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Comparative Analysis of the Nutritional and Anti-nutritional Compositions of Mango (*Mangifera indica*), Pawpaw (*Carica papaya*) and Pineapple (*Ananas comosus*) Sold in Lafia Modern Market, Nigeria

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Abstract

The study examined the nutritional and anti–nutritional compositions of mango, pawpaw and pineapple using standard analytical techniques. The result of proximate composition showed that mango has higher fat, ash, crude fibre, moisture, carbohydrate, fatty acid and energy contents than pawpaw and pineapple, while pawpaw has a higher crude protein value than mango and pineapple. The antinutrient composition of the samples revealed that pineapple has higher oxalate, alkaloids, tannins and phytate than mango and pawpaw. The results of amino acid composition revealed that Leucine was the most concentrated essential amino acid (EAA) in mango, pawpaw and pineapple, with the values of 4, 61, 5.02 and 5.60 g/100g cp, respectively. It was also found that Tryptophan was the least concentrated essential amino acid in the three samples with a value of 0.84, 0.92 and 0.63 g/l00g in mango, pawpaw and pineapple, respectively. The calculated isoelectric points (pI) for mango, pawpaw and pineapple fruits were 6.09, 6.83 and 5.97, respectively. The P–PER values were 1.83, 1.67, and 1.80 for the mango, pawpaw and pineapple fruit samples, respectively. The study revealed that the three fruits were good sources of nutrients needed by the body and were low in anti-nutrients. Their consumption is highly recommended.

Keywords: Anti-nutrients, mango, nutrients, pawpaw, pineapple

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Introduction

Fruits are one of nature's most nutrient-rich and health-promoting food groups, playing a critical role in the human diet by providing essential vitamins, minerals, fibre, and bioactive compounds. Globally, nutrition and public health experts emphasize fruit consumption as a cornerstone of dietary recommendations for maintaining good health and preventing chronic diseases [1]. Fruits not only provide energy in the form of natural sugars but also serve as excellent sources of phytochemicals and antioxidants, which help combat oxidative stress and reduce the risk of non-communicable diseases such as cardiovascular disease, type 2 diabetes and certain cancers [2].

In Nigeria, fruit consumption is widespread due to the country's favourable tropical climate, which supports the cultivation of a wide variety of fruits. Among the most consumed are mango (*Mangifera indica*), pawpaw (*Carica papaya*), and pineapple (*Ananas comosus*). These fruits are abundant in local markets, especially during their respective peak seasons, and are popular due to their sweet taste, ease of accessibility, and high nutritional value. Their popularity is evident in markets across Nigeria, including the Lafia Modern Market in Nasarawa State, where these fruits are sold fresh to meet the dietary needs of the local population. Despite their wide availability and regular consumption, there remains limited localized scientific data on the comparative nutritional composition of these fruits as sold in Nigerian markets. The nutritional content of fruits can vary significantly depending on several factors, including geographic origin, soil type, climatic conditions, stage of ripeness at harvest, post-harvest handling, and storage methods [3]. Therefore, it is essential to evaluate the nutritional profile of fruits within specific local contexts to provide accurate and reliable information to consumers and public health stakeholders.

Specifically, this study examines the proximate, anti-nutrients and amino acid composition of mango, pawpaw and pineapple. The findings will contribute to the existing body of knowledge on the quantities and qualities of the nutrients and anti–nutrient composition of the fruits.

Materials and Methods

Sample collection and preparation

The three fruit samples: Mango (*Mangifera indica*), pawpaw (*Carica papaya*) and pineapple (*Ananas comosus*) were bought from different vendors in Lafia Modern Market. The fruits were identified by the Department of Agronomy, Faculty of Agriculture, Nasarawa State University, Keffi. The samples were cleaned using tap water, peeled and then sliced into smaller pieces for easy drying. Thereafter, the samples were dried in an oven at 110°C. The samples were then ground into fine powder using a pestle and mortar and stored in a cool, dry container before analysis. The method of preparing the samples adopted in the study follows the approach used in Eze and Obinwa [4].

Proximate analysis
The proximate analyses of the samples for moisture, crude fat, crude fibre, and total ash were carried out in triplicate according to the methods of the Association of Official Analytical Chemists [5]. Nitrogen was determined by the micro–Kjeldahl method, and the percentage of nitrogen converted to crude protein was calculated by multiplying by 6.25. The total carbohydrate content was determined by the difference method [5].

Anti-nutrient content determination
The contents of oxalate, saponins, alkaloids, flavonoids, tannins, cyanide, phytate, and total phenols were determined on each of the samples by the methods described by Eze and Obinwa [4].

Amino acid analysis
The amino acid analysis was carried out by Ion Exchange Chromatography (IEC) [6] using the Technico Sequential Multisample (TSM) Amino Acid Analyzer (Technicon Instruments Corporation, New York). The period of analysis was 76 min for each sample. The gas flow rate was 0.50 ml min^{-1} at 60 ^{o}C with reproducibility consistent within ± 3%. The net height of each peak produced by the chart recorder of the TSM (each representing an amino acid) was measured and calculated. Amino acid values reported were the averages of two determinations. Nor–leucine was the internal standard. Tryptophan was determined after alkali (NaOH) hydrolysis by the colourimetric method.

Determination of Isoelectric Point (pI), Quality of Dietary Protein and Predicted Protein Efficiency Ratio (P–PER)
The predicted isoelectric point was calculated using the method described by Olaofe and Akintayo [7]. To calculate the isoelectric points of the samples, the formula in equation (1) was used.

$$\text{pIm}=\sum_{i=1}^{n=1} pIiXi \qquad (1)$$

Where:
pIm = The isoelectric point of the mixture of amino acids.
pIi = The isoelectric point of the i^{th} amino acid in the mixture.
Xi = The mass or mole fraction of the amino acids in the mixture.

The quality of dietary protein was measured by finding the ratio of available amino acids in the sample protein compared with the needs expressed as a ratio. Amino acid score (AAS) was then estimated by applying the FAO/WHO [6] formula:

$$\text{AAS}=\frac{mg\ of\ amino\ acid\ in\ 1\,g\ of\ test\ protein}{mg\ of\ amino\ acid\ in\ 1\,g\ reference\ protein}\times 100 \qquad (2)$$

The Predicted Protein Efficiency Ratio (P–PER) of the samples was calculated from their amino acid composition based on Alsmeyer *et al*. [8] equation as stated in equation (3):

$$\text{P–PER}=-0.468+0.454(\text{Leucine})-0.105(\text{Tyrosine}) \qquad (3)$$

Comparative analysis of the nutritional and anti-nutritional compositions of

Statistical analysis
The carbohydrate content was determined by subtracting the values of all other proximate parameters from 100. The fatty acid and energy values were calculated by the formulas (0.8 x crude fat) and (protein x 17 + fat x 37 + carbohydrate x 17), respectively. All analyses were carried out in triplicate, and data were presented as mean ± standard deviation. The mean, standard deviation and coefficient of variation were determined using Microsoft Excel.

Results and Discussion

Proximate composition of mango, pawpaw and pineapple
The proximate composition of the samples is shown in Table 1. Generally, mango shows a higher proximate profile than the other two samples. The coefficient of variation per cent (CV%) ranged from 6.05% in crude protein to 100% in crude fibre content.
Table 1 shows that the fruits are high in carbohydrate content and can therefore serve as good sources of energy, providing the body with accessible fuel needed for daily activities. The carbohydrate contents of 49.54, 29.67 and 23.79% in mango, pawpaw and pineapple, respectively, were higher than the reported values of 18.26% (pawpaw) and 12.06% (pineapple) by Ekpete *et al*. [9]. The study also indicates that mango has the highest energy value (1090.21 kJ/100g) and fatty acid (4.84%), while pineapple has the lowest energy value (638.69 kJ/100 g). The calorific (energy) values of these fruits were low compared with 10,000 kJ daily energy expenditure [10]. Fibre helps in the maintenance of human health and has been known to reduce cholesterol levels in the body. In this study, mango has the highest fibre content of 20.24% while pineapple has the lowest value of 2.47%. The fibre content is within the range of 1.2 – 23.8% reported for some common fruits [11]. High fibre foods expand the inside wall of the colon, causing the passage of waste, thus making it an effective anti-constipation. Fibre also reduces the risk of bowel diseases and improves the general health and well-being of individuals [12].
Proteins are essential nutrients for the human body; they are one of the building blocks of body tissue, therefore serving as a fuel source. The protein content of the fruit samples is generally low, with pawpaw having the highest crude protein content of 9.55%, followed by pineapple (8.68%), and then mango (8.54%), which was the lowest. The protein content in this report was lower than the 12.8% reported by Ajenu *et al.* [11]. It was reported that fruits are generally low in protein and mineral constituents but could serve as a

reliable source of these nutrients when taken in adequate quantities [2]. The ash content of the fruits ranged from 2.67% in pineapple to 9.09% in mango. Ash content provides a measure of the total amount of minerals within a food. The ash content in this work compares well with the report of 1.0 – 9.6% in some fruits [11]. Mango has the highest fat content of 6.05%, followed by pineapple (5.19%) and pawpaw (3.41%). The three fruit samples have low fat content. The low-fat content agrees with a study by Champagne *et al.* [13]. Fruits are generally low in fat content and hence are usually recommended in weight-reducing diets. The moisture content in this study ranges from 4.68% in pineapple to 5.62% in mango, showing that mango had the highest moisture content among the studied fruits. However, this value was lower than 8.4% in the pulp of *I. gabonensis* [14] and 16.3% obtained for pawpaw [11]. The lower moisture values in this study are desired as this tends to increase their shelf life and make them less susceptible to microbial contamination. High moisture content in fruits is an index of their water activity, a measure of stability and susceptibility to microbial contamination [15].

Table 1: Proximate composition of mango, pawpaw and pineapple (%)

Parameter	Mango	Pawpaw	Pineapple	Mean	SD	CV(%)
Crude Protein	8.54±0.05	9.55±0.5	8.68±0.40	8.92	0.54	6.05
Fat	6.05±0.04	3.41±0.05	5.19±0.01	4.88	1.35	27.66
Ash	9.09±0.06	5.66±0.04	2.67±0.01	5.80	3.21	55.34
Crude fibre	20.24±0.17	5.62±0.12	2.47±0.03	9.44	9.84	100
Moisture	5.62±0.04	5.42±0.02	4.68±0.03	5.24	0.50	8.62
Carbohydrate	49.54±0.24	29.67±0.15	23.79±0.58	34.30	19.13	55.77
Fatty acid	4.84±0.04	2.73±0.05	4.20±0.01	3.92	1.08	27.55
Energy (KJ/100g)	1090.21	724.71	638.69	817.87	239.75	29.31

*Values are mean ± standard deviation of triplicate determinations; SD = standard deviation; CV = Coefficient of variation; Calculated fatty acid (0.8 x crude fat); Calculated energy (protein x 17 + fat x 37 + carbohydrate x 17)

Table 2: Anti-nutrient composition of mango, pawpaw and pineapple

Parameter	Mango	Pawpaw	Pineapple	Mean	SD	CV(%)
Oxalate (%)	6.64±0.04	4.59±0.10	14.38±0.81	8.53	5.16	60.50
Saponin (%)	0.08±0.04	0.11±0.01	0.11±0.11	0.08	0.03	37.50
Alkaloids (%)	8.23±0.14	9.21±0.04	11.03±0.30	9.48	1.42	14.97
Flavonoid (%)	15.59±0.22	13.46±0.22	7.88±0.04	12.28	3.94	32.08
Tannins (%)	4.33±0.03	6.39±0.10	13.28±0.05	8.00	4.68	58.50
Cyanide (%)	0.63±0.02	0.58±0.02	0.35±0.02	0.52	0.15	29.13
Phenol (%)	0.43±0.01	0.33±0.01	0.07±0.01	0.31	0.26	83.87
Phytate (mg/100 g)	216.20±0.42	230.98±0.60	552.83±3.50	333.34	155.32	46.59

*Values are mean ± standard deviation of triplicate determinations; SD = standard deviation; CV = Coefficient of variation.

Anti-nutrient composition of mango, pawpaw and pineapple

Table 2 shows the anti-nutrient composition of the three fruit samples studied. The coefficient of variation per cent (CV%) ranges from 14.97% in alkaloids to 83.87% in phenols. This shows that phenols were the most varied parameter, while alkaloids were the least varied parameter.

Anti-nutritional factors are those substances or chemical compounds found in fruits and food substances in general, and they are known to interfere with metabolic processes, such that growth and bioavailability of nutrients are negatively influenced [16]. However, some of these anti–nutrients (especially flavonoids, alkaloids and phenols) have been found to have protection against some diseases [17] and also confirmed that ripening could also be a way of reducing anti–nutrients in fruit samples [18]. Table 2 also shows flavonoids as the highest anti-nutrient content in mango (15.59 %) and pawpaw (13.46%), and oxalate as the highest in pineapple (14.38%). The flavonoid contents in this study were higher than 0.373 and 0.433% of the leaves and fruits of *Nauclea latifolia* [4], and 3.15% of the pulp of *I. gabonensis* [19]. Flavonoids are super antioxidants and free radical scavengers which prevent oxidative cell damage caused by free radicals. In this way, they prevent chronic diseases such as cancer [20]. The high flavonoid levels in this study imply that both mango and pawpaw were good sources of dietary antioxidants. The cyanide values in this study were slightly higher than the values of 168.97 and 92.70 mg/100 g in the leaves and fruits of *N. latifolia* [4]. However, the cyanide content in the current study is quite lower than the threshold level of 60 mg per day in adults [21]. The alkaloid contents of the samples range from 8.23-11.03% with pineapple having the highest value (11.03%). This value is higher than 8.03 % in *I. gabonesis* [19]. The higher value in this study is desired because alkaloids seem to be the most significant and efficient phytochemical in terms of therapeutic use [10]. The samples contain an appreciable amount of phenol, which ranged from 0.07% in pineapple to 0.43% in mango. This makes them a source of dietary phenols. Saponins reduce the uptake of certain nutrients, including glucose and cholesterol, in the gut through intraluminal physicochemical interaction [22]. Generally, the saponin content in the samples is low, with mango having the lowest value (0.08%) and pawpaw and pineapple having the highest value (0.11%). Phytates reduce the bioavailability of minerals such as zinc, iron, copper, and manganese, but in lower concentrations, they can suppress colon cancer, control dental cavities and lower blood glucose [4]. Pineapple has the highest phytate level (552.83 mg/100g), followed by pawpaw (230.98 mg/100g), while mango has the lowest value (216.20 mg/100g). The phytate levels are lower compared to 0.423 and 0.377% in the leaves and fruits of *N. latifolia* [4] but higher than 7.89 mg/100g reported by Ekissi *et al*. [18]. Pineapple has the highest oxalate value (14.38%), followed by mango (6.64 %) and the pawpaw (4.59%). The oxalate levels in this study are higher than those reported by Ekissi *et al*. [18]. Tannins in fruits impose an astringent taste that affects palatability, reduces food intake, and consequently body growth as well as protein utilization [23]. The tannin contents in this study range from 4.33% in mango to 13.28% in pineapple. The high Tannis content in pineapple may be responsible for its sour taste, especially when not fully ripe.

Amino acid composition of mango, pawpaw and pineapple

The result of the amino acid composition of the samples is presented in Table 4. The Table reveals eighteen amino acids in the studied samples. The amino acid contents are generally higher in the pawpaw fruit, followed by pineapple and then mango. The coefficient of variation, as shown in Table 3, ranges from 6.2% in proline to 25.4% in glutamic acid.

Table 3: Amino acid concentration (g/100g crude protein) in mango, pawpaw and pineapple

Parameter	Mango	Pawpaw	Pineapple	Mean	SD	CV(%)
Leucine (Leu)*	4.61	5.02	5.60	5.08	0.5	9.8
Lysine (Lys)*	3.58	4.33	3.58	3.97	0.4	10.2
Isoleucine(Ile)*	3.01	3.27	2.86	3.05	0.2	6.6
Phenylalanine(Phe)*	2.57	3.19	2.02	2.59	0.5	10.2
Tryptophan(Try)*	0.84	0.92	0.63	0.79	0.2	25.0
Valine(Val)*	3.42	4.01	3.47	3.63	0.3	7.7
Methionine(Met)*	3.54	2.16	1.71	2.47	0.8	15.7
Proline(Pro)*	3.05	3.45	3.25	3.25	0.2	6.2
Arginine(Arg)	3.36	4.82	3.53	3.90	0.8	20.2
Tyrosine(Tyr)	2.24	2.27	2.87	2.46	0.3	12.2
Histidine(His)*	1.60	2.24	2.17	1.97	0.3	15.2
Cysteine (Cys)	0.30	0.54	0.46	0.44	0.1	22.7
Alanine (Ala)	3.11	2.92	3.30	3.11	0.3	9.6
Glutamic acid(Glu)	4.07	6.91	5.60	5.53	1.4	25.4
Glycine (Gly)	2.33	2.71	2.54	2.53	0.2	6.7
Threonine (Thr)*	2.42	3.16	2.64	2.74	0.4	13.4
Serine(Ser)	2.81	3.55	2.96	2.77	0.5	18.05
Aspartic acid (Asp)	6.63	6.67	5.26	6.19	0.7	12.0
P-PER	1.83	1.67	1.80	1.554	0.12	7.72
Leu/Ile	1.53	1.54	1.96	1.67	0.27	16.2
Isoelectric point (pI)	6.09	6.83	5.97	6.04	0.5	8.3

*Essential amino acids; P-PER= Predicted protein efficiency ratio; SD = standard deviation; CV = Coefficient of variation

In Table 3, glutamic acid (Glu) was found to be the most highly concentrated non-essential amino acid (6.91 and 5.60 g/100g cp) in pawpaw and pineapple samples, respectively, while aspartic acid is the most concentrated non-essential amino acid (6.63 g/100g crude protein) in the mango sample. The value in this study is in conformity with 6.66 g/100g crude protein reported for pulp of *I. gabonesis* [19]. Glutamic acid acts as a fuel for the brain and helps to recover the body's physiological imbalances. It is also a good neurotransmitter and may help lower blood pressure levels [24]. The current study finds that glutamic and aspartic acids are the most abundant amino acids in the three samples, which is in accordance with the observations of some researchers [25, 26]. Leucine constituted the highest single essential amino acid (EAA) in the mango, pawpaw and pineapple fruit samples, respectively (4, 61, 5.02 and 5.60 g/100g cp). Leucine, with isoleucine and valine, play very important roles in promoting muscle function, bones, and skin [27].

Tryptophan is the least concentrated essential amino acid in the three samples, with a value of 0.84, 0.92 and 0.63 in mango, pawpaw and pineapple, respectively, while Cysteine is the least concentrated non-essential amino acid in the mango (0.30), pawpaw (0.54) and pineapple (0.46) samples, respectively. Tryptophan helps maintain nitrogen stability and regulates appetite, sleep and mood, while cystine is used for the synthesis of protein and is also a precursor of pyruvate and taurine [24]. The calculated isoelectric points (pI) for mango, pawpaw and pineapple fruits are 6.09, 6.83 and 5.97, respectively. This is useful in predicting the pI for a protein to enhance the quick precipitation of protein isolate from biological samples [28]. The isoelectric points from the current study are greater than 5.18 in the pulp of *A. digitata* [26]. The predicted protein efficiency ratio (P–PER) is one of the quality parameters used for protein evaluation [16]. The P – PER values are 1.83, 1.67 and 1.80 for the mango, pawpaw and pineapple fruit samples, respectively. The P–PER values in this study compare well with values of 1.10 and 1.47 reported for the pulp and seed of *A. digitata* [26]. The Leu/Ile ratios in this study are 1.53 (mango), 1.54 (pawpaw) and 1.96 (pineapple). The Leu/Ile ratios in the samples are within the range reported in the pulp (1.49) and seed (1.86) of *A. digitata* [26].

Classification of amino acid compositions of mango, pawpaw and pineapple into acidic, basic, neutral, and sulphur-containing amino acids

Table 4 reveals the highest total amino acid (TAA) of 62.14 in pawpaw, followed by 54.48 in pineapple and then 53.47 in mango. The percentage TEAA contents with His for the samples are 53.53, 51.09 and 51.30 in the mango, pawpaw and pineapple samples, respectively. These values are far greater than the 39% considered to be adequate for ideal protein food for infants, 26% for children and 11% for adults [29]. They are also greater than the reported values of 50% in egg

[6]. Histidine is important for the synthesis of red and white blood cells. It is a precursor for histamine, which is good for sexual arousal and improved blood flow [30]. The concentrations of total sulphur amino acids (TSAA) with the values of 3.82 (mango), 3.15 (pawpaw), and 2.17 (pineapple) g/100g crude protein are lower than the 5.8 g/100 g cp recommended for infants [29]. The % cystine in TSAA is 7.85, 17.14 and 21.19% for mango, pawpaw and pineapple, respectively. The essential aromatic acids (EArAA) values of 2.57(mango), 3.19(pawpaw) and 2.02(pineapple) g/100 g cp are lower than the ideal range suggested for infant protein (6.8 – 11.8 g/100 g cp) [29]. The total acidic amino acids (TAAAs) of 10.70, 13.58, and 10.86 g/100 g cp in the mango, pawpaw and pineapple, respectively, are greater than the total basic amino acids (TBAAs) of 8.54 (mango), 11.36 (pawpaw) and 9.26 (pineapple) g/100g cp, indicating that these fruits are probably acidic [25]. This study reveals that the three fruit samples contained appreciable amounts of essential as well as non-essential amino acids needed in the diet. However, the concentrations are higher in the pawpaw than in the other two samples.

Table 4: Classification of amino acid composition of mango, pawpaw and pineapple

Amino Acid Description	Mango	Pawpaw	Pineapple	Mean	SD	CV (%)
Total Amino Acid (TAA)	53.47	62.14	54.48	56.71	4.70	8.31
Total Non-Essential Amino Acid (TNEAA)	24.85	30.39	26.30	27.30	2.84	10.40
%TNEAA	46.47	48.91	48.70	48.03	1.35	2.81
Total Essential Amino Acid with His	28.62	31.75	27.93	29.43	2.03	6.91
Without Histidine	27.02	29.51	25.76	27.43	1.91	6.96
%TEAA with Histidine	53.53	51.09	51.30	52.97	1.35	2.61
% TEAA Without Histidine	50.53	46.81	47.28	48.21	2.02	4.19
Essential AliphaticAmino Acid (EAAA)	13.46	15.46	14.57	14.49	1.00	0.07
Essential Aromatic amino acid (EArAA)	2.57	3.19	2.02	2.59	0.58	22.39
Total Neutral Amino Acid (TNAA)	19.24	24.97	20.14	21.45	3.08	14.35
% Total Neutral Amino Acid (%TNAA)	35.98	39.55	36.96	37.49	1.84	4.91
Total Acidic Amino Acid (TAAA)	10.70	13.58	10.86	11.71	1.62	13.83
% TAAA	20.01	21.85	19.93	20.59	1.08	5.25
Total Basic Amino Acid (TBAA)	8.54	11.36	9.26	9.72	1.46	15.02
% TBAA	15.97	18.28	16.99	17.08	1.16	6.79
Total Sulphur Amino Acid (TSAA)	3.82	3.15	2.17	3.05	0.82	26.88
% Cystine in TSAA	7.85	17.14	21.19	17.38	6.84	44.47

SD = standard deviation; CV = Coefficient of variation. His = Histidine

Table 5: Amino acid scores of mango, pawpaw and pineapple

EAA	PAAESP (g/100g)	Mango		Pawpaw		Pineapple	
		EAAC	AAS	EAAC	AAS	EAAC	AAS
Ile	4.0	3.01	0.75	3.27	0.82	2.86	0.72
Leu	7.0	4.61	0.70	5.02	0.72	5.60	0.80
Lys	5.5	3.58	0.65	4.33	0.79	3.38	0.65
Met+Cys(TSAA)	3.5	3.82	1.09	2.70	0.80	2.17	0.62
Phe+Tyr	6.0	3.41	0.60	4.11	0.70	2.65	0.44
Thr	4.0	2.42	0.61	3.16	0.79	2.64	0.66
Try	1.0	0.84	0.84	0.92	0.92	0.63	0.63
Val	5.0	3.42	0.70	4.01	0.80	3.47	0.69

AAC=Amino acid composition; PAAESP=Provisional amino acid (egg) scoring pattern; EAAC=Essential amino acid composition; AAS=Amino acid scores

Amino acid scores of mango, pawpaw and pineapple
Table 5 shows the amino acid scores of mango, pawpaw and pineapple.
Results of essential amino acids based on the provisional amino acid scoring pattern [6] standard are shown in Table 5. Generally, all the amino acid scores in this report have values less than 1.0, except for the TSAA value of mango (1.09), which is greater than 1.0. Thus, by implication, a dietary formula based on these fruit samples will require essential amino acid supplementation for all the essential amino acids based on the amino acid scoring pattern. It has been reported that EAAs most often acting in a limiting capacity are Met (and Cys), Lys and Try [29]. In this study, Phe+Tyr are the limiting essential amino acids in all the studied fruit samples.

Conclusion

The findings of the study corroborate the nutritional and anti-nutritional composition of mango, pawpaw, pineapple and other fruits investigated by previous researchers. The result of the current study shows that the three fruit samples are good sources of carbohydrates, fibre, and are low in anti–nutrients, specifically phytate and cyanide. Thus, when consumed in sufficient amounts, they could contribute to the nutritional needs and help to combat some diseases associated with a poor diet, and serve as edible fruit or a complement to food and feed materials that are limited in nutrients. However, these fruits area poor source of essential amino acids based on the provisional amino acid scoring pattern by FAO/WHO, and thus, a dietary formula based on them will require EAA supplementation for all the essential amino acids. The values obtained for phytate and oxalate are lower than the lethal dosage reported in other studies, while the toxic effect of these anti-nutrients may not occur when these fruits are consumed because their levels are not enough to elicit toxicity.

Conflict of interest: The authors have declared that there is no conflict of interest reported in this work.

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