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Amino Acids Profile and Mineral Content of Wheat Based *Funkaso* as Affected by Addition of Pearl Millet and Soybean Flours

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Abstract A 3×4×2 factorial design was used to formulate wheat based *funkaso*. Amino acid profile and minerals content of funkaso produced from 24 formulations were determined. All the essential amino acid varied significantly ($P<0.05$) from the control. Samples supplemented with 30% soybean had higher ($P<0.05$) values of the essential amino acid (EAA). Amino acid levels obtained are comparable to Food and Agricultural Organization (FAO) and World Health Organization (WHO) standards. Phosphorus, zinc and calcium contents appreciated with 30% soybean flour incorporation among all the samples and differ significantly ($p<0.05$). The value obtained in this study ranged between 0.05 and 0.26 ppm. The iron content ranged between 0.08 and 9.75 ppm, CC (commercial control) is insignificantly different to sample AA7 (60% whole wheat flour: 40% pearl millet flour: 0% Soybean flour) at $p<0.05$ but differs to remaining formulation at 5% level of significance. The highest iron level was observed in N2 (70% wheat flour: 0% Pearl millet flour: 30% soybean flour) and the least in N3 (80% wheat flour: 20% pearl millet flour: 0% Soybean flour). The Cu in all the samples are significantly different ($P<0.05$).

Keywords: *amino acid, minerals, pearl millet, soybeans, wheat*

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1. Introduction

Funkaso is a prestigious traditional fermented wheat based foods consumed in northern Nigeria by Kanuris and Shuwa Arabs. It is of great importance in the diet of these ethnic groups (kanuris and shuwa Arab) prepared mostly on special occasions and festive periods. The origin of *funkaso* is lost in antiquity and method of preparation varied from one processing to another due to lack of standardized ingredient formulation that would ensure product consistency until reported recently by Adam et al. [1].

The traditional processing of *funkaso* involved mixing of whole wheat flour (fine or grits) together with water, yeast, baking powder and pint of salt to form a batter which is allowed to stand depending on weather condition and deep fat fried in oil. Apart from standardizing *funkaso* production, Adam et al. [1] substituted wheat with pearl millet at various levels which reduced the cost of production and increased the profit margin.

Funkaso being cereal based product is relatively low in protein, this necessitates its complementation with legume grain such as soybean and cowpea which has been proposed as ideal source of protein supplementation of starchy foods [2]. The mutual compensation is closest to ideal when ratio by mass of cereal to legume is roughly 70:30 [3,4] in which the proportion provided about equal part by mass of protein. Therefore, blending both cereal and legumes in funkaso production could make available the required essential amino acid that may be needed by the body.

Adam et al. [1] standardized procedure and ingredients formulations in *funkaso* production as well as determined its proximate composition, functional and sensory properties of the product but information on the amino acid profile and mineral content are scanty. Therefore, there is the needs to determine the amino acid profile and mineral content of *funkaso* if the product is to make a head way. The objectives of the study were to produce *funkaso* from the blend of wheat, pearl millet and soybean flours at various proportions and determine their amino acid profile and mineral contents.

2. Materials and Methods

2.1. Source of Materi

Wheat cultivars (*Norman*, Cettia, Atilla gan Atilla), Pearl millet cultivar (SOSAT C-88) and soybean were obtained from Lake Chad Research Institute Maiduguri, Maiduguri, Nigeria and other ingredients were purchased from Maiduguri Monday market, Nigeria

2.2. Sample Preparation

Wheat, pearl millet and soybean flours were prepared as described by Adam et al. [1] The wheat grain was cleaned to remove unwanted chaff and dirt; it was then milled into fine flour without conditioning so as to prevent separation of the bran from the endosperm which is not desired in production of whole wheat flour for *funkaso* production. Pearl millet grain was cleaned to remove foreign matters, conditioned so as soften the bran, mellow the endosperm hence facilitating its separation during dehulling. The dehulled grain is then washed with water and allowed to dry in the sun, milled in a hammer mill and finally sieved to obtain fine flour. Soybean was sorted, washed and soaked for 5 h in a clean water of three times its weight and volume until the coat becomes soaked and wet to enhance the removal of some soluble anti-nutrient factor and facilitate dehulling. The soybean was further washed, drained and partially sundried. The soybean was then toasted at surface temperature of 180°C ± 5°C for 30 min in an open thick aluminum pot [1,5,6] It was milled into fine flour in a hammer mill and let to pass through a 0.8 mesh size screen.

2.3. Formulation of Blends

Table 1. Formulations (%) of *funkaso* from whole wheat, pearl millet and soybean flours blends

Formulations code	Whole wheat flour	Pearl millet flour	Soybean flour
AA1	100	-	-
AA2	70	-	30
AA3	80	20	-
AA4	56	14	30
AA5	70	30	-
AA6	49	21	30
AA7	60	40	-
AA8	42	28	30
C1	100	-	-
C2	70	-	30
C3	80	20	-
C4	56	14	30
C5	70	30	-
C6	49	21	30
C7	60	40	-
C8	42	28	30
N1	100	-	-
N2	70	-	30
N3	80	20	-
N4	56	14	30
N5	70	30	-
N6	49	21	30
N7	60	40	-
N8	42	28	30

AA =Atilla gan Atilla); C = Cettia; N = Norman.

A 3×4×2 factorial design as reported by Gomez and Gomez [7] was used for the formulation of *funkaso* where three (3) varieties of wheat [*Norman*, Cettia (CTA), Atilla gan Atilla] were substituted with pearl millet (SOSAT) at four (4) levels and soybean (ER-biu) at two (2) level giving rise to a total of 24 samples (Table 1). The flour blend ratios (%) used were 100%; 70: 00:30; 80:20:0; 56:14:30; 70:00:30; 49:21:30; 60; 40:00; and 42:28:30. Other quantity of ingredients salt, yeast, baking powder and water remained the same for all formulations as described by Adam et al. [1].

2.4. *Funkaso* Production

Funkaso was produced from 24 funkaso formulations by mixing each formulation (Table 1) with 105 ml of distilled water, 1.5 g of baking powder, 1.2 g of yeast and 1.8 g of salt (NaCl) form a batter. The batter was allowed to stand for 4 h and then deep fat fried [1].

2.5. Amino Acid Determination

The amino acid profile of wheat, pearl millet and soybean flours along with *funkaso* produced from several formulations from these flour blends were determined using methods described by Benitez (1989). The known samples were dried to a constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and later loaded into Technicon Sequential Multi-Sample Amino Acid Analyzer (TSM).

The samples were defatted using chloroform and methanol (solvents) mixed in the ratio of 2:1 and 4 g of each of the samples was placed in extraction thimble for 15 h defatting in Soxhlet extraction apparatus [8].

The prepared sample (200 mg portion) was taken, wrapped in Whatman filter paper (No.1) and each was placed in Kjeldahl digestion flask. Then, 10 ml of concentrated sulphuric acid was added to each sample. A 0.5 g catalyst mixture containing sodium sulphate (Na_2SO_4), copper sulphate ($CuSO_4$) and selenium oxide (SeO_2) in the ratio of 10:5:1 was added into each flask to facilitate digestion. Also, four pieces of anti-bumping granules was added. The flasks were fixed into the kjeldhal digestion apparatus and the sample digested for 3 h until clear light green solutions were obtained. The digested samples were cooled and diluted with distilled water, leveled up to 100 ml in standard volumetric flask. An aliquot of 10 ml of the diluted solution was taken and followed with 10 ml of 45% sodium hydroxide introduced into the Marham distillation apparatus and distilled into 10 ml of 2% boric acid containing four drops of bromocresol green/methyl red indicator until about 70 ml of distillate was collected. The distillate, each was titrated with standard 0.01N hydrochloric acid to a grey coloured solution [9].

$$\%\ Nitrogen = \frac{(a-b)\times 0.01\times 14\times V\times 100}{W\times C} \quad (1)$$

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

2.6. Hydrolysis of the Samples

A known weight of the defatted sample each was weighed into glass ampoule and 7 ml of 6NHCl added to each and oxygen expelled by passing nitrogen into each of the ampoules (this was done to avoid possible oxidation of some amino acids during hydrolysis e.g. methionine and cysteine) The glass ampoules were then sealed with Bunsen burner flame and placed in an oven pre-set at 105°C ± 5°C for 22 h. The ampoules were allowed to cool before broken open at the tip and content of each was filtered. It should be noted that tryptophan is usually destroyed by 6NHCl during hydrolysis (Benitez, 1989). The filtrates were then evaporated to dryness at 40°C under vacuum in a rotary evaporator. The residues were dissolved each with 5 ml acetate buffer solution (pH 2.0) and stored in plastic specimen bottles, which was kept in the freezer for subsequent use [9].

After hydrolysis, about 5 to 10 µl each of hydrolysate was loaded into Technicon Sequential Multi-Sample Amino Acid Analyzer. This was dispensed into the cartridge of the analyzer. The TSM analyzer is designed to separate and analyze free acidic, neutral and basic amino acids of the hydrolysates. The period of this analysis lasted for 76 min [9].

Method of calculating amino acid values from the chromatogram peaks: The net height of each peak produced by the chart recorder of TSM (each representing an amino acid) was measured. The half-height of the peak on the chart was found and width of the peak on the half height was accurately measured and recorded. An approximated area of each peak was then obtained by multiplying the height with the width at half-height [9]. The norcleucine equivalent (NE) for each amino acid in the standard mixture was calculated using the formula:

$$Norcleucine\ Equivalent\,(NE) = \frac{Area\ of\ Norcleucine\ peak}{Area\ of\ each\ Amino\ Acid} \qquad (2)$$

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

Where; $S_{std} = NE_{std} \times Molecular\ weight \times \mu MAA_{std}$.

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

$$Concentration\,(g/100g\ protein) = \frac{NH \times W @ NH}{2 \times S_{std} \times C} \qquad (3)$$

Where,

$$C = \frac{Dilution \times 16}{Sample\ Wt\,(g) \times N\% \times 10 \times Vol.loaded} \div NH \times W\,(Nleu).$$

2.7. Chemicalscore

Chemical score was calculated as described WHO/FAO [10]

Where the equation

Where, NH = Net height; W = Width @ half height; Nleu = Norcleucin.

2.8. Mineral Determinations

Mineral content of *funkaso* was determined with atomic absorption spectrophotometer. The minerals determined were zinc, potassium, iron, sodium, calcium, phosphorus and copper.

2.9. Dry-ashing Method

Five grammes of the blended sample were weighed into crucibles and all ashed at 550°C for 5 h. Then, 5 ml each of concentrated hydrochloric acid (HCl) and nitric acid (HNO_3) was added to the ash and heated for dissolution. The solution was made up to 100 ml with distilled water. Similarly, blank was prepared with same acids and diluted to 100 ml with distilled water.

The measurement of absorbance and the concentration of samples (ppm) were done with atomic absorption spectrophotometer for the whole portion of sample (100 ml) solution. Blank standard was prepared (ppm) and absorbance of standard against concentration was read. Then, graph of absorbance against concentration was plotted. The absorbance of samples was read and minerals of interest were calculated [8,11] using:

$$Mineral\ of\ interest\,(ppm) = A \times \frac{Fv}{Wt} \times D \qquad (4)$$

Where: A = Concentration of samples as obtained from graph; Wt = Weight of sample used; Fv = Final volume of sample extracted or digest weight of sample used; D = Dilution factor

2.10. Statistical Analysis

The data generated from the study were subjected to analysis of variance (ANOVA) as described by Gomez and Gomez [7] and means separated using Duncan Multiple Range Test as described by Duncan [12]

3. Results

3.1. Essential Amino Acid Profile of Wheat, Pearl Millet and Soybean Flours

Essential amino acid (EAA) and amino acid score profile of wheat, pearl millet and soybean are presented in Table 2. The essential amino acids varied significantly (P<0.05) among the wheat cultivars, pearl millet (SOSAT C-88) and soybean. Pearl millet (SOSAT C-88), Wheat (Norman), SOSAT C-88, SOSAT C-88, SOSAT C-88, SOSAT C-88, SOSAT C-88 and SOSAT C-88 had the highest (P<0.05) leucine, lysine, isoleucine, phenylalanine, valine, methionine, threonine and tryptophan, respectively. On the other hand, SOSAT C-88 had the highest score of leucine (133), isoleucine (110), phenylalanie + tyrosine (128), valine (109), methionine + cysteine (136), threonine (97) and tryptophan (204) and wheat (Atillagan Atilla had the highest lysine score, 98). Therefore, leucine, lysine, isoleucine, phenylalanine, valine, methionine, threonine and tryptophan were found to be the limiting amino acid in wheat (Cettia CTA), SOSAT C-88, wheat (Cettia CTA), wheat (Cettia CTA), wheat (*Atillagan atilla*), soybean, wheat (Cettia CTA) and soybean, respectively.

Essential acid profile and amino acid score of *funkaso* produced from various formulations of whole wheat, pearl millet and soybean flour blends are presented in Table 3. The essential amino acid content varied significantly (P<0.5) among the formulations. Leucine, lysine, isoleucine, phenylalanine, valine, methionine, threonine and tryptophan ranged from 6.88 to 10.33, 5.14 to 6.66, 1.99 to 6.22, 3.54 to 4.97, 3.09 to 4.33, 1.28 to 1.79, 2.77 to 4.05 and 0.89 to 1.31 g/100 g protein, respectively.

On the other hand, formulation N6 (49% Norman: 21% SOSAT C-88: 30% soybean) had the highest leucine sore (148) and methionine + cysteine score (89), Formulation C2 (70% Cettia: 0% SOSAT C-88: 30% Soybean) had highest lysine score (122), N4 (56% Norman: 14% SOSAT C-88: 30% Soybean) had the highest isoleucine score (105) and phenylalanie + tyrosine (149), C8 (42% Cettia: 28% SOSAT C-88: 30% Soybean) had the highest valine score (87) and threonine score (101) and A6 (49% Attilagan atilla: 21% SOSAT C-88: 30% Soybean) had highest tryptophan score (131).

Therefore, leucine, lysine, isoleucine, phenylalanine, valine, methionine, threonine and tryptophan were found to be the limiting amino acid in Formulation C1 (100% Cettia CTA: 0% SOSAT C-88: 0% Soybean), A5 (70% Atilla gan Atilla: 30% SOSAT C-88: 0% Soybean), C5 (70% Cettia CTA: 30% SOSAT C-88: 0% Soybean), A7 (60% Atilla gan Atilla: 60% SOSAT C-88: 0% Soybean), N5 (70% Norman: 30% SOSAT C-88: 0% soybean), N1 (100% Norman: 0% SOSAT C-88: 0% Soybean), A3 (80% Atilla gan Atilla: 20% SOSAT C-88: 0% soybean) and A7 (60% Atilla gan Atilla: 40% SOSAT C-88: 0% soybean).

Table 2. The essential amino acid content (g/100g protein) and chemical score of various formulations of whole wheat, pearl millet and soybean flour

Crops	Leucine	Lysine	Isoleucine	Phenylalanine +	Tyrosine	Valine	Methionine +	Cysteine	Threonine	Tryptophan
AA	6.55^{c}(94)	5.39^{b}(98)	3.15^{d}(79)	3.15^{d}	3.10^{c}(104)	2.16^{e}(43)	1.45^{c}	1.67^{c}(89)	2.44^{d}(61)	1.01^{c}(101)
C	6.27^{e}(90)	5.05^{c}(92)	3.05^{e}(76)	3.05^{e}	3.10^{c}(103)	2.18^{d}(44)	1.51^{b}	0.88^{e}(68)	2.24^{e}(56)	0.98^{d}(98)
N	6.37^{d}(91)	6.02^{a}(86)	3.81^{b}(95)	3.81^{b}	2.92^{d}(113)	4.75^{b}(95)	1.23^{e}	1.76^{b}(85)	2.84^{b}(71)	1.05^{b}(105)
ST	9.30^{a}(133)	3.72^{e}(53)	4.39^{a}(110)	4.39^{a}	3.27^{b}(128)	5.45^{a}(109)	2.44^{a}	2.31^{a}(136)	3.88^{a}(97)	2.04^{a}(204)
SB	7.07^{b}(101)	4.61^{d}(84)	3.48^{c}(87)	3.48^{c}	3.62^{a}(118)	4.03^{c}(81)	1.28^{d}	1.34^{d}(75)	2.73^{c}(68)	0.93^{e}(93)
FAO/WHO (1973)	7.0	5.5	4.0		6.0	5.0		3.5	4.0	1.0

Means (±SE) in the same column having different superscripts are significantly (p<0.05) different. ST = SOSAT C - 88; SB = Soybean; N = Norman; C = Cettia CTA; AA = Atillagan Atilla.

Table 3. Essential Amino aminoacid content and chemical score of *Funkaso* produced from various formulations

Formulations			Code	Essential amino acids (g/100g protein)									
WT	ST	SB		Leucine	Lysine	Isoleucine	Phenyl +	Tyrosine	Valine	Methio +	Cysteine	Threonine	Tryptophan
AA	0	0	A1	7.18^{l}(103)	5.64^{f}(103)	3.14^{k}(79)	3.99^{h}	3.09^{f}(118)	3.45^{p}(69)	1.44^{j}	1.15^{def}(74)	3.49^{h}(87)	1.18^{f}(118)
70AA	0	30	A2	8.98^{e}(128)	6.66^{a}(121)	3.53^{f}(88)	4.43^{d}	2.92^{g}(123)	4.15^{e}(83)	1.41^{k}	3.45^{a}(139)	3.61^{g}(90)	0.97^{l}(97)
80AA	20	0	A3	7.00^{m}(100)	5.62^{f}(102)	3.27^{j}(82)	3.81	2.92^{g}(112)	3.59^{m}(72)	1.49^{i}	1.21^{cdef}(77)	2.88^{q}(72)	1.23^{d}(123)
56AA	14	30	A4	8.29^{h}(118)	5.94^{e}(108)	3.14^{k}(79)	3.90^{i}	3.09^{f}(117)	4.00^{g}(80)	1.39^{l}	1.33^{bcdef}(78)	2.99^{p}(75)	1.18^{f}(118)
70AA	30	0	A5	7.99^{i}(114)	5.36^{gh}(77)	1.99^{o}(50)	3.72^{k}	3.44^{d}(119)	3.56^{n}(71)	1.55^{g}	1.03^{f}(74)	2.77^{r}(69)	1.10^{i}(110)
49AA	21	30	A6	9.28^{d}(133)	6.04^{d}(86)	3.27^{j}(82)	4.25^{e}	3.27^{e}(125)	3.97^{h}(79)	1.39^{l}	1.57^{b}(85)	3.33^{i}(83)	1.31^{a}(131)
60AA	40	0	A7	7.53^{k}(108)	5.57^{fg}(80)	3.60^{e}(90)	3.54^{l}	2.75^{g}(105)	3.77^{k}(75)	1.71^{b}	1.27^{bcdef}(85)	3.24^{k}(81)	0.89^{m}(89)
42AA	28	30	A8	8.74^{f}(125)	5.30^{h}(96)	3.59^{e}(90)	4.25^{e}	3.09^{f}(122)	4.09^{f}(82)	1.68^{c}	1.20^{cdef}(82)	3.49^{h}(87)	1.13^{h}(113)
100C	0	0	C1	6.94^{o}(99)	5.30^{h}(96)	3.01^{l}(75)	4.25^{e}	3.09^{f}(122)	3.39^{q}(68)	1.52^{h}	1.21^{cdef}(78)	3.41^{i}(85)	1.10^{i}(110)
70C	0	30	C2	8.95^{e}(128)	6.73^{a}(122)	3.34^{i}(84)	4.52^{c}	3.27^{e}(130)	4.00^{g}(80)	1.39^{l}	1.39^{bcde}(79)	3.66^{e}(91)	0.99^{k}(99)
80C	20	0	C3	6.88^{o}(98)	5.51^{g}(100)	3.40^{h}(85)	4.08^{g}	2.75^{g}(114)	3.51^{o}(70)	1.44^{j}	1.59^{b}(87)	3.19^{m}(80)	1.03^{j}(103)
56C	14	30	C4	8.49^{g}(121)	6.20^{bc}(113)	3.50^{fg}(88)	4.25^{e}	3.44^{d}(128)	3.94^{i}(79)	1.44^{j}	1.21^{cdef}(76)	3.99^{b}(100)	1.20^{e}(120)
70C	30	0	C5	7.76^{j}(111)	5.33^{h}(97)	2.81^{m}(70)	3.99^{h}	3.27^{e}(121)	3.45^{p}(69)	1.55^{g}	1.27^{bcdef}(81)	3.16^{n}(79)	1.15^{g}(115)
49C	21	30	C6	8.99^{e}(128)	5.83^{ef}(106)	3.14^{k}(79)	4.34^{d}	3.09^{f}(124)	3.74^{l}(75)	1.39^{l}	1.51^{bc}(83)	3.19^{m}(80)	1.20^{e}(120)
60C	40	0	C7	8.20^{h}(117)	5.65^{f}(103)	3.66^{d}(92)	4.43^{d}	2.75^{g}(120)	3.86^{j}(77)	1.65^{d}	1.33^{bcdef}(85)	3.63^{f}(91)	1.10^{i}(110)
42C	28	30	C8	8.99^{e}(128)	6.05^{d}(110)	3.85^{c}(96)	4.43^{d}	3.27^{e}(128)	4.33^{a}(87)	1.49^{i}	1.45^{bcd}(84)	4.05^{a}(101)	1.28^{b}(128)
100N	0	0	N1	7.00^{m}(100)	6.63^{a}(121)	3.50^{fg}(88)	4.43^{d}	2.92^{g}(123)	3.39^{q}(68)	1.30^{m}	1.21^{abcd}(72)	3.99^{b}(100)	1.23^{d}(123)
70N	0	30	N2	9.46^{c}(135)	5.94^{e}(108)	6.22^{a}(156)	4.96^{a}	3.61^{c}(143)	4.00^{g}(80)	1.55^{g}	1.21^{cdef}(79)	3.74^{d}(94)	1.21^{e}(121)
80N	20	0	N3	8.39^{g}(120)	6.28^{b}(114)	3.86^{c}(97)	3.99^{h}	3.09^{f}(118)	4.24^{c}(85)	1.60^{e}	1.21^{cdef}(80)	3.16^{n}(79)	1.26^{c}(126)
56N	14	30	N4	8.76^{f}(125)	6.56^{ab}(119)	4.19^{b}(105)	4.97^{a}	3.96^{a}(149)	4.00^{g}(80)	1.49^{i}	1.33^{bcdef}(81)	3.88^{c}(97)	1.26^{c}(126)
70N	30	0	N5	7.99^{i}(114)	6.04^{d}(110)	3.60^{e}(90)	4.25^{e}	3.44^{d}(128)	3.09^{r}(62)	1.55^{g}	1.09^{ef}(75)	3.74^{d}(94)	1.18^{f}(118)
49N	21	30	N6	10.33^{a}(148)	6.17^{c}(112)	3.48^{g}(87)	4.19^{f}	2.94^{g}(119)	4.29^{b}(86)	1.59^{f}	1.54^{bc}(89)	3.02^{o}(76)	1.21^{e}(121)
60N	40	0	N7	8.58^{g}(123)	5.99^{e}(109)	3.50^{fg}(88)	4.25^{e}	3.44^{d}(128)	4.09^{f}(82)	1.79^{a}	1.27^{bcdef}(87)	3.24^{k}(81)	1.28^{b}(128)
42N	28	30	N8	9.79^{b}(140)	6.38^{ab}(116)	3.60^{e}(90)	4.26^{e}	3.82^{b}(135)	4.16^{d}(83)	1.58^{f}	1.38^{bcde}(85)	3.48^{h}(87)	1.24^{d}(124)
100CC	0	0	CC	7.47^{k}(107)	5.14^{i}(93)	3.01^{l}(75)	4.61^{b}	3.44^{d}(134)	4.21^{c}(84)	1.28^{n}	1.39^{bcde}(76)	3.22^{l}(81)	1.18^{f}(118)
FAO/WHO (1973)				7.0	5.5	4.0		6.0	5.0		3.5	4.0	1.0

Mean ± Standard of triplicate determinations. Means within each column not followed by the same superscripts are significantly different (P<0.05): WT = Wheat; ST = SOSAT C-88 (Pearl millet cultivar) SB = Soybean; CC = Commercial; AA =Atilla gan Atilla); C = Cettia; N = Norman. Values in bracket are chemical score of individual amino acid in the complementary food formulations. Phenyl. = Phenylalanine. Methio. = Methionine.

3.2. Minerals Content

The mineral content of whole wheat, pearl millet and soybean flours is presented in Table 4. The mineral composition of *funkaso* produced from different formulation is presented in Table 5. It revealed that phosphorus, zinc and calcium contents appreciated with 30% soybean flour incorporation among all the samples but differed significantly at p>0.05. The phosphorus level ranged between 0.26 and 4.83, N4 had the highest and C5 had the least. Samples AA5, AA8, C5 and C6; and AA2 and AA7 remained insignificant at 5%. Potassium appeared have the highest value when compared to the minerals analyzed, it ranged between 1.13±0.03 to 9.86±0.03 the highest being observed in sample N2 and least in N3 (80% Whole wheat flour, 20% pearl millet, 0%) both of which are significantly different to the commercial (CC). The increased or high level of potassium could be as result of supplementation and/or coupled with the 1% potash solution that rubbed on the surface of the calabash prior of spreading of batter, so as to prevent the drop batter for *funkaso* from sticking and to obtain maximum spreadabilty of the product. The Zn value obtained for the CC did not vary with the value of AA1 at 5% level of significance, the least value was observed in sample N5 and the highest in sample N6. No significant observation were observed among the following samples C4 and N4; AA6, C7 and C8; AA8 and N2, respectively.

Table 4. The mineral content of whole wheat, pearl millet and soybean flour

Flours	Na	K	P	Zn	Ca	Fe
AA	50.89^{b}	3.6033^{b}	1.08^{d}	0.64^{a}	89.91^{a}	2.77^{a}
C	39.38^{d}	4.6967^{a}	2.00^{b}	0.65^{a}	43.39^{d}	2.63^{b}
N	107.90^{a}	3.0100^{d}	2.23^{a}	0.17^{c}	44.79^{c}	2.64^{b}
ST	47.82^{c}	3.6133^{b}	1.06^{e}	0.10^{d}	55.30^{b}	ND
SB	50.64^{b}	3.3967^{c}	1.27^{c}	0.51^{b}	28.41^{e}	ND

Means (±SE) in the same column having different superscripts are significantly (p<0.05) different. ST = SOSAT C - 88; SB = Soybean; N = Norman; C = Cettia CTA; AA = Atillagan Atilla; ND = Not Detected.

Table 5. Minerals content of Nigerian *Funkaso*

Formulations			Code	Mineral content (mg/Kg)						
WT	ST	SB		**Potassium**	**Phosphorus**	**Zinc**	**Calcium**	**Iron**	**Cupper**	**Sodium**
100AA	0	0	A1	3.63^{m}	0.64^{i}	0.89^{j}	0.26^{a}	0.40^{g}	1.30^{e}	ND
70AA	0	30	A2	2.30^{n}	0.64^{i}	0.90^{j}	0.06^{fg}	ND	0.36^{l}	ND
80AA	20	0	A3	1.73^{o}	0.38^{mn}	1.06^{g}	0.08^{ef}	0.04^{lm}	0.14^{o}	ND
56AA	14	30	A4	8.40^{f}	0.52^{k}	0.11^{r}	0.08^{ef}	0.08^{klm}	1.20^{f}	ND
70AA	30	0	A5	8.06^{g}	0.71^{gh}	0.22^{q}	0.09^{ef}	0.08^{klm}	0.43^{j}	ND
49AA	21	30	A6	8.76^{de}	0.30^{o}	1.01^{h}	0.08^{ef}	0.09^{jkl}	0.24^{mn}	ND
60AA	40	0	A7	7.73^{h}	0.73^{g}	0.95^{i}	0.12^{cd}	0.10^{hijk}	0.29^{m}	ND
42AA	28	30	A8	8.20^{fg}	0.61^{j}	0.63^{o}	0.09^{ef}	0.50^{f}	0.26^{mn}	ND
100C	0	0	C1	8.96^{d}	0.28^{o}	0.80^{l}	0.10^{e}	0.13^{hijk}	0.38^{k}	ND
70C	0	30	C2	8.63^{e}	0.46^{l}	0.68^{n}	0.16^{b}	0.15^{hi}	0.14^{o}	ND
80C	20	0	C3	9.63^{bc}	0.52^{k}	1.10^{f}	0.05^{fg}	0.14^{hij}	1.60^{c}	ND
56C	14	30	C4	9.43^{c}	0.68^{hi}	1.49^{d}	0.11^{de}	0.09^{jkl}	1.33^{e}	ND
70C	30	0	C5	9.76^{ab}	0.59^{j}	0.72^{m}	0.06^{fg}	0.20^{hi}	0.75^{h}	ND
49C	21	30	C6	6.10^{j}	0.26^{o}	0.79^{l}	0.09^{ef}	0.19^{hi}	0.51^{i}	ND
60C	40	0	C7	1.76^{o}	0.30^{o}	1.25^{e}	0.12^{cd}	0.11^{hijk}	0.07^{p}	ND
42C	28	30	C8	4.40^{l}	0.44^{lm}	0.94^{i}	0.13^{c}	0.14^{hij}	1.00^{g}	ND
100N	0	0	N1	1.40^{p}	0.37^{o}	0.96^{i}	0.13^{c}	0.22^{h}	0.32^{m}	ND
70N	0	30	N2	9.50^{c}	0.39^{mn}	0.49^{p}	0.14^{bc}	5.20^{b}	0.80^{g}	ND
80N	20	0	N3	9.86^{a}	1.10^{e}	0.80^{l}	0.10^{e}	9.75^{a}	0.37^{l}	ND
56N	14	30	N4	1.13^{q}	2.37^{b}	0.82^{k}	0.13^{c}	5.15^{b}	1.88^{b}	ND
70N	30	0	N5	7.43^{i}	4.83^{a}	0.71^{m}	0.12^{cd}	2.09^{e}	1.46^{d}	ND
49N	21	30	N6	5.23^{k}	2.13^{c}	1.51^{c}	0.11^{de}	ND	ND	ND
60N	40	0	N7	7.43^{i}	0.98^{f}	2.63^{a}	0.12^{cd}	4.27^{c}	3.89^{a}	ND
42N	28	30	N8	2.40^{n}	1.39^{d}	1.27^{e}	0.10^{e}	ND	ND	ND
100CC	0	00	CC	1.76^{o}	0.44^{lm}	1.90^{b}	0.13^{c}	3.37^{d}	1.17^{f}	ND

Mean ± Standard of triplicate determinations. Means within each column not followed by the same superscripts are significantly different (P<0.05): WT = Wheat; ST = SOSAT C-88 (Pearl millet cultivar) SB = Soybean; CC = Commercial; AA =Atilla gan Atilla); C = Cettia; N = Norman; ND = Not detected.

4. Discussion

4.1. Amino Acid Profile of Nigerian *Funkaso* from Several Formulations

The amino acid levels obtained in these study are comparable to that of required level for human in beef and even more than in some the amino acid as developed by the Food and Agricultural Organisation and World Health Organisation [10] as reference pattern [13]. Amino acids whose value have found to be greater that of beef are as follows with the corresponding value given by WHO, leucine up to 10.33(4.8); lysine 6.73(4.2); phenylalanine 4.98 (2.8) and threonine 4.05(2.8). The valine observed in the *Funkaso* CC (4.21) is the same with that of the beef reference pattern4.2. Tryptophan A7 (0.89) to (1.79) g/100g and cysteine A5 (1.03) to A2 (3.45) g/100g values were found to be very low with respect to that beef having 1.4 and 4.2, these might have been as a result of the sensitivity of the amino acid content which have tempered with actual level during hydrolysis [14].

4.2. Minerals of Nigerian *Funkaso* from Several Formulations

Calcium is necessary for supporting bone and growth. The value obtained in these study ranged between 0.05 and 0.26, the CC having the highest and least in C2 both of which are different from the remaining formulations at $p>0.05$. Sample (N8 and C7) and (N6 and C6) remained indifferent at $p<0.05$. The iron content ranged between -0.08 and 9.75, CC is insignificantly different to sample A7 at $p<0.05$ but differs to remaining formulation of 5% level of significance. The highest iron level was observed in N2 and the least in N3. The value for Cu in all the samples are significantly different ranging from -0.05 to 3.89. The Na was undetected; these might be due to sensitivity of the instrument used and/or the standard used in running the analyses.

5. Conclusion

Funkaso produced from the blends of millet and soybean as the first of its kind, which contained all the essential amino acids that satisfied the dietary requirement of humans. It contained an increased protein and lysine content compared to commercial wheat *funkaso*. Policy should be implemented towards nutritional programmer on these products. Sample A1 (Atilla gan atilla) remained the most acceptable following the various parameters used in evaluating its acceptability.

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