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STUDIES ON THE UTILIZATION AND PROXIMATE COMPOSITION OF WILD *AFRAMOMUM ANGUISTIFOLIUM (SONN.) K. SCHUM* FRUITS IN NAKASEKE DISTRICT, UGANDA

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ABSTRACT

Nakaseke district is located in the central region of Uganda and has high abundance of edible *Aframomum anguistifolium* (wild cardamom) fruit, locally known as "Amatuunguru''. The fruit is consumed by only few people who access it from the wild and there is limited information on the nutritional benefits of the fruit. This study determined the utilization and consumptive benefits of *A. anguistifolium* fruits among the local communities of Nakaseke district as well as the proximate composition of the fruit. A cross-sectional survey using an interview guide was conducted to establish the utilization and consumptive benefits of the fruit while the proximate composition (crude protein, fat, carbohydrate, fiber and ash, moisture) was determined using standard methods of Association of Official Analytical Chemists (AOAC). The results revealed that fruits are collected and consumed by the local communities because of their nutritional and medicinal values. *A. anguistifolium* plant is not domesticated despite the different consumptive benefits accrued from it. The results revealed that children are the major collectors (consumers) of the fruit (48%) compared to women and men and they collect the fruit from the wild as they go about their chores like collecting firewood, tending grazing animals and fetching water. The fruit's availability is highest in the rainy season and maturity indicators include the fruit exocarp turning red in colour. The exocarp is removed and thrown away during consumption leaving the inside part which is edible. The fruit was found to contain moisture (72.98%). The content of the dry matter was ash (13.97%), crude fat (4.35%), crude protein (6.82%), crude fiber (12.55%) and nitrogen-free extracts/NFE (62.30%). Hence the fruit is a suitable supplement for moisture, fats, proteins and crude fiber needed in human diet. The plant is still collected from the wild and grows mainly in swampy areas (wetlands) which are being cleared for agriculture, settlement and road construction. This plant could be endangered if its conservation is not prioritized.

Key words: *Aframomum anguistifolium* fruits, utilization, consumptive benefits, proximate, wild, Uganda

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INTRODUCTION

Aframomum anguistifolium (sonn.) K. Schum plant exists as a herb and is common around bushy areas where swamps and wetlands are found [1]. The fruit ripens throughout the year and dried seeds can be stored for medicinal use. It is usually collected from the wild and is not protected or planted by the local people. *A. anguistifolium* is propagated from seeds and its fruits are usually eaten by monkeys, which are responsible for dispersing the seeds in the wild [2, 3]. The fruit treats bacterial and fungal infections in great apes and studies have shown that it has antibacterial and antifungal properties [4].

The fruits are also commonly consumed by man for their nutritive and medicinal values [5, 6]. Ripe fruits of *A. anguistifolium* are collected and the outer peeling removed using teeth and the pulp is eaten as a snack with or without seeds. The fruit pulp is occasionally macerated and mixed with water, filtered and added to orange juice, porridge or used as an ingredient for making local wine. The discarded seeds are dried, ground and used as condiments /spices for local breads [2].

Despite the nutritional and medicinal values of *A. anguistifolium*, the local utilization of the fruit in Uganda is limited to a few people as it is being neglected. For example, *A. anguistifolium* was found to be harvested and used by only 27.5% and 31.4%, respectively of households in Bunyoro, Uganda [7]. Furthermore, the proximate composition of the wild *A. anguistifolium* fruits grown in Nakaseke District, Uganda is not yet known. Therefore, this study determined the proximate composition of *A. anguistifolium* fruits, their utilization and consumptive benefits among the local communities in Nakaseke District, Uganda.

MATERIALS AND METHODS

Description of the Study Area

The survey on the utilization of *A. anguistifolium* fruit and collection of the fruits for proximate analysis was done in Wakyato and Kapeeka sub-counties in Nakaseke district (Figure 1) during the months of June to August, 2014.

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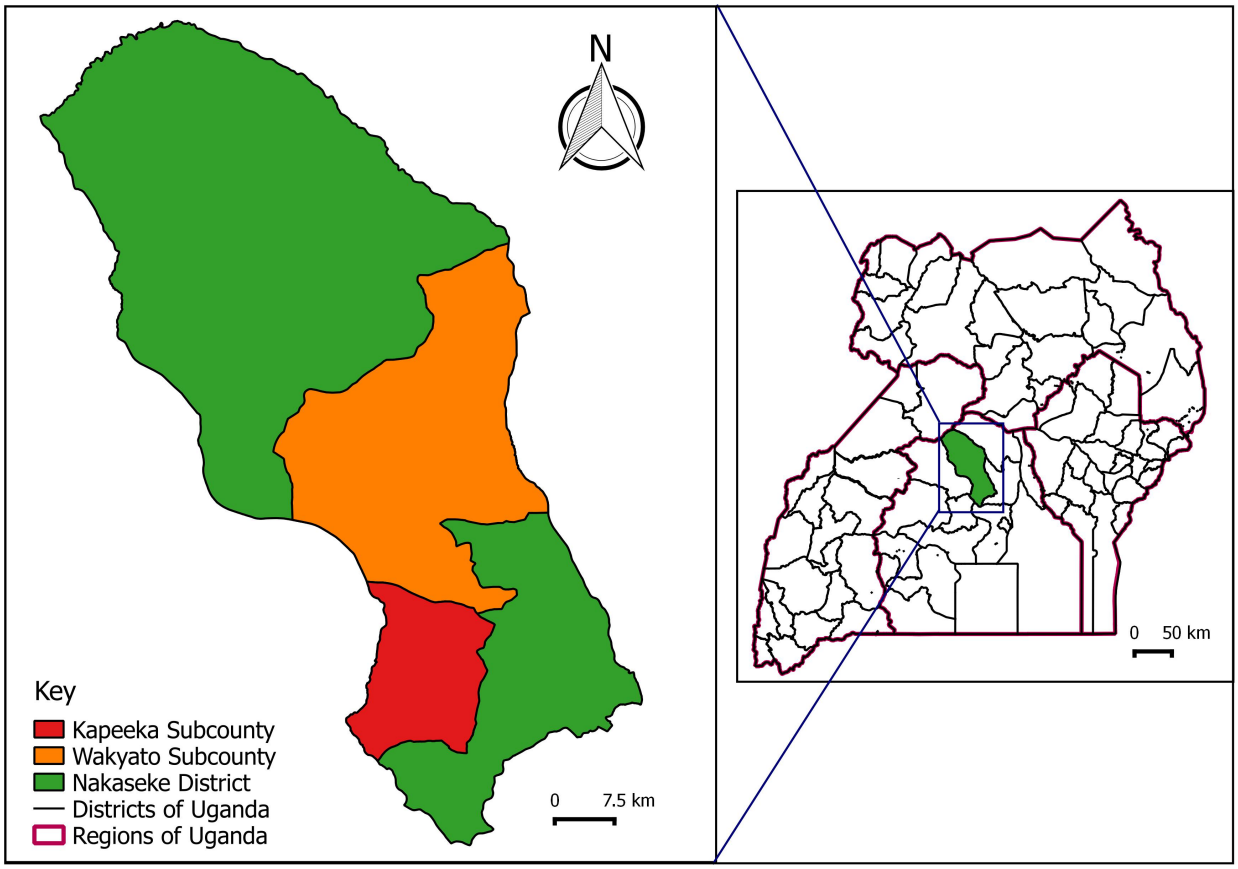

Figure 1: Map of Uganda showing Nakaseke District and the study sites
Source: Generated from QGIS 3.2

The district is located north of Kampala, the capital city of Uganda in the Central region of Uganda at coordinates 2-3^0 N and 32-32^0 23"E [8]. Most parts of Nakaseke are characterized by shallow seasonal wetlands and flat-topped hills with altitude ranging from 1000-1250 m above sea level (average 1150 m). The basement rocks of the district are composed of young intrusive rocks which are mostly acidic comprised of sand, quartz and clay alluvial. The soils are dominated by red sandy loams and relatively fertile clay loams which support the growth of various crops [8].

Nakaseke district has a population size of 197,373 people and most of the households (67.1%) depend on subsistence farming as a main source of livelihood [9]. The main crops grown by most of the households in Nakaseke district are cassava, beans, sweet potatoes and bananas [10]. The district experiences two rainfall seasons (March to June and August to November) per year, with an average annual rainfall of 1300mm. The mean annual maximum and minimum temperatures of the district are 28.8^{0}C and 16.3^{0}C, respectively [10].

Survey of the Utilization and Consumptive Benefits of *A. anguistifolium*
The study was conducted in Wakyato and Kapeeka sub-counties in Nakaseke district (Figure 1). Sample size for the survey was determined using Krejcie and Morgan formula [11] with the total population size of 72239 that is Wakyato (36317) and Kapeeka

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(35922) [9]. A total of 300 respondents were involved in the study representing 79% of the required sample size of 382 due to the non-response of some of the respondents. These respondents were then interviewed by the aid of a structured interview guide comprising both open and closed ended type questions to ascertain the various ways of utilization and consumptive benefits of *A. anguistifolium* fruit. With open ended questions, the respondents were free to answer the questions in their own words and express their own thoughts in a freewheeling manner, while for closed ended questions, the respondents were asked to select from a fixed list of options (Appendix 1).

Sample Collection for Proximate Analysis

A total of thirty fruit samples from highly inhabited swampy areas were randomly collected from Wakyato and Kapeeka sub-counties in Nakaseke district. The fruits were cut from the plant (as shown in Figure 2 A) using a knife and then immediately packed in labelled sterile polythene bags and transported to the laboratory for further processing.

Figure 2: *A. anguistifolium* fruits attached to the parent plant (A), flower (B), freshly cut fruit (C)

Proximate Analysis of *A. anguistifolium*

The proximate components (moisture, ash, crude fat, crude protein, crude fiber, carbohydrate) of the fruit were determined using standard methods [12, 13,14].

Determination of Moisture Content

A dried crucible was put in the oven at 105^{0}C for 3 hours and then transferred to the desiccator to cool. Then the weight of the empty dish and lid was recorded. The fresh sample (pulp) was put into the crucible and its weight determined by getting the difference in the weight of the crucible from the weight of crucible with the sample. The sample was evenly distributed on the pre-weighed crucible and spread to uniformity. The crucible with the uniformly spread sample was then placed in the oven at 105^{0}C to dry. The crucible containing the sample was later transferred to the desiccator to cool and then re-weighed. The weight loss of the sample was the moisture content while the remainder was the dry matter which was used to determine the rest of the nutrient contents.

$$\text{Calculation of \% moisture content} = \frac{Lost\ weight}{Original\ sample\ weight} X100$$

$$\text{Calculation of \% dry matter} = \frac{Dry\ matter\ weight}{Original\ sample\ weight} X100$$

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Determination of the ash content

The crucible was placed in the dry air oven at 550^{0}C overnight to ensure that impurities on the surface of the crucible were burnt off. The crucible was then removed from the dry air oven and cooled in the desiccator for 30 minutes and later weighed. An evenly distributed sample was weighed and added to the crucible in duplicates and heated over a hot plate until fumes were no longer produced (to burn off the carbon). Using a pair of tongs, the crucibles containing the samples were transferred to the furnace and heated at 550^{0}C for three (3) hours until the sample was burnt to gray, forming ash. The crucibles with the samples (ash) were then cooled in the desiccators and weighed. The lost weight from the sample was called organic matter while the weight that remained was taken as inorganic matter (ash or mineral content).

$$\text{Calculation of \% Ash} = \frac{\textit{Remaining weight}}{\textit{Dry matter sample weight}} \; x \; 100$$

Determination of Crude Fat Content

The Soxhlet method was used. The boiling flask was dried in an incubator at 105^{0}C overnight. About 3.00g ground dried sample was weighed and put into an extraction thimble which was then transferred into a Soxhlet apparatus. The boiling flask filled with about 250ml of petroleum ether was placed on the heating mantle. The Soxhlet apparatus were connected together as water was turned on to cool them and the heating mantle switched on to commence crude fat extraction. After 12 hours of extraction, the boiling flask was incubated at 80^0 C until all the solvent was completely evaporated and the bottle completely dried. After drying, the bottle was transferred to the desiccator to cool. The bottle and its dried contents were then re-weighed. The weight gain of the flask represented the amount of ether extract (the crude fat).

$$\text{Calculation of \% fat} = \frac{\textit{Weight of fat}}{\textit{Weight of sample}} \; x \; 100$$

Determination of crude protein content

The Kjeldahl method comprising three stages was used.

Digestion: Dried ground sample (3.0 g) was weighed and put into 1000ml Kjeldahl flask. Then 15g of K_2SO_4, 0.04g of anhydrous $CuSO_4$ and 2 glass boiling beads were added. The exhaust fan to the digestion rack was then turned on and concentrated H_2SO_4 (40ml) was added to wash down any sample adhering to the flask, using the dispensing burette.

Distillation: The Markham apparatus was first steamed out to remove any ammonia which had remained. The sample was then transferred into the distillation unit (automated) and 40% sodium hydroxide added. Ammonia was then distilled off for five minutes, and trapped into boric acid with methyl red indicator until the colour turned from pink to green.

Titration: The sample was then titrated against 0.02M HCl until the green colour changed back to pink and the percentage crude protein was calculated from the expressions below:

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$$\text{Nitrogen (\%)} = \frac{\textit{Titre volume}}{\textit{Dry matter sample weight}} x\ 100$$

Crude protein = % Nitrogen x 6.25

Determination of Crude Fiber

About 3.0g of weighed samples were ground and transferred into a 200ml beaker. Then 50ml of 12.5% sulfuric acid and 150ml of distilled water were added and topped up to a 200ml mark with distilled water. The beaker was then placed on a hot plate and the sample boiled for 30 minutes under the reflux flask condenser. The sample was then filtered using qualitative filter paper placed in a funnel under a vacuum pump, and the residue was then washed back into the same beaker. Then 50ml of 12.5% sodium hydroxide was added to the beaker and again made up to a 200ml mark with distilled water. The sample was then boiled for 30 minutes under reflux flask condenser and thereafter filtered using pre-weighed ashless filter paper under a vacuum pump. The residue was then rinsed with distilled water followed by acetone and later wrapped in a pre-weighed ashless filter paper. The wrapped residue was transferred into a pre-weighed crucible and then placed in the oven for drying and later cooled in the desiccator. The crucible was then weighed and transferred using a pair of tongs to the hot plate to remove the carbon and then to the furnace set at 700^0C for 3 hours. The samples were later transferred to the desiccator for cooling, and then weighed. The lost weight constitutes crude fiber. The percentage fiber was calculated using the expressions below,

$$\text{Calculation of \% crude fiber} = \frac{\textit{Loss in weight}}{\textit{Original sample weight}} \times 100$$

Determination of carbohydrate Content

The calculation of nitrogen free extract, NFE (carbohydrate content) was made after completion of the analysis of moisture, ash, crude fiber, ether extract (crude fat), and crude protein. The sum of the percentages of ash, crude fiber, fat and protein is subtracted from 100% to obtain nitrogen free extracts that is, NFE, carbohydrate content (%) on dry matter basis =100% - [ash (%) on dry basis + crude fiber (%) on dry basis + fat (%) on dry basis + protein (%) on dry basis].

Data Analysis

The data collected was analyzed using computer software IBM SPSS Version 20 (IBM Corp. Armonk, NY: Released 2011). Respondents' perceptions on the utilization and consumptive benefits of *A. anguistifolium* fruit were expressed in frequencies (%), while the proximate composition of the fruit was summarized using the mean and standard error of the mean. Difference in proximate composition of the fruit between Kapeeka and Wakyato sub-counties were compared using student t test at 5% level of significance.

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RESULTS AND DISCUSSION

The Gender of Respondents

Out of the respondents interviewed, 68% were female and 32% were male. The respondents interviewed were in the age group above 50 years (35%), 40-49 years (23%), 30-39 (26%) and 20-29 years (16%).

Utilization and Consumption benefits of *A. anguistifolium* fruits

Children were mentioned as the main collectors of *A. anguistifolium* (48%), followed by women (29%) and then men (10%) while 13% of the respondents reported that all categories (men, women and children) collect the fruits at any given time. The collection of the fruit is related to its consumption in these communities. Children are the major collectors especially when they are sent to collect firewood, graze animals in the field and fetch water while the women and men collect the fruits as they clear bushes for farming or as they return from their gardens. Studies indicate men are less involved in gathering fruits than women and children [7]. Furthermore, men generally consume less fruits than women and children [15, 16] while children consume more fruits than adult men and women [17]. The fruit turns red at maturity and to eat this fruit, the exocarp is removed and thrown away leaving the inside part (pulp) which is edible. In Tanzania [2] the ripe fruit is collected and the sugary pulp eaten frequently as a snack. It is sweet and liked by all, but particularly by children; the crushed seeds are used as a substitute for pepper.

Further, from interviews it was discovered that there are people who have started harvesting the fruit for sale and they take it to the city of Kampala. So, the fruit is generating incomes for the community despite the fact that it is still in the wild. The respondents also mentioned that the fruit is consumed by monkeys amongst other animals, and this agrees with findings from a study that mountain gorrillas (*Gorilla gorilla beringei*) in South Western Uganda liked the sweet red fruits of *A. angustifolium* [25]. In another study, the pith of *A. angustifolium* was among the herb foods ranked as highly preferred [26] among the wild mountain gorillas. Therefore, the wild fruit is competed for between humans and monkeys and this potentially makes it a threatened species.

Availability and consumption of *A. anguistifolium* fruits was highest in April-June (42%) followed by October –December (35%) which are usually rainy seasons [8] and those are periods when the fruit is ready and mature for consumption. *A. anguistifolium* fruits declined in the dry periods of January-March (10%) and July-September (13%) associated with the seasonal availability of the fruits (they were immature), hence low consumption. Availability of fruits is among the factors that influence their consumption [18].

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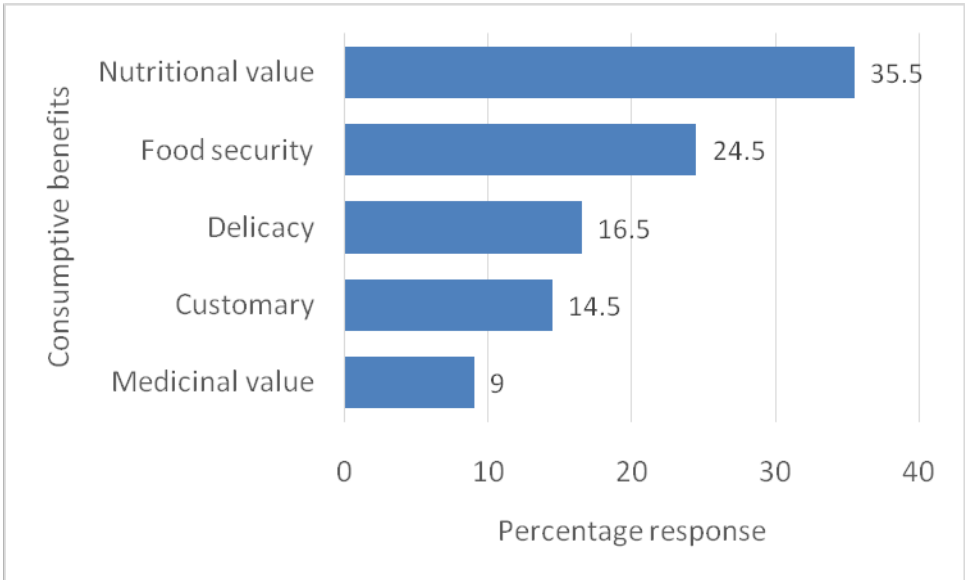

Figure 3: Percentage consumption patterns of *A. anguistifolium* fruits

Consumption of *A. anguistifolium* fruits among the people of Nakaseke district was reported to be mainly for their perceived nutritional benefits (35.5%). Other consumptive benefits included: food security in times of food shortage, delicacy to the locals, customary practice and medicinal value as shown in Figure 3. These findings agree to a large extent with Acipa [19], who reported that people ate wild food plants for nutritional value, food shortage, customary value, delicacy and medicinal value. In West Nile (Arua district) Uganda, *A. anguistifolium* fruits were mentioned among the common plant species harvested for food. Furthermore, in a study carried out in sub-Saharan Africa, fruit consumption was found to be influenced by nutritional value, cultural beliefs and norms and famine [18].

In a study carried out in Uganda [20], both the methanol and ether extracts of *A. anguistifolium* tested positive for various phytochemicals especially flavonoids and terpenoids, which have antibacterial activity, hence justifying the use of the fruit in ethnomedicine. Furthermore, the authors found that the fruits were consumed to treat a number of intestinal parasites and for food. This confirms other reports that various human societies have used wild plants for both food and medicine [21]. Recent studies indicate that the fruit is used as traditional medicine for treating coughs among the rural communities in Madagascar [22].

Proximate Composition of *A. anguistifolium* Fruits

There was no significant difference ($p>0.05$) in the mean values of the proximate composition (Moisture, Ash content, Fat content, Protein, Dry matter, Crude fiber, NFE) of the fruit between Kapeeka and Wakyato sub-counties (Table 1). This is possibly due to relatively similar soil and climatic conditions in the two sub-counties. The trends of the overall mean values of each proximate component are presented below.

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Dry Matter and Moisture Contents

The average dry matter of *A. anguistifolium* was 27.02% and moisture content was 72.98% as shown in Table 1. Results of a study conducted in Cameroon, indicated a much lower moisture content (10.4g/100g (%) in a similar genus (*Aframomum daniellii*) collected from markets in Cameroon [23], while for pulp of *A. anguistifolium* from a study in Nigeria was 16.48% [27]. Such relative difference could be due to the different geographic distribution and the diverse climatic conditions of the varieties.

Ash Content

Ash content is a measure of the total amount of minerals within a food [14]. The average ash percentage in *A. anguistifolium* fruits was 13.98%, which is in close range with ash content in *A. daniellii* of 9.3g/100g [23]. The moderately high ash composition shows that the fruit is a good source of mineral elements (29).

Crude fat content

The obtained average crude fat percentage in *A. anguistifolium* of 4.35% was lower than that in *A. daniellii* (23.1g/100g) [23] and *Aframonum chrysanthum* (7.16%) [28].

Protein content

Crude protein content in the fruit was 6.82%, which was in close range of 9.45% in *A. anguistifolium* found in Oyam district, Northern Uganda [19]. Further, the amount of crude protein of *A. anguistifolium* in the current study is in a closer range to crude protein content in *A. daniellii* (8.5g/100g) [23]. The investigated *A. anguistifolium* in Nakaseke recorded lower protein content (6.82%) than the WHO recommended range of 10-15% for the human diet [24]. Therefore, the fruit should be consumed in addition to a variety of protein foods because of its nutrition benefits.

Crude fiber and carbohydrate contents

The obtained crude fiber content in *A. angustifolium* of 12.55% was close to crude fiber amount (17.36%) in the same fruit obtained from Oyam district, Northern Uganda [19]. The N.F.E (in full) (carbohydrate) was 62.29% much higher than carbohydrate amount in *A. daniellii* (11.9g/100g) [23]. The obtained N.F.E (carbohydrate) content in *A. angustifolium* in this study falls within the WHO recommended total carbohydrate range for the human diet of 55-75% [24].

The generally low nutrient (crude protein, crude fiber) composition of *A. angustifolium* fruits in Nakaseke district concurs with the findings of Acipa [19]. Nevertheless, *A. angustifolium* fruits should be incorporated in diets of people who are experiencing marginal nutrient deficiency so as to supplement the crude protein and fiber contents in their diets.

CONCLUSIONS

Nakaseke district is endowed with natural wealth of plant species like *A. anguistifolium* and most of them still exist in the wild. Local people are depending on these for food and medicine. *A. anguistifolium* fruits were found to contain moderate amounts of proteins,

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fats, carbohydrates, minerals (ash) and can supplement the diets of people who are deficient in these nutrients. People could benefit from the identified nutritional properties of *A. anguistifolium* fruits and hence the recommendation that they be domesticated. Domestication of the plant will increase its availability, sustainability and conservation. Additionally, for people who are selling the fruit, it can contribute to household income and hence improve the livelihoods of people.

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Table 1: Proximate composition of *A. anguistifolium* fruits (n=30)

Parameter	Sub County	Mean±SE	t	p-value	Total (Mean±SE)
Moisture	Kapeeka	73.16±0.27	1.031	0.307	72.98±0.17
	Wakyato	72.80±0.22			
Ash content	Kapeeka	14.01±0.35	0.116	0.908	13.98±0.22
	Wakyato	13.96±0.27			
Fat content	Kapeeka	4.35±0.05	0.240	0.811	4.35±0.03
	Wakyato	4.34±0.05			
Protein	Kapeeka	6.78±0.15	0.496	0.622	6.82±0.09
	Wakyato	6.87±0.12			
Dry matter	Kapeeka	27.24±0.18	1.702	0.094	27.02±0.13
	Wakyato	26.80±0.18			
Crude fiber	Kapeeka	12.52±0.14	0.389	0.698	12.55±0.10
	Wakyato	12.59±0.14			
NFE	Kapeeka	62.38±0.11	1.056	0.295	62.30±0.07
	Wakyato	62.23±0.93			

REFERENCES

1. **Agea JG, Okia CA, Abohassan RAA, Kimondo JM, Obua J, Hall J and Z Teklehaimanot** Wild and Semi-Wild Food Plants of Bunyoro-Kitara Kingdom of Uganda: Growth Forms, Collection Niches, Parts Consumed, Consumption Patterns, Main Gatherers and Consumers. *Environmental Research Journal*, 2011; **5**:74-88.

2. **Ruffo CK, Birnie A and B Tenganäs** Edible Wild Plants of Tanzania, Technical Handbook No. *27*, Nairobi, 2002.

3. **Agmen FL, Chapman HM and M Bawuro** Seed dispersal by tantalus monkeys (*Chlorocebus tantalus tantalus*) in a Nigerian montane forest. *African Journal of Ecology*, 2010; ***48*(4)**: 1123–1128.

4. **Cousins D and MA Huffman** Medicinal properties in the diet of gorillas: anethno-pharmacological evaluation, *African study monographs. 2002; **23**: 65.*

5. **Costa-Neto EM** Zoopharmacognosy, the self-medication behavior of animals. *Interfaces Científicas - Saúde E Ambiente*, 2012; ***1*(1)**: 61–72.

6. **Oryema C, Oryem-origa H and R Nanna** Edible wild fruit species of Gulu District, Uganda. *International Journal of Biology and Biological Sciences*, 2013; ***2* (April)**: 68–82.

7. **Agea JG, Kimondo JM, Okia CA, Abohassan RAA, Obua J, Hall J and Z Teklehaimanot** Contribution of wild and semi-wild food plants to overall household diet in Bunyoro-Kitara Kingdom, Uganda. *Agricultural Journal,* 2011; ***6 (4)**: 143-144.*

8. **District Environment Action Plan, DEAP** Nakaseke District Local Government. District Environment Action Plan 2012-2017. 2012.

9. **Uganda Bureau of Statistics.** The National Population and Housing Census 2014 Kampala, Uganda. 2017

10. **Uganda Bureau of Statistics.** Nakaseke Local Government Report Based On CIS Summary Results 2009. Volume I. Kampala. 2011.

11. **Krejcie RV and DW Morgan** Determining Sample Size for Research Activities. *Educational and Psychological Measurement. 1970; **30**:* 607-610.

12. **AOAC.** *Official methods of Analysis, 15th edition* (Vol. 1). Washington D.C., USA.1990

13. **AOAC.** Official methods of analysis, *17th Ed.* Washington D.C., USA. 2000.

14. **Suzanne Nielsen S** *Food analysis Laboratory manual, 2nd Edition. The Journal of nutrition*. 2009, Vol. 7.

15. **Baker AH and J Wardle** Sex differences in fruit and vegetable intake in older adults. Appetite. *PubMed.* 2003; **40**: 269–75.

16. **Prattala R, Paalanen L, Grinberga D, Helasoja V, Kasmel A and J Petkeviciene** Gender differences in the consumption of meat, fruit and vegetables are similar in Finland and the Baltic countries. *Eur J Public Health. PubMed*. 2007; **17**: 520–5.

17. **Australian Bureau of Statistics.** Australian Health Survey: Consumption of Food Groups from the Australian Dietary Guidelines 2011-12. 2016.

18. **Reul MT, Minot N and L Smith** *Patterns and determinants of fruit and vegetable consumption in Sub-Saharan Africa: A multicountry comparison*. Kobe, Japan: World Health Organization. 2004.

19. **Acipa A, Kamatenesi-Mugisha M and H Oryem-Origa** Documentation and nutritional profile of some selected food plants of Otwal and Ngai sub counties Oyam district, Northern Uganda, African Journal of food, Agriculture, Nutrition and Development. 2013; ***19*(2)**: 289–294.

20. **Anywar GU and C Kirimuhuzya** Phytochemical profile and antibacterial activity of crude extracts of the pod of Aframomum angustifolium (Sonn.) K. Schum. *European Journal of Biological Research*. 2015; ***5*(2)**: 36–41.

21. **Pardo-de-Santayana M, Tardio J, Blanco E, Carvalho AM, Lastra JJ, San Miguel E and R Morales** Traditional knowledge of wild edible plants used in the northwest of the Iberian Peninsula (Spain and Portugal): A comparative study. *J Ethnobiol Ethnomed*. 2007.

22. **Rakotoarivelo N H, Rakotoarivony F, Ramarosandratana AV, Jeannoda VH, Kuhlman AR, Randrianasolo A and RW Bussmann** Medicinal plants used to treat the most frequent diseases encountered in Ambalabe rural community, Eastern Madagascar. *Journal of Ethnobiology and Ethnomedicine*. 2015; **11**: 68.

23. **Bouba AA, Njintang YN, Foyet SH, Scher J, Montet D and FMC Mbofung** Proximate Composition, Mineral and Vitamin Content of Some Wild Plants Used as Spices in Cameroon. *Food and Nutrition Sciences*. 2012; **3**: 423-432.

24. **WHO.** Diet, Nutrition and the Prevention of Chronic Diseases. Report of a Joint WHO/FAO Expert Consultation. WHO Technical Report Series No. 916. Geneva.2003.

25. **Biser JA** Really Wild Remedies-Medicinal Plant Use by Animals. *ZooGoer*. 1998; **27(1).**

26. **Ganas J, Ortmann S and MM Robbins** Food Preferences of Wild Mountain Gorillas. *American Journal of Primatology.* 2008; **70**:927–938.

27. **Asemave K and SS Ode** Proximate and Antinutritional Analyses of Seed, Pulp and Peel of *Aframomum Angustifolium (Sonn) K.Schum*. *Organic & Medicinal Chem IJ*. 2018; **7(4)**: 555720.

28. **Nwachoko N, Essien EB and EO Ayalogu** Proximate and Quantitative Phytochemical Analysis of *Aframomum chrysanthum*. *Open Access Library Journal*, 2015; **2**: e1529.

29. **Pereda JAO** Tecnologia de Alimentos, Componentes dos Alimentos e Processos. 2005; **Vol. 1;** Artmed: Porto Alegre, Brasil.