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Comparative Evaluation of the Proximate and Amino Acid Composition of Dried Fruit Pulps of Mango (*Mangifera indica* Linn)Accessions in Ebonyi State, Southeast Nigeria

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ABSTRACT

Ebonyi State is a major production area for mango in Nigeria and postharvest losses is one big challenge to optimal utilization of this important food resource, especially as the fruits only bloom within a very short period of the year. The nutritional qualities of dried fruit pulps of mango accessionsavailable in the area were evaluated and compared by proximate and amino acid profiling. Twenty-one mango accessions were collected from different locations of the state and used in the study. The proximate components were determined using the Official Methods of the Association of Analytical Chemists (AOAC) while amino acids were quantified using the Technicon Sequential Multi-Sample Amino Acid Analyzer (TSM). The result revealed significant variations among the mango accessions for the chemical nutrient components and amino acid contents ($P<0.05$) but no particular accession was found to be richer in all the components measured. Glutamic acid was found to be the most abundant amino acid followed by alanine, aspartic acid and lysine, while the sulphur amino acids (cysteine and methionine) were the most limiting. Lysine followed by leucine were the predominant essential amino acids. Compared to literature reports on the contents of these parameters in the undried juice, the pulp drying significantly concentrated the chemical nutrients with protein content ranging from 1.90-5.08%, crude fat (2.10-3.56%), ash (2.07-6.83%), crude fibre (4.81-7.48%) and carbohydrates (77.75-83.47%), whereas total amino acids and total essential amino acid (EAA) respectively varied from 68.71 – 91.28% and 26.04 - 37.17mg/100g of the pulp protein. We therefore recommend adoption of mango fruit drying as a cheap approach to reducing postharvest losses and increase availability of the food outside its harvest season.

Keywords: Ebonyi State, mango accessions, fruit pulp drying, proximate components, amino acid contents.

INTRODUCTION

Mango is a very important and one of the most consumed tropical fruits in the world and the most economically important fruit in the Anacardiaceae family [1]; [2]. The high nutritional value, flavour and attractive colours and fragrance of mango fruits juice have placed mango in a popular position as an important source of food and income [3]; [4]. In this same line of thought, [5] submitted that mango isone of the most extensively exploited fruits for food, juice, flavor, fragrance and color worldwide. All over the world, mango is consumed both as fresh fruits and processed products [6]. The good nutritional values of mango fruits, particularly vitamins A and C, dietary fibre and carbohydratess, has been recognized [7]; [8]; [9]; [10]. [11] reported that the fruits of all mango accessions are better sources of vitamin A than orange fruits.

Although indigenous to the Indian subcontinent and Southeast Asia [12], it is now cultivated in many tropical regions and widely distributed in the world [13]. It was reported that mango ranks second only to banana both in production volume and quality among internationally traded tropical fruits, and fifth in production volume among major fruit crops worldwide, withIndia ranking first among the world's producing countries and Nigeria ranking 8th [14]; [15]; [16]. Other prominent mango producing countries include China, Thailand, Mexico, Pakistan, Indonesia, Philippines and Nigeria [17]. Back home in Nigeria, [18] listed mango producing states to include Benue, Jigawa, Plateau, Kebbi, Niger, Kaduna, Kano, Bauchi, Sokoto, Adamawa Taraba and the Federal Capital Territory (FCT) with Benue considered the highest producer. These authors, perhaps, did not know that Southeast states of Nigeria (particularly Ebonyi) shear boundary with Benue State, and is also as good as Benue in mango production. The food and Agricultural Organization [19] has earlier listed the zone as one of the major producing areas in Nigeria.

The study area, Ebonyi State, is geographical located between latitude6° 15' 00" and longitude 8° 05' 00" E.Fig. 1 shows the map of the state where the mango samples were collected. A wide range of mango accessions are grown practically all over the State. Like other states of Nigeria, mango is abundant only in about a quarter of the year (April-June) and losses due to absence of post harvest storage and processing facilities in the area are generally a major challenges. At the moment, information on the nutrient profiles of the fruit of various mango accessions grown and consumed in the state is lacking, particularly the amino acid profile composition. Most studies on the nutrient composition of mango and many other fruits in Nigeria often places emphasis on the quantity of protein (crude or total protein) rather than the quality (amino acid composition). Moreover, no study has been carried out on the nutritional quality of dried mango fruit pulps. It is this need that the present studies intend to address.

MATERIALS AND METHODS

Sample collection and preparation

Fresh ripe samples of mango fruits were obtained from orchards in Ebonyi, Ikwo and Ohaukwu Local Government Areas of Ebonyi State. The fruits were randomly plucked from the trees based on visual observation of healthiness and maturity, labelled appropriately and transported in aseptic bags to the laboratory where they were washed clean in distilled water, dried with clean tissue and stored in a refrigerator to prevent spoilage. Prior to the laboratory analysis, the fruit epicarp was peeled off and the fleshy edible mesocarp (pulp) was sliced, homogenized and oven dried at 75°Cfor 24 hours [20]. The dry powder was used for the proximate and amino acid analyses.

Determination of proximate composition

The sample powder was used for proximate composition analysis based on the official method of analysis of the Association of Official Analytical Chemists (AOAC, 2000). The components determined are crude protein, crude fat, ash, crude fibre, moisture and carbohydrates, where the crude protein was calculated by multiplying the total nitrogen by a conversion factor of 6.25.

Amino acid analysis

The amino acids were determined using the Technicon Sequential Multi-Sample Amino Acid Analyzer (TSM) method [21]. For each mango sample, 0.5 g of the powdered sample was measured into a clean test tube and 1.5 ml distilled water, 2.5 ml of6N HCI and 1 ml Norleucine standard (25 µMol.) were added to hydrolyse the sample. The hydrolysis was done at 110°C for 24 hours. Tryptophan is usually destroyed by HCL at this step. After cooling, the hydrolysate was evaporated to dry residues in a vacuum evaporator and the residue was then dissolved in acetate buffer (pH 2.0) and filtered through Whatman No. 42 filter paper. The filtrate (25µl) was injected into the column cartridges of the TSM amino acid analyser for profiling of the amino acids. The concentration of each amino acid was calculated from an external standard using the area under the peak of the corresponding chromatogram and expressed in g/100g protein.

Statistical analysis

One-way analysis of variance (ANOVA) procedure of SAS software version 9.1 was used to carryout descriptive statistics in the data and detect the significance of mean difference. Differences were considered statistically significant at $P < 0.05$ and the means were grouped by the least significant difference (LSD) analysis method at 0.05 probability level.

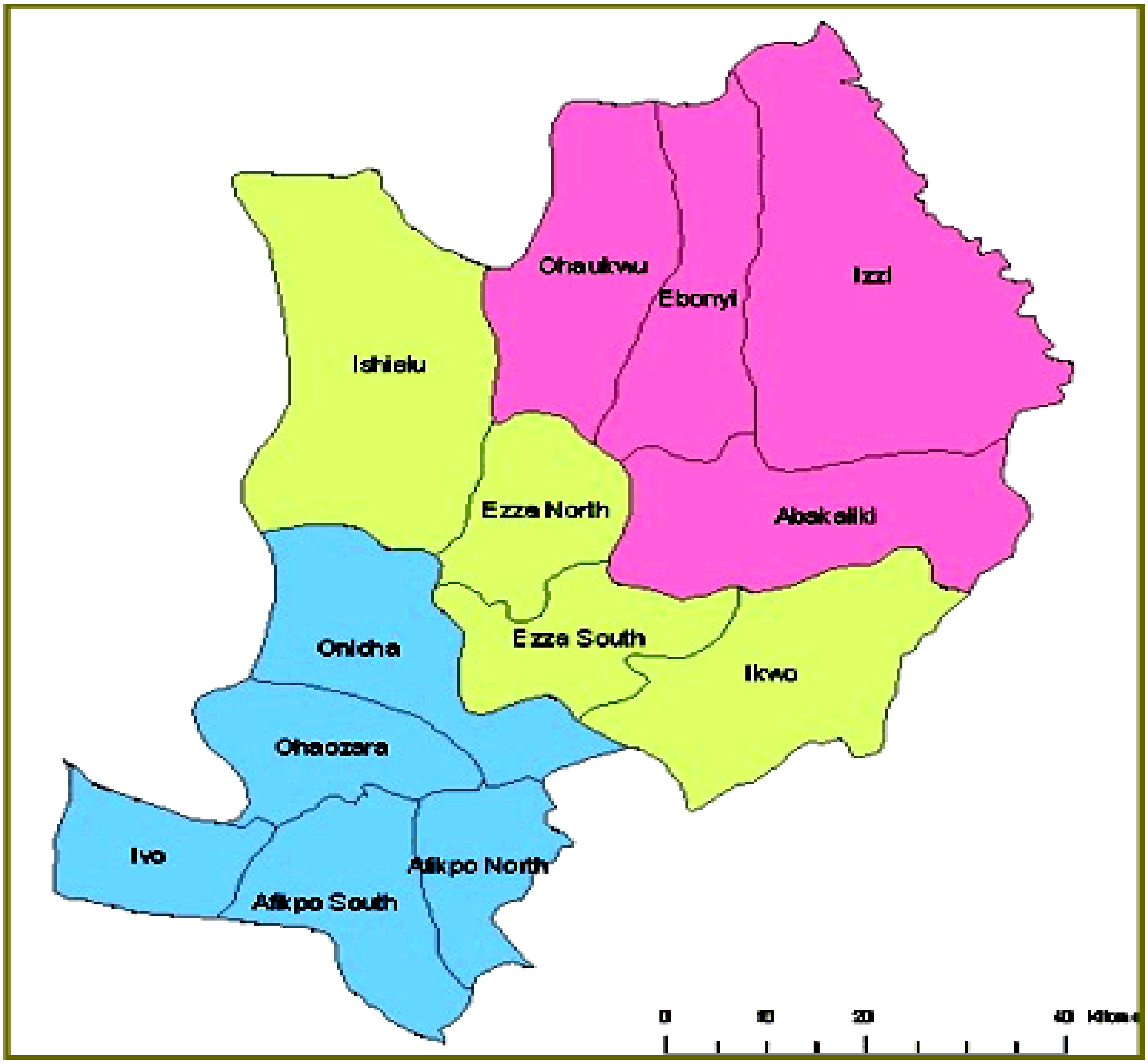

Fig. 1: Map of Ebonyi State Showing Ebonyi, Ikwo and Ohaukwu Local Government Areas where the Mango Samples were collected.

Table 1: List of Mango Samples Studied

Sample code	Local name	Source location	Fruit description
Mango 1	Ochalime	Ebonyi State College of Education orchard	Ellipsoid to ovoid in shape, smooth leathery skin, yellow colour when ripe
Mango 2	Ofaneze	Ebonyi State College of Education orchard	Ovoid in shape, spotted leathery skin, yellow when ripe
Mango 3	Ishimkpi	College of Education Ikwo orchard	Ovoid in shape, rough leathery skin, green to yellow when ripe
Mango 4	Opioro	College of Education Ikwo orchard	Oblong in shape, smooth leathery skin, yellow to orange colour when ripe
Mango 5	Small opioro	College of Education Ikwo orchard	Oblong in shape, rough skin, greenish colour with yellow tip when ripe
Mango 6	Big opioro	College of Education Ikwo orchard	Ovoid to olongoid in shape, smooth or rough leathery skin, yellow to orange colour when ripe with sweet to turpentine flavour
Mango 7	Green Hindis	College of Education Ikwo orchard	Kidney shaped, smooth leathery skin, intense yellow and slight turpentine flavour when ripe
Mango 8	Big kerosene mango	Ezzamgbo farm	Ellipsoid to ovoid in shape, smooth leathery skin, spotted yellow colour and smell of kerosene when ripe
Mango 9	Sweet opioro	Ezzamgbo farm	Obliquely ovoid to oblong in shape, smooth leathery skin, yellow to orange colour when ripe
Mango 10	Red Hindis	Ezzamgbo farm	Kidney shaped, smooth leathery skin, intense yellow to red colour and slight turpentine flavour when ripe, small seed
Mango 11	Ishimkpi	Ezzamgbo farm	Oblong in shape, rough leathery skin, greenish yellow when ripe
Mango 12	Opioro	Ezzamgbo farm	Oblong in shape, rough leathery skin, yellow to orange colour and sweet to turpentine flavour when ripe
Mango 13	Small ishimkpi	PRESCO Campus, Abakaliki	Obliquely ovoid to oblong in shape, rough leathery skin, greenish-yellow colour when ripe
Mango 14	Small kerosene mango	Ezzamgbo farm	Ellipsoid in shape, smooth leathery skin, yellowish and smell of kerosene when ripe
Mango 15	Small opioro	College of Education Ikwo orchard	Ovoid in shape, smooth leathery skin, yellowish when ripe
Mango 16	Rough opioro	College of Education Ikwo orchard	Oblong in shape, rough leathery skin, yellowish when ripe with hairs on seeds
Mango 17	Ishimkpi	College of Education Ikwo orchard	Ovoid in shape, rough leathery skin, greenish-yellow colour when ripe
Mango 18	Big kerosene (orobo)	College of Education Ikwo orchard	Ovoid to oblong in shape, smooth or rough leathery skin, green to yellow or orange colour when ripe, fruit is big with small seed
Mango 19	Bitter mango	College of Education Ikwo orchard	Ovoid in shape, smooth leathery skin, greenish-yellow and bitter when ripe and has little or no seed
Mango 20	Green mango	College of Education Ikwo orchard	Obliquely ovoid, smooth or leathery skin, greenish colour with orange coloured tip when ripe
Mango 21	German mango	College of Education Ikwo orchard	Ovoid to kidney shape, smooth leathery skin, intense yellow to orange colour with slight turpentine flavour when ripe

RESULTS AND DISCUSSION

Proximate components

Table 2 shows the mean proximate composition of the mango samples on dry weight basis in percent. The resultrevealed significant variability (P<0.05) in the chemical nutrient composition of the mango accessions available in the Abakaliki Area of Ebonyi State, Southeast Nigeria. The values indicate that the mango accessions are generally rich food resources.

The protein content ranged widely from 1.90-5.08% with an average value of 3.20%.The highest protein value detected (5.08%) is about 167% higher than the lowest value (1.90%). The highest amount of protein (5.08%) was detected in mango 6 followed by mango 3 (4.38%), while mango 18 and mango 5 recorded the least protein values of 1.90% and 2.07% respectively.Mangoes 8, 3 and 6, in and ascending order, recorded higher amounts of protein (>4.0%) while mangoes 14, 5 and 18 in a descending order, had lower amounts (<2.5%). Majority of the mangoes (15 out of 21) had protein values between 2.5 – 4.0%.These values are however much higher than 0.61 - 1.3% reported for mango pulps from Nayarit in Mexico by [22] and also higher than 1.9 – 2.8% reported for mango pulps in Limpopo, South Africa [23], but lower than 7.96 % reported for Ethiopian mango fruit pulps by [24] all on dry weight basis.

Lipid content did not vary as much as protein among the mango samples. The values ranged from 2.10-3.56% with a mean value of 2.74%.The highest value (3.56%), detected in mango 10, is about 70% higher than the lowest value (2.1%) found in mango 12. Of the 21 mango samples, 13 had lipid levels between 2.0 - 3.0% while 8 had values greater than 3.0%.These values are more than 10-fold higher than 0.2% recorded for Limpopo mango cultivars by [25]

Ash content varied more widely than protein among the mangoes, ranging from 2.07-6.83% with an average value of 3.23%. The highest value (5.83%) which was found in mango 7 is as high as182% higher than the lowest value (2.07%) recorded in mango 2.In an increasing order, mangoes 15, 4, 3 and 7 topped the list in terms of ash content with each containing >4.0% while mangoes 14, 5 and 2, in a decreasing order, had the lower values <2.2%. The values are by far higher than 0.9 – 1.02% reported by [26] for Mexican mango pulps on dry weight basis and much higher than 2.0% reported by [27], but lower than 8.5% reported by [28].

Crude fibre content is next only to carbohydrates in abundance across all the mango species. The amounts ranged from 4.81 – 7.48% with a mean value of 6.46%. The highest amount (7.48%)was recorded in mango 2 and is about 55.51% higher than the lowest amount (4.81%)which was found in mango 13.These values are very high when compared to 1.6 – 2.6% reported by [3] while Hassan [4], [5], [6] all reported complete absence of crude fibre in mango fruit juice.

Carbohydrates was found to be the most abundant chemical nutrient across all the mango samples studied, an index of high energy value of the mango fruits. The values varied from 77.75 – 83.47% with an average value of 81.08%. The result revealed lower variability among the mango species in terms of carbohydrates with the highest amount obtained (83.47%) only about 7.36% higher than the lowest value. This observation is very similar both in values and pattern to that reported by [9].

The values of all the proximate parameters reported here are relatively high owing to the drying effect on the mango pulp which invariably concentrated the chemical nutrients [11]. Although, vitamins are partially destroyed during drying [14], the drying process hadan important benefit of concentrating food nutrients and could significantly extend the shelf-life of fruits. This would allow for storage and availability of the food resource outside its season.

Table 2: Percentage Proximate Composition of Dried Fruit Pulps of Mango Accessions available in Ebonyi State, Nigeria

Sample Name	Crude Protein	Crude Fats	Ash	Crude fibre	Moisture	Carbohydrates
Mango 1	2.51±0.066^{l}	3.06±0.138^{d}	2.53±0.196^{m}	7.02±0.258^{d}	3.29±0.220^{g}	81.59±0.452^{g}
Mango 2	2.61±0.215^{k}	2.24±0.071^{hi}	2.07±0.212^{q}	7.48±0.612^{a}	3.67±0.070^{cd}	81.94±0.757^{f}
Mango 3	4.38±0.185^{b}	2.28±0.075^{h}	5.20±0.359^{b}	5.60±0.432^{j}	2.94±0.078^{i}	79.61±0.685^{n}
Mango 4	3.39±0.105^{fg}	3.28±0.145^{b}	4.35±0.356^{c}	5.35±0.301^{k}	3.33±0.252^{g}	80.29±0.969^{m}
Mango 5	2.07±0.130^{n}	3.10±0.136^{cd}	2.13±0.092^{pq}	6.53±0.315^{ef}	2.70±0.179^{l}	83.47±0.225^{a}
Mango 6	5.08±0.175^{a}	2.98±0.163^{de}	3.20±0.360^{h}	7.04±0.189^{cd}	3.94±0.082^{b}	77.75±0.329^{o}
Mango 7	3.23±0.125^{h}	2.47±0.075^{g}	5.83±0.175^{a}	6.24±0.315^{h}	3.22±0.168^{gh}	79.00±0.280^{n}
Mango 8	4.02±0.117^{c}	2.67±0.121^{f}	2.26±0.267^{o}	6.95±0.087^{d}	2.90±0.105^{i}	81.20±0.416^{h}
Mango 9	3.60±0.150^{e}	2.91±0.040^{e}	2.95±0.387^{j}	6.37±0.186^{g}	3.64±0.170^{d}	80.53±0.455^{l}
Mango 10	2.53±0.270^{l}	3.56±0.233^{a}	3.11±0.264^{i}	7.05±0.252^{cd}	2.77±0.106^{k}	80.98±0.809^{i}
Mango 11	3.28±0.299^{h}	3.04±0.104^{d}	2.68±0.494^{l}	6.60±0.297^{e}	3.20±0.155^{h}	81.20±0.963^{h}
Mango 12	2.65±0.341^{k}	2.10±0.105^{ij}	2.33±0.306^{n}	6.49±0.302^{f}	4.08±0.221^{a}	82.35±0.182^{d}
Mango 13	3.96±0.153^{c}	3.12±0.128^{c}	3.74±0.297^{e}	4.81±0.368^{l}	3.57±0.139^{e}	80.80±0.469^{j}
Mango 14	2.35±0.305^{m}	2.67±0.257^{f}	2.15±0.293^{p}	6.59±0.229^{e}	4.05±0.252^{a}	82.19±0.055^{e}
Mango 15	3.78±0.268^{d}	3.12±0.236^{c}	4.11±0.193^{d}	6.02±0.090^{i}	3.31±0.211^{g}	79.66±0.137^{n}
Mango 16	3.36±0.300^{g}	2.17±0.172^{i}	3.49±0.205^{g}	7.41±0.228^{a}	2.85±0.136^{ij}	80.73±0.256^{k}
Mango 17	2.76±0.250^{j}	2.17±0.125^{i}	3.05±0.160^{i}	7.07±0.157^{c}	3.72±0.210^{c}	81.23±0.139^{h}
Mango 18	1.90±0.155^{o}	3.15±0.150^{c}	2.80±0.224^{k}	6.27±0.245^{h}	2.69±0.085^{l}	83.19±0.061^{b}
Mango 19	3.43±0.425^{f}	2.18±0.129^{i}	3.53±0.218^{f}	7.11±0.226^{b}	2.91±0.123^{i}	80.84±0.367^{j}
Mango 20	3.55±0.304^{e}	2.90±0.095^{e}	3.77±0.246^{e}	5.39±0.262^{k}	3.47±0.201^{f}	80.93±0.336^{i}
Mango 21	2.84±0.162^{i}	2.27±0.082^{h}	2.64±0.255^{l}	6.33±0.271^{g}	2.81±0.172^{jk}	83.10±0.240^{c}
Range	*1.90-5.08*	*2.10-3.56*	*2.07-6.83*	*4.81-7.48*	*2.69-4.08*	*77.75-83.47*
Grand average	*3.20±0.801*	*2.74±0.456*	*3.23±1.018*	*6.46±0.741*	*3.29±0.462*	*81.08±1.431*

*Values are means ± standard deviations of three determinations. Means with the same letterson the same column are not significantly different at 95% confidence level.

Amino acid profile

The mean concentrations of amino acids in the protein of the dried mango pulps are presented in Table 3. The mango samples varied significantly in their contents of the amino acids ($p < 0.05$). The most abundant amino acid across all the mango accessions was glutamic acid followed by alanine, aspartic acid and lysine, while the least abundant was sulphur amino acid (methionine) followed by tyrosine and histidine. Cysteine was not detected. Glutamic acid alone accounted for between 14.48 – 16.75% of the total amino acids in the mango fruit pulp protein, alanine (the next in abundance) accounted for 8.81 – 13.77%, aspartate occupied 10.11 – 12.89% and lysine occupied 7.94 – 10.12%, whereas the limiting methionine only scored 0.94 – 1.25%. [12] also reported glutamic acid and methionine respectively as the most and least abundant amino acids in mango, though in the seeds. Similar reports have been submitted for other food resources including mushrooms [21]; [22], cowpea [23]; [24], [25]. The abundance of glutamate may be explained by its central role in amino acid metabolism, particularly in transamination reactions. Plants generally uptake inorganic nitrogenin the form of nitrate, nitrite and ammonia prior to incorporation into amino acids is ultimately reduced to ammonium, NH4. The plant enzyme, glutamine synthetase has high affinity for NH4 and uses Glutamate as substrate, powered by ATP to form glutamine. To avoid toxicity by NH4, plants may have evolved with high levels of glutaminesynthetase which means reaction furnishing Glutamate to satisfy the need is always enhanced.

With the exception of cysteine that was not detected in the mango juice and tryptophan which is usually destroyed in the acid hydrolysis step of the amino acid analysis protocolused and therefore not detected also, all the essential amino acids (histidine, isoleucine, leucine, lysine, methionine, threonine, phenylalanine and valine) were found in reasonable amounts in the juices of all the mango accessions evaluated. The values ranged from 26.04mg/100g in mango 6 to 37.17mg/100g in mango 18.Although these values fall below the standard composition in foods (49.47-51.07 g/100g protein) defined by FAO/WHO [17], these amounts of EAA are reasonably good in fruits. In this study, the essential amino acids in the mango fruits pulp proteins were ranked in order of abundance as: lysine >leucine>valine> Threonine > isoleucine >phenylalanine > histidine > methionine.The proportion of essential amino acids (EAA) in the juices ranged from 37.63 – 41.49% of the total amino acids. These values are understandably lower than 47.13 – 49.60% found in cowpea in our previous study [16].

CONCLUSION

This study has shown that the mango accessions available and consumed in Abakaliki in Ebonyi State of Nigeria are nutritionally rich as revealed by the proximate and amino acid data reported here. The study suggests that none of the accessions consistently had the highest contents of all the chemical nutrients and amino acids measured. We report here that drying of the mango fruit pulps significantly concentrated its nutrients and recommend adoption of the practice as a cheap strategy to reduce postharvest losses and increase availability of the food resource. It is interesting also to note that 16 out of the 21 mango samples (76.2%) had essential amino acid content greater than 30 mg/100g pulp protein.

Table 3: Amino Acid Profile of Dried Fruit Pulps of Mango Accessions available in Ebonyi State, Nigeria (in g/100g protein)

Mango Accession	Lysine	Histidine	Arginine	Aspartic Acid	Threonine	Serine	Glutamic Acid	Prolin
Mango 1	6.96±0.057^{l}	2.24±0.042^{f}	3.58±0.057^{g}	8.58±0.106^{i}	3.32±0.078^{l}	3.82±0.106^{i}	12.69±0.163^{g}	3.00±
Mango 2	7.33±0.057^{k}	2.27±0.084^{f}	3.67±0.064^{f}	9.22±0.304^{b}	3.45±0.042^{k}	4.20±0.134^{g}	13.18±0.212^{c}	3.16±
Mango 3	8.90±0.099^{a}	2.57±0.071^{b}	4.01±0.184^{b}	9.25±0.092^{b}	4.22±0.106^{c}	4.90±0.134^{b}	13.29±0.269^{b}	3.92±
Mango 4	8.35±0.035^{f}	2.35±0.071^{e}	3.80±0.000^{d}	8.62±0.040^{i}	3.84±0.078^{fg}	4.79±0.021^{c}	12.69±0.269^{g}	3.46±
Mango 5	5.96±0.057^{o}	2.10±0.156^{g}	3.20±0.120^{j}	8.92±0.113^{e}	3.21±0.078^{m}	3.44±0.198^{k}	10.15±0.212^{n}	2.65±
Mango 6	8.95±0.078^{a}	2.70±0.021^{a}	4.36±0.057^{a}	9.60±0.156^{a}	4.42±0.156^{a}	4.98±0.057^{a}	13.41±0.106^{a}	3.77±
Mango 7	8.02±0.113^{g}	2.46±0.042^{c}	3.80±0.000^{d}	8.55±0.064^{ij}	3.80±0.021^{g}	4.75±0.078^{cd}	12.77±0.163^{f}	3.56±
Mango 8	8.74±0.014^{b}	2.53±0.092^{b}	4.02±0.064^{b}	9.05±0.064^{d}	4.09±0.163^{d}	4.90±0.021^{b}	13.03±0.212^{d}	3.87±
Mango 9	8.62±0.035^{c}	2.51±0.021^{bc}	3.67±0.304^{f}	9.12±0.170^{c}	3.88±0.021^{f}	4.83±0.078^{bc}	12.88±0.000^{e}	3.82±
Mango 10	6.42±0.134^{m}	2.41±0.156^{d}	3.54±0.127^{g}	8.66±0.219^{hi}	3.09±0.156^{n}	3.68±0.092^{j}	11.59±0.424^{l}	2.65±
Mango 11	7.84±0.071^{i}	2.37±0.042^{e}	3.72±0.120^{e}	8.80±0.113^{fg}	3.75±0.071^{h}	4.68±0.099^{e}	12.13±0.205^{j}	3.60±
Mango 12	7.16±0.042^{kl}	2.24±0.085^{f}	3.41±0.304^{i}	8.78±0.127^{g}	3.52±0.141^{j}	3.95±0.057^{h}	12.76±0.269^{f}	6.20±
Mango 13	8.78±0.042^{b}	2.50±0.135^{bc}	4.06±0.120^{b}	9.17±0.064^{bc}	4.28±0.042^{b}	4.50±0.424^{f}	13.41±0.106^{a}	3.62±
Mango 14	6.14±0.191^{n}	2.15±0.092^{g}	3.41±0.057^{i}	8.78±0.834^{g}	3.09±0.156^{n}	3.35±0.212^{l}	11.40±0.269^{m}	2.80±
Mango 15	8.59±0.156^{d}	2.54±0.071^{b}	3.93±0.064^{c}	8.69±0.262^{h}	3.98±0.035^{e}	4.97±0.035^{a}	12.73±0.106^{fg}	3.82±
Mango 16	7.51±0.071^{j}	2.29±0.021^{f}	3.67±0.064^{f}	8.61±0.064^{i}	3.65±0.078^{i}	4.45±0.078^{f}	11.89±0.000^{k}	3.31±
Mango 17	6.66±0.212^{m}	2.26±0.021^{f}	3.67±0.184^{f}	8.84±0.226^{f}	3.25±0.092^{m}	3.86±0.078^{i}	12.46±0.375^{h}	2.90±
Mango 18	5.46±0.07^{o}	2.13±0.071^{g}	3.20±0.120^{j}	8.86±0.332^{f}	3.12±0.113^{n}	3.09±0.156^{m}	10.15±0.212^{n}	2.44±
Mango 19	8.46±0.120^{e}	2.48±0.021^{c}	3.80±0.000^{d}	8.59±0.042^{i}	4.11±0.042^{d}	4.84±0.057^{bc}	12.76±0.057^{f}	3.66±
Mango 20	7.92±0.035^{h}	2.43±0.042^{cd}	3.63±0.247^{f}	9.11±0.148^{c}	3.80±0.064^{g}	4.72±0.071^{d}	12.24±0.587^{i}	3.46±
Mango 21	7.35±0.078^{k}	2.24±0.134^{f}	3.50±0.177^{h}	8.47±0.134^{k}	3.56±0.042^{j}	4.46±0.057^{f}	12.27±0.212^{i}	3.36±
Range	*5.46-8.95*	*2.10-2.70*	*3.20-4.36*	*8.47-9.60*	*3.09-4.42*	*3.09-4.98*	*12.69-13.41*	*2.44-*
Grand Average	*7.62±1.045*	*2.37±0.170*	*3.69±0.299*	*8.87±0.337*	*3.68±0.413*	*4.34±0.595*	*12.37±0.924*	*3.48±*

Table 3 Continued

Mango Accession	Glycine	Alanine	Valine	Methionine	Isoleucine	Leucine	Tyrosine	Phenyl
Mango 1	3.76±0.113^{g}	9.65±0.212^{k}	5.50±0.283^{b}	0.83±0.092^{c}	3.71±0.141^{c}	5.97±0.247^{d}	1.83±0.113^{e}	3.00±0
Mango 2	3.96±0.170^{e}	6.94±3.302^{o}	4.71±0.262^{g}	0.89±0.000^{b}	3.71±0.141^{c}	6.61±0.156^{b}	1.99±0.106^{d}	3.46±0
Mango 3	4.47±0.134^{b}	11.06±0.106^{b}	5.55±0.191^{b}	1.02±0.106^{a}	3.87±0.085^{b}	6.83±0.078^{a}	2.07±0.219^{c}	3.50±0
Mango 4	4.04±0.064^{d}	10.16±0.184^{i}	4.79±0.099^{f}	1.04±0.071^{a}	3.87±0.085^{b}	6.28±0.156^{c}	2.07±0.219^{c}	3.25±0
Mango 5	3.56±0.000^{i}	9.46±0.163^{l}	4.01±0.424^{k}	0.76±0.000^{d}	2.54±0.445^{i}	5.25±0.191^{h}	1.83±0.113^{e}	3.08±0
Mango 6	4.62±0.035^{a}	11.25±0.106^{a}	5.78±0.106^{a}	1.06±0.092^{a}	3.97±0.049^{a}	6.77±0.156^{a}	2.14±0.113^{b}	3.54±0
Mango 7	3.93±0.085^{e}	10.66±0.516^{e}	5.31±0.071^{c}	0.99±0.042^{a}	3.95±0.071^{a}	6.01±0.156^{d}	2.22±0.000^{a}	3.46±0
Mango 8	4.40±0.106^{b}	10.85±0.163^{c}	5.48±0.120^{b}	0.94±0.071^{ab}	3.95±0.021^{a}	6.62±0.099^{b}	2.07±0.212^{c}	3.63±0
Mango 9	3.77±0.170^{fg}	10.45±0.431^{f}	5.14±0.226^{d}	0.93±0.021^{b}	3.94±0.092^{a}	6.01±0.156^{d}	2.14±0.113^{b}	3.46±0
Mango 10	3.64±0.085^{h}	10.32±0.460^{g}	4.35±0.658^{i}	0.72±0.021^{d}	3.08±0.049^{g}	5.71±0.000^{f}	1.99±0.106^{d}	3.08±0
Mango 11	3.75±0.071^{g}	10.25±0.573^{gh}	4.83±0.021^{f}	0.86±0.042^{bc}	3.91±0.134^{ab}	5.85±0.240^{de}	2.07±0.219^{c}	3.59±0
Mango 12	3.82±0.170^{f}	10.29±0.269^{g}	4.42±0.262^{hi}	0.89±0.078^{b}	3.43±0.092^{d}	6.00±0.134^{d}	1.99±0.106^{d}	3.25±0

Mango 13	4.46±0.050^{b}	10.75±0.156^{d}	5.53±0.127^{b}	0.94±0.071^{ab}	3.81±0.177^{bc}	6.64±0.120^{b}	1.83±0.113^{e}	3.59±0
Mango 14	3.80±0.134^{f}	9.84±0.269^{j}	4.17±0.163^{j}	0.76±0.035^{d}	3.20±0.269^{f}	5.72±0.170^{f}	2.07±0.219^{c}	2.96±0
Mango 15	3.94±0.071^{e}	10.83±0.050^{c}	5.00±0.149^{e}	1.01±0.092^{a}	3.71±0.141^{c}	6.57±0.099^{b}	2.22±0.000^{a}	3.41±0
Mango 16	2.57±2.249^{j}	9.67±0.403^{k}	4.46±0.085^{h}	0.85±0.092^{bc}	3.82±0.113^{bc}	5.75±0.212^{f}	2.07±0.219^{c}	3.46±0
Mango 17	3.70±0.141^{gh}	9.30±0.318^{n}	4.71±0.714^{g}	0.72±0.092^{d}	3.33±0.042^{e}	5.73±0.290^{f}	1.75±0.226^{f}	2.96±0
Mango 18	3.65±0.071^{h}	9.46±0.269^{l}	3.42±0.163^{l}	0.75±0.092^{d}	2.72±0.247^{h}	5.42±0.325^{g}	1.83±0.113^{e}	3.04±0
Mango 19	4.30±0.141^{c}	10.34±0.644^{g}	4.84±0.205^{f}	0.86±0.042^{bc}	3.81±0.134^{bc}	5.86±0.255^{de}	1.99±0.106^{d}	3.59±0
Mango 20	3.80±0.064^{f}	10.75±0.156^{d}	4.73±0.184^{g}	0.82±0.099^{c}	3.94±0.092^{a}	5.90±0.156^{d}	2.14±0.113^{b}	3.63±0
Mango 21	3.92±0.106^{e}	9.38±0.481^{m}	4.46±0.085^{h}	0.92±0.035^{b}	3.91±0.134^{ab}	5.70±0.290^{f}	1.99±0.113^{d}	3.34±0
Range	*2.57-4.62*	*6.94-11.25*	*3.42-5.78*	*0.72-1.06*	*2.54-3.97*	*5.25-6.83*	*1.75-2.22*	*2.96-3.*
Grand Average	*3.90±0.557*	*10.08±1.077*	*4.82±0.616*	*0.88±0.116*	*3.62±0.431*	*6.06±0.469*	*2.01±0.171*	*3.34±0*

*Values are means ± standard deviations of two determinations. Means with the same lettersin the same column are not significantly different at 95% confidence level. Cysteine was not detected

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