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Production and Nutritional Evaluation of High Energy/Protein Meal ('Danwake') from Wheat, Cowpea, Bambara Groundnut and Cassava

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ABSTRACT

Traditional food system is all food from a particular culture produced from locally available and highly nutritious sources which are culturally accepted by the people. It includes socio-cultural meanings, acquisition, processing techniques, usage, composition and nutritional consequences for people using the food. This work aimed at the quality evaluation of different high energy/protein meal ('danwake') formulated from blends of germinated wheat, dehulled cowpea and dehulled Bambara groundnut, and Fermented cassava flour. Germinated wheat, dehulled cowpea and bambara groundnut, fermented cassava, baobab leaves (kuka) and potash (kanwa) were incorporated in the proportion of 70:17:4:4:3.5:1.5 for composite 'danwake' flour test 1 Aa. The ratios 60:15:5: 16:3:1 is for composite flour test 2 Bb, 9:18:9:60:3:1 for composite 'danwake' flour test 3 Cc respectively. A control 'danwake' flour wheat flour 100% (WWF) and cassava flour 100% (CCF) served as control. Proximate, mineral, vitamins, amino acid profile, *in vitro* protein digestibility and anti-nutritional factors were analyzed. Proximate analysis showed that formulated composite 'danwake flours' have 363.24Kcal, 363.62 Kcal, and 350.43 Kcal for Aa, Bb, and Cc respectively for total energy, 17.35 %, 18.92 %, and 12.86 % protein contents for Aa, Bb, and Cc respectively, 68.67 %, 65.28 %, 69.08 % carbohydrate contents for Aa, Bb, and Cc respectively. Moisture contents ranged between (6.42-7.11) percent, with the blend with 60% wheat flour has the least moisture contents of 6.40%. All the formulations including the commercial flours contained the following vitamin range (0.08-0.1 ug/g) thiamine, (0.02-0.05 ug/g) riboflavin, (0.11-0.16 ug/g) cyanocobalamine, (0.08-0.40 ug/g) ascorbic acid and (0.01-0.02 ug/g) vitamin A, while the mineral element range (0.02-0.26 mg/100g) Cr, (0.14-0.76 mg/100g) Zn, (0.64-1.75 mg/100g) Fe, (0,97-1.77mg/100g) Ca, and (0.15-0.51 mg/100g) Mn. Amino acid Lysine, Asphatic acid and Glutamic acid, Alanine, Methionine and Phenylalanine were higher in 'danwake' blend Bb. Norleucine was not detected in all the samples. The formulated composite 'danwake' flours were superior to control in terms protein content, vitamins and mineral element levels. The composite 'danwake' flours, Bb is more nutritious followed by Aa, while Cc is the least in terms of mineral element levels, vitamins and amino acid.

Keywords: danwake, bambara groundnut, cassava, wheat, cowpea

INTRODUCTION

Traditional food system is all food from a particular culture produced from local sources which are culturally accepted by the people. It includes socio-cultural meanings, acquisition, processing techniques, usage, composition and nutritional consequences for people using the food (Kuhnien and Receiver 1996). It refers to human, managed biophysical systems that are involved in the production, distribution and consumption of food in a particular environment (Onimawo, 2010).

Under nutrition, including micro-nutrient deficiencies is the leading risk factor for disease and death worldwide accounting for over half the disease burden in developing countries and poor combination of the various foods is the bane of adequate nutrient intake. Food systems are a natural

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locus for improving nutritional security in societies hence, when properly prepared and combined; Nigerian traditional food can assume nutrition security in all segments of society (Onimawo, 2010).

Breakfast meal in Africa particularly Northern Nigeria for both adults and infants are based on local staple diet made from tubers, cereals and legumes (Kanu *et al*, 2007). However, most cereals are limited in essential amino acids such as tryptophan, although some are rich in lysine (Onweluzo and Nnamuchi, 2009). Tubers such as Cassava are poor in protein (Westby, 2002), while legumes are rich in essential amino acid particularly the sulphur amino acids (Kanu *et al.*, 2007).

Thus a combination of such foodstuffs will improve nutritional value of the resulting blend that make it better compared to the individual components alone (Mensa-Wilmot *et al*, 2001). Traditional foods of northern Nigerian origin are including: ‘‘danwake’’, ‘Nakiya’, ‘pate-pate’, ‘Sinasir’, ‘Akamu’, ‘Masa’, ‘Dambu’ (Nkama *et al*, 1998), ‘Moi-moi’, ‘Kosai’ which are produced from legumes, tubers and cereals. ‘‘Danwake’’ is a popular breakfast meal of northern Nigeria, prepared either from mono tuber (eg cassava flour), mono cereal (eg.wheat flour) or cassava flour fortified with cowpea flour as a dumpling. Different proportions and combinations of cassava flour, cowpea flour or wheat flour are used. Baobab leave and potash are added during preparation. Groundnut oil, seasoning is added to the cooked ‘‘danwake’’. Traditional foods based on cereals or tubers have to undergo modification to warrant a balance in essential nutrients. Many cereal-legume combinations have been found to provide supplementary effect on the protein/amino acid profile of the combined composition (McDonald and Greenhalgh, 1985). Since the chief ingredient in” ‘‘danwake’’ is cassava flour (lafun) which is poor in terms of protein contents (Westby, 2002). The traditional breakfast meal for both adults and children in Northern Nigeria are based on staple diets made mostly from mono tubers and mono cereals especially cassava and wheat which are of low nutritional quality and high energy density leading to nutritional imbalances such as obesity, under nutrition and micronutrient deficiencies. Thus, this informed the production and formulation of high protein meal from wheat, cassava, bambara groundnut and cowpea

MATERIALS AND METHODS

Sources of Materials

The cassava was obtained from Bichi L.G.A. of Kano state, Bambara groundnut and baobab leaves were obtained from Maiduguri Monday market. Improved variety of the cowpea (Banjara) was obtained from Maiduguri Metropolis through Borno state Agricultural Development Program (BOSADP) and improved wheat variety (Seri M82) was obtained from Lake Chad Research Institute (LCRI).

Preparation of Cassava Flour

The fresh cassava roots were peeled, washed, steeped in water for 3 days and pulped. The cassava pulp was pressed using a screw press to reduce the water contents. The pressed pulp was dried using Advanced Laboratory Equipment engineering Company (ALEEC) cabinet dryer at 60^0C for 2 days to obtain constant moisture content of 8% and then milled into fine flour Oyewole and Afolami (2001), while fermentation was excluded for the unprocessed cassava flour.

Preparation of Cowpea Flour

Five hundred grams (500g) of cowpea was sorted, cleaned of dirt and soaked in water for 5 minutes and then dehulled using mortar and pestle. The dehulled seeds were dried to a constant weight, milled and then

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sieved with a 5mm pore sieve to obtain fine flour (Odedeji and Oyeleke, 2011)

Five hundred grams (500g) of the cowpea was sorted, cleaned of dirt, milled and sieved with 5mm pore sieve to obtain the unprocessed cowpea flour.

Preparation of Bambara Groundnut Flour

Five hundred grams (500g) of Bambara groundnut was sorted, cleaned of dirt and soaked in water overnight. It was then dehulled, drained, and dried to moisture content of about 7- 8 %, and then sieved using 5mm pore sieve into a fine powder (Okafor *et al*. 2003). Five hundred grams (500g) of dry Bambara groundnut was sorted, cleaned and sieved using 5mm pore sieve to obtain the unprocessed 3 ambara groundnut flour.

Preparation of Wheat Flour

The grains were sprouted in accordance with the method reported by Kulkarni *et al*. (1991). Five hundred grams (500g) of the wheat samples were soaked in a plastic bucket containing 300 ml of distilled water and steeped for one hour at room temperature (28± 2°C). The steeped water was discarded by decantation and the grains were germinated for 72 hours by spreading on a clean grease free tray pan and thereafter, it was sun dried for 2-3 days by putting it in a sterilized tray pan. The wheat grains were milled using a disc attrition mill (hunt No.2A Premier Mill hunt and Co, UK) to an average particle size of less than 0.3mm. The mill grain was then sieved through a fine mesh (5mm) to obtain the wheat flour**.** Five hundred grams (500g) of wheat was sorted and cleaned of dirt, milled and sieved using 5mm pore sieve to obtain the unprocessed wheat flour.

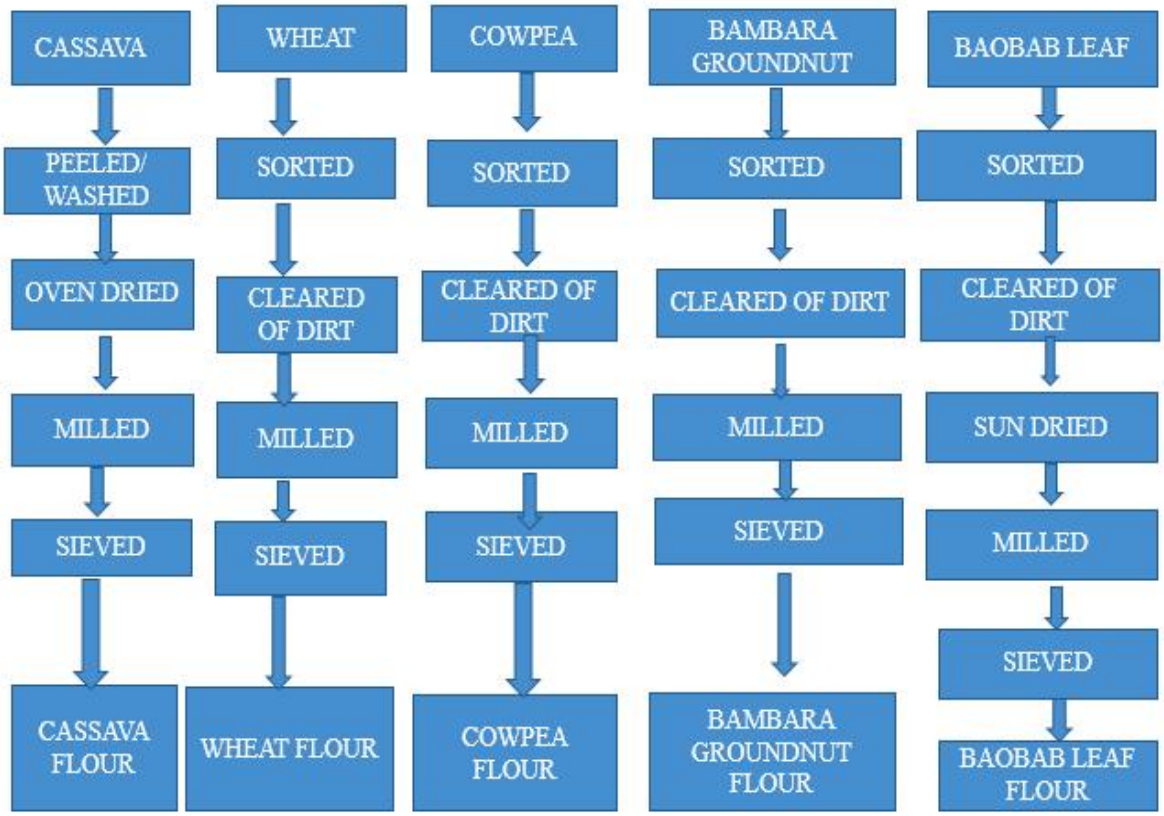

Figure 1: Flow Diagram for the preparation of unprocessed samples.

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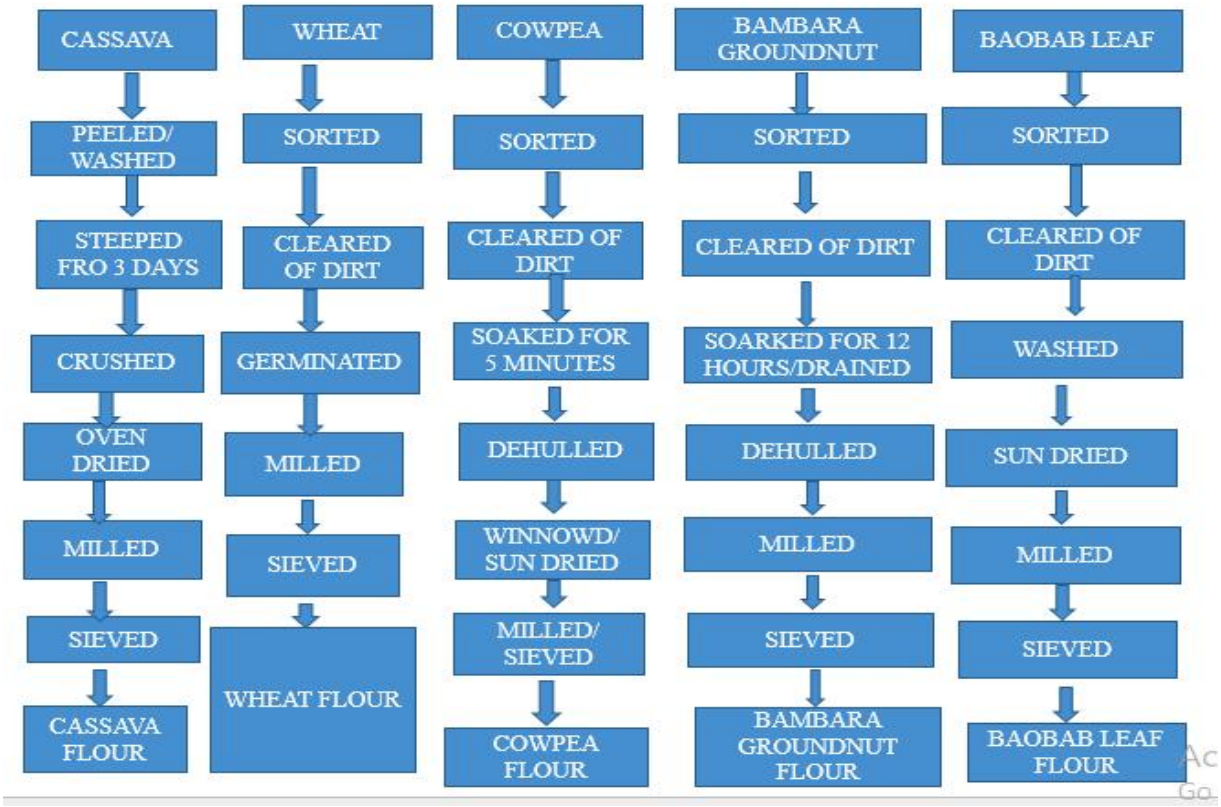

Figure 2: Flow diagram for the preparation of processed samples Formulation of Composite ‘‘danwake’’ flour.

The formulation of the ‘‘‘danwake’’’ flour was done as follows;

Table 1: Formulation of composite ‘‘danwake’’ flours (g).

FORMULATIONS	PWF	PCF	PBF	WWF	CCF	POTASH	BAOBAB	TOTAL
Aa	70	16	4	-	4	2	4	100
Bb	60	15	15	-	4	2	4	100
Cc	9	18	9		60	2	4	100
WWF	-	-	-	94	-	2	4	100
CCF	-	-	-	-	94	2	4	100

Key: PWF= Processed wheat flour, PCF= Processed cowpea flour, PBF= Processed Bambara groundnut flour, CCF= Cassava flour, WWF= White wheat flour

Determination of Proximate Composition

Proximate analysis was carried out on the cassava, cowpea, Bambara groundnut, wheat blends according to the methods of AOAC, (2020) to determine their proximate composition i.e. their (moisture, ash, crude protein, crude fat, crude fibre, total energy content and carbohydrate content.

Determination of Moisture Content

Two grams (2g) of each sample was weighed into a petri dish of known weight and dried to a constant weight at 105^{o}C for 5hours in an oven. The dried sample was weighed into a desiccator and weighed. The difference in weight of the sample before and after drying is the moisture content.

$$\% \text{ moisture} = \frac{\text{Loss in weight due to drying}}{} \times 100$$

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Initial weight of the sample

Determination of Ash Contents

The ash content was determined by combusting the samples in a muffle furnace at 55°C for 12hours and calculating the percentage ash using the formulae;

$$\text{Ash (\%)} = \frac{W_1 - W_2}{W3} \times 100$$

Where; W_1=Sample + crucible before ashing, W_2=Ash + crucible after ashing, W_3=Weight of sample

Determination of Protein (kjedahl method)

Digestion

Two grams (2g) of the sample was weighed into Kjedahl digestion tubes and 20ml of sulphuric acid added into the digest. The tube was heated in the digestion chamber for 16-18hours. NaOH added and the volume was made up to 100ml by distilled water.

Distillation

Five milliliters (5mls) of Borate was pipetted into a conical flask and 3- 4 bromocresol and methylene indicator added into the conical flask. 5mls of the digested sample was introduced into the distillation flask through the funnel and 15-20mls of 40% NaOH was then added into the distillation flask. All the inlets closed. The conical flask containing the borate and mixed indicators was placed at the extended tube (outlet) of the dilation unit and. 50 - 75ml of the distillation collected into the conical flask. This was then titrated with the standard HCl.

Standardization of HCl

Five milliliters (5mls) of ammonium solution was pipetted and distilled with about 15ml of 40% sodium hydroxide solution. The liberated ammonia was collected in 5ml of 2% boric acid and 4 drops of mixed indicator and titrated with the standard HCl. The amount of HCl required for the titration was the acid factor used in the calculations of crude protein content.

The percentage protein was calculated using the formula.

$$\frac{A \times N \times F \; 14.007}{\text{Weight of sample} \times \text{Aliquot taken}} \times 100$$

Where; A=Volume of the acid used, N=Molarity of acid, F=Factor 6.25

Determination of Crude Fat Content

Soxhlet extraction method was used for the analysis of fat content of the products. Three grams (3g) of each sample was weighed into fat extraction thimbles and seed for the covered with cotton wool to prevent splashing of the sample during extraction. The extraction units (tecator soxhlet 1046) was set up and fat extracted using petroleum ether.

$$\text{\% extractable fat} = \frac{W1 - W2}{Wl} \times 100$$

Where, Wl=Weight of sample before extraction, W2=Weight of sample without fat, W3=Weight of flask with fat

Determination of carbohydrate (nitrogen-free extract)

The carbohydrate content was determined by the difference using the formular;

Percentage of carbohydrate = 100 - (% moisture, + % protein + % ash + % fat 4- % crude fibre). (AOAC, 2022).

Determination Total Energy

The total energy value was determined according to the method of Mahgoub, (1999) using the formula below;

Total energy (Kcal /l00g) = (% available carbohydrates x 4) + (% protein x 4) + (% fat x 9)]

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Determination of vitamin content

Vitamin content was determined by dissolving 1g f the water in a beaker placed in an ultrasonic water bath for 30 minutes, it was centrifuge at 1200 rpm for 10 minutes and then filtered using acrodisc filter membrane. The filtrate was injected into the mobile phase containing 0.1% TFA (Triflouroacetic acid) and acetonitrile (standard solution) in the HPLC for separation. The data generated was displayed as peaks on the chromatograph. Peaks were identified based on retention time of reference standard (vitamin purchased from sigma chemical) (AOAC, 2015).

Determination of Mineral Element

Two grams (2g) of sample was weighed into a crucible and incinerated at 600°C for 2hours. The ashed sample transferred into 100ml volumetric flask and 100ml of distilled water added into it and readings taken on the AAS for Ca, Zn, Cr, Fe, and Mn. The appropriate lamps and correct wave length for each element were specified in the instruction manual AOAC (2020).

Determination of Amino Acid Profile

The amino acid profile in the known sample was determined using methods described by Benitez (1989). The known sample was dried to constant weight, defatted, hydrolysed, and evaporated in a rotary evaporator and load into the Technicon sequential Multi-Sample Amino Analyzer (TSM).

Defatting of Sample

The sample was defatted using chloroform/methanol mixture of ratio 2:1. About 4g of the sample was put in extraction thimble and extracted for 15 hours in soxhlet extraction apparatus (AOAC, 2006).

Determination of nitrogen

A small amount (200mg) of ground sample was weighed, wrapped in Whatman filter paper (No.1) and put in the kjeldhal digestion flask. Concentrated sulphuric acid (10ml) was added. Catalyst mixture (0.5g) containing sodium sulphate (Na_2SO_4) copper sulphate (Cu_2SO_4) and selenium oxide (SeO_2) in the ratio of 10:5:1 added into the flask to facilitate digestion. Four pieces of anti-bumping granules was added.

The flask was then put in Kjeldhal digestion apparatus for 3 hours until the liquid turn light green. The digested sample was cooled and diluted with distilled water to 100ml in standard volumetric flask. Aliquot (10ml) of the diluted solution with 10 ml of 45% sodium hydroxide was put into the Markham distillation apparatus and distilled into 10ml of 2% boric acid containing 4 drops of bromocresol green/methyl red indicator until about 70ml of distillate collected AOAC (2020).

The distillate water was then titrated with standardized 0.01 N hydrochloric acid to grey coloured percentage nitrogen

$$= \frac{(a-b) \times 0.01 \times 14 \times V \times 100}{W \times C}$$

Where:
a =Titre value of the digested sample,
b =Titre value of blank sample,
v =Volume after dilution (100ml),
W =Weight of dried sample (mg),
C. =Aliquot of the sample used (10ml),
14. =Nitrogen constant in mg.

Hydrolysis of the Sample

A known weight (4g) of the defatted sample was weighed into glass ampoule. 7ml of 6N HCl added and oxygen expel by passing nitrogen into the ampoule (this is to avoid possible oxidation of some amino acids during hydrolysis e.g. methionine and cystine). The glass ampoule was then scale with Bunsen burner flame and put in

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an oven preset at $105^0C \pm 5^0C$ for 22 hours. The ampoule allowed cooling before broken open at the tip and the content filtered to remove the organic components. It should be noted that tryptophan will be destroyed by 6N HCl during hydrolysis.

The filtrate was then evaporated to dryness in hot air oven. The residue dissolves with 5ml to acetate buffer (pH 2.0) and stored in plastic specimen bottles, which were kept in the freezer. AOAC (2020).

Loading of the Hydrolysate into TSM Analyzer

The amount to be loaded is between 5 to 10 micro liters. This is dispended into the cartridge of the analyzer. The TSM analyzer is designed to separate and analyse free acidic, neutral and basic amino acids of the hydrolysate. The period of an analysis last for 76 minutes (Benitez, 1989)

Method of Calculating Amino Acid Values from the Chromatogram Peaks

An integrator attached to the analyzer calculates the peak area proportional to the concentration of each of the amino acids. Alternatively, the net height of each peak produced by the chart recorder of TSM (each representing and amino) was measured. Approximately area of each peak was then obtained by multiplying the height with the width at half-height. The norcleucine equivalent (NE) for each amino acid in the standard mixture was calculated using the formula.

$$NE = \frac{\text{Area of Norceucine Peak}}{\text{Area of each Acid}}$$

A constant S was calculated for each amino acid in the standard mixture:

Where; $S_{std} = NE_{std} \times$ Molecular weight x μMAA_{std}.

Finally, the amount of each amino acid present in the sample was calculated in g/16gN of g/100g protein using the following formula:

Concentration (g/100g protein) = NH x W@NH/2 x S_{std} x C

$$\text{Where C} = \frac{\text{Dilution x 16}}{\div \text{NH x W (nleu)}}$$

Sample Wt (g) x N% x 10 x Vol. loaded

Where: NH =Net height, W=Width @ half height, nleu=Norleucine (Benitez, 1989)

Determination of *in Vitro* protein digestibility (Nills, 1979)

One milliliter (1ml) of 11% trypsin was introduced into 16 test tubes and 1ml of 0.1% NaCl added and allowed to stand to equilibrate, 1ml of ‘‘danwake’’ blend mixture added to all the test tubes (labeled as digestibility at 1 hour and 6 hours). The reaction in each of the test tube was stopped with 5ml of neutralized formalin at 60 minutes and 6 hours. The content of the test tube was then filtered using filter paper. The filter papers were dried in an oven at 108°C for 3 hours. The nitrogen of the undigested sample was determined by the Kjedalh method.

% in vitro protein digestibility

$$= \frac{CP_1 - CP_2}{CP_1} \times 100$$

Where, CP1=Total protein of unprocessed grain, CP2=Total protein after digestion with trypsin

Determination of Antinutritional Factors of the samples

Determination of Phytate Content of the samples by method of Francis (2007)

Four grams (4g) of the sample was soaked in 100 cm^3 of 2% HCl for 3hrs and then filtered through two layers of filter paper. Twenty five centimeter cube ($25cm^3$) of the filtrate was placed in $250cm^3$ conical flask and $5cm^3$ of 0.3 % NH_4SCN solution was added as an indicator .Fifty three centimeter cube ($53.0cm^3$) of distilled

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water was added to reach the proper acidity. This mixture was titrated against $FeCl_3$ solution, which contains about 0.00195 g of Fe per cm^3 of $FeCl_3$ solution. The result was multiplied by factor 1.95 to obtain Phytate P. Phytate P result will be multiplied by factor 3.55 to convert to Phytate.

Determination of Cyanide Contents of the Samples

Cyanide was determined by alkaline picrate method of Williams and Edward (1980). The known sample was weighted and cyanide sample extracted, alkaline picrate solution was prepared and cyanide content of the sample determine.

Extraction of Samples for Cyanide Determination

Five (5) grams of the sample was grinded into a paste. The paste dissolved in 50ml distilled water in a corked conical flask, the cyanide extract was allowed to stay overnight. The extract then filtered and the filtrate used for the cyanide determination (Edward, 1980).

Preparation of Alkaline Picrate Solution

One (1g) gram of picrate and five (5) grams of sodium carbonate was dissolve in a volume of minimally warm water. The volume makes up to 200ml with distilled water (Edward, 1980).

Procedure for cyanide determination

To one (1) milliliter of the sample filtrate in a corked test, four (4) milliliter of alkaline picrate was added and incubated in water bath at 40^0c for five minutes. After colour development, the absorbance of the corked test tube was read in spectrophotometer at 490nm. The absorbance of the blank containing only one (1) milliliter distilled water and four (4) milliliter alkaline picrate also read. The cyanide content was extrapolated from a cyanide standard curve (Edward, 1980).

Data Analysis

All determinations were carried out in triplicate. All data collected were subjected to analysis of variance (ANOVA) using SPSS statistical package version 23.0, and Duncan's multiple range was used to compare the means (Steel and Tone, 1986).

RESULTS

Proximate Composition

Table 2 presents the proximate composition of unprocessed and processed samples of wheat, cowpea, Bambara groundnut and cassava flour. A significant ($P<0.05$) decrease in moisture contents were observed in the unprocessed samples of the cereals, legumes and tubers. The ash content of processed wheat (1.00%) and processed Bambara groundnut (2.00%) and processed cassava (1.53%) exhibited significant increase ($P<0.05$). A significant ($P<0.05$) increase in protein contents were observed in the germinated wheat (6.46%) and dehulled cowpea (17.40 %), while the dehulled bambara groundnut (19.50%) and the fermented cassava (2.11%) did not show any significant ($P>0.05$), with the unprocessed bambara groundnut (19.40%) and unprocessed cassava (2%). Dehulled bambara groundnut (19.50%) had the highest protein contents. A significant decrease ($P<0.05$) in fat contents were observed in the germinated wheat (1.60%), dehulled cowpea (0.92%) and fermented cassava (7.22%).

An increase in the total fibre contents were observed in the unprocessed cowpea (3.70%), dehulled bambara groundnut (3.70%) and fermented cassava (7.22 %), while unprocessed wheat (4.20%) did not show any difference when compared with the germinated wheat (4.00%). A significant ($P<0.05$) increase in total carbohydrate contents were observed in the germinated wheat (80.77%), dehulled cowpea (71.86%), dehulled bambara groundnut (66.56%) and fermented cassava (83.18%) There was slight

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increase in total carbohydrate and total energy contents of the processed samples. The differences were significant (P <0.05). Germinated wheat had the highest carbohydrate content. The values for the total energy content showed a significant (P<0.05) increase in the germinated wheat (367.64%) and dehulled cowpea (363.40%), while significant (P<0.05) decrease was observed in dehulled bambara groundnut (370.84%) and fermented cassava (350.45%), while unprocessed cassava having the highest total energy level.

Table 3 showed the proximate composition of the different composite ‘‘danwake’’ flour compared with cassava flour (CCF) and wheat flour (WWF). The composite ‘‘danwake’’ flour Bb (6.40%) had the lowest moisture content, followed by blend Aa (6.80%). There were no significant (P>0.05) difference between the moisture content of Blend Aa and Bb. They all exhibit low moisture contents. The blend Bb had the highest protein content (18.92%), followed by Aa (17.36 %), while CCF had the lowest protein content (2.49%). Bb had the highest fat content (2.98%) followed by Cc (2.41%), but it’s lowest in CCF (1.22%). CCF has the highest carbohydrate content (80.52%) followed by WWF (79.84%).There were no significant (P>0.05) in the carbohydrate content of the two commercial blends CCF (80.52%) and WWF (79.85%). However, WWF (371.89 Kcal/100g) has the highest energy followed by Bb (363Kcal/100g) and Aa (363.24 Kcal/00g). The higher fibre contents were recorded by the control group CCF.

Vitamin Composition

Table 4 shows the vitamin Composition of unprocessed and processed wheat, cowpea, bambara groundnut and cassava. A significant (P<0.05) decreases were observed in the vitamins B1, B2, B12 and A contents of the fermented wheat and dehulled cowpea. The vitamin B1 and C contents of the fermented wheat (0.06± 0.01 ug/g) and fermented cassava (0.11 ± 0.02 ug/g) showed significant (P <0.05) increase.

Table 5 shows the results of the vitamin content of composite ‘‘danwake’’ flour compared with the commercial groups WWF and CCF. ‘‘danwake’’ flour Bb and Cc recorded a higher value for B1 (0.10 ug/g) and (0.10±0.01 ug/g) respectively, there were no significant (P <0.05) difference in the B1 content of Bb and Cc. The control group WWF recorded a higher value of 0.11 ug/g when compared with UCF which had 0.08 ug/g. There were no significant (P>0.05) difference in the B_2 and B6 contents of all the blends significant reduction in ascorbic acid contents were recorded in the ‘‘danwake’’ flour Aa, Bb, Cc when compared with the commercial control group UCF and WWF. The differences were statistically significant (P <0.05). The result of vitamin A content showed that there were no significant different in the contents of Aa, Bb, UCF and WWF. However the ‘‘danwake’’ flour supplemented with 60% CCF recorded the least value of vitamin.

Mineral Element Composition

Table 6 presents the mineral element composition of the unprocessed and processed wheat, cowpea, bambara groundnut and cassava. Significant (P <0.05) decreases were observed in the chromium contents of the germinated wheat (0.01 mg/100g) and dehulled cowpea (0.02 mg/ 100g) when compared with the unprocessed wheat (0.03mg/100g) and unprocessed cowpea (0.05mg/100g). A significant (P <0.05) decrease was also observed in the magnesium content of the dehulled cowpea (0.40 mg/100g) and dehulled bambara groundnut (1.10mg/100g) when compared with the unprocessed cowpea (0.60mg/100g) and

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unprocessed bambara groundnut (1.20mg/100g). Significant (P<0.05) increase in the Fe content of the dehulled cowpea was observed. Significant (P <0.05) increases in the Zn, Fe, Ca and Mn contents were observed in the germinate wheat, bambara groundnut and cassava respectively, while the processed samples had 0.90, 1.20, 1.10and 0.76 mg/100g respectively. The differences were significant (P<0.05). The iron content and calcium content were higher in processed samples compared to raw samples, except for cassava, where the calcium content was higher in processed wheat, cowpea, bambara groundnut and cassava, but the differences were not significant (P >0.05).

Table 7 present the mineral element levels of composite ‘‘‘danwake’’ flour’. The Zinc content of the composite ‘‘‘danwake’’’ flours Aa, Bb and Cc mg/100g, 0.24 mg/100g and 0.22 mg/100g respectively did not show any significant (P >0.05) difference, while CCF 0.75 mg/100g had the highest Zinc content. ‘‘‘danwake’’’ flour prepared from Bb showed the highest (2.23mg/100g) Fe content when compare with Aa (1.40mg/100g), Cc (1.75 mg/100g), CCF (1.68mg/100g) and WWF (0.64 mg/100g). The ‘‘‘danwake’’’ flour prepared from Bb showed higher calcium and manganese content of 1.77±0.01 mg/100g and 0.64 mg/100g respectively when compared with the other flours of the control.

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Table 2: Proximate composition of unprocessed and processed wheat, cowpea bambara groundnut and cassava flours (%).

Parameters	Wheat		Cowpea		Bambara groundnut		Cassava	
	germinated	unprocessed	dehulled	unprocessed	unprocessed	dehulled	unprocessed	fermented
Moisture	5.16+0.01^{a}	4.40+001^{b}	6.9±0.02^{a}	6.2±0.01^{b}	6.00±0.03^{a}	5.47±0.03^{b}	5.05±0.04^{a}	3.42±0.01^{b}
Ash	1.33+0.11^{a}	1.00+10.01^{b}	1.12±0.02^{a}	1.03±0.04^{a}	3.00±0.01^{a}	2.00±0.03^{b}	1.08±0.01^{a}	1.53±0.02^{b}
Protein	6.46+0.12^{a}	5.80±0.01^{b}	17.40±0.01^{a}	16.92±0.02^{b}	19.5±0.01^{a}	19.40±0.01^{a}	2.11±0.01^{a}	2.09±0.01^{a}
Fat	2.08+001^{a}	1.60+0.12^{b}	1.03±0.01^{a}	0.92±0.02^{b}	6.50±0.01^{a}	3.0±0.02^{b}	1.22±0.01^{a}	1.03±0.01^{b}
Fiber	4.20+003 ^{a}	4.00+002^{a}	3.70±0.01^{a}	3.07±0.02^{b}	3.70±0.01^{a}	3.57±0.01^{b}	7.57±0.01^{a}	7.22±0.01^{b}
CHO	80.77±0.02^{a}	83.21±0.01^{b}	70.35+0.03^{a}	71.86±0.01^{b}	61.30±0.02^{a}	66.56±0.04^{b}	79.84±0.06^{a}	83.18±0.04^{b}
TE(Kcal/100g)	367.64±0.21^{a}	370.44±0.05^{b}	360.27±0.12^{a}	363.40±0.22^{b}	381.70±0.02^{a}	370.84±0.03^{b}	371.89±0.26^{a}	350.45±0.23^{b}

Values are mean ± SEM, n =3

Values with different superscript along the row are significantly different (P<0.05)

Table 3: Proximate composition of composite ‘‘danwake’’ flour (%).

Sample	Moisture	Ash	Crude protein	Total fat	Fiber	Carbohydrate	Total energy (Kcal/100g)
Aa	6.80± 0.06^{a}	1.83± 0.02^{a}	17.36± 0.01^{a}	2.12± 0.02^{a}	3.22± 0.01^{a}	68.67± 0.09^{a}	363.24±0.29^{a}
Bb	6.40± 0.01^{a}	1.96± 0.02^{b}	18.92± 0.01^{b}	2.98± 0.01^{b}	4.05± 0.01^{b}	65.28± 0.03^{b}	363.62±0.64^{a}
Cc	7.11± 0.06^{b}	2.21± 0.01^{c}	12.86± 0.02^{c}	2.41± 0.01^{c}	6.08± 0.01^{c}	69.33± 0.07^{a}	350.43±0.33^{b}
CCF	6.42± 0.01^{c}	1.53± 0.02^{d}	2.49± 0.01^{d}	1.22± 0.01^{d}	7.82± 0.02^{d}	80.52± 0.07^{c}	343.02±0.16^{c}
WWF	7.36± 0.03^{d}	0.85± 0.02^{e}	10.15± 0.02^{e}	1.33± 0.02^{e}	0.52± 0.01^{d}	79.84± 0.06^{dc}	371.89±0.26^{d}

Values are mean ± SEM, n =3;

Values with different superscript along the column are significantly different (P<0.05)

Key: Aa = 70% PWF with 17% PCF, 4% CCF, 4% PBF, 1.5% kanwa and 3.5% kuka; Bb = 60% PWF with 15% PCF, 16% CCF, 5% PBF, 1% kanwa and 3% kuka; Cc = 60% CCF with 18% PCF, 9% PBF, 9% PWF, 1% kanwa and kuka 3%; CCF= cassava flour; WWF= white wheat flour; PWF= processed wheat flour; CF= processed cowpea flour; PBF = processed bambara groundnut flour

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Table 4: Vitamin composition of unprocessed and processed wheat, cowpea and bambara groundnut (ug/g).

Vitamins	Aa	Bb	Cc	CCF	WWF
B1	0.08±0.01^{a}	0.10±0.02^{b}	0.10±0.01^{cb}	0.08±0.01^{a}	0.11±0.03^{b}
B2	0.05±0.02^{a}	0.05±0.00^{a}	0.04±0.01^{a}	0.02±0.01^{b}	0.03±0.01^{cb}
B12	0.15±0.01^{a}	0.14±0.01^{a}	0.14±0.01^{a}	0.11±0.01^{cb}	0.16±0.01^{a}
C	0.11±0.01^{a}	0.11±0.02^{a}	0.08±0.01^{cb}	0.40±0.01^{e}	0.40±0.01^{fe}
A	0.02±0.01^{a}	0.03±0.02^{a}	0.01±0.01^{cb}	0.02±0.03^{a}	0.02±0.01^{a}

Values are mean ± SEM, n =3;

Values with different superscript along the column are significantly different (P<0.05)

Key: Aa = 70% PWF with 17%PCF, 4%CCF, 4%PBF, 1.5% kanwa and 3.5%kuka; Bb = 60% PWF with 15%PCF, 16%CCF, 5%PBF, 1% kanwa and 3% kuka; Cc = 60% CCF with 18%PCF, 9%PBF, 9%PWF, 1% kanwa and kuka 3%; CCF= cassava flour; WWF= white wheat flour, PWF= processed wheat flour; PCF= processed cowpea flour; PBF = processed bambara groundnut flour.

Table 5: wheat, cowpea, bambara groundnut and cassava (ug/g).

	Samples							
	Wheat		Cowpea		Bambara groundnut		Cassava	
Vitamin	Unprocessed	Fermented	unprocessed	Dehulled	unprocessed	dehulled	Unprocessed	fermented
B1	3.87±0.03^{a}	2.94±0.01^{b}	3.21±0.01^{a}	2.73±0.12^{b}	2.90±0.24^{a}	2.08±0.03^{b}	0.08±0.01^{a}	0.11±0.02^{b}
B2	2.18±0.10^{a}	1.38±0.01^{b}	2.01±0.05^{a}	1.32±0.10^{b}	4.98±0.23^{a}	3.60±0.02^{b}	0.02±0.01^{a}	0.03±0.01^{a}
B12	1.34±0.01^{a}	0.51±0.20^{b}	5.33±0.21$^{a`}$	3.91±002^{b}	3.13±0.04^{a}	2.40±0.08^{b}	0.11±0.01^{a}	0.11±0.01^{a}
C	0.49±0.11^{a}	0.06±0.01^{b}	0.48±0.21^{a}	0.33±0.01^{b}	0.33±0.23^{a}	0.26±0.01^{b}	0.40±0.01^{a}	0.08±0.03^{b}
A	3.14±0.10^{a}	1.21±0.03^{b}	1.74±0.15^{a}	0.80±0.21^{b}	0.87±0.02^{a}	0.52±0.0^{b}	0.02±0.01^{a}	0.02±0.03^{a}

Values are mean ± SEM, n =3

Values with different superscript along the raw are significantly different (p<0.05).

Table 6: Mineral element composition of unprocessed and processed of wheat, cowpea, bambara groundnut and cassava (mg/100g).

	Samples							
	Wheat		Cowpea		Bambara groundnut		Cassava	
	Unprocessed	**germinated**	**unprocessed**	**Dehulled**	**unprocessed**	**Dehulled**	**unprocessed**	**fermented**
Cr	0.03±0.11^{a}	0.01±0.03^{b}	0.05±0.12^{a}	0.02±0.13^{b}	0.01±0.00^{a}	0.01±0.01^{a}	0.02±0.01^{a}	0.02±0.01^{a}
Zn	0.70+0.01^{a}	0.90±0.02^{b}	1.10±0.03^{a}	1.20±0.02^{a}	1.20±0.03^{a}	1.10±0.02^{a}	0.64±0.01^{a}	0.76±0.01^{b}
Fe	1.90+0.03^{a}	2.60±0.02^{b}	4.20±0.04^{a}	3.40±0.03^{b}	2.60±0.02^{a}	2.20±0.02^{a}	0.59±0.01^{a}	0.96±0.02^{b}
Ca	2.50+0.11^{a}	2.70±0.10^{b}	2.20±0.01^{a}	2.0±0.01^{a}	3.60±0.01^{a}	3.00±0.01^{a}	0.98±0.01^{a}	0.97±0.01^{a}
Mn	2.30±0.10^{a}	2.60±0.11^{a}	0.60±0.03^{a}	0.40±0.02^{b}	1.20±0.02^{a}	1.10±0.01^{a}	0.23±0.01^{a}	0.28±0.01^{a}

Values are mean ± SEM, n =3;

Values with different superscript along the raw are significantly different (P<0.05).

Table 7: Mineral element Composition of Composite ‘‘danwake’’ flour produced from wheat, cowpea and bambara groundnut and cassava (ug/g).

Minerals	Aa	Bb	Cc	CCF	WWF
Cr	0.19±0.02^{a}	0.12±0.01^{b}	0.12±0.01^{cb}	0.02±0.01^{d}	0.26±0.01^{e}
Zn	0.25±0.01^{a}	0.24±0.01^{a}	0.12±0.01^{cb}	0.76±0.01^{b}	0.14±0.01^{c}
Fe	1.40±0.02^{a}	2.23±0.01^{b}	1.75±0.01^{c}	1.68±0.01^{d}	0.64±0.02^{ed}
Ca	1.60±0.01^{a}	1.77±0.01^{b}	1.25±0.01^{c}	0.97±0.0^{d}	1.27±0.01^{ec}
Mn	0.51±0.01^{a}	0.64±0.01^{b}	0.15±0.01^{c}	0.28±0.01^{d}	0.30±0.01^{e}

Values are mean ± SEM, n =3

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Values with different superscript along the column are significantly different (P<0.05)
Key: Aa = 70% PWF with 17% PCF,4% CCF,4% PBF,1.5% kanwa and 3.5% kuka; Bb = 60% PWF with 15%PCF, 16%CCF,5%PBF,1% kanwa and 3% kuka; Cc = 60% CCF with 18%PCF,9%PBF,9%PWF,1% kanwa and kuka 3%; CCF= cassava flour; WWF= white wheat flour, PWF= processed wheat flour; PCF= processed cowpea flour; PBF = processed bambara groundnut flour

Amino Acid composition

Table 8 presents the amino acid composition of unprocessed and processed wheat, cowpea, bambara groundnut and cassava. A Significant (P <0.05) increase was recorded in the lysine content of the germinated wheat (2.99 g/100g), while no significant (P >0.05) differences were observed in the lysine content of the unprocessed and processed cowpea, bambara groundnut and cassava flours. The methionine content of fermented cassava (0.56 g/100g) showed a significant (P <0.05) difference. A significant (P <0.05) reduction in the histidine content was observed in the germinated wheat sample. The arginine content is higher in germinated (4.93 g/100g) wheat and cassava (2.55 g/100g), while no change was recorded in dehulled cowpea (4.99 g/100g), and slight reduction was observed in dehulled bambara groundnut (4.34 g/100g). Significant reduction was observed in the threonine content of germinated wheat (2.76 g/100g), There were no significant (P>0.05) difference in the serine composition of the germinated wheat (2.70 g/100g). Cowpea (11.20 g/100g), bambara groundnut (10.22 g/100g) and cassava (1.23 g/100g). The glutamic acid contents were lower in all the processed samples.

However, the differences were not significant (P>0.05). Significant (P<0.05) decrease in proline content of the is germinated wheat (2.11g/100g) and fermented cassava (1.49 g/100g) but dehulled cowpea, bambara groundnut and fermented cassava, did not show any difference (P >0.05), except for germinated wheat, where the differences were significant (P <0.05).A significant (P<0.05) increase was observed in the alanine content of germinated wheat (3.25 g/100g) and fermented cassava(1.63 g/100g), but dehulled cowpea (0.52 g/100g) and bambara groundnut (0.50 g/100g) did not show any difference. There were no significant (P>0.05) difference in the cystine content of all the processed samples when compared to the unprocessed ones. A significant (P<0.05) decrease in the valine content was observed in the germinated wheat (3.25 g/100g), while an increase was observed in the fermented cassava (1.98 g /100g). However, dehulled cowpea (4.15 g/100g) and bambara groundnut (4.13 g/100g) did not show any difference. The processed samples did not show any significant (P>0.05) in the methionine and isoleucine content of the samples when compared to the processed samples, except for cassava, where a significant (P<0.05) differences were observed. Norleucine was not detected in all the samples.

Table 9 also presents the amino acid composition of composite ‘‘danwake’’ flour. The ‘‘danwake’’ blend Bb had a lysine content of 4.34 g/100g and histidine (2.20 g/100g) which is higher and significantly (P <0.05) different when compared with other blends and that of control. The food blend Bb recorded a higher value 6.80 g/100g and 10.60 g/100g for arginine and aspartic acid respectively, the differences were significant (P <0.05).

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A higher value of threonine (3.50 g/100g) content were observed in composite ‘‘danwake’’ flour Aa, when compared with the composite ‘‘danwake’’ flours Bb (3.41 g/100g) and Cc (3.62 g/100g). The control ‘‘danwake’’ flour WWF had a higher value for threonine (2.52 g/100g) compared to CCF (1.23 g/100g). The differences were significant (P <0.05). There were not significant (P>0.05) differences in the serine content of the composite ‘‘danwake’’ flours Aa (3.23 g/100g), Bb (3.17 g/100g) and Cc (3.01±0.02 g/100g), while significant (P<0.05) difference was observed when compared with the serine content of the control ‘‘danwake’’ flour CCF (1.23g/100g) and WWF (2.52 g/100g).

The composite ‘‘danwake’’ flour blends Bb had higher values for glutamine (14.35 g/100g) acid, proline (3.48 g/100g), glycine (3.79 g/100g) and alanine (3.98 g/100g) when compared with the control. The composite ‘‘danwake’’ blend Bb recorded a higher value for methionine (1.66 g/100g), followed by Cc (1.51 g/100g). The composite ‘‘danwake’’ flour Aa (1.39 g/100g) recorded a least value for methionine. The methionine content of control flour WWF (2.25 g/100g) is higher than those of the composite ‘‘danwake’’ flours Aa (1.39 g/100g), Bb (1.66 g/100g) and Cc (1.51 g/100g). There were no significant (P>0.05) difference in the isoleucine content of composite ‘‘danwake’’ flour Aa (3.07 g/100g) and Cc(3.00 g/ 100g). There were significant (P<0.05) difference in the leucine content of all the composite ‘‘danwake’’ flour. Norleucine were not detected in all the composite ‘‘danwake’’ flours, including the control ‘‘danwake’’ flours. Composite ‘‘danwake’’ flour Bb had higher value for tyrosine (3.47 g/100g) and phenylalanine (4.31 g/100g), while composite ‘‘danwake’’ flour Aa (2.98 g/100g) had least value for tyrosine, and Cc (2.75 g/100g) had least value for phenylalanine.

DISCUSSION

Proximate composition

Low moisture contents observed from these samples implies that food blends from wheat, cassava, cowpea and bambara groundnut will have a better shelf life. This is in accord with a similar work reported by Modu *et al.* (2010), who reported that low moisture levels in food blends can support a longer shelf life. This is because food spoilage micro-organisms thrive, where the moisture content of a food is very high.

The decrease in ash contents of germinated wheat, dehulled cowpea, bambara groundnut, an increase in the total ash contents of the cassava might be as a result of the processing methods applied. Although the percentage ash contents fall within the range reported by Modu *et al*, (2010). The loss in fat contents showed a significant reduction in the processed samples, this might be due to loss of volatile oil as a result of the processing method such as dehulling method Falmata *et al.* (2014).

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Table 8: Amino acid composition of unprocessed and processed of wheat, cowpea, bambara groundnut and cassava (g/100g).

	Wheat		Cowpea		Bambara groundnut		Cassava	
Amino acid	**Unprocessed**	**Germinated**	**unprocessed**	**Dehulled**	**unprocessed**	**Dehulled**	**unprocessed**	**fermented**
Lysine	2.87±0.02^{a}	2.99±0.03^{b}	3.92±0.01^{a}	3.90±0.12^{a}	3.42±0.11^{a}	3.40±0.13^{a}	2.01±0.12^{a}	2.13±0.13^{a}
Histidine	1.52±0.10^{a}	1.47±0.01^{a}	1.78±0.02^{a}	1.76±0.01^{a}	1.51±0.01^{a}	1.50±0.02^{a}	1.09±0.01^{a}	1.65±0.0^{a}
Arginine	4.25±0.12^{a}	4.93±0.21^{b}	4.99±0.03^{a}	4.99±0.02^{a}	4.36±0.22^{a}	4.34±0.21^{a}	1.76±0.02^{a}	2.55±0.01^{b}
Asphartic acid	9.00±0.25^{a}	9.15±0.32^{a}	9.98±0.01^{a}	9.99±0.01^{a}	8.97±0.01^{a}	8.95±0.11^{a}	4.15±0.13^{a}	4.30±0.12^{a}
Threonine	2.98±0.0.02^{a}	2.76±0.21^{b}	2.96±0.01^{a}	2.97±0.01^{a}	2.67±0.01^{a}	2.65±0.01^{a}	1.18±0.01^{a}	1.38±0.01^{a}
Serine	2.76±0.13^{a}	2.70±0.03^{a}	11.10±0.02^{a}	11.20±0.02^{a}	10.21±0.12^{a}	10.22±0.13^{a}	1.03±0.03^{a}	1.23±0.01^{a}
Glutamic acid	10.23±0.01^{a}	9.97±0.04^{b}	2.63±0.10^{a}	2.61±0.11^{a}	1.97±0.01^{a}	1.96±0.01^{a}	6.14±0.21^{a}	6.50±0.01^{b}
Proline	2.36±0.03^{a}	2.11±0.05^{b}	4.01±0.02^{a}	4.03±0.02^{a}	3.92±0.11^{a}	3.94±0.12^{a}	1.76±0.01^{a}	1.49±0.01^{b}
Glycine	3.92±0.14^{a}	4.01±0.25^{b}	3.43±0.21^{a}	3.45±0.22^{a}	3.44±0.01^{a}	3.45±0.02^{a}	1.58±0.02^{a}	1.51±0.02^{a}
Alanine	3.03±0.03^{a}	3.25±0.10^{b}	0.51±0.01^{a}	0.52±0.01^{a}	0.49±0.01^{a}	0.50±0.01^{a}	1.39±0.01^{a}	1.63±0.01^{b}
Cystine	0.4±0.0.02^{a}	0.44±0.02^{b}	3.96±0.22^{a}	3.95±0.02^{a}	3.75±0.10^{a}	3.74±0.11^{a}	0.29±0.02^{a}	0.24±0.01^{a}
Valine	3.76±0.03^{a}	3.25±0.10^{b}	4.14±0.01^{a}	4.15±0.01^{a}	4.12±0.01^{a}	4.13±0.01^{a}	1.26±0.01^{a}	1.98±0.02^{b}
Methionine	0.98±0.01^{a}	0.96±0.02^{a}	0.76±0.11^{a}	0.77±0.10^{a}	0.57±0.01^{a}	0.56±0.01^{a}	0.25±0.02^{a}	0.56±00.01^{b}
Isoleucieine	2.47±0.01^{a}	0.96±0.02^{a}	3.01±0.01^{a}	3.02±0.01^{a}	3.01±0.01^{a}	3.00±0.01	1.30±0.01^{a}	1.09±0.01^{b}
Leucine	6.02±0.01^{a}	2.50±0.01^{a}	6.63±0.04^{a}	6.64±0.22^{a}	5.97±0.02^{a}	5.98±0.03^{a}	2.18±0.02^{a}	2.28±0.02^{a}
Tyrosine	2.40±0.21^{a}	2.49±0.01^{b}	2.50±0.01^{a}	2.55±0.01^{b}	2.43±0.01^{a}	2.45±0.02^{a}	1.47±0.01^{a}	1.74±0.02^{b}
Phenylalanine	3.19±0.02^{a}	3.37±0.02^{b}	3.53±0.02^{a}	3.55±0.03^{a}	3.19±0.10^{a}	3.20±0.11^{a}	1.02±0.01^{a}	1.17±0.02^{a}

Values are mean ± SEM, n =3;

Values with different superscript along the raw are significantly different (P<0.05)

Key: ND= not detected

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Table 9: Amino acid contents of composite ''danwake'' flours produced from wheat, cowpea and bambara groundnut and cassava (g/100g).

Sample	Aa	Bb	Cc	CCF	WWF	RDA
Lysine	3.52±0.01[a]	4.34±0.01[b]	3.78±0.01[c]	2.13±0.01[d]	4.10±0.01[f]	5.8
Histidine	2.22±0.02[a]	2.29±0.01[a]	2.16±0.01[a]	1.65±0.01[b]	2.09±0.01[a]	1.9
Arginine	5.27±0.01[a]	6.80±0.01[b]	5.60±0.01[c]	2.55±0.01[d]	4.76±0.03[e]	2.0
Asphartic acid	8.90±0.01[a]	10.60±0.01[b]	8.96±0.01[a]	4.30±0.01[c]	9.15±0.01[d]	-
Threonine	3.50±0.02[a]	3.41±0.01[a]	3.36±0.02[a]	1.38±0.01[b]	3.18±0.01[c]	3.4
Serine	3.23±0.02[a]	3.17±0.01[a]	3.01±0.02[a]	1.23±0.02[b]	2.52±0.02[c]	-
Glutamic acid	13.00±0.02[a]	14.35±0.02[b]	12.65±0.01[c]	6.50±0.01[d]	14.64±0.02[e]	-
Proline	3.47±0.02[a]	3.48±0.01[b]	3.02±0.01[c]	1.49±0.01[d]	3.76±0.03[e]	-
Glycine	4.11±0.02[a]	3.79±0.01[c]	2.99±0.03[e]	1.51±0.02[f]	5.58±0.01[h]	-
Alanine	3.56±0.02[a]	3.98±0.02[b]	2.23±0.02[c]	1.63±0.01[d]	4.39±0.02[e]	-
Cystine	1.25±0.01[a]	1.24±0.02[a]	1.24±0.02[a]	0.24±0.01[b]	1.24±0.01[c]	2.5
Valine	4.21±0.01[a]	3.77±0.01[b]	3.54±0.01[d]	1.98±0.01[e]	4.26±0.01[g]	3.5
Methionine	1.39±0.02[a]	1.66±0.01[b]	1.51±0.01[c]	0.54±0.01[d]	2.25±0.01[e]	
Isoleucine	3.07±0.01[a]	3.26±0.01[b]	3.00±0.02[a]	1.09±0.01[c]	4.30±0.01[d]	2.8
Leucine	7.29±0.01[a]	6.81±0.01[b]	6.98±0.01[c]	2.77±0.01[d]	7.98±0.02[a]	6.6
Norleueine	ND	ND	ND	ND	ND	-
Tyrosine	2.98±0.01[a]	3.47±0.02[b]	3.31±0.01[c]	1.73±0.01[d]	3.47±0.01[e]	6.3
Phenylalanine	4.04±0.01[a]	4.31±0.01[b]	2.75±0.01[c]	1.17±0.01[d]	5.02±0.02[e]	6.3

Values are mean ± SEM, n =3;
Values with different superscript along the column are significantly different (P<0.05)
Key: Aa = 70% PWF with 17% PCF,4% CCF,4% PBF,1.5% kanwa and 3.5% kuka; Bb = 60% PWF with 15% PCF, 16% CCF,5% PBF,1% kanwa and 3% kuka; Cc = 60% CCF with 18% PCF,9% PBF,9% PWF,1% kanwa and kuka 3%; CCF= cassava flour; WWF= white wheat flour, PWF= processed wheat flour; PCF= processed cowpea flour; PBF = processed bambara groundnut flour; ND= Not detected,
RDA= Recommended Daily Allowance.

The decrease observed in the protein content during fermentation of yellow maize was attributed to a possible increase in the number of microorganism that use protein for metabolism. During fermentation and germination, microorganism hydrolyze protein and its complexes to release free amino acid for synthesis of new proteins (Frazier and Westhoff, 1978). This result agrees with the report of Onweluzo and Nwabugwu (2009), and Modu *et al.,* (2010), and Laminu *et al.,* (2014). The process of roasting of the soy bean and pumpkin seed did not have effect on their protein content and this is in agreement with the report of Laminu *et al*., (2014) and Griifith *et al*., (1998).

The reduction in fibre contents of the germination wheat dehulled cowpea and bambara groundnut observed in this study is in agreement with the report by Mbaeyi and onweluzo *(*2010), who reported that reduction in fibre contents could be due to retrogration of starch during processing. Nout (1991) reported similar findings.The Carbohydrate contents of cowpea and bambara groundnut,shows no much effect of the dehulling method. The observations are in agreement with those reported by Nout. (1991).

The low moisture content exhibit by the composite ''danwake'' flours Aa, Bb and Cc will have a good shelf life because moisture contents of food encourage microbial growth as reported by Anigo *et al.* (2010).

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The protein content of the formulation Aa and Bb, were significantly higher than the protein content of control ‘‘danwake’’ flour WWF, while the protein content of was close to that of the control WWF. The improvement of the protein contents of the blends might be attributed to the processing techniques which include germination and dehulling, and this is in line with the earlier report of Mbaeyi and onweluzo (2010).

The low fat content exhibited by the composite ‘‘danwake’’ flour implies that the food can have a longer shelf life without becoming rancid. The value for the fat content obtained in this study is lower than FAO/WHO value (10.-15) (2009).

Vitamin Content

The decrease in the B- group vitamin observed is in accord with earlier report of Agunbiade *et al.* (2013). The loss in vitamin C and A might be attributed to the fact that vitamin A is sensitive to light while vitamin C is sensitive to heat. During dehulling mild heat is generated, which account for the loss of the vitamins. The vitamin contents of the composite ‘‘danwake’’ flours Aa, Bb and Cc were favourably compared to the control ‘‘danwake’’ flour WWF. Elemo *et al.* (2011) reported the increase in concentration of naicine and thiamine, riboflavin and other vitamins in sorghum after fermentation.

Mineral Element Composition

The increase in the levels of Zn, Fe, Ca and Mn in the agreement with those reported by Elemo *et a*l, (2011). The decrease observed in the dehulled cowpea and bambara groundnut sample might be attributed to the fact that ash contents were lost during processing. Akingbala *et al.* (1981) reported that more than 50 % of the ash in sorghum was leached out of the steep water and wash water

The low levels of Cr observed in the composite ‘‘danwake’’ flours Aa, Bb and Cc could be due to processing method particularly fermentation. However, the composite ‘‘‘danwake’’’ flour Aa had a higher values of Zn, Fe, Ca, and Mn. This could be attributed to biosynthesis and activities of microorganisms during germination (Elemo *et al*, 2011).

Amino acid composition

The increase observed in some of the essential amino acids of germinated flour of wheat and fermented cassava flour could be attributed to the activities of some microorganisms that convert some of the nutrients in the food into amino acids for their utilization during fermentation period. This is in accord with similar findings of Embaby, (2010), who reported that an increase in amino acid during fermentation might be due to the breakdown of other nutrients such as carbohydrate to synthesize amino acid that fermenting seed needed for its biochemical activities and growth. The decrease in the amino acids of the dehulled cowpea and bambara groundnut might be due to denaturation of the protein content of the samples during processing. The result of the amino acid profile of the blends shows that level of the essential amino acids in the blend Cc is close to the RDA 6-12 years (Institute of Medicine, 2001). This indicates that the use of multiple legumes) (Bambara groundnut and beans) for the blends enhances the essential amino acids of the blends. These are needed for adequate growth and development of children between the ages of 6-12 years (Institute of Medicine, 2001).

CONCLUSION

In conclusion, the results obtained from this study indicated that danwake produced from a blend of wheat, cowpea and Bambara

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groundnut offers superior nutritional properties compared to the control made from cassava flour alone. The incorporation of wheat, cowpea and Bambara groundnut flours significantly enhances the protein content, fibre content and micronutrient profile of danwake, thereby making it more nutritious and balanced food option. Therefore, this study recommends the use of wheat, cowpea and Bambara groundnut flours as a viable alternative to cassava flour for danwake production, contributing to improved nutrition and food security, especially in region where danwake is staple food.

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