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NUTRIENT AND ANTI NUTRIENT COMPOSITION OF READY – TO – EAT SUPPLEMENT MADE FROM AFRICAN WALNUT, AFRICAN YAM BEAN AND MAIZE

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ABSTRACT
Background: Studies have shown that cereals and legumes are used for feeds in Nigeria as they complement and supplement each other if adequately processed, combined and blended. African walnut, (Conophora, African yam bean (*Stenostylis stenocarpa*) and maize (Zeamays) have been used over ages as food as individual foods. The study was done to determine the nutrient composition of locally produced ready – to– eat flours from African walnut, African yam bean and maize.
Objectives: Three specific objectives were formulated for the study and they included 1.formulate experimental supplement from the African walnut, African yam bean and maize flours blends based on 25gramme protein in 100g weight; 2. determine the nutrient composition of African walnut, African yam bean and maize flours; 3. determine the anti-nutrient composition of African walnut, African yam bean and maize flour blend and gruel.
Methodology: Experimental design was used in this study. The seeds of African walnuts, African yam bean and maize were procured, sorted, washed, boiled and processed into flours and slurry. The flours were mixed and five different diets were formulated in varied proportions as M, A and Y, based on 25g protein. Nutrient and anti-nutrient composition were analyzed using Statistical Product for Service Solution (SPSS) software version 21 and then analysis of variance to separate means of the flour values.
Results: The least moisture value of 2.00+0.06% was from M.W.Y.. The protein content of M.W.Y had highest of 20.00+0.05%. On carbohydrate, M.W.Y had the highest value of 67.63+0.20%. Fat content was highest in M.W.Y (10.92+0.00%). On the tannin levels of the raw samples, the least came from M.W.Y (1.22±0.10). The phytate, phenol, flavonoids, saponins and oxalate also had varied values but were all within safe levels.
Conclusion: From the findings of this study, the products have high nutrient profiles and low levels of antinutrients and as such, holds promise for improving nutritional status of people with poor nutrition.

Keywords: *African walnuts, African yam bean and maize flours, slurry, gruel*

INTRODUCTION

Adequate nutrition is one of the pillars of sound public health. Traditional foods are important part of the culture, history, identity and heritage of a religion or country and are key elements in dietary pattern Coasta, Albuguerquer and Effie (1). ACTION meal was prepared by Institute of Human Virology as a ready - to- eat supplement. Ready – to - eat therapeutic food supplements (RUTFS) from our local crops have been successful in treating severe malnutrition however they are not enough for the people that need them (2). Ekumankama and Okeke (3) stated that African walnut is a legume seed that has high amino acid and caloric values. African walnut can be eaten as snacks and processed to enrich staple foods (rice, garri, yam and wheat), soup and stews. African walnuts as a rich protein and oil source, can be incorporated to yield nutritious meals that can benefit people whose nutritional status is jeopardized (4). Sirilakshmi (5). stated that walnuts have the highest antioxidant activity among plants or legume species. It has phytochemicals like ellagiacid, flavonoids, phenolic compound, luteolin (a major antioxidant) and tocophenols. Consequently, they are healthful alternatives to meat given their richness in protein, mineral and vitamins (6).

African yam bean (AYB) is a climbing legume and it is cultivated to produce seeds. In Nigeria, it is grown in the northern and eastern parts of the country where it is grown mainly for its seeds (7).The nutritive value of the African yam bean has also been assessed using albino rat and broiler chicks in the laboratory and amino acid content of the African yam bean is similar to that of other pulses Ajayi (8). AYB has a better pattern of essential amino acids than cowpea, pigeon pea and soya bean (9).

Maize is a good source of energy and vitamins and it can be prepared in many different ways like roasting, boiling, grinding as flours and combined to make a lot of maize meals for human consumption. Maize is a good source of energy and vitamins and it can be prepared in many different ways like roasting, boiling, grinding as flours and combined to make a lot of maize meals for human consumption.

Cereals and legumes can complement and supplement each other if adequately processed, combined and blended. These three crops have been studied and used individually over ages as food. The need to assess the nutrient and anti-nutrient composition of high protein ready- to - eat supplement from African walnut, AYB and maize flour blends form the basis of this study. Three specific objectives were formulated to guide the study and they included 1.formulate experimental supplement from the African walnut, African yam bean and maize flours blends based on 25gramme protein in 100g weight; 2. determine the nutrient composition of African walnut, African yam bean and maize flours; 3. determine the anti-nutrient composition of African walnut, African yam bean and maize flour blend and gruel.

MATERIALS AND METHODS

Experimental design was used in this study. The matured seeds of African walnuts, African yam bean and maize were procured from a local market in Enugu state, Nigeria were sorted washed, boiled and processed into flours and slurry. Figure 1: Flowchart for the processing of African walnut, AYB and maize.

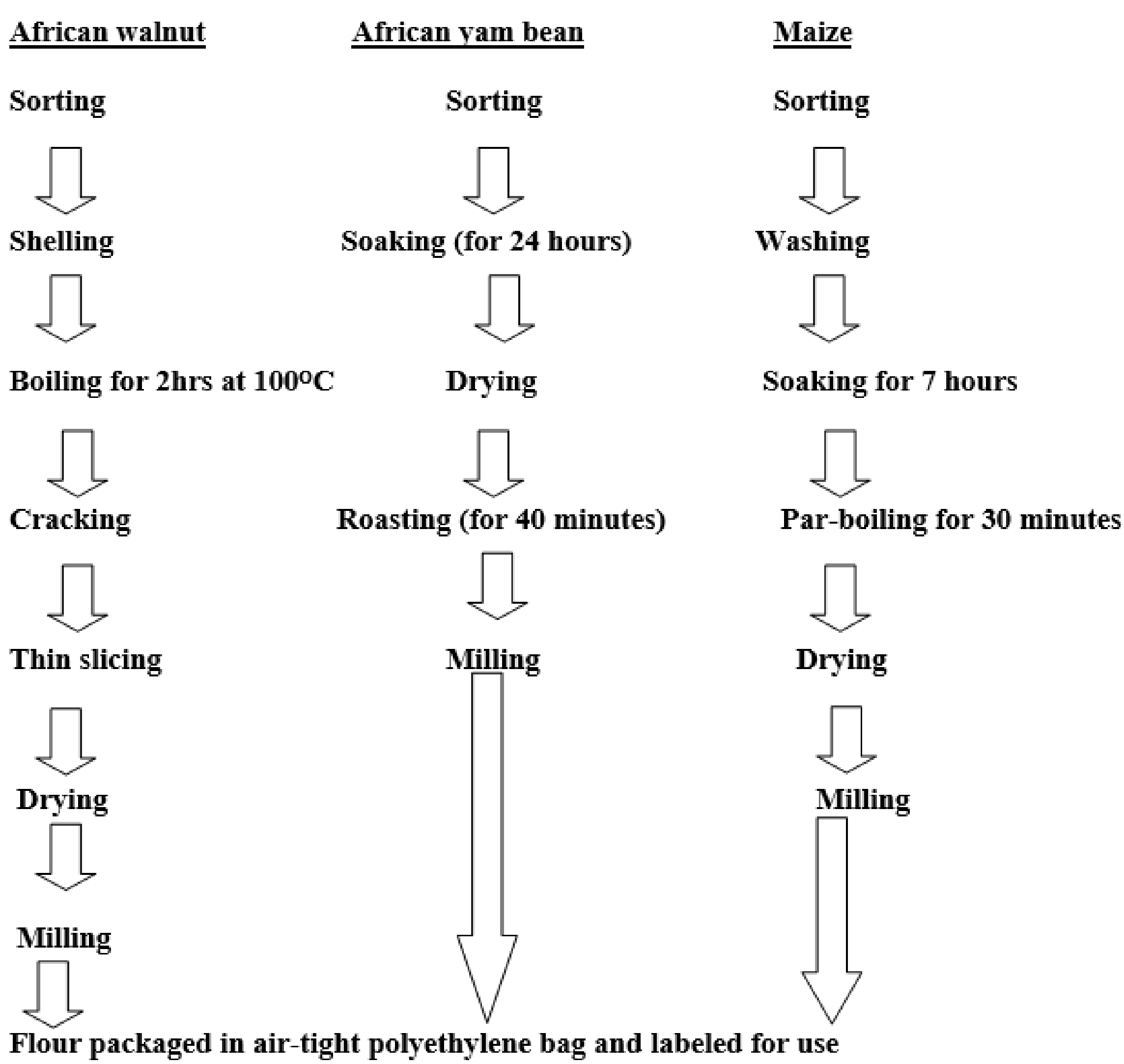

Figure 1: Flowchart for the processing of African walnut, AYB and maize.

Formulation of blends

Five diets were formulated. The formulation was based on plant protein cereal/legume combination guide in the proportion of 70:30, and 60:40 cereal/legume. The flours and slurry were distributed according to calculated contribution to generate 25grammes protein and 890 kilocalories (equivalent to one third daily protein plus extra 30% and caloric need of an adult PLHIV. The protein need of70kg (reference man) is 57g (10) plus 30% extra protein for a malnourished man which is74g. The 1/3 = 24.6, approximately 25g.

The formulated diets according to maize, African and AYB proportion contributions are as follows:

$M_{70}W_{20}Y_{10}$: maize 70, African walnut 20 and AYB proportion

$M_{70}W_{15}Y_{15}$: Maize 70, African walnut 15 and AYB proportion

$M_{70}W_{10}Y_{20}$: Maize 70, African walnut and AYB proportion

$M_{60}W_{30}Y_{10}$: Maize 60, African walnut 30 and AYB proportion

$M_{60}W_{10}Y_{30}$: Maize 60, African walnut 10 and AYB proportion

Chemical analysis

Proximate, minerals, vitamins, phytochemicals and anti-nutrients compositions were determined in triplicate using standard methods. Micro- Kjedahl method as described by AOAC (11) was used for protein. Fat was determined using the Soxhlet extraction, crude fibre content of the sample were all determined using (11) methods. The carbohydrate was determined by the ClegAnthrone (12).The vitamin content of the flours were determined by liquid chromatography for the water soluble vitamins (B and C) – mass spectrometry (LC/MS) method Konings (13) high performance liquid chromatography was used for the fat soluble vitamins of ADEK as described by Blake (14) : (15:16). Mineral determination was done using atomic absorption spectrometric method whereby each of the food samples was ashed and dissolved in an aqueous solution.

Data analysis

Statistical analysis was done using IBM SPSS Statistics software version 21. Analysis of variance (ANOVA) was used to compare the mean values of the flour blend at $p<0.05$.

RESULTS

Table 1a presents the nutrient composition of the maize, African walnut and African yam bean flour blends (experimental diets) per 100g. Moisture content varied and was lowest (2.00± 0.06%) in$M_{60}W_{30}Y_{10}$. $M_{70}W_{20}Y_{10}$ had the highest moisture of 8.50±0.01%. The $M_{70}W_{15}Y_{15}$ had the highest protein content of 15.63±0.06% and the lowest value was found in $M_{70}W_{10}Y_{20}$ (10.639±0.00%) among the 70:30 cereal/legume combination.

Table 1a: Nutrient composition and energy value of the flour blends per 100g

Test diets	Moisture (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Ash (g)	Fibre (g)	Energy (kcal)
$M_{70}W_{20}Y_{10}$	8.50± 0.01	12.50±0.01	5.98±0.02	67.63±0.12	3.00±0.08	2.89±0.10	374
$M_{70}W_{15}Y_{15}$	5.25±0.00	15.63±0.06	9.20±0.00	63.54±0.05	4.00±0.08	2.30±0.30	462
$M_{70}W_{10}Y_{20}$	10.00±0.01	10.63±0.00	7.76±0.03	64.51±0.09	5.00±1.05	2.10±0.10	370
$M_{60}W_{30}Y_{10}$	2.00±0.06	20.00±0.05	8.00±0.23	62.80±0.02	5.00±1.05	2.20±0.03	403
$M_{60}W_{10}Y_{30}$	5.00±1.01	19.38±0.20	10.92±0.0	55.50±0.00	6.00±1.05	3. 20±0.10	397.8

Means ±SD of three determinations
$M_{70}W_{20}Y_{10}$: Maize 70, African walnut 20 and AYB proportion
$M_{70}W_{15}Y_{15}$: Maize 70, African walnut 15 and AYB proportion
$M_{70}W_{10}Y_{20}$: Maize 70, African walnut and AYB proportion
$M_{60}W_{30}Y_{10}$: Maize 60, African walnut 30 and AYB proportion
$M_{60}W_{10}Y_{30}$: Maize 60, African walnut 10 and AYB proportion

Table 1b: presents the proximate composition of gruel (Wet weight). Moisture content varied and was lowest (28.00±0.10) in MWY and highest in MWY (30.00±0.21). MWY had the highest fat of 9.19±0.21%. The MWY had the highest protein content of 8.75±0.06% and the lowest value was found in MWY (4.63±0.24).

Table 1b: Proximate composition of gruel (Wet weight)

Parameter	**MWY**	**MWY**	**MWY**	**MWY**	**MWY**
Moisture (g)	30.00±0.21	28.00±0.60	28.00±0.10	28.00±0.42	28.00±0.16
Protein (g)	5.63±0.06	6.25±0.02	4.63±0.24	8.75±0.06	6.25±0.03
Fat (g)	4.44±0.12	5.62±0.21	6.76±0.06	5.38±0.03	9.19±0.21
Fibre (g)	1.01±0.43	1.60±0.04	2.10±0.78	1.40±0.44	0.70±0.03
Ash (g)	6.02±0.54	6.12±0.54	8.00±0.06	5.00±0.12	4.05±0.41
Carbohydrate (g)	52.9±0.10	54.53±0.42	50.51±0.43	51.47±0.02	51.1±0.02

Means +SD of triplicate determinations
$M_{70}W_{20}Y_{10}$: Maize 70, African Walnut 20 and AYB10 proportion
$M_{70}W_{15}Y_{15}$: Maize 70, African walnut 15 and AYB15 proportion
$M_{70}W_{10}Y_{20}$: Maize 70, African walnut 10 and AYB20 proportion
$M_{60}W_{30}Y_{10}$: Maize 60, African walnut 30 and AYB10 proportion
$M_{60}W_{10}Y_{10}$: Maize 60, African walnut 10 and AYB30 proportion

Table 2 shows the vitamin and mineral composition of the experimental diets. The MWY (15.38g) had lowest vitamin A level (0.177 iu, RE), thiamin level was highest in the MWY (1.11±0.41mg) and least in MWY (0.20±0.21mg). On riboflavin, highest value was found in MWY (10.60±0.03mg) and least in MWY (1.85±0.01mg). Niacin content was highest in MWY (3.48±0.61mg) and least in MWY (0.98±0.32mg). Other test diets had 3.48mg, 3.47mg, and 3.02mg for MWY, MWY MWY and MWY respectively. There were also variations in the levels of vitamin B3 content of the test diets. MWY has the highest value of 0.519±0.04mg and this was closely followed by 0.424±0.08mg of MWY while the least of 0.213±0.01mg is from MWY. On vitamin E, MWY had highest value of 0.168±0.23mg and the least is from MWY (0.133±0.03mg). The vitamin K levels also varied with highest in MWY (0.972±.06mg) and the least in MWY (0.505±0.0.050mg). The vitamin D level was highest in the MWY (0.559±0.10mg) and least in MWY (0.190±0.01mg). Table 2 also shows that the iron content of the test diet varied. The highest value was found in MWY (10.5±0.0mg) while the least was found in MWY (9.60±0.3mg). Then, the MWY was the second least in iron content (10.1±0.05mg). Zinc content of the blends is highest in MWY (.59±0.02g).

Table 2: Vitamin and mineral composition of the experimental diets.

Nutrient	M70W20Y10	M70W15Y15	M70W10Y20	M60W30Y10	M60W10Y30
Vitamin A RE (ug)	0.213±0.12	0.201±0.01	0.177±0.03	0.191±0.03	0.201±0.00
Thiamin (mg)	1.11±0.41	1.01±0.02	0.99±0.08	0.31±0.04	0.20±0.21
Riboflavin (mg)	10.60±0.03	10.40±0.05	9.85±0.05	1.85±0.01	9.89±0.90
Niacin (mg)	3.48±0.61	3.47±0.02	3.57±0.01	3.02±0.05	0.98±0.32
Vitamin B(mg)	0.424±0.08	0.519±0.04	0.213±0.01	0.314±0.03	0.348±0.61
Vitamin E (mg)	0.147±0.21	0.133±0.03	0.168±0.23	0.154±0.51	0.139±0.01
Vitamin K (mg)	0.872±0.05	0.872±0.13	0.933±0.06	0.505±0.05	0.972±0.06
Vitamin D (mg)	0.242±0.21	0.190±0.01	0.249±0.02	0.559±0.10	0.236±0.04
Iron (mg)	10.1±0.05	10.5±0.07	10.4±0.05	10.20±0.01	9.60±0.03
Zinc (mg)	0.37±0.07	0.59±0.02	0.38±0.25	0.52±0.06	0.50±0.85

Means +SD of triplicate determinations
M70W20Y10: Maize 70, African Walnut 20 and AYB10 proportion
M70W15Y15: Maize 70, African walnut 15 and AYB15 proportion
M70W10Y20: Maize 70, African walnut 10 and AYB20 proportion
M60W30Y10: Maize 60, African walnut 30 and AYB10 proportion
M60W10Y10: Maize 60, African walnut 10 and AYB30 proportion

Table 3 presents the anti-nutrient composition of the raw samples. The anti-nutrient composition of the samples on table 4 varied significantly between groups. On the tannin levels of the raw samples, MW Y had the highest value (1.37±0.14 followed by MW Y that had 1.34±0.13 while the least came from MW Y (1.22±0.10). The phytate levels were highest in the MW Y (0.36±0.17) and the least (0.27±0.02) was found in MWY The phenol also varied with highest in MWY with 0.60±0.01 and lowest (0.36±0.12) in MW Y Table 4 also shows that flavonoids, saponins, oxalate and TI also had varied values.

Table 3: Anti-nutrient composition of the raw samples (flour blends) per 100g (dry weight).

Experimental diets (raw and gruel)	Tannin mg	Phytate (%)	Phenol (mg)	Flavonoid (%)	Saponins %	Alkaloids %	Oxalates %
$M_{70}W_{20}Y_{10}$	1.35±0.10	0.36±0.17	0.38±0.06	0.89±0.10	0.30±0.01	1.01±0.01	1.46±0.01
$M_{70}W_{15}Y_{15}$	1.31±0.30	0.29±0.10	0.37±0.08	1.04±0.07	0.34±0.20	1.01±0.20	1.47±0.02
$M_{70}W_{10}Y_{20}$	1.36±0.23	0.24±0.16	0.60±0.10	0.95±0.02	0.33±0.32	1.04±0.30	1.47±0.70
$M_{60}W_{30}Y_{10}$	1.37±0.16	0.30±0.07	0.36±0.02	1.02±0.02	0.61±0.01	1.87±0.68	1.20±0.87
$M_{60}W_{10}Y_{30}$	1.22±0.10	0.29±0.03	0.37±0.17	1.00±0.21	1.11±0.06	3.21±0.70	1.48±0.10

Means +SD of triplicate ($p<0.05$).
$M_{70}W_{20}Y_{10}$ Maize 70, African Walnut 20 and AYB10 proportion
$M_{70}W_{15}Y_{15}$: Maize 70, African walnut 15 and AYB15 proportion
$M_{70}W_{10}Y_{20}$: Maize 70, African walnut 10 and AYB20 proportion
$M_{60}W_{30}Y_{10}$: Maize 60, African walnut 30 and AYB10 proportion
$M_{60}W_{10}Y_{30}$: Maize 60, African walnut 10 and AYB30 proportion

Table 4 presents the anti-nutrient composition of gruel on wet weight basis. The anti-nutrient composition of the samples on table 4 varied significantly between groups. On the tannin levels of the gruel, M W Y had the least value (0.45±0.17)followed by M W Y that had 0.51±0.31 while the least came from M W Y (1.22±0.10). The phytate levels were highest in the M W Y (0.27±0.12) and the least (0.27±0.02) was found in M W Y The phenol also varied with least in M W Y with 0.24±0.51 and lowest (0.36±0.12) in M W Y. Table 4 also shows that flavonoids, saponins, oxalate and TI also had varied values.

Table 4: Anti-nutrient composition of the gruel/prepared experimental diets per 100g on (wet weight) basis respectively.

Experimental diets (Gruel/prepared)	Tannin mg	Phytate (mg)	Phenol (%)	Flavonoid %	Saponins %	Alkaloids %	Oxalates %	LSD
$M_{70}W_{20}Y_{10}$:	0.635+0.21	0.325+0.08	0.285+0.00	0.268+0.6	0.275+0.21	0.31+0.16	0.58+0.21	0.632+0.10
$M_{70}W_{15}Y_{15}$:	0.817+0.15	0.265+0.02	0.236+0.51	0.214+0.16	0.250+0.16	0.106+0.1	0.315+0.24	609+0.14
$M_{70}W_{10}Y_{20}$:	0.511+0.31	0.269+0.12	0.294+0.03	0.239+0.01	0.213+0.04	0.14+0.02	0.580+0.03	0.48+0.12
$M_{60}W_{30}Y_{10}$:	0.796+0.20	0.286+0.12	0.356+0.14	0.261+0.10	0.346+0.17	0.312+0.	0.612+0.80	0.290+0.10
$M_{60}W_{10}Y_{10}$:	0.488+0.21	0.270+0.04	0.239+0.05	0.254+0.12	0.45+0.17	0.56+0.42	.0645+0.01	0.255+0.12

Means +SEM of triplicate ($p<0.05$).
TI: Trypsin inhibitor
Means +SEM of triplicate samples ($p<0.05$).
M W Y Maize 70, African Walnut 20 and` AYB proportions
M W Y: Maize 70, African walnut 15 and AYB proportion
M W Y: Maize 70, African walnut and AYB proportion
M W Y: Maize 60, African walnut 30 and AYB proportion
M W Y: Maize 60, African walnut 10 and AYB proportion

DISCUSSION

All the sample flour blends had lower moisture content. This property is good for effective preservation of the flours/samples and it is in line with Paul (17) that stated that flour preserve better when the moisture content is less than 14%. If more than this value and the flours are kept at ordinary room temperature, it can be easily attacked and destroyed by moulds, bacteria and insects which results in food spoilage and its resultant food poisoning if consumed. It will also lead to wastage of food that could also result to food insecurity among the family in the community.

The observed higher protein content could be as a result of better proportion of the two legumes used in this study. This agrees with the observations of Pamplona-Roger, (6). that stated the mixture of nuts and grains is doubly beneficial because it provides complete proteins that are equal or superior to those of meat. Idowu (18), Yusuf et al (19), (20) and Adebayo et al, (15) made similar observations from their studies on African yam bean and other legumes. They found them adequate to have supported growth and repair of worn out tissues. Protein, fat, ash, zinc were lower in M W Y but it had higher carbohydrate values. However, the mean protein values of the five test diets compared favourably with the documented protein value (13/13.4%) of the ACTION meal that was prepared by Institute of Human Virology as supplement for PLHIV. The ACTION meal was lower than the formulated diet in both carbohydrate and fat. Better fat content could be due to the fact that African walnut was more oil based than groundnut as contained in the ACTION meal.

The total energy levels of the supplements were low, only one of the test diets met the desired caloric need. However, those with low caloric value can be upgraded by the addition of graded amounts of groundnut oil and sugar. This was in line with suggestion of Onyango et al., (21) in order to meet any needed/extra calorie. This makes the supplement a good source of energy for maintenance of body energy. With the addition of oil and sugar, the supplement met the extra desired energy need and was able to have sustained the good nutritional and health condition that usually follow usually result from adequate consumption and good dietary habit. If the addition is red oil, it could also be beneficial in improving the pro- vitamin A levels of the supplementary meal. Calcium levels of the meal could also be improved by addition of little fish bone to the blends as suggested by Nnam and Odigwe, (22) in their study on complementary feed adequacy. Generally, there were discrepancies observed between the calculated and analyzed nutrient contents of the developed experimental meals. The adequacy of the protein and other nutrients level of the experimental diet could be attributed to the high levels of nutrient in the base ingredients (African walnut, African yam bean and maize).Variations in the nutrient contents of the flour groups could be due to the proportions of inherent amino acids of each of the blends as observed (20) and may not be attributed to processing techniques and the preparation methods adopted.

Table 3 presents the anti-nutrient composition of the raw samples. The anti-nutrient composition of the samples on table 3varied significantly between groups but were found to be at safe levels. This could have been as a result of processing of the seeds which has reduced the antinutrients to safe levels. This is commendable as toxicity is ruled out as in its intake as a ready – to – eat supplement.

The table 4 presents the anti-nutrient composition of the gruel. The anti-nutrient composition of the gruel varied significantly among groups. On the antinutrient composition of the raw and prepared experimental diets, variations existed in the antinutrient content of both raw and prepared (gruel) samples of the experimental diets. The antinutrient contents were all within normal range but lowest in the prepared samples than the raw (per 100g). These levels could be due to the processing techniques employed making them safe for human consumption. At these levels, they can be regarded as or more of phytochemicals. The tannin, phytate, saponins, oxalate, phenols and trypsin inhibitor levels in the raw samples were all significantly higher than in the prepared samples. This is not surprising as processing techniques are core methods of reducing inherent antinutrients content of legumes to safe levels. This is in line with the observations of Analike (23): Khattab (24): Chikwendu (25) and Edoga et al., (26). This is beneficial because antinutrients in legumes affect the availability of nutrients as they chelate the nutrients in the legumes making nutrients unavailable. This was not observed in the present study but improving digestibility and utilization of the product anyway it is used. These enables such leguminous foods effect some medicinal and physiological properties experienced by consumers. Processing would also improve digestibility, decreased toxicology with more optimal conditions for enzymatic degradation of phytates present in the flour blends.

CONCLUSION

The flour blends of African walnut, African yam bean and maize were found to be rich sources of nutrients. It has higher protein, higher calorie as a ready – to – eat food supplement. The product holds promise to improve nutritional status of people with malnutrition. People need adequate information with varieties of our local food crops in order to ensure dietary diversification. There is need to carry out a feeding trial with the developed food supplement AW, AYB and maize ready - to – eat supplement.

Conflict of Interest declaration: The authors declare that there is no conflict of interest.

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