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The nutritional quality of fermented Bambara groundnut (BG) and local rice (FARO-8 short grain) flour blends and the effect on the mean growth of fed albino weanling rats

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ABSTRACT

This study evaluated the nutritional quality of fermented BG and local rice (FARO-8 short grain) flours and the effect on the mean growth weight of albino weanling rats. Bambara groundnut (BG) is a highly nutritious crop that plays an important role in people's diet but contains antinutrients. The BG seeds used for the study were fermented at different periods to produce flours. Blends of fermented Bambara groundnut and local rice flours were formulated and the nutrient content and the biological value were determined. A total of seven diets were formulated. The ratios of the blends of 48hrs fermented Bambara groundnut to Uzuakoli rice (FARO-8 short grain) were: 80:20 (BFE₁:R), 70:30 (BFE₂:R), 60:40 (BFE₃:R). Other three diets formulated using Bambara groundnut flours at 24hr, 48hr and 72hr fermentation periods alone were in the ratio of 100:0 respectively (BTF:0, BFE:0 and BST:0). Then, 0-hr Bambara groundnut blend in the ratio of 100:0 served as the control (BZE*). Seven groups of albino rats were fed the blends respectively and the mean growth were measured weekly using electronic weighing balance during the study period. This study was carried out for 35 days. Result of the nutrient determination showed that the moisture content of the diet blend ranged from 9.27 to 10.30%. There were significant differences (P<0.05) in the protein content of the blends and it ranged from 18.48 to 22.81%. The fat content also varied and ranged from 5.76 to 8.30%. The ash values ranged from 3.26-3.94%. The fibre content also varied. All the composites had high carbohydrate values that ranged from 53.65 to 58.98%. There were significant differences in the mineral values (P<0.05). There were also significant differences in their vitamin levels (P>0.05). The antinutrients showed high level of significant differences

($P < 0.05$). The mean growth values (119.94g) of the rats fed diet BFE:0 were the highest. Results obtained showed that fermentation had a significant effect on the protein quality of the blends and on the mean growth weight of the albino rats. Fermentation of legumes is necessary in improving the nutritional quality.

Keywords: Nutritional quality, fermented Bambara groundnut and local rice blends, mean growth.

Introduction

Bambara groundnut (*Vigna subterranea* L.) is a legume indigenous to Africa and is cultivated across the semi-arid sub-Saharan Africa region (Hillocks et.al, 2012). Bambara groundnut is thought to have its center of origin somewhere between West and Central Africa (Temagne et.al, 2018). This nutrient-dense legume is sometimes termed a “complete food” due to its balanced macronutrient composition. Bambara groundnut contains ~64.4% carbohydrate, 23.6% protein, 6.5% fat, and 5.5% fiber and is rich in minerals (Azman et.al, 2019). Bambara groundnut seeds contain phytochemicals such as flavonoids and tannins. These compounds are usually found in the seed coats and are more abundant in seeds with dark or red-colored seed coats. A positive correlation between darkness of seed coat and total phenolic compounds has been established (Tsamo et.al, 2018). Despite having an antioxidant capacity, the presence of polyphenolic compounds can form indigestible complexes with dietary minerals, starch, and proteins, thereby reducing their bioavailability (Unigwe et.al, 2019). Binding with proteins can inhibit the activity of digestive enzymes. Tannin compounds can also impart bitterness and astringency to the food (Rauf et.al, 2019)), thereby affecting palatability. Phytic acid is more abundant in the seed cotyledon, where it serves as a phosphorus reserve for the plant (Rousseau et.al 2020). Fermentation is a traditional, low-technology processing option that can be used to enhance the nutritional value of Bambara groundnut (Adebiyi et.al, 2019).

The problems associated with Bambara groundnut are the concern on the nutrition security of this food product.

To this effect, blends of fermented Bambara groundnut and a local rice to determine its nutrients and biological value were done. This will help to provide information on the effect of fermentation on the nutritive potentials of this legume and its complementary effect with a local cereal (rice). This study was done to determine the complementary effect of fermented Bambara groundnut and a local rice on the mean growth of fed albino weanling rats.

Materials and methods

Preparation of flours

Healthy and mature seeds of Sokoto white of the Bambara groundnut (*Voandzeia subterranea*) were purchased from Umuahia Main Market while the rice variety which is the local short grain (FARO-8) was purchased from Uzuakoli rice mill all in Abia State. The seeds of the Bambara groundnut and rice grains used for the study were handpicked to remove dirt and stones.

Eight hundred grammes (800g) each of the Bambara groundnut seeds were steeped in clean water and fermented for 24hrs, 48hrs and 72 hrs. The seeds were allowed to ferment by the natural microflora of the seeds. One portion of the Bambara groundnut seeds was left unfermented and was coded 0hr.

At the end of each fermentation period, the seeds were dried separately in oven at 55 °C and milled into a fine flour using a disc attrition mill model 2002 F.H Bentall and Co.,UK and milled twice in order to get fine flour. The milled samples were sieved using muslin cloth to ensure uniform particle size.

The rice grains were also milled and both flours were stored separately in air-tight polythene bags.

Formulation of composite flours

The crude nitrogen (N) concentration of the BG and rice were determined by micro-Kjeldahl procedure (AOAC, 2023) before being used in the formulation of the diet blends. Based on the values of the crude N and ratios of the food sources, the total amounts required to furnish 10% protein per day for the albino rats on each composite was calculated. There were 7 composites in total. The diets were blends of the Bambara groundnut flours at different fermentation periods and Uzuakoli local rice (FARO-8 short grain). Other nutrients such as minerals, vitamins, vegetable oil and sucrose were added to balance the diets. The diets were stored individually in labelled polythene bags until used for the study. A total of seven diets were formulated. The ratios of the blends from 48hr Bambara groundnut flours to Uzuakoli rice (FARO-8 short grain) were: 80:20 (BFE₁:R), 70:30 (BFE₂:R), 60:40 (BFE₃:R). Other three diets formulated using Bambara groundnut flours at 24hr, 48hr and 72hr fermentation periods alone were in the ratio of 100:0 (BTF:0, BFE:0 and BST:0) respectively. Then, 0 hr Bambara groundnut blend (BZE*) in the ratio of 100:0 served as the control.

Chemical analysis

Chemical analysis of the nutrient and antinutrient composition were determined using standard methods. Each analysis was carried out in triplicates on all samples. The micro-Kjeldahl method was used to determine the crude protein while Soxhlet method was used to determine fat as described by Nielsen (2002). Ash was determined using the dry method as described by Nielsen (2002). Carbohydrate values

were determined by difference method. For the antinutrient composition, Hydrogen cyanide (HCN) was quantified using the AOAC (2023), The estimation of Phytin –Phosphate (Phytin –P or phytate), tannin and oxalates were determined using the colorimetric procedure described by Onwuka (2018).

Mean growth measurement using body weight

Thirty-five healthy albino weanling rats were used for this study. The rats which were housed in a metabolic cage were divided into seven groups of five per group and fed with pellets of the formulated diets and water *ad libitum*. The seventh group served as the control. The diets fed to the rats were formulated according the protein requirement for growth in rats. This study lasted for 35 days including the seven days acclimatization period.

Feed intake were monitored, calculated and values measured. The body weights of the individual rats were measured weekly during the study period using electronic weighing scale and the values recorded. The weights of the albino weanling rats in grams (g) were taken before the starting of the experiment (initial weight) and at the end of the experiment (new weight) for each individual rat in a group. Then, the total weight per week were calculated by subtracting the initial weight of each rat in a group from the new weight. Mean weight were also calculated.

Mean weight per week = total weight of rats ÷ number of rats per group

Calculation of nitrogen

Nitrogen content (N) of the diet blends in grams (g) consumed by the rats were calculated using the formula:

$$\text{Crude protein (g)} = \text{N} \times 6.25$$

$$\text{Therefore, N} = \text{Crude protein (g)} \div 6.25$$

Data analysis

The mean, standard error of the mean (SEM) and analysis of variance (ANOVA) of the data obtained from the study was computed using computer application software package, statistical package for IBM (SPSS) version 23. Means were separated by Duncan's Multiple Range Test and significance judged at $P > 0.05$.

Results

Table 2 shows the proximate composition of Bambara groundnut-rice blends. The moisture content of BFE₂:R and BFE₃:R which had the highest value (10.35% and 10.16%) respectively showed a significant difference ($P < 0.05$) to the rest of the blends. Meanwhile, diet BTF:0 had the lowest value (9.24%).

There were significant differences in the protein content of the blends ($P < 0.05$). Diet BFE:0 had the highest protein value (22.81%) while BZE:0 had the lowest (18.48%). However, BST:0 (21.43%) and BTF:0 (20.81%) had comparable protein values. It was observed that the diets without rice in the blends were found to have higher protein content while those containing rice had lower protein content.

The fat composition of the blends varied. Diet BZE:0 (the control) had the highest fat value (8.30%) and was significantly higher ($P < 0.05$) while BFE:0 (8.17%) and BST:0 (8.24%) had comparable values ($P > 0.05$) with the control. Diet BFE₃:R had the lowest (5.69%).

The ash content of the blend varied also. The ash content of BFE₃:R (3.94%) was significantly higher ($P < 0.05$). Diet BFE₂:R and BFE₁:R (3.83% and 3.78%) had comparable values ($P > 0.05$) respectively. Meanwhile, the ash content of diet BZE:0 was the lowest (3.26%).

The fibre content of BFE:0 (2.76%) and BTF:0 (2.72%) were the highest among the diet blends and was significantly different ($P < 0.05$). This was followed by BST:0 (2.64%). However, BFE₂:R and BFE₃:R had the lowest fibre values (2.18 and 2.13%) respectively and their values had no significant differences ($P > 0.05$).

There were significant differences in the carbohydrate content of the diet blends. The carbohydrate content of BFE₂:R, BFE₁:R and BFE₃:R were the highest in value (58.93, 58.91 and 58.59%) respectively ($P > 0.05$). There were no significant differences ($P > 0.05$) in the values of BZE:0 and BTF:0 as they had comparable values (57.60 and 56.99%) respectively whereas BFE:0 and BST:0 had the least but comparable values (53.65 and 54.77%) ($P > 0.05$) respectively.

Table 3 shows the antinutrient composition of Bambara groundnut-rice blends. The hydrogen cyanide (HCN) value of BST:0 (0.19mg/100) was the highest among the blends whereas BFE₂:R and BFE₃:R had the least values (0.11mg/100) respectively. For the phytate level, BZE:0 had the highest value (0.55mg) among the blends. BFE₃:R had the least phytate value (0.13mg/100). The tannin level of BFE₁:R (0.29mg) and BST:0 (0.28mg/100) was significantly higher ($P < 0.05$) while BFE₃:R had the least tannin value (0.17mg/100). The hemagglutinin value of BST:0 (5.93mg/100) was significantly higher ($P < 0.05$) while BFE₃:R had the least value (1.46mg). The oxalate level of diet BZE:0 (1.29mg) (the control) was the highest while BFE₃:R had the lowest value (7.60mg/100).

Table 4 shows the weekly mean growth of rats fed composite diets. The mean growth of the group of rats fed diet BFE:0 was the highest (119.94g) and was significantly different ($P < 0.05$) among the other group of rats fed experimental diets. This was followed by the group of rats fed diets BFE₂:R and BFE₃:R which had no significant difference ($P > 0.05$) in their values (114.87g and 113.56g) respectively. The group of rats fed diet BST:0 and BFE₁:R compared well ($P > 0.05$) in their values respectively (109.46g and 106.60g) while the group of rats fed diet BZE:0 had the least mean growth (90.97g).

Table 4 shows the nitrogen intake of the group of rats fed the composite diets. The group of rats fed diet BFE:0 had the highest nitrogen intake value (3.59g) while the group of rats fed diet BZE:0 had the least nitrogen value (2.96g).

Discussion

The high moisture content of BFE₂:R and BFE₃:R could be as a result of the presence of rice in the diet blend. Both of them contains higher proportion of rice among the blends. However, their moisture values were within the moisture range for properly dried foods (5-15%) and this indicated that the samples would have good keeping or storage quality.

The high protein value of BFE:0 could be attributed to the fact that the composites were based on Bambara groundnut flour which is a leguminous seed. Since BFE:0 is a product of fermentation, the increases in the protein levels could also be attributed to hydrolytic breakdown of tannin-protein complexes by microbial enzymes to release free proteins as observed by (Ojha et.al, 2018) in their study.

The high fat content of BZE:0 (8.30%), BFE:0 (8.17%) and BST:0 (8.24%) could be as a result of the combined ratio in the blends which affected the quantity of fat incorporated into the blend. The low-fat content of BFE₃:R (5.59%) could also be attributed to the ratio of the composites that affected the quantity of fat in it. It was discovered from the study that, the higher the rice in the blend, the lower the fat content.

The high ash content of BFE₃:R could be attributed to the ratio of the blend. It was observed from the study that the higher the quantity of rice in the blend, the higher the ash content. This signified that the duo combination of Bambara groundnut and rice caused an increase in the ash content of the blends. Based on this fact, the higher content of BFE₃:R could be indicative of higher mineral content. This indicated that the blend would have high level of mineral content.

The fibre value for BFE:0 (2.76%) and BTF:0 (2.72%) suggested that legumes have higher fibre content more than cereals. The high fibre content of legumes could be a source of fibre for people who are placed on a high fibre diet.

The higher carbohydrate values for BFE₂:R, BFE₁:R and BFE₃:R (58.93, 58.91 and 58.59%) were understandable. It could be attributed to the presence of rice in the blend ratios. Since rice is a rich source of carbohydrate, the combination of the legume-cereal foods could have led to increase in the carbohydrate content more than the blends that do not contain rice.

For the antinutrients, the high hydrogen cyanide (HCN) value (0.19mg/100) found in BST:0 diet could be attributed to re-absorption of the antinutrient with prolonged soaking while the low values in BFE₂:R and BFE₃:R might be as a result of the combination of rice in the blends. Meanwhile, a cyanide content in the range of 10-20mg per 100g of pulse is considered safe. He noted that many legumes, except lima bean (*Phaseolus lunatus*) contain cyanide within this limit. The high phytate value of the control might be due to the fact that Bambara groundnut used for the blend were not fermented. Meanwhile, the low value of phytate in BFE₃:R might be due to the higher proportion of rice in the blends. The high tannin value of BFE₁: R and BST:0 could be attributed to re-absorption of the antinutrient as a result of prolonged soaking. The high hemagglutinin value of BST:0 could also be due to re-absorption of the antinutrient with prolonged soaking. The low hemagglutinin values of BFE₃:R could be due to the higher proportion of rice in the blend. The high oxalate level of diet BZE:0 might be due to the fact that the Bambara groundnut was not fermented and was still in its natural form while the low level of BFE₃:R might be as a result of the reduction effect that fermentation had on the Bambara groundnut.

The high mean growth of the group of rats fed diet BFE:0 could be easily understood. They had the highest nitrogen intake which contributed positively to this effect (table 5). Food fermentation has been shown to effectively increase the nutritional composition of foods as well as decrease the levels of antinutritional factors (ANFs) and toxic constituents (Olagunju et.al, 2019). An improved protein digestibility during fermentation is attributed to the release of protein from plant tissues by the enzymatic breakdown of dietary fibres, with a simultaneous reduction in/degradation of polyphenols, tannins and phytic acid by the action of microbial enzymes (Annor et.al, 2017). This signified that fermentation increased the protein content of the Bambara groundnut used to formulate the blend and the nitrogen content of the blend by improving its digestibility and this was utilized effectively to bring about growth. Protein is a food nutrient that the primary function in the body is to cause growth. Bambara groundnuts are legumes and legumes are rich sources of protein. The group of rats fed diet BZE:0 which had the least nitrogen intake (table 5), likewise, had the lowest mean growth. This result was not surprising. Due to the

high presence of antinutrients in the unfermented Bambara groundnut, the nitrogen utilization in the body was affected. This factor could have affected the growth of the rats fed this diet. Adebo et.al (2022) stated that during fermentation, insoluble/complex storage proteins undergo perturbations in structural configurations, which render them more accessible and susceptible to attack by pepsin and endopeptidase that breaks down proteins into smaller peptides that are more soluble.

Conclusion

Protein is a food nutrient that the primary function in the body is to cause growth. The mean growth of the rats was affected by the quality of the protein and also the proportion of rice to Bambara groundnut in their diets. Without the use of animal protein to enhance the protein quality, a higher proportion of Bambara groundnut in the diet caused a positive increase in the growth of the rats. This combination is not common where cereals usually have a higher proportion in the formulation of diets. Therefore, it is recommended that a higher proportion of legumes to cereals in diet is required to bring about growth especially for young children.

Table 1: Composition of the 7 experimental diets in grams (g) for the 35 days.

Ratio/		1	2			3	4	5	6		7
Ingredients		80:20:00	70:30:00			60:40:00	100:00:00	100:00:00	100:00:00		100:00:00
BFE ₁		1283.1	-			-	-	-	-		-
BFE ₂		-	1122.8			-	-	-	-		-
BFE ₃		-	-			962.5	-	-	-		-
BTF		-	-			-	1700.65	-	-		-
BFE		-	-			-	-	1632.4	-		-
BST		-				-	-	-	1604.05		-
BZE*		-				-	-	-	-		1716.4
Rice		809.2	1213.8			1618.4	-	-	-		-
Veg.oil		209.23	209.23			209.23	209.23	209.23	209.23		209.23
Vitamin. mix ⁺		20.92	20.92			20.92	29.92	29.92	29.92		29.92
Mineral. mix ⁺	83.7			83.7		83.69	83.69	83.69	83.69		83.69

Sucrose	109 4			850	606		1350.9 7	1545.4 5	1573.1 1	1460 .8	
Total	350 0			350 0	350 0		3500	3500	3500	3500	

[†]SOURCE:- Bio-organics nutrient system LTD. Plot 893 Isheri road by Ojodu b/stop, Ikeja Lagos, Nigeria.

Values were regarded as 3500g; BZE (the control)- unfermented Bambara groundnut; BTF- 24hrs fermented Bambara groundnut ; BFE- 48hrs fermented Bambara groundnut; BST-72hrs fermented Bambara groundnut; R – Rice; subscript-1=(80:20), 2= (70:30) and 3= (60:40)

Table 2: Proximate composition of Bambara groundnut-rice blends (g/100)

Diets and ratio	Moisture	Crude protein	Fat	Ash	Crude fibre	Carbohydrate	Energy (KJ)
BFE1:R (80:20)	9.46bc±0.33	19.78d±0.01	6.64d±0.01	3.78b±0.01	2.20d±0.06	8.91a±0.62	1566.99
BFE2:R (70:30)	10.35a±0.23	19.35e±0.01	6.09e±0.01	3.83b±0.02	2.18d±0.01	8.93a±0.51	1539.42
BFE3:R (60:40)	10.16a±0.01	18.74f±0.01	5.69f±0.01	3.94a±0.02	2.13d±0.02	58.59a±0.77	1508.45
BTF: 0 (100:0)	9.24c±0.01	20.81c±0.01	6.85c±0.00	3.36d±0.01	2.72a±0.01	56.99b±0.00	1560
BFE: 0 (100:0)	9.33c±0.01	22.81a±0.01	8.17ab±0.01	3.28e±0.02	2.76a±0.01	53.65c±0.05	1587.29
BST: 0 (100:0)	9.45bc±0.01	21.43b±0.06	8.24ab±0.02	3.47c±0.01	2.64b±0.01	54.77c±0.02	1585.57
BZE*:0 (100:0)	9.84b±0.01	18.48g±0.16	8.30a±0.09	3.26e±0.03	2.52c±0.00	57.60b±0.18	1536.20

Mean ± SEM of three determinations; a-g values in the same column with different superscript letters differed from each other (P<0.05)

BZE*(control)- unfermented Bambara groundnut; BTF- 24hrs fermented Bambara groundnut ; BFE- 48hrs fermented Bambara groundnut; BST-72hrs fermented Bambara groundnut; R – Rice;

Table 3: Antinutrient composition of Bambara groundnut-rice blends (mg/100)

Diets	HCN*	Phytate	Tannin	Hemagglutinin	Oxalate
BFE₁:R (80:20)	0.13 ^d ± 0.01	0.36 ^d ± 0.01	0.29 ^a ± 0.01	1.73 ^e ± 0.02	0.33 ^d ± 0.01
BFE₂:R (70:30)	0.11 ^e ± 0.01	0.28 ^e ± 0.01	0.25 ^b ± 0.02	1.61 ^f ± 0.01	0.29 ^e ± 0.02

BFE₃:R (60:40)	0.11 ^e ± 0.01	0.13 ^f ± 0.03	0.17 ^d ± 0.01	1.46 ^g ± 0.03	0.24 ^f ± 0.01
BTF:0 (100:0)	0.14 ^c ± 0.01	0.43 ^c ± 0.01	0.22 ^c ± 0.01	4.77 ^d ± 0.01	0.92 ^c ± 0.32
BFE:0 (100:0)	0.17 ^b ± 0.02	0.43 ^c ± 0.01	0.23 ^b ± 0.01	5.14 ^c ± 0.01	1.24 ^b ± 0.00
BST:0 (100:0)	0.19 ^a ± 0.00	0.48 ^b 0.01	0.28 ^a ± 0.01	5.93 ^a ± 0.01	1.28a ± 0.01
BZE*:0 (100:0)	0.13 ^d ± 0.01	0.55 ^a ± 0.02	0.25 ^b ± 0.01	5.50 ^b ± 0.01	1.29 ^a ± 0.05

Mean ± SEM of three determinations; a-g values in the same column with different superscript letters differed from each other (P<0.05)

BZE*(control)- unfermented Bambara groundnut; BTF- 24hrs fermented Bambara groundnut ; BFE- 48hrs fermented Bambara groundnut; BST-72hrs fermented Bambara groundnut; R – Rice; Ratios- 1=(80:20), 2= (70:30), 3= (60:40)

HCN* Hydrogen cyanide

Table 4 : Weekly mean growth of rats fed experimental diet blends (g).

Diets and ratios	Wee k0	Week1	Wee k2	Week3	Week4	Week5	Week6	Week 7	Mean Total
BFE ₁ :R (80:20)	47.0 ^{0a} ±1.22	65.00 ^b ±0.00	81.6 ^{0b} ±1.44	100.16 ^b ±2.78	129.00 ^c ±4.58	143.00 ^c ±6.25	141.00 ^d ±5.34	146.00 ^c ±5.10	106.60 ^c ±5.95
BFE ₂ :R (70:30)	50.0 ^{0a} ±0.00	61.00 ^{bc} ±2.45	90.0 ^{0a} ±3.54	105.32 ^a ±2.26	138.40 ^a ±7.49	153.40 ^b ±5.87	157.40 ^b ±5.81	163.40 ^b ±6.21	114.87 ^b ±6.88
BFE ₃ :R (60:40)	50.0 ^{0a} ±0.00	72.00 ^a ±1.22	87.0 ^{0a} ±3.00	93.54 ^c ±6.34	136.10 ^b ±3.67	152.60 ^b ±4.03	156.60 ^b ±4.31	160.60 ^b ±4.79	113.56 ^b ±6.56
BTF:0 (100:0)	50.0 ^{0a} ±0.00	63.00 ^b ±3.39	82.0 ^{0b} ±2.00	95.14 ^{bc} ±2.16	117.14 ^d ±4.82	133.06 ^d ±3.71	137.06 ^d ±3.71	140.66 ^d ±3.10	102.23 ^{cd} ±5.34
BFE:0 (100:0)	50.0 ^{0a} ±0.00	66.00 ^b ±2.92	91.0 ^{0a} ±1.87	107.00 ^a ±2.00	141.50 ^a ±3.96	165.60 ^a ±4.30	168.60 ^a ±3.56	169.80 ^a ±4.72	119.94 ^a ±7.28

BST: 0 (100: 0)	50.0 0 ^a ±0.0 0	59.00 ^c ±1.00	87.0 0 ^a ±1.2 2	97.00 ^b ±1.22	139.06 ^a ±8.40	146.56 ^c ± 9.33	150.06 ^c ± 8.39	147.00 ^c ±6.47	109.46 ^c ± 6.47
BZE *:0 (100: 0)	50.0 0 ^a ±0.0 0	57.00 ^c ±1.22	76.4 0 ^c ±2.9 1	84.60 ^d ± 2.82	106.80 ^e ± 3.44	113.98 ^e ± 1.30	119.38 ^e ± 1.63	119.60 ^e ±2.01	90.97 ^e ± 4.25

Mean ± SEM of three determinations; a-e values in the same column with different superscript letters differed from each other (P<0.05)

BZE*(control)- unfermented Bambara groundnut; BTF- 24hrs fermented Bambara groundnut ; BFE- 48hrs fermented Bambara groundnut; BST-72hrs fermented Bambara groundnut; R – Rice; Ratios- 1=(80:20), 2= (70:30), 3= (60:40)

Table 5 : Nitrogen intake of rats fed Bambara groundnut-rice blends (g)

Diets and ratios	1	2	3	4	5	6	7
	BFE ₁ :R	BFE ₂ :R	BFE ₃ :R	BTF:0	BFE:0	BST:0	BZE*:0
	(80 : 20)	(70 : 30)	(60 : 40)	(100 : 0)	(100 : 0)	(100 : 0)	(100 : 0)
Nitrogen intake	3.15 ^d ±0.00	3.09 ^e ±0.00	3.00 ^f ±0.00	3.30 ^c ±0.03	3.59 ^a ±0.00	3.49 ^b ±0.01	2.96 ^g ±0.03

Mean ± SEM of three determinations; a-e values in the same column with different superscript letters differed from each other (P<0.05)

BZE*(control)- unfermented Bambara groundnut; BTF- 24hrs fermented Bambara groundnut ; BFE- 48hrs fermented Bambara groundnut; BST-72hrs fermented Bambara groundnut; R – Rice; Ratios- 1=(80:20), 2= (70:30), 3= (60:40)

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The author(s) declare that it is not applicable.

Consent for publication

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Competing interests

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References

1. Adebisi, J.A., Njobeh, P.B., and Kayitesi, E. (2019). Assessment of nutritional and phytochemical quality of dawadawa (African fermented condiment) produced from Bambara groundnut (*Vigna subterranea*). *Microchemistry Journal* 149:104034.

2. Annor, G.A., Tyl, C., Marcone, M., Ragaee, S., and Marti, A. (2017). Why do millets have slower starch and protein digestibility than other cereals? *Trends In Food Science And Technology* 66: 73-83.
3. Association of Official Analytical Chemists, (AOAC) (2023). *Official methods of analysis*. Washington D.C, USA. 22nd edition, Pp. 810-850.
4. Azman, H.R., Barkla, B.J., Mayes, S. and., King, G.J. (2019). The potential of the underutilized pulse Bambara groundnut (*Vigna subterranea L.*) for nutritional food security. *Journal of Food Composition Analogy* 77:47–59.
5. Hillocks, R.J, Bennett, C., and Mponda, O.M. (2012). Bambara nut: a review of utilization, market potential and crop improvement. *African Crop Science Journal*. 20:1–16. Available online at: <https://www.ajol.info/index.php/acsj/article/view/78601>
6. Nielsen, S.S. (2002). *Introduction to the chemical analysis of foods*. CBS Publishers and distributors, New Delhi, India, Pp 96 – 186.
7. Ojha, P., Adhikari, R., Mishra, A., Subedi, U., and Karki, T.B. (2018). Malting and fermentation effects on antinutritional components and functional characteristics of sorghum flour. *Food Science and Nutrition* 6:47-53
8. Olagunju, O.F., Ezekiel, O.O., Ogunshe, A.O., Oyeyinka, A., and Ijabadeniyi, O.A (2019). Effects of fermentation on proximate composition, mineral profile and antinutrients of tamarind (*Tamarind indica L.*) seed in the production of dawadawa-type condiment. *LWT-Food Science Technology* 90:455-459.
9. Onwuka, G.I. (2018). *Food Analysis and Instrumentation (Theory and Practice)- Second edition*. Naphthali Printers, pp. 299-314.
10. Rauf, A., Imran, M., Abu-Izneid, T., Iahtisham-Ul-Haq, Patel, S., and Pan, X. (2019). Proanthocyanidins: a comprehensive review. *Biomedical Pharmacotherapy* 116:108
11. Rousseau, S., Kyomugasho, C., Celus, M., Hendrickx, M.E.G., and Grauwet, T. (2020). Barriers impairing mineral bioaccessibility and bioavailability in plant-based foods and the perspectives for food processing. *Critical Review in Food Science and Nutrition*) 60:826–43.
12. Temegne, N., Gouertoumbo, W., Wakem, G., Nkou, F., Youmbi, E., and Ntsomboh-Ntsefong, G. (2018). Origin and ecology of Bambara groundnut (*Vigna Subterranea L.*): a review. *Journal of Ecology of Natural Resource* 2:1–10.

13. Tsamo, A.T., Ndibewu, P.P., and Dakora, F.D. (2018). Phytochemical profile of seeds from 21 Bambara groundnut landraces via UPLC-qTOF-MS. *Food Resources International* 112:160–168.
14. Unigwe, A.E, Doria, E., Adebola, P., Gerrano, A.S., and Pillay, M. (2018). Anti-nutrient analysis of 30 Bambara groundnut (*Vigna subterranea*) accessions in South Africa. *Journal of Crop Improvement* 32:208–224.

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