemical properties of soil as well as surrounding vegetation. In most of the cases accumulation of heavy metals have adverse effects on microbes.

KEYWORDS: Heavy metals, Biomass, Elements, Analysis

INTRODUCTION

Basically "heavy metals" refer to a naturally occurring elemental group with high atomic weight and density (5 times greater than that of water). The environment is the setting in which people, animals, plants, and microorganisms reside or operate. It is made up of the Earth's surface, its atmosphere, and its ocean. The four spheres—the biosphere (living things), the atmosphere (air), the lithosphere (land), and the hydrosphere (water)—that make up the Earth's system all coexist harmoniously with one another. Chemicals that are more prevalent than in any other area of the environment are known as environmental contaminants or pollutants (Martin 2018; Masindi 2012; Walker 2012). Industrialization has accelerated during the past 100 years. As a result, there is now a greater demand for the reckless exploitation of Earth's natural resources, which has made environmental pollution a global issue. Significant environmental damage has been caused by numerous contaminants, including gaseous pollutants, nanoparticles, radioactive isotopes, organic pollutants, organometallic compounds, and inorganic ions. In this chapter, heavy metal and its analysis techniques will be covered in more detail.

WHY IT IS NECESSARY TO STUDY HEAVY METALS

It is very much needed nowadays to determine concentration of heavy metals in various environmental segments such as air, water, soil as well as plant samples. Since heavy metals are carcinogenic in nature and produces toxic effects therefore some remedial measures would also be pre-requisite for the same. Some researchers have reported about the analysis of these metals in the environment because of their carcinogenic and toxic nature.

HEAVY METALS SOURCES

Since the Earth's origin, these heavy metals have been naturally occurring in the crust of the planet. Heavy metal use has dramatically increased, which has led to an impending rise in metallic substances in both the terrestrial environment and the aquatic environment (Gautam et al 2016). Due to anthropogenic activity, which is the main cause of pollution, heavy metal pollution has emerged. This is primarily because of metal mining, smelting, foundries, and other industries that are based on metal, as well as the leaching of metals from various sources like landfills, waste dumps, excretion, livestock and chicken manure, runoffs, automobiles, and roadwork's. The use of pesticides, insecticides, fertilizers, and other agricultural chemicals has been a secondary source of heavy metal pollution.

Some of the major metals with their harmful effects are as following:

Aluminium, vanadium chromium, manganese, cobalt, nickel, copper, zinc, arsenic, selenium, molybdenum, silver, cadmium, mercury, and lead are some of the heavy metals that are discussed in more detail. They are arranged in descending order by atomic number.

ALUMINIUM:

Although it is reported that aluminium competes with cations in biological systems, particularly magnesium, the mechanism of aluminium action is unknown. Where it binds with citrate and transferrin in the blood, there is a difference in oxidation state, but it still competes. Along with calcium availability, aluminium may also have an impact on second messenger systems. Aluminium forms an irreversible bond with the elements of the cell nucleus. The metal was found to hinder the production of microtubules in neurons. Typically, there is little absorption through the digestive system.

VANADIUM:

Vanadium enters the cells through a two-phase mechanism. It involves the fast equilibration of vanadate by transport through the anion channels. It then involves a slower phase which includes the reduction of vanadate to vanadyl (Valco 2005). Vanadate is a potent inhibitor of the plasma membrane ATPase and is reactive with a variety of enzymes, making it more toxic than vanadyl. Vanadate is also taken up at a higher rate by erythrocytes than vanadyl since vanadyl has to be oxidised to vanadate.

CHROMIUM:

The absorption of chromium from breathed particles varies. In addition to chromium's physical and chemical characteristics, the activity of macrophages in the alveoli also influences chromium absorption. It is mainly taken up by the jejunum. The degree of absorption is affected by the metal's composition and oxidation state.

MANGANESE:

Manganese is absorbed by the gut either through a high affinity, quickly storable, low capacity active transport mechanism or through non-saturable simple diffusion through the mucosal layer of the gut. Metallurgical slivers that are coughed up through the alveoli when they are too big to diffuse (ATSDR Toxicological Profile for Manganese, 2012).

COBALT:

Cobalt absorption via inhalation depends critically on biological solubility. Low systemic macrophage due to phagocytosis and mucociliary transport of physiologically insoluble cobalt particles. The alveolar macrophages may have partially dissolved cobalt particles. Through the walls of the bronchial and alveolar cavities, soluble forms of the metal enter the bloodstream. Fasting and iron insufficiency both enhances the absorption of cobalt and can affect cobalt oral absorption. Iron and cobalt compete for the same absorption pathway in the intestine, even though cobalt absorption does not require ferritin (ATSDR Toxicological Profile of Cobalt, 2004)

NICKEL:

Through the digestive system, nickel is absorbed as a lipophilic molecule with a small molecular weight. The gut's ion and ligand composition will have an impact on how well nickel is absorbed there. Research in Animal studies have demonstrated that nickel in low concentrations will be absorbed by active transport and enhanced diffusion. On the other hand, if there is a high concentration of nickel, the carriers become saturated and nickel is absorbed through passive diffusion. When nickel was absorbed by the jejunum and passively diffused through the ileum, in vitro tests produced results that are comparable. Nickel is transported in the blood by binding to albumin with ultra-filterable ligands such amino acids and short polypeptides. A lipophilic molecule with a low molecular weight that contains nickel is absorbed (ATSDR Toxicological Profile for Nickel, 2017)

COPPER:

Many enzymes require copper to operate normally; it is regarded as a necessary element. By means of cuproenzymes, which are involved in redox processes. Due to the formation of superoxide and hydroxyl radicals, this state transition can also make the substance hazardous. In typical conditions, a number of homeostatic systems maintain a level of copper that is physiologically necessary. Controlling absorption, intracellular transport, cellular uptake and outflow, sequestration/storage, and excretion of copper from the body are all parts of maintaining copper homeostasis (ATSDR Toxicological Profile for copper, 2004)

ZINC:

Zinc has been implicated in second messenger metabolism, extracellular signal recognition, dephosphorylation, protein phosphorylation, and in transcription factors activity. Zinc interacts with second messenger metabolism such as the interference of the metal with calcium regulation and with cyclic nucleotide metabolism. Zn^{2+} is influxed into the cell when the heart cells are electrically stimulated, through the voltage-dependent Ca^{2+} channels (Valko 2005).

MOLYBDENUM:

The mechanisms of molybdenum toxicity have not been thoroughly established. There is little information about the toxicity of molybdenum in people and animals. Although studies cannot be compared due to differences in copper level and other dietary ingredients, it was shown that rabbits were more responsive than rats. Since there is no evidence to the contrary, it is thought that molybdenum toxicity is identical across all species, with the exception of ruminants.

ARSENIC:

Recent research using animal models demonstrated that carcinogenic activity identical to human arsenic-induced cancer, is found in the skin, liver, urinary bladder, and lung. Therefore, typical processes of There may be some action (ATSDR Toxicological Profile for Arsenic, 2007). The prostate and Kupffer cells can develop cancer as a result of arsenic poisoning. Arsenic causes cancer by altering epigenetic processes, producing ROS, and harming the DNA maintenance system [Engwa 2019]. As contamination can be seen in groundwater due to extensive use of agrochemicals. It has harmful effects on prostate gland causes prostate cancer, leukemia and cause lesions in hepatic region i.e. liver cancer. In plants, High concentration of as cause's cell necrosis, chlorosis, and electrolyte leakage from cell membranes (Singh *et al.* 2006) has been observed. Formation of ROS damage proteins, nucleic acids and cause peroxidation of membrane lipids (Moller *et al.* 2007).

LEAD (Pb):

Pb is highly toxic as it is hard to degrade in environment, soil and water. Sources of lead depend on the lead products being used in a particular area (Gabby 2006, Gabby 2003). Its toxicity affects human population and causes intestinal cancer, lung cancer, and also affects central nervous system and causes root growth inhibition, alteration in nitrate assimilation, inhibition in calvin cycle and stomatal closure in plants.

CADMIUM:

Major source of cadmium is contaminated food and water. Its accumulation can persist in plants and animals for nearly 25-30 years. Another major source of Cd is phosphate fertilizer. Cadmium can also be accumulated in soil and ecosystem by sewage sludge which causes its consumption similarly as fertilizer. Since long time persistency of Cd in human body is carcinogenic hence It can cause gastric cancer, renal cancer, breast cancer, lung cancer in humans and in plants it affects opening of stomata, uptake of mineral and water balance in plants. It alters membrane permeability and metal ion homeostasis also decreases ATPase activity of plasma membrane.

EFFECT OF HEAVY METALS INTO THE ECOSYSTEM

Movement of heavy metals largely depends on certain factors such as temperature, direction, circulation of gases and some other factors like polarity, molecular stability and vapor pressure etc. heavy metals are main sources of soil pollution, water pollution and air pollution. Heavy metal causes severe toxicity when they get deposited on a surface for a longer time period therefore timely detection of their concentration is necessary. Otherwise, it will create a threat to our environment as well as whole human population.

ANALYSIS OF HEAVY METALS IN SOIL SAMPLES

It has been suggested that mostly used technique for heavy metal detection is AAS (Atomic Absorption Spectroscopy). Basically, there are two types of instruments being used for analytical studies i.e. General purpose and advanced type. All those instruments which are being used for heavy metal analysis considered under advanced type. A descriptive detail of some is given below:

ATOMIC ABSORPTION SPECTROMETER (AAS)

This technique was developed by Alan Walsh (1950) for analysis of certain metal concentration in sample. It is the most common technique for heavy metal and micronutrient analysis in any sample. This technique is reliable and can test more than 62 different metals in a solution. It is easy to handle, less time consuming with lesser chances of error and even better than any other spectroscopic technique. This instrument works on the principle of Lambert-Beer Law. It uses furnace and flame for elemental analysis. Although there are many other spectroscopic techniques which are being used but AAS has its own place in the field of heavy metal detection and widely used by researchers (Malandrinoz *et al.* 2002; Kartal *et al.* 2004; Kenduzler and Turker, 2003).

MICROWAVE PLASMA: ATOMIC EMISSION SPECTROSCOPY (MPAES):

It is an atomic emission method, much as flame atomic emission method. The fundamental idea is that when an atom of a certain element is stimulated by applying external energy, it releases radiation (light) when it returns to the ground state in a distinctive spectrum of wavelengths. The microwave plasma is the source of atomic emission in MPAES. A very potent plasma that can handle a variety of sample types can be created by excitation in a magnetic field as opposed to an electric one. The electromagnetic field at the plasma torch is created using a microwave waveguide that has been optimised. A toroidal plasma and an efficient core zone for sample injection are produced by magnetic excitation. The microwave energy is focused by the axial magnetic field and the radial electrical field, creating a stable plasma with intense atomization emission lines (Atomic Emission Spectroscopy: Microwave Plasma; 2019).

INDUCTIVELY COUPLED PLASMA OPTICAL EMISSION SPECTROSCOPY (ICP-OES)

First analysis of elements through ICP OES is done by Greenfield (1965). It is best suited for multi-elemental analysis in each sample simultaneously upto ng (0.1-10 ng/ml) level (Wendt *et al.* 1965; Dunken *et al.* 1966, Kirkbright *et al.* 1972) Recent advancements made in this instrument improvise its working efficiency and made it better for heavy metal analysis (Bettinelli *et al.* 2000; Simon *et al.* 2013). Govindaraju and Mevelle introduced ICP-AES spectroscopy for the study of rock samples. Because the equipment could identify multiple elements at once, it was preferred for use in rock analysis over commonly used

methods like atomic absorption spectrometry and X-ray fluorescence spectrometry. Knasmuller and others, in soils contaminated with Cu, Ni, Cr, Cd, Hg, Sb, and As were also examined. emissions from the smelters in Saualpe, Slovakian, Arnoldstein, Brixlegg, and Eastern Austria Carinthia area of the Alps and Austria. High metal concentration was reported by Kim *et al.* (Kim *et al.* 2006) in Dressing plant soil, farmland soils, and agricultural (Paddy cultivated) areas near Duckum Au- Ag mine at Duckum, Korea, employing this method.

INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY (ICP-MS)

The most potent method is inductively coupled plasma mass spectrometry (ICP-MS), which has the potential to identify several elements at ultratrace levels (Beauchemin, 2008). Inductively coupled plasma mass spectrometry (ICPMS) speciation analysis has become a standard procedure in recent years for the ultra-sensitive detection of substances containing trace metals and metalloids (Hieftje and Rosen 2004). From a review of the literature, it was clear that this instrument has been utilised for food and beverage analysis (White *et al.* 2003; Trandafir and nour 2012) environmental analysis (Meisel *et al.* 2003), clinical and biological materials analysis (Schoenberg *et al.* 2001; Fritsche and Meisel 2004), and industrial analysis of metals, chemicals, and advanced synthetic materials (Hywell *et al.* 2001; penny *et al.* 2002). Inductively coupled plasma atomic emission spectroscopy, optical spectrometry, and atomic absorption spectroscopy have all been replaced by this method, which is more sensitive than those methods and can simultaneously detect many elements. ICP-MS can identify trace elements.

ATOMIC FLUORESCENCE SPECTROMETER (AFS)

Atomic-fluorescence spectroscopy (AFS) has undoubtedly evolved into a highly sensitive, selective, and versatile method for determining a variety of environmentally and biomedically significant elements [Wu *et al.* 2013]. Several groups of researchers have used this technique as a complementary technique that may allow for greater analytical sensitivity than Atomic absorption spectroscopy.

X-RAY FLUORESCENCE (XRF) SPECTROSCOPY

The fundamental physics of X-Ray fluorescence (XRF) spectroscopy is based on a simple relationship of atom-radiation interaction. It is a highly sensitive analytical tool used for heavy metal analysis (Gilfrich, 1990; Torok *et al.* 1998; Anjos *et al.* 2000). Using X-ray Fluorescence spectrometry, Philip *et al.* (Webb *et al.* 1997) quantified rock samples (XRF). They stated that one of the most significant advantages of XRF was its ability to perform accurate quantitative analysis on a wide range of elements. They did, however, mention that, as with most other analytical techniques, matrix effects (inter element effects) must be corrected while performing quantitative analysis. (Kaminski and Landsberger, 2000) found Zn, Sb, Cd, Pb, Cu, Sn, As, Cr, Hg, and Ni in soils (industrial and residential) with a history of ferrous and nonferrous smelters.

NEUTRON ACTIVATION ANALYSIS (NAA)

It is a high-efficiency quantitative and qualitative method for determining trace elements in various types of samples. Soete claims that (Hoste *et al.* 1972) Heves discovered the mechanism of NAA in 1936 when he observed that when exposed to a source of radiation; samples containing certain rare earth elements became radioactive neutrons. The primary distinction between NAA and other techniques is that the former is founded on Later ones focus on nuclear transitions, while earlier ones focus on electronic transitions. Heavy metals were discovered using (Alfassi, 1985) investigated epithermal neutron activation. He proposed that an important source for the nuclear reactor was determined by activation analysis due to its high flux of bombardment.

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Chapter
11

NANO CHEMISTRY -OVERVIEW

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ABSTRACT

Nanochemistry is a branch of chemistry that deals with the study of chemical systems and processes at the nanoscale. It focuses on the properties, behavior, and manipulation of materials at the nanometer scale, which is typically between 1 and 100 nanometers. In nanoscale systems, unique phenomena and properties emerge due to the quantum mechanical effects and increased surface-to-volume ratio. These properties can differ significantly from those observed in bulk materials. This branch of chemistry involves the synthesis, characterization, and manipulation of nanoparticles, nanocrystals, nanotubes, nanowires, and other nanoscale materials. This field is interdisciplinary, involving the aspects of chemistry, physics, materials science, and engineering. It has significant implications for various industries, including healthcare, electronics, energy, and environmental sectors, and holds great potential for technological advancements. Researches in nanochemistry include analyzing and characterizing nanoparticles to understand their structure, composition, surface properties, and interactions and applying nanotechnology to develop new drug delivery systems, diagnostic tools, and therapies for medical applications. Scientists from different disciplines collaborate to explore the fundamental principles of nanoscale phenomena and develop new applications.

KEYWORDS: Nanochemistry, nanomaterials, nanocrystals, nanotubes, industrial field, applications.

INTRODUCTION

The concept of the "atom" as the fundamental building block of matter was proposed by ancient Greek philosophers such as Democritus, in the 5th century BCE. However, it wasn't until the 19th century that scientists began to develop a more rigorous understanding of atomic and molecular behavior through the work of pioneers like John Dalton, Amedeo Avogadro, and Dmitri Mendeleev. In the early 20th century, the development of quantum mechanics revolutionized the understanding of atomic and molecular behavior. Scientists like Max Planck, Albert Einstein, Erwin Schrödinger, and Werner Heisenberg introduced quantum theories that explained the behavior of matter and energy at the atomic and subatomic levels. These theories laid the foundation for understanding the unique phenomena that occur at the nanoscale. The invention of the scanning tunneling microscope (STM) by Gerd Binnig and Heinrich Rohrer in 1981 was a breakthrough in the field of nanoscale imaging. The STM allowed scientists to visualize individual atoms and manipulate them at the atomic level, opening up new possibilities for studying and manipulating matter on the nanoscale. In the 1980s and 1990s, significant progress was made in the synthesis of nanoparticles with controlled sizes and properties. Researchers like Sumio Iijima discovered carbon nanotubes in 1991, and Richard Smalley, Harold Kroto, and Robert Curl were awarded the Nobel Prize in Chemistry in 1996 for their discovery of fullerenes, including the well-known C60 buckyball. Nanoscience and nanotechnology gained recognition as distinct interdisciplinary fields encompassing various disciplines, including chemistry, physics, materials science, and engineering. Nanochemistry continues to be an active and interdisciplinary field of research. The field continues to

evolve, with ongoing advancements in nanomaterial synthesis, nanoscale characterization techniques, and the development of Nano systems for various applications.

NANOPARTICLES

Nanoparticles are small particles with dimensions in the nanometer range, typically between 1 and 100 nanometers. They can be composed of various materials such as metals, metal oxides, semiconductors, polymers, and organic compounds. Nanoparticles possess unique properties and behaviors that differ from bulk materials due to their small size and increased surface-to-volume ratio. They can have different shapes, such as spheres, rods, wires, tubes, or other geometries. The size and shape of nanoparticles influence their physical, chemical, and optical properties. Nanoparticles have a large surface area-to-volume ratio compared to bulk materials. This increased surface area results in more exposed atoms or molecules, leading to enhanced reactivity and interactions with the surrounding environment. They exhibit unique optical properties due to their size and shape. For example, metallic nanoparticles can display plasmonic effects, which give rise to vibrant colors and strong absorption and scattering of light. Quantum dots, a type of semiconductor nanoparticles, exhibit size-dependent fluorescence emission.

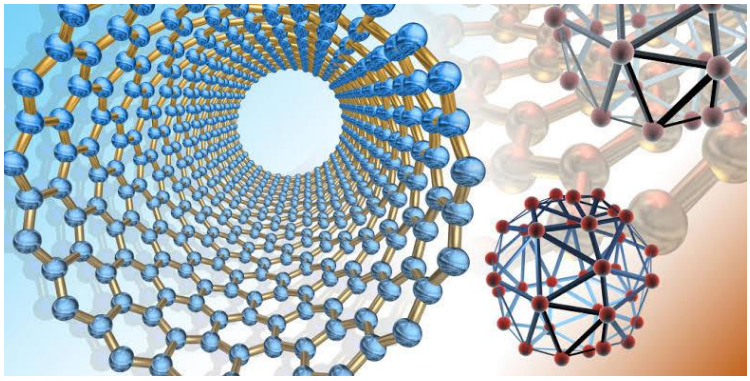

Figure 1: Nanoparticles

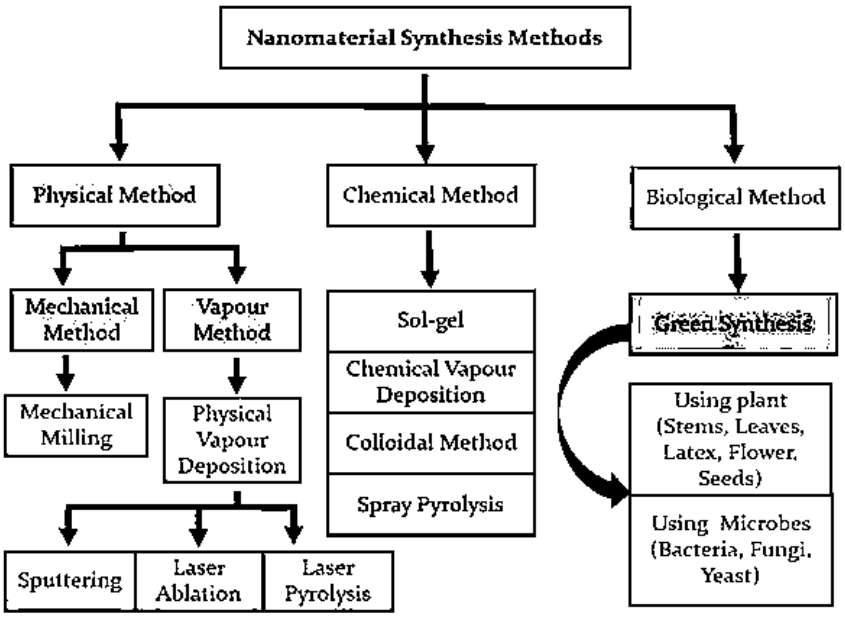

Figure 2: Synthesis Methods for Nanoparticles

Nanoparticles have a wide range of applications in various fields. They are used in electronics, catalysis, energy storage, environmental remediation, drug delivery, imaging, sensing, and many other areas. Their small size and unique properties make them suitable for targeted drug delivery, high-performance

catalysts, ultra-sensitive sensors, and advanced electronic devices. To synthesize nanoparticles, various methods are employed, including chemical precipitation, sol-gel synthesis, vapor deposition, laser ablation, and template-assisted synthesis. These methods allow scientists to control the size, shape, composition, and surface properties of nanoparticles.

IMPORTANCE OF NANOCHEMISTRY IN INDUSTRIAL FIELD

Nanochemistry has significant importance in the industrial field due to its potential for creating new materials with enhanced properties and developing innovative technologies. It enables the synthesis and manipulation of nanomaterials with unique properties. Industries can utilize these advanced materials for various applications, such as lightweight and durable materials for aerospace, high-performance coatings, and advanced composites. It plays a crucial role in developing more efficient energy storage and conversion devices. For example, nanostructured electrodes and catalysts can enhance the performance and stability of batteries, fuel cells, and solar cells. These advancements can lead to longer-lasting batteries, more efficient energy conversion, and the integration of renewable energy sources into the power grid.

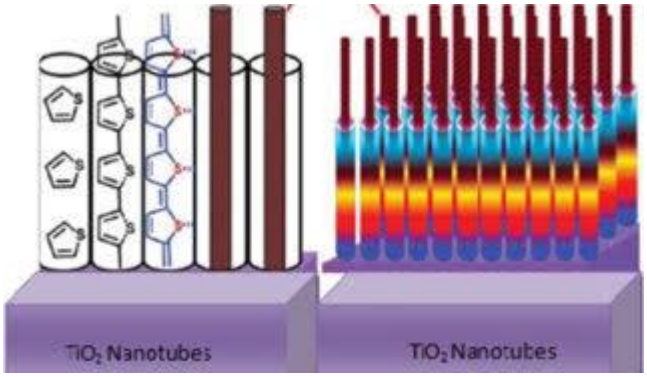

Figure 3: Nanotubes

This advanced field of chemistry has contributed to the miniaturization and improvement of electronic devices. Nanoscale materials like nanowires, quantum dots, and graphene have unique electrical and optical properties that can be utilized in electronics, photonics, and optoelectronics. It enables the fabrication of nanoscale components with enhanced functionality, such as faster and smaller transistors, high-resolution displays, and sensors. It has revolutionized the field of drug delivery and therapeutics. Nanoparticles can be designed to carry drugs to specific target sites in the body, improve drug solubility, prolong drug release, and enhance therapeutic efficacy. It offers promising solutions for environmental challenges. Nanomaterials can be used for pollutant detection, water purification, air filtration, and remediation of contaminated sites. For example, nanostructured catalysts can efficiently degrade pollutants, and nanosensors can detect and monitor environmental contaminants at low concentrations.

Nanochemistry provides the tools for developing sustainable and eco-friendly technologies. It has implications for manufacturing processes and quality control. Nanoscale materials and coatings can improve the durability, strength and performance of manufactured products. Moreover, nanosensors and Nano probes enable more sensitive and accurate monitoring of production processes and product quality. This interdisciplinary nature allows for collaboration between scientists, engineers, and industry professionals, leading to the translation of fundamental research into practical applications.

IMPORTANCE OF NANOCHEMISTRY IN PHARMACEUTICAL FIELD

Nanochemistry plays a significant role in the pharmaceutical field, offering numerous advantages and opportunities for drug discovery, and diagnostics. It enables the design and development of innovative drug delivery systems. Nanoparticles, liposomes, micelles, and other Nano carriers can encapsulate drugs, protecting them from degradation and enhancing their stability. These Nano carriers can also

improve drug solubility, control drug release rates, and target specific tissues or cells, leading to enhanced therapeutic efficacy and reduced side effects. It allows for the precise engineering of drug delivery systems to optimize drug delivery, bioavailability, and patient compliance. Functionalized nanoparticles can be designed to recognize and bind to specific receptors or markers on target cells. This targeting approach improves drug concentration at the desired site, enhances treatment efficacy, and reduces systemic toxicity. Many drug compounds have poor solubility, which limits their therapeutic effectiveness. Nanochemistry offers solutions to enhance drug solubility through techniques like nanocrystals formation or formulation into Nano emulsions or nanoparticles. By reducing drug particle size to the nanoscale, the surface area-to-volume ratio increases, improving drug dissolution and absorption. This can lead to increased drug bioavailability and improved therapeutic outcomes.

Nanotechnology-based diagnostics and therapeutics can be tailored to individual patients based on their specific genetic, physiological, or disease characteristics. For example, nanosensors and Nano probes can detect biomarkers or genetic abnormalities at low concentrations, allowing for early disease detection and personalized treatment strategies. It facilitates combination therapy, where multiple drugs or therapeutic agents are combined within a single Nano carrier. This approach enables synergistic effects, simultaneous targeting of multiple pathways, and controlled release of different drugs, enhancing therapeutic outcomes. This field provides the means to design multifunctional nanoparticles capable of delivering various therapeutic agents in a coordinated and controlled manner.

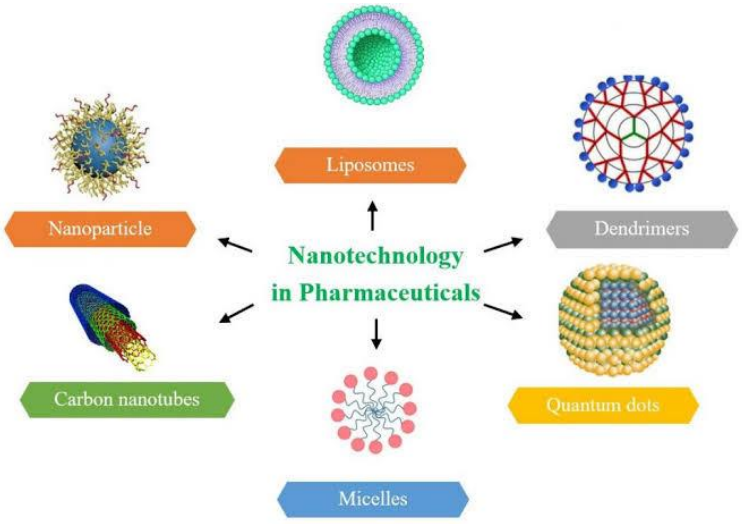

Figure 4: Nanochemistry in Pharmaceutical Field

Nanochemistry plays a crucial role in molecular imaging and diagnostics. Nanoparticles can be engineered to carry imaging agents, such as fluorescent dyes, quantum dots, or magnetic nanoparticles, allowing for high-resolution imaging of tissues or cells. The application of nanochemistry in the pharmaceutical field offers tremendous potential for improving drug delivery, enhancing therapeutic efficacy, and advancing diagnostics.

APPLICATIONS OF NANOCHEMISTRY IN POLLUTION CONTROL

Nanochemistry offers several applications in pollution control, providing innovative solutions to address environmental challenges.

Water pollution: This field of chemistry plays a crucial role in the development of efficient water purification technologies. Nanomaterials, such as nanoparticles and nanocomposites, can be used as adsorbents to remove pollutants, heavy metals, and contaminants from water. Their high surface area and reactivity enable effective adsorption and catalytic degradation of pollutants. Additionally, Nano

membranes and nanofillers can be employed for precise filtration and separation processes, allowing for the removal of even smaller contaminants.

Air Pollution: Nanochemistry contributes to the development of advanced air filtration systems. Nanoparticles, such as activated carbon nanoparticles or metal-organic frameworks (MOFs), can be incorporated into air filters to capture and remove harmful gases, volatile organic compounds (VOCs), and particulate matter. Nanostructured materials with tailored surface properties can enhance the adsorption and catalytic degradation of air pollutants, leading to improved air quality.

Environmental Remediation: This advanced field of chemistry offers solutions for the remediation of contaminated sites. Nanomaterials can be used for the removal and degradation of pollutants in soil and groundwater. For example, nanoparticles can be functionalized with specific molecules to selectively target and immobilize contaminants, enhancing their removal from the environment. Additionally, nanocatalysts can facilitate the degradation of persistent organic pollutants (POPs) or hazardous substances through advanced oxidation processes.

Sensor Technologies: Nanochemistry plays a vital role in the development of nanosensors for pollution monitoring and detection. Nanomaterials, such as nanowires, nanotubes, and quantum dots, can be utilized to create highly sensitive and selective sensors for detecting pollutants, gases, and heavy metals.

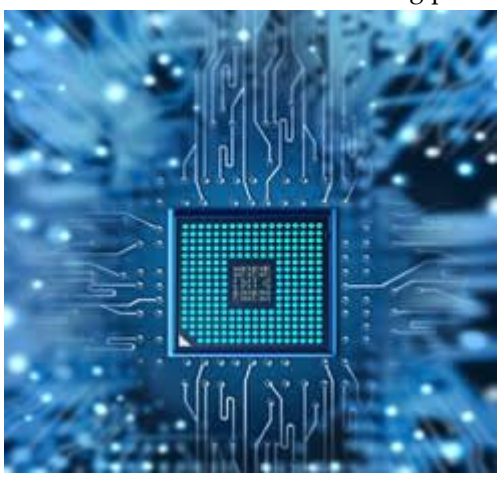

Figure 5: Nanosensors

Photocatalysis: Nanochemistry enables the development of efficient photocatalytic systems for pollution control. Semiconductor nanoparticles, such as titanium dioxide (TiO_2) or zinc oxide (ZnO), can be used as photocatalysts to degrade pollutants under light irradiation. These nanoparticles absorb photons and generate electron-hole pairs, leading to the generation of reactive species that can oxidize and degrade pollutants.

This field has the potential to contribute to sustainable and cleaner environments by mitigating the impact of pollution on human health and ecosystems.

IMPORTANCE OF NANOCHEMISTRY IN AGRICULTURAL FIRELD

Nanochemistry has the potential to revolutionize the agricultural field by offering innovative solutions to address various challenges and improve agricultural practices. It enables the development of Nano fertilizers and Nano pesticides that provide targeted and controlled release of nutrients and agrochemicals. Nano fertilizers can enhance nutrient uptake efficiency, reduce fertilizer leaching, and promote plant growth. Nano-based pesticide formulations can improve the efficacy of pest and disease control while minimizing environmental impact. It offers solutions for effective crop protection and disease management. Nanomaterials can be used to develop Nano encapsulated bio control agents, delivering them precisely to the target sites. Nanostructured materials can also be used to develop smart

sensors for early detection of plant diseases, enabling timely interventions and reducing crop losses. Nanosensors can monitor soil conditions, moisture levels, nutrient availability, and pesticide residues in real-time, allowing farmers to optimize irrigation, fertilizer application, and pest management. Nanomaterial-based devices can facilitate the collection and analysis of agricultural data, enabling data-driven decision-making for efficient farm management.

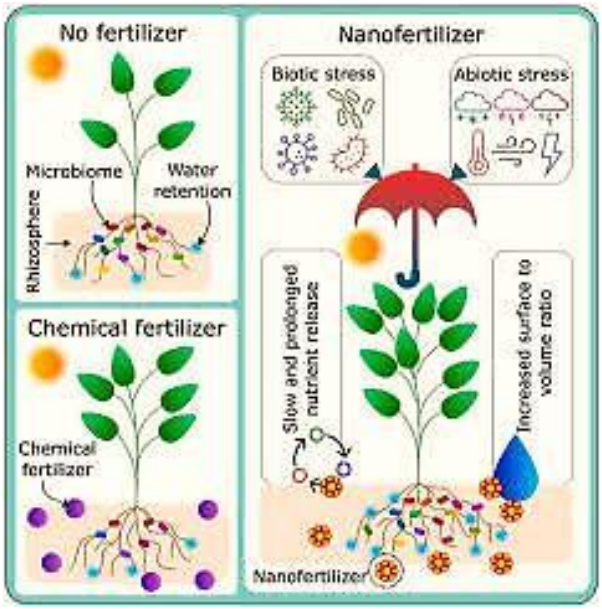

Figure 6: Effects of Nano fertilizers

Nanochemistry plays a role in soil remediation and water management practices. Nanomaterials, such as nanoparticles and nanocomposites, can be used for soil remediation to remove pollutants, heavy metals, and contaminants from agricultural soils. Nanomaterial-based water filtration systems can efficiently remove harmful substances, pathogens, and pollutants from irrigation water, improving water quality and minimizing the risk of crop contamination. It also offers tools and techniques for plant genetics and biotechnology research. Nanoparticles can be used for gene delivery and transformation of plant cells, facilitating genetic modification and the development of genetically modified crops with improved traits, such as disease resistance, enhanced nutrient uptake, or increased tolerance to abiotic stresses. It can enhance post-harvest management and preservation of agricultural products. Nanomaterials, such as edible coatings and films, can extend the shelf life of fruits and vegetables by reducing water loss, delaying spoilage, and preventing microbial growth. By utilizing nanochemistry principles and techniques, the agricultural industry can improve crop productivity, enhance resource management, reduce environmental impact, and ensure food security. However, it is important to consider the potential environmental and health risks associated with nanomaterials, and further research is needed to ensure their safe and sustainable use in agriculture.

ADVANCED RESEARCHES IN NANOCHEMISTRY

Nanochemistry is a highly active area of research, with scientists exploring a wide range of topics and applications. Researchers focus on developing novel methods for synthesizing nanoparticles with precise control over their size, shape, composition, and surface properties. Various techniques, such as sol-gel synthesis, chemical vapor deposition, and template-assisted synthesis, are explored to fabricate nanoparticles with tailored properties for specific applications. It plays a vital role in advancing energy-related technologies. Researchers investigate nanomaterials, such as nanowires, quantum dots, and nanocomposites, for applications in solar cells, batteries, fuel cells, and supercapacitors. The aim is to

improve energy conversion efficiency, enhance energy storage capacity, and develop sustainable and efficient energy systems.

Nanochemistry is utilized to develop highly efficient and selective catalysts for various chemical reactions. Researchers explore the use of nanoscale materials, such as metal nanoparticles, metal-organic frameworks (MOFs), and graphene-based materials, to enhance catalytic activity, increase reaction rates, and enable new reaction pathways. Nanocatalysts find applications in environmental remediation, chemical synthesis, and industrial processes. It contributes to the development of nanoscale drug delivery systems for targeted and controlled release of therapeutic agents. Researchers design and optimize Nano carriers, such as liposomes, polymeric nanoparticles, and dendrimers, to enhance drug solubility, stability, and bioavailability. The goal is to improve drug delivery to specific tissues or cells, reduce side effects, and enhance therapeutic efficacy. It is instrumental in the development of highly sensitive nanosensors and Nano probes for biomedical, environmental, and analytical applications.

Researchers are exploring innovative applications, fundamental principles, and interdisciplinary collaborations to further expand the frontiers of nanochemistry.

ADVANTAGES AND DISADVANTAGES OF NANOCHEMISTRY

Nanochemistry offers several advantages and opportunities in various fields, but it also has some potential disadvantages and challenges.

ADVANTAGES

Nanochemistry allows for precise control over the size, shape, composition, and surface properties of nanoparticles and nanomaterials. This control enables the development of materials with unique and tailored properties, leading to improved performance in various applications. Nanomaterials often exhibit enhanced or novel properties compared to their bulk counterparts due to their small size and increased surface-to-volume ratio. These properties can include improved reactivity, optical properties, electrical conductivity, and mechanical strength, opening up new possibilities for advanced technologies. The unique properties of nanomaterials can lead to improved performance in various applications. For example, nanocatalysts can exhibit higher catalytic activity and selectivity, nanomaterials can offer improved energy storage and conversion efficiency, and nanosensors can provide enhanced sensitivity and selectivity in detecting analytes. It enables the development of novel applications and technologies that were not previously possible. It contributes to advancements in fields such as electronics, medicine, energy, environmental remediation, and agriculture, offering innovative solutions to complex challenges. Nanomaterials often require lower quantities of raw materials compared to traditional materials, leading to more efficient resource utilization. This can contribute to sustainability by reducing waste and energy consumption during manufacturing processes.

DISADVANTAGES

The small size and unique properties of nanoparticles can raise concerns about their potential health and environmental impacts. It is crucial to understand and address the safety aspects of nanomaterials, including their toxicity, bioaccumulation, and potential release into the environment. The precise synthesis and large-scale production of nanomaterials can be challenging and expensive. Developing scalable and cost-effective manufacturing processes for nanomaterials remains a significant hurdle in the widespread commercialization of nanochemistry-based technologies. The rapid development of this field raises regulatory and ethical considerations. It is important to establish guidelines and regulations to ensure the safe and responsible use of nanomaterials and to address any potential ethical concerns associated with their applications. Despite significant progress, there are still gaps in our understanding of the behavior and interactions of nanomaterials. Further research is needed to fully comprehend the long-term effects of nanomaterials on human health, ecosystems, and the environment. Some

nanomaterials and nanotechnology-based products can be expensive, which can limit their accessibility and adoption, especially in developing countries or resource-constrained settings.

CONCLUSION

Major benefits of nanotechnology include improved manufacturing methods, water purification systems, energy systems, physical management, nanomedicine, better food production methods, nutrition and large-scale infrastructure auto-fabrication. As with any technology, it is important to carefully evaluate the advantages and disadvantages of nanochemistry, ensuring that potential risks are mitigated, and the benefits are maximized. Continued research, regulation, and responsible use are essential in harnessing the full potential of nanochemistry while addressing any associated challenges.

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Chapter
12

HEAVY METALS TOXICITY-HUMAN AND ENVIRONMENT

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ABSTRACT
Heavy metals are naturally occuring rudiments that have a high atomic weight and a density at least 5 times greater than that of water. Their multiple artificial, domestic, agrarian, medical and technological operations have led to their wide distribution in the terrain; raising enterprises over their implicit goods on mortal health and the terrain. Their toxin depends on several factors including the dose, route of exposure, and chemical species, as well as the age, gender, genetics, and nutritive status of exposed individualities. Because of their high degree of toxin, arsenic, cadmium, chromium, lead, and mercury rank among the precedence essence that are of public health significance. They are also classified as mortal carcinogens (known or probable) according to the U.S. Environmental Protection Agency, and the International Agency for Research on Cancer.This review analyses of the environmental occurrence of the trace metals, their production and use, toxicity to humans, molecular mechanisms of toxicity, genotoxicity, and carcinogenicity.

KEYWORDS: Heavy metals, human exposure, toxicity, genotoxicity, carcinogenicity

INTRODUCTION

Environmental pollution of heavy metals is increasingly becoming a problem and has become of great concern due to the adverse effects they are causing around the world. These inorganic adulterants are being discarded in our waters, soils and into the atmosphere due to the fleetly growing husbandry and essence diligence, indecorous waste disposal, diseases and pesticides. Some metals affect natural functions and growth, while other metals accumulate in one or further different organs causing numerous serious conditions similar as cancer. Heavy metals are defined as metallic rudiments that have a fairly high viscosity compared to water (1). With the supposition that heaviness and toxin are inter-related, heavy metals also include metalloids, similar as arsenic, that are suitable to induce toxin at low position of exposure (2). In recent times, there has been an adding ecological and global public health concern associated with environmental impurity by these metals. Also, mortal exposure has risen dramatically as a result of an exponential increase of their use in several artificial, agrarian, domestic and technological operations (3). Reported sources of heavy metals in the terrain include geogenic, artificial, agrarian, pharmaceutical, domestic backwaters, and atmospheric sources (4). Environmental pollution is veritably prominent in point source areas similar as mining, foundries and smelters, and other essence-grounded artificial operations (1, 3, 4). Natural phenomena such as weathering and volcanic eruptions have also been reported to significantly contribute to heavy metal pollution [1, 3, 4, 7, 8] Industrial sources include metal processing in refineries, coal burning in power plants, combustion of petroleum products, nuclear power stations and high tension lines, industries producing plastics, textiles, microelectronics, preservation of wood. Studies show that that metals such as cobalt (Co), copper (Cu), chromium (Cr), iron (Fe), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se) and zinc (Zn) are essential nutrients that affect various biochemical and physiological functions [12]. Lack of these micro-nutrients results in a variety of deficiency diseases or syndromes [12].

ARSENIC

Arsenic is a ubiquitous element that's detected at low concentration in nearly all environmental matrices (9). The major inorganic forms of arsenic include the trivalent arsenite and the pentavalent arsenate. Several arsenic- containing composites are produced industrially, and have been used to manufacture products with agrarian operations similar as germicides, dressings, pesticides, algicides, lamb dips, wood preservatives, and dye-stuffs. They have also been used in veterinary drug for the eradication of tapeworms in lamb and cattle (34). Arsenic composites have also been used in the medical field for at least a century in the treatment of syphilis, yaws, amoebic dysentery, and trypanosomaiasis (10, 11). It's estimated that several million people are exposed to arsenic chronically throughout the world, especially in countries like Bangladesh, India, Chile, Uruguay, Mexico, and Taiwan, where the ground water is defiled with high attention of arsenic. Exposure to arsenic occurs via the oral route (ingestion), inhalation, dermal contact, and the parenteral route to some extent (12). Impurity with high situations of arsenic is of concern because arsenic can beget several mortal health goods. Several epidemiological studies have reported a strong association between arsenic exposure and increased pitfalls of both carcinogenic and systemic health goods (13).

CADMIUM

Cadmium is a heavy essence of considerable environmental and occupational concern. It's extensively distributed in the earth's crust at an average attention of about 0.1 mg/ kg. The highest level of cadmium composites in the terrain is accumulated in sedimentary rocks, and marine phosphates contain about 15 mg cadmium/ kg (14). Cadmium is frequently used in various industrial activities. The major industrial applications of cadmium include the production of alloys, pigments, and batteries [15]. The main routes of exposure to cadmium are via cigarette smoking, and ingestion of food. Skin immersion is rare. Mortal exposure to cadmium is possible through a number of several sources including employment in primary essence diligence, eating defiled food, smoking cigarettes, and working in cadmium- defiled work places, with smoking being a major contributor (19, 17). Cadmium is a severe pulmonary and gastrointestinal inconvenience, which can be fatal if gobbled or ingested. After acute ingestion, symptoms similar as abdominal pain, burning sensation, nausea, puking, expectoration, muscle cramps, vertigo, shock, loss of knowledge and storms generally appear within 15 to 30 min (18). Cadmium composites are classified as mortal carcinogens by several nonsupervisory agencies. The International Agency for Research on Cancer (19) and the U.S. National Toxicology Program have concluded that there's acceptable substantiation that cadmium is a mortal carcinogen Some of these metals including arsenic, cadmium, chromium, and nickel have found to be associated with DNA damage through base pair mutation, deletion, or oxygen radical attack on DNA [20].

CHROMIUM

Chromium (Cr) is a naturally occurring element present in the earth’s crust, with oxidation state ranging from chromium (II) to chromium (VI) (21). Chromium enters into colorful environmental matrices (air, water, and soil) through various natural and anthropogenic sources with the highest amount entering from artificial establishments, diligence with the largest donation to chromium release include essence processing, tannery installations, chromate product, pristine sword welding, and ferrochrome and chrome color product. The increase in the environmental concern for chromium is due to air and wastewater release of chromium, with major part contributed from metallurgical, refractory, and chemical diligence. Hexavalent chromium Cr (VI)) is a poisonous artificial contaminant that's classified as mortal carcinogen by several nonsupervisory and non-regulatory agencies (22-24). Major factors governing the toxin of chromium composites are oxidation state and solubility. Cr(VI) composites, which are important oxidizing agents and therefore tend to be prickly and sharp, appear to be much further poisonous systemically than Cr(III) composites, given analogous quantum and solubility(25,26).

Adverse health goods convinced by Cr (VI) have also been reported in humans. Workers exposed to Cr (VI) - containing composites have reported respiratory cancers in various parts of the world (27, 28).

LEAD

Lead is a naturally being bluish-grey metal present in small quantities in the earth's crust. Although lead is naturally occurring in the earth crust, human activities such as burning of fossil fuels, mining and manufacturing activities contribute to higher concentrations in the environment. It is largely contributed from lead acid batteries, gasoline, sewage sludge, lead added in paints, sulphide deposits having lead. Human body receives its major part of lead from water distributed through led piping's which are still being used in some parts (29,30). Adults absorb 35 to 50% of lead through drinking water, which is much higher in case of children rising upto 50 %.Absorption of lead is greatly affected by age of the individual and the physiological condition.

Experimental studies have indicated that lead is potentially carcinogenic, converting renal excrescences in rats and mice (31,32), and is thus considered by the IARC as a probable mortal carcinogen (33). Studies have indicated that exposure to lead led to damage in genetic makeup through various mechanisms which may include inhibition of DNA synthesis.

MERCURY

Mercury is a heavy metal belonging to the transition element series of the periodic table. Mercury is a wide environmental toxin and contaminant which induces severe alterations in the body tissues and causes a wide range of adverse health goods (34). Mercury is employed in the electrical assiduity (switches, thermostats, batteries), dentistry (dental emulsions), and multitudinous artificial processes including the product of acidulous soda pop, in nuclear reactors, as antifungal agents for wood processing, as a detergent for reactive and precious essence, and as a preservative of pharmaceutical products (35). Humans are exposed to all forms of mercury through accidents, environmental pollution, food impurity, dental care, preventative medical practices, artificial and agrarian operations, and occupational operations (36). Epidemiological studies have demonstrated that enzymatic exertion was altered in populations exposed to mercury; producing genotoxic differences, and suggesting that both habitual and fairly low position mercury exposures may inhibit enzyme exertion and induce oxidative stress in the cells (37). There's no mistrustfulness that the connection between mercury exposure and carcinogenesis is veritably controversial. Still, in- vitro studies suggest that the vulnerability to DNA damage exists as a result of cellular exposure to mercury. These studies also indicate that mercury-convinced toxin and carcinogenicity may be cell-, organ- and/ or species-specific.

A comprehensive analysis of published data indicates that heavy metals such as arsenic, cadmium, chromium, lead, and mercury, occur naturally. However, anthropogenic activities are responsible for environmental contamination. Their large scale use in industrial, medical, agricultural fields have resulted in higher concentrations in the environment, causing detrimental effects on human health and environment. Their toxicity in the living beings is affected by many factors which include dose, age, gender, nutritional status and more. Lead, mercury, cadmium, arsenic because of their high degree of toxicity is ranked in the priority metals for public health significance. These metallic elements are considered systemic toxicants that are known to induce multiple organ damage, even at lower levels of exposure. They are also classified as human carcinogens (known or probable) according to the US Environmental Protection Agency and the International Agency for Research on Cancer. Several studies have shown that toxic metals exposure causes long term health problems in human populations. Recent reports have pointed out that these toxic elements may interfere metabolically with nutritionally essential metals such as iron, calcium, copper, and zinc [38, 39].

A recent review of a number of individual studies showed that the mixtures of these metals i.e. arsenic, lead and cadmium have more pronounced effects on the system than the individual metal in both low and high doses [40]. In many areas of metal pollution, exposure to low doses of various is a major public

health concern. Understanding the mechanistic basis of heavy metal interactions is essential for assessment of health risk and management of chemical mixtures. Hence, research is needed to further find out the molecular mechanisms and impact on public health associated with human exposure to mixtures of toxic metals.

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Chapter 13

COMPUTER AIDED STUDIES (AN APPLICATION OF MODELING USING COMPUTER-A GREENER APPROACH)

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ABSTRACT

It is a demand in the modern era of chemical sciences to develop and design new and useful compounds for the service of mankind without the use of methods which are traditional one. Workers were trying to develop and synthesizing series of new compounds since past in the laboratories using traditional synthetic methods and they used to check their properties thereafter. This process is time consuming and this led to synthesis of a large number of compounds. Some recent trends have been emerged and developed in the field of designing of compounds which may include microwave synthesis, computer aided designing etc... Out of these methods this chapter will focus on computer aided simulation of spectra of compounds on the PC. These computational methods are less time consuming, involve less chances of error, helpful in controlling and causing less pollution and may prove to be helpful in designing compounds with desired properties, in the studies like this. This chapter includes introduction to the computational methods, a little theory behind these methods, their applications and use of software /s methods precisely semi-empirical methods in different types of studies such as simulation of spectra and a little bit of QSAR studies.

KEYWORDS: QSAR studies, Computational methods, Software.

INTRODUCTION

It is a requirement to synthesize new compounds which are useful for mankind. Chemists are doing their work in this regard. But this can be made easy and eco-friendly using computer simulation studies. This may be considered as a greener approach. This approach is in wide use now-a-days.

CHEMICAL SYNTHESIS

1. Chemical synthesis, the construction of complex chemical compounds from simpler ones.
2. It is the process by which many substances important to daily life are obtained.
3. It is applied to all types of chemical compounds, but most syntheses are of organic molecules.
4. Green synthesis
5. Green synthesis is an environmentally friendly method presenting a different way of thinking in chemistry intended to eliminate toxic waste, reduce energy consumption, and to use ecological solvents (water, ethanol, ethyl acetate, etc.)
6. The term *Green chemistry*, offered to the scientific community in 1991 was designed for elimination or decrease in hazardous substances, trying to reduce the exposure of humans and environment to chemicals.

Therefore, one can have an idea that Chemistry has a different view today.

Chemistry Today: A Different View: Figure 1 shown below expresses the different view adopted in the studies of Chemistry, today.

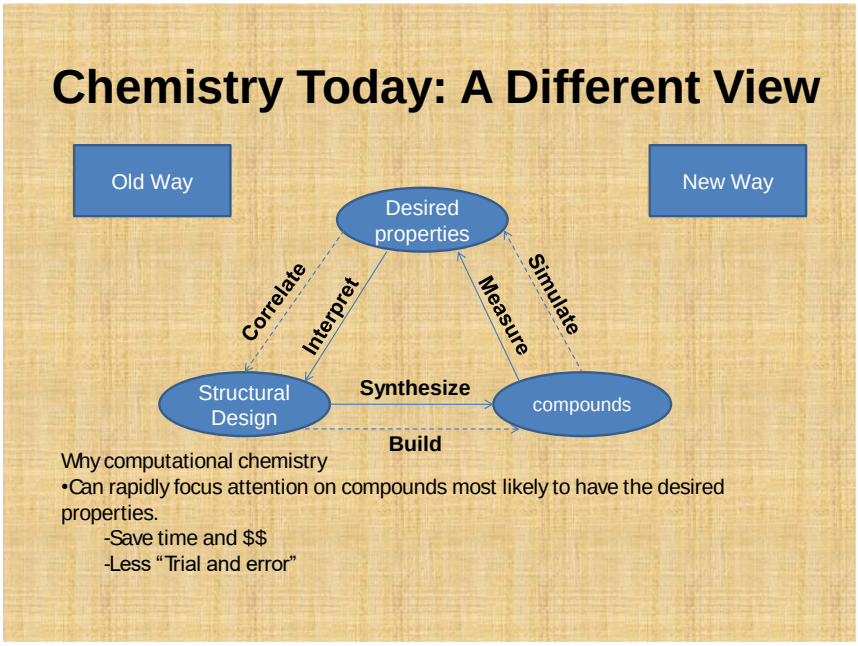


Figure 1: Chemistry today

METHODS IN SCIENCE

Science is defined as the study of how nature behaves. Modern scientists agree that there are four methods in science:

1. Observational science
2. Experimental science
3. Theoretical science
4. Computational science

OBSERVATIONAL SCIENCE

Observational science is significantly process-focused, scientific visualization, a form of computer graphics, turns the numbers into images that can then be used by the observational scientists.

EXPERIMENTAL SCIENCE

Experimental science is fundamentally concerned with taking observations and evidence collected using observational techniques.

In experimental science, the scientist is primarily concerned with the variables:

1. The independent variable, the condition that is being investigated and/or manipulated by the experimentalist
2. The dependent variable, the condition which is counted or measured
3. The confounding variables, those variables that are not controlled and that may or may not affect the outcome of the experiment.

THEORETICAL SCIENCE

Theoretical science is primarily mathematical. Theoretical scientists often attempt to mathematically represent some observable or non-observable phenomenon. By applying a variety of mathematical techniques, theoreticians look to "prove" the validity of some hypothesis or conjecture.

COMPUTATIONAL SCIENCE

- Computational science is the application of computer science and mathematical techniques to the solution of large and complex problems.

- Computational science allows scientists to do things that were previously too difficult to do due to the complexity of the mathematics, the large number of calculations involved, or a combination of the two.
- Computational science allows scientists to build models that allow predictions of what might happen in the lab.

Computational science is often defined as being that science that is at the intersection of science, computer science, and mathematics (Figure 2). Alternatively known as modeling and simulation.

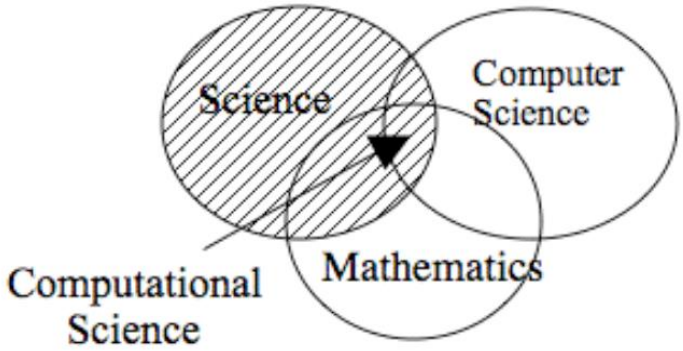


Figure 2: modeling and simulation

MOLECULAR MODELERS/ MOLECULAR MODELING

- Chemists are increasingly identifying themselves as molecular modelers and/or computational chemists.
- There are roughly two types of computational chemists: those who apply the techniques and tools of computational chemistry to solve interesting problems, and those who work to improve the techniques and tools.
- Molecular modeling is rapidly becoming one of the important tools to be learned, along with basic wet lab skills (titrating, making solutions, etc.) and the use of specialized chemistry tools such as infrared spectrophotometers and spectroscopy instruments.

Molecular modeling allows the user to determine three fundamental items of interest of a molecule or system of molecules:

- The structure, or geometry of the molecule
- The property or properties of a molecule or system of molecules
- The activity, or reactivity, of a molecule or system of molecules.

FUNDAMENTAL APPROXIMATIONS

1. The Born-Oppenheimer approximation: states that we ignore the motion of nuclei in molecules
2. The Hartree-Fock (HF) approximation: states that we can simplify our calculations by aggregating, or combining, the motion of electrons
3. The Linear Combination of Atomic Orbitals (LCAO): states that we can construct molecular orbitals by a relatively straightforward addition of calculated atomic orbitals.

Most molecular modeling tools look to solve the Schrodinger Equation.

In its most well-known format, the Schrodinger equation is represented by:

$$H\Psi = E\Psi$$

The Hamiltonian operator, performing a complex mathematical operation on the atom or molecule.

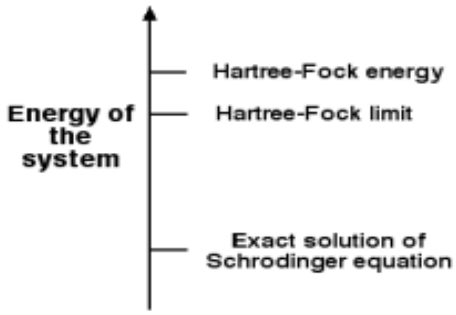
$$H_{elec} = -\frac{1}{2}\sum^{elec}\left(\frac{\partial^2}{\partial x_i^2}+\frac{\partial^2}{\partial y_i^2}+\frac{\partial^2}{\partial z_i^2}\right)-\sum_i^{elec}\sum_I^{nucl}\left(\frac{Z_I}{R_I-r_i}\right)+\sum_i^{elec}\sum_{j<i}^{elec}\left(\frac{1}{r_i-r_j}\right)+\sum_J^{nucl}\sum_{J<I}^{nucl}\left(\frac{Z_I Z_J}{R_I-R_J}\right)$$

SOLVING THE SCHRODINGER EQUATION

A more accurate calculation of the Schrodinger equation will always result in a lower energy value for the molecular system. The variation theorem states that the calculated energy ($\bar{E}$) will always be greater than the true energy (E):

$\bar{E} > E$

The graphic shown here looks to help visualize this reality.



Basically modeling is the solution of Schrödinger equation as set-up for a system within these approximations till self- consistent results are obtained as suggested by Hartree and Fock , shown in the following figure 3 if the system as three electrons.

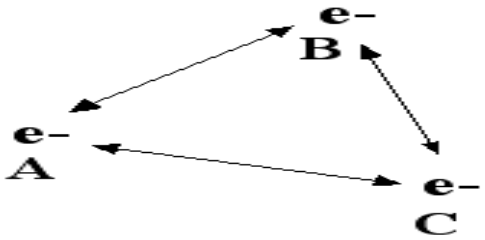


Figure 3: system as three electrons

COMPARISON OF MODELING TECHNIQUES

Figure 4 below explains the comparison between the modeling techniques.

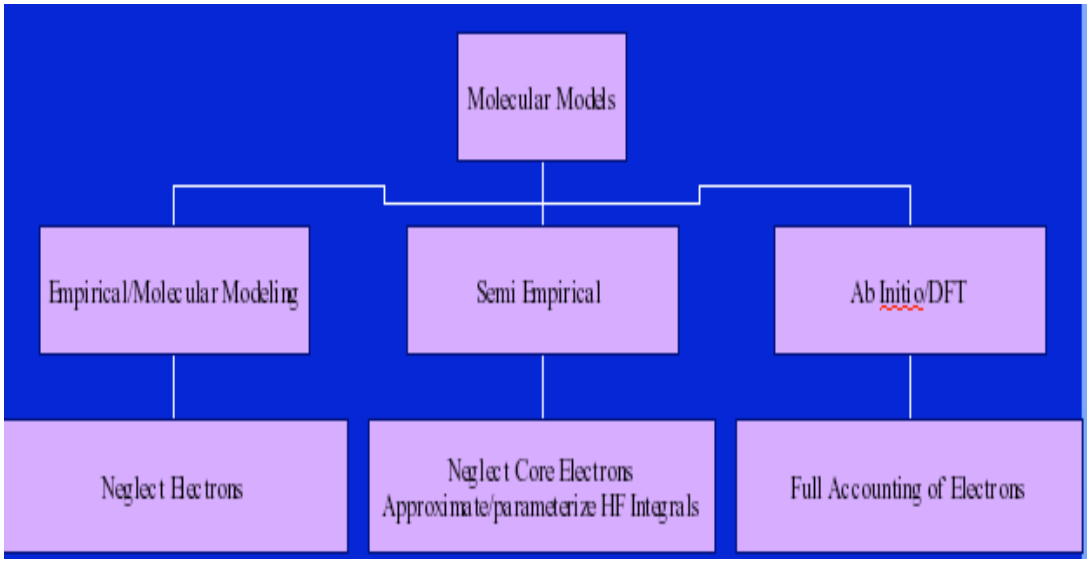


Figure 4: Each and every modeling method

Each and every modeling method has its own limitations and area of applications. Comparison between these methods is self-explanatory in the figure 4.

COMPUTATIONAL TOOLS

- In molecular modeling, there are a number of computer software programs and packages, all running on various types of computer hardware systems. These computational tools can be called engines, because these are the tools that make the calculations run.
- In chemistry choices are available for computational engines.

Here are some choices:

- MOPAC:-The calculation is done relatively quickly as compared to other tools, but without some of the accuracy and with less information.
- GAMESS is ab initio package
- HYPERCHEM is also one. Its professional version performs calculations using semi-empirical, ab-initio , DFT etc.

BASIS SET

The computational chemist has ingredients for using these modeling packages, the choice of which depends on the knowledge of package and skill of the user. These are called basis sets. Basis sets can be categorized as per follows:

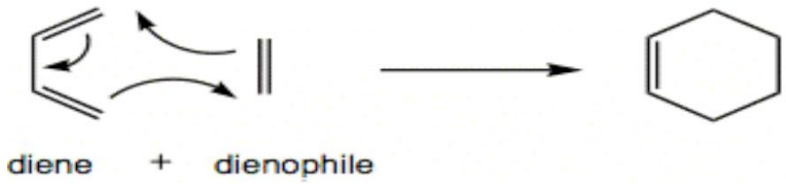
- Minimal basis sets
- Split-valence basis sets
- Double/triple/quadruple valence basis sets
- Polarized basis sets
- Diffuse basis set

Each of these basis set has its own specific application.

APPLICATIONS

Some of the applications of semi-empirical methods are given below:

1. Study of a reaction: These methods say, Semi-empirical methods can be applied for studying the reactivity of organic systems. One such example is the well-known reaction: Diels-Alder reaction.



Calculations can be performed using semi-empirical method on both butadiene and ethene, running a molecular orbital calculation using AM1 or PM3.

The energy of the HOMO (highest occupied molecular orbital) for butadiene, and the of the LUMO (lowest unoccupied molecular orbital) for the alkene can be computed. Applying which the compatibility of these M.O.'s can be judged and it can be predicted that which orbital combines with which one while forming the adduct.

2. Visualizing a molecule: Semi-empirical methods can also be used for visualizing the larger molecules which can't be imagined as such. One such example is the molecule shown in the figure which is tetraphenylporphine, a complicated molecule composed of a number of carbon and nitrogen ring structures. Figure 5 below

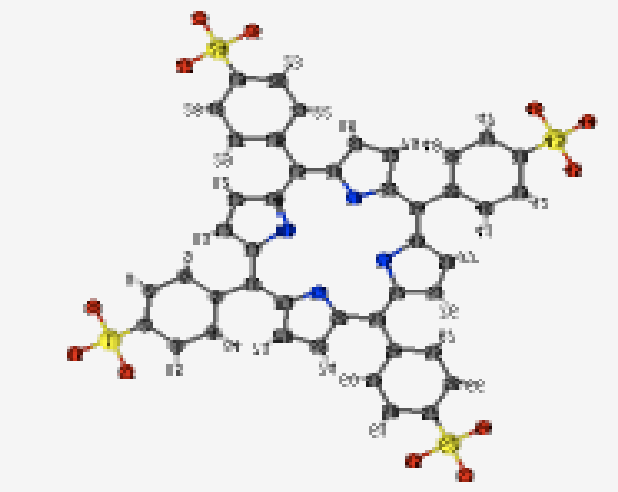


Figure 5: tetraphenylporphine

3. Study of properties like Electron Density:-The electron density at some point (r) can be mathematically expressed as integral of square of wave function of a system:

Computational chemistry software packages will check the result of an electron density calculation by summing up the electron density function over all space. The result of this summation should equal the number of electrons. This also helps in studying this property on the molecule as shown below in figure 6, taking example of acetaldehyde.

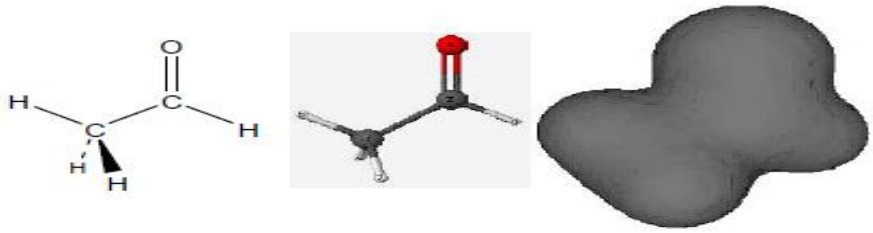


Figure 6: Study of properties like Electron Density

4. Study of reactions or Conformations this is shown taking example of n-butane. As we rotate around the C2-C3 bond in butane, we have come across various conformers of different energy. As shown in the figure 7 below. This energy profile is drawn on the basis of computation done using semi-empirical package.

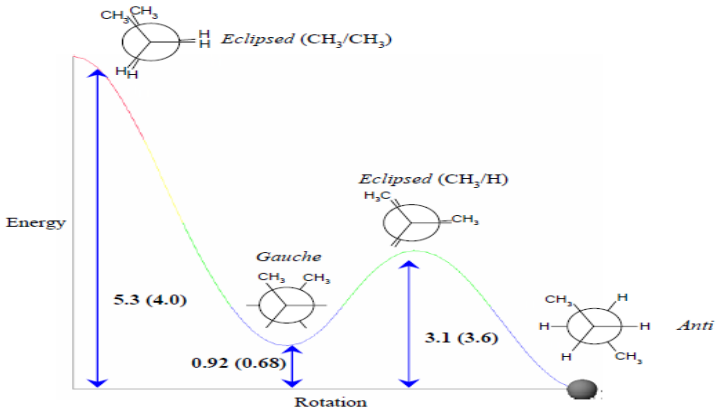
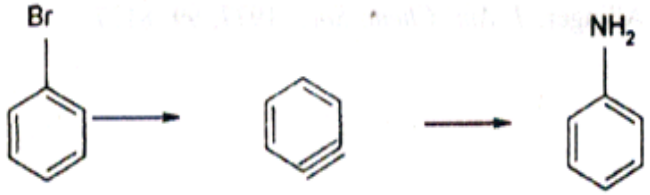


Figure 7: various conformers of different energy

APPLICATIONS OF SEMI EMPIRICAL METHODS EXPLORED BY OUR GROUP IN THE LABORATORY

STUDY OF ENERGY BARRIERS FOR THE REACTIONS

Energy barriers for the reactions can be studied using such quantum chemical software's. One such study confirms the benzyne intermediate formation in the conversion of halo benzene to amino benzene. The proposed Mechanism is:



Energy profile for this reaction is shown below in Figure 8

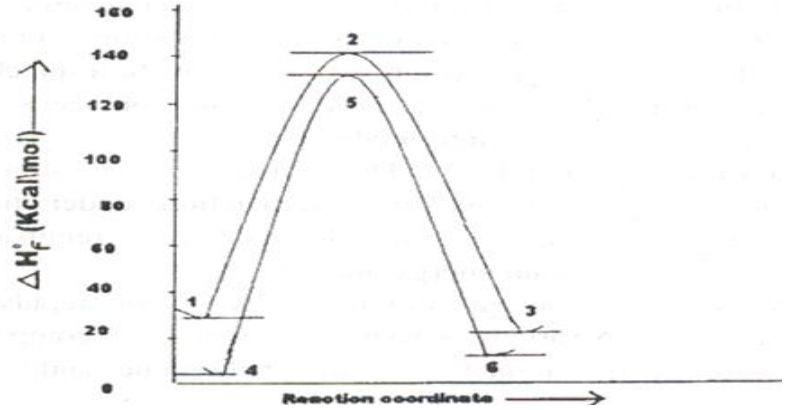


Figure 8: Energy profile for this reaction

These values shown in the above diagram are AM1 computed values using MOPAC package.

THEORETICAL STUDIES OF ELECTRONIC AND GEOMETRIC STRUCTURES OF THE COMPOUNDS

Theoretical studies of electronic and geometric structures of compounds can be done successfully using these packages. Some of such studies are carried out on organic compounds which are used as ligands in the formations of metal complexes. Such studies were carried out on Schiff base ligands some of them are shown below, Figure 9:-

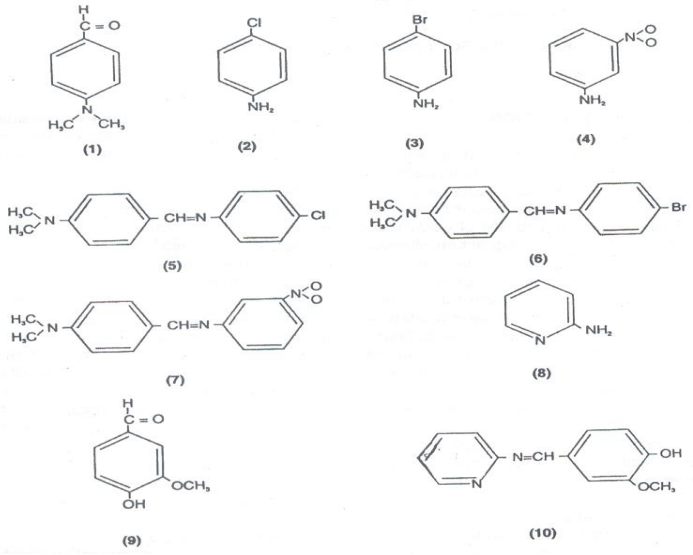


Figure 9: Schiff base ligands

Such studies show that electron densities in Schiff bases are ample and maximum on azomethinic nitrogen. This fact supports that these Schiff bases can coordinate to central metal atom through azomethinic nitrogen.

COMPUTER SIMULATION OF IR SPECTRA USING THESE PACKAGES

Normal modes analysis of some of the compounds can also be performed using specific keywords with the help of these computer packages. On the basis of normal mode analysis computer simulation of IR spectra can be done.

One such study for S-Benzyl 1-β-M-(2-furyl methyl ketone) dithio carbazate schiff base has been carried out with AM1, PM3 MNDO and MNDO-d methods. These computer simulated IR spectra are shown in figure 10 below:

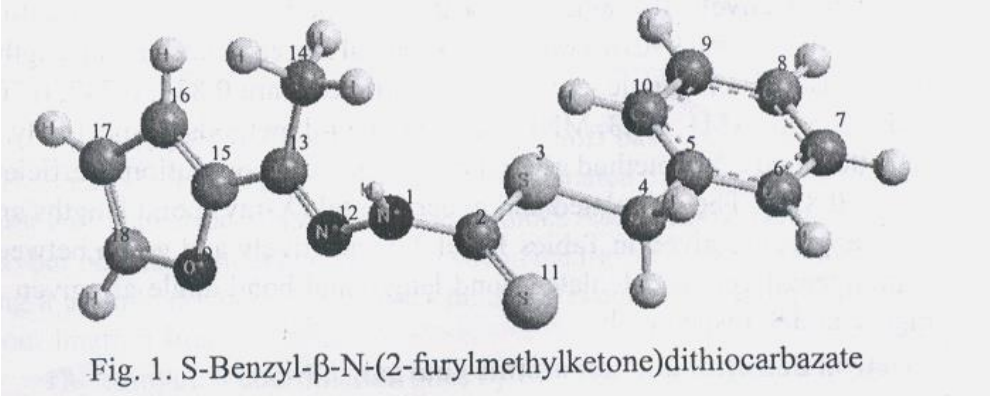


Figure 10: computer simulated IR spectra

The computed normal modes are shown in the table below with the simulated spectra in figure 11 below

TABLE-4
EXPERIMENTAL AND CALCULATED FUNDAMENTAL VIBRATIONAL FREQUENCIES OF S-BENZYL-β-N-(2-FURYL METHYLKETONE) DITHIOCARBAZATE SCHIFF BASE OF S-BENZYL DITHIOCARBAZATE BY AM1, PM3, MNDO AND MNDO-d SEMI-EMPERICAL METHODS

IR Bands	Experimental	AM1	PM3	MNDO	MNDO-d
N-H	3102	3301	3209	–	3692
C=N	1618	2071	1984	2075	1815
N-N	1023	1418	–	1478	1168
C=S	1096	717	763	796	726
C-O-C	1232	809	969	1166	668

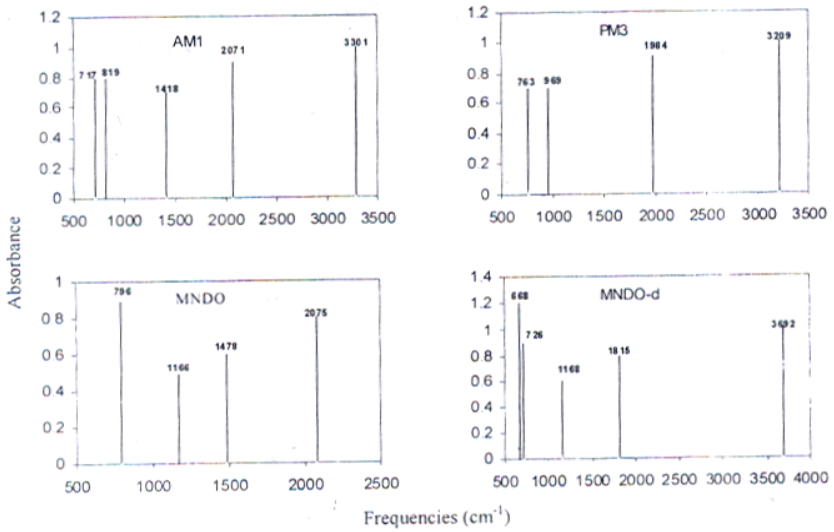


Figure 11: Compounds with Simulated Spectra

QSAR TECHNIQUES/ STUDIES

QSAR studies are important step in the field of drug designing as shown in the figure 12 below

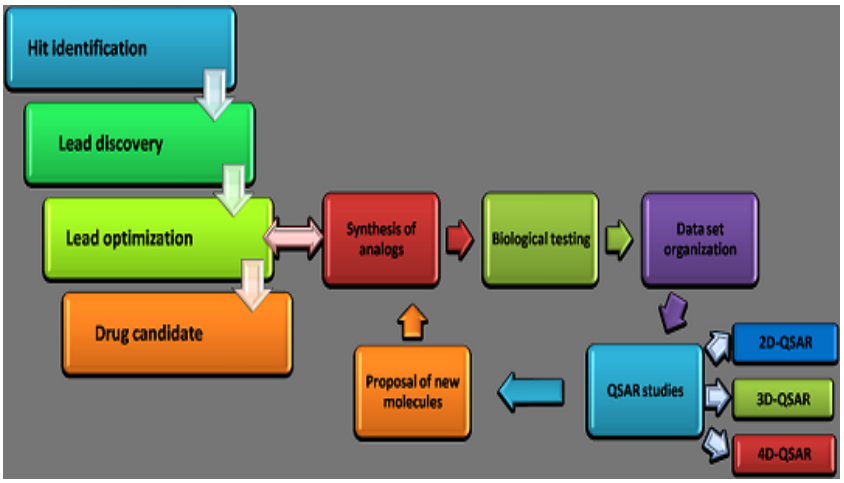


Figure 12: QSAR studies are important step in the field of drug designing

Some of the compounds may have antimicrobial significance. Their activities can be correlated to their quantum chemically predicted structural, physical parameters to perform QSAR (Quantitative structure and activity relationship) studies.

One such study is given here for the compounds shown in the figure 13.

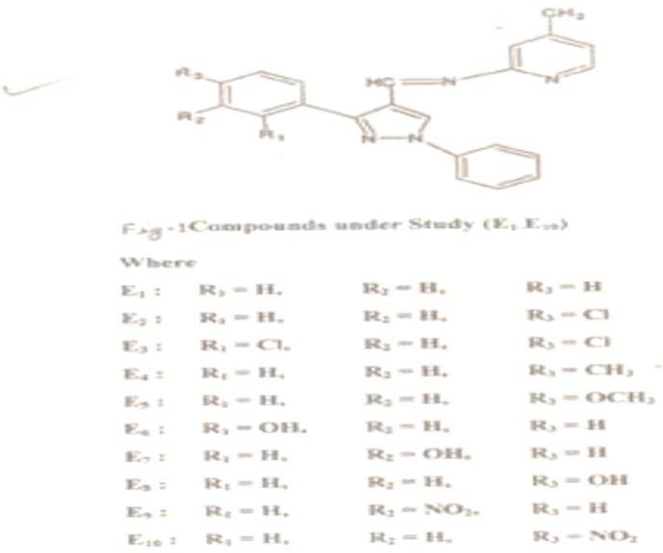


Fig -1Compounds under Study (E_1 E_{10})

Where

E_1 :	$R_1 = H$,	$R_2 = H$,	$R_3 = H$
E_2 :	$R_1 = H$,	$R_2 = H$,	$R_3 = Cl$
E_3 :	$R_1 = Cl$,	$R_2 = H$,	$R_3 = Cl$
E_4 :	$R_1 = H$,	$R_2 = H$,	$R_3 = CH_3$
E_5 :	$R_1 = H$,	$R_2 = H$,	$R_3 = OCH_3$
E_6 :	$R_1 = OH$,	$R_2 = H$,	$R_3 = H$
E_7 :	$R_1 = H$,	$R_2 = OH$,	$R_3 = H$
E_8 :	$R_1 = H$,	$R_2 = H$,	$R_3 = OH$
E_9 :	$R_1 = H$,	$R_2 = NO_2$,	$R_3 = H$
E_{10} :	$R_1 = H$,	$R_2 = H$,	$R_3 = NO_2$

Figure 13: Compounds under study

The AM1, PM3, MNDO and ZINDO computed 3D-QSAR equations for these compounds against different pathogens are shown below.

AM1 PREDICTED 3D QSAR EQUATIONS

AM1/E1- E10/A. Niger:

p(MIC) = -0.261 (log P) +0.529 (HOMO)+0.211(DM) – 3.733768792

r= 0.9999729 r2 =0.9999457 r2(adj.) =0.99992253

SE = 0.5840697 t= 6.393 F=43025.45

AM1/E1- E10/E.coli:

p(MIC) = -0.07 (Hyd.E) + 0.621 (log P) +0.451(DM)

r= 0.99994588 r2 =0.99989177 r2(adj.)= 0.99984538

SE = 0.3060350 t= 18.45 F=21556.24

PM3 COMPUTED 3D –QSAR EQUATIONS

PM3/E1- E10/A. Niger:

p(MIC) = -0.03 (Hyd.E) + 0.555 (log P) +0.473(DM)-5.782432417

r= 0.99997225 r2 =0.99994450 r2(adj.)= 0.9992072

SE = 0.2237040 t= -25.85 F=42040.59

PM3/E1- E10/E.coli:

p(MIC) = 0.05 (Hyd.E) – 0.421 (log P) +0.627(DM) -6.008535411

r= 0.99997366 r2 =0.99994732 r2(adj.)= 0.99992474

SE = 0.2173922 t= -27.64 F=44288.42

MNDO COMPUTED 3D QSAR EQUATIONS

MNDO/E1- E10/A. Niger:

p(MIC) = 0.086 (log P) +0.0985 (HOMO) -0.07(DM) – 2.652300614

r= 0.99998662 r2 =0.99997323 r2(adj.)= 0.99996176

SE = 0.2556331 t= -10.38 F=87175.88

MNDO/E1- E10/E.Coli:

p(MIC) = -0.14 (log P) +1.12 (LUMO)+0.016(DM) – 2.520404426

r= 0.99996617 r2 =0.99993234 r2(adj.)= 0.99990334

SE = 0.3956055 t= -6.376 F=34482.77

ZINDO COMPUTED 3D QSAR EQUATIONS

ZINDO/E1- E10/A. Niger:

p(MIC) = 0.186 (log P) +0.691 (LUMO)+0.153(DM) – 8.202752592

r= 0.99991753 r2 =0.999983507 r2(adj.)= 0.99976438

SE = 0.5630258 t= -14.57 F=14144.70

ZINDO/E1- E10/E.coli:

p(MIC) = 0.2 (log P) -0.02 (Hyd.E)+0.816(LUMO) – 8.067256515

r= 0.99992279 r2 =0.99984558 r2(adj.)= 0.99977941

SE = 0.4394233 t= -18.36 F=15108.35

The correlation coefficients for the above equations are quite significant and appreciable.

CONCLUSION

On the basis of experience after a lot of work done using these semi-empirical methods author wishes to say that these methods are quite reasonable for studies and are less time consuming.

Among these methods AM1 method provide appreciably good results.

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Chapter
14

PHYTOCHEMISTRY OF A WILD PLANT ELDERBERRY (*SAMBUCUS NIGRA*)-AN OVERVIEW

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ABSTRACT

Some of the Indian wild plants are a rich source of antioxidants apart from protein, carbohydrates and minerals, which are known to prevent different diseased states. Literature surveys reveal that consumption of different types of natural foods may lower the risk of serious health disorders because of their antioxidant activity. Polyphenols, flavonoids, lignins, alkaloids, terpenoids, carotenoids, vitamins, and other compounds present in these plants have been found to possess bioactive and antioxidant potential (Vayalil, 2002). Phytoconstituents are the natural bio-active compounds found in plants. Phytochemicals have a number of potential health benefits. Alkaloids, tannins, flavonoids, and phenolic compounds are the most significant of these bioactive plant constituents (Doss, 2009). It is essential to comprehend the relationship between phytoconstituents and the bioactivity of plants for the synthesis of compounds with specific activities to treat various health conditions and chronic diseases (Pandey, *et al.,* 2013).

KEYWORDS: Phytochemistry, Bioactivity of plants, Health disorders

INTRODUCTION

IMPORTANT PHYTOCHEMICALS

Alkaloids are the basic natural product that is composed of heterocyclic nitrogen atoms. Organisms like bacteria, fungi, animals, and plants naturally produce alkaloids. The plant-based alkaloids are used as drugs, spices, dyes. Some alkaloids, like caffeine and nicotine, are stimulants; morphine is used as an analgesic, and quinine is used to treat malaria (Rao, 1978).

Tannins are a diverse collection of high-molecular-weight polyphenolic compounds that are capable of forming both reversible and irreversible complexes with proteins, polysaccharides, alkaloids, nucleic acids, minerals, and so on. (Schofield *et al.,* 2001). Tannins are frequently found in fruits like grapes, persimmons, blueberries, tea, chocolate, legume forages. (Giner-Chavez, 1996). Plant extracts containing tannin are used as an astringent, diuretic, antiseptic, antioxidant, and in some pharmaceuticals (Dolara *et al.,* 2005).

Saponins have been included in a large group of plant protective molecules known as phyto-protectants because they may be considered a component of the defense systems of plants. Many saponins are known to protect plants from insect attack, inhibit mold growth, and kill bacteria (Lacaille-Dubois and Wagner, 2000).

Phenolic compounds are a huge complex of chemical constituents found in plants (Walton *et al.,* 2003). Phenolic compounds and their antioxidant properties are valuable as protecting agents against free radical-mediated disease processes.

Flavonoids are polyphenolic compounds that are powerful antioxidants. Some fruits, vegetables, and beverages like tea, coffee, and fruit drinks contain flavonoids (Pridham, 1960). Flavonoids have been accounted for numerous natural properties including antimicrobial, cytotoxicity, and antitumor activities. (Tapas *et al.,* 2008).

The terpenoids are a class of natural products which have been derived from five-carbon isoprene units. Many of the terpenoids are commercially interesting because of their use as flavors' and fragrances in foods and cosmetics or quality of agricultural products, such as the flavor of fruits and the fragrance of flowers (Harborne and Tomas-Barberan, 1991).

It is necessary to understand the chemical activities and other biochemical activities of potential compounds in wild plants. In this study, the bioactive properties of wild fruit elderberry and their antioxidant capacity was reviewed.

CHEMICAL COMPOSITION OF SAMBUCUS NIGRA: FRUIT AND FLOWERS

The chemical composition of Sambucus nigra is rich and depends on different factors, such as cultivar, location, ripening stage and climatic conditions.

Water is the main element of fresh elderberry fruits (71 – 78 %), containing also a range of minerals, specially magnesium and calcium, vitamin C (6.11 to 116.7 mg/ 100 g FW), (Vulić, J, et,al. 2008) fibre and amino acids. Uzlasir, et al, while assessing the effect of infusion time, temperature and extracting solvent such as water, 80 %methanol and 80% ethanol also proved the presence of ascorbic acid (1.46 to 22.47 g/ L). Among the different minerals present, only magnesium was present at a higher level in elderberries than in elderflowers. The primary metabolites, sugars, and organic acids are important quality parameters for elderberries. Also, volatile compounds are extremely important responsible for the aroma of the elderflowers, of fruits and their extracts. (Sandrine *et al.,* 2020)

CARBOHYDRATES

The studies revealed main sugars present were glucose (33.33–50.23 g/kg FW) and fructose (33.99–52.25 g/kg FW), but only small amounts of sucrose were present in the fruit (0.47–1.68 g/kg FW,Vulić et al.). Carbohydrates present in Sambucus nigra fruit also include dietary fibre, mainly, pectin, pectic acid, protopectin, Ca-pectate and cellulose. (Młynarczyk *et al.,* 2018)

PROTEINS

Elderberry is a source of whole protein , 2.7 - 2.9% in berries, 2.5% in flowers and 3.3% content is present in leaves. This protein contains 16 amino acids, the total content of the essential amino acids is around 9% in flowers and 11.5% in leaves. The main amino acids reported were Glutamic acid, aspargic acid and alanine. (Młynarczyk *et al.,* 2018)

FATS

Fats are accumulated substantially in elderberry seeds (%fat content: 22.4) and seed flour (%fat content: 15.9). The major fatty acids are polyunsaturated fatty acids, which constitute 75.1 and 21.5 percentage of total fatty acids in seeds and seed flour, respectively, whereas monounsaturated fatty acids (14.21% and 4.21%) and saturated fatty acids (10.64% and 4.81%) make up a significantly lower share. Polyunsaturated fatty acids that are found in highest concentrations in seeds are α-linolenic, linoleic and oleic acid. (Młynarczyk *et al.,* 2018)

BIOACTIVE COMPOSITES

Analysis of elderberry showed that it contains high bioactive compounds primarily polyphenols such as flavonols, Phenolic acids, anthocyanins, and proanthocyanidins, as well as terpenes and lectins. (Anton *et al.,* 2013). The composition of elderberry depends on numerous factors: the variety, degree of ripeness, as well as environmental and climatic conditions (Kader & Barrett, 2005). Elderberry is a good source of protein, with percentage content in fruits at 2.7 –2.9, in flowers at2.4, while in the leaves at3.3. Amino

acids in fruits, leaves and flowers are present in the free or conjugated form. The predominant flavonols were quercetin, kaempferol and isorhamnetin. Polyphenolic composites are present in the leaves, fruits and flowers. The flowers of elderberry contained tenfold more flavonols (214.25 mg/ 100 g) than fruits (20.18 mg/ 100 g) and several times further than the leaves (17.01 mg/ 100 g) (Dawidowicz *et al.,* 2006). Elderberry flowers and fruits, piecemeal from flavonols, contain large quantities of phenolic acids.

MEDICINAL POTENTIAL

In folk medicine, elderberry has been used in the treatment of numerous health ailments. Elderberry has medicinal properties associated with the presence of polyphenols, potential antioxidants. Due to the presence of flavonoids, elderflowers demonstrate primarily diaphoretic, antipyretic and diuretic activities. Moreover, elderflowers show anti-inflammatory and antibacterial properties and therefore are used for gargling to cure sore throats or as compresses to treat conjunctivitis. They are most frequently used as infusions of dried flowers for internal or external application.

The fruit of Sambucus nigra, like flowers, exhibits diaphoretic, antipyretic and diuretic activities, and also it act as a laxative and detoxifier, hence elderberries are frequently, an ingredient of herbal mixtures used as a remedy for constipation or to help weight reduction. In addition, elder fruit demonstrates a moderate analgesic effect and can be used as an adjuvant painkiller against migraine, sciatica and neuralgic pains (Beaux *et al.*, 1999, Bown, 1995, Grieve, 1984, Ożarowski and Jaroniewski, 1987, Schmersahl, 1964).

SIDE EFFECTS AND CONTRAINDICATIONS TO ELDERBERRY CONSUMPTION

Elderberry fruits are small, black berries, whose color and extent act aronia berries and blueberries. The content of primary metabolites (sugars and organic acids) gives elderberry the typical sweet and tangy taste, while its characteristic aroma is related to the presence of different unpredictable and phenolic compounds. The purple color of fruit originates from anthocyanins and color colors, (Akindahunsi AAet.al., 2005), so it could be used in numerous foods and nutritive supplements. The use of elderberry fruits is occasionally limited due to the presence of cyanogenic glycosides in this species. Elderberry isn't a poisonous; still, its leaves, stems, roots, flowers and unripe fruits contain cyanogenic glycosides, substantially sambunigrin, prunasin, holocain and zierin, which are converted to hydrogen cyanide during digestion (Jensen & Nielsen, 1973). All parts of the elderberry contain cyanogenic glycosides, the most abundant of which are sambunigrin and prunasin. Likewise, elderberry contains m- hydroxy substituted glycosides, similar as zierin and holocalin (DellaGreca etal., 2000, Jensen and Nielsen, 1973). These composites are potentially poisonous, because they can be hydrolyzed resulting in the release of cyanide (Bromley, Hughes, Leong, & Buckley, 2005). Still, they do occur primarily in unripe berries and are degraded during heat treatment (Williamson, motorist, & Baxter, 2009). The maximum quantities of sambunigrin are present in elder leaves (27.68 –209.61 μg/ g FW), minimum quantities were set up in flowers (1.23 –18.88 μg/ g FW), whereas berries contain the smallest quantities of this emulsion (0.08 –0.77 μg/ g FW). It was discovered that incubation in a boiling water bath for 5 – 10 min, made lectins fully sensitive to hydrolytic enzymes in vitro and therefore reduced the threat of allergenicity (Jiménez *et al.,* 2017). The consumption of immature plants or high amounts of fruits may cause nausea, vomiting and diarrhoea, but elderberry is most extensively consumed in the processed form. Thermal processing of raw material leads to the decay of sambunigrin, so the consumption of fruits subjected to heating processes doesn't cause symptoms of poisoning (Williamson, motorist, & Baxter, 2009).

CONCLUSION

It was observed that this fruit is a rich source of antioxidant agents and has a variety of phytochemicals. Hence, the proper propagation, conservation, and chemical analysis are recommended so that these fruits should be incorporated for the health related problems. Studies reveal that the fruit and flowers of Sambucus nigra are largely nutritional and rich in bioactive components like polyphenols and

anthocyanins, having high antioxidant activity, which significantly promote health. It was shown that elderberry has substantially antibacterial and antiviral properties, hence can reduce sugar and lipid amount, and also exhibit antidepressant and antitumor properties. Due to the presence of phytochemicals, elderberries also show anti-inflammatory, anti-cancer, anti-viral, anti-malarial, antibacterial activity.

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Chapter
15

MEDICINAL CHEMISTRY AND DRUG DISCOVERY

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ABSTRACT
Drug discovery is the course by which fresh contender medications are discovered. For history, drug preparations stood discovered by ascertaining the active component from traditional therapies or by opportune discovery, for instance with penicillin. More newly, chemical archives of synthetic minor molecules, naturally available products or natural extracts were screened in whole cells or entire organisms to ascertain constituents that had an anticipated therapeutic outcome in an evolution known as classical pharmacology. After arranging a sequencing of the human genome permitted quick cloning and synthesis of huge extents of refined proteins, it has turned into conjoint exercise to make use of high throughput-screening of bulky combinations collections alongside sequestered biological targets which are theorized to be disease-modifying in a practice acknowledged as reverse pharmacology. Successes from these displays are then seasoned in cells and then in animal beings for efficacy researches.

KEYWORDS: Drug discovery, Penicillin, Biological targets, Pharmacology.

INTRODUCTION

Contemporary drug discovery embroils the documentation of screening triumphs, medicinal chemistry and optimization of those knockouts to upturn the affinity and selectivity (to condense the probable of side effects), efficacy and potency, metabolic constancy (to upsurge the half-life), and oral bioavailability. As soon as a substance that accomplishes all of these necessities has been recognized, the progression of drug development may continue. If efficacious, various stages of clinical trials are advanced. Current drug discovery is consequently a financially intensive practice that comprises hefty funds by pharmaceutical industry establishments along with national administrations (who afford scholarships and loan assurances). In spite of progresses in technology and appreciative of biological structures, drug discovery is quiet an overlong, "costly, tough, and incompetent progression" with low degree of innovative therapeutic discovery. In 2010, the research and development (R&D) budget of every new molecular entity was around US dollar 2 billion. In the era of 21st century, elementary discovery study is subsidized chiefly by governments and by benevolent establishments, whereas later-stage advancement is sponsored principally by pharmaceutical enterprises or project entrepreneurs. To be endorsed to emanate to market, drugs need go through numerous efficacious stages of clinical trials, and lead through a new drug authorization procedure, so-called the New Drug Application of the respective countries. (US Food and Drug Administration, 2018).

HISTORY

The impression that the outcome of a drug in the humanoid body is arbitrated by particular interfaces of the drug fragment with biotic macromolecules, (nucleic acids or proteins in maximum circumstances) headed scientists to the decision that specific chemicals are essential for the biotic action of the drug. This completed for the commencement of the present era in pharmacology, as pure chemicals, in its place of

crude extracts of medicinal plants, befitted the customary drugs. Examples of drug combinations sequestered from crude preparations are like morphine, the active representative in opium, and digoxin, a heart stimulant obtained from *Digitalis lanata*. Organic chemistry likewise steered to the synthesis of numerous of the natural products isolated from biotic bases.

Traditionally, ingredients, whether crude extracts or refined chemicals, were partitioned for biotic activity deprived of information of the biological target. Only later an active constituent was acknowledged was a work made to recognize the target. This methodology is well-known as classical pharmacology, onward pharmacology, or phenotypic drug discovery.

Cloning of humanoid proteins opened up screening of huge archives of molecules against particular targets believed to be associated to specific ailments. This methodology is known as reverse pharmacology and is the utmost commonly used method nowadays. In the 2020s, quantum and qubit computing starter to be employed to rigorously diminish the period required to drug discovery. (Warren, 2011).

TARGETS

A "target" is created inside the pharmaceutical organization. Normally, the "target" is the naturally prevailing molecular or cellular arrangement tangled in the pathology of attention somewhere the drug-under-development is destined to act. Though, the peculiarity amongst a "new" and "well-known" target can be prepared without a complete appreciative of just whatever a "target" is. This peculiarity is characteristically prepared by pharmaceutical establishments affianced in the discovery and improvement of therapeutics. In an approximation from 2011, about 435 humanoid genome products were acknowledged as therapeutic drug targets of USFDA-approved drugs. "Established targets" are those targets for which there is a worthy scientific appreciative, sustained by an extensive publication antiquity, of together in what mode the target utilities in common physiology and in what way it is tangled in humanoid pathology. This does not indicate that the technique of action of drugs those are believed to act by a certain well-known target is completely agreed. Somewhat, "well-known" narrates straight to the expanse of circumstantial indicators existing on a target, in specific efficient data. In broad, "new targets" are all of those targets which are not "established targets" nevertheless which have been or are the theme of drug discovery struggles. The mainstream of targets carefully selected for drug discovery exertions are proteins, for example G-protein-coupled receptors (GPCRs) and enzymes like protein kinases.

SCREENING AND DESIGN

The method of discovery a novel drug against a picked target for a certain ailment customarily embroils high-throughput screening (HTS), wherein hefty archives of chemicals are established for their capacity to transform the target. For instance, if the target is a unique GPCR, molecules will be screened for their capability to constrain or excite that receptor (see agonist and antagonist): if the target is an enzymatic protein kinase, the chemicals are verified for their capacity to inhibit that enzyme kinase.

One more role of HTS is to demonstrate how discerning the molecules are for the selected target, as anyone wishes to discover a molecular entity which will obstruct with simply the picked target, nevertheless not former, interrelated targets. To this conclusion, former screening rounds will be made to realize whether the "successes" beside the elected target will hinder with former allied targets – this is the course of cross-screening. Cross-screening is convenient since the more unconnected targets a molecule occupies, the more probable that off-target toxicity may happen with that molecule as soon as it reaches the clinical site.

Amid the physicochemical possessions related with drug absorption comprise solubility and ionization (pKa); permeability is be found out by PAMPA test and Caco-2 analysis. PAMPA method is striking as a

primary screening due to the little depletion of drug and the small price tag equaled to tests like as Caco-2 test, Blood–brain barrier (BBB) and gastrointestinal tract (GIT) with which to hand is a great correlation. Whilst HTS is a regularly used technique for new drug discovery, it is not the lone process. It is the *de novo* drug design is one more scheme for drug discovery, in which a forecast is made through the categories of chemical compounds that might apt into an active site of the target enzyme. For illustration, computer-aided drug design and virtual screening are regularly employed to ascertain new organic moieties that could act together with a target protein molecular dynamics and Molecular modelling simulations may be employed as a guide to mend the potency and possessions of new drug molecule leads. There is also archetype transference in the drug discovery arena to swing away from HTS, which is costly and might only cover partial chemical space, to the screening of minor libraries (maximum some thousand molecules). The methods include protein-directed dynamic combinatorial chemistry and fragment-based lead discovery (FBDD). The ligands in such tactics are typically far smaller, and they bind to the target cell protein with frailer binding affinity than those hits that are recognized from HTS. Additional alterations through organic chemical synthesis into lead molecular compounds are frequently necessary. Such changes are habitually guided by protein X-Ray crystallographic analysis of the protein-fragment complex. The benefits of these methodologies are that they permit more effectual screening and the chemical library, though small, characteristically covers a huge chemical arena when equated to HTS.

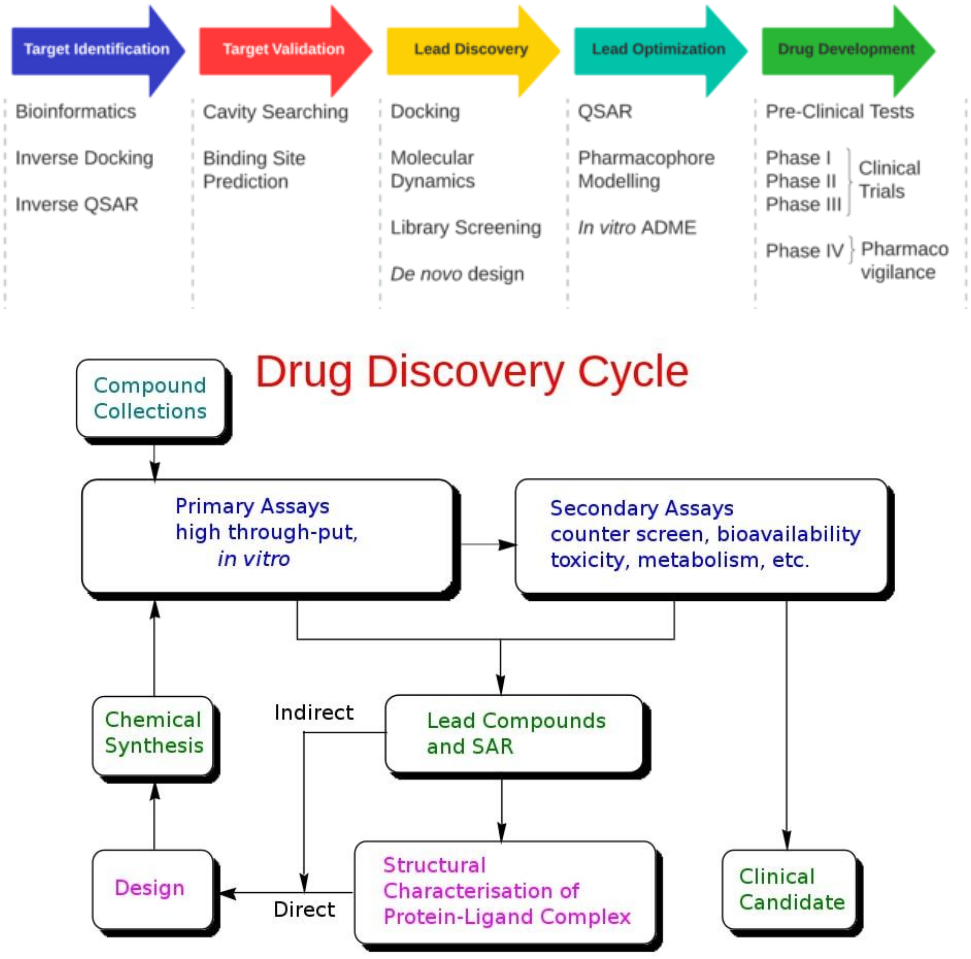


Figure 1: Drug Discovery Cycle

When a lead molecule series has been recognized with satisfactory target potency and selectivity and favorable drug-like possessions, one or two molecular compounds will then be recommended for the

process of drug development. The finest of these compounds is commonly called the lead molecule or compound, whereas the former will be labeled as the "backup" molecule. These pronouncements are largely sustained by computational modelling novelties (Takenaka, 2001).

Some of the main computational practices employed in drug development. Computational methods play a vital role in drug development by facilitating the identification of possible drug molecules, predicting their properties and improve the design (Wikipedia).

NATURE AS A SOURCE

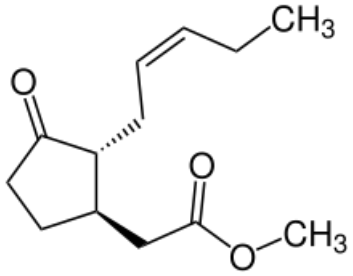
By tradition, several drugs and other chemicals compounds with biotic action have been discovered by reviewing chemical compounds those organisms produce to streak the action of other organisms for existence.

Regardless of the upswing of combinatorial organic chemistry as an essential measure of lead molecule discovery development, natural products are still playing a chief role as preliminary candidates for drug discovery. According to a report of 2007 states that, of the 974 minor molecular new chemical compound entities established amid 1980 and 2005, around 65% were of natural derivative or semisynthetic derivatives of these natural products. For certain treatment expanses, such as antihypertensive and anti-inflammatory drugs.

PLANT-DERIVED

A lot of secondary metabolites formed by plants have prospective therapeutic medicinal possessions. Most of these secondary metabolites consist or bind to and alter the function of proteins such as receptors, enzymes, etc. Subsequently, plant resulting natural products have frequently been employed as the preliminary agents for new drug discovery.

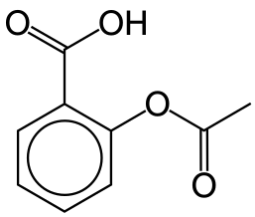
JASMONATES



Jasmonates are important in responses to injury and intracellular signals. They induce apoptosis and protein cascade via proteinase inhibitor, have defense functions, and regulate plant responses to different biotic and abiotic stresses. Jasmonates also have the ability to directly act on mitochondrial membranes by inducing membrane depolarization via release of metabolites.

Jasmonate derivatives (JAD) are also important in wound response and tissue regeneration in plant cells. They have also been identified to have anti-aging effects on human epidermal layer. The discovery of JADs on skin repair has introduced newfound interest in the effects of these plant hormones in therapeutic medicinal application.

SALICYLATES



Salicylic acid (SA), a phyto-hormone, was originally a derivative from willow bark and has then been recognized in many other species. They are involved in sickness and immunity responses in both plant

and animal tissues. They possess salicylic acid binding proteins which have demonstrated to affect manifold animal tissues. The first revealed medicinal properties of the isolated medicinal compound were convoluted in pain and fever treatment. They also show an active part in the suppression of cell proliferation.

ANIMAL-DERIVED

Some of the drugs employed in modern medication have been exposed in animals or are centered on some compounds originate in animals. For instance, the anticoagulant medicines, hirudin and its synthetic counterpart, bivalirudin, are centered on salivary chemistry of the leech, *Hirudo medicinalis*. Exenatide, which is employed for the treatment of type 2 diabetes mellitus, was advanced from salivary chemical compounds of, a venomous lizard known as the Gila monster.

MICROBIAL METABOLITES

Microbial species strive for active living space and nutritional materials. To subsist in the environments, numerous microbial organisms have settled capabilities to inhibit contending species from multiplying. Microbial organisms are the sources of antimicrobial agents. Streptomyces isolates have been such a valued spring of antibiotics, that these have been termed as medicinal molds. The typical specimen of an antibiotic revealed as a protection mechanism in contradiction of a different microbe is penicillin in bacteriological cultures contaminated by Penicillium fungi in the year1928.

MARINE INVERTEBRATES

Marine surroundings are potential foundations for new bioactive representatives. Arabinose nucleosides revealed from marine invertebrates in middle1950s, confirmed for the first time that carbohydrate moieties other than ribose and deoxyribose produce bioactive nucleoside arrangements. It was in the late 2004 when the first marine-based drug was permitted. For example, ziconotide, the cone snail toxin also acknowledged as Prialt is used for the treatment of austere neuropathic pain. Quite a lot of other marine-derivative agents are currently in clinical trials for symptoms like anti-inflammatory use, pain and cancer. One type of these agents is bryostatin-similar molecules, are under exploration for anti-cancer therapy. (Faulkner et al, 2004; Rollinger et al, 2008).

CHEMICAL DIVERSITY

As stated above, combinatorial organic chemistry was a fundamental tool facilitating the proficient generation of large screening archives for the essentials of high-throughput screening. Though, now, after about two-three decade spans of combinatorial organic chemistry, it has been realized that in spite of the improved effectiveness in organic chemical synthesis, no escalation in lead molecule or drug contenders have been resulted. This has headed to exploration of chemical features of combinatorial organic chemistry products, paralleled to current drug molecules or natural products. The chemo-informatics conceptual chemical miscellany, portrayed as dissemination of compounds in the chemical arena centered on their physicochemical features, is habitually employed to label the variance amongst the combinatorial chemistry collections and natural products. The synthetic, combinatorial archive compounds appear to embrace merely a partial and reasonably even chemical space, while present drug molecules and predominantly natural products, reveal far superior chemical assortment, dispensing more steadily to the chemical arena.

STRUCTURAL ELUCIDATION

The elucidation process of the chemical structure establishment is very critical to dodge the re-discovery of a chemical candidate that is by this time well-known for its structural configuration and chemical action. Mass spectrometry is a technique in which specific chemical compounds are recognized centered on the mass/charge ratio, after the process of ionization. Chemical candidates are existent in natural surroundings as combinations, so the hyphenation of liquid chromatography and mass spectrometry

(LC-MS) is regularly employed to separate, isolate and identify the different chemical entities. Catalogues of mass spectral databases for known chemical compounds are available for comparison and are referred to consign a structural configuration to an unidentified mass spectrum. NMR (Nuclear magnetic resonance spectroscopy) is another major tool for the determination of chemical structure and configuration of natural products. NMR provides information regarding specific protons i.e. hydrogen and carbon (13C) atoms in the structure, letting comprehensive reestablishment of the molecule's structural design. (Chen and Kirchmair, 2020).

NEW DRUG APPLICATION

Once a drug candidate is established with confirmation all the way through its history of research to demonstrate that it is safe and effective for the envisioned use, the establishment can file an application as the New Drug Application (NDA) – to have the drug molecule for commercial use and presented for clinical application. NDA position permits the Federal Drug Administration to inspect all acquiesced data details on the drug candidate to reach a conclusion on whether to accept or not accept the drug molecule based on its safety, specificity of effectiveness, and efficacy of doses. (US Food and Drug Administration, 2019).

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Chapter 16

GREEN CHEMISTRY LABORATORIES - COLLABORATION WITH THE CONCEPT OF SUSTAINABLE DEVELOPMENT

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ABSTRACT

Practical education is the most important part of science education. Well-equipped laboratories of various disciplines of science like Physics, Chemistry, Botany, Zoology, Agriculture, Medical Science, Biochemistry etc. have been established in respective educational institutions. Different types of experiments are done by the students in these laboratories every day. Here we will discuss the Chemistry lab. In chemistry experiments, mainly substances are examined and analyzed. Various chemical reagents are being used for this purpose and many new chemical substances are produced. These chemicals are not only poisonous to human beings but also very hazardous to the environment also. So what is the problem? The problem is that despite knowing about the harmful nature of all the reagents, solvents and test products being used in chemical testing, arrangements for their proper disposal are still not made in any Chemistry laboratory.

Now at this time when we are facing environmental problems like severe environmental pollution, climate change etc, it cannot be permissible to use the old traditional methods in chemistry laboratories continuously. Hence for sustainable development in teaching and learning practical education and research work, we should think about establishing Green or eco-friendly Chemistry Laboratories in Educational institutes.

KEYWORDS: Green chemistry laboratories, Safe chemicals, Hazardous chemical substances, Environmental friendly substances.

INTRODUCTION

Green chemistry is not a topic and sub-discipline of chemistry – it is an eco-friendly approach towards minimizing harmful effect of all the chemicals that are excessively using in not only all divisions of chemistry, but also all divisions of science, business, and arts.

Green chemistry is a clean and positive approach to introduce innovative ideas and remedies to reduce chemical problems to a certain limit and apply sustainability to molecular design [1]. In this approach it is found clear that Chemists need to design safe chemical products and processes that have reduced impacts on humans and the environment health and therefore create sustainable chemical building blocks for materials and products in our industry and society.

WHAT IS THE NEED OF GREEN CHEMISTRY LABORATORIES IN EDUCATIONAL INSTITUTES?

In the chemistry labs of educational institutes and research units of universities, students and research scholars perform various chemical detection tests, analysis and organic and inorganic synthesis in glass wares of different capacities. For example, if a student adds 2 - 3 ml of chemical reagent in a test tube of

10 - 15 ml capacity for testing given sample solution or powder hardly generates 3 - 4 ml of a waste of hazardous chemical substance per student or test tube as test products. The problem is that if a batch of 30 students performs at a time in a lab, then 30 × 4 = 120 ml of a hazardous substance is thrown in the sink of the lab. Practical work is done in a chemistry laboratory for about 5 hours a day. So after every practical class, 120 ml or a large amount of the waste chemical substances are mixed in the drainage. Still, in almost all chemistry labs, the detection and analysis of substances are constantly done only through traditional methods. On this base, every chemical laboratory seems to be a chemical factory.

ADVANTAGES OF GREEN CHEMISTRY EXPERIMENTS

Green chemistry means several advantages. One it is environmentally friendly. Also, clean-up of both chemical reactants and products are simple. In the educational laboratory setting during green chemistry experiments materials are often safer for a large number of students in a single lab and students can easily relate to its Concepts. The use of safe chemicals reduces the burden of waste treatment and its disposal and the cost of installation of treatment units is also less.

Definition: What is Green Chemistry?

"Green Chemistry is the design of chemical products and processes that reduce and/or eliminate the use or generation of hazardous substances" as defined by the American Chemical Society. It is based on 12 principles.

GREEN CHEMISTRY: PRINCIPLES AND LAB PRACTICES

The twelve principles of green chemistry provide a framework for evaluating and minimizing the life-cycle impacts of a product or process. In addition to setting best practices in how to minimize these impacts, some principles also incorporate tools for calculating efficiency or minimizing waste [2][3].

- **Principle 1 - Prevention** – It is better to prevent waste production than to treat and cleanup it after its production. We should plan to minimize waste at every step.
- **Principle 2 – Atom Economy** - Reduce waste at the molecular level by maximizing the number of atoms from all reagents that are incorporated into the final products. This principle ensures the use of more efficient reactions which have high yield. For example 100% atom economy is achieved for the Diels-Alder transformation.
- **Principle 3 – Use and Generate Less Toxic Materials**; Less Hazardous Chemical Synthesis – This principle focuses on minimizing use & generation of hazardous chemicals.
- **Principle 4 – Design Safer Chemicals** – Design eco-friendly, biodegradable and nature based products.
- **Principle 5 – Safer Solvents and Auxiliaries** – This principle supports the principle 2 and 3, in minimizing the waste production. We need to develop solvent less chemical reactions or use safer solvents such as water and alcohol.
- **Principle 6 – Minimize energy use; Design for Energy Efficiency** – Principle 6, emphasizes the minimize use of energy, seeks to minimize energy use in all parts of a chemical process.
- **Principle 7 – Renewable Feed stocks** – We know that non-renewable feed stocks coal and petroleum are the major source of most of the organic chemicals and solvents but continuous use a non-renewable feedstock like petroleum is not sustainable. In accordance of Principle 7, develop new processes to create chemicals from renewable feed stocks like algae, sugar cane, wood, cow dung, plant products and other renewable resources. For example the biodiesel is made from vegetable oil by Esterification Reaction.
- **Principle 8 – Reduce Derivatives** – Unnecessary use of derivatives such as blocking groups, protection/de-protection, temporary modification of physical/chemical processes should be minimized

or avoided because such steps require additional reagents and can generate waste. One common way is with enzymes and biological processes to make transformations.

- **Principle 9 – Use catalysts** – Use Catalysts in most of the industrial chemical reactions to achieve higher atom economy (high yield) and generate less waste.
- **Principle 10 – Design for Degradation** - Related to Principle 4 to Use and Design Safer Chemicals, Principle 10, to Design for Degradation, focuses on designing products that readily degrade and do not persist and accumulate in the environment. Synthesis of biodegradable polymers is one of the greener alternatives of Polymerization chemistry.
- **Principle 11 – Real-Time Monitoring to Prevent Pollution** - Principle 11 encourages Real-Time Monitoring of Chemical Reactions, allows chemists to detect undesirable chemicals and adjusted the reaction conditions to minimize their creation.
- **Principle 12 – Accident Prevention** – Accidents occurring in chemical industries are not only a threat to the lives of the people, but they also have a long lasting impact on the environment. Ex. Bhopal gas Tragedy (December 1984).

APPLICATION OF GREEN CHEMISTRY PRINCIPLES AND BEST PRACTICES TO ESTABLISH GREEN CHEMISTRY LABORATORIES IN EDUCATIONAL INSTITUTES

Increasing pollution problems due to excessive use of chemicals forced us to think that in school and college lab and research units experiments it is necessary to have waste treatment units in all chemical laboratories. It is clear from the above discussion of the 12 principles of green chemistry that it is better to first consider the processes used and prevention of waste and hazardous chemicals produced during design, rather than disposing, treating and handling of waste products after their generation. For that harmful substances should be replaced by safe and eco-friendly (green) chemicals and solvents [4]. We need to consider -

- The raw materials that are being used, how they were made and what hazards were generated in their production.
- The materials used and waste generated (including chemicals, heat, and solid waste) in the creation of a chemical product.
- The ancillary materials needed to use a product and the fate of the product in the environment (e.g. pharmaceuticals).
- The disposal of all materials and wastes used and generated in making the product.

To implement the principles of Green chemistry we need to follow some best practices in the practical syllabus of all science streams. Here in this, I have discussed some best practices.

BEST PRACTICES FOR APPLYING GREEN CHEMISTRY PRINCIPLES IN CHEMISTRY EXPERIMENTS

Usually in school and college chemistry laboratories, students are taught to do some common experiments like Simple and fractional distillation, Extraction of natural substances, organic and inorganic synthesis, chromatographic separation, boiling and melting point determination, qualitative and quantitative analysis etc. They are also taught to use various equipment's and make them familiar with the properties of chemicals. Now this time we need to modify these experiments according to green chemistry principles by applying some best practices. Here in this chapter, we will discuss the application of some best practices in chemistry labs which can help to reduce the harmful impact of chemicals. Many of the chemicals we use in various chemical processes have various health and environmental hazards. These are oxidizers and carcinogens. Many organizations have developed Greener Alternative ways by using less toxic materials minimizes the risk of exposure or release of those materials during manufacturing, transport and use by us. It also helps to reduce the generation of hazardous waste [5].

USE OF SAFE OR GREEN SOLVENT (PRINCIPLE 4 AND 5)

During many chemical transformations, solvents are needed to aid in the chemistry or are used to separate products from starting materials. Solvents and auxiliary substances are generally end up as waste products and contribute greatly to the life-cycle impacts of a chemical process. Here we will learn about the use of green (eco-friendly) solvents in place of hazardous ones in the chemistry lab of under and post-graduate classes and research units but Green and safe chemicals also need to be used in limits -

(i) **Distillation:-** In a Simple and fractional distillations, toluene and cyclohexane are commonly used solvents for purification of compounds, separation of mixture and boiling point determination in organic chemistry. Both solvents are hazardous. In place of toluene and cyclohexane , less hazardous solvents like acetone and safe solvents like water –ethanol mixture can be used for the same experiments.[6][7]

(ii) **Chromatography:**- TLC and Column Chromatography techniques are used in the organic chemistry for testing the purity of a product, separation of pigments from plants and extraction process . Generally Hexane, Heptanes and Dichloromethane are commonly used solvents but these are not safe. The green and safe solvent in chromatography is Ethyl acetate. Use of recycled solvents and micro-column (micro-column chromatography) [8], [9] are also the part of green chemistry.

(iii) **Extraction: -** Extraction techniques are commonly performed as a means for isolating and purifying a product (i.e., essential oil or natural product extraction). Solvents commonly used in extractions are Dichloromethane, petroleum ether, or hexanes. These are problematic or hazardous. Greener solvents like Ethyl acetate and Iso-propanol have similar properties (e.g. miscibility, boiling point), so these can replace traditional solvents. Both liquid and supercritical carbon dioxide have been used as substitutes for organic solvents in extraction and chromatographic methods [10]. Carbon dioxide is advantageous because it can be obtained from and returned to the environment and is neither toxic nor flammable which increases the safety of extraction procedures [11].

Table 1: Under the green & clean chemistry, researchers have identified the nature of various solvents – [CHEM21 Online Learning Platform [http://learning.chem21.eu/].[12]

Recommended (Safe solvents)	Water, EtOH, i-PrOH, *n*-BuOH, EtOAc, i-PrOAc, *n*-BuOAc, anisole, sulfolane.
Recommended or problematic?	MeOH, *t*-BuOH, benzyl alcohol, ethylene glycol, acetone, MEK, MIBK, cyclohexanone, MeOAc, AcOH, Ac2O,
Problematic	Me-THF, heptane, Me-cyclohexane, toluene, xylenes, chlorobenzene, acetonitrile, DMPU, DMSO,
Problematic or hazardous?	MTBE, THF, cyclohexane, DCM, formic acid, pyridine.
Hazardous	Diisopropyl ether, 1,4-dioxane, DME, pentane, hexane, DMF, DMAc, NMP, methoxy-ethanol, TEA.
Highly hazardous	Diethyl ether, benzene, chloroform, CCl4, DCE, nitromethane, CS2, HMPA.
*To deal with this problem Purchasing of harmful solvents by school or college should be banned.	

(iv) **Safe and green chemical reactions for Organic Chemistry Laboratories (Principle 2 and 3) : -** Greener alternatives to organic chemistry reactions have been published by many new publications can be easily adoptable options for greener organic chemistry experiments in place of traditionally conducted in the undergraduate organic chemistry laboratory curriculum [13],[14].

Table 2: Reactions Selected for Assessment are -

Experiment 1 : Aldol Condensation
Experiment 2 : Esterification
Experiment 3 : Oxidation
Experiment 4 : Diels-Alder reaction
Experiment 5 : Electrophilic Aromatic Substitution
Experiment 6 : Substitution (SN2)
Experiment 7 : Bromination
Experiment 8 : Reduction
Experiment 9 : Friedel-Crafts Alkylation and Acylation
Experiment 10 : Polymerization
Experiment 11: Wittig reaction etc

Aqueous Organic Reactions - As we all know that water is a low-cost universal solvent. It is not toxic and inflammable and abundant in nature. Chemists have been exploring organic reactions in water [15]. Recently, Lipshutz and co-workers have created several surfactants to facilitate organic transformations under aqueous conditions. These surfactants naturally form micelles and micellar catalysis provides a pathway for synthesizing novel and conventional materials in aqueous media. Green Chemistry Principles 1 (waste prevention), 5 (safer solvents and auxiliaries), 6 (design for energy efficiency) and 9 (catalysis) can be employed when using micellar catalysis [16] [17].

VOLUME REDUCTION (PRINCIPLE 1 AND 11)

30 to 50 students are present in the practical class of chemistry at a time, so if each student will perform experimental work, then during qualitative/ quantitative analysis, test tubes of 10 – 50 ml or burette of 50 ml capacity are used by the students. Large amounts of sample powder taken, large amounts of reagent added and large volumes of solvent used by each student produce a large quantity of waste. It is highly advisable to use a testing plate having micro pits or white tiles and micro-size modern design highly precise lab wares in which a very small amount of sample and reagent are added with the help of droppers or micropipettes. This practice will produce less volume of waste. Micro-scale approaches can reduce solvent and product waste [18]. A limited quantity of sample powder, reagent and solvent should be provided to the students by the laboratory staff under strict monitoring rules.

ENSURE THE MAXIMUM USE OF INSTRUMENTS (PRINCIPLE 1 AND 3)

Qualitative analysis of elements and radicals uses large amounts of chemical reagents. Some of them are very harmful to the humans and environment. A qualitative analysis should be performed with the help of Instruments such as a spectrophotometer, IR and UV spectrometer, mass spectrometer etc. Volumetric analysis conducted by traditional methods uses harmful indicators in endpoint detection. Volumetric analysis can be done as conductometric and potentiometric titrations without the use of indicators.

Virtual lab experiments (Principle 1) – Virtual labs provide remote experimentations as an on-demand service over the web. These labs provide remote access to labs at the undergraduate level, postgraduate level and for the research scholar. Generally, during a complete course, one type of experiment like

volumetric analysis is performed by the student more than one time. So it is advisable that after practicing the steps of experiments some experiments should be performed on the virtual lab.

USE OF SAFE CHEMICALS DURING LEARNING (PRINCIPLE 1 AND 5)

We should avoid using harmful chemicals to learn the use of all equipment present in the lab. Water can be used to perform calibration and learn the proper use of lab glass wares such as burette, pipette, volumetric flask, measuring cylinder etc. Acetic/ citric/ tartaric acids etc can be used in learning preparation of solutions of different molar concentrations.

MINIMIZE ENERGY USE (PRINCIPLE 6)

Energy is needed to heat or cool a reaction, for separations, condensations, purifications, removal of solvent from the final product, in transport and in a variety of other ways. In green chemistry, we look for ways to conduct experiments at ambient temperatures and pressures (or closer to ambient) so that the energy needed to create high or low pressures or temperatures can be minimized. Solvent-free organic reactions has been explored for the past 20 years due to the advantages of eliminating waste (Principle 1) and designing for energy efficiency (Principle 6) along with faster reactions under conditions such as grinding, microwave, irradiation, or mechanical stirring in the presence or absence of heat when compared to traditional methods [19].

CHALLENGES

It is common practice that when a new school or college is established in small or medium cities while purchasing chemicals for the laboratory, orders are placed based on the old traditional experimental methods so that the students use the same harmful chemical during the practical [20]. Due to this, the problem remains the same. It becomes difficult to solve. The reasons behind using harmful chemical substances during a practical are -

- Less availability and high cost of Eco-friendly, biodegradable and natural products
- Lack of awareness of hazardous materials and their high cost of handling and disposal among the people
- Neutrality towards environmental issues
- Lack of interest in adopting green chemistry principles
- Shortage of trained staff in laboratories for monitoring

CONCLUSION

Now it is necessary to seriously consider the replacement of hazardous chemicals at all levels. To apply the principles of green chemistry everywhere like in chemistry laboratories of all science faculty of educational institutes and especially small, middle and large industries, it is better to first introduce the chapter "Green chemistry and its principles" in the science book from the lower level and teach it thoroughly in the complete tenure of education. Initiatives have been taken by many universities. To implement all the design and development of newer methodologies, chemicals and technologies of green chemistry, the government must take strict rules and regulations. Some good steps need to be taken like giving green ranking, awards and more grants to the green chemistry lab of the institute.

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Chapter 17

ECO-FRIENDLY FARMING

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ABSTRACT

Agriculture and technology are considered as the backbone of the world economy. The nations of this world will have to double their present food production by 2050 with the increasing population. The effect of sustained and over usage of chemical fertilizers in crop production has resulted in human health hazards and pollution of the environment and groundwater. Eco-friendly farming relies primarily on the cycling of organic matter to maintain soil fertility. It works on the concept of 'feed the soil to feed the plant. Eco-friendly agriculture practices are crop production, soil, and water management, weed control, Insect and pest control and agricultural engineering. The strike of balance between the environment and the livelihood becomes immensely important due to the risks caused by conservative agriculture practices. Adapting eco-friendly farming reduces the negative impacts on the planet and its people while enjoying long-term productivity. These methods can help reduce and even prevent the adverse effects of large-scale farming.

KEYWORDS: Chemical fertilizers, health hazards, Sustainable Agriculture, Food Security

INTRODUCTION

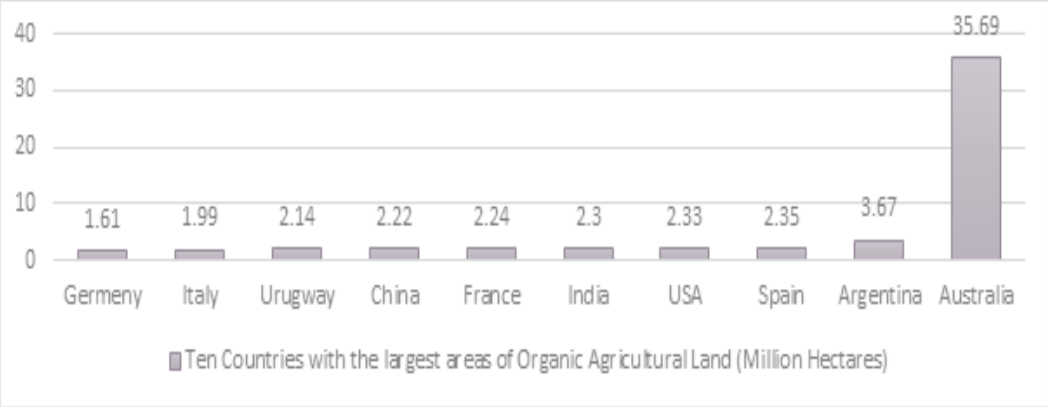
The backbone of the world economy is agriculture and technology. With the ever-increasing population, the demand for food also increases and nations must double their food production by 2050. Perseverance of natural resources including land, water, and energy is required for agriculture. Chemical fertilizers are fundamental in modern agriculture because they give crops vital nutrients. They are produced using industrial procedures and offer crops a concentrated and accessible source of nutrients including nitrogen, phosphorous, and potassium, which considerably increase crop yields. However, given their widespread use, questions have been raised about how they may affect human health, soil health, crop productivity, and the sustainability of the environment (Satish Kumar, Diksha, Satyavir S. Sindhu, Rakesh Kumar [2022].

Chemical fertilizers used in agriculture can pollute the environment in a variety of ways. Excessive fertilizer application or inappropriate timing can cause nutrient runoff, resulting in water pollution and eutrophication of bodies of water. They can potentially contribute to air pollution due to ammonia leakage and greenhouse gas generation during manufacture and application. With the overuse of nitrogen fertilizers, plants' root systems may not be well-established, and the soil may lack sufficient structure and organic matter. This causes the soil more exposed to erosion, particularly during heavy rainfall events. The soil which contains essential nutrients can be washed away, resulting in soil acidification, reduced soil fertility and production. They can potentially upset the microbial community balance in the soil and hinder the growth and activity of these beneficial bacteria, altering the natural soil ecosystem and lowering its resilience. (Chandini & Kumar, Randeep & Kumar, Ravendra & Prakash, Om. ,.2019). Excessive use of chemical fertilizers can result in chemical residue accumulation in crops. When

these residues are eaten, they can pose concerns to human health, including toxicity and long-term health impacts. Proper fertilizer management practices, precision agricultural technology, and the adoption of sustainable farming practices are critical to mitigating these concerns. (Serpil Savci,.2012).

SUSTAINABLE AGRICULTURE

A comprehensive approach to farming and food production that helps in fulfilling the requirements of the current generation, as well as the future generation's needs, is known as sustainable agriculture. It strives to reduce environmental impact by conservation of natural resources, decrease in pollution, and maintaining biodiversity. It focuses on soil conservation, water management, and ecological and animal habitat protection. (Gupta et al, .2021). It relies primarily on the cycling of organic matter to maintain soil fertility and works on the concept of 'feed the soil to feed the plant. Eco-friendly agriculture practices are crop production, soil and water management, Insect pest and, weed control. Most countries are adopting organic agricultural practices to reduce environmental changes.



Source: FiBL Survey 2021

Figure 1: Ten Countries with largest areas of organic agriculture land

METHODS OF SUSTAINABLE AGRICULTURE

ORGANIC FARMING

Organic farming is a farming practice that emphasizes natural processes and procedures while avoiding the use of synthetic inputs such as synthetic fertilizers, pesticides, genetically modified organisms (GMOs), and growth hormones. Soil health and fertility are extremely important in organic farming. Crop rotation, cover cropping, composting, and the use of organic amendments such as animal manure, green manure, and plant residues are used to improve the soil's foundation, quantity of nutrients, and bacterial activity. These practices improve soil biodiversity, preservation of water capacity, and nutrient availability, hence enhancing long-term soil health and lowering the demand for external inputs.

Organic farmers utilize a variety of methods to manage pests, illnesses, and weeds without the use of synthetic pesticides. In organic farming they use mechanical weed management methods like as manual weeding, mulching, and the use of flame weeders or specialised instruments are frequently used (Adamchak, 2023).

INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM) is a pest-control strategy that integrates several tactics for successful and long-term management. It starts with pest monitoring and detection, then moves on to preventive measures including cultural controls and crop rotation. To manage pest populations, biological controls such as the introduction of natural enemies, as well as mechanical or physical controls such as traps or handpicking, are used. Chemical controls are employed sparingly, with insecticides and application techniques carefully chosen. IPM reduces pesticide usage, protects natural ecosystems, and delivers long-term pest management solutions by combining various practices (Karlsson Green, K., Stenberg, J. A., & Lankinen, Å. (2020).

HYDROPONICS AND AQUAPONICS

Hydroponics is a soilless growth process in which plants are grown in a nutrient-rich water solution. To anchor the roots, the plants are often supported with inert growth material such as perlite, vermiculite, or rock wool. The water solution is precisely adjusted with critical nutrients for plant development and is recirculated or refilled as needed. Plants and growth material are held in growing pots or trays, allowing the roots to receive nutrient-rich water. It comprises the minerals and components required for plant growth and may be manually combined using automated nutrient delivery devices. Pumps and irrigation systems provide nutritional solutions to plant roots, guaranteeing enough moisture and nutrients. pH and nutrient levels are measured and changed on a regular basis to ensure optimal growth for plants (Fussy, Andre, and Jutta Papenbrock. (2022).

Aquaponics is a hybrid of hydroponics and aquaculture, resulting in a symbiotic system in which fish and plants live. It entails combining a fish tank or aquaculture system with hydroponic plant beds. The fish waste feeds the plants naturally, while the plants filter and clean the water for the fish. Typically, species such as tilapia, trout, or catfish are kept in fish houses. The fish excrete ammonia-containing feces. Beneficial bacteria transform ammonia from fish waste into nitrites and ultimately nitrates, which are used by plants as a source of nutrients. The nutrient-rich water from the fish tank is sent to the hydroponic plant beds. The plants absorb the nutrients, filter the water, and return it to the fish tank, resulting in a closed-loop system (Rakocy, James E., 2012).

AGROFORESTRY

Agroforestry is a land use management strategy that combines the cultivation of trees or woody perennials with the production of agricultural crops or animals. It entails purposefully mixing agricultural operations with tree cultivation in order to foster mutually beneficial connections and maximize yield. Agroforestry systems are intended to increase environmental sustainability, soil health, biodiversity conservation, and economic advantages to farmers.

Trees improve soil fertility by fixing nitrogen, contributing organic matter in the form of leaf litter, and improving soil structure. Their extensive root systems improve water infiltration and reduce erosion. Agroforestry systems support biodiversity and ecological balance by providing habitat for a wide range of plant and animal species. Trees absorb carbon dioxide from the atmosphere, aiding in climate change mitigation by functioning as carbon sinks (Nair, P. K. R., 1991).

Agroforestry may help farmers diversify their income by offering extra goods such as timber, fruits, nuts, and medicinal plants. It also can produce value-added goods like as honey or essential oils. The integration of trees with crops or livestock can improve farming system resilience by providing shade, wind protection, and protecting against harsh weather events (Sakthi Vel, 2017).

ANCIENT INDIAN AGRICULTURE

The emphasis on organic and natural agricultural practices was a fundamental component of ancient Indian agriculture. Farmers used organic fertilizers like cow dung, urine, and compost formed from plant components to feed the soil and improve its fertility. These natural fertilizers supplied a plentiful supply of nutrients and organic matter, fostering healthy plant development and environmentally sound agricultural practices (Behera, 2020).

COW DUNG MANURE (JEEVAMRUTHA)

Jeevamrutha, which translates as "Divine Nectar of Life," is a traditional organic fertilizer and soil conditioner produced from cow dung, urine, jaggery/molasses, water, and beneficial microbes. It has various advantages in agriculture. Beneficial microorganisms break down the organic matter in Jeevamrutha during the fermentation process, releasing nutrients and enzymes that encourage plant development and enhance soil fertility. Jeevamrutha can be sprayed to the soil or used as a foliar spray to enrich the soil with organic matter, increase nutrient availability, and improve plant nutrient absorption. It also enhances soil structure, inhibits dangerous pathogens, and minimizes pest and disease occurrence. Jeevamrutha is a cost-effective and environmentally friendly alternative to synthetic fertilizers, encouraging environmental sustainability in farming practices (Ashmeet Kaur, 2020).

VERMICOMPOSTING

Vermicomposting is a type of composting that uses earthworms to turn organic waste into nutrient-rich compost. Composting worms, such as Eisenia fetida (red worms) or Lumbricus rubellus (red wigglers), are used to manage the decomposition of organic materials such as kitchen scraps, vegetable waste, garden clippings, and manure.

The establishment of a suitable home for composting worms is the first step in vermicomposting. To provide a moist and carbon-rich atmosphere, a composting bin or container with proper ventilation is set up and filled with bedding materials such as shredded paper, coconut coir, or leaves. After that, the organic waste is placed to the bin, and the worms are introduced (Abul-Soud, *et al.*, 2009).

PANCHAGAVYA

Panchagavya is a traditional organic concoction used as a natural plant growth booster and insect repellant in Indian agriculture. These components provide nutrients to plants that are required for proper development, blooming, and fruiting. Lactobacillus, yeast, and other beneficial bacteria found in Panchagavya aid in nutrient cycling, soil conditioning, and other processes.

Panchagavya is made by combining cow dung, urine, milk, curd, and ghee in particular amounts and fermenting it for a set length of time. The fermenting mixture is then diluted with water and sprayed or soaked into the soil. Panchagavya contains anti-pest effects. Panchagavya's combination of cow products and microbes provides an unfavorable habitat for pests and illnesses. When sprayed on plants, it develops a protective coating on the leaves, making them less vulnerable to pests. Panchagavya bacteria also aid in the biological management of pests by competing for resources and space with dangerous diseases and insects. (Balasubramanian *et al.,* 2009).

BIOFERTILIZERS

Bio fertilizers have gained popularity due to their ability to boost agricultural output while minimizing detrimental environmental effects. They are organic, environmentally acceptable substitutes for chemical fertilizers that contain or are generated from live microorganisms (Dhir, B. 2017).

NITROGEN-FIXING MICROBES

Rhizobium, Azotobacter, and Azospirillum are present in these bio fertilizers and work in symbiotic relationships with leguminous plants to fix atmospheric nitrogen and transform it into a form that is useful to plants (Alori Elizabeth Temitope, Babalola Olubukola Oluranti, 2018).

PHOSPHATE SOLUBILIZING/MOBILIZING MICROBES

In many agricultural systems, crop yield can be hampered by phosphorus deficit as it is frequently found in soil in insoluble forms that plants cannot easily access. Phosphorus-solubilizing microorganisms (PSMs) can change insoluble forms of phosphorus into soluble forms that are more easily absorbed by plants. organic acids or enzymes are secreted by bacteria that solubilize phosphorus from soil minerals so that plants can absorb it (Buddhi Charana Walpola and Min-Ho Yoon, 2012).

POTASSIUM SOLUBILIZING/MOBILIZING MICROBES

Bound or fixed potassium from soil minerals or organic matter is turned into usable forms by these microorganisms so that plants can absorb it. These microbes improve potassium availability by producing organic acids, enzymes, or metabolites that help potassium ions to be released from mineral or organic sources. Bacteria, fungi, and actinomycetes have been identified as potassium-solubilizing/mobilizing microbes (Abdoulaye Soumare *et al.,* 2023).

ZINC SOLUBILIZING MICROBES

Zinc-solubilizing microorganisms help in zinc availability to plants through a variety of processes, including the formation of organic acids, siderophores, and chelating chemicals which can remove zinc from soil minerals or organic matter. (Hamzah Saleem Muhammad, *et al.* 2022) They can also benefit plants by improving nitrogen cycling, nutrient absorption efficiency, and resistance to abiotic stressors such as drought, salt, and heavy metals (Kamran *et al.,* 2017).

PLANT GROWTH-PROMOTING RHIZOBACTERIA (PGPR)

A varied collection of bacteria that colonize and interact with plants in the rhizosphere (the soil zone around plant roots) are called Plant growth-promoting rhizobacteria (PGPR. They can improve plant growth and development via a variety of processes. PGPR has a mutualistic interaction with plants, benefiting both the bacteria and the host plant. Through direct and indirect mechanisms, they colonize the rhizosphere and promote plant growth.

Plant growth-promoting chemicals such as auxins, cytokinins, gibberellins, and ethylene modulators can be produced by PGPR, which regulates plant growth and development processes. These chemicals can accelerate root development, improve nutrient absorption, and increase plant vigor overall. Some PGPR can solubilize or mobilize nutrients like phosphorus, potassium, and iron, making them more available to plants. They can create enzymes, organic acids, or siderophores that aid in the acquisition and utilization of nutrients (Jeyanthi and Kanimozhi, 2018).

CONCLUSION

Eco-friendly farming ensures that the environment stays clean and preserves rich biodiversity. The negative impacts on the planet and its people enjoying long-term productivity can be achieved by adopting eco-friendly farming. It helps to reduce and even prevent the adverse effects of large-scale farming. A strong immune system is built by healthy organic food. Higher levels of antioxidants and certain micronutrients are more in Eco-friendly grown foods. They contain no harmful chemicals, pesticides, or fertilizers and food tastes better. Organically grown produce aids in the maintenance of environmental equilibrium and sustainability of the world.

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Chapter 18

HEAVY METAL POLLUTION OF DRINKING WATER-RISK FOR HUMAN HEALTH- A REVIEW

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ABSTRACT

Water pollution has come a major trouble in moment's world. Collection of heavy essence, a many of them, is potentially poisonous and these get distributed to different areas through different pathways. With an increase in the earth's population, development and industrialization are taking place fleetly and these get the major source of water impurity. With heavy essence in lakes, gutters, groundwater, and colorful water sources, water gets defiled by the increased attention of heavy essence and metalloids through release from the suddenly mine chase, disposal of high essence wastes, growing artificial areas, prime gasoline and maquillages, operation of diseases inland, beast coprolites, E-waste, sewage sludge, fungicides, wastewater irrigation, coal, etc. Exposure to heavy essence has been linked to habitual and acute toxin, which develops deceleration; neurotoxicity can damage the feathers, lead to the development of different cancers, damage the liver and lungs; bones can come fragile; and there are indeed chances of death in case of huge quantum of exposure. This chapter substantially focuses on heavy essence pollution in water and its poisonous effect on living organisms

KEYWORDS: Water Pollution, Waste water irrigation, industrialization

INTRODUCTION

Even in the current era of growing technology, the concentration of heavy metals present in drinking water is still not within the recommended limits as set by the regulatory authorities in different countries of the world. Drinking water contaminated with heavy metals namely; arsenic, cadmium, nickel, mercury, chromium, zinc, and lead is becoming a major health concern for public and health care professionals. Occupational exposure to heavy metals is known to occur by the utilization of these metals in various industrial processes and/or contents including color pigments and alloys. However, the predominant source resulting in measurable human exposure to heavy metals is the consumption of contaminated drinking water and the resulting health issues may include cardiovascular disorders, neuronal damage, renal injuries, and risk of cancer and diabetes (5).

SOURCES OF CONTAMINATION

Ready expansion and artificial development near the gutters have led to further stress on the swash, and with increased stress, the water becomes weakened, and worsening environmental health is observed (1). The water- soil interface and the water- atmosphere interface is the medium through which the heavy essence trip (2, 3). Both anthropogenic conditioning and geochemical processes are responsible for heavy essence impurity in ecosystems (4)

NATURAL SOURCES

Trace essence are set up in redundant situations in the terrain, they're formed by geographical processes similar as stormy eruptions, riding of jewels, and filtering into gutters, lakes, and abysses due to the

action of water (5). The presence of heavy essence in water depends on the original geology, hydrogeology, and geochemical characteristics of the aquifer (6).

ANTHROPOGENIC SOURCES

Anthropogenic events, in which mortal agreement replaced the natural timber and agrarian conditioning, have increased the environmental impacts. The water carrying capacity has dropped with the rapid-fire increase in industrialization and urbanization. Hg attention in water has increased with husbandry conditioning and mortal conditioning. Conditioning like domestic sewage into the water, solid waste burning, coal and oil painting combustions, and pyrometallurgical processes and mining are the main reason for this.

DOMESTIC SEWAGE

Huge quantum of undressed sewage from domestic is thrown into the swash. This undressed waste from domestic has the presence of poisons. These poisons are due to the presence of solid waste or from the waste of plastic, or the impurity of bacteria due to the presence of these the water can get defiled. Domestic undressed water is thrown directly into the water resource and this majorly causes pollution inside the water and harms the ecosystem (7).

INDUSTRIAL SOURCE

Impurity of heavy essence in the submarine terrain is veritably dangerous since these rudiments cannot be degraded and they get accumulated inside the living organisms (8). Residue from the assiduity is the major source through which these heavy essences get into the submarine ecosystems, and their accumulation in water varies with the type of wastewater treatment used (9).

URBANIZATION

With an increase in the population has created numerous issues and one of the issues is the pollution of water (10). An increase in the population leads automatically leads to further generations of solid waste (11). Both solid waste and liquid waste are deposited into the water without any treatment. Mortal excreta also pollute the water. Therefore, polluted water leads to a generation of a large number of bacteria, which a trouble to mortal well- is being (12)

AGRICULTURE SOURCE

The population in rural areas is less but the use of fertilizers, pesticides, and eroded soil contaminates the water. When it rains the water from the surface runoff and that rainwater enters the nearby water resource and thus pollutes the existing water [13].

ATMOSPHERIC SOURCE

Small adulterants patches which are present in the air, get into the water sluice through the rain, when it rains these patches come down and also with the inflow of water enters into the ocean, therefore contaminating the water there. These adulterants that are present in the air generally get from the burning of fossil energies. Is CO2, which combines with water and produces sulfuric acid?

MINING SOURCE

Heavy Essence is present on the earth and therefore they can enter the water system through colorful pathways and one of them is through mining sources. When it rains or through flowing water, it leaches heavy essence out from their geological conformation

HEAVY METAL INTAKE THROUGH WATER

Soil gets polluted with the presence of heavy metal on surface and underground water and the pollution rises when mined ores are discarded on the ground surface for manual dressing [14]

EFFECT ON LIVING ORGANISM

The water in the swash and lakes can be largely weakened depending on the volume of inflow and propinquity to the point sources. Due to the mortal civilization, the element content in water is raised.

Similar rudiments are cadmium, lead, mercury, zinc, and chromium. The sediments constitute a partial donation to contaminating the natural marvels due to their exertion and essence remobilization processes. Essence remainders that are present in the defiled surroundings have the inflexibility to get bio accumulated into the submarine terrain (15) A drop in pH of water either due to acid rain or any other acidic incidents, due to the heavy essence's deposit into the water column, causes submarine biota to come toxic. Low situations of heavy essence can also make habitual stress, through fish might not get dead but can beget them to lose weight and come lower, reducing their capacity to contend for food and niche (16) For the growth of shops, many HMs like As, Cd, Hg, Pb, and Se aren't important as they don't perform any given physiological function in them. Others, similar as Co, Cu, Fe, Mn, Mo, Ni, and Zn, are crucial rudiments that are needed for regular factory development and metabolism, but their quantities can snappily exceed the applicable situations, performing in poisoning (17,18). Heavy essence attention in shops varies by factory species, and the effectiveness with which colorful shops absorb essence is measured by factory immersion or essence transfer factors from soil to plant. Heavy essence similar as Cd, Pb, and Ni indeed their small attention in shops can be dangerous to them. Poisoning due to this heavy essence will affect in the complex interplay between the primary unwelcome ions and fresh necessary or unnecessary ions. Essence affects the exertion of enzymes by switching essence ions from essence enzymes, as well as precluding factory growth (19).

CONCLUSION

Water pollution is a global problem, and the world's population is suffering the consequences of alloyed water. Living organisms are also affected by the weakened water veritably much and it's veritably dangerous to the terrain. Acute and choric ails are caused by heavy essence attention in drinking water that exceed the admissible limits set by several public and transnational associations. These can range from nonfatal, similar as muscle and physical weakness, to fatal, similar as brain, nervous system, and indeed cancer. Water quality testing is necessary for the protection of mortal health and the terrain.

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