Nutritional Quality Evaluation of Garri-Like Product from Sweet Potato

Kure O.A[1], Samuel M.S[2], Kure, A[3]

[1, 2, 3]Department of Food Technology, Federal Polytechnic, Kaura Namoda, Zamfara State, Nigeria

Abstract: ***Sweet potato was used to produce garri at 0 (non fermentation), 24, 48, and 72 hours fermentation periods, respectively. Each was used to formulate a feed of 10% protein and the nutritional quality of the products were evaluated using in-vivo protein quality evaluation. A 28 days feeding eperiment was done using 21 male weanling albino rats and data obtained were used to compute protein quality indices: feeding efficiency ratio (FER), Feed, conversion efficiency (FCE), Protein efficiency ratio (PER), net protein retention (NPR) and apparent digestability (AD). Feed intake for diet A (SPNF), B (SPF1), C (SPF2), D (SPF3), E (cassava garri), F (Casein diet) and G (basal diet) ranged from 713.20 to 528.40g respectively. Diet A-G had a FER of -0.05, 0.02, 0.01, -0.02, 0.08 and 0.07; PER of -0.05, 0.19, 0.14, 0.12, 0.20, 1.00 and 0.00. AD of 97.95, 98.10, 97.60, 98.00, 97.74, 97.90 and 0.00 respectively. This evaluation has shown that sweet potato garri is of low nutritional quality, as it is of high energy value but deficient in growth-supporting nutrients. However, fermented garri samples showed better performance than non-fermented ones.***

Keywords: sweet potato, garri, in-vivi protein, evaluation

1. Introduction

Sweet potato (*Ipomea batatas*) is a versatile root crop grown in all parts of tropical and subtropical world. It is valued for its short growing period of 90 to 120 days, high nutritional content and its sweetness. Despite these values, it has not gained popularity in Nigeria due to minimal integration into the average North-West Nigerian diet. Limited product diversity coupled with little awareness of its potential benefits and physical properties could account for it's low consumption in Nigeria. These notwithstanding the unavailability of ready market and storage limitations that cultivators mostly in North-West of Nigeria have to grapple with, poses great challenges. Studies on sweet potato leaves and root tubers have yielded good results, though further studies are required to consolidate some findings. This will enhance broad utilization of sweet potatoes which will be of economic advantage to the country while encouraging many farmers to go into its cultivation (Dincer, et al, 2011).

According to FAO statistical data (2014), Nigeria is rated number three among the world producers of sweet potato with 2.8 million tons while China is first with 81.7 million tons. As at 2015 Nigeria was second after China 171.37 million with 3.86 million tons.

Sweet potatoes contain protein inhibitors which act as an effective defence against insects and micro-organisms but are no problem to humans because they are destroyed by heat. Lecithins or haemaglutennins are also present in potato, these toxins are capable of agglutinating the erythrocytes of several mammalian species including humans, but this is of minimal nutritional significance as haemoglutenins are also destroyed by heat and potatoes are normally cooked before they are eaten. Three sugars which occur in plant tissues (raffinose, starchyose and verbatose) are not digestible in the upper digestive tract, and so are fermented by colon bacteria to yield the flatus gases hydrogen and carbon dioxide. Sweet potatoes contain raffinose, although the level of raffinose present depends on the cultivar. In some parts of Africa the cultivars used are considered too sweet and cause flatulence (Lin et al., 1985).

According to Ernest (2000), garri is creamy white granular flour with a slightly fermented flavour and a slightly sour taste made from fermented, gelatinized fresh cassava tubers. It is a starchy staple food with high dietary energy and is consumed by both young and old in almost all parts of Nigeria and many African countries (Oluwole, 2004). It is commonly consumed either by being soaked in cold water with sugar, coconut, roasted groundnut, dry fish, boiled cowpea as complements or as a paste made with hot water and eaten with vegetable sauce. When properly stored, it has a shelf life of six month or more (Odomela, 2005).

The process of producing cassava garri was adopted for the production of garri from sweet potato in order to reduce seasonal wastage of sweet potato in Zamfara State where it is one of the most abundant crop. This attempt provide a more shelf stable food item which is entirely different from conventional sweet potato products. Thus encouraging diversification and wider production. This project work is a follow-up of previous study (Kure et al, 2012) aimed at the diversification of the use of sweet potato and seek to assess the nutritional quality of the sweet potato garri using a feeding trial of 28 days with male albino rats.

2. Materials and Methods

2.1 Source of raw materials

Sweet potatoes tubers (white variety), muslin cloth, grater, brooms and sacks were purchased from the Kaura Namoda market. Packaging materials, detergent, disinfectant, masking tape, card board paper, instant filled milk (nunu), and common salt were purchased at a supermarket in Kaura Namoda. Corn starch was purchased from Kabir superstore, Kaduna, rice husk from rice miller in Gusau market and corn oil from Jafatu superstore, Gusau. Vitalyte (Anglian Nutrition Product company (ANUPCO), U.K. and hand gloves were purchased at Agrovet chicken and feed store, Kaduna. Two non-biochemical cages (4-in-1), feeding troughs and drinkers were fabricated by Yashi Metal Construction, Kaura Namoda, Zamfara State, while the Electronic compact weighing balance (model KDBN2010) from the Department of Food Technology, Federal Polytechnic Kaura Namoda was used. The albino rats were purchased from Department of Pharmacology, Faculty of Pharmacy A.B.U Zaria.

2.2 Production of sweet potato garri

The method described by Kure et al (2012) was used to produce garri from sweet potato (Figure 1). Fresh raw sweet potatoes tubers were washed, peeled manually under running water, washed again with clean water, sliced and grated to a pulp using a grater. The pulp was then put into muslin cloth bag and pressure applied by heaping stones on it to drain excess water. The pulp was left in the bags to ferment for a period of 0, 1, 2 and 3 days, respectively to vary the level of sourness, after which the pressed cake was then roasted to dryness at a temperature of 110^{o}C-130^{o}C. The freshly prepared garri was cooled, packaged and labelled, accordingly.

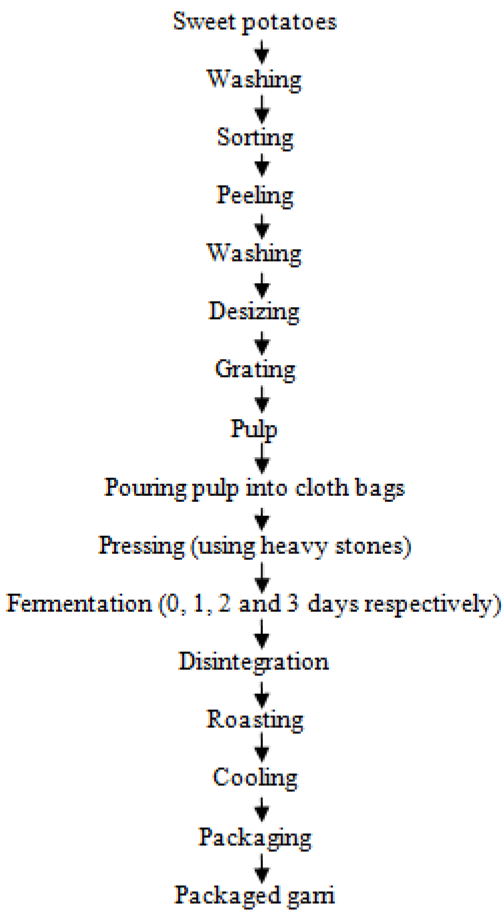

Figure 1: Flow chart for the production of Sweet Potatoe Garri
Source: Kure et al, (2012).

2.3 In-Vivo Protein Quality Evaluation

2.3.1 Feed formulation

The sweet potato garri was used to formulate a feed of 10% protein as required for in-vivo protein quality evaluation by Pellet and Young (1980). The SPNF, SPF1, SPF2, SPF3, has an initial protein content of 3.07%, 2.56%, 2.56% and 3.58%, respectively. The potato garri has a protein content of 1.32% while the milk used has a protein content of 25% . The Pearson Square method (Ihekoronye and Ngoddy 1985) was used to balance the feed to 10% protein.

Table 1: Formulation of experiment diets (g/100g feed portion)

	SPNF	SPF1	SPF2	SPF3	CG	CD	BD
Garri	54.72	53.48	53.48	56.02	50.68	-	-
Corn starch	-	-	-	-	-	48	80
Casein diet (nunu powder milk)	25.28	26.52	26.52	23.98	29.32	32	-
Corn oil	10	10	10	10	10	10	10
Cellulose (rice husk)	5	5	5	5	5	5	5
Common salt	4	4	4	4	4	4	4
Vitamin premix	1	1	1	1	1	1	1
	100	100	100	100	100	100	100

Source: Adapted from Pellet and Young (1980) with modification, Vitalyte (Anglican Nutrition Product

Company (ANUPCO), U.K. Vit A, D3, E, K, B2, B6, B12, C, nicotine acid, pantothenic acid, Kcl, $NaSO_4$, C_uSo_4, Mg_2SO_4, Nacl, $ZnSO_4$, $MnSO_4$, lysine, methionine, lactose).
Key:
SPNF – Sweet potato garri no ferementation. SPF1 – Sweet potato garri 1 day fermentation
SPF2 – Sweet potato garri 2 days fermentation. SPF3 – Sweet potato garri 3 days fermentation
CG – Cassava garri. CD – Casein diet. BD – Basal diet

2.4 Feeding Trials

The nutritional quality of the sweet potato garri samples were evaluated using a modification of the In-vivo protein quality evaluation method based on growth rate of animals as described by Pellet and Young (1980). Experimental rats were placed on an initial commercial stock diet for three days acclimatization period with prompt water supply prior to commencement of the experiment.

A 28 days feeding experiment was performed using twenty-one male albino rats weighing between 45.6g to 72.5g which were randomly distributed into seven wire mesh cages. The wire mesh cages were labelled A-G according to the formulated feeds. Food and water were given ad-*libitum*. Weights of rats and food consumed were taken daily for the first fourteen (14) days, then at 7 days interval for the other 14 days. Cages were placed on cardboard to permit collection of faeces. Faeces were collected daily for the last seven days and stored in a freezer, after which it was pooled together, thawed, air-dried and weighed. This was grounded and the nitrogen content determined by the formal titration method as described by Ayo and Agu(2012).

2.5 Protein Quality Indices

The data obtained from the feeding trials were used to compute the following protein quality indices: protein efficiency ratio (PER), relative protein efficiency ratio (RPER), net protein ratio (NPR), relative net protein ratio (RNPR), apparent digestibility (AD) and feed efficiency ratio (FER) and feed conversion efficiency (FCE), (Pellet and Young 1980, Rasco, 2002, Bender and Bender, 1995).

$$\text{Protein efficiency ratio (PER)} = \frac{\text{weight gain of test animals}}{\text{protein consumed}}$$

$$\text{Relative protein efficiency ratio (RPER)} = \frac{\text{PER of test protein X 2.5}}{\text{PER for casein}}$$

$$\text{Net protein ratio (NPR)} = \frac{\text{average weight gain of test animal} + \text{average weight loss of control animals}}{\text{protein consumed by test animals}}$$

Relative net protein ratio (RNPR) = NPR of test protein expressed relative to a value of 100 for NPR of reference protein

$$\text{Apparent digestibility (AD)} = \frac{\text{Nitrogen in feed} - \text{Nitrogen faeces} \times 100}{\text{Nitrogen in feed}}$$

$$\text{Feed efficiency ratio (FER)} = \frac{\text{Body weight gain}}{\text{Feed intake}}$$

$$\text{Feed conversion efficiency FCE)} = \frac{\text{mean daily feed intake}}{\text{mean daily weight gain}}$$

3. Results and Discussion

3.1 In-vivo protein quality evaluation

3.1.1 Body weight changes and feed intake

Table 2 shows the body weight changes and feed intake as obtained from the feeding trials conducted. The TWG/L and MDWG/L range from -37.30g for diet G to 54.00 for diet F and A,B, C, D, E has a TWG/L of -33.30, 10.80, 7.00, 7.10, -10.50 respectively and MDWG/L of -1.19, 0.39, 0.25, 0.25 and 0.38. Rats fed with the casein diet (F) had the highest weight gain, while these fed the basal diet had the least and became weak as time progress and died on day 22, 23 and 24th of the feeding trial. Diet D has the highest total feed intake protein and nitrogen intake while diet G has the least total feed intake with zero products.

Table 2: Body weight changes and feed intake

DIETS	TWG/L	MDWG/L	TFI	MDFI	PI	NI	NO
A	-33.30	-1.19	713.20	25.47	56.66	14.6	0.27
B	10.80	0.39	708.20	25.30	56.65	14.5	0.28
C	7.00	0.25	641.10	22.90	51.29	13.13	0.31
D	7.10	0.25	753.00	26.90	60.24	15.43	0.31
E	-10.5	-0.38	647.30	23.11	51.78	13.26	0.3
F	54.00	1.93	690.60	24.70	55.25	14.14	0.3
G	-37.30	-1.33	528.40	18.90	-	-	-

Key: A – Sweet potato garri non fermented SPNF. B – Sweet potato garri 1 day fermentation (SPF1)
C – Sweet potato garri 2 days fermentation (SPF2). D – Sweet potato garri 3 days fermentation (SPF3)
E – Cassava garri. F – Casein diet (CD). G – Basal diet (BD)

Parameters
TWG/L = Total Weight gain/ loss
MDWG/L = Mean daily weight gain/ loss
TFI = Total feed intake
MDFI = Mean daily feed intake
P_i = Protein intake
N_i = Nitrogen intake
N_o = Nitrogen out

3.2 Nutritional quality indices

The nutritional quality parameters of experimental diets, A-G as obtainable from feeding trials are as shown in table 3. Diet F has the highest FER (0.08) followed by B (0.02), C and D with (0.01), E, A and G has FER of 0.02, -0.05 and -0.07, respectively. FCE were 91.60 for C, 64 87 for B, 60.24 for D and 12.80 for F, while A, E and G has FCE of -21.40, -60.82 and 14.21, respectively. The casein diet F has the highest PER of 1.00, followed by B with 0.19, C with 0.14 and D with 0.12. Diet A, E and G has PER of -0.59, -0.20 and 0.00, respectively. The NPR was highest for diet F with 0.01 while diet A, B, C, D and E have a NPR of -0.04, -0.94, -0.02, -0.02, -0.03, respectively. The apparent digestibility (AD) ranged from 0 for G to 97.95 for A, 98.10 for B, 97.60 for C, 98.00 for D, 97.74 for E and 97.90% for F.

Table 3: Nutritional quality parameters of experimental diets

DIETS	FER	FCE	PER	RPER	NPR	AD
A	-0.05	-21.40	-0.59	-1.51	-0.04	97.95
B	0.02	64.87	0.19	0.49	0.94	98.10
C	0.01	91.60	0.14	0.36	-0.02	97.60
D	0.01	60.24	0.12	0.31	-0.02	98.00
E	-0.02	-0.60.82	0.20	-0.51	-0.03	97.74
F	0.08	12.80	1.00	2.50	0.01	97.90
G	-0.07	-14.21	0.00	0.00	0.00	0.00

Key:
A – Sweet potato garri no fermentation (SPNF). B – Sweet potato garri 1 day fermentation (SPF1)
C – Sweet potato garri 2 days fermentation (SPF2). D – Sweet potato garri 3 days fermentation (SPF3)
E – Cassava garri. F – Casein diet. G – Basal diet

Parameters
FER – Feed Efficiency Ratio
FCE – Feed Conversion Efficiency
PER – Protein Efficiency Ratio
RPER – Relative Protein Ratio
RNPR – Relative Net Protein Ratio
AD – Apparent Digestibility

From the Body Weight changes of the rat, (Table 2) diet F has the highest TWG/L with 54g while diet G has -1.33, indicating role of protein in living system. The experimental rats in diet G lost weight daily and died at the 22,nd 23rd and 24th day of the experiment due to lack of protein for growth and maintenance.

Animal fed Diets B, C and D gained weight but not as observed for that on casein diet, which contains more essential amino acids than others. Those fed Diet A had weight loss which means the protein in their food was not available for use, which indicate a poor quality of protein. According to Ihekoronye and Ngoddy (1985), the nutritional value of protein is a combination of two factors; total essential amino acid content of the protein and its digestibility. The high total feed intake of animal fed diet D may be due to the good sensory appeal and palatability of the diet as earlier reported (Kure et al, 2012).

Relating this statement with diet A which has shown high digestibility and did not gain weight shows the feed does not have enough essential amino acid in the diet.

Feed conversion efficiency (FCE) is a measure of an animal's efficiency in converting feed mass into increases of the desired output (weight gain) Diet A, E and G has very poor feed conversion efficiency with the negative values which can be related to why the animals weight gain was not commensurate with feed intake because their body was unable to convert the food for appropriate use. Diet F have the least FCE of 12.80, which is the best according to National Research Council (2007), animal that have a low FCE are considered efficient users of feed, so the lower the FCE the more efficient the feed in the body.

PER indicates the relationship between weight gain in the experimental animal fed the protein diets to those fed the basal diet. A protein that does not support growth has a PER of zero, which is indicated in A, E and G, and a very low PER in B, C and D which account for their little weight gain. Diet F has the highest PER of 1.00, which shows that the protein present in the diet supports growth.

The result of the weight gain in the diet A to E which is garri based diet has shown that garri is deficient in almost all food classes except carbohydrate in accordance with the report by Tayo Fasan (2014), who worked on "protein-fortified garri" This leads to its association with kwashiorkor. Ogbuji and David-Chukwu (2015) in an evaluation of cassava food products also reported that cassava garri had largely carbohydrate (84.88%), crude protein 2.03%, crude lipid 1.30%, crude fibre 0.37%, ash 0.33% and moisture 11.10%. Hence numerous attempt by food scientists in the country to try and fortify it with other classes of food, especially food rich in protein such as groundnut, beans and recently cowpea (Adefuye, 2014).

4. Conclusion

The result of this research work shows a non-significant nutrient improvement on the sweet potato garri fed to the albino rats. The growth rates of the animals were far less than that of the casein standard diet-fed animals. This indicates a low nutritional quality of the sweet potato garri, due to its good energy value but deficiency in the assential amino acids needed for growth. Fermentation improved the nutritional quality, as the fermented sweet potato garri samples (Diets B, C and D) were of better nutritional quality than the non-fermented samples (Diet A).

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