ANTI-NUTRITIONAL AND AMINO ACID COMPOSITION OF WATER YAM-YELLOW MAIZE AND AFRICAN YAM BEAN FLOUR MIXTURES

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Abstract
Anti nutrient and amino acid composition of water yam yellow maize and African yam been flour mixture were evaluated in this study. The flour samples processing followed the standard unit operation for dry-milling prior to the determinations. Four blends of composite flours were prepared by homogenously mixing water yam flour, (WY) yellow maize flour (YM) and African yam been flour (AYB) in ratios of 30:40:30, 40:30:30, 50:20:30, 60:10:30 and 100 Anti nutrient composition results indicates that phytate content ranged from 0.44 to 1.99%; trypsin inhibitor ranged from 0.12 to 1.01%mg/100g and tannin content ranged from 0.64 to 2.09%. there were statistical (p<0.05) differences in the anti nutrient content amongst the flour samples. Sample CHM (50WY:20YM:30AYB) was significantly (p<0.05) higher than other samples. While sample EJO(100%WX) was the lowest in phytate content. Sample CHM (50%WY: 20%YM: 30%AYB) and EJO (100%WY) were significantly (P<0.05) not different from each other but were higher than all other samples in trypsin inhibitor content.
AFK (30%WY: 40%YM: 30%AYB) and sample CHM (50%WY: 20%YM: 30%AYB) were significantly (P >0.05) not different but were higher than other samples in tannin content. In terms of amino acid content sample DIN (60%WY: 10%WY: 30%AYB) was statistically (P<0.05) in most of the amino acid content than other flour samples. Glutamic acid had the highest concentration in all the flour samples. Flour sample DIN was found to be adequate for both children and adult in amino acid content with FAO/1991 reference amino acid required.

Key words: Anti nutrient, Amino acid, flour blends

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INTRODUCTION

The problem of adequate nutrition in Nigeria is much similar to those of other developing countries especially due to low protein intake which has been attributed to the increasingly high cost of animal sources such as beef, mutton, game (bush meat) and sea food. Furthermore, inadequate utilization of most plant protein sources has also contributed to the inability of most Nigerian adults and children not meeting the recommended daily allowance for protein –calorie requirement (Akinyele, 1987). This condition generally translates to widespread malnutrition which is seen more among vulnerable groups such as children, expectant, lactating mothers and individual with specific nutritional needs like sports men.

There is now a renewed interest on the utilization of plant proteins which are both cheap and are readily available for consumption (IWE and ONUH, 1992). Cereal grains contain 60 to 70% starch and are excellent energy rich food for human, Doctors recommends cereals as the first food to be added to infants diets and a healthy diet for adults should have most of its calorie I the form of complex carbohydrates such as cereal grain starch (Chandras and samber,2013). Yam (Dioscorea) belongs to *Diosco reaceae* family. They have been suggested to have nutritional superiority when compared with other tropical root crops. They are reported as good sources of essential dietary nutrients (shandari et al 2003). Earlier reports have also pointed out that a few yam species and grains contain some toxic compounds and can impact serious health complication (Anthony 2004). This health implication may be bio-unavailability of the food nutrient, vomiting and diarrhea when large amount are ingested without proper processing or if eaten raw (Webster et al., 1984).

In this study an attempt was made to understand the anti nutrient and amino acid composition of flour mixture from water yam, yellow maize and African yam bean mixture.

MATERIALS AND METHODS

The water yam was identified as TDA 297 and bought at National Root Crop Research Institute (NRCI), Umudike, Abia State, Nigeria. The yellow maize and the cream coloured African yam bean were identified and bought at National Institute of Horticulture (NIHOT) Mbato sub zone, Okigwe, Imo state. Xanthan gum (G 1253, sigma – Aldrich USA) was procured from pharmaceutical shop in Onitsha, Dangote iodized table salt was purchased from a food shop in Eke market in Afikpo, Ebonyi state, Nigeria.

Preparation of raw materials

Water yam flour

Water yam was washed, peeled manually under water containing 0.20% solution of sodium metabisulphate. Slicing of the water yam (3mm x 5mm) was done with a stainless knife, then transferred into another container of the same concentration of sodium metabisulphate and allowed for 5minutes. They sliced water yam were removed and allowed to drained for 1hour under air current and dried at 60^oC for 6 hours in a Chirana type air convention oven (HS201A). Dried chips were cooled for 2 hours at room temperature under air current and milled using Brabender roller mill (Model 3511A). The flour sample was sieved through 0.50mm mesh size, packaged and sealed in polyethylene bag for further use.

African yam bean flour

The cream colored African yam bean seeds were sorted to eliminate contaminants, cleaned in an aspirator (Model: OB 125 Bindapst Hungary) located at the Food Processing Laboratory of Federal Polytechnic, Mubi. Cleaned seeds were soaked for 1hour at room temperature. The seeds were sundried for 4 days at ($30^o \pm 2^o$ C) and milled with Brabender roller mill (Model 3511A) to pass through screen with 0.50mm openings and resulting coarse meal were re-milled into fine flour. The flour was stored in an air tight plastic container at room temperature for further use.

Yellow maize flour

The yellow maize grain were sorted, and cleaned in an aspirator (Model: OB 125 Bindapst Hungary) located at the Food Processing Laboratory of Federal Polytechnic, Mubi to eliminate contaminants. The cleaned maize grains were conditioned 40^oC for 30minutes in a stainless steel container. The seeds were sundried for 4 days at ($30^o \pm 2^o$ C) and then cracked and milled with Brabender roller mill (Model 3511A). The seed coats were removed to obtain the maize flour to pass through a screen with 0.50mm openings and resulting coarse meal were re-milled into fine flour. The flour was stored in an air tight plastic container at room temperature for further use.

Flour blending ratio

The flours from the water yam, yellow maize and African yam bean (AYB) were blended in the ratio as shown in (Table 1.) prior to preliminary study of the flour samples.

Table 1: Flour blending ratio

Coded Samples	WY (%)	YM (%)	AYB (%)	Total (%)
AFK	30	40	30	100
BGL	40	30	30	100
CHM	50	20	30	100
DIN	60	10	30	100
EJO	100	0	0	100

Sample EJO = Control (100% water yam)
WY = Water Yam
YM = Yellow Maize
AYB = African yam bean

Analytical procedure
The following analyses were carried out in triplicate or sample extracts from water yam, yellow maize and African yam bean flour blend.

Anti-nutritional contents
Phytate content was quantified according to young and Greaves 1940; Wheeler and Ferrel 1971) methods. Trypsin inhibitor was quantified according to the method of Kakade etal (1974) as modified by smith et al (1980). Tannin content was determined using (Pearson 1976) method.

RESULTS AND DISCUSSION

The result of the anti-nutritional content of the raw flour blends are shown in Table 2.
The phytate content of the flour blends ranged from 0.44 to 1.99%, with sample CHM having the highest phytate content, while sample DIN had the least phytate content. The phytate content of the flour samples were statistically (P<0.05) different from one another. Trypsin inhibitor content values ranged from 0.12 to 1.01mg/g, with flour sample CHM having the highest value, while flour sample DIN had the least trypsin inhibitor. Flour Samples AFK and DIN and flour samples CHM and EJO respectively were statisticlly (p>0.05) not different from each other but differed (P<0.05) statistically from flour sample BGL. Addition of yellow maize upto 30% and African yam bean reduced the trypsin inhibitor.The tannin content values ranged from 0.64 to 2.09%, with sample CHM having the highest value, while flour sample DIN had the least tannin content. Samples AFK and CHM were not statistically (p>0.05) different from each other but differed (p<0.05) from other flour samples. Flour sample EJO was statistically (P<0.05) lower than all other flour samples. Addition of yellow maize and African yam bean flour might have reduced the tannin content in the composite flour.

Amino acid profile of water yam, yellow maize and African yam bean flour blends.
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Amino acid profile of water yam, yellow maize and African yam bean flour blends.
The result of the amino acid profile of water yam, yellow maize and African yam bean flour blends are shown in Table 3. The lysine content of the flour blends ranged from 2.33 to 8.66mg/100g, with flour sample DIN having the highest value, while flour sample CHM had the least value. Samples AFK, BGL, CHM and EJO were not statistically (p>0.05) different from one another but were statistically (P<0.05) lower than sample DIN in lysine content. Addition of 10% yellow maize and 30% of African yam bean might have increased the lysine content of the flour blend. The valine content of the flour blends ranged from 3.33 to 7.33mg/100g, with sample DIN having the highest value, while sample EJO had the least valine content. Flour samples AFK, BJK and CHM were not statistically (P>0.05) different from one another, but were statistically (P<0.05) lower than flour sample EJO. Addition 10% yellow maize and 30% African yam bean might have increased the valine content of the flour sample. The methionine content of the flour samples ranged from 1.33 to 3.33mg/100g, with sample DIN having the highest value, while samples AFK, CHM and EJO had the least value. Flour sample EJO was statistically (P<0.05) higher than all other flour samples.
The values for phenylalanine ranged from 4.66 to 7.33mg/100g, with sample DIN having the highest while sample EJO had the least value. The phenylalanine content of EJO flour sample was statistically (P<0.05) lower than other flour samples. Inclusion of 10% yellow mazine and 30% Africa yam bean might have increased the phenylalanine content of flour sample. The histidine content ranged from 3.33 to 6.33mg/100g, with flour sample DIN having the highest value, while sample BGL had the least value. Flour sample DIN was statistically (P<0.05) higher than all other flour samples in histidine content. The tryptophan content ranged from 1.66 to 2.66mg/100g, with sample

DIN having the highest value, while sample EJO had the least value in tryptophan content There was no significant (p>0.05) difference in tryptophan content. The leucine content ranged from 4.00 to 8.33mg/100g, with sample DIN having the highest value, while sample EJO had the least value. The leucine content of EJO flour sample was statistically (P<0.05) lower than all other flour samples. The proline content of the flour ranged from 2.00 to 5.33mg/100g with sample DIN having the highest value, while sample EJO had the least value. Flour samples AFK, CHM and DIN were not statistically (P>0.05) different from one another but differed (P<0.05) statistically from sample EJO in proline content. The glycine content of the flour sample ranged from 3.33mg/g to 5.66mg/100g, with sample DIN having the highest value, while samples, BGL and EJO had the least values. Flour samples AFK, CHM, DIN and EJO were not statistically (P>0.05) different from one another. The arginine content of the flour sample, ranged from 3.00 to 7.66mg/100g with flour sample DIN having the highest value, while the flour sample EJO having the least value. Flour sample DIN was statistically (P<0.05) higher than all other flour samples. Inclusion of 10% yellow maize and 30% African yam bean flours might have increased the arginine content of the flour sample. The tyrosine content of the flour samples ranged from 2.33 to 4.66mg/100g with sample DIN having the highest value, while flour sample EJO had the least value. Flour samples AFK, BGL, CHM and DIN were not statistically (P>0.05) different from one another but were statistically (p<0.05) higher than flour sample EJO. The alanine content of the flour samples ranged from 3.66 to 5.50mg/100g, with flour sample DIN having the highest value, while flour samples BGL and EJO had the least value. All the flour samples did not differ (P<0.05) statistically from one another in alanine content. The aspartic acid content of the flour samples ranged from 9.00 to 13.33mg/100g, with flour sample DIN having the highest value, while flour sample EJO had the least value. Sample AFK, BGL, CHM and DIN were not statistically (P>0.05) different from one another but were all statistically (p<0.05) higher than flour sample EJO. The serine content of the flour ranged from 4.66 to 6.33mg/100g, with flour sample DIN having the highest value, while flour sample BGL had the least value. All the flour samples did not differ (P>0.05) statistically in the serine content. The glutamic acid content of the flour samples ranged from 11.00 to 18.00mg/100g, with flour sample DIN having the highest value, while flour sample EJO had the least value. Flour sample DIN was statistically (p<0.05) higher than all other flour samples. Inclusion of 10% yellow maize and 30% African yam bean in the flour blend increased the glutamic acid content of the flour. The threonine content of the flour samples ranged from 2.00 to 5.66mg/100g, with flour sample DIN having the highest value, while flour sample EJO had the least value. Flour Samples AFK, BGL and DIN were not statistically (P>0.05) different from one another but differed (p<0.05) statistically from flour sample EJO. The isoleucine content of the flour samples ranged from 1.66 to 4.00mg/100g, with flour sample DIN having the highest value, while flour sample CHM had the least value. Flour samples AFK, BGL and DIN did not differ (P>0.05) statistically one another, but differed (P<0.05) statistically from flour sample CHM. The cystein content of the flour samples ranged from 1.33 to 2.33mg/100g, with flour sample EJO having the highest value, while flour sample BJK had the least value. All the flour samples did not differ (P>0.05) statistically in cystein content.

Generally, flour sample DIN appeared to be superior in amino acid content compared with all other flour samples and that of reference standard (FAO/WHO/1991) except for cysteine content.

Anti-nutrient composition of raw flour.

Raw flour phytate content:

The phytate content of the raw flour and their blends are shown in Table 2.The phytate content ranged from 0.44 – 1.73% in this study. Earlier reported values of phytate content of water yam were lower than the value observed in this study (Polycarp *et al*., 2013; Shajeela *et al.*, 2011).

Phytic acid is an important storage form of phosphorus. It is insoluble and cannot be absorbed in the human intestines. Phytic acid has 12 irreplaceable hydrogen atoms with which it could form insoluble salts with metals such as calcium, iron, zinc and magnesium. The formation of these insoluble salts renders the metals unavailable for absorption into the body. Phytic acid can also affect digestibility by chelating with calcium or by binding with substrate or proteolytic enzyme and making trace element unavailable to the consumers, stunted growth and ricketing in young animals (Osagie, 1998) therefore, the low level of phytate in the flour sample DIN (60% WY:10%YM:30%AYB) is nutritionally advantageous and making trace element available to the consumer, However, the local methods of food processing used in Nigeria minimized the concerns posed by metal chelation and protein-binding action brought about by the phytate naturally present in food materials of plant origin (Osagie, 1998). Moreso, the use of exogenous phytases to enhance phosphorus digestibility is now common practice in countries where the contribution of agriculture to environment pollution is a concern (Ukachukwu, 2015).

Raw flour trypsin inhibitor:

The trypsin inhibitor content of the water yam flour and the blends are shown in Table 2. The trypsin inhibitor content of flours in this study ranged from 0.12 – 1.01mg/g. The value observed in this study for water yam flour was lower than earlier report by Shaajeela *et al*. (2011), the variation could be as a resulted of varietal and agronomical differences. Tryspin inhibitors have low molecular weight (20,000 – 25,000) with relatively few disulphide bonds but possessing a specificity which is primarily directed towards trypsin. Boiling for sufficient time makes the tuber soft enough and inactivates all the trypsin inhibitors (Bradbury and Holloway, 1988). However, heat treatment needs to be conducted under closely controlled conditions to avoid reducing the availability of amino acids, particularly lysine (Ukachukwu, 2015).

Raw flour tannin content:

The tannin content of the raw water yam flour and the blends are shown in Table 3. The tannin content of flour in this study ranged from 0.64 – 2.00%.The value observed for water yam in this work was lower than the earlier reported value (Shaajeela *et al*., 2011). Phenolics and tannin are water soluble components (Uzogaraa *et al*., 1990) and as such can be eliminated by soaking followed by cooking (Singh 1988; Murugesan and Ananthalakshmi, 1991; Kataria *et al*., 1989 Singh and Singh, 1992; Shanthakumari *et al*., 2008). Polyphenols (condensed tannins) are fairly high in cowpeas. Tannins decrease protein quality by decreasing digestibility and palatability. It has been suggested that tannins play a major role in the plant's defense against fungi and insects (Osagie, 1998).

The result of the Amino Acid compositions of raw flour

The Amino Acid of the raw water yam flour and the blends are shown in Table 3.

The results obtained showed that all the samples contained all the amino acids that are found in plant proteins. In this study the predominant amino acid was glutamic acid while the least amino acid was cysteine; likewise, Adeoti *et al*. (2013) observed a result of similar trend for maize Tuwo-Cirina forda flour blend. There was an improvement in the protein content of the composite flour. Yam in itself is not a balanced food. Nutritional deficiency diseases occur within poorer regions where yam and other root and tuber crops are consumed alone as staple foods and a major health issues, especially micronutrient deficiencies, can lead to several health consequences including impared cognitive and physical development. (Baah *et al*., 2009).

TABLE 2: Anti nutritional factors of water yam, yellow maize and African yam bean flour blends

Sample	Phytate (%)	Trypsin Inhibitor (mg/g)	Tannin (%)
AFK	$1.73^{b} \pm 0.15$	$0.20^{c} \pm 0.10$	$2.00^{a} \pm 0.20$
BGL	$1.30^{c} \pm 0.01$	$0.88^{b} \pm 0.01$	$1.68^{b} \pm 0.01$
CHM	$1.99^{a} \pm 0.00$	$1.01^{a} \pm 0.01$	$2.09^{a} \pm 0.00$
DIN	$0.44^{e} \pm 0.20$	$0.12^{c} \pm 0.00$	$0.64^{d} \pm 0.01$
EJO	$1.04^{d} \pm 0.01$	$0.99^{a} \pm 0.00$	$1.40^{c} \pm 0.10$

Values are means of triplicate determination ± standard deviation.
Means with the same superscript within the column are not statistically (P>0.05) different from each other.

TABLE 3: Amino acid profile of water yam, yellow maize and African yam bean flour blends

Amino acid	AFK	BJK	CHM	DIN	EJO	FAO(1991)	Adult
Lysine	4.05^{b}	3.00^{b}	2.33^{b}	8.66^{a}	3.66^{b}	5.80	1.60
Valine	5.33^{b}	4.00^{bc}	3.66^{bc}	7.33^{a}	3.33^{c}	3.50	1.30
Methionine	1.33^{b}	2.00^{b}	1.33^{b}	3.33^{a}	1.33^{b}	2.2	1.70
Phenylalanine	5.33^{ab}	5.66^{ab}	5.00^{ab}	7.33^{a}	4.66^{c}	5.43	1.90
Histidine	3.66^{cd}	3.33^{d}	4.66^{bc}	6.33^{a}	5.00^{b}	1.90	1.60
Tryptophan	2.00^{a}	2.00^{a}	2.00^{a}	2.66^{a}	1.66^{a}	1.1	-
Leucine	6.66^{b}	7.66^{ab}	7.33^{ab}	8.33^{a}	4.00^{c}	6.60	1.90
Proline	3.66^{ab}	3.66^{ab}	3.00^{b}	5.33^{a}	2.00^{b}	-	-
Glycine	4.33^{ab}	3.33^{ab}	4.33^{ab}	5.66^{a}	3.33^{ab}	-	-
Arginine	5.33^{b}	4.66^{bc}	4.00^{bc}	7.66^{a}	3.00^{b}	2.0	-
Tyrosine	3.66^{ab}	4.00^{bc}	3.00^{ab}	4.66^{a}	2.33^{b}	-	-
Alanine	5.00^{a}	3.66^{b}	4.66^{ab}	5.50^{a}	3.66^{b}	-	-
Aspartic acid	11.00^{ab}	11.33^{ab}	10.33^{ab}	13.33^{a}	9.00^{b}	-	-
Serine	5.00^{a}	4.33^{a}	5.66^{a}	6.33^{a}	4.66^{a}	-	-
Glutamic acid	14.00^{a}	14.33^{b}	12.00^{c}	18.00^{a}	11.00^{c}	-	-
Threonine	5.00^{a}	4.00^{a}	3.00^{bc}	5.66^{a}	2.00^{c}	3.40	0.90
Isoleucine	2.66^{abc}	3.33^{ab}	1.66^{c}	4.00^{a}	2.00^{bc}	2.80	1.30
Cystein	2.00^{a}	1.33^{a}	2.00^{a}	1.33^{a}	2.33^{a}	2.50	-

Values are mean of triplicate determination ± standard deviation. Means with the same superscript within the column are not significantly (P > 0.05) different from each other.
Keys:
WY: YM: AYB
AFK = 30: 40: 30
BGL = 40: 30: 30
CHM = 50: 20: 30
DIN = 60: 10: 30
EJO = 100

CONCLUSION

Addition of African yam bean and yellow maize flours to water yam flour increased the anti nutrient as well as the amino acid of the composite flour, different sample blending showed raised amount of anti nutrient levels, anti nutrient can be activated by heat treatments. Flour sample DIN(60%WY: 10%YM: 30AYB) was generally considered as the best blend that could be used for value added products based on its amino acid profile as compared with compared to FAO/WHO/1991) reference amino acid for children and adult consumers.

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