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Nutritional and phytochemical assessment of dried seeds from *Buchholzia coriacea* harvested in Côte d'Ivoire

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Abstract

Buchholzia coriacea is a spontaneous wild edible plant, which is consumed by the peoples of Africa countries. This study aims to contribute to the valorization of *Buchholzia coriacea* flour in Côte d'Ivoire. The assessment of the physico-chemical, phytochemical and nutritional characteristics of *Buchholzia coriacea* flour powder showed respectively very low levels of lipids (1.5 ± 0.11%), ash (4.49 ± 0.14%), crude fiber (2,11 ± 0.06) and reducing sugars (8.66 ± 0.10%) while the carbohydrate, total sugars and protein levels obtained were 68.02±0.85%, 15.66 ± 0.22% and 17.1 ± 0.55, respectively. Then the moisture content was low at 9.79 ± 0.42%. In contrast, the results for the flour powder phytochemicals showed polyphenols richness (422.92 ± 1.32%) followed by alkaloids (38.69 ± 0.64%), flavonoids (26.88 ± 0.71%), tannins (26.87 ± 0.51%) and anthocyanins (19.10 ± 0.85%). Steroids were low at 0.33 ± 0.23%. Antioxidants such as vitamin C were 2.38± 0.06 mg/100g DM. Finally, minerals such as magnesium, phosphorus and iron have high levels of 789.7 ± 085 mg/100g DM, 665.1± 0.99 mg/100g MS, and 559.1 ± 0.99 mg/100g DM, respectively. In contrast, potassium with an average of 2.44 ± 0.09 mg/100 g DM was the weakliest represented mineral. In short, Buchholzia coriacea seed had very interesting nutritional and phytochemical characteristics. This diversity could be beneficial to populations in food and in the prevention of oxidative stress related diseases.

Keywords: *Buchholzia coriacea*; Physico-Chemical; Polyphenols; Vitamin C; Magnesium

1 Introduction

Buchholzia coriacea belongs to the Capparaceae family. It is commonly referred to as "wonderful colas" because of the nutritional and medicinal properties of its seed. In reality, colas seeds are highly valued in most African communities due to their medicinal benefits and socio-cultural application during ceremonies. It grown in the tropical forests of Nigeria, Cameroon, Liberia, the Central African Republic, Congo and Côte d'Ivoire; [1] [2]. The commonly consumed parts of the plant are the seeds, which are either cooked or raw [3]. In addition, this kola species has many pharmacological activities such as antioxidant, anticancer, antidiabetic, anti-inflammatory, anti-hypertensive, anti-viral, cardiovascular and antimicrobial capacity [4]. Indeed, the nutritional and photochemical evaluation of *B. coriacea* seeds showed that it contained minerals and a significant class of phytochemical compounds such as alkaloids, glycosides, saponin, steroids, tannin, flavonoids, terpenes and phenols [5, 6]. In addition, the latter compounds mentioned above would after consumption contribute to human health and well-being [5]. However, the biochemical composition of *Buchholzia coriacea* had not been sufficiently studied in Côte d'Ivoire, whereas traditional medicine merely sells the therapeutic virtues related to the consumption of nuts, leaves and bark. The aim of the present study therefore is to

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determine some physical and chemical characteristics and some phytochemical components of the *Buchholzia coriacea* seeds produced in Côte d'Ivoire.

2 Material and methods

2.1 Collection of *Buchholzia coriacea* seeds

The mature seeds of *Buchholzia coriacea* purchased on the market of the Grémian district in the city of Divo, located in the region of Loh Djiboua (Côte d'Ivoire) were authenticated by the floristic center of the National University of Côte d'Ivoire.

Figure 1 Different parts of the *Buchholzia coriacea* plant

- A: leaf, shell, nut;
- B: Cutout slide; C: Flour

2.2 Preparation of Samples

The biological material used for this study consists of the mature seeds of *Buchholzia coriacea* which after purchased on the market were put in a jute bag and then were immediately transported to the Nutrition and Food Safety Laboratory of Nangui Abrogoua University for analysis. Once in the laboratory, the seeds were separated from the shell, weighed, washed and then broken down into thin strips and dried in the sun for 3 days. Therefore, the dried samples were ground into fine powder to obtain the flour after sieving (250 µm diameter) (Figure 2).

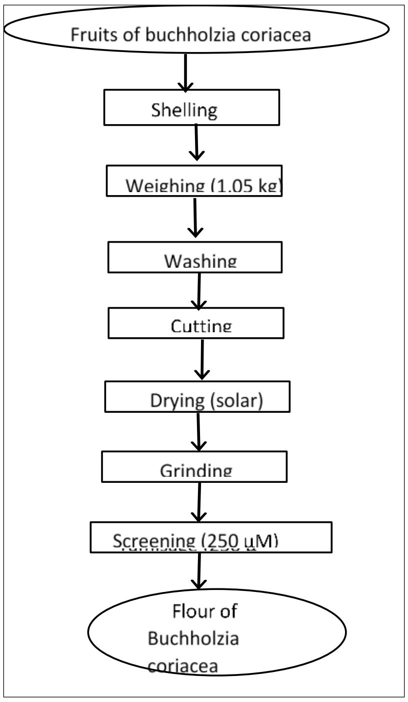

Figure 2 Preparation of *Buchholzia coriacea* flour

2.3 Proximate composition

The AOAC method *[7]* was used to determine crude fibre and the moisture content after drying at 105 °C for 24 hours *to constant weight.* The AOAC method *[7]* was also used in the determination of total ash content *by incinerating in a furnace at 550 °C*, and fat extraction *in a Soxhlet apparatus for 8 h using hexane* for the determination of lipid content. The AOAC method *[8]* was again used to determine *Nitrogen by the Kjeldahl method and crude protein content was subsequently calculated by multiplying the nitrogen content by a factor of 6.25.* The extraction of sugars was done by the method described by *[9]*, then the determination of total sugars was done by the method of *[10]*, while reducing sugars was done by the method of *[11],* using 3.5 dinitrosalycilic acids (DNS). The total carbohydrate content of the flours was determined using the FAO (1998) method as following:

$$\text{Total Carbohydrate (\%)} = 100\ \% - (\%\ \text{Moisture} + \%\ \text{Ash} + \%\ \text{Lipids} + \%\ \text{Protein})$$

The theoretical calorific energy (kJ/100g) *of the samples of* Buchholzia coriaceae seeds *has been calculated from the specific* coefficients for proteins, lipids and carbohydrates *[12]*:

$$\text{Energy value (KJ/100g)} = (\text{protein} \times 17) + (\text{lipids} \times 37) + (\text{carbohydrate} \times 17)$$

2.4 Mineral analysis

The quantification of minerals was carried out after incinerated the flours at 550°C for eight hours (08 h) in a muffle furnace. The minerals, such as potassium, iron and magnesium were analyzed after nitric acid digestion using an atomic absorption spectrophotometer (Model No. 560, Elmer Corp, Norwalk/ United States). Phosphorus was estimated colorimetrically (UV-visible spectrophotometer, Model DR 2800/United States). All results for mineral composition are recorded on the basis of edible portion of sample as mg/100 g dry weight

2.5 Biochemical Analysis

Vitamin C (ascorbic acid) content was determined by the method of *[13], after* dissolving the flours in metaphosphoric acid-acetic acid followed by titration with a solution of 2.6 dichlorophenolindophenol.

2.6 Antinutrients Analysis:

Total polyphenolics compound contents in *Buchholzia coriacaea* powder were determined as described by *[14]* from the methanol extracts using Folin-Ciocalteu reagent. *Tannin and* glycosides screening were carried out by the spectrophotometric method described by [15]. The determination of alkaloid, anthocyanin and flavonoid, contents, was estimated by the filtration method of [16]. Saponin content were estimated by the spectrophotometric method described by [17] and steroids by Liebermann-Burchard test using chloroforme-acide acétique [18]; [19].

2.7 Statistical analysis of the data

All measurements were carried out in triplicate. Statistical analyses of the data were performed using Statistical version 7.1 software. Comparisons of means were determined using Student's test and statistical significance was defined at $p \leq 0.05$.

3 Results and discussion

3.1 Physical measurements of fruits and seeds

The analysis of physical measurements of *Buchholozia coriacea seeds* was shown in Table 1. The physical measurements (length, width and circumference) were made on the whole fruit and the seed. Morphological appearance showed significant differences ($P<0.05$) in seed length, width and circumference. In terms of length (5-6.76 cm; 2-3.66 cm), width (7-8.1 cm; 3-4.96 cm) and Circumference (10-13.9 cm; 4-6.51 cm) of the fruits and seeds respectively, the dimensions investigated in this study were close to those of the fruits and seeds of the morphotype of *Buchholzia coriacea* found by [20]. The differences observed in the dimensions of the fruits and seeds of *Buchholzia coriacea* could be due to the agronomic value of the soil, the climate and the delay in flowering. Also, rainfall would have a determining effect on fruit size [21]. the results of this study were comparatively higher than those of [22] which worked on *Pterocarpus santalinoides* seeds and fruits.

Table 1 Physical properties of the fruit of *Buchholozia coriacea*

Properties	Whole fruit	seed
Length (cm)	5-6.76 ± 0.40	2-3.66 ± 1.52
Width(cm)	7-8.1 ± 0.32	3-4.96 ± 0.1
Circumference(cm)	10-13.9 ± 0.42	4-6.51 ± 0,1

3.2 Proximate composition

Table 2 Biochemical composition of *Buchholzia coreacea*

Composition	(% of DM)
Moisture	9.78 ± 0.42
lipids	1.5 ±0.11
Protein	14.1 ±0.55
carbohydrates	68.02±0.85
Total sugars	15.66 ±0.22
Reducing sugars	8.66 ± 0. 10
Ashes	4.49±0.14
Crude fiber	2,11 ± 0.06
Energy value (KJ/100g DM)	1451.54

As regards the physicochemical characteristics, the results in table 2 showed that the moisture content of the powder obtained from the dried seeds amounted to 9.78 ± 0.42 %. This low moisture content could be explained by the drying and crushing processes experienced by the seeds of *Buchholzia coriacea*. This value was comparable to those previously reported for raw *Buchholzia coriacea* seed flour [23], however, it was higher than *Blighia sapida* powder (7.33 ± 0.5%) harvested in Côte d'Ivoire by [24] and *Cucurbita maxima* (5.01± 0.01%) harvested in Nigeria [25]. Therefore, this result showed that the quality of this powder could be protected from the development of microorganisms when it is well preserved. Indeed, according to [26], the moisture content was a very important parameter in the preservation of flours as a moisture content greater than 12 % would promote the growth of microorganisms. Under these conditions, the methods of production of the powders would seem to be adequate for a good conservation. However, the protein content obtained in the present study (14.1 ± 1.55 %) would be comparable to those of [27] which worked on the Fermented, raw, and blanched seed seeds of *Buchholzia*. The result indicated that *B. coriacea* was higher than that of kolanut (8.9 %) [28] and better kola seeds (3.95 %) [29]. It is also interesting to know that it is however, higher than the crude protein content of fluted pumpkin seeds, a popular vegetables seeds with a value of 7% [30] and so can serve as an alternative source of plants seeds protein. In addition, [31], suggested that environmental condition could also affect the proximate compositions. Indeed, according [32], the varietal composition as reported by various workers can be due to a different environment where plants have been planted, seasons and weather conditions. However, the crude lipids in *Buchholzia coriacea* flour studied are higher than those reported by [33] in species *Cola pierlotii* (0.52 %) seeds; But lower than fat observed from bitter cola seeds (4.33 %) as observed by [34]. Researchers further explained that a diet that provides 1-2 % of its fat calorie energy is said to be enough for humans because excessive consumption of fat is involved in certain cardiovascular disorders [30]. Concerning carbohydrates (68.02 ± 0.85%), the rates investigated were lower than those of *Cola pierlotii* (81.5 %) observed by [33] on their nuts from Congo but similar to those reported by [35] (66-77 %) on the raw, blanched and fermented seed of wonderful kola in Nigeria. Speaking of proteins, they are essential macronutrients for the human body, as they are involved in many biological functions such as muscle tissue formation, production of enzymes and hormones, and growth [36]. The crude fibre obtained in this study (2.11%) was higher than 1.7% obtained by [29] in *Buchholzia coreacea*. from Nigeria. It was lower than what was found in some vegetable seeds such as Cola acuminate seeds (7.3 %); *Cola notida* (4.18 %) and *Buchholzia coriacea* (6.27 %) as observed respectively by [32] and [37]. Adequate intake of dietary fibre had been reported by [38] to lower the serum cholesterol level, risk of coronary heart diseases, hypertension, constipation, and diabetes. According authors, dietary fiber plays important physiological and biochemical role in digestion [29;39]. Comparing the metabolizable energy values of *Buchholzia* seeds (1451.54KJ/100g DM) with that of the *Artocarpus altilis* (1492.60 ± 7.53 Kj/100g) study in Nigeria by [37] and compares fairly with those reported for some legumes such as bambara groundnut (1691.3 kJ/100 g), kersting's groundnut (1692.9 kJ/100 g) and cranberry beans (1651.7 kJ/100 g) [40], red kidney bean (1678.4 kJ/100 g) [41]. It showed that *Buchholzia coriacea* seeds was also a good source of energy that can be utilized as human nutrition.

3.3 Mineralogical composition of *Buchholzia coreacea*

The mineralogical composition of *Buchholzia coriacea* seeds showed in table 2 revealed that the magnesium (789.7 ± 0.85 mg/100g DM) was the highest, followed by phosphorus (665.1 ± 0.99 mg/100g DM) and iron (559.1± 0.99 mg/100g DM) respectively. The ash content is a reflection of the mineral contents preserved in the seeds of *B. coriacea*. The values were comparable to those reported by [22] in their studies on Pterocarpus santalinoides seeds (3, 96 %) but higher than what was obtenaid in *colas acuminata* (2.27%) and *colas nitida* (2.21%) seeds [32]. Therefore, it is important to ascertain the mineral contains of the investigated samples since they are required for tissue functioning and necessary for human nutrition. According to [42], ash content refers to the mineral content of a food. The oligoelement most representative in this study was magnesium; whose value is strictly superior to the pulp of *Telfairia occidentalis* (0.260g/100g DM) investigated in Nigeria [43]. Magnesium is a mineral which intervenes both in the body's defense mechanism against bacterial and viral attacks and in maintaining the normal functioning of muscles and nerves [44]. According to the same author, it contributes to the growth and regeneration of tissues and helps maintain the pH of normal blood. Iron is a micronutrient whose deficiency increases the risk of anemia, asthma, pallor and tumour [45]. However, the iron and phosphorus content obtained in this study were higher than those of [43] and [22] on *Telfairia occidentalis* (iron=13.86 mg/100g DM) and *Pterocarpus santalinoides* (phosphorus (22.71 ± 0.01 mg/100 g DM) respectively.

Table 3 Mineralogical composition of *Buchholzia coriacea*

Mineralogical component	mg/100g DM
magnesium	789.7 ± 0.85
phosphorus	665.1 ± 0.99
iron	559.1± 0.99
potassium	2.38 ± 0.09

3.4 Phytochemical compounds of *Buchholzia coriaceae* seeds

The phytochemical screening (Table 4) of *Buchholzia coriacea* samples revealed the presence of some phyto-compounds such as alkaloids, polyphenols, tannins, flavonoids, steroids, saponins, glycosides, anthocyanin and vitamin C. These phytochemicals, are synthesized for defense and other biological functions in plants, and would also provide multiple benefits at low doses [46; 47]. Saponins are also secondary metabolites that are involved in plant defense systems as a result of their antimicrobial activities [48]. The saponin content (9.78 0.85 mg/100 g) in our sample were higher than those of *Buchholzia* seeds in Nigeria (1.2 ±0.4 mg/100 g) presented by [49]. Some researchers opined that saponins and phenols in food medicine and mastic ants contribute to the low rate of atherosclerosis and coronary heart disease [50]. Similarly, saponins from soybean have been shown to have hypocholesterolmic as well as anticarcinogenic effects [51]. Saponins consumption often times causes deleterious effects such as haemolysis and permeability of the intestines, [52]. As for flavonoids (26.88 ±0.71 mg/100g), the value obtained in this study was quite lower than those of [49] *in Buchholzia coriacea* seed (255,9 ±5.8 mg/100g DM) in Nigeria; whereas higher to those of [53] in *Telferia occidentalis* (8.32 ±0.39 mg/100g). Flavonoids have strong antioxidant properties that allow the human body to reduce the effects of free radicals that cause cardiovascular disease, including cancer [54; 55]. The biological function of flavonoids includes protection against allergies, inflammation, free radicals, platelet aggregation, microbes, ulcers, hepatoxins, viruses and tumor [56]. Concerning polyphenols, Findings of this study were however higher than the findings of [53] in its study on *Telferia occidentalis* (272.68 ±0.46 mg/100g). Furthermore, while the presence of tannin was inconsistent with earlier work on the seed by [57] but similar than the findings of [49] who obtained 27.8 ± 1.2 mg/100g in their study. A research by [58] opined that the tannins provided neuroprotective, cardioprotective, and even antitumoral activities. Furthermore, other phytochemicals like alkaloid (38.69±0.64 mg/100 g) and glycosides (21.5±0.85) were significantly higher respectively from those of [53] for Côte d'Ivoire's *Telferia occidentalis* (1.1 mg/ 100g) and 2.06

mg/100 g, the value of glycosides content on *Buchholzia* seeds as discovered by [49] in Nigeria. While anthocyanin (19.1±0.85 mg/100 g) from the analysis were highest than 12.18 mg/100g in *Lonchocarpus sericeus* seeds in Nigeria [59]. In human health, anthocyanin has been associated with various benefits due to their antioxidant, anti-inflammatory, neuroprotective, and anti-diabetic properties. Chemically, anthocyanin are polyphenols and belong to a large class of secondary metabolites known as flavonoids [60]. Therefore, some researchers argued the interest of alkaloids in antiplasmodial, antispasmodic, anticancer activity [61; 62]. Therefore, vitamin C is a powerful antioxidant that helps to fight infections and aids in the formation of collagen; it is also required in the development of healthy bones, teeth and joints [63]. Vitamin C also helps in other activities and functions of all cells. It enhances the absorption of iron; it is also needed in the maintenance of healthy gums for healing of wounds and removing excess oxygen from tissues [63]. However, these findings are lower than 4.9 mg/100g obtained by [51] in *Mucuna pruriens* seeds and 8.14 mg/100 g in *Lonchocarpus sericeus* seeds [61].

Table 4 Phytochemical analysis of *Buchholzia coriacea* seeds

Phytochemical parameters	Content (mg/100 g)
Polyphénols	422.92 ± 1.32
Alkaloids	38.69 ± 0.64
Flavonoids	26.88 ± 0.71
Tannins	26.87± 0.51
Glycosides	21.5 ± 0.85
Anthocyanin	19.1 ± 0.85
Steroid	0.33 ± 0.03
Saponins	9.78 ± 0.85
Vitamin C	2.38 ± 0.06

4 Conclusion

This study showed that *Buchholzia coriacea* seeds contains high percentage of carbohydrates, protein and fat which makes it a good source of energy. The broad class of phytochemical compounds like polyphenols, alkaloids, and vitamin C could have multiple health benefits at low doses for human body. Therefore, *Buchholzia coriacea* seeds may be beneficial for human or animal consumption as a source of nutrients and energy.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have not reported any conflicts of interest.

Statement of informed consent

Every participant in the study gave their informed consent.

References

[1] Ezekiel OO, Onyeoziri NF. Preliminary Studies on the antimicrobial properties of *Buchholzia coriacea* (wonderful kola), African *journal of biotechnology.* 2009; 8(3): 472-474.

[2] Omayone TP, Salami AT, Odukanmi AO, Olaleye SB. Diet containing seeds of *Buchholzia coriacea* accelerates healing of acetic acid induced colitis in rats. Asian Pac J Trop Biomed 2018; 8:166-72

[3] Quattrochi-Umbeto FLS. CRC World Dictionary of Plant Names- Common names, Scientific names, Eponyms, Synonyms and Entomology. CRC Press. 2007; 367-368.

[4] Zailani HA, Banyawa M, Muhammad AA. Effects of aqueous leaf extract of Cola acuminata on parasitaemia, haematological and liver function parameters in Plasmodium berghei infected mice. Direct Res. J. Health Pharm. 2016; 4(2):14-20

[5] Ibrahim TA., Fagbohum ED., Phytochemical and nutritive Quality of Dried Seeds of *Buchhozia coriacea*, *Greener journal of Physical Science*. 2012; 2(5):185-191.

[6] Ogechukwu UB, Chika A, Peter E, Daniel A, Afamefule OF Antimicrobial, antiinflammatory, and chemical evaluation of *Buchholzia coriacea* seed (Wonderful Kola). Am. J. Life Sci. 2016.;4(5): 106-112.

[7] AOAC. Official methods of Analysis of Association of Official Analytical Chemists International, 16th ed. AOAC International Arlington. 1995; 250.

[8] AOAC. Association of Official Analytical Chemists Method of Analysis; 15th edition,Washington D.C. 1990; 222-236.

[9] Martinez-Herrera J, Siddhuraju P, Francis G, Davila-Ortiz G, Becker K. Chemical composition, toxic/anti-metabolic constituents, and effect of different treatments on their levels, in four provenances of Jatropha curcas L. from Mexico. Food Chem. 2006; 96(1): 80-89

[10] N'guetta AMN. Agro morphological, nutritional charateristics of Citrullus lanatus (Curcubitacea) cultivars grown in Côte d'Ivoire and use of their cakes in broiler (Gallus gallus) production. Thesis for the title of Doctor in Biochemistry and Food Technology of the University Nangui Abrogoua (Ivory Coast). 2016.

[11] Yao AK, Koffi DM, Blei SH, Irie ZB, Niamke SL. Biochemical and organoleptic properties of three traditional Ivorian dishes (attiéké, placali, attoukpou) based on native cassava granules. International Journal of Biological and Chemical Sciences. 2015; 9(3): 1341-1353.

[12] FAO. Food energy methods of analysis and conversion factors. FAO Ed, Rome. 2002;97

[13] Pongracz G, Weiser H, Matzinger D. Tocopherols Antioxydant. Fat. Science Technology. 1971; 97: 90- 104.

[14] Singleton, V., Orthofer R, Lamuela-Raventos RM. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin Ciocalteau reagent. *Methods Enzymol.* 1999; 299:152-178.

[15] Bainbridge Z, Tomlings K, Wellings K, Westby A. Methods for assessing quality characteristics of non-grain starch staples (Part 3, laboratory methods) Chatham, United Kingdom Natural Resources Institute. 1996; 34-39.

[16] Harbone JB. Phytochemical Methods. Chapman and Hall Ltd., London, UK. 1973 pp.49-188

[17] Shiau I.L. Shih TL, Wang YN, Chen HT, Lan HF, Lin HC, Yang BY, Ko CH, Murase Y, Quantification for saponin from a soapberry (*Sapindus mukorossi Gaertn*) in cleaning products by a chromatographic and two colorimetric assays,J. Fac. Agric. Kyushu Univ. 54. 2009; 215–221.

[18] Sofowara A. Phytochemical Screening of Nigerian Medicinal Plants" parts III. Lioyeria 1990; 41:234-246.

[19] Trease GE, Evans WC Trease and Evans Pharmacognosy, 14th edn. W.B. Saunders Company Limited, London, 1995; pp 191–293

[20] Lemmens RHMJ, Louppe D, Oteng-Amoako AA., Corbière H Plant resources of tropical Africa. Prota 2012. 7(2) 891 p.

[21] Ahouansou HR, Sanya AE, Bagan CG, Foudjet EA. Study of some physical characteristics of nuts and shea seeds produced in Benin. Science and Technology, Applied Science and Technology 2008; 2 (1 and 2): 29-38.

[22] Etche Etche P, Kouadio IA, Digbeu YD, Due. AE. physical, biochemical and nutritional characteristics of the seeds of *pterocarpus santalinoides* lher. ex de (papilionoideae), a spontaneous plant found in Côte d'Ivoire. World Journal of advance Healthcare Research, 2022; 6(3): 140- 149

[23] Aremu MO, Passali DB, Ibrahim H. Akinyeye RO. Chemical composition of wonderful kola (*Buchlozia coriacea*) and breadfruit (*Artocarpus altilis*) seeds grown in south–south, Nigeria, *Bangladesh J. Sci. Ind. Res.* 2017; 53(2), 125-132,

[24] Coulibaly TI. Nutritional approach of the arille flour (Blighia Sapida) harvested in Côte d'Ivoire. Master's degree in Food Science and Technology from Nangui Abrogoua University, 2016. 52 p

[25] Mohaammed SS, Paiko YB, Mann A, Ndamitso MM, Mathew JT, Maaji S. Proximate, Mineral and Anti-Nutritional Composition of Cucurbita Maxima Fruits Parts, Nigerian *Journal of Chemical Research*, 2014; 19, pp.37-49

[26] Aryee FNA, Oduro I, Ellis WO, Afuakwa JJ. The physicochemical properties of flour samples from the roots of 31 varieties of cassava. *Food control.* 2006; 17: 916- 922.

[27] Ijarotimi OS, Nathaniel FT, Faramade OO. Determination of chemical composition, nutritional quality and anti-diabetic potentials of raw, blanched and fermented wonderful, Kola (*B. coriacea*) seed flour. *Journal of Ham Nutrition and Food Science.* 2015; 3(2):1060–1067

[28] Jayeola CO. Prelimanary Studies on the use of kolanuts (*Cola nutida*) for soft drink production. Journal of Food Technol Afr. 2001;6(1):25-26

[29] Amaechi NC. Nutritive and Anti-Nutritive evaluation of Wonderful kola (*Buccholzia coriacea*) seeds.Pak J Nutr. 2009;8(8):1120-1122

[30] Arogba SS. Studies on kolanut and cashew kernels moisture absorption isotherm: proximate composition and functional properties. Food Chem. 1999;67: 223-228.

[31] Ezekiel OO, Onyeoziri N F Preliminary Studies on the antimicrobial properties of *Buchholzia coriacea* (wonderfulkola), African *journal of biotechnology* (es). 2009; 8(3): 472-474

[32] Dewole EA, DEWUMI DFA, Alabi JYT, Adegoke A. Proximate and phytochemical of cola nitida and *cola acuminate*. Pakistan journal of Biological sciences 2013;16(22): 1593-1596.

[33] Lognay G. Wathelet B, Maesen P. Cola pierlotii R.Germ. study of the chemical composition of the seed. Biotechnol. Agron. Soc. Environ. 2013 17(2), 309-311

[34] Eleyinmi AF, Bressler DC, Amoo IA, Sporns R, Oshodi AA. Chemical Composition of Bitter Kola (*Garcinia kola*) seed and hulls. Polish J Food Nutr Sci. 2006;15(4):394-400.

[35] Izah SC, Uhunmwangho EJ. Eledo BO. Medicinal Potentials of *Buchholzia coriacea* (Wonderful Kola) Medicinal Plant Research 2018; .8 (.5): 27-42

[36] Ponka R, Nankap ELT, Tambe ST, Fokou E Nutritional composition of some artisanal infant flours from Cameroon. *International Journal of Innovation and Applied Studies*. 2016;16(2): 280-292

[37] Aremu MO. Passali DB, Ibrahim H. Akinyeye RO. Chemical composition of wonderful kola (*Bucchlozia coriacea*) and breadfruit (*Artocarpus altilis*) seeds grown in south–south, Nigeria. Bangladesh J. Sci. Ind. Res. 2018; *53(2),* 125-132

[38] Ishida H, Suzunoh, Sugiyana N, Innami S, Todoro T, Mackawa A. Nutritional evaluation of chemical components of leaves, stalks and stem of sweet potatoes (Ipomea botatas) Food Chem. 2000; 68:359-367

[39] Ibrahim TA; Fagbohun ED. Phytochemical and Nutritive Qualities of Dried Seeds of *Buchholzia Coriacea* Research and Reviews: Journal of Food and dairy Technology 2014; 2 (2): 1-7

[40] Aremu, MO, Olaofe, O., Akintayo, TE. A Comparative Study on the Chemical and Amino Acid Composition of Some Nigerian Under-Utilized Legume Flours. Pakistan Journal of Nutrition 2006 5 (1): 34-38,

[41] Audu SS, Aremu M.O. Effect of Processing on Chemical Composition of Red Kidney Bean (*Phaseolus vulgaris L.*) Flour. Pakistan Journal of Nutrition 2011;10 (11): 1069-1075

[42] Andrée ES, Kadji BRL, Dje KM, Kone FTM, Dabonne S, Koffi-Nevry AR. Nutritional, microbiological and organoleptic quality of flour made from maize (Zea mays) and saffron (Dacryodes edulis) produced in Côte d'Ivoire. *Int. J. Biol. Chem. Sci*. 2019; 13(1): 325-337

[43] Al Essien, Udo HB, Rub. E. Chemical assessment of canned pumpkin fruit clove and pulp (*Telfairia occidentalis*). Food chemistry. 1992; 45(3) :175-178.

[44] Rathee M., Singla S., Tamrakar A. K. Calcium and Oral Health: A review. *International Journal of Scientific Research*. 2013; 2(9): 335-336.

[45] Kadja A. B. Seven African plants used as toothpicks: mineral compositions, phenolics and biological activities. These University Nangui-Abrogoua (Côte d'Ivoire). 2014; 166p.

[46] Thurber MD, Fahey JW. Adoption of *Moringa oleifera* to combat under-nutrition viewed through the lens of the "Diffusion of innovations" theory. Ecol Food Nutr. 2009; 48: 212-225.

[47] Sasidharan S, Chen Y, Saravanan D, Sundram KM, Yoga Latha L. Extraction, isolation and characterization of bioactive compounds from plants'extracts. African Journal of Traditional, Complementary, and Alternative Medicines. 2011; 8(1):1-10.

[48] Ayoola GA, Coker HA, Adesegum SA, Adepoju-Bello AA, Obaweya K, Ezennia CE, Atangbayila T.O. Phytochemical screening and antioxidant activities of selected medicinal plants used for malaria treatment in southwestern Nigeria. *Trop.J. Pharm. Res.* 2008; 7: 10191-1024

[49] Ikechukwu EL, Okafor PN, SI. Egba. In vitro assessment of the anti-sickling properties of *Buchholzia coriacea* and Mucuna pruriens seed extracts. In vitro Cell Dev Bio- Anim. 2020, 56(9): 773-782

[50] Johns T. Phytochemicals as evolutionary mediators of human nutritional physiology. International Journal of Pharmacognosy. 1996; 34(5):327-34.

[51] Oh YJ, Sung MK. Soybean saponins inhibit cell proliferation by suppressing PKC activation and induce differentiation of HT-29 human colon adenocarcinoma cells. Nutrition and Cancer. 2001; 39(1):132-8

[52] Francis G, Kerem Z, Makkar HP, Becker K. The biological action of saponins in animal systems: a review. British Journal of Nutrition. 2002; 88(06):587-605.

[53] Ouattara 1, Y D. Digbeu, YG. Koffi, EA. DUE. Nutritional potentiality and antinutritional properties of *Telfairia occidentalis* from Côte d'lvoire. GSC Biological and Pharmaceutical Sciences, 2022, 18(02), 338–343

[54] Benguo L, Xiaona G, Kexue Z, Yang L. Nutritional evaluation and antioxidant activity of sesame sprouts. Food Chemistry 2011; 129 799–803.

[55] Annegowda H, Bhat R, Tze LM., Karim A, Mansor. The free radical scavenging and antioxidant activities of pod and seed extract of *Clitoria fraichildiana* (Howard) –And undertilized legume. *J Food Sci & Tech*. 2013; 50(3): 535-541.

[56] Heikens HE, Fherse, E Endert, M Ackerman S, G Van Mont Frans. Liquorice-induced hypertension, a new understanding of an old disease. J Med. 1995; 5:230-234

[57] Sodipo OA, Akiniyl JA, Ogunbamosu JU, Studies on certain charcteristics of extracts of bark of Pensnystalia macrucean (K. schemp) pierre Exbelie. Global J. Pure Appl. Sci.6, 2000, 83-87

[58] Gülçin L, Huyut Z, Elmasta M, Aboul-Enein HY. Radical scavenging and antioxidant activity of tannic acid. Arab J Chem. 2010; 3:43-53.

[59] Oyedeji OA, Azeez L, Adewuyi SO, Osinfade BG, Bamimore MO Flavonoid profile, anthocyanin, carotenoid, sugar and vitamin compositions of *Lonchocarpus sericeus* seeds. African Journal of Food Science and Technology. 2015; 6(5) pp. 131-135

[60] Pereira SR, Pereira R, Figueiredo I, Freitas V, Dinis TC, Almeida LM. Comparison of anti-inflammatory activities of an anthocyanin-rich fraction from Portuguese blueberries (*Vaccinium corymbosum L.*) and 5-aminosalicylic acid in a TNBS-induced colitis rat model. *PLoS One*. 2017;12: e 0174116

[61] Zirihi GN, Datté JY, Kra-Adou KM, Grellier P. Phytochemical and pharmacological studies of the alcoholic extract (MFA) of Fagara macrophylla (Oliv.) Engl. (Rutaceae): the chemical structure of the active compound inducing antipaludic activity. *Journal of Chinese Clinical Medicine*. 2007; 2: 205-210.

[62] N'Guessan K, Kadja B, Zirihi GN, Traoré D, Aké-assi L Phytochemical screening of certain Ivorian herbal medicines. Sciences & Nature. 2009; 6: 1-15.

[63] Pullar JM, Carr AC, Vissers MCM. The roles of vitamin C in skin health. Nutrients 2017; 9(8):866]