International Journal of Food Science and Nutrition
ISSN: 2455-4898
Impact Factor: RJIF 5.14
www.foodsciencejournal.com
Volume 3; Issue 4; July 2018; Page No. 24-29

Microbial count and amino acids profile of *Gurasa* as affected by addition of pearl millet and cowpea

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Abstract
A 3x4x2 factorial design comprising 3 wheat cultivars, 4 levels of pearl millet substitution and 2 levels of cowpea that yielded 24 experimental group in addition to a 100% commercial wheat flour sample were employed for *gurasa* production. The microbiological quality and Amino acid profile of the different formulations of the *gurasa* was determined using applied bio systems PTH amino acid analyzer. Samples of *gurasa* produced from wheat, pearl millet (SOSAT) and cowpea composites of 56:14:30, 49:21:30) and 42:28:30 showed significant increase in lysine content (3.52% to 5.30%) when compared with A100 (100%Wheat Atilla), C100 (100% Wheat Certia), S100 (100% Wheat Seri-M82) and control. *Gurasa* produced from the blends of local wheat cultivars, millet and cowpea increased the protein content as well as lysine (essential amino acid) that can satisfy the dietary requirement of human, especially for local consumers.

Keywords: wheat, gurasa, pearl millet, cowpea, amino acid

1. Introduction
Wheat is utilized mainly as flour (whole grain or refined) for the production of a large variety of products around the world. The products include leavened and unleavened bread and other baked products. Examples are Tortilla, Chapati, Pita, Parotta, Yufka, Tandoori Roti, Sangak, Balady, Barbari, Taftoon, Lavas, Ciabatta, Baati, Bafla, Kulcha, Chapathi, Phulka and Poor; South Indian Parotta and North Indian Parotta are the widely consumed traditional products in the Indian subcontinent1. In Nigeria the common traditional wheat products are Alkaki and Gurasa. Many studies have been reported on alkak [2, 3, 4, 5]. but information on gurasa is scanty. Notwithstanding, Dandago and Igwe6 described Gurasa as an indigenous bread that is generally produced in the northern part of Nigeria, particularly Kano. It is made by mixing hard wheat flour, salt, sugar and water, and manual kneading into a dough which is then baked at high temperature short time using earthenware pots known as Tanderu, previously heated from within with cornstalk fire or firewood. Gurasa is a popular food product among the Hausas which is served with soups or groundnut cake.
Gurasa consumption cut across all ages, and it could serve as a vehicle for improving the nutritional well being of the people through the incorporation of low cost legume flour with better nutrient profile leading to higher protein content with high lysine level, an essential amino acid deficient in cereals. In general, cereal proteins are low in lysine, tryptophan and threonine. Because of this deficiency, lysine has become the limiting amino acids in cereals. It is thus of nutritional significance to enhance the essential amino acid in plant proteins [7].

2. Materials and Methods
Three indigenous wheat varieties (Atilla, Certia and Seri-M82), millet and cowpea flour were cleaned, milled and mixed with sugar, yeast and water at various proportions to form a dough and allowed to ferment, cut and round in shape and baked in oven. Microbial count of samples from each formulation was determined as reported by Kawu *et al*. [8]. The amino acid profile in the gurasa sample was determined using the methods described by Benitez [9].

2.1 Sample Preparation
Essentially the grains were cleaned to remove extraneous matter such as stones, chaffs, sands and broken grains, conditioned to a moisture content of 14%, and milled with a hammer mill (meadows model 35). The flour was sieved using sieves of 315 microns to separate the bran from the endosperm, the produce the fine flour ready for use in composites blending. While the beans were steeped in water for about 30mins. At the end of steeping, the steeped water was decanted and beans sun-dried for 3 days. The dried beans were then milled with a hammer mill with 315 micron sieves to obtain fine flour and packaged in a clean polyethylene bags and kept for analysis in the Laboratory of Food Science and Technology, Kano University of Science and Technology, Wudil, Kano State until use.

2.2 Formulations
A 3×4×2 completely randomized factorial design was used to formulate gurasa production. It comprises of three (3) wheat cultivar substituted with pearl millet (SOSAT) at four (4) levels and cowpea at two (2) levels and one (1) commercial gurasa as control, making total of twenty five samples.

2.3 determination of total plate count
Enumeration of aerobic micro-organism was carried out using nutrient agar. For the enumeration of mesophillic bacteria, the

serial dilution method as described by Kawu *et al*. [8] was employed. One gramme of the sample was mixed with 0.2% peptone water. The sample was shaken and thoroughly comminuted to make a homogenate solution; this gave the dilution of 101. One millilitre of the prepared solution was transferred in to one milliliter of the diluents (0.1% peptone water), this gave the dilution of 101. This procedure was repeated up to the third dilution which gave the dilution of 103.

The dilution bottles were agitated. One millilitre of each dilution was pipetted into a separate corresponding petri-dish in duplicates. About 15 ml of the nutrient agar (NA) cooled to 45oC was poured into each plate. The sample and the agar medium were mixed by rotating the plate on a flat surface and allowed to solidify. The petri-dishes were then inverted and incubated at 35oC for 48 hours. Plates containing between 30-300 colonies were selected and counted. The number obtained was multiplied by the dilution factor this gave the number of colony forming units per gramme of the sample (cfu/g).

2.4 Determination of Fungal Count

Enumeration of aerobic mesophillic fungi/mould was carried out using Potato dextrose agar. For the enumeration of mesophillic fungal/mould, the serial dilution method as described by Kawu *et al*. [8] was employed. One game of the sample was mixed with 99 ml of 0.1% peptone water. The sample was shaken and thoroughly comminuted to make a homogenate solution; this gave the dilution of 101. One milliliter of this prepared solution was transferred in to 9 millilitre of the diluents (0.1% peptone water); this gave the dilution factor of 102. This procedure was repeated up to the third dilution which gave the dilution of 103.

The dilution bottles were agitated. One ml of each dilution was pippetted into separate corresponding petri-dishes in duplicates. About 15 ml antibiotic supplemented agar (cooled to 45oC) was poured into each plate. The sample and the agar medium were mixed by rotating the plate on a flat surface and allowed to solidify. The petri-dishes were then inverted and incubated at 25 oC for 3-5days10. Plates containing less than 50 colonies were selected and counted at 3-5 days incubation periods. The count was reported as fungi/mould colony forming unit per gramme of the sample (cfu/g). A set of control plate for each sample containing agar and diluents was incubated to ascertain the sterility of the media.

This formula was used to calculate the number of bacteria/fungi colony forming units per gram of the sample.

$$N=n/vd$$

Where,

N= the number of bacterial colony per gramme of sample
n= Number of colonies counted
v= volume of sample used
d= dilution factor

2.5 Amino Acid Determination

The amino acid profile of gurasa was determined using methods described by Benitez9. Each sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into an automated Applied Biosystems PTH Amino Acid Analyzer.

2.5.1 Defatting 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 [11].

2.5.2 Hydrolysis of the sample

A known weight of the defatted sample was weighed into glass ampoule. Seven mls of 6M HCL, was added and oxygen was expelled 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 sealed with Bunsen burner flame and put in an oven preset at 1050C± 50C for 22 hours. The ampoule was allowed to cool before breaking it open at the tip and the content was filtered to remove the humins.

The filtrate was then evaporated to dryness using rotary evaporator. The residue was dissolved with 5 ml to acetate buffer (pH 2.0) and stored in plastic specimen bottles, which were kept in the freezer.

2.5.3 Chromatograph

The analyzer is designed to separate and analyze free acidic, neutral and basic amino acids of the hydrolysate. An integrator attached to the Analyzer calculate the peak area proportional to the concentration of each of the amino acids.

3. Results and Discussion

3.1 Microbiological Counts of Gurasa Ingredients

The Total bacterial, yeast and mould count are shown in Table 1. The total bacteria count ranged from 2.8x104 to 4.8x104 cfu/g, while yeast and mould ranged from 4.0x104 to 7.2x104 cfu/g. Yeast and Mould growth had the highest load of 7.2 x104 cfu/g in the Certia wheat and also had the highest Bacteria count of 4.8x104 cfu/g. These findings are contrary to those of Ijah *et al*. 12 that did not observe growth in wheat flour examined. The presence of these bacteria could be either from the field, before or after harvest.

3.2 Microbiological Counts of Gurasa from Several Formulations

Table 2 shows the total bacterial,yeast and mould count observed in the gurasa produced from several formulations. The total bacteria count of gurasa ranged from 1.0x104 to 5.8x104 cfu/g, yeast and mould ranges from 1.0 x104 to 6.2x104 cfu/g. The values are within the range reported by Khanom *et al*. [13] The presence of heavy load on the control sample (commercial gurasa) could be due to poor hygiene from the local producers. The load varied from one sample to the other which could either due to handling and processing methods. Yeast and mould growth had also been seen on all the samples of gurasa produced. This could be as a result of the high Moisture content present on the gurasa product. This can be as a result of the water used during the process of production or could arise during harvest of the raw material. Contamination of street vended foods has been attributed to exposure to polluted environment, poor sanitation, poor hygienic practices and recontamination after production. High level of contamination as a result of staphylococus aureus may be linked to human source during production.

Table 1: Microbiological Counts of Gurasa Ingredients

Samples	Total bacteria count (cfu/g)	Yeast/mould (cfu/g)
Atiilla	$3.6x10^4$	$4.0x10^4$
Certia	$4.8x10^4$	$7.2x10^4$
SERI- M82	$4.0x10^4$	$4.8x10^4$
Pearl. Millet (SOSAT)	$2.8x10^4$	$4.2x10^4$
COWPEA	$3.2x10^4$	4.0^x10^4

Key; A = Atilla, C =Certia, S = Seri-M82, M = Millet, Cp = Cowpea, CTRL = Commercial Control, ND =Not detected.

Table 2: Microbiological Counts of Gurasa Produced from Several Formulations

Sample code	Total bacteria count (cfu/g)	Yeast & mold (cfu/g)
A (100)	$1.8x10^4$	$1.0x10^4$
ACp (70:30)	$1.0x10^4$	$1.3x10^4$
AM (80:20)	$1.0x10^4$	$1.5x10^4$
AMCp(56:14:30)	$2.2x10^4$	$1.7x10^4$
AM (70:30)	$1.6x10^4$	$1.8x10^4$
AMCp(49:21:30)	$1.4x10^4$	$1.9x10^4$
AM (60:40)	$1.6x10^4$	$1.1x10^4$
AMCp(42:28:30)	$3.2x10^4$	$1.1x10^4$
C (100)	$1.6x10^4$	$2.1x10^4$
CCp (70:30)	$2.8x10^4$	$3.1x10^4$
CM (80:20)	$2.8x10^4$	$2.7x10^4$
CMCp(56:14:30)	$1.5x10^4$	$3.1x10^4$
CM(70:30)	$3.0x10^4$	$2.3x10^4$
CMCp(49:21:30)	$2.1x10^4$	$2.1x10^4$
CM(60:40)	$3.2x10^4$	$6.0x10^4$
CMCp(42:28:30)	$2.2x10^4$	$3.1x10^4$
S(100)	$1.0x10^4$	$1.9x10^4$
SCp(70:30)	$1.1x10^4$	$2.1x10^4$
SM(80:20)	$2.1x10^4$	$2.5x10^4$
SMCp(56:14:30)	$2.9x10^4$	$2.5x10^4$
SM(70:30)	$1.7x10^4$	$4.3x10^4$
SMCp(49:21:30)	$1.9x10^4$	$3.9x10^4$
SM(60:40)	$3.9x10^4$	$4.9x10^4$
SMCp(42:28:30)	$3.1x10^4$	$2.1x10^4$
CTRL	$5.8x10^4$	$6.2x10^4$

Key; A = Atilla, C =Certia, S = Seri-M82, M = Millet, Cp = Cowpea, CTRL = Commercial Control, ND =Not detected.

3.3 Essential Amino Acid of Gurasa from Several Formulations

The chromatograph showing peaks of amino acid in standard are shown in Figures 1, 2, and 3. While, Table 3 shows that gurasa contained all the essential amino acid. Isoleucine ranged from 2.49 to 4.19%, leucine from 5.25 to 10.15%, phenylalanine from 3.19 to 4.90%, and methionine 1.09 to 3.53%; others are threonine from 2.99 to 4.30%, Valine from 4.99 to 3.18%, lysine 3.52 to 5.30% and tryptophan ranged from 0.40 to 1.35%. This also shows that isoleucine, leucine, phenylalanine, threonine, valine and tryptophan showed no significant difference ($p > 0.05$) in all the samples. In general, cereal proteins are lower in lysine, tryptophan and threonine. Because of this deficiency, lysine has become the limiting amino acids in cereals. The essential amino acid contents of the wheat cultivars used for the study are similar to those reported by other scientists [14]. Effect of addition of pearl millet and cowpea in gurasa (traditional flat bread) increases the amount of lysine in gurasa level, but, the range of methionine level in sample S 100, SMC treated at level of 42:28:30 and the control CTRL were significantly different at $p<0.05$. The range of lysine in sample A100 and S100 showed no significant difference with the control CTRL. Sample C, CCp, CM and CMCp also showed no significant difference ($p > 0.05$) with each other. Threonine and tryptophan increased as a result of the substitution wheat with pearl millet and cowpea. This shows that, the level of the ten essential amino acid increased significantly with higher level of cowpea addition when compared with the control. Samples of gurasa treated at level of 56:14:30, 49:21:30, 42:28:30 shows a significant increase in lysine content (concentration g/g proteins) when compared with their control at 100% Atilla, Certia and Seri-M82. However there was a drop in concentration of lysine in samples at level of 80.20: 60, 40 treated with millet.

3.4 Non-Essential Amino Acid of Gurasa from Several Formulations

Table 4 shows that all the non-essential amino acid was well represented. Alanine, aspartic acid, cysteine, serine, glycine, glutamic acid, tyrosine and proline had no significant difference ($p>0.05$). Glycine level was significantly different in sample CCp at ($p<0.05$). There are similar reports in literature on improvement of essential amino profile by supplementing cereals with legume [15, 16].

Table 3: Essential Amino Acid (Amino acid concentration g/g proteins) of *Gurasa* from Several Formulations

Sample code	Isoleucine	Leucine	Phenylalnine	Methionine	Threonine	Valine	Lysine	Tryptophan	Arginine	Histidine
A (100)	3.60 ± 0.15^{a}	6.45 ± 0.06^{a}	3.99 ± 0.19^{a}	1.27 ± 0.23^{c}	4.10 ± 0.64^{a}	4.27 ± 0.23^{a}	3.87 ± 0.17^{abc}	1.03 ± 0.25^{a}	5.33 ± 0.27^{abc}	2.49 ± 0.09^{a}
ACp (70:30)	3.99 ± 0.19^{a}	6.80 ± 0.50^{a}	4.90 ± 0.50^{a}	1.39 ± 0.31^{c}	3.49 ± 0.41^{a}	4.45 ± 0.05^{a}	3.52 ± 0.51^{c}	1.34 ± 0.14^{a}	6.26 ± 0.24^{ab}	2.30 ± 0.30^{a}
AM (80:20)	3.79 ± 029^{a}	6.88 ± 0.18^{a}	3.72 ± 0.68^{a}	1.28 ± 0.22^{c}	3.38 ± 0.32^{a}	4.79 ± 0.71^{a}	4.29 ± 0.21^{abc}	1.13 ± 0.14^{a}	5.85 ± 0.15^{ab}	2.81 ± 0.79^{a}
AMCp(56:14:30)	3.60 ± 0.60^{a}	5.92 ± 0.28^{a}	4.25 ± 0.25^{a}	1.39 ± 0.21^{c}	3.99 ± 0.19^{a}	4.99 ± 0.91^{a}	4.61 ± 0.59^{abc}	1.35 ± 0.06^{a}	6.10 ± 0.10^{ab}	3.00 ± 0.00^{a}
AM (70:30)	3.28 ± 0.30^{a}	5.60 ± 0.60^{a}	3.99 ± 0.09^{a}	1.23 ± 0.17^{c}	3.55 ± 0.55^{a}	3.89 ± 0.81^{a}	3.77 ± 0.45^{abc}	1.13 ± 0.09^{a}	5.24 ± 0.16^{abc}	2.39 ± 0.31^{a}
AMCp(49:21:30)	3.01 ± 0.01^{a}	5.25 ± 0.25^{a}	3.54 ± 0.44^{a}	1.20 ± 0.20^{c}	3.55 ± 0.55^{a}	3.68 ± 0.62^{a}	4.42 ± 0.38^{bc}	1.17 ± 0.08^{a}	4.81 ± 0.21^{bcd}	2.17 ± 0.13^{a}
AM (60:40)	3.50 ± 0.00^{a}	5.89 ± 0.81^{a}	3.19 ± 0.11^{a}	1.28 ± 0.22^{c}	3.69 ± 0.61^{a}	4.00 ± 0.00^{a}	3.81 ± 0.79^{abc}	1.16 ± 0.14^{a}	2.90 ± 2.20^{d}	2.30 ± 0.30^{a}
AMCp(42:28:30)	3.75 ± 0.35^{a}	7.30 ± 0.50^{a}	3.72 ± 0.68^{a}	1.28 ± 0.22^{c}	3.22 ± 0.18^{a}	3.85 ± 0.15^{a}	4.81 ± 0.21^{abc}	1.09 ± 0.16^{a}	5.68 ± 0.38^{ab}	2.30 ± 3.30^{a}
C (100)	3.40 ± 0.40^{a}	7.64 ± 0.54^{a}	3.54 ± 0.54^{a}	1.28 ± 0.22^{c}	2.99 ± 0.91^{a}	3.65 ± 0.65^{a}	4.82 ± 0.18^{ab}	1.14 ± 0.14^{a}	5.16 ± 0.14^{bcd}	2.23 ± 0.17^{a}
CCp (70:30)	3.47 ± 1.43^{a}	9.10 ± 5.10^{a}	4.52 ± 0.48^{a}	1.28 ± 0.22^{c}	4.30 ± 1.30^{a}	4.00 ± 1.00^{a}	5.22 ± 0.18^{ab}	1.15 ± 0.14^{a}	6.54 ± 0.54^{ab}	2.36 ± 0.34^{a}

CM (80:20)	3.47±0.43 [a]	7.70±0.70 [a]	3.72±1.68 [a]	1.23±0.17[c]	4.19±0.11 [a]	3.74±1.66 [a]	4.22±0.18[ab]	1.09±0.12 [a]	5.35±1.35[abc]	2.25±1.25[a]
CMCp(56:14:30)	3.60±1.60 [a]	7.99±2.91 [a]	3.72±1.68 [a]	1.02±0.02[c]	3.99±1.91 [a]	3.68±1.62 [a]	5.22±0.18[ab]	1.09±0.14 [a]	7.54±0.54[a]	2.27±0.23[a]
CM(70:30)	3.30±1.30 [a]	7.24±3.16 [a]	3.46±1.44 [a]	1.28±0.22[c]	3.61±1.59 [a]	3.27±1.23 [a]	4.19±0.11[abc]	1.07±0.11 [a]	4.99±0.91[bcd]	2.70±0.70[a]
CMCp(49:21:30)	3.66±1.64 [a]	8.18±2.13 [a]	4.08±1.02 [a]	1.23±0.17[c]	3.36±1.29 [a]	3.83±1.77 [a]	4.87±0.04[abc]	1.08±0.24 [a]	6.54±1.54[ab]	2.03±1.03[a]
CM(60:40)	2.49±1.41 [a]	6.89±3.81 [a]	3.46±1.44 [a]	2.43±0.37[c]	3.19±1.11 [a]	3.18±1.12 [a]	4.13±1.07[abc]	0.40±0.60 [a]	4.81±0.79[bcd]	2.11±1.09[a]
CMCp(42:28:30)	3.50±1.50 [a]	7.82±2.78 [a]	3.90±1.90 [a]	1.28±0.22[c]	3.88±0.82 [a]	3.62±1.58 [a]	5.30±1.30[a]	1.05±0.09 [a]	5.59±0.51[ab]	2.20±1.20[a]
S(100)	3.40±1.40 [a]	10.15±5.15 [a]	4.43±1.37 [a]	1.49±0.41[b]	3.44±1.36 [a]	4.09±1.01 [a]	4.86±1.03[abc]	1.23±0.15 [a]	6.10±2.10[ab]	2.36±1.34[a]
SCp(70:30)	4.19±1.11 [a]	9.45±6.45 [a]	4.08±1.02 [a]	1.42±.36[c]	3.49±1.41 [a]	3.71±1.69 [a]	4.88±0.82[abc]	1.31±0.11 [a]	3.25±1.25[cd]	2.30±1.30[a]
SM(80:20)	3.89±1.81 [a]	8.99±1.91 [a]	3.90±0.90 [a]	3.53±1.53[c]	3.27±1.23 [a]	3.53±0.53 [a]	4.50±0.50[abc]	1.11±0.15 [a]	5.16±0.14[bcd]	2.27±0.23[a]
SMCp(56:14:30)	3.37±1.33 [a]	9.88±082 [a]	4.43±1.37 [a]	1.47±0.43[c]	3.38±2.32 [a]	4.00±0.00 [a]	4.98±0.92[abc]	1.23±0.15 [a]	5.51±0.53[ab]	2.30±0.30[a]
SM(70:30)	3.50±0.00 [a]	8.87±1.83 [a]	3.72±1.68 [a]	1.20±0.20[c]	2.99±0.91 [a]	3.31±1.27 [a]	4.32±1.28[abc]	1.07±0.12 [a]	4.81±0.79[bcd]	2.20±0.20[a]
SMCp(49:21:30)	3.30±1.30 [a]	9.80±5.80 [a]	4.34±1.26 [a]	1.47±0.43[c]	3.47±1.43 [a]	3.89±0.81 [a]	4.93±0.87[abc]	1.23±0.14 [a]	5.76±0.7[4ab]	2.31±0.27[a]
SM(60:40)	3.14±1.06 [a]	7.99±2.91 [a]	3.54±1.54 [a]	1.09±0.01[c]	3.47±1.43 [a]	3.38±0.45 [a]	4.67±1.93[abc]	1.05±0.09 [a]	4.47±1.43[bcd]	2.04±0.04[a]
SMCp(42:28:30)	3.29±1.21 [a]	9.55±0.75 [a]	3.90±1.90 [a]	1.39±0.31[a]	3.44±1.26 [a]	3.62±0.58 [a]	4.72±0.68[c]	1.21±0.13 [a]	5.25±1.05[abc]	1.21±0.19[a]
CTRL	3.50±0.00 [a]	6.83±3.77 [a]	4.25±1.25 [a]	1.28±0.22[a]	2.99±0.91 [a]	4.60±0.60 [a]	4.19±1.11[abc]	1.20±0.12 [a]	5.16±1.14b[cd]	2.11±0.09[a]

Values are mean of three replicates ± SD, number in the same column followed by the same letter are not significantly different at p>0.05 level. Key; A = Atilla, C =Certia, S = Seri-M82, M = Millet, Cp = Cowpea, CTRL = Commercial Control.

Table 4: Non-Essential Amino Acid (Amino acid concentration g/g proteins) of Gurasa From Several Formulations

Sample Code	Alanine	Aspartic acid	Cystine	Glutamic acid	Glycine	Proline	Serine	Tyrosine
A (100)	4.95±0.40[a]	9.16±0.59[a]	1.29±0.36[a]	11.88±1.82[a]	4.30±0.30[b]	3.65±0.10[a]	4.79±0.71[a]	1.13±0.14[a]
ACp (70:30)	4.47±0.43[a]	9.5.2±5.52[a]	1.45±0.05[a]	13.20±2.16[a]	4.46±0.44[b]	3.96±0.45[a]	4.99±0.91[a]	1.35±0.06[a]
AM (80:20)	5.23±0.17[a]	8.99±0.91[a]	1.57±0.53[a]	12.87±2.83[a]	3.89±0.19[b]	3.45±0.45[a]	3.89±0.62[a]	1.13±0.09[a]
AMCp(56:14:30)	1.57±0.53[a]	9.30±0.70[a]	1.57±0.53[a]	5.00±0.00[a]	2.87±0.83[b]	3.75±0.25[a]	3.78±0.62[a]	1.17±0.08[a]
AM (70:30)	4.32±0.28[a]	9.80±1.12[a]	1.16±0.21[a]	11.20±1.20[a]	3.61±0.41[b]	3.45±0.45[a]	4.00±0.00[a]	1.16±0.14[a]
AMCp(49:21:30)	3.79±0.71[a]	8.49±0.41[a]	1.17±0.14[a]	10.44±0.36[a]	3.37±0.33[b]	3.04±0.04[a]	3.85±0.15[a]	1.09±0.16[a]
AM (60:40)	3.87±0.17[a]	8.90±0.90[a]	1.35±0.27[a]	11.35±1.35[a]	3.89±0.19[b]	3.55±0.55[a]	3.65±0.65[a]	1.14±0.14[a]
AMCp(42:28:30)	4.70±0.70[a]	9.05±0.05[a]	1.36±0.32[a]	14.12±3.08[a]	4.02±0.02[b]	3.32±0.35[a]	4.00±1.00[a]	1.15±0.14[a]
C (100)	3.49±0.41[a]	7.50±0.50[a]	1.25±0.23[a]	14.00±0.00[a]	4.30±0.30[b]	3.35±0.35[a]	3.74±1.66[a]	1.09±0.12[a]
CCp (70:30)	3.67±1.63[a]	8.56±0.54[a]	1.15±0.21[a]	15.29±10.21[a]	5.51±1.49[a]	3.65±0.65[a]	3.68±1.62[a]	1.09±0.12[a]
CM (80:20)	3.56±1.54[a]	7.75±0.75[a]	1.17±0.09[a]	14.37±11.27[a]	4.39±1.31[b]	3.25±1.25[a]	3.27±1.23[a]	1.07±0.11[a]
CMCp(56:14:30)	3.94±1.86[a]	8.49±4.41[a]	1.19±0.19[a]	15.40±10.40[a]	3.96±1.94[b]	3.75±0.75[a]	3.83±1.77[a]	1.08±0.24[a]
CM(70:30)	3.37±1.33[a]	7.10±1.10[a]	1.16±0.15[a]	13.47±11.43[a]	4.11±1.09[b]	3.14±1.06[a]	3.18±1.12[a]	0.40±0.60[a]
CMCp(49:21:30)	3.79±0.21[a]	7.94±0.46[a]	1.28±0.22[a]	14.99±10.91[a]	4.30±1.30[b]	3.35±0.35[a]	3.62±1.58[a]	1.05±0.09[a]
CM(60:40)	3.04±1.02[a]	7.19±0.89[a]	3.93±2.13[a]	12.85±7.85[a]	3.13±1.07[b]	2.34±1.37[a]	4.09±1.01[a]	1.23±0.15[a]
CMCp(42:28:30)	3.64±1.56[a]	8.06±2.04[a]	1.28±0.22[a]	12.11±8.09[a]	4.46±1.44[b]	3.95±1.95[a]	3.71±1.69[a]	1.31±0.11[a]
S(100)	4.02±1.02[a]	8.57±1.82[a]	1.33±0.27[a]	14.31±8.90[a]	3.96±0.94[b]	6.10±2.10[a]	3.53±0.53[a]	1.11±0.15[a]
SCp(70:30)	3.79±0.71[a]	8.99±1.91[a]	1.21±0.19[a]	13.47±10.51[a]	3.80±0.20[b]	3.25±1.25[a]	4.00±0.00[a]	1.23±0.15[a]
SM(80:20)	3.60±0.60[a]	8.49±4.41[a]	1.21±0.19[a]	13.17±7.13[a]	3.47±1.43[b]	3.14±1.06[a]	3.31±1.27[a]	1.07±0.12[a]
SMCp(56:14:30)	3.86±0.83[a]	8.74±1.66[a]	1.21±0.19[a]	14.00±6.00[a]	3.80±0.80[b]	3.35±1.35[a]	3.89±0.81[a]	1.23±0.14[a]
SM(70:30)	3.26±1.24[a]	8.56±1.54[a]	1.15±0.15[a]	12.56±7.83[a]	3.18±1.12[b]	3.04±1.04[a]	3.38±0.45[a]	1.05±0.09[a]
SMCp(49:21:30)	3.33±0.77[a]	8.49±2.41[a]	1.33±0.27[a]	13.78±6.72[a]	3.70±1.70[b]	3.25±1.25[a]	3.62±0.58[a]	1.21±0.13[a]
SM(60:40)	3.18±1.12[a]	7.84±2.76[a]	1.09±0.01[a]	12.34±3.26[a]	3.61±1.59[b]	2.94±0.56[a]	4.60±0.60[a]	1.20±0.12[a]
SMCp(42:28:30)	3.64±0.56[a]	8.90±1.90[a]	1.21±0.19[a]	12.87±7.83[a]	3.63±0.45[b]	3.14±1.06[a]	4.79±0.71[a]	1.13±0.14[a]
CTRL	4.28±0.22[a]	8.40±2.46[a]	1.51±0.51[a]	12.56±7.54[a]	3.99±1.91[b]	3.45±1.45[a]	4.99±0.91[a]	1.35±0.06[a]

Values are mean of three replicates ± SD, number in the same column followed by the same letter are not significantly different at p>0.05 level. Key; A = Atilla, C =Certia, S = Seri-M82, M = Millet, Cp = Cowpea, CTRL = Commercial Control

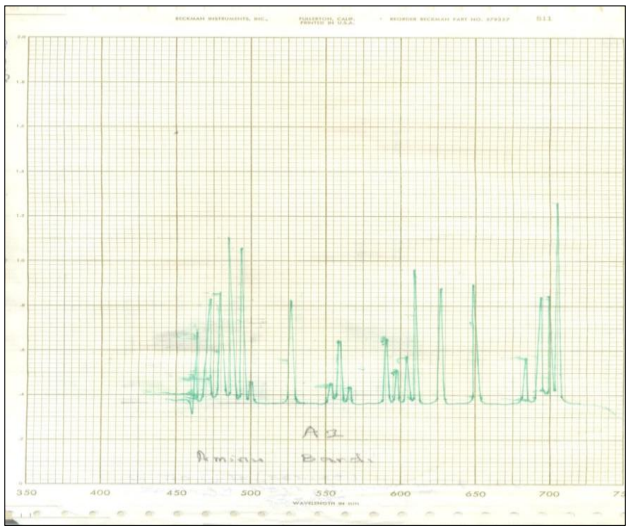

Fig 1: AC (70% Atilla, Atilla Wheat, 30% cowpea)

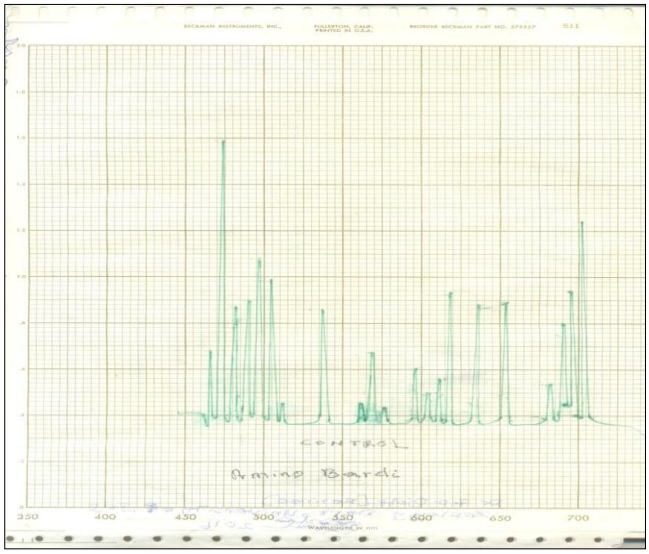

Fig 2: Commercial Control

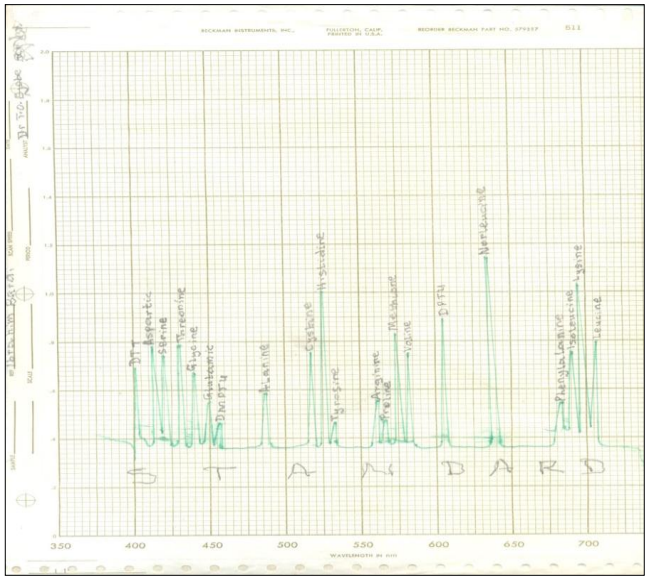

Fig 3: Standard

4. Conclusion/Recommendation

Gurasa produced from the blends of millet and cowpea was the first of its kind, which contains all the essential amino acids that satisfied the dietary requirement of humans. It contains an increased protein and lysine content compared to commercial wheat gurasa. Lower bacterial load, indicated that the gurasa was good for consumption. Policy should be implemented towards nutritional programmer on these products.

5. Acknowledgement

Aminu Barde is grateful to management of Kano University of Science and Technology Wudil for their financial support

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