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Proximate Composition, Physical, Functional, and Sensory Properties of Gurasa Produced from Flours of Indigenous Wheat Cultivars, Pearl Millet and Cowpea

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ABSTRACT – ***The quality of the three local wheat varieties, pearl millet and cowpea composite based gurasa (a Nigerian traditional flat bread) were evaluated. 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 proximate composition, weight, volume, swelling power, solubility index, water absorption capacity and acceptability of the gurasa were determined using standard methods. Water absorption ranged from 50 to 55% and increased with addition of cowpea flour. Swelling power decreased with increase in the solubility of the flour. Gurasa supplemented with pearl millet and cowpea had the highest protein (14.58%), crude fats (4.93%) and energy (333.13kcal/100 g) which increased with the level of substitution. Weight and volume of the gurasa ranged from 128.33 to 153.33g and 186.67 to 386.67 cm3 respectively. Sensory evaluation showed that all the gurasa products were acceptable in terms of colour, taste, aroma and texture when compared with the control gurasa. 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 – Gurasa, pearl millet, wheat, cowpea, amino acid, physicochemical properties

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1. INTRODUCTION

Wheat was first cultivated in the Middle East some 10,000 years ago and is now the most extensively grown cereal crop in the world, covering 237 million hectares, and accounting for a total of 420 million tonnes annually[1]. Roughly 90 to 95 percent of the wheat produced in the world (about 600 million tonnes[2], is common wheat (*Triticum aestivum*), which is better known as hard wheat or soft wheat, depending on the variety. Despite the intensification of the production of wheat locally in Nigeria, wheat still remains an imported commodity, consuming a greater part of Nigeria foreign exchange. Attempts had been made to make bakery products with partial replacement of wheat flour using common cereals available of which millet is one of them mainly grown in northern Nigeria. Pearl millet is the common cereal grain grown by farmers in the Semi Arid region of northern Nigeria. It grows well in the poor sandy soil and matures within short rainfall period avoiding drought[3]. Similar studies on substitution of wheat with pearl millet in some baked products have been carried out in Nigeria. Badau *et al.*[4] substituted wheat with pearl millet at various ratios using wheat and pearl millet in the ratio of 1:1 and found that the substitution did not affect the protein contents and acceptability of the resulting *alkaki*. Study from the institute of Food Technology in Dakar, Senegal confirmed bread could be prepared from 30 percent millet and 70 percent wheat[5]. Use of wheat and millet blend in *gurasa* production not only will increase profit margin but also help in boosting the production of *gurasa*. *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.

2. MATERIALS AND METHODS

2.1 Raw materials

Three types of wheat grains, one millet variety and cowpea were used in the study. The wheat samples were Seri-M82 (10 kg), Cettia (10 kg) and Atilla gan Atilla (10 kg); The millet variety was Sosat (10 kg), and the cowpea (7 kg) was the white beans. The cereal grains and grain legume (cowpea) were obtained from the International Institute of Tropical Agriculture in Kano metropolitan, Kano State, Nigeria. The following materials were used: Potato Dextrose Agar medium (PDA), Distilled water, MacConkey broth medium, Nutrients agar medium, Concentrated H_2SO_4, Digestion tablet, 50% sodium hydroxide, 2% Boric acid and Formaldehyde, Distilled water was sourced from The Food Science and Technology Analysis Laboratory at Kano University of Science and Technology Wudil, Kano State.

2.2 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 fine flour ready for use in composites blending. The beans were steeped in water for about 30 mins. 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.

2.3 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.

2.4 Proximate composition

Moisture, crude fat, crude protein, crude fat, ash and carbohydrate contents were determined as described by AOAC[6]. Energy was evaluated using a Atwater.

2.5 Physical and Functional Properties Determination

2.5.1 Determination of *Gurasa* volume

Gurasa volume was measured by small seeds displacement method as described by Greene and Bowell[7]. A container was used to measure the volume using small grains. Rapeseeds were poured into the container of known volume until the bottom was covered. The *gurasa* was placed inside the container which was then filled to the top with more seeds. The extra rapeseeds, which equal the *gurasa* volume, were then measured using a graduated cylinder.

2.5.2 Determination of *Gurasa* weight

Weight determination, as described by Nwosu *et al*.[8]. Essentially, *Gurasa* weight was determined by measuring the weight of the *gurasa* sample in a calibrated weighing balance.

Flour

↓

Mixing

↓

1st Proofing (1 hour)

↓

Dividing and shaping

↓

2nd Proofing (30mins)

↓

Baking (15 mins)

↓

Cooling

↓

Packaging

↓

GURASA

Figure 1: Flow chart for the production of *Gurasa*

2.5.3 Water absorption capacity (WAC)

Water absorption capacity was deter med as described by AOAC[6]. About 2 g each of the flour of ingredients and *gurasa* blends was weighed into a centrifuge tube. Five milliliters of water was added and mixed well. The mixture was allowed to stand for 30 minutes and centrifuged at 600 rpm for 15 minutes. The supernatant was decanted and the new weight of the sample was taken as water absorbed and the result was expressed on weight (g) of water per 100 g dry samples. The experiment was repeated and triplicate determinations were made for each *gurasa* blend.

$$\%\,WAC = \frac{weight\ of\ sample\ after\ centrifuge}{weight\ of\ the\ original\ sample} \quad x \quad \frac{100}{1}$$

2.5.4 Swelling power and solubility index determination

The method described by Hirsch and Kokini[9] was used for swelling power and solubility index determination. One gram of the flours of ingredients and *gurasa* blends were poured into pre-weighed graduated centrifuge tube appropriately labeled. Then, 10 ml of distilled water was added to the weighed sample in the centrifuge tube and the solution was stirred and placed in a water bath heated at different temperature of 85°C for one hour while shaking the sample gently to ensure that the starch granules remained in suspension until gelatinization occurred. The samples were cooled to room temperature under running water and centrifuged for 15 min at 3000 rpm. After centrifuging, the supernatant was decanted from the sediment into a pre-weighed petri-dish; the supernatant in the petri-dish was weighed and dried at 105 °C for 1 h. The sediment in the tube was weighed and the reading recorded. The starch swelling power and solubility was determined according to the equations below;

Swelling power = $\frac{weight \text{ of swollen sediment}}{weight\ of\ starch\ sample}$

Solubility = $\frac{\text{weight of dry supernatant}}{\text{weight of starch sample}} \times 100$

2.6 Sensory Evaluation

The sensory evaluation was conducted by a panel of twenty (trained) judges drawn from staff and students of Kano University of Science and Technology, Wudil. The samples were rated for taste, colour, aroma, texture and overall acceptability based on nine point hedonic scale where 9 representing like extremely and 1 representing dislike extremely as described by Ihekoronye and Ngoddy[10]. The panelists were served in white and transparent glass cups and were asked to rinse their mouth with water before next serving. The sample were coded and kept far apart to avoid overcrowding and for independent judgment.

2.7 Statistical Analysis

Data generated from the study were subjected to Analysis of Variance (ANOA) and where differences occur among the treatments, means were separated using Duncan multiple range test (statistical package of window version 8.0).

3. RESULTS AND DISCUSSION

Proximate Composition of *Gurasa* Ingredients

The proximate composition of the three wheat cultivars (Atilla gan Atilla, Certia and Seri-M82), Pearl millet and Cowpea are shown in Table 1. The moisture content ranged from 7.67 to 8.81%, protein from 9.47 to 24.34%, fat from 3.92 to 4.73%, ash from 1.19 to 2.95%, fibre from 0.88 to 2.93% and Carbohydrate from 60.40 to 75.40%. This is in lined with the literature in Table 2.1 reported by Souci *et al*.[11], Belitz *et al*.[12].The values of Moisture, protein, ash, fat, crude fibre and carbohydrate contents were significantly different ($p<0.05$). The protein contents of Atilla, Certia, Seri- M82 and Pearl Millet were significantly lower than Cowpea. Atilla gan atilla had the highest protein and fat contents among the local wheat verities. The protein and fat content of pearl millet and Atilla gan atilla were significant, while cowpea having high amount of proteins and less amount of carbohydrate.

Table 1: Proximate Composition of *Gurasa* Ingredients

S/N	Sample	Moisture%	Protein%	Fats%	Ash%	Crude fibre%	Carbohydrate%	Calories(Kcal/100g)
1	Atilla	8.66±0.64^{a}	11.67±0.30^{b}	4.73.±0.30^{a}	1.29±0.11^{b}	1.17±0.75^{bc}	72.47±0.29^{a}	379.47±0.98
2	Certia	7.67±0.18^{b}	9.11±0.63^{c}	3.92±0.64^{b}	1.19±0.15^{b}	0.88±0.99^{c}	77.24±0.49^{b}	382.97±4.37
3	Seri-M82	8.81±0.96^{a}	9.47±0.63^{c}	3.98±0.81^{b}	1.35±0.11^{b}	1.16±0.76^{c}	75.40±0.56^{c}	375.37±3.48
4	Pearl millet(SOSAT)	7.65±0.30^{b}	11.83±0.80^{b}	4.43±0.15^{ab}	1.28±0.10^{b}	1.90±0.40^{d}	74.08±0.75^{bc}	378.83±4.18
5	Cowpea	4.91±0.96^{c}	24.34±0.63^{a}	4.71±0.25^{a}	2.95±0.26^{a}	2.93±0.81^{a}	60.40±1.02^{a}	381.82±1.50

Values are mean of three replicates ± Standard Deviation, number in the same column followed by the same letter are not significantly different (P>0.05).

Proximate Composition of *Gurasa* Produced from Several Formulations

Table 2 shows the proximate composition of *gurasa*. Moisture content of *guras*a ranged from 19.40% to 29.49%. Sample A (atilla), ACp (atilla and cowpea), AM (atilla and millet), AMCp (atilla, millet and cowpea), CM (certia and millet), CMCp (certia, millet and cowpea), S (SeriM82), SCp (Seri-M82 and cowpea), SM (Seri-M82 and millet) were significantly different (p<0.05). The control samples A (atilla100%), C (certia 100%) and S (Seri-M82 100%) had Moisture content of 29.18%, 28.09% and 28.88% respectively, and the commercial control CTRL (commercial control) was 29.10%, (Table 2). It was observed that there was a decrease in moisture content in the samples treated with cowpea and millet. Firmness of *gurasa* is as a result of moisture loss; less water is required to keep *gurasa* soft. Level of proteins in *gurasa* samples ranged from 8.39 to 13.8%. Sample A (atilla), ACp (atilla and cowpea), AM (atilla and millet), AMCp (atilla, millet and cowpea), CCp (certia and cowpea), CM (certia and millet), CMCp (certia, millet and cowpea), SCp (Seri-M82 and cowpea), SM (Seri-M82 and millet), SMCp (Seri-M82, Millet and cowpea) were significantly different (p<0.05). McKevith[13] reported that wheat protein is relatively low amounts and therefore, essential amino acids must be supplied from another source of the diet. Higher amount of protein was observed in the samples using millet and cowpea flour replacement. The fat content ranged from 4.02% to 5.00% showed no significant difference (P>0.05). Crude fibre ranged from 0.97% to 1.94%. The values of sample C, S and the Commercial control were significantly different (p<0.05). According to Schneeman[14], crude fibre contributes to the health of the gastrointestinal system and metabolic system in man. Carbohydrate ranged from 50.37 to 61.64% but had no significant difference (p>0.05). The protein, ash, and crude fibre contents of the *guras*a increased with increasing levels of pearl millet and cowpea flours. Ash content ranged from 1.65 to 3.11%. The increased in ash content could come from both pearl millet and cowpea flour addition. This implies that the *gurasa* would be a source of high energy and nutrient dense food for consumers. The addition of beans flour to wheat flour was expected to increase the protein content of the final product, since legumes generally contain more proteins than cereals. Addition of legume flour on wheat flour baked products improved the essential amino acid balance of such foods.

Physical Properties of *Gurasa* Produced from Several Formulations

The weight and volume of *gurasa* produced from several formulations are shown in Tables 3. The volume and weight of *gurasa* ranged from 186.67 to 386.67 cm^3 and 128.00 to 153.00 g respectively. There was a significant difference in weight and Volume (p<0.05). Commercial *gurasa* with 100% wheat had the highest volume and weight. *Gurasa* at 100% level such as Atilla 100% rises to 366.67cm^3, Certia 100% 286.67 cm^3, Seri-M82 326.67cm^3 and the Commercial control which was 386.67scm^3. *Gurasa* substituted with millet showed a good result when compared with the control. But, as the rate of substitution increased the volume of *gurasa* also decreased significantly. This could be attributed to the decrease in structure forming proteins in wheat, which lowered the ability of the dough to rise during proofing leading to reduction in the *gurasa* volume as reported by Olaoye *et al*[15]. The weight of *gurasa* is as a result of high moisture content and high rate of substitution. The weight of *gurasa* decreased significantly with increased in rate of substitution.

Functional Properties of Composite Flour for Production

The water absorption capacity (WAC), swelling capacity and solubility of *gurasa* composite flours. (*Gurasa* formulations) are shown in Table 4. There was no significant difference o>0.05) in the mean WAC of the blend. Mean values ranged from 50 to 55%. It was found that all the treatments had no effect on the water absorption capacity (WAC). The increase in temperature caused an increase in the movement of the flour molecules, thereby allowing more samples to be dispersed in the solvent[16]. The higher WAC of flour could be attributed to the presence of higher amount of carbohydrates (starch) and fibre in the flour. Water absorption capacity is a critical function of protein in various food products like dough and baked products[17]. Significant difference existed in the swelling capacity of the blends. Value ranged from 7.17 to 9.30%. Sample A (Atilla 100%), C (Certia 100%), S (Seri-M82 100%) had the highest values while others decreased with replacement of wheat with millet and cowpea flour. The swelling capacity of flours depend on the variety and particle size of the flour[18]. Significant difference (p<0.05) existed in the mean solubility of the blends. Sample A 100%, C 100% and S 100% had the least values. The range of solubility increased with decrease in swelling capacity. Samples were significantly different (p<0.05) when compared with the Commercial control (CTRL).

Table 2 Proximate Composition of *Gurasa* Produced from Several Formulations

Sample code/%	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)	Calorie Kcal/100g
A (100)	29.18± 1.49^{a}	11.68±0.30^{c}	4.38± 0.28^{a}	2.97± 0.91^{a}	1.11± 0.19^{a}	50.37± 0.78^{a}	288.86± 3.78
ACp (70:30)	26.88± 0.68^{ab}	13.86±0.63^{ab}	4.50± 0.73^{a}	2.71± 0.29^{a}	1.25± 0.18^{a}	50.79± 0.78^{a}	299.10± 6.07
AM (80:20)	28.37± 1.79^{a}	10.55±0.61^{def}	4.03± 088^{a}	3.11± 0.62^{a}	1.12± 0.11^{a}	52.83±0.20^{a}	289.75± 2.48
AMCp(56:14:30)	20.99± 0.97^{cd}	14.58±0.63^{a}	4.35± 0.18^{a}	2.60± 0.16^{a}	1.94± 0.09^{a}	55.53± 0.63^{a}	319.59± 3.25
AM (70:30)	24.23± 1.88^{dc}	10.19±0.61^{efg}	4.18± 0.33^{a}	2.24± 0.18^{a}	1.17± 0.18^{a}	57.99± 2.31^{a}	310.07± 7.58
AMCp(49:21:30)	21.16± 0.75^{cd}	13.48±0.63^{b}	4.18± 0.28^{a}	2.10± 0.26^{a}	1.85± 0.17^{a}	57.21± 0.61^{a}	320.11± 7.59
AM (60:40)	29.49± 0.77^{a}	9.11±0.62^{hij}	4.02± 0.19^{a}	2.42± 0.28^{a}	1.46± 0.40^{a}	53.50± 0.25^{a}	286.62± 3.21
AMCp(42:28:30)	19.74± 1.19^{d}	13.13±0.00^{b}	4.37± 0.21^{a}	2.46± 0.13^{a}	1.93± 0.40^{a}	58.37± 1.06^{a}	325.33± 4.17
C (100)	28.09± 0.67^{ab}	9.84±0.00^{fgh}	4.27± 0.42^{a}	1.79± 0.35^{b}	0.97± 0.01^{c}	55.02± 0.98^{a}	297.95± 4.06
CCp (70:30)	26.33± 0.23^{ab}	10.15±0.61^{def}	4.87± 0.68^{a}	1.84± 0.04^{b}	1.16± 0.44^{a}	55.26± 1.48^{a}	305.47± 2.10
CM (80:20)	27.44± 1.40^{ab}	9.11±0.63^{hij}	4.72± 0.65^{a}	1.70± 0.14^{b}	1.20± 0.44^{a}	55.83± 1.62^{a}	302.24± 3.77
CMCp(56:14:30)	21.54± 0.66^{cd}	11.30±0.30^{cd}	4.05± 0.00^{a}	1.84± 0.15^{b}	1.81± 0.03^{a}	59.47± 0.86^{a}	319.53± 4.38
CM(70:30)	25.75± 0.64^{ab}	8.75±0.00^{ij}	4.67± 0.22^{a}	1.67± 0.27^{b}	1.23± 0.07^{a}	58.51± 0.76^{a}	311.07± 4.42
CMCp(49:21:30)	20.69± 0.55^{e}	10.55±0.61^{def}	4.57± 0.33^{a}	1.78± 0.09^{b}	1.82± 0.17^{a}	60.59± 0.76^{a}	325.69± 3.42
CM(60:40)	27.05± 0.04^{ab}	9.48±0.62^{ghi}	4.40± 0.36^{a}	1.97± 0.15^{a}	1.37± 0.32^{a}	55.74± 0.96^{a}	300.48± 1.84
CMCp(42:28:30)	19.40± 2.28^{d}	10.55±0.61^{def}	4.93± 0.33^{a}	1.65± 0.06^{b}	1.83± 0.21^{a}	61.64± 3.06^{a}	333.13± 8.00
S(100)	28.88± 0.33^{a}	10.19±0.61^{cfg}	4.12± 0.40^{a}	1.89± 0.29^{b}	0.92± 0.29^{b}	53.10± 1.45^{a}	293.84± 2.53
SCp(70:30)	26.89± 0.99^{ab}	11.30±0.35^{cd}	4.27± 0.23^{a}	2.19± 0.30^{a}	1.28± 0.26^{a}	54.07± 2.06^{a}	299.91± 4.97
SM(80:20)	27.46± 1.07^{ab}	9.84±0.00^{fgh}	3.75± 0.61^{a}	2.55± 0.91^{a}	1.21± 0.05^{a}	55.19± 1.57^{a}	293.87± 9.53
SMCp(56:14:30)	20.63± 0.06^{cd}	11.85±0.30^{c}	4.47± 0.15^{a}	2.13± 0.28^{a}	1.84± 0.15^{a}	59.38± 0.45^{a}	325.15± 1.76
SM(70:30)	21.48± 0.98^{ab}	9.11±0.63^{ij}	4.25± 0.40^{a}	2.12± 0.28^{a}	1.24± 0.15^{a}	56.44± 1.87^{a}	300.45± 2.05
SMCp(49:21:30)	21.48± 1.79^{cd}	10.90±1.06^{cde}	4.30± 0.30^{a}	2.11± 0.32^{a}	1.46± 0.45^{a}	59.75± 2.52^{a}	321.30± 8.31
SM(60:40)	26.75± 0.95^{ab}	8.39±1.68^{j}	4.10± 0.17^{a}	2.00± 0.03^{a}	1.32± 0.29^{a}	57.61± 1.16^{a}	300.90± 3.05
SMCp(42:28:30)	21.45± 1.43^{cd}	11.29±1.68^{cd}	4.20± 0.13^{a}	2.03± 0.17^{a}	1.93± 0.12^{a}	59.20± 3.14^{a}	319.76± 5.26
CTRL	29.10± 0.33^{a}	11.63±0.11^{c}	5.00± 0.13^{a}	2.76± 0.02^{a}	0.96± 0.29^{b}	50.55± 0.44^{a}	293.72± 2.10

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

Table 3: Physical Properties of *Gurasa* Produced from Several Formulations

Sample Code	Weight(g)	Volume(cm^3)
A (100)	130.67±7.10^{l}	366.67±5.22^{b}
ACp (70:30)	134.00±4.51^{ij}	266.67±5.22^{h}
AM (80:20)	135.00±5.08^{hi}	316.67±5.22^{d}
AMCp(56:14:30)	136.67±1.15^{g}	236.67±5.22^{j}
AM (70:30)	130.00±8.08^{l}	276.67±5.77^{g}
AMCp(49:21:30)	145.67±5.20^{b}	216.67±5.77^{k}
AM (60:40)	128.33±5.69^{m}	216.67±5.77^{k}
AMCp(42:28:30)	128.00±9.50^{m}	220.67±5.77^{k}
C (100)	134.00±1.73^{ij}	286.67±5.77^{f}
CCp (70:30)	128.33±4.04^{m}	236.67±5.77^{j}
CM (80:20)	140.00±1.73^{de}	256.67±5.77^{i}
CMCp(56:14:30)	138.00±4.04^{f}	206.67±5.77^{l}
CM(70:30)	134.67±6.08^{hi}	200.00±0.00^{l}
CMCp(49:21:30)	142.00±6.42^{c}	200.00±0.00^{l}
CM(60:40)	128.67±7.64^{m}	186.67±5.77^{m}
CMCp(42:28:30)	133.33±0.58^{j}	190.00±0.00^{m}
S(100)	135.67±4.35^{gh}	326.67±5.77^{c}
SCp(70:30)	139.00±0.58^{ef}	260.00±0.00^{hi}
SM(80:20)	141.00±3.22^{cd}	303.33±5.77^{e}
SMCp(56:14:30)	139.00±1.16^{ef}	206.67±5.77^{l}
SM(70:30)	132.00±4.16^{k}	266.67±5.77^{h}
SMCp(49:21:30)	146.33±1.73^{b}	216.67±5.77^{k}
SM(60:40)	131.00±2.31^{kl}	260.00±0.00^{l}
SMCp(42:28:30)	134.00±0.00^{ij}	260.00±0.00^{l}
CTRL	153.00±5.77^{a}	386.67±5.77^{a}

Values are mean of three replicates ± Standard Deviation, number in the same column followed by the same letter are not significantly different at $p>0.05$. Key; A = Atilla, C = Certia, S = Serim82, M = Millet, Cp = Cowpea

Table 4: Functional Properties of Composite Flours for Production

Sample code	Water absorption capacity %	Swelling C. %	Solubility %
A (100)	50.00 ± 0.00^{a}	9.30 ± 0.17^{a}	3.99 ± 0.01^{j}
ACp (70:30)	55.00 ± 0.00^{a}	8.20 ± 0.34^{f}	4.63 ± 0.05^{i}
AM (80:20)	52.00 ± 0.03^{a}	8.96 ± 0.05^{c}	5.43 ± 0.05^{h}
AMCp(56:14:30)	53.00 ± 0.02^{a}	8.00 ± 0.00^{gh}	6.20 ± 5.31^{fg}
AM (70:30)	52.00 ± 0.03^{a}	7.79 ± 5.32^{ijk}	6.30 ± 5.31^{efg}
AMCp(49:21:30)	53.00 ± 0.00^{a}	7.61 ± 0.02^{kl}	6.60 ± 0.00^{def}
AM (60:40)	55.00 ± 0.00^{a}	7.63 ± 5.31^{jkl}	7.26 ± 0.23^{dc}
AMCp(42:28:30)	50.00 ± 0.00^{a}	7.60 ± 0.00^{l}	8.00 ± 0.00^{a}
C (100)	50.00 ± 0.00^{a}	9.00 ± 0.00^{c}	4.13 ± 0.11^{j}
CCp (70:30)	55.00 ± 0.00^{a}	8.17 ± 0.11^{fg}	4.66 ± 0.05^{i}
CM (80:20)	55.00 ± 0.00^{a}	8.70 ± 0.00^{d}	5.13 ± 0.05^{h}
CMCp(56:14:30)	55.00 ± 0.00^{a}	7.93 ± 0.05^{hi}	6.00 ± 0.00^{g}
CM(70:30)	50.00 ± 0.00^{a}	7.79 ± 5.31^{ijk}	6.26 ± 0.05^{cfg}
CMCp(49:21:30)	55.00 ± 0.00^{a}	7.54 ± 0.07^{l}	6.56 ± 0.05^{de}
CM(60:40)	50.00 ± 0.00^{a}	7.17 ± 0.28^{m}	7.06 ± 0.05^{c}
CMCp(42:28:30)	55.00 ± 0.00^{a}	7.57 ± 0.05^{l}	6.20 ± 0.32^{c}
S(100)	50.00 ± 0.00^{a}	8.88 ± 1.11^{ab}	4.33 ± 0.32^{j}
SCp(70:30)	55.00 ± 0.00^{a}	9.10 ± 0.36^{a}	4.87 ± 0.28^{i}
SM(80:20)	50.00 ± 0.00^{a}	9.25 ± 0.56^{c}	5.57 ± 0.54^{h}
SMCp(56:14:30)	55.00 ± 0.00^{a}	8.57 ± 0.28^{e}	6.20 ± 0.17^{fg}
SM(70:30)	50.00 ± 0.00^{a}	7.99 ± 0.35^{ij}	6.46 ± 0.11^{def}
SMCp(49:21:30)	55.00 ± 0.00^{a}	7.69 ± 0.10^{jkl}	6.60 ± 0.00^{d}
SM(60:40)	50.00 ± 0.00^{a}	7.62 ± 0.01^{jkl}	7.40 ± 0.00^{b}
SMCp(42:28:30)	55.00 ± 0.00^{a}	7.60 ± 0.00^{l}	7.99 ± 0.01^{a}
CTRL	55.00 ± 0.00^{a}	8.80 ± 1.05^{ab}	4.50 ± 0.00^{i}

Values are mean of three replicates ± Standard Deviation, number in the same column followed by the same letter are not significantly different ($p > 0.05$). Key; A = Atilla, C = Certia, S = Seri-m82, M = Millet, Cp = Cowpea, CTRL = Commercial Control.

Functional Properties of *Gurasa* Produced from Several Formulations

Table 5 shows water absorption capacity, swelling capacity and solubility of *gurasa* produced from several formulations. The swelling capacity of *gurasa* ranged from 5.00 and 5.50%, solubility from 1.70 to 5.12% and water absorption capacity ranged from 26.00 to 41.00%. As the rate of substitution increases the swelling capacity decreases. This depends on the flour variety, particle size and the processing method. Solubility rate increased with increasing rate of substitution.. Water absorption capacity shows a significant difference ($p>0.05$) in all the samples.. Sultan[19] reported that the water absorption is due to increase in quality of flour mixture which also ensures the retention of moisture during dough processing for baked products. Sultan[19] reported that the water absorption is due to increase in quality of flour mixture which also ensures the retention of moisture during dough processing for baked products. Water is a basic component that helps to get a homogenous mixture of other components in dough, and providing it with a desired viscoelastic structure as well as very effective on final product quality. Water as a dissolving agent for many organic or inorganic substances is a substance that helps in dissolving hydrophilic components such as salt, sugar and insoluble proteins and forms gluten by hydrating insoluble proteins in water[20].

Sensory Quality of *Gurasa* Produced from Several Formulations

The pictures of *gurasa* produced from several formulations are shown in Plate 1 and its sensory attributes are shown in Table 6. The colour of *gurasa* ranged from 5.00 to 8.05, taste 4.85 to 7.45, aroma 5.30 to 7.80, Texture 5.15 to 8.30 and the overall acceptability ranged from 5.05 to 7.83 respectively. In respect to the colour of *gurasa* produced, it showed that all the samples were significantly different ($p<0.05$) from each other. Sample C 100% Certia obtained the best colour when compared with the control. The Taste of the *gurasa* also showed that sample were significantly different ($p<0.05$). The taste of sample A was highly excellent in respect of the sensory attributes. All the samples were significantly different ($P<0.05$) when compared with the control. Aroma of the *guras*a shows that sample A100 and the Control sample showed a significant difference ($p<0.05$). *Gurasa* texture showed that their mean values were within the range when compared with the Commercial control. The overall acceptability of *gurasa* showed that apart from the control, Sample A100 was the best followed by Sample C100 . The mean comparison of scores of different attributes like colour, texture, aroma, taste and overall acceptability were recorded and found to be significantly different($p<0.05$). It was found that as the rate of substitution increases, acceptability rate decreased. Commercial control *gurasa*, Atill gan atilla at 100% and Certia *gurasa* showed an excellent result in-terms of colour, taste, aroma, texture and overall acceptability. Our observations were in agreement with those reported by Ameh *et al*.[21] in which the overall acceptance of wheat-rice bran composite breads decreased as more rice bran was incorporated into the bread. The study has shown that pearl millet and cowpea flour could be used with wheat as composite flours to produce acceptable *gurasa*.

Table 5: Functional Properties of G*uras*a Produced from Several Formulations

Sample Code	Swelling Capacity%	Solubility %	Water absorption %
A (100)	5.00 ± 0.30^{ab}	2.15 ± 0.35^{hi}	38.00 ± 0.01^{cde}
ACp (70:30)	4.49 ± 0.29^{d}	2.16 ± 0.26^{hij}	40.00 ± 0.03^{ab}
AM (80:20)	4.22 ± 0.22^{c}	3.00 ± 0.20^{g}	37.33 ± 0.02^{cde}
AMCp(56:14:30)	4.14 ± 0.15^{gh}	3.53 ± 0.23^{b}	39.67 ± 0.01^{bcd}
AM (70:30)	4.00 ± 0.20^{ij}	3.95 ± 0.15^{cd}	39.00 ± 0.00^{abc}
AMCp(49:21:30)	3.91 ± 0.20^{jk}	4.25 ± 0.25^{cd}	41.00 ± 0.02^{a}
AM (60:40)	4.30 ± 0.30^{jk}	4.55 ± 0.25^{b}	35.00 ± 0.04^{f}
AMCp(42:28:30)	4.30 ± 0.30^{k}	5.12 ± 0.26^{a}	36.33 ± 0.02^{def}
C (100)	4.51 ± 0.31^{c}	1.70 ± 0.30^{jk}	38.67 ± 0.00^{def}
CCp (70:30)	4.40 ± 0.30^{c}	1.95 ± 0.45^{ijk}	37.33 ± 0.01^{cde}
CM (80:20)	4.22 ± 0.22^{c}	2.50 ± 0.50^{h}	39.00 ± 0.01^{abc}
CMCp(56:14:30)	4.08 ± 0.18^{cb}	3.20 ± 0.30^{fg}	26.00 ± 0.19^{g}
CM(70:30)	4.12 ± 0.18^{ij}	3.70 ± 0.30^{def}	38.67 ± 0.00^{bcd}
CMCp(49:21:30)	3.40 ± 0.20^{k}	3.95 ± 0.35^{cd}	38.00 ± 0.00^{cde}
CM(60:40)	3.82 ± 0.23^{l}	4.40 ± 0.30^{bc}	38.33 ± 0.00^{bcde}
CMCp(42:28:30)	3.65 ± 0.35^{k}	4.90 ± 0.40^{b}	38.00 ± 0.00^{cde}
S(100)	$5.50\pm.15^{a}$	2.00 ± 0.00^{k}	38.00 ± 0.03^{cde}
SCp(70:30)	4.60 ± 0.30^{c}	2.10 ± 0.30^{hij}	38.00 ± 0.01^{cde}
SM(80:20)	4.43 ± 0.33^{c}	2.45 ± 2.45^{h}	39.00 ± 0.01^{abc}
SMCp(56:14:30)	4.26 ± 0.28^{e}	2.95 ± 0.45^{g}	38.00 ± 0.01^{cde}
SM(70:30)	4.20 ± 0.21^{ij}	3.50 ± 0.50^{efg}	37.33 ± 0.02^{cde}
SMCp(49:21:30)	4.20 ± 0.22^{jk}	3.80 ± 0.50^{de}	37.33 ± 0.02^{cde}
SM(60:40)	3.90 ± 0.20^{jk}	4.04 ± 0.45^{cd}	38.00 ± 0.02^{a}
SMCp(42:28:30)	4.25 ± 0.25^{k}	4.85 ± 0.55^{b}	39.00 ± 0.00^{abc}
CTRL	4.90 ± 0.20^{b}	2.25 ± 0.25^{hij}	38.00 ± 0.01^{cde}

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

Table 6. Sensory Scores of *Gurasa* Produced from Several Formulations

Sample code	Color	Taste	Aroma	Texture	Overall acceptability
A (100)	7.45 ± 0.99^{ab}	7.45 ± 1.82^{a}	7.45 ± 1.46^{ab}	7.25 ± 1.48^{ab}	7.70 ± 1.30^{a}
ACp (70:30)	6.95 ± 088^{bc}	6.10 ± 1.41^{cdef}	6.40 ± 1.31^{cde}	6.40 ± 1.72^{bcd}	6.80 ± 1.05^{abcd}
AM (80:20)	5.45 ± 1.39^{efghij}	6.55 ± 1.31^{abcd}	5.60 ± 1.56^{defg}	6.50 ± 1076^{bcd}	6.40 ± 1.66^{bcdef}
AMCp(56:14:30)	5.75 ± 1.59^{defgh}	5.45 ± 1.63^{efg}	5.60 ± 1.56^{defg}	5.55 ± 1.82^{cde}	5.60 ± 1.23^{fghi}
AM (70:30)	5.20 ± 1.64^{fghi}	6.20 ± 1.00^{bcde}	5.65 ± 1.59^{defg}	5.90 ± 1.48^{cde}	5.90 ± 1.48^{defgh}
AMCp(49:21:30)	5.00 ± 1.91^{ghij}	5.65 ± 1.49^{defg}	5.65 ± 1.63^{defg}	5.75 ± 2.09^{cde}	5.85 ± 1.63^{defgh}
AM (60:40)	4.65 ± 1.89^{j}	6.00 ± 1.29^{cdef}	6.00 ± 1.55^{cdefg}	5.45 ± 1.9^{de}	5.95 ± 1.35^{cdefgh}
AMCp(42:28:30)	4.75 ± 1.50^{ij}	5.45 ± 1.73^{efg}	5.55 ± 1.98^{defg}	5.15 ± 1.81^{e}	5.55 ± 1.57^{fghi}
C (100)	8.05 ± 0.99^{a}	7.20 ± 1.50^{ab}	6.85 ± 1.66^{abc}	6.60 ± 1.84^{bc}	7.15 ± 1.56^{ab}
CCp (70:30)	6.85 ± 1.81^{bc}	6.50 ± 1.60^{abcde}	6.20 ± 1.60^{cdefg}	5.95 ± 2.13^{cde}	6.65 ± 1.84^{bcde}
CM (80:20)	6.30 ± 1.17^{cde}	6.00 ± 1.21^{cdef}	6.20 ± 1.57^{cdefg}	6.10 ± 1.97^{cde}	6.30 ± 1.21^{bcdefg}
CMCp(56:14:30)	6.00 ± 1.74^{cdef}	5.90 ± 2.02^{cdefg}	6.00 ± 1.52^{cdefg}	5.95 ± 1.82^{cde}	5.30 ± 1.75^{ghi}
CM(70:30)	5.80 ± 1.47^{defg}	6.25 ± 1.13^{bcde}	5.85 ± 1.95^{cdefg}	5.85 ± 1.59^{cde}	5.35 ± 1.96^{ghi}
CMCp(49:21:30)	5.90 ± 1.71^{defg}	$5.85\pm1..66^{cdefg}$	5.35 ± 2.03^{fg}	5.15 ± 2.39^{e}	5.30 ± 1.75^{ghi}
CM(60:40)	5.20 ± 2.00^{fghi}	5.05 ± 1.95^{fg}	5.55 ± 3.32^{defg}	5.40 ± 1.56^{de}	4.84 ± 2.20^{i}
CMCp(42:28:30)	5.44 ± 1.73^{efghi}	5.95 ± 1.37^{cdef}	5.45 ± 1.63^{efg}	5.50 ± 1.85^{cde}	5.05 ± 2.16^{hi}
S(100)	7.30 ± 1.03^{ab}	6.25 ± 1.48^{bcde}	6.50 ± 1.76^{bcd}	6.25 ± 1.48^{bcde}	6.95 ± 1.05^{abc}
SCp(70:30)	6.70 ± 1.21^{bcd}	5.95 ± 127^{cdef}	6.20 ± 1.32^{cdefg}	5.85 ± 1.59^{cde}	5.90 ± 1.91^{defgh}
SM(80:20)	5.20 ± 1.82^{fghij}	6.10 ± 1.33^{cdef}	6.35 ± 1.22^{cdef}	5.80 ± 1.79^{cde}	6.00 ± 1.17^{defgh}
SMCp(56:14:30)	5.60 ± 1.53^{efghij}	5.80 ± 1.54^{cdefg}	5.60 ± 2.08^{defg}	5.90 ± 2.02^{cde}	5.90 ± 1.44^{defgh}
SM(70:30)	5.40 ± 1.50^{efghij}	6.05 ± 1.73^{cdef}	6.40 ± 1.72^{cde}	5.70 ± 1.55^{cde}	6.10 ± 1.74^{cdefg}
SMCp(49:21:30)	5.70 ± 1.68^{efghi}	5.95 ± 1.70^{cdef}	5.95 ± 1.73^{cdefg}	5.80 ± 1.73^{cde}	5.55 ± 1.73^{fghi}
SM(60:40)	6.15 ± 1.84^{cdef}	5.95 ± 1.73^{cdef}	5.45 ± 1.87^{efg}	5.80 ± 1.60^{cde}	6.15 ± 1.46^{bcdefg}
SMCp(42:28:30)	4.90 ± 1.9^{hij}	4.85 ± 1.89^{g}	5.30 ± 1.52^{g}	5.55 ± 1.39^{cde}	5.65 ± 1.95^{efghi}
CTRL	7.50 ± 1.63^{ab}	6.85 ± 2.32^{abc}	7.80 ± 1.05^{a}	8.30 ± 0.86^{a}	7.83 ± 1.38^{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 = Serim82, M = Millet, Cp = Cowpea

A1

C1

S1

Plate 1 *Gurasa* produced from various formulations: A1 (100% ATTILLA); C1 (100% Certia); S1 (100% Seri-M82)

4. CONCLUSION

Gurasa produced from wheat, pearl millet and cowpea blends had increased protein. The higher Water Absorption Capacity of flour could be attributed to the presence of higher amount of carbohydrates (starch) and fibre in the flour. The range of solubility increased with decrease in swelling capacity. The mean sensory scores of *gurasa* produced from the several formulations showed that the products were fairly accepted and addition of pearl millet and cowpea had changed their proximate composition and functional properties. Product of 100%wheat flour, 70%wheat/30%cowpea, 80%wheat/20%millet and 70%wheat/30%millet were recommended to *gurasa* producers.

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