Original Article

Nutritional Evaluation of Blends From Malted Millet and Orange Fleshed Potatoe Flours

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OPEN ACCESS
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Specialty Section;This article was submitted to Sciences a section of NAPAS.
Submitted:12/11/2024
Accepted: 12/12/2024

Citation:
Ayo, J A; Awogbenja, M.D; Ayo, V I, Gbuusu B; Akaahan S. P and Maiogo, Y J ***(2024).***Ayo, J A; Awogbenja, M.D; Ayo, V I, Gbuusu B; Akaahan S. P and Maiogo, Y J ***7(1):92 -101.***
DOI:10.5281/zenodo.7338397

Publisher:cPrint,Nig.Ltd
Email:cprintpublisher@gmail.com

Abstract
The study evaluated blends produced from malted millet and orange fleshed sweet potato (OFSP) flour The OFSP flour were substituted into the malted millet flour at 0, 5, 10, 15, 20, 25% to produce A, B, C, D, E,F and G flour blends, respectively. Blood meal(2%), bone meal (2%) and salt (1%) were added to the respective flour blends and fed to the albino rats for 28 day after five days acclimatization. The nutritional quality, haematological, serum and growth performance of formulated diet on the animal fed were determined. The moisture, total ash and carbohydrate contents of the feed decreased from 8.20 to 6.90, 2.03 to 0.70 and 76.28 to 60.83% respectively while the fibre, fat, and protein contents of the feed increased from 2.30 to 3.22, 3.16 to 4.56 and 10.61 to 21.74%, respectively with increase in added orange fleshed sweet potato. The feed efficiency ratio increased from 0.02 to 0.05, while the protein efficency ratio decreased 0.49 to 0.04 with increase in orange fleshed sweet potato flour substitution. A high correlation coefficient(r=0.8) was observed between the fed intake and weight gain for the 28 days duration of feeding. The haematological properties result showed variations in Haemoglobin, packed cell volume, Red blood cell, Fasting blood sugar and white blood cell over the duration of 4 weeks. The blend with 20% of malted millet based on weight gain and quality of hematological properties is recommended for human consumption.

Key Words: Proximate, functional properties, vitamins, feed intake, weight gain

Introduction
Sweet potatoes (*Ipomoea batalas*) are nutritious and delicious root vegetables. The sweet potatoes are creamy and soft enough to be

an ingredient in several pie recipes. Sweet potatoes are among the best sources of vitamin and naturally packed with vitamin B_5, riboflavin, niacin, thiamine and carotenoids, due to their naturally orange colour (Ayo *et al.,* 2022). It is packed with medicinal benefits, containing anti-inflammatory, anti-diabetic and anti-cancer properties.

Orange fleshed sweet potato is one of the varieties of sweet potato with more beta carotene than those with light colour flesh. Its cultivation is being encouraged in Africa, where vitamin A deficiency poses a serious health problem. Most Nigerian commercially available cultivars have a white to light creamy-yellow flesh colour (Leighton, 2008). However,â-carotene rich orange fleshed sweet potato is being introduced into Nigeria based on its possible contribution to reduction in the prevalence of vitamin A deficiency. â-carotene participates in protein synthesis and cell differentiation by keeping the epithelial tissues and skin healthy, contributing to the growth of an individual as well as preventing illness due to infectious diseases (Kalam *et al.,* 2019). Sweet potato roots also contain carbohydrate (especially starch), protein, fat, fibre and high amount of minerals (Rosewaeer *et al*., 1989).

Bovell-Benjamin (2007) and Irakiza *et al*. (2014) reported that orange fleshed sweet potato (OFSP) consists of very high trans-â-carotene concentrations and shows high pro-vitamin A activities. OFSP could serve as an essential vitamin A supplement for cereal-based foods , which has great potentials that can be used for food-based intervention programs in addressing vitamin A deficiency (Kalam *et al.,* 2019). Averagely, OFSP comprises 3000-16000 µg/100g of â-carotene that can contribute 250 to 1300 retinol activity equivalent (RAE) (Gurmu *et al*., 2017). It is also a very good source of energy.

Millet are not placed as a single important commodity in the North American and European food basket at the present time, but their importance as an ingredient in multigrain and gluten-free cereal products has been highlighted. However, in many African and Asian countries, millet serve as a major food component and various traditional foods and beverages, such as bread (fermented or unfermented), porridge, and snack foods are made of millet, specifically among the non affluent segments in their respective societies (Chandrasekara and Josheph, 2012). In addition to their nutritive values, several potential health benefits such as preventing cancer and cardiovascular diseases, reducing tumor incidence, lowering blood pressure, risk of heart disease, cholesterol and rate of fat absorption, delaying gastric emptying, and supplying gastrointestinal bulk have been reported for millet (Truswell 2002; Gupta *et al.,* 2012). Millet grains, before consumption and for preparing of food, are usually processed by commonly used traditional processing techniques include decorticating, malting, fermentation, roasting, flaking, and grinding to improve their palatability, nutritional, and sensory properties

The underutilisation of orange flesh potato and over use of millet have called for research into their potentials in food processing and development of varieties of food particularly for health disadvantaged populace such as diabetics. Most of the vitamins (Vitamin B_5) in millet grains are not made available during digestion, which could be improved by malting or germinating. The present uprise in the population of diabetics has urgently called for proper investigations into food products before introduction to the populace.

The acceptability of the malted millet-orange fleshed sweet potato flour blend will reduce its underutilisation and improve nutrients intake of the consumers. Also, the outcome of the animal feed trial will give useful information about it's safety for appropriate populace. The aim of the study was to determine the effect of malted millet-orange fleshed sweet potato flour blend on the nutritional, glucose blood level and hematological profiles of albino rat.

MATERIALS AND METHODs

Materials and Preparation of the flour blends

Experimental site

The research work was carried out at Federal University Wukari, Taraba State, North Central geopolitical zone of Nigeria. The orange fleshed sweet potato (OFSP) and millet was obtained from Nasarawa Agricultural Development Programme (NADP) and Modern market, Lafia, Nigeria, respectively

Production of orange fleshed sweet potato flour (OFSPF)

The method for the production of the orange fleshed sweet potato flour was based on the procedure of Mais, (2008). The tubers were sorted and washed with water to remove dirt in form of soil. They were peeled manually using a potato peeler and sliced using a slicer. The resultant slices were drained, dried in the cabinet dryer at 55^0 C for 48 h, after which it was milled using a hammer crusher and sieved using a 2 mm mesh sieve. The flour obtained was packaged in a zip lock polyethylene bag for further use.

Production of malted millet flour (MMF)

The millet grains were manually cleaned by handpicking the chaff and stones were removed by washing in running water (sedimentation) using local calabash. The washed grains were spread on jute bag, covered, sprinkled with water twice per day and allowed to germinate. The grain was germinated and terminated by drying at 50^{o}C in a hot air cabinet dryer (APV- machine Dryer)(Ratau, 2018). The dried plumule was removed manually by scrubbing within the hand and milled into flour using attrition milling machine (Lister Inc England). The flour was sieved (0.4mm mesh size) and vacuum packaged (Phlico Vacum sealer, Hongkong) in polyethylene bag.

Formulation of Experimental Diets

The OFSP flour were substituted into the malted millet flour at 0, 5, 10, 15, 20, 25% to produce flour blends. Blood meal(2%), bone meal (2%) and salt (1%) were mixed with flour blends to feed the albino rats for 28 day after five days acclimatization (Ayo *et al.,* 2022)

Table 1: Formulation of Experimental Diets

Sample Code	Malted Millet Flour (%)	OFSP flour (%)	Blood Meal (g)	Bone Meal (g)	Salt (NaCl)(g)
A	100	0	2	2	1
B	95	5	2	2	1
C	90	10	2	2	1
D	85	15	2	2	1
E	80	20	2	2	1
F	75	25	2	2	1
G	0	100	2	2	1

OFSP: Orange Fleshed Sweet Potato.

Experimental animals and management

Twenty one mature Albino rats weighing 195g-200g and 7-8 weeks old were obtained from the Small Animal Experimental/Research Unit of National Veterinary Research Institute (NVRI-VOM) Jos, Plateau State. The rats were three in a cage, allowed for 5days pre-treatment period for acclimatization. They were housed in cages measuring 64cm x 62cm x 48cm,fed twice daily 8:00am and 5:00pm. Measured feeds and potable water were offered daily.

Chemical Analysis

Determination of Proximate Composition

The proximate compositions (moisture content, crude fibre, crude fat, total ash, and crude protein) of the flour were determined as described by AOAC (2012).

Determination of Vitamins

The vitamin A and vitamin B content were determined as described by Yinusa *et al* (2022) and Okwu and Josiah (2006), respectively.

Performance indices

The increase in body weight were measured every three days for the study period with standard weighing balance. The nutritional qualities of the malted millet- OFSP flour blends were determined using the parameters including: cumulative feed intake and cummulative weight gain ovr the period of feeding(28day). The quantity of feed (OFSP-malted millet flour blends) and water consumed were measured daily from the quantity of feed and water supplied the previous day and the quantity remaining after 24 h.

Hematological indices :

The blood samples were collected from the rat tail veins by ocular method. The concentration of glucose was determined using glucometer. Packed cell volume (PCV) was determined by the Microhaematocrit method (Coles,1986). The haemoglobin concentration was determined by the cyanomethemoglobin method (Kachmar,1970). Red blood and white blood counts were determined by the methods described by Coles (1986).

Statistical analysis

Data were analyzed by analysis of variance in completely randomized design using SPSS. (16.0 version) Means were separated using Duncan's Multiple Range Test (DMRT) at $p<0.05$.

RESULTS AND DISCUSSION

Proximate Composition of Malted Millet-Orange Fleshed Sweet Potato Flour Blends

The proximate composition of the formulated diets is presented in Table 2. One of the major criteria use to determine the nutrient values and food quality is the proximate composition (Adejuwon *et al.*, 2021) The carbohydrate and moisture content decreased from 76.28 to 60.83% and 8.20 to 6.90%, respectively with increase in the added orange fleshed sweet potato flour. The decrease in carbohydrate could be due to the lower level of carbohydrate in the millet after malting while the decrease in moisture could also be due to the moisture content of the added malted millet flour. The total ash decreased from 2.03 to 0.70% and this could be due to the lower level of mineral content of the malted millet as a result of processing process. The crude fibre increased from 2.30 to 3.22% and decreased to 2.56%. the increase could be due to the effect of the added malted millet flour to the orange fleshed sweet potato flour while the decrease may or could be due to non-addition of the orange fleshed sweet potato flour to augment the crude fibre content of the malted millet flour. The fat and protein contents increased from 3.16 to 4.56 % and 10.61 to 21.74% respectively. This increase could be due to the relative high content of protein in the added malted millet flour (Amadou *et al.*, 2013). Protein not only acts as a source of amino acids in food but also play a major part in the organoleptic properties of foods (Ayo *et al.*, 2022). Protein helps repair and build body tissues, allows metabolic reactions to take place and coordinates bodily functions. In addition to providing body with a structural framework, proteins also maintain proper pH and fluid balance.

Table 2: Proximate Composition of Malted Millet-Orange Fleshed Sweet Potato Flour Blends

	Orange Fleshed Sweet Potato - Malted Millet Flour Blends (%)						
Composition	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Moisture	8.20^a±0.01	8.02^b±0.01	7.89^c±0.13	7.58^d±0.01	7.31^e ±0.01	7.05^f ±0.01	6.90
Total Ash	2.03^a ±0.01	1.91^b ±001	1.72^c ±0.03	1.44^d ±0.02	1.29^e ±0.01	1.09^f ±0.01	0.70
Crude Fiber	2.30^g±0.01	2.45^f±0.01	2.60^d±0.01	2.86^c ±0.01	3.00^b±0.01	3.22^a±0.01	2.56
Fat	3.16^g ±0.01	3.3^f 2±0.0	3.76^e±0.02	3.90^d ±0.01	4.07^c ±0.01	4.07^c ±0.01	4.56
Protein	10.61^g ±0.02	13.53^f ±0.02	17.00^e±0.01	19.38^d ±0.02	20.82^c±0.03	21.07^b±0.03	21.7
Carbohydrate	76.28^a±0.02	72.41^b ±0.01	67.97^c±0.02	64.8^{c}3±0.04	62.31^e±0.01	61.43^f±0.00	60.8

Values are Means ± standard deviation of triplicate determinations. Means within the same column with different letters are significantly different at p<0.05. A = 100:0, B = 95:5, C = 90:10, D = 85:15, E = 80:20, F = 75:25, G = 0:100 Orange Fleshed Sweet Potato- Malted MilletFlour Blends

Vitamin Composition of Malted Millet-Orange Fleshed Sweet Potato Flour Blends

The vitamin A decreased from 783.08 to 671.09 mg/100g and the vitamin B_1 increased from 0.97 to 2.87 mg/100g (Table 3). The increase in vitamin B_1 content could be due to the relative high level of Vit B in the added orange fleshed sweet potato flour (Liao *et al.*, 2022).. Thiamin (vitamin B1) helps the body's cells convert the carbohydrates into energy. Thiamine also plays a role in muscle contraction and conduction of nerve signals. Vitamin B1 regulates the functioning of the nervous system, heart and brain. It also maintains good eye sight and boosts immunity (Kalam et al., 2019).

Table 3: Vitamin Composition of Malted Millet-Orange Fleshed Sweet Potato Flour Blends

	Orange Fleshed Sweet Potato - Malted Millet Flour Blends						
Samples	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Vitamin A(mg/g	783.08^{a}±0.05	758.94^{b}±0.05	737.62^{d}±0.02	710.95^{d}±0.00	695.23^{e}±0.02	687.15^{f}±0.01	671.09^{g}±0.01
Vitamin B1(mg/g	0.97^{e}±-0.02	1.04^{e}±0.14	1.58^{c}±0.22	1.73^{c}±0.01	2.31^{b}±0.02	2.71^{a}±0.02	2.87^{a}±0.01

Values are Means ± standard deviation of triplicate determinations. Means within the same column with different letters are significantly different at p<0.05. A = 100:0, B = 95:5, C = 90:10, D = 85:15, E = 80:20, F = 75:25, G = 0:100 Orange Fleshed Sweet Potato-Malted MilletFlour Blends

Daily Feed Intake and Weight Gain of Rats Fed with Malted Millet-Orange Fleshed Sweet Potato Flour Blends

The feed intake and weight gain of rats fed with malted millet-orange fleshed sweet potato flour blends is shown in Table 4 and 5 respectively. The result revealed that the rat fed 100% orange sweet potato flour had the highest weight gain (37.26g).

The feed intake is the single most important piece of information that a nutritionist can use to minimize feed cost, while ensuring performance is maintained. Feed intake is important in attaining target growth rate in animals and has significant impact on efficiency production (Whittington *et al*., 2022). Weight gain is an increase in body weight, this can involve an increase in muscle mass, fat deposits, excess fluids such as water or other factors.

Table 4: Daily Feed (g) Intake of Rats Fed Malted Millet-Orange Fleshed Sweet Potato Flour Blends

	Orange Fleshed Sweet Potato - Malted Millet Flour Blends (g)						
Days	**A**	**B**	**C**	**D**	**E**	**F**	**G**
1	35.8^{a}±0.00	34.0^{f}±0.00	17.4^{g}±0.00	27.2^{b}±0.00	24.6^{c}±0.00	38.9^{d}±0.00	28.0^{e}±0.1
2	38.7^{b}±0.01	15.4^{a}±0.00	24.5^{b}±0.00	22.8^{c}±0.00	21.6^{e}±0.00	11.0^{f}±0.00	27.1^{g}±0.00
3	41.1^{c}±0.00	31.5^{b}±0.00	34.1^{d}±0.00	43.5^{a}±0.00	40.3^{e}±0.00	11.0^{g}±0.00	13.7^{f}±0.00
4	40.8^{d}±0.00	28.7^{c}±0.00	42.8^{e}±0.00	48.1^{b}±0.00	29.1^{a}±0.00	36.3^{g}±0.00	37.1^{f}±0.00
5	21.0^{e}±0.00	23.2^{d}±0.00	36.2^{f}±0.00	40.0^{c}±0.00	47.9^{b}±0.00	24.2^{e}±0.00	32.6^{g}±0.00
6	44.7^{f}±0.00	14.4^{e}±0.00	44.7^{g}±0.00	28.9^{d}±0.00	42.4^{c}±0.00	29.8^{a}±0.00	26.9^{b}±0.00
7	44.2^{g}±0.00	26.2^{f}±0.00	46.9^{a}±0.00	26.6^{e}±0.00	39.0^{d}±0.00	17.1^{c}±0.00	8.7^{b}±0.00
8	49.2^{a}±0.00	31.5^{c}±0.00	40.7^{b}±0.00	49.3^{f}±0.01	29.3^{e}±0.00	49.4^{d}±0.00	35.5^{g}±0.00
9	51.2^{b}±0.00	29.2^{d}±0.00	48.5^{c}±0.00	22.8^{g}±0.00	13.6^{a}±0.00	28.9^{e}±0.00	3.1^{f}±0.00
10	57.8^{c}±0.00	7.6±^{e}0.00	57.7^{d}±0.00	57.9^{a}±0.00	47.3^{b}±0.00	37.0^{f}±0.00	24.0^{a}±0.00
11	48.7^{d}±0.00	53.6^{f}±0.01	55.6^{e}±0.01	24.0^{b}±0.01	56.2^{c}±0.00	43.9^{a}±0.00	14.8^{g}±0.00
12	55.6^{e}±0.01	14.6^{g}±0.00	52.8^{f}±0.00	52.3^{c}±0.00	46.8^{d}±0.00	45.1^{a}±0.00	14.7^{b}±0.00
13	41.0^{f}±0.01	41.2^{a}±0.00	43.7^{g}±0.00	57.5^{d}±0.00	34.0^{e}±0.00	32.6^{b}±0.00	18.2^{c}±0.00
14	48.7^{g}±0.00	42.4^{b}±0.01	54.9^{a}±0.01	56.8^{e}±0.02	49.8^{f}±0.01	45.8^{c}±0.01	42.5^{d}±0.00
15	41.8^{a}±0.00	23.3^{c}±0.00	46.3^{b}±0.00	31.0^{f}±0.01	42.0^{g}±0.01	25.2^{d}±0.00	16.2^{e}±0.00
16	54.2^{b}±0.00	30.2^{d}±0.01	59.3^{c}±0.02	54.1^{g}±0.00	51.7^{a}±0.00	29.6^{e}±0.01	10.0^{f}±0.01
17	51.2^{c}±0.01	40.8^{e}±0.0	43.1^{d}±0.01	27.9^{a}±0.00	28.9^{b}±0.00	10.0^{f}±0.00	42.9^{g}±0.00
18	52.9^{d}±0.00	34.8^{f}±0.00	54.1^{e}±0.00	39.9^{b}±0.00	35.8^{c}±0.00	12.2^{g}±0.00	33.6^{a}±0.01
19	33.0^{e}±0.01	34.5^{g}±0.00	57.5^{f}±0.00	22.5^{c}±0.00	28.6^{d}±0.00	15.9^{a}±0.00	7.9^{b}±0.00
20	44.4^{f}±0.01	31.3±^{a}0.00	47.9^{g}±0.01	26.3^{d}±0.01	28.1^{e}±0.01	48.5^{b}±0.00	40.7^{c}±0.00
21	54.3^{g}±0.00	45.0^{b}±0.00	51.4^{a}±0.00	10.4^{e}±0.01	25.5^{f}±0.00	29.1^{c}±0.01	11.2^{d}±0.01
22	54.0^{a}±0.01	49.0^{c}±0.01	37.6^{b}±0.00	38.5^{f}±0.01	34.9^{g}±0.01	14.0^{d}±0.01	13.2^{e}±0.01
23	50.6^{b}±0.01	31.5^{d}±0.00	37.8^{c}±0.01	12.5^{g}±0.01	18.0^{a}±0.01	23.4^{f}±0.01	9.3^{e}±0.00
24	39.9^{c}±0.00	36.7^{d}±0.00	40.3^{e}±0.00	19.2^{a}±0.00	63.9^{b}±0.00	38.6^{g}±0.00	15.7^{f}±0.01
25	39.8^{d}±0.00	33.1^{e}±0.00	44.2^{a}±0.01	37.8^{b}±0.01	26.3^{c}±0.01	41.5^{f}±0.00	48.3^{g}±0.00
26	34.5^{e}±0.00	4.9^{f}±0.00	42.2^{b}±0.00	40.8^{c}±0.00	39.7^{d}±0.00	41.7^{a}±0.00	4.4^{g}±0.01
27	44.1^{f}±0.00	21.5^{g}±0.00	41.6^{c}±0.00	18.7^{d}±0.00	30.8^{e}±0.00	31.4^{a}±0.00	16.9^{b}±0.00
28	45.4^{g}±0.01	13.1^{a}±0.00	48.3^{d}±0.00	18.7^{e}±0.00	30.5^{f}±0.00	37.3^{c}±0.00	1.70^{b}±0.00

Values are Means ± standard deviation of triplicate determinations. Means within the same column with different letters are significantly different at p<0.05. A = 100:0, B = 95:5, C = 90:10, D = 85:15, E = 80:20, F = 75:25, G = 0:100 Orange Fleshed Sweet Potato- Malted MilletFlour Blends

Table 5: Daily Weight (g) of Rats Fed Malted Millet-Orange Fleshed Sweet Potato Flour Blends

	Orange Fleshed Sweet Potato - Malted Millet Flour Blends(g)						
Days	**A**	**B**	**C**	**D**	**E**	**F**	**G**
1	87.0^{a}±0.00	82.6^{c}±0.00	97.8^{b}±0.00	72.3^{e}±0.00	83.5^{d}±0.00	96.2^{f}±0.00	99.25^{g}±0.00
2	93.1^{b}±0.00	79.9^{d}±0.00	99.4^{c}±0.00	70.55^{g}±0.00	83.5^{a}±0.00	96.45^{e}±0.00	90.7^{f}±0.00
3	95.9 ^{a}±0.00	79.25^{b}±0.00	99.85^{d}±0.00	72.35^{c}±0.00	86.5^{e}±0.00	100.25^{f}±0.00	102.1^{g}±0.00
4	96.37^{b}±0.00	84.55^{c}0.00	109.56^{d}±0.00	73.6^{e}±0.00	88.35^{f}±0.00	100.6^{g}±0.00	95.85^{a}±0.00
5	98.0^{c}±0.00	80.8^{d}±0.00	101.4^{e}±0.00	75.5^{f}±0.00	95.15^{g}±0.00	102.9^{a}±0.00	94.75^{b}±0.00
6	99.06^{d}±0.00	83.95^{e}±0.00	108.2^{f}±0.00	81.6^{g}±0.00	97.65^{a}±0.00	106.85^{b}±0.00	94.05^{c}±0.00
7	109.57^{e}±0.00	83.3^{f}±0.00	105.9^{g}±0.00	76.2^{a}±0.00	92.4^{b}±0.00	108.6^{c}±0.00	94.9^{d}±0.00
8	107.9^{f}±0.00	85.65^{g}±0.00	114.3^{a}±0.00	87.3^{b}±0.00	102.6^{c}±0.00	109.85^{d}±0.00	92.7^{e}±0.00
9	104.5^{a}±0.00	87.4^{b}±0.00	111.03^{c}±0.00	85.1^{d}±0.00	99.45^{e}±0.00	109.7^{f}±0.00	91.6^{g}±0.00
10	105.7^{b}±0.00	85.55^{c}±0.00	111.2^{d}±0.00	82.65^{e}±0.00	97.2^{f}±0.00	108.85^{g}±0.00	85.2^{a}±0.00
11	109.86^{c}±0.00	86.05^{d}±0.00	111.7^{e}±0.00	86.36^{f}±0.00	99.5^{g}±0.00	109.95^{a}±0.00	84.2^{b}±0.00
12	113.2^{d}±0.00	87.05^{e}±0.00	112.7^{f}±0.00	86.15^{g}±0.00	103.1^{a}±0.00	111.15^{b}±0.00	85.15^{c}±0.00
13	113.7^{e}±0.00	85.9^{f}±0.00	114.7^{a}±0.00	86.55^{b}±0.00	103.5^{c}±0.00	113.7^{d}±0.00	82.6^{e}±0.00
14	110.06^{f}±0.00	88.8^{g}±0.00	115.3^{a}±0.00	87.6^{b}±0.00	103.25^{c}±0.00	10.15^{d}±0.00	82.8^{e}±0.00
15	111.8^{g}±0.00	88.55^{a}±0.00	119.86^{b}±0.00	88.65^{c}±0.00	106.6^{d}±0.00	111.85^{e}±0.00	82.55^{f}±0.00
16	114.46^{a}±0.00	88.65^{b}±0.00	117.6^{c}±0.00	90.2^{d}±0.00	106.4^{e}±0.00	111.8^{f}±0.00	82.1^{g}±0.00
17	111.6^{b}±0.00	87.1^{c}±0.00	117.16^{a}±0.00	90.45^{d}±0.00	107.6^{e}±0.00	112.5^{f}±0.00	78.8^{g}±0.00
18	116.96^{c}±0.00	88.95^{d}±0.00	118.2^{e}±0.00	93.35^{f}±0.00	107.15^{g}±0.00	118.1^{a}±0.00	81.7^{b}±0.00
19	118.86^{d}±0.00	89.35^{e}±0.00	122.7^{f}±0.00	91.4^{g}±0.00	110.0^{a}±0.00	116.8^{b}±0.00	79.55^{c}±0.00
20	119.7^{e}±0.00	90.15^{f}±0.00	121.26^{g}±0.00	96.15^{a}±0.00	111.3^{b}±0.00	117.4^{c}±0.00	77.85^{d}±0.00
21	118.67^{f}±0.00	88.7±^{g}0.00	123.57^{a}±0.00	94.35^{b}±0.00	111.45^{c}±0.00	117.2^{d}±0.00	77.05^{e}±0.00
22	120.1^{g}±0.00	89.85^{a}±0.00	120.5^{b}±0.00	94.5^{c}±0.00	111.1^{d}±0.00	119.6^{e}±0.00	76.0^{f}±0.00
23	121.9^{a}±0.00	122.52^{b}±0.00	122.26^{c}±0.00	94.3^{d}±0.00	113.2^{e}±0.00	119.3^{f}±0.01	75.0^{g}±0.01
24	122.5^{b}±0.00	91.0^{c}±0.00	124.0^{a}±0.00	96.0^{d}±0.00	113.4^{e}±0.00	119.0^{f}±0.00	73.75^{g}±0.00
25	124.2^{c}±0.00	92.45^{d}±0.00	128.15^{b}±0.00	98.45^{e}±0.00	114.85^{f}±0.00	119.85^{g}±0.00	73.15^{a}±0.00
26	123.7^{d}±0.00	92.55^{e}±0.00	121.96^{f}±0.00	97.85^{g}±0.00	110.95^{a}±0.00	121.30^{b}±0.00	72.0^{c}±0.00
27	133.36^{e}±0.00	95.50^{f}±0.00	128.97^{g}±0.00	100.5^{a}±0.00	117.05^{b}±0.00	122. 9^{c}±0.00	67.85^{d}±0.00
28	124.26^{f}±0.00	75.35^{g}±0.00	126.9^{a}±0.00	99.5^{b}±0.00	116.25^{c}±0.00	123.0^{d}±0.00	67.2^{e}±0.00
Total Weight Gain	37.26	17.25	29.1	27.2	32.75	26.9	29.05

Values are Means ± standard deviation of triplicate determinations. Means within the same column with different letters are significantly different at p<0.05. A = 100:0, B = 95:5, C = 90:10, D = 85:15, E = 80:20, F = 75:25, G = 0:100 Orange Fleshed Sweet Potato-Malted MilletFlour Blends

Cumulative Feed Intake and Weight Gain of Rats Fed Malted Millet-Orange Fleshed Sweet Potato Flour Blends

Cumulative feed intake and weight gain of rats fed malted millet and orange fleshed sweet potato flour blends is presented on Table 6. The results showed that cumulatively in the first week, Sample A (100% malted millet) has the highest cummulative feed intake while sample G (100% orange fleshed sweet potato) has the least. The same trend was observed in 2nd, 3rd and 4th week for samples containing 5 to 20% orange fleshed sweet potato. However decrease in cumulative feed intake was observed above 20% (Table 6). The same trend was also observed for the weight gain as shown in Table 7. Weight gain is mostly the has corelation with quantaity of feed intake as shown in the present study. This quality attributes may explains the reason for corresponding weight loss with increase in added orange fleshed sweet potato and decrease in amlted millet as shown in Table 7.

Table 6. Cumulative Feed Intake of Rats Fed with Malted Millet-Orange Fleshed Sweet Potato Flour Blends

	Orange Fleshed Sweet Potato - Malted Millet Flour Blends(g)						
Wks	**A**	**B**	**C**	**D**	**E**	**F**	**G**
1	264.59^{a}±0.01	244.89^{c}±0.0	237.09^{b}±0.01	206.30^{d}±0.01	174.09^{d}±0.01	173.39^{c}±0.01	168.30^{e}±0.01
2	618.49^{a}±0.01	600.47^{b}±0.03	557.69^{d}±0.01	521.88^{e}±0.02	451.02^{f}±0.03	388.49^{c}±7.08	326.89^{b}±0.01
3	960.11^{a}±0.01	950.40^{b}±0.14	769.81^{c}±0.01	762.52^{d}±0.02	633.39^{b}±0.14	621.47^{e}±0.03	489.39^{f}±0.01
4	1258.58^{a}±0.02	1251.59^{b}±0.01	1006.02^{c}±0.03	956.81^{a}±0.03	849.38^{d}±0.21	823.90^{g}±0.01	598.8^{f}±0.03

Values are Means ± standard deviation of triplicate determinations. Means within the same column with different letters are significantly different at p<0.05 . A = 100:0, B = 95:5, C = 90:10, D = 85:15, E = 80:20, F = 75:25, G = 0:100 Orange Fleshed Sweet Potato - Malted Millet Flour Blends

Table 7. Cumulative Weight Gain of Rats Fed Malted Millet-Orange Fleshed Sweet Potato Flour Blends

	Orange Fleshed Sweet Potato - Malted Millet Flour Blends(g)						
Weeks	**A**	**B**	**C**	**D**	**E**	**F**	**G**
1	22.56^{d}±0.01	8.89^{d}±0.01	8.10^{d}±0.01	3.89^{d}±0.01	2.39^{d}±0.01	0.65^{d}±0.07	-4.02^{d}±0.00
2	24.71^{c}±0.02	9.14^{c}±0.01	9.11^{c}±0.03	4.31^{c}±0.01	3.91^{c}±0.01	2.84^{c}±0.01	-14.24±0.01
3	31.62^{b}±0.02	14.00^{b}±0.07	12.83^{b}±0.02	9.64^{b}±0.01	8.21^{b}±0.02	4.42^{b}±0.03	-19.27±0.03
4	35.74^{a}±0.02	19.33^{a}±0.02	19.16^{a}±0.03	14.61^{a}±0.02	11.62^{a}±0.03	10.06^{a}±0.01	-25.52^{a}±0.03

Values are Means ± standard deviation of triplicate determinations. Means within the same column with different letters are significantly different at p<0.05. A = 100:0, B = 95:5, C = 90:10, D = 85:15, E = 80:20, F = 75:25, G = 0:100 Orange Fleshed Sweet Potato - Malted Millet Flour Blends

Hematological Profile of Albino Rats Fed with Malted Millet and Orange Fleshed Sweet Potato Flour Blends

The hematological profile of albino rats fed malted millet-orange fleshed sweet potato flour blend is presented in Table 8. The hematological profiles (HB, PCV, TWBC, RBC, RBC and FBS) at 0 week were in the range of 8.82 to 12.45, 27 to 39.10, 59.5 to 264.5, 345.05 to 485.20 and 91.50 to 155.1%, respectively with increase in the added prange fleshed sweet potato flour. While at the commencement of the feed, the hematological profile decreased at 0% malted millet and increased at 0% orange fleshed sweet potato for the four weeks. With the increase in percentage (5-25%) orange fleshed sweet potato flour, the hematological profile of the rats increased. This could be as a result of the effect of the orange fleshed sweet potato flour. The malted millet has the lowest value in all the hematological profile of the rats while the 0% orange fleshed sweet potato has the highest value for the period of four weeks of experiment which could be as a result of addition of orange fleshed sweet potato (Kumar *et al.*, 2015).

The effect of OFSP on the haematological parameters was significant, p=0.05, for WBC, PCV, RBC and HB. The high concentration of PCV, HB, RBC, and RBC of the experimental rats fed on 100% OFSP further established nutritional quality of these products. This finding agrees with the report of Roberts (2000) who established that diets containing quality protein and iron usually enhance production of hemoglobin and immunity in animals. In contrary, low FBS and HB that were observed in 100% and 25% OFSP may lead to poor production of hemoglobin and, hence, could cause anemia (Ijarotimi and Keshinro, 2012).

Table 8. Hematological profile of albino rats Fed with the flour blends

		Orange Fleshed Sweet Potato - Malted Millet Flour Blends						
Weeks	**Parameters**	**A**	**B**	**C**	**D**	**E**	**F**	**G**
0	HB (g/dl)	8.82^{e}±0.03	9.22^{e}±0.02	9.62^{e}±0.03	10.63^{e}±0.04	11.21^{e}±0.21	11.83^{e}±0.04	12.45 ^{e}±0.07
	PCV (%)	27.06^{d}±0.08	28.1^{d}±0.14	28.20^{d}±1.13	33.07^{d}±0.03	36.07^{d}±0.03	37.25^{d}±0.35	39.10 ^{d}±0.14
	TWBC (L^{-1})	59.5^{c} ±0.70	97.75^{c}±0.00	103.25^{b}±0.06	120.2^{b}±0.28	172.20^{b}±0.28	232.15^{b}±0.21	264.25^{b}±0.00
	RBC (L^{-1})	345.05^{a}±0.07	380.1^{a}±0.16	390.1^{a}±0.10	415.10^{a}±0.14	445.1^{a}±0.16	480.22^{a}±0.31	485.20^{a}±0.25
	FBS (%)	91.50^{c}±0.70	95.25^{c}±0.35	103.1^{c}±0.22	130.06^{c}±0.08	135.1^{c}±0.14	146.5^{c}±0.70	155.1^{c}±0.10
1	HB (g/dl)	9.25 ^{e}±0.03	9.30 ^{e}±0.42	9.95 ^{e}±0.35	10.15 ^{e}±0.21	10.3 ^{e}±0.14	10.75 ^{e}±0.35	11.91 ^{e}±0.00
	PCV (%)	19.37^{d}±3.61	21.25^{d}±0.20	23.5^{d}±17.5	30.5^{d}±0.07	31.75^{d}±0.35	33.97^{d}±0.03	35.25^{d}±0.03
	TWBC (L^{-1})	95.5^{b}±0.70	105.5^{e}±0.70	107.5^{c}±0.70	117.5^{b}±0.21	123.5^{b}±0.70	139.5^{c}±0.21	143.5^{b}±0.70
	RBC (L^{-1})	247.5^{a}±0.08	254.5^{a}±0.09	285.5^{a}±0.70	360.2^{a}±0.35	380.5^{a}±0.70	383.0^{a}±1.41	395.0^{a}±0.41
	FBS (%)	75.5^{b}±0.70	85.0^{c}±1.41	95.5^{c}±0.70	112.5^{c}±0.70	126.0^{c}±1.41	132.0^{b}±1.41	135.0^{b}±0.08
2	HB (g/dl)	9.45 ^{e}±0.07	10.3 ^{e}±0.14	10.57^{e}±0.03	10.97^{e}±0.03	11.65 ^{e}±0.21	12.25 ^{e}±0.35	12.37 ^{d}±0.35
	PCV (%)	25.25^{d}±0.70	27.75^{d}±3.18	32.5^{c}±0.70	33.20^{c}±0.35	34.75^{c}±0.35	36.75^{c}±0.35	39.25^{c}±0.35
	TWBC (L^{-1})	37.3^{b}±0.42	75.5^{b}±0.70	177.0^{b}±1.41	184.2^{b}±0.35	231.5^{b}±0.70	255.5^{b}±0.70	272.5^{b}±0.70
	RBC (L^{-1})	362.5^{a}±0.70	375.0^{a}±4.24	397.5^{b}±0.70	414.5^{a}±0.70	455.5^{a}±0.70	475.5^{a}±0.70	477.0^{b}±1.41
	FBS (%)	9.55^{d}±0.70	10.50^{d}±0.70	11.95^{d}±0.70	13.00^{d}±4.24	20.5^{d}±0.70	40.5^{c}±0.70	70.50^{c}±0.70
3	HB (g/dl)	3.90^{e}±0.70	5.55^{e}±0.07	7.50^{e}±0.70	7.55^{e}±0.07	8.55^{e}±0.70	8.87^{e}±0.03	10.55^{e}±0.70
	PCV (%)	11.50^{d}±0.70	16.5^{e}±0.70	22.5^{c}±0.70	25.5^{c}±0.70	26.00^{d}±1.41	27.5^{d}±0.70	31.5^{d}±0.70
	TWBC (L^{-1})	111.5^{b}±0.70	135.5^{b}±0.70	171.5^{b}±0.70	272.5^{a}±20.5	290.5^{b}±0.70	335.5^{b}±0.70	436.0^{a}±0.70
	RBC (L^{-1})	161.5^{a}±0.70	195.5^{a}±0.70	272.5^{a}±0.70	293.5^{b}±0.70	305.5^{a}±0.70	357.5^{a}±0.70	363.5^{a}±0.70
	FBS (%)	10.50^{d}±0.70	13.5^{c}±0.70	24.5^{d}±0.70	35.5^{c}±0.70	35.5^{c}±0.70	42.5^{c}±0.70	44.5^{b}±0.70
4	HB (g/dl)	10.1^{e}±0.70	10.1^{e}±0.70	10.50^{e}±0.70	11.5^{e}±0.70	11.55^{e}±0.70	12.2^{d}±0.70	50.0^{d}±56.5
	PCV (%)	30.5^{d}±0.7	33.50^{e}±0.70	33.50^{d}±0.70	35.5^{d}±0.70	37.50^{d}±0.70	37.50^{d}±0.70	38.5^{c}±0.70
	TWBC (L^{-1})	38.5^{c}±0.70	93.5^{b}±0.70	117.50^{b}±0.70	121.5^{b}±0.70	125.5^{a}±0.7	125.5^{b}±0.70	133.54^{b}±0.70
	RBC (L^{-1})	43.5^{c}±0.70	137.5^{b}±0.70	232.0^{a}±196.5	393.5^{a}±0.70	415.0^{a}±7.07	445.5^{a}±0.70	447.5^{a}±0.70
	FBS (%)	41.00^{c}±1.41	47.5^{a}±0.70	49.50^{c}±0.7	56.5^{b}±0.70	61.50^{c}±0.70	75.5^{c}±0.7	84.50^{c}±0.70

Values are Means ± standard deviation of triplicate determinations. Means within the same column with different letters are significantly different at p<0.05. A = 100:0, B = 95:5, C = 90:10, D = 85:15, E = 80:20, F = 75:25, G = 0:100 Orange Fleshed Sweet Potato - Malted Millet Flour Blends

The PCV, HB and RBC reported in this work were lower than 30–45%, 10–15b/dL and 5.0–10.0x10^6/mm^3, respectively reported in Porter and Kaplan (Merck Manual) (2012). The expected values for normal fasting blood glucose (FBS) concentration are between 70mg/dL (3.9mmol/L and 100mg/L). Generally, hematological factors are affected by several factors which include physiological environmental condition, dietary content, fasting, age, administration of drugs, anti-aflatoxin treatment and continuous supplementation of vitamin affects the blood profile of healthy animal. Others include health of animal, degree of physical activity, sex breeds of animal, diseases and stress factors, climate geographical location, season, day length, time of day, life habit of species, oestrus cycle and pregnancy.

The Packed Cell Volume (PCV) is a measurement of the proportion of blood that is made up of cells. The value is expressed as a percentage or fraction of cells in blood. Generally, a normal range is considered to be 38.3 to 48.6% (men). 35.5 to 44.9 % (women). White Blood Cell (WBC) is type of blood cell that is made in the bone marrow and found in the blood and lymph tissue. WBC of less than 4x10^9/L indicates leukopenia. A WBC count of more than 11x10^9/L indicates leukocytosis. The major functions of the white blood cell are to fight infections, defend the body by phagocytocis against invasion by foreign organisms and to produce or at least transport and distribute antibodies in immune response. Animals with low white blood cells are exposed to high risk of disease infection, while those with high counts are capable of generating antibodies in the process of phagocytocis and have high degree of resistance to diseases (Soetan *et al*., 2013) and enhance adaptability to local environmental and disease prevalent conditions (Iwuji and Herbert, 2012).

Red Blood Cells (RBC) are the most common type of blood cell and the vertebrate's principal means of delivering oxygen to the body tissues—via blood flow. Red blood cells (erythrocytes) serve as a carrier of haemoglobin. It is this haemoglobin that reacts with oxygen carried in the blood to form oxyhaemoglobin during respiration (Chineke *et al*., 2006). Generally, a normal range for RBC is considered to be: Male: 4.3-5.9x10^{12}/L Female: 3.5-5.5x10^{12}/L. A reduced red blood cell count implies a reduction in the level of oxygen that would be carried to the tissues as well as the level of carbon dioxide returned to the lungs (Ugwuene, 2011).

Haemoglobin is the iron-containing oxygen-transport metalloprotein in red blood cells of almost all vertebrates as well as the tissues of some invertebrates. Generally, a normal range is considered to be: Male: 2.09-2.71 mmol/L Female: 1.86-2.48 mmol/L. The expected values for normal fasting blood glucose concentration are between 70 mg/dL (3.9 mmol/L) and 100 mg/dL (5.6 mmol/L). Chineke *et al*. (2006) also reported that apart from genotype, age, sex, differences in hematological indices may be caused by nutritional, environmental and hormonal factors. According to Radostits *et al.* (1994), low nutritional grassland, pasture, stress, parturition and climate factors could greatly alter the blood values of goats and sheep as well as other farm animals

Conclusion and Recommendation.

The result of this study revealed that locally available food commodities such as malted millet – orange fleshed sweet potato can be utilized as protein-rich complementary food that is capable of reducing malnutrition among children. These blends could also be used to manage diabetic cases and vitamin A deficiency in children considering the glycaemic index and the vitamin A content. Most of the assessed hematological parameters fall within the required standard for healthy animal, hence the flour blends can be accepted for both animal and human consumption. The blend with 20% malted millet based on the weight gain, glycemic index and hematological quality is recommended for use.

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