NUTRIENT AND SENSORY PROPERTIES OF FLOUR BLENDS FROM FERMENTED SORGHUM (*SORGHUM BICOLOR*), FERMENTED COWPEA (*VIGNA UNGICULATA*) AND UNRIPE FRESH BANANA (*MUSA ACUMUNATA*).

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ABSTRACT

The study examined the nutrient composition, sensory properties and acceptability of porridges made from blends of fermented sorghum, cowpea and fresh unripe banana flours. Sorghum grains were fermented for 24h, cowpea for 48h and banana were dried in a hot air oven at 55^0C to 96% dry matter and milled into fine flour (70mm mesh screen).

The flours were blended in ratios of 60:30:10, 50:30:20 and 40:40:20 (protein basis) of sorghum, cowpea and banana. The composites were used to prepare porridges. The porridges were chemically and organoleptically evaluated using standard methods. The nutrient contents of the porridges were compared with Nutrend, a commercial complementary food. The protein levels of the product ranged from 9.17 – 11.68%, carbohydrate 85.14 – 87.53% and fat 2.29-2.89% these values were comparable to that of Nutrend that has protein 16.67%, carbohydrate 66.43% and fat 9.38%, These products had reasonable levels of iron (14.51mg), zinc (19.45mg), calcium (6.34mg) and phosphorus (71.65mg). The products were acceptable to the judges. The organoleptic attributes of the products were comparable to those of Nutrend (P>0.05). The 50:30:20 blends (sorghum, cowpea and unripe banana) had greater acceptance over the other blends.

Keywords: Nutrient composition, sensory properties, acceptability, complementary food.

INTRODUCTION

Infant feeding practices in Nigeria are among the major causes of childhood malnutrition, this is due to decline in breast feeding and early introduction of inadequate complementary foods (1) in Nigeria, the commonly accepted complementary foods for babies are porridges prepared with supplemented starchy foods like maize (*zea mays*), sorghum (*sorghum bicolor*) and tubers. Animal protein is rarely given due to its high cost (2).

The nutritive values of some of these foods have been studied (3). They are grossly inadequate to meet the need of a growing child. Cowpea the most readily available and popular food legume produced in Northern States of Nigeria is rich in protein, carbohydrates, vitamin B complex and minerals. However, its use has not been fully explored in complementary feeding. This is due to flatulence and indigestion associated with its consumption. The consumption of blends of cereals, legumes, fruits and vegetables is encouraged because they are cheap and nutritious. Cereals contain adequate levels of sulphur containing amino acids (methonie and cystine), which are limiting in legumes. Legumes contain high levels of lysine deficient in cereals. There is urgent need for a judicious combination of these foods, to produce blends for preparation of porridges to improve nutrient quality and intake. The use of locally available and commonly consumed food crops such as cereal grains, legumes and fruits for the formulation of complementary foods should be encouraged because they are nutritious, cost effective and could be acceptable to both the mothers and the children. The thrust of this work was to produce complementary foods that would meet the nutritional needs of infants and children based on sorghum, cowpea and banana flours.

MATERIALS AND METHODS

Source of raw materials

White sorghum (sorghum bicolor), cowpea (*vigna* *unginculata*) grains and unripe banana (*musa acumunata*) were used for this study. The foods were purchased from Nsukka township market in Enugu State, Nigeria.

Treatment of Samples

Sorghum grains:
Sorghum grians were handpicked and sorted to remove unwanted materials. Four kilograms of the cleaned sorghum sample were divided into four equal portions. Three portions were fermented for 24h, 48h and 72h in deionzed water in ratio 1:3 (w/v) at 28 + 2˚c. After fermentation, the grains were washed and wet – milled into fine paste (70mm mesh screen). The pastes were separately dried in a hot air oven at 55^0C and stored in an air tight polythene bag for various analysis.

The other portion (control) was not fermented. It was washed in deionized water in a ratio of 1:3 (w/v) and wet milled into a fine paste (70mm mesh screen). The paste was sieved through a transparent clean cheese cloth and drained. It was dried in a hot air oven at 55^0C and stored in an air tight polythene bag for use in various analysis.

Unripe unfermented banana flour
About 1kg of this sample was washed with deionized water. The washed banana was peeled and cut into slices and dried in a hot air oven at 55^oc. The dried banana was milled into fine flour (7mm mesh screen) and stored in an air tight polythene bag for analysis.

Formulation of composite flours
The 24h fermented sorghum, 48h fermented cowpea and unripe banana flours were mixed in various ratios based on nitrogen (protein basis). A Kenwood mixer was used for mixing each samples at speed 6 for 2 minutes to achieve uniform mixing as follows:

Fermented Flour	Sorghum	Cowpea	Banana
A	60	30	10
B	50	30	20
C	40	40	20

The following composites were formulated.
1. $SCUB_1$ (60:30:10): 24h fermented sorghum, 48h fermented cowpea and unfermented unripe banana flours.
2. $SCUB_2$ (50: 30: 20): 24h fermented sorghum, 48h fermented cowpea and unripe unfermented banana flours.
3. $SCUB_3$ (40: 40: 20): 24h fermented sorghum, 48h fermented cowpea and unripe unfermented banana flours.
4. $SCUB_4$ NUTREND (Control)

Chemical analysis
The AOAC methods (5) were used in the determination of the following chemical content, crude protein (Macro Kjeildahl method). Moisture (by the oven drying method) Fat (Soxhlet solvent extraction method), crude fibre (6) Ash and carbohydrate (was estimated by difference). For minerals, the dry ash method was used. Iron was determined by the use of spectrophotometer and read at wavelength of 562mm. Magnesium, calcium and phosphorus were determined by titrametric method flame photometry, carried out by wet digestion.
Anti nutrients (Tannins and Phytates) were extracted using the modified methanol procedure of price et al (6).

Preparation of Porridges
Recipe

Water - 250ml (1 cup)
Composite flour - 50g (9 level table spoons).

Procedure

* Grams of flour was dissolved in 250mls of water
* The mixture was poured into a clean saucepan
* Cooked over low heat for about 15 minutes
* The mixture was stirred until smooth and ready for consumption.

Sensory evaluation

The porridges were tested for flavour, color, texture and general acceptability. Fifteen-nursing mothers were randomly selected from the immunization groups of Uwani Medical Centre, Enugu, Enugu State, Nigeria. They were presented with evaluation sheets and asked to assign scores to each of the characteristics. They were provided with water for mouth rinsing to avoid carry over effect. A 9-point Hedonic Scale where 9 was the highest score and 1 the lowest was used for the evaluation. (The degree of likeness was expressed as, like extremely (9 points), like very much (8 points), like slightly (6 points), neither like nor dislike (5 points), dislike slightly (4 points) dislike moderately (3 points), dislike very much (2 points and dislike extremely (1 Point). Like extremely to like slightly constituted good and dislike slightly to dislike extremely constituted poor and neither like nor dislike meant that the porridge was neither good nor poor.

The porridge samples coded SCUB 1, SCUB 2, SCUB3, SCUB4, (control) were presented to each of the judges in different white plastic cups for evaluation. Each panelist evaluated the four porridges using the Hedonic scale which was coded to correspond with the codes.

Statistical analysis

Means, standard deviation and one way analysis of variance (8) were used for the statistical analysis of the result.

Results:

The proximate composition of unfermented and fermented sorghum, cowpea and fresh unripe unfermented banana flour is shown in Table 1.
Fermentation had varied effects on the protein content of Sorghum. The 24h fermented sorghum had the highest protein (12.92%) when compared to the unfermented sorghum that had (10.42%). The 24h fermentation of Cowpea slightly increased the protein level to 26.65% against the unfermented cowpea (26.64%). The unripe unfermented banana had 5.64% protein
The proximate composition of nutrend and flour blends from fermented sorghum, cowpea and unripe unfermented banana (residual moisture basis is shown in Table 2.).
Nutrend had higher protein (16.67%) than any of the blends. The protein levels for the composites ranged from 12.37% for SCUB 1 to 12.95% for SCUB 2, while SCUB 1 recorded the least protein. (12.37%), SCUB 2 had the highest (12.95%). The total lipids of Nutrend (9.38%) was higher than any of the blends. The blends on the other hand, had comparable values which ranged from 3.16 -3.82%. The SCUB 1 had the least value (3.16%). The ash values differed, ranging from 0.96 – 1.08%, while Nutrend recorded 2.40% which is two times higher than the value for each blend.

Nutrend had the least carbohydrate (66.34%) compared to the blends (79.43 – 80.88%). The results of the mineral and vitamin content of unfermented and fermented sorghum cowpea and unripe unfermented banana flour is shown in table 3. The 24h fermented sorghum recorded the highest level of Zinc as against the control (8.10mg) and others (8.12 and 7.95mg) respectively. Cowpea fermented for 24h had the least Zinc (16.15mg) as against the control and the 48h flour (19.45 and 18.70mg) respectively. Unripe unfermented banana had (25.00mg) zinc. the 48h fermented cowpea had the highest levels of zinc (18.70mg), calcium (3.00mg), Iron (25.25mg) and phosphorus (41.00mg).
The mineral composition of Nutrend and blends of fermented sorghum, cowpea and unripe unfermented banana (dry weight basis) is shown in Table 4. Nutrend had very high Ca as compared with the blends (390.0 vs 5.05, 4.43 and 6.33mg, respectively). The SCUB 3 had higher Ca than the other two blends (SCUB 1: 5:05 and SCUB 2:4.43) Iron level was highest in SCUB 2 than in other blends including the Nutrend. (14.5mg vs 10.03, 10.02mg and 10.00mg). The values of some nutrients like calcium, zinc phosphorus were improved when the samples were blended. Magnesium was not declared in Nutrend. The SCUB1 and 2 had 0.01mg each.

The sensory properties of porridges made from

from Nutrend, and the composite flours is shown in Table 5. Nutrend had higher colour score than any of the test porridges, SCUB1, SCUB 2 and SCUB 3 (8.07% vs 7.73% 7.20% and 7.67% respectively). For texture and flavour, Nutrend emerged with highest scores, however, the flavour score of SCUB1, SCUB 2 and SCUB 3 were similar (7.80%, 7.90% and 7.93%). The general acceptability rate of the test porridges were almost on the same level with Nutrend. (8.20% vs 7.87%) respectively.

Discussion

The protein levels of the sorghum and cowpea were 10.26% and 26.78% respectively. The values were comparable with those of some multimixes (10.6g/100g to 13.4g/100g) formulated for use as weaning foods in Nigeria(9) and that of cerelac (10.5%) and commercial infant food in Nigeria (10). However, Unripe banana had lower protein (5.64%).

The fairly high level of protein (12.37%, 12.95% and 12.63%) observed in the composites could be due to the high protein level of the cowpea (26.78%). Studies have shown that cowpea is a very good source of protein (11). Increased protein could also demonstrate the beneficial effect of adequate processing and supplementation(12). Also, the increase might be attributed to the hydrolytic activities of the proteolysis organisms present in the fermenting medium. They hydrolyze protein and its complexes with the release of free amino acids which are then used for the synthesis of new proteins(13). In general, the protein content of the formulated porridges was within the acceptable range for infants, 25gN/156g/100kcals of standard protein FAO/WHO(14). However, the protein levels of the flour mixtures could be upgraded by increasing the ratio of cowpea in the blends.

The increase in the fat level of fermented sorghum could be attributed to enzymic actions during fermentation. Fatty acid may have been synthesized during the metabolic activities of the microflora that is used in the synthesis of new lipid, thereby increasing the lipid level of the food. The low fat content for unripe banana (0.77) is expected. All root tubers exhibit low lipid. The low fat for banana coupled with its high starch content, makes it an ideal food for geriatric patients. The level of fat in the composites were (3.16%, 3.82% and 3.53%). Nutrend contained higher fat (9.38%) than the composites. Studies reported some lipase activities in fermenting grains, the lipase hydrolyses fat to glycerol and fatty acids, the free fatty acids react with some other components of the fermenting mash to form esters. These produce the characteristics aroma in foods(15). This degradation could lead to decrease in fat levels. Similar phenomena could have been the reason for the increases and decreases of fat in this present study. It is also of interest to note that foods with low fat content, have longer shelf-life than those with higher fat concentration due to oxidative rancidity and vice-versa(16).

The decrease observed in carbohydrate level of the fermented sorghum was not surprising. It is known that during fermentation, complex carbohydrates are hydrolyzed to simple sugars, which are used for metabolic processes(17). Beyond 48h of fermentation, the Cho level deceased. The decrease were attributed to increased activity of a-amylase(15), which hydrolyzes starch to simple sugars (glucose) which in turn becomes sources of energy for the fermenting micro organism. The high carbohydrate of unripe banana is expected.

The main nutrient supplied by roots and tubers is dietary energy provided by carbohydrates. The dry matter of root crops, banana and plantain is made up mainly of carbohydrate, usually up to 90 percent(18). The higher Carbohydrate content (80.88%, 79.43% and 80.17%) of the composites could be attributed to the kind of foods combined. The increase in the fibre value of fermented sorghum at 48h (3.08%) as against the control (2.28%) supports the findings of Eka(19), that fermentation could enhance nutritive value or decrease it. Also the slightly higher fiber content of SCUB 2(2.72%) composite could be due to the carbohydrate level of the foods combined to form the composites. The fair increase in the level of zinc, calcium, phosphorus and riboflavin in the fermented sorghum could be attributed to increased activity of microbial enzymes. They hydrolyzed the nutrient and released the minerals in them. Also, this could indicate that sorghum is a good source of these nutrients. The thiamin and riboflavin levels of the fermented sorghum were higher when compared to their controls. The reason for this could be as a result of the release of of these nutrients during fermentation by the micro flora enzymes. The gradual decrease in phytate level noticed in Sf $_{48}$ and Sf_{72} (2-40mg - 0.55mg) as against the control (2.85mg) could be as a result of fermentation. This supports (Okeke and Ibeanu)[20]observation that fermentation reduces anti nutrients in foods and increases the nutritive values of those foods. Also, it is expected that such foods will be easily digested because of the partial breakdown by some enzymes during fermentation. Similarly, the gradual decrease of tannins and phytate level in fermented cowpea could as well be attributed to the effect of fermentation. The general acceptability of the products were affected by the flavour, texture and colour. The products with higher flavour were much more acceptable.

Nutrend was the most acceptable, followed by SCUB 2 (50:30:20). This could be due to the familiarity of the judges to "Nutrend", an already known infant food in the market. SCUB 1 and SCUB 3 had comparable acceptability (7.87%). This could be due to the similarity in the flavour that accorded them the same level of acceptance. In general, the welcomed acceptability of all the porridges by the judges showed that the composites could be accepted by infants.

CONCLUSION

The study shows that fermentation increased protein in sorghum grain (Sf_{24}) and in cowpea seed (Cf_{48}). The fat levels of the Sf_{48}, Sf_{72} and CF_{48} were increased as a result of fermentation. The unfermented cowpea (Cu) had higher level of ash than the fermented products. In effect, fermentation did not affect the level of ash in cowpea while there were significant improvement in the level of ash among the fermented sorghum than the unfermented once. The phytate level in all the products were significantly reduced especially in cowpea products which ranged from 12.90 to 375mg/100g. Almost all the products had minimal levels of tannins (0.66mg to 0.83mg).

The result of the composites concludes that SCUB 2 had better nutrient composition than the other composites, except for calcium, zinc and phosphorus. The mean scores of the porridges regarding the sensory properties (colour, texture, flavour and general acceptability) did not vary much from that of Nutrend. This implies that any of the porridges could be used and accepted as complementary food for young children.

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Table 1: Proximate composition of unfermented and fermented sorghum, cowpea and unripe unfermented banana (Dry weight basis).

Sample	Protein %	Ash %	Fat %	Crude fibre%	CHO %
Sorghum					
Su	10.42±0.63	2.13±0.07	2.49±0.14	2.28±0.00	82.68±0.02
Sf_{24}	12.92±0.29	2.19±0.07	2.59±0.35	2.44±0.28	79.86±0.02
Sf_{48}	10.26±0.49	2.43±0.00	3.48±0.07	3.08±0.07	80.75±0.01
Sf_{72}	11.12±0.42	2.44±0.07	3.53±0.00	2.80±0.14	80.11±0.02
Cowpea					
Cu	26.64±0.14	3.75±0.14	1.12±0.07	2.94±0.21	65.55±0.01
Cf_{24}	26.65±0.36	2.23±0.14	1.72±0.07	1.41±0.07	69.29±0.07
Cf_{48}	26.78±0.14	2.30±0.28	1.81±0.07	1.26±0.42	62.95±0.01
Banana					
UB	5.64±0.28	3.54±0.14	0.77±0.14	2.49±0.07	87.56±0.02

Means ± SD of 3 determinations
Su: Unfermented sorghum flour
Sf_{24}: Sorghum flour fermented for 24h
Sf_{48}: Sorghum flour fermented for 48h

Table 2: Proximate composition of unfermented and fermented sorghum, cowpea and unripe unfermented banana flours (residual moisture basis).

Nutrients	Nutrend 100%	SCUB 1 60:30:10	SCUB 2 50:30:20	SCUB 3
Protein (%)	16.67	12.37±0.04	12.95±0.08	2.28±0.00
Fat (%)	9.38	3.16±0.00	3.82±0.07	2.44±0.28
Ash (%)	2.40	0.96±0.07	1.08±0.07	3.08±0.07
Fibre (%)	5.21	2.61±0.01	2.72±0.01	2.80±0.14
Carbohydrate (%)	66.34	80.88±0.18	79.43±0.28	80.17±0.03

*Control
Means ± SD of 3 determinations
SCUB 1: (60:30:10): 24h fermented sorghum, 48h fermented cowpea and unripe unfermented banana flours.
SCUB 2: (50:30:20): 24h fermented sorghum, 48h fermented cowpea and unripe unfermented banana flours.

Table 3: Mineral and vitamin level of unfermented sorghum, cowpea and unripe unfermented banana flours (mg/100g)

Sample	Zinc (mg/100mg)	Calcium (mg/100g)	Magnesium (mg/100g)	Iron (mg/100g)	Phosphorus (mg/100g)	Thiamin (mg/100g)	Riboflavin (mg/100g)
Sorghum							
Su	8.10±0.14	070±0.00	1.100±0.00	12.50±0.56	34.50±2.12	0.12±0.00	3.05±0.01
Sf_{24}	8.20±0.28	0.50±0.14	0.95±0.07	11.95±0.07	41.00±1.41	0.16±0.00	3.45±0.01
Sf_{48}	8.12±0.16	0.85±0.07	1.00±0.00	12.10±0.14	35.00±1.41	0.14±0.00	4.45±0.00
Sf_{72}	7.95±0.35	0.65±0.07	0.95±0.07	12.10±0.04	48.00±1.41	0.13±0.01	3.25±0.01
Cowpea							
Cu	19.45±0.21	2.30±0.00	0.90±0.00	25.15±0.21	40.50±0.70	5.20+0.01	5.65±0.00
Cf_{24}	16.15±0.07	2.05±0.07	4.45±0.52	24.50±0.03	36.50±0.70	6.70+0.00	5.05±0.01
Cf_{48}	18.70±0.14	3.00±0.28	0.90±0.00	15.25±0.21	41.00±1.41	5.50+0.00	4.20±0.00
Banana							
UB	25.00+0.28	3.54±0.14	0.95±0.67	24.15+0.07	35.50.+0.70	1.50+0.00	2.10±0.00

Means ± SD of 3 determinations
Su: Unfermented sorghum flour
Sf_{24}: Sorghum flour fermented for 24h
Sf_{48}: Sorghum flour fermented for 48h
Sf_{72} Sorghum fermented for 72h
Cu: unfermented Cowpea flour
Cf_{24}: Cowpea flour fermented for 24h
Cf_{48}: Cowpea flour fermented for 48h
UB: Unripe unfermented banana flour.