CHEMICAL AND MICROBIAL EVALUATION OF SOME UNCOMMON INDIGENOUS FRUITS AND NUTS

***[1,2]Ogwu, M. C., [1]Osawaru, M. E. and [1]Atsenokhai, E. I.**

[1]Department of Plant Biology and Biotechnology, Faculty of Life Sciences, University of Benin, Benin City, Nigeria
[2]Keimyung University, Center for International Education and Development, 1095 Dalgubeol - Daero, Daegu, South Korea
*Corresponding author: matthew.ogwu@uniben.edu

ABSTRACT. *Fruits and nuts are essential components of animal and human diets and desert. They represent diverse genetic resources in tropical and subtropical regions of the world. In Nigeria, exotic fruits are more popular as indigenous ones are largely underutilized. This study examined the chemical components of five uncommon fruits: African oil bean [Pentaclathra macrophylla, Fabaceae], Bambara groundnut [Vigna subterranean, Fabaceae], African bush mango [Irvingia gabonensis, Irvingiaceae], African pear [Dacryodes edulis, Burseraceae] and Nigerian walnut [Tetracarpidium conophorum, Euphorbiaceae]. The fresh fruits/nuts were collected from parts of Edo State, Southern Nigeria. Results showed that alkaloid was present in fresh and cooked samples of walnut and pear, and only present in fresh samples of P. macrophylla and V. subterranean. Alkaloid was absent in both fresh and cooked I. gaborensis. The result of mineral composition of the samples suggests highest calcium, potassium and magnesium content was obtained in African pear and P. macrophylla for sodium, zinc and iron. Presence of ascorbic acid, thiamine, riboflavin and lactic acid was confirmed in all the fruits. The highest concentration of ascorbic acid, thiamine, riboflavin and lactic acid was obtained from I. gaborensis, V. subterranean, P. macrophylla and D. edulis respectively. The highest bacterial and fungal count in fresh samples was from Bambara groundnut and P. macrophylla respectively. This study has implicated the relevance of these uncommon fruits and nuts. It is recommended therefore that their awareness should be improved in order to sustain their marketability and food use.*

KEYWORDS: Tropical fruits and nuts, Underutilized fruits, Plant genetic resources, Vegetables, Phytochemicals, Nigeria

INTRODUCTION

Tropical and subtropical regions of the world are endowed with fruits. Fruits and nuts may be classified as vegetables. Botanically they are diverse in characters and circumscription. According to Aigbokhan (2014) a plant may play primary or secondary roles as fruits. Economically, they have the potential to attract foreign exchange. Ethnobotanically fruits are essential components of different cultural, social and spiritual functions especially African and Asia. Fruits are plagued with varying problems, including production, storage, transports and marketability. Many fruits are classified as underutilized or underexploited. More so in the opinion of Acquaah (2007) consumers prefer succulent and juicy fruits.

Most traditional fruits and vegetables have a problem of appealing to consumers who view consider them as unhealthy and unsafe for human consumption. Among these are: African oil bean [*Pentaclathra macrophylla* Benth, Fabaceae], Bambara groundnut [*Vigna subterranean* [Lin.] Verdc, Fabaceae], African bush mango [*Irvingia gabonensis* (Aubry ex O' Rorke) Baill, Irvingiaceae], African pear [*Dacryodes edulis* (G. Don) H.J. Lam., Burseraceae] and Nigerian walnut [*Tetracarpidium conophorum* (Mull. Arg.) Hutch and Dalziel, Euphorbiaceae]. Eze (2012) recognized D. *edulis, V. subterranean and P. macrophylla* as underutilized in spite of their economic oil and suitability to tropical and subtropical climes. V. *subterranean* is a hardy plant able to withstand high temperature and dry conditions (Stone *et al.* 2011). *P. macrophylla* popularly called ugba in southern Nigeria possess edible seed and leaves (Idu *et al.,* 2011). African pear is a fruit tree native to Nigeria and Cameroon, whose fruits may be eaten fresh, boiled or roasted alone or with *Zea mays* (Vivien & Faure, 1996). *D. edulis* is also called butterfruit because of its creamy, delicious, oily pulp rich in amino acid such as leusine and lysine as well as micronutrients and minerals (Stone *et al.,* 2011). The juicy fruit pulp of *I. gabonensis* is rich in Vitamin C and is widely consumed as a dessert fruit or snacks through Western and Central Africa while its pulp can be used in making jam, jelly and juice (Ejiofor, 1994; Leaky *et al.*, 2005 & Okolo *et al.,* 1999). The seeds are sun dried and ground to be used as a thickener in soup in Nigeria. *V. subterranean* is indigenous to tropical African and is highly overlooked by researcher, development agencies and humanitarian programs, even though they are packed with nutrients (Stone *et al*., 2011). Ripe fruits of T. *conophorum* is boiled and eaten as a snack, which is high in protein and polyunsaturated fat (Onimawo, 2010). It is popular for its aftertaste, medicinal properties and source of conophor oil. The study of Ogwu *et al*., (2014) reveal that fruits and nuts represent over 50 % of plant diversity in home gardens in Edo state.

This study aims to conduct microbial assessment and determine the nutritional and chemical composition of cooked and uncooked *P. macrophylla, T. conophorum, I. gaborensis, V. subterranean and D. edulis.* The study will provide supporting data for the food use of these fruits and increase awareness about their health benefits.

MATERIALS AND METHODS

STUDY AREA: The study area has climatic conditions typical of tropical regions and is positioned between Longitude 06^0 04^1 E 06^0 43^1 E and Latitude 05^0 44^1 N and 07^0 34^1 N. Detailed description of the study area have been reported by Osawaru & Ogwu (2014).

COLLECTION OF SAMPLES: All the samples used in this study (Plates 1 – 5) were collected from home gardens, distant farms, markets and as ruderals from Edo state southern Nigeria. A survey was conducted hitherto to implicate them as uncommon consumed fruits in parts of Nigeria. Actual collection was done according to Osawaru & Ogwu (2014).

Plate 1: Bambara groundnut (*Vigna subterranean*)

Plate 2: Africa pear (*Dacryodes edulis*)

Plate 3: African oil bean (*Pentaclathra macrophylla*)

Plate 4: Bush mango (*Irvingia gaborensis*)

Plate 5: Nigerian Walnut (*Tetracarpidium conophorum*)

PREPARATION OF SAMPLES

Tetracarpidium conophorum (Walnut)**:** Walnut samples were categorized into fresh and spoilt. Analytical work on fresh samples were carried out two days after collection while those for spoilt samples were obtained after storing the fresh samples under natural conditions for 10 days. Some samples were left in order to determine the shelf life of the fruits. Samples of walnut were divided into two groups A-B, group A was subjected to mild cooking at boiling water temperature (100 ^{0}C) for 10 minutes. Samples in group B were left in its fresh state and categorized as "uncooked"

Vigna subterranean (Bambara groundnut)**:** The fruits and seeds were carefully cleansed with distilled water and partitioned into two for the purpose analysis (cooked and uncooked). The raw seeds were classified as uncooked seed. The cooked seed was prepared by soaking the raw seeds in water for 14 h at room temperature (24 ± 2 ºC) with a seed to water ratio of 1:5 (w/v). Thereafter, the soaked seeds were washed twice with ordinary water, followed by rinsing with distilled water and then dried in a hot air oven at 50 ºC for 24 h. The soaked seeds were placed in a round-mouthed tall beakers fitted with condensers. The contents of the beaker were cooked. Cooked seeds, along with cooking water, were dried at 50 ºC for 24 h.

Pantaclethra macrophylla (African oil bean seed): The seeds were thoroughly washed to remove extraneous materials and visually inspected in order to discard defective seeds. The selected seeds were dried in an oven at 45 ^{0}C for 8 hours the difference in weight after drying was used to determine the moisture content of the raw seed sample. The dried

samples were ground into powder for subsequent analysis. The cooked sample was obtained by parboiling of the whole seeds for 4 hours, which facilitated the removal of the shell to obtain the cotyledon.

Irvingia gabonensis (African mango): Samples were categorized into fresh and spoilt. Analytical works were carried out within two days after purchase. The spoilt samples were obtained after storing the fresh samples under natural conditions for 10 days. Some samples were left in order to determine the shelf life of the fruits.

Dacryodes edulis (African pear): Samples of African pear were divided into two groups A - B, group A was subjected mild cooking at boiling water temperature (100 ^{0}C) for 10 minutes. Samples in group B were left in its fresh state and categorized as "uncooked". The pulp was separated from the fruit with a sharp knife.

CHEMICAL ANALYSIS OF SAMPLES: The moisture, crude fiber, fat and ash contents were determined according to AOAC method (1996). Crude protein was determined using Kjeldahl method as recommended by AOAC (2000). Carbohydrate content was determined using Anthrone method according to Pearson *et al*. (1976). Mineral analysis was carried out using the methods of Omogbai & Ojeaburu (2010). The method as proposed by Trease and Evans (1983) was adopted for detecting alkaloids. The following micronutrients were determined using standard procedures: ascorbic acid content, thiamine and total titrable acidity

MICROBIOLOGICAL ANALYSIS OF SAMPLES: Nutrient agar was prepared according to Lapage *et al.* (1970); American Public Health Association (2001 & 2004) & Horwitz *et al.* (2007). The method of American Public Health Association (1992; 1993 & 2001) was adopted in the preparation of potato dextrose agar. Serial dilution was done as enumerated by Aneja (2005).

SHELF LIFE STUDY OF AFRICAN MANGO: The shelf life study on African mango fruit was determined by monitoring the microbial load of the fruit stored at room temperature (25.0 ± 2.5^0C). Microbial counts were taken at an interval of five days. Physical and sensual characteristics of the samples were also examined.

STATISTICAL ANALYSIS: Data obtained were subjected to descriptive statistical analysis as described by Ogbeibu (2005).

RESULTS

Results are presented in Tables 1 - 10.
Alkaloid was present in fresh and cooked samples of Nigerian walnut and African pear, and only present in fresh samples *P. macrophylla* and *V. subterranean.* Alkaloid was absent in both fresh and cooked *I. gaborensis*.

Table 1: Qualitative examination of alkaloids in fresh and cooked uncommon fruit samples

SAMPLES	FRESH	COOKED
Nigerian walnut seeds	+	+
African pear pulp	+	+
Pantaclethra macrophylla seeds	+	-
African mango pulp(15 days)	-	-
Bambara groundnut seeds	+	-

Key: + = Present
= Absent

The result of mineral composition of the samples are presented in Tables 2. The highest calcium, potassium and magnesium content was obtained from African pear and *P. macrophylla* for sodium, zinc and iron.

Table 2: Mineral composition (mg/100g) of fresh and cooked uncommon fruit samples

	Sodium		Calcium		Potassium		Zinc		Iron		Magnesium	
	(mg/100g) ± SD											
Samples	Fresh	Cooked	Fresh	Cooked	Fresh	Cooked	Fresh	Cooked	Fresh	Cooked	Fresh	Cooked
NW	44.570 ± 1.37	37.05± 0.13	48.40 ±3.13	38.07± 2.53	61.35 ±1.61	58.31±1.30	5.44± 0.37	6.52±0.41	2.76± 0.11	1.75±0.05	55.66 ±0.20	47.28± 1.00
AFP	135.065±3.44	108.10 ±8.01	328.7 ±4.02	290.52 ±5.08	472.1 ±21.32	487.65± 8.56	3.89± 0.1	5.28±0.13	2.205 ±0.18	1.71±0.25	247.4 55±8.13	224.15 ±3.31
PM	320.85±8.81	267.17 ±7.88	201.34±7.96	221.87 ±4.65	270.84±5.39	243.38± 10.85	5.48± 0.32	9.79±0.23	9.61± 0.01	9.73±0.17	190.865±6.51	223.91 ±6.44
BG	9.245 ±0.08	5.53±0.58	219.94±3.39	177.37 ±15.39	250.415±4.36	221.11± 14.74	2.64± 0.13	1.33±0.10	5.46± 0.25	3.37±0.40	112.315±0.73	98.60± 0.49
AM	165.535±1.46	147.615± 0.58	242.58 ± 1.46	218.43 ± 0.51	85.26 ± 1.22	51.475 ± 1.63	2.62 ± 0.13	1.680 ± 0.20	3.325 ± 0.22	1.395 ± 0.29	16.7 ± 1.91	10.475 ± 0.60

Values are means ± standard deviations of duplicates.
Keys: NW (Nigerian walnut), APF (African pear fruit), PM (*Pantaclethra macrophylla* seeds), BG (Bambara groundnut) and AM (African Mango).

The proximate composition of *P. macrophylla* is presented in Table 3. Result suggest high amount of crude fat and protein.

Table 3: Proximate analysis of fresh and cooked *Pantaclethra macrophylla* (African oil bean seed)

Proximate Analysis (%)	Fresh samples	Cooked samples
Moisture	10.135± 0.150	8.535 ± 0.390
Crude fat	45.600 ± 0.180	50.170 ± 0.110
Crude protein	24.700 ± 0.170	22.800 ± 0.030
Carbohydrate	13.230 ± 0.250	11.465 ± 0.150
Ash	3.180 ± 0.060	2.820 ± 0.160
Crude fibre	3.155 ± 0.050	4.210 ± 0.480

Values are means ± standard deviations of duplicates.

The result of proximate composition of Bambara groundnut is presented in Table 4. High amount of carbohydrate and crude protein were recorded.

Table 4: Proximate analysis of fresh and cooked Bambara groundnut (*Vigna subterranean*).

Proximate Analysis (%)	Fresh samples	Cooked samples
Moisture	8.450 ± 0.460	7.435 ± 0.260
Crude fat	6.240 ± 0.090	8.320 ± 0.040
Crude protein	21.355 ± 0.290	19.685 ± 0.090
Carbohydrate	54.505 ± 0.190	57.585 ± 0.250
Ash	3.690 ± 0.370	3.300 ± 0.400
Crude fibre	5.7450 ± 0.110	3.680 ± 0.170

Values are means ± standard deviations of duplicates.

Proximate composition of African bush mango is presented in Table 5. High amount of moisture was obtained which was not reduced by cooking.

Table 5: Proximate analysis of fresh and spoilt *Irvinga gabonesis* fruit pulp (African mango).

Proximate Analysis (%)	Fresh samples	Spoilt samples (15 days)
Moisture	83.610 ± 0.570	85.690 ± 0.810
Crude fat	2.610 ± 0.050	2.240 ± 0.090
Crude protein	3.060 ± 0.270	4.390 ± 0.340
Carbohydrate	3.940 ± 0.250	1.220 ± 0.092
Ash	2.540 ± 0.510	1.520 ± 0.130
Crude fibre	4.250 ± 0.134	4.950 ± 0.510

Values are means ± standard deviations of duplicates.

The proximate composition of Nigeria walnut seeds is presented in Table 6. High moisture content, crude protein and carbohydrate and low crude fat, crude fibre and ash were suggested by the result.

Table 6: Proximate analysis of fresh and cooked *T.* conophorum seeds samples.

Proximate Analysis (%)	Fresh samples	Cooked samples
Moisture	43.760 ± 0.085	42.775 ± 0.250
Crude fat	5.495 ± 0.021	10.300 ±0.200
Crude protein	24.250 ± 0.340	23.385 ± 0.330
Carbohydrate	19.205 ± 0.710	17.340 ± 0.200
Ash	2.940 ± 0.230	2.6150 ± 0.120
Crude fibre	4.350 ± 0.210	3.560 ± 0.420

Values are means ± standard deviations of duplicates determination.

The result of proximate composition of African pear is presented in Table 7. Results suggest high percentage moisture, crude fat and carbohydrate and low crude fibre, ash and crude protein.

Table 7: Proximate analysis of fresh and cooked *Dacryodes edulis* fruit pulp

Proximate Analysis (%)	Fresh samples	Cooked samples
Moisture	46.400 ± 0.156	45.595 ± 0.120
Crude fat	34.445 ± 0.450	39.125 ± 0.120
Crude protein	3.375 ± 0.134	2.470 ± 0.440
Carbohydrate	11.735 ± 0.064	9.275 ± 0.370
Ash	2.590 ± 0.028	2.250 ± 0.100
Crude fibre	1.455 ± 0.064	1.215 ± 0.021

Values are means ± standard deviations of duplicates determination.

The result of micronutrient analysis is presented in Table 8. Highest concentration of ascorbic acid, thiamine, riboflavin and lactic acid was obtained from *I. gaborensis, V. subterranean, P. macrophylla* and *D. edulis* respectively. In African Mango, the results suggest high amounts of ascorbic acid in fresh and cooked samples as well as low in thiamine, riboflavin and lactic acid.

Table 8: Micronutrient composition (mg/100 g) of some fresh and cooked uncommon fruits samples.

	Ascorbic acid(mg/100 g) ± SD		Thiamine (mg/100 g) ± SD		Riboflavin (mg/100 g) ± SD		Lactic acid (mg/100 g) ± SD	
Samples/treatments	Fresh	Cooked	Fresh	Cooked	Fresh	Cooked	Fresh	Cooked
NW	51.900 ± 0.260	47.360 ± 0.530	0.020 ± 0.000	0.001 ± 0.000	0.004 ± 0.000	0.001 ± 0.000	0.070 ± 0.000	0.160 ± 0.004
APF	34.83 ± 0.040	26.590 ± 0.260	0.160 ± 0.030	0.100 ± 0.007	0.650 ± 0.060	0.054 ± 0.003	0.520 ± 0.057	1.135 ± 0.053
PM	18.80 ± 0.270	15.600 ± 0.420	0.072 ± 0.010	15.600 ± 0.420	0.071 ± 0.010	0.040 ± 0.000	0.003 ± 0.000	0.001 ± 0.000
BG	0.058 ± 0.004	0.250 ± 0.002	0.660 ± 0.050	0.565 ± 0.035	0.430 ± 0.028	0.355 ± 0.035	0.091 ± 0.001	0.128 ± 0.003
AM	62.560 ± 0.570	58.830 ± 0.040	0.050 ± 0.000	0.003 ± 0.000	0.003 ± 0.000	0.0205 ± 0.0007	0.210 ± 0.02	0.085 ± 0.010

Values are means ± standard deviations of duplicates
Key: NW (Nigerian walnut), APF (African pear fruit), PM (*Pantaclethra macrophylla seeds*), BG (Bambara groundnut) and AM (African Mango)

The result of microbial count of fresh and cooked samples is presented in Table 9. The highest bacterial and fungal count in fresh samples was from *V. subterranean* and *P. macrophylla* respectively.

Table 9: Microbial load (cfu/g) of some fresh and cooked uncommon fruit samples

	Bacterial count (cfu/g)		Fungal count (cfu/g)	
Samples/treatments	Fresh	Cooked	Fresh	Cooked
NW	7.4×10^2	5.3×10^1	1.1×10^2	2.2×10^1
APF	4.1×10^3	2.4×10^1	2.7×10^3	1.2×10^1
PM	2.5×10^4	6.4×10^3	8.1×10^3	2.3×10^3
BG	7.8×10^4	4.2×10^2	4.9×10^2	8.4×10^1

Value are means ± standard deviations of duplicates
KEYS: NW (Nigerian walnut), APF (African pear fruit), PM (*Pantaclethra macrophylla* seeds) and BG (*V. subterranean).*

Microbial load of the fruit was monitored and expressed in (cfu/g).

Table 10: Shelf life monitoring of *I. gabonensis* stored at 28 ± 2°C.

Time (days)	Microbial load (cfu/g)
One	2.0×10^3
Five	4.7×10^6
Ten	1.3×10^8
Fifteen	5.8×10^{11}

DISCUSSION

The study has investigated the phytochemical composition and microbial status of five uncommon fruits in Edo state southern Nigeria. The fruit samples were collected and analyzed for their proximate composition, mineral composition, micronutrient composition and the shelf life was determined by monitoring the microbial load based on a time interval of five days. Most tropical fruits are underutilize and under exploited regardless of enormous attention from researchers. Rural dwellers depend on wild fruits to meet their daily food needs as well as income generation. Fruits are examples of vegetables and may provide daily energy, protein and vitamins. They are components of balanced diets.

The qualitative examination for alkaloids in fresh and cooked uncommon fruit samples suggest the presence of alkaloids in the samples. *P. macrophylla* seeds, African pear and Bambara groundnut gave a positive result, while negative result was obtained from Fresh African mango pulp and African mango pulp. It was shown that, prolonged cooking had some effect on the qualitative presence of alkaloids in *P. macrophylla* seeds and Bambara groundnut (Table 1).

Fruits are suppliers of minerals and vitamins, which may influence the wellbeing and health status of individuals. The macro and microelemental composition of well-known tropical fruits such as banana, sweet lime, African pear, orange, passion fruit and others have been reported (Eromosele *et al*., 1991; Aremu & Udoessien, 1990 & Burguera *et al*., 1992). The results of the present study are in agreement with similar aspects of Bratte *et al.* (2010) which revealed high crude protein, ether extracts, crude fibre, ash and nitrogen-free extracts, trace amounts of the essential and non-essential amino acids and vitamins, which indicate they can be classified as an energy feed.

The phytochemical, vitamins and proximate composition of *D. edulis* at different stages of maturation were investigated by Majesty *et al.* (2012), the results obtained reveal the presence of flavonoids, alkaloids, saponins, tannins, cyanogenic glycosides, oxalate, thiamine, riboflavin, niacin, ascorbic acid and tocopherol. The Chemical composition and the effect of heat treatment on seeds of *Dacryodes edulis* were studied by Ujowundu *et al.* (2010) to suggest that among the proximate analysis, the moisture and carbohydrate values were the highest. Potassium, calcium, and phosphorus were also predominant while Sodium, magnesium, selenium, zinc and iron were present in appreciable amounts but manganese was not detected. These results correspond with those obtained in this study. More so, the result agrees with the report of Onyeike *et al.* (1995) that the crude fat is present in *I. gabonensis* seeds. A significant result obtained in this study is the absent of alkaloid in both samples in *I. gabonensis* seeds. This could be attributed to the method used in the analysis. This is similar to the observations of Ogunmefun *et al.* (2013). More so, it could be as a result of the source of the samples.

The seeds of *P. macrophylla* are rich in protein, oil and energy as well as in sodium, potassium, magnesium, calcium and phosphorus while iron, zinc, copper and lead may be of lower concentrations (Oyeleke *et al.,* 2014). This suggests that African oil bean seed has a potential for dietary improvement in food industries. Meanwhile, in the same study, arsenic and cadmium were not detected as tannin, saponin and flavonoid were present while cardiac glycoside and alkaloid are absent. The present study suggests the presence of alkaloids in fresh samples of African oil bean.

Though *T. conophorum* nuts are generally eaten in Nigeria, very little work has been done on the proximate composition and heavy metal content of this nut. The aftertaste of *T. conophorum* could be attributed to the presence of alkaloids. *T. conophorum* is used as a male-fertility agent (Ajaiyeoba & Fadare, 2006). Edem *et al*. (2009) reported the proximate composition, ascorbic acid and heavy metal contents of the nut. Ayodele (2003) reported the presence of oxalates, phylates and tannin in the raw *T. conophorum* nuts. Oyenuga (1997) reported on the amino acid and fatty acid components of the nut and on the use of its leaf juice for the treatment of prolonged and constant hiccups. Nwokolo (1987) also reported on the impact of traditional processing on the nutrient and sensory qualities of the nut. Okpero (2001) reported on the methods of processing the *T. conophorum* nuts while Okafor (1988) reported on the use of *T. conophorum* seeds and processing waste in livestock feed formulation. Walnuts are rich in linoleic and linolenic acids and in other health-related compounds such as high-biological-value proteins (e.g. arginine) fibre, vitamins, tannins, folates and polyphenols which may provide additional antiatherogenic properties (Nus *et al*., 2004). Walnuts contain polyunsaturated fatty acids, which may protect against cardiovascular disease (CVD) and may enhance tocopherol absorption (Jeanes *et al*., 2004).

The results obtained for the mineral composition of fresh and cooked uncommon fruit samples suggest the relative presence of these essential minerals. The mineral composition of fresh fruits is reduced by cooking. Although, it is important to note that the concentration of zinc (mg/100 g) was shown to increase in the cooked samples as against the fresh samples in Bambara groundnut. More so, the concentration of Iron (mg/100g) was shown to increase in the cooked samples as against the fresh samples only in Bambara groundnut. The mineral composition (mg/100 g) of fresh and spoilt African mango sample was shown to decrease significantly with time. The result of proximate analysis of fresh and cooked *Pantaclethra macrophylla* (African oil bean seed) gave credence to the name of the seed (African oil bean seed). It was shown that the oil content of the cooked seed constitute close to 50 % of the seed composition. The crude fibre of the seed was shown to increase on cooking.

In fresh and cooked Bambara groundnut (*Vigna subterranean*), it was shown that carbohydrate constitutes over 50% of the fresh seed proximate composition, although this value was shown to reduce on cooking. The crude protein composition of the fresh seed was shown to reduce on cooking. Other parameters affected by the treatment include; crude fibre, ash, and moisture. The crude fat content was shown to increase significantly on cooking.

The crude fibre content of fresh and spoilt *Irvinga gabonesis* fruit pulp (African mango) was shown to slightly increase in the spoilt sample; the carbohydrate content was also shown to reduce. There was an increase in the moisture content of the spoilt sample, suggesting an increase in the metabolic activity of microorganisms in the spoilt sample. Microorganisms are known to break down carbohydrate with the release of water and carbon dioxide. The levels of moisture, crude protein, ash, carbohydrate and crude fibre in *Tetracarpidium conophorum* (Nigerian walnut) seeds samples were shown to be negatively affected by the treatment. Although, the level of crude fat was shown to be affected positively, suggesting that heat treatment liberated some of the fruit fatty acids from triacylglycerol. For *Dracryodes edulis* fruit pulp, result obtained showed that the fruit is highly rich in oil; the oil content of the fruit was also shown to increase significantly on cooking. In the study by Yusuf *et al.* (2012) the oil extracted from *I. gabonensis* showed high level of saturation and the analysis revealed that it is rich in Myristic and lauric acid, which makes it very suitable for cosmetics and pharmaceuticals.

The micronutrient composition (mg/100 g) of some fresh and cooked uncommon fruit samples suggests the presence of some essential micronutrient. The ascorbic acid content, thiamine levels, riboflavin concentration and lactic acid were present. There was a marked change in the ascorbic acid content of all fresh and cooked uncommon fruit samples analyzed. This suggests that heat treatment has an effect on the Vitamin C content of fruits. Thiamine and riboflavin concentration was observed to be higher in the fresh samples when compared to the cooked samples. The Lactic acid concentration was observed to increase on cooking. The micronutrient composition (mg/100 g) of fresh and spoilt *Irvinga gabonesis* fruit pulp (African mango) showed great difference between the micronutrient composition of fresh African mango pulp and the spoilt fruit. The micronutrient content was shown to decrease as a result of deterioration of the fruit pulp by microorganisms. These micronutrients play essential roles in the human diet.

The bacterial load of the fresh samples was shown to decrease on cooking. Nigerian walnut had the lowest bacterial load, while Bambara groundnut had the highest bacterial load. The fungal load of the fruit samples was comparatively lower to the bacterial load. The shelf life was determined by storing the fruit sample at a temperature of 28 ± 2 °C for a total period of fifteen days when the physical appearance of the fruit does not look appealing for consumption. The microbial load of the fruit samples was used to determine the shelf-life of the sample. The shelf life of the fruit was shown to be at ten and fifteen days when the microbial load was determined to be within the limit of Specific Spoilage Organisms counts of 10^5 to 10^8 cfu/g. The maximum permissible level of total aerobic colony of ready-to-eat foods as given by Fylde Borough Council extracted from manual of PHLSG (2008) was 10^4 to less than 10^6 cfu/g of ready-to-eat food products. Also, according to (Rho & Schaffner, 2007), the limit of microbial growth that determines shelf-life differs according to the food type and storage conditions. Specific Spoilage Organisms counts from 10^5 to 10^8 cfu/g are commonly considered as convenient quality limits. Thus, based on the data collected on the fifth day and tenth day, and following the guidelines of PHLSG (2008) and (Rho & Schaffner, 2007) on ready-to-eat food

Acquaah (2007) recommended that breeders develop new varieties of vegetables and fruits with superior yield, nutritional qualities, adaptation, and general appeal as well as the extension of shelf life through the use of genetic engineering techniques to reduce the expression of compounds associated with fruit deterioration.

In conclusion, the study has shown that these uncommon fruits are rich in chemical composition although often neglected. There is a need to increase awareness of these important aspects of these fruits as well as mobilization of farmers that cultivate them. These farmers should be supported with amenities including credit and storage facilities. At present, these fruits are regarded underutilized and the status deserves a change.

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