Evaluation of Chemical Nutritional Composition of African pear pulp Obtained from Mararaba Jamma Market Jos, Plateau State

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ABSTRACT

Malnutrition is a major health problem in Nigeria, particularly among the rural populace where people cannot afford conventional sources of protein or other food additives to enrich their diets The assessment of the chemical compositions of pulp and seed of African pear was obtained from Mararaba Jamma Market Jos, Plateau State, North Central Nigeria, which was analysed using standard analytical methods. The parameters analysed were moisture, protein, ash, fat and fibre, with the respective of 10.00±0.21,18.00±0.05, 3.40±0.00, 44.75±0.22 and 7.40±0.51 %. The carbohydrate content obtained was16.44±0.27 %, while the energy value was 2241.23±0.52 KJ/100g. The sample analysed included reasonable amounts of sodium, potassium, iron, phosphorus, magnesium, zinc and calcium. Anti-nutritional analysis revealed the presence of oxalate, phytate, saponins, alkaloids and cyanide within the permissible limits. The compositions of the essential and non-essential amino acids obtained from the sample were 19.55 and 33.81 g/100 g proteins, respectively. African pear pulp could therefore serve as an additional promising source of nutritional content for human and animal feed formulations.
Keywords: African pear, proximate, Anti-nutritional

INTRODUCTION

African pear pericarp has been reported to have butter qualities and to be rich in oil and vitamins[1]. The cooked flesh of this fruit has a texture similar to butter, and this portion is eaten either raw or cooked. *Dacryodes edulis* is rich in carbohydrates, sugars, fiber, vitamins, especially thiamine, riboflavin and vitamin B_6. It also contains certain minerals such as calcium, iron, magnesium, potassium, phosphorus and zinc. They protect the body cells from oxygen-related damage caused by free radicals due to their antioxidant properties. In addition, the presence of fiber in this fruit helps prevent constipation and ensures regular bowel movements. Studies have shown that regular intake of pears

protects women against postmenopausal breast cancer[2].

Current trends have linked conventional plant protein supplements to high levels of anti-nutritional factors such as high levels of trypsin inhibitors of legumes (soya beans) and gossypol (cotton). Studies on the use of other non-conventional plant protein supplements are very much needed. Knowledge of the nutritional andanti-nutritional factors of these plants will therefore stimulate the use of these plants as supplements for legumes in feed formulations[3]. However, unlike some other oil-bearing materials such as groundnuts, cotton seeds, soybeans, palm pulp and palm kernels, oil extraction from elemi pulp and kernels is not commercially available in Nigeria, particularly in the Niger State. This situation would improve if the data needed for the design and operation of the oil extraction plants were available. The aim of this study is to evaluate the chemical nutritional constituents of African pear pulp.

MATERIALS AND METHODS

Sample collection and preparation

The fruits were obtained from different parts of this country African pears was obtained from Mararaba Jamma Market Jos, Plateau State in North Central Nigeria. The samples were washed and rinsed with distilled water respectively and allowed to dry at room temperature for three weeks. The dried seeds were milled in attrition mill, sieved through 200 μm wire mesh, packed in a plastic container which was sealed with aluminum foil and stored at ambient temperature prior to analysis[4].

Proximate Analysis

The moisture, ash, fat and protein contents of the African elemi pulp and seeds were determined using the methods of AOAC[5]. Total carbohydrate content was determined by subtracting percentage protein, ash, moisture, crude fiber, along with the fat from 100%[6]. The energy value (kcal/100g) was estimated by multiplying the percentage of crude protein, crude lipid as well as carbohydrate by 4, 9 and 4 respectively as conversion factors[7].

Mineral analysis

The sample was digested by weighing in triplicate 1.00 g into beakers and 10 cm^3 of the acid mixture ($HClO_4$:H_2SO_4:HNO_3) in the ratio of 1:4:3 was added in each case. The mixture was swirled and left in a fume cupboard overnight. The samples were then digested on a Kjedhal digestion block until the solutions became quite clear. The digests

were allowed to cool, diluted with 20 cm^3 of water, filtered using Whatman filter papers No. 1, made up to mark with deionized water in 100 cm^3 volumetric flasks and then transferred into sample bottles. The samples were analyzed for their mineral contents (Ca, Cu, Fe, Zn, Mn and Mg) using atomic absorption spectrophotometer (AAS) Buck model 210 VGP. A flame photometer (AA-500F, China) was used for the determination of potassium and sodium, while phosphorus was determined colorimetrically using the vanudo-molybodate colorimetric method (KF1700, Sweden)[5].

Evaluation of anti-nutritional factors

The phytate, saponins, alkaloids, cyanide and oxalate contents were determined using the methods of AOAC[5].

Determination of Amino Acid profile

About 200 mg of the ground seed sample was defatted using methanol/chloroform mixture in a ratio of 1:1. From the defatted sample, 30 mg was weighed into a glass ampoule, 7 cm^3 of 6 M HCl was added and oxygen expelled by passing nitrogen into the ampoule. The sealed ampoule was placed in the oven at 105 ^oC for 22 h, this was allowed to cool and filtered. The filtrate was then evaporated to dryness at 40^oC under vacuum in a rotary evaporator. The residue was dissolved in 5 cm^3 acetate buffer (pH 2.0) and loaded into the amino acid analyzer where the amino acid compositions of the seed samples were determined by Ion Exchange Chromatographic method using the Technicon Sequential Multisample Amino Acid Analyzer[5].

GC/MS Analysis of the Samples

GC-MS analysis of the oil extracted from unfermented and fermented for 24 and 48 h from the sample using petroleum ether was analyzed by the methods of Orishadipe *et al.,*[8]. The GC column that contained oven with temperature of 70°C, injecting temperature (250°C), linear velocity (flow control mode), column flow (1.80 cm^3/min), total flow (40.8 cm^3/min), pressure (116.9 kPa), purge flow (3.0 cm^3/min) as well as linear velocity (49.2 cm/s) were used for this analysis. A sample volume of 8.0 µl was injected using split ratio of 20:0. The peak area, that is, the percentage amount of every component was calculated by comparing its average peak area to the total area.

Physico-chemical Properties of the Oil Samples

The contents Peroxide value, viscosity, saponification value and specific gravity were analyzed base on the method of Mathew *et al.,*[7]. The procedure of AOAC[5] was used to

determine acid value, free fatty acid, temperature, pH and iodine value.

Statistical analysis

All determinations were performed in triplicate. The statistical analyses were conducted using analysis of variance (ANOVA).

RESULTS AND DISCUSSION

The proximate compositions of the sample being considered are presented in Table 1. The values obtained for protein was 18.00 ± 0.05 % this value was similar to the protein contents ranging from 11.20 to 18.80 % in *Blighia sapida* seeds[9]. This protein value obtained from this study indicates that it can contribute to the daily human protein requirements based on 23 -56g as stipulated[10].

The moisture content of any food is an index of its stability and susceptibility to microbial contamination[11]. Moisture contents of 10.00 ± 0.21 % obtained for African pear pulp was lower than the 75-91.33 % reported for the pulp of *Curcubita maxima*[12].

Thus, inferring that the samples have a comparable higher microbial stability. The crude fibre content of 7.40 ± 0.51 % was obtained for the sample. This value are higher than earlier reports of Karaye *et al.,*[13] who indicated 3.07% for *C. maxima* seed. Low fibre in diet has been associated with heart diseases, cancer of the colon and rectum, varicose veins, phlebitis, obesity, appendicitis, diabetes and constipation[14].

Table 1: The Results of Proximate Composition of the Sample

Parameters	Content (%)
Moisture	10.00±0.21
Ash	3.40±0.00
Protein	18.00±0.05
Crude fat	44.75±0.22
crude fibre	7.40±0.51
Carbohydrate	16.44±0.27
Energy value (kJ/100g)	2241.23±0.52

Crude fat contents of 44.75 ± 0.22 % obtained for the sample was higher than the 0.43% reported for the seeds of *Parkia filicoidea*[15]. Fats are vital in the structural and biological functioning of the cells and help in the transport of nutritionally essential fat soluble vitamins[16]. The ash contents of the African pear pulp was 3.40 ± 0.00 %. This value was lower than 7.45 % reported for *Cucurbita species*[17]. This value was higher than the 2.48 ± 0.18 % reported for *Cumis melo* variant agrestis seeds[18]. The proportion of ash content is a reflection of the mineral contents of food materials[16]. The carbohydrate content of 16.44 ± 0.27 % was obtained for African pear pulp which was higher than 6.39 ± 2.66% value reported for *Arachis hypogaea*[19] but lower than the 66.64 ± 0.10 % reported for *C. maxima*[20]. The carbohydrate contents of this fruit shows that they are not useful as alternative source of carbohydrate.

Table 2: The Result of Mineral Compositions (in mg/100g) of the Sample

Parameters	Content
Na	16.66±0.01
K	19.39±0.89
P	16.15±0.07
Fe	11.25±0.31
Ca	3.06±0.13
Mg	8.02±0.19
Cu	1.07±0.08
Zn	5.45±0.35
Mn	5.32±0.21
Pb	BDL

KEY: BDL = Below detection limit

The mineral contents of the test sample as presented in Table 2 shows that African pear pulp has iron content to be 11.25 ± 0.31 mg/100g. The value obtained from this study are high when compared to the 0.13 mg/100 g in *Boerhavia diffusa* and 0.016 mg/100g in *C. nudiflora*[9]. The concentrations of this mineral implies that, this sample will serve as blood building foods and should be desired for human and animal feed formulations. The intake of phosphorus helps in bone growth, proper kidney function and cell growth. It also plays a role in maintaining the body's acid-alkaline balance[14]. The phosphorus contents of the sample was 16.15 ± 0.07 mg/100g for African pear pulp. The value was very low when compared to the 4000 mg/100g reported for beniseeds[21]. The dietary allowance for phosphorus is 800 mg/100g[22]. Therefore, this sample may not be good sources to be solely relied on for this element. Potassium plays an important role in the human body and sufficient amounts of it in the diet protect against heart disease, hypoglycaemia, diabetes, obesity and kidney dysfunction. Regular intakes of potassium lower blood pressure[23]. The potassium content African pear pulp was 19.39 ± 0.89 mg/100g. The concentration was high when compared to those of *B. diffusa (*0.71 mg/100g) and *Commelina nudifora* (0.68 mg/100g)[9]. Zinc contents obtained from the samples was 5.45 ± 0.35 mg/100g. The zinc content is higher than that observed in *Solanium incanum* (1.28 mg/100 g) and *Commelina nudiflora* (0.12 mg/100 g)[24]. Zinc plays a role in gene expression, regulation of cellular growth and participants as a co-factor in enzymes responsible for carbohydrate protein and nucleic acid, metabolism[25]. The sodium contents of African pear pulp was 16.66 ± 0.01 mg/100g. The dietary allowance for sodium is 110 mg/100g – 3300 mg/100g for adults[22]. The value obtained from this sample was low and may not serve as dietary supplement for sodium. Calcium is an essential mineral for bone development. The calcium content of African pear pulp obtained was 3.06 ± 0.13 mg/100g. The recommended daily allowance for calcium is 210 - 1200 mg/day[21] based on this, these samples could be classified as poor sources of calcium. The concentration of magnesium obtained from this sample was 8.02 ± 0.14 mg/100g. This value was higher than 7.76 mg/100g reported for *P. biglobosa* seeds and 6.65 mg/100g for *B. diffusa*[25]. Magnesium is needed for more than 300 biochemical reactions in the body, helping to maintain normal muscle and nerve functions, keeping heart rhythm steady, supporting a healthy immune system and regulating blood sugar levels[26]. The copper

content of the sample was 1.07 ± 0.08 mg/100g. Copper stimulates the immune system to fight infections, repair injured tissues as well as promote healing. Severe deficiency of copper in pregnant mothers increases the risk of health complications in their foetuses and infants[27]. The manganese content of African pear pulp was 5.32 ± 0.21 mg/100g. This value was higher when compared to 0.46 mg/100g reported for *B. diffusa* and 0.16 mg/100g accounted for *C. nudiflora* by Anhwange *et al.*,[24]. Lead contents are below detection limit in this sample. This shows that incidence of lead toxicity is unlikely with African pear pulp.

The result of anti-nutritional compositions of African pear pulp are presented in Table 3. These values are generally low such that none of them is above the lethal dosage approved by standard bodies like National Agency for Food and Drugs Administration and Control (NAFDAC) in Nigeria (2002). The cyanide content of the sample are 0.56 ± 0.41 mg/100g for African pear pulp. This value was higher than 0.17 ± 0.01 mg/100g reported for *Devar parvicarpa* by Ibanga and Okon[28]. This indicates that the samples will not contribute to cyanide toxicity if consumed in a large quantity. Only plants with more than 200 mg of hydrocyanic acid equivalent per 100g fresh weight are considered dangerous[29].

The concentration of oxalate of the sample was 0.28 ± 0.51 mg/100g. This value was low compared to the 1.60 ± 0.08 mg/100g reported for *C. Maxima* Fruits Parts[30]. Oxalates form insoluble complexes with calcium, magnesium, zinc and iron which interfere with utilization of these minerals[31]. Phytate content of the sample was 4.11 ± 0.25 mg/100g which is higher than 1.05 ± 0.01 mg/100g reported for *D. parvicarpa*[28].

Table 3: The Result of Anti-nutritional Factors of the Sample (mg/100g)

Parameters	Content
Alkaloid	6.40±0.13
Cyanide	0.56±0.41
Saponins	2.08±0.55
Oxalate	0.28±0.51
Phytate	4.11±0.25

However, the value was similar compared with 4.03±0.01 mg/100g reported for *C. Maxima* Fruits Parts[30]. Phytatic acid intake of 4-9 mg/100g decreases Fe^{2+} absorption by 4 - 5 fold in humans[32]. The finding thus indicates that the phytate content in the African pear pulp is above the safe limit. The alkaloid content was 6.40 ± 1.03 mg/100g for African pear pulp. Alkaloids cause gastrointestinal and neurological disorders especially when taken in doses in excess of 20 mg/100g sample[33]. This indicates that the samples are within safe limit for alkaloids.

Table 4: The Result of Amino Acid Composition of the Sample

Amino acid	Content **(g/100 protein)**
Lysine	3.27
Histidine	1.20
Arginine	3.28
aspartic acid	5.34
Threonine	1.99
Serine	2.50
Glutamic acid	8.63
Proline	1.42
Glycine	3.05
Alanine	3.53
Cystine	0.79
Valine	3.36
Methionine	0.94
Isoleucine	2.25
Leucine	5.16
Tyrosine	1.91
Phenylalanine	4.02
Tryptophan	0.72
TEAA	19.55
TNAA	33.81

KEY: TEAA = Total essential amino acid TNAA = Total non-essential amino acid

The results of the amino acids profile as shown in Table 4 indicates that the African pear pulp was rich in essential amino acids such as lysine, histidine, threonine, leucine, isoleucine, methionine and phenylalanine and non-essential amino acids which include; arginine, aspartic acid, glutamic acid, valine, cystine, glycine, proline, tyrosine and alanine. The contents of non-essential amino acids in these samples are more than those of essential amino acids. The compositions of the essential and non-essential amino acid are 19.55 and 33.81 g/100g protein for African pear pulp respectively. These values are similar to the amino acids contents of *C. Maxima* seeds reported by Mohammed *et al.,*[34]. The result of fatty acid compositions of African pear pulp are presented in Table 5. Fatty acid composition of African pear pulp is in a ratio of 5:3 for total unsaturated fatty acid and saturated fatty acids (TUFA/TSFA) which is also higher compared to the 2.90% reported for pumpkin seed kernels by Mohammed[35]. The presence of both saturated and unsaturated fatty acids in these samples could be an advantage since both may complement the function of each other[36].

Table 5: The Result of Fatty Acid Contents of the Sample Obtained from GC-MS Spectrum of its Oil

Compound name	Molecular formula	Molar mass	%Area
1,2-dimethylbenzene	C_8H_{10}	106	2.92
1-Ethyl-2-methylbenzene	C_9H_{12}	120	5.77
1-Ethyl-4-methylbenzene	C_9H_{12}	120	2.34
4-Ethyl-1,2-dimethylbenzene	$C_{10}H_{14}$	134	2.01
2-ethyl-1,3-dimethylbenzene	$C_{10}H_{14}$	134	1.48
1-Ethenyl-4-ethylbenzene	$C_{10}H_{12}$	132	1.33
Hexadecanoic acid	$C_{16}H_{32}O_2$	256	40.92
9-Octadecenoic acid	$C_{18}H_{34}O_2$	282	43.23
TSFA			15.85
TUFA			84.15
TUFA/TSFA			5.31

KEY: TUFA = total unsaturated fatty acid TSFA = Total saturated fatty acid

The physiochemical properties of oils from the African pear pulp are presented in Table 6. At room temperature (29 ^{o}C) oils are liquids. The colour of the oil appears as yellow in the African pear pulp. The specific gravity of the oil was 0.92 ± 0.00 for African pear pulp which was similar compared to the pulp and seed oil of *Dacryodes edulis* as 0.82 and 0.84 respectively[37]. The refractive indices of the oils was 1.64 ± 0.20 for African pear pulp. The refractive indices for the sample are similar to the ASTM values which range from 1.47 to 1.51[38]. Iodine value of 11.8 ± 0.43 mg/100g for African pear pulp are obtained. This indicates that the oils contain high level of unsaturated bonds thus storage procedures should ensure their protection from oxidative deterioration. However, it may not be good drying oils since a good drying oil should have iodine value of 100g I_2/100g[1]. Acid value is used as an indicator for edibility of oil and suitability for use in the paint industry[39]. The acid value of the oil of the sample was 3.85 ± 0.32 for African pear pulp. Pearson[40] reported acid values of 4.0 for sesame, 7.0 for olive oil and 5.0 for grape seed which are all higher than the values obtained in this study. However, based on this value the oil could be edible and suitable for industrial applications. The free fatty acid value of the sample was 2.35 ± 0.11 mg/KOH/g. This value was within the allowable limits for edible oils whose maximum acceptable level is 4 mg/KOH/g[41]. The peroxide value for the oil obtained from the sample was 3.85 ± 0.32 mEqO_2/kg.

Table 6: The Result of Physicochemical Properties of Oil Extracted from African pear Pulp

Parameters	**Contents**
Colour	Yellow
iodine value(mg/100g)	118±0.43
saponification value (mgKOH/g)	239±0.67
peroxide value (m Eqv O_2/kg)	3.85±0.32
acid value	4.70±0.21
specific gravity	0.92±0.00
refractive index	1.64±0.20
Free fatty acids(as oleic)	2.35±0.11

Fresh oils have values less than 10 mEq/Kg. Higher peroxide values between 20 and 40 results in a rancid taste while the low peroxide values further confirm the stability of oil[42]. The low value obtained in this work is indicative that the oil are fresh and highly stable. The saponification value of oil is used in checking adulteration and industrial suitability[34]. The relatively high saponification value of the sample obtained in this work (239.00 ± 0.67 mgKOH/g for African pear pulp) is suggestive that the oil was not contaminated and could be suitable for cosmetic production[43].

CONCLUSION

The results obtained from this study show that the sample could be good sources of protein, fats, fibre, lipids and other essential minerals such as sodium, potassium, iron, phosphorus, zinc and calcium. The low anti-nutrient contents of these plants also suggest that, they could be exploited as good dietary sources for humans and animal feeds formulations. The oils obtained from the sample do have the potentials of being developed for food, pharmaceutical and chemical industrial applications. In addition, the essential and non-essential amino acid contents of this fruit indicate that they could be good for persons with hypertensive diseases.

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