Effect of Germinated Soybean Flour Supplementation on the Physico-Chemical, Functional and Sensory properties of Instant *Kunun gyada powder*

Abstract

Kunun gyada is a traditional Nigerian cereal porridge commonly made from rice flour and groundnut milk. Instant *kunun gyada* powder was developed from blends of flours from rice, germinated soybean, sesame and groundnut paste. Five different formulations of instant *kunun gyada* powder were investigated namely; KGP1 60:40 ratio of groundnut paste to rice flour (control); KGP2, 60:30:5:5 (groundnut paste to rice flour to germinated soy flour and to roasted sesame flour); KGP3 60:30:10 (groundnut paste to rice flour and to germinated soy flour); KGP4 60:25:10:5 (groundnut paste to rice flour to germinated soy flour and to roasted sesame flour) and KGP5 60:25:15 (groundnut paste to rice flour and to germinated soy flour). The slurry of the mixtures was drum-dried and the product was then ground and sieved (0.5mm mesh size). The protein content of the instant *kunun gyada* powder increased from 3.61% - of 14.44%. In terms of microbiological quality no *Salmonella*, coliforms or yeast and molds growth were detected in the finished product. The water activity was 0.54 while the peroxide value ranged from 0.19 – 0.47 mEq/kg. The products were acceptable to consumers, in all sensory attributes evaluated.

Key words: Instant *kunun gyada*, germinated soybean flour, sensory, nutritional and microbial quality.

1. Introduction

Cereals-based staple food for human has found many uses in traditional food products, especially in Africa. Cereals supply most of the calories required in a diet and based on world production, wheat and rice accounts for 760.2 and 501.0 million tonnes of the world's cereal production respectively and the utilization of rice is estimated at 497.8 million tonnes (FAO, 2017). Cereal products can be nutritionally improved by supplementing with legumes as a source of protein. *Kunun gyada* is a cereal-based Nigerian porridge which is usually prepared from a cereal flour base in combination with groundnut milk (Nkama *et al.*, 1995). Information on the ratio and formulation of ingredients of *kunun gyada* is lacking; however, Nkama (1994) reported the ratio of the major ingredients in *kunun gyada* preparation as follows": maize-groundnut (50:50); millet-groundnut (60:40) and wheat-ground nut (60:40). The traditional *kunun gyada* is mostly prepared from single whole cereal grain which has low (2.30%) protein content (Nkama *et al.,* 1995). In Northern Nigeria, malnutrition is very high due to low levels of purchasing power, hence foods of high nutritional value in terms of protein, minerals and vitamins is unavoidably lacking. Protein of animal origin are not affordable (Ogbonna *et al*., 2010). The rate of poverty and chronic under nutrition in Nigeria is very high and this has remain unchanged for several years. Furthermore, the consumption of nutrient-dense foods remains insufficient (Ndidi *et al*., 2014).

The preparation of *kunun gyada* is time consuming and there is a great deal of variation in its production (Nkama *et al.,* 1995). Therefore, any research efforts to standardize the production process of *kunun gyada* to enhance its consumption and production in commercial quantity should be encouraged. "The need for value addition to the product in terms of increased protein content is very important, since research has shown that the product is low in protein (Nkama *et al.,* 1995) and can easily go bad when stored unrefrigerated. When refrigerated the product can only be kept for a maximum of four days" (Gaffa *et al.,* 2002). More studies need to be conducted on the product because of its popularity and general consumption in Nigeria, more especially as a weaning cereal product in the northern part of Nigeria. The development of products from germinated soybean is an option to further increase the utilization of soybean seeds (Paucar-Menacho *et al.,* 2010). Huang *et al*. (2014) showed that germinated soybeans and mung beans could be used as good supplement for functional foods since germination has improved isoflavones, phenolics, L-ascobic acid and antioxidant content. Kouton *et al*. (2017) used roasted soybean and germinated cereal to improve the protein content of infant porridges, but the research did not cover germination of the soybean seeds.

Germination of soybean can improve the nutritional value, and reduce the anti-nutritional factors (Paucar-Menacho *et al.,* 2010; Kumar *et al*., 2006; Bau *et al*., 2000). Germination of soybean has been shown to induced modification of biologically active components such as lecithin, saponins, phytosterols and oestrogenic compounds (Bau *et al*., 2000). Germination of soybean has also been found to increase the protein and fibre contents, decreased lipid and increased γ-aminobutryric acid (GABA), tocopherols and isoflavones of the soy gem (Kim *et al*., 2013). Oduro *et al.* (2007) reported improvements in the protein content of breakfast meal produced from blends of roasted soybean and bread fruit flours from 6.85-36.59% by addition of 10, 30, 50, 70 and 90% roasted soy flour to bread fruit flour. Shin *et al*. (2013) studied "the effects of various treatment on soy bean for bread quality, in terms of beany flavour and texture. They used soy flour that was non-heat treated (raw and germinated) and heat-treated (steamed and roasted). The germinated non-heated soy bread had the highest specific loaf volume 3.53 cm3/g and bread with heat-treated flour had less beany odor and taste than the bread from non-heat treated flour. This indicates that germinated soy flour can be used to improve bread, and heat treatment can reduce the beany odour".

Instant foods are convenient and hygienic food products which are faster and easy to prepare (Gandhi *et al.*, 2018). Instantization is a process that increases the amount of space between powder particles to allow moisture to easily penetrate, especially during reconstitution (Tamime, 2009), also referred to porosity and encompasses the interstitial void volume and the open pore volume within the particles which enhances reconstitution into a homogeneous liquid product (Black *et al.*, 2017). It is an important quality attribute of instant powder to reconstitute in water by process of wetting and dispersing which is the ability of the powder to absorb water by capillary action due to porosity and disperse in water with gentile mixing (Ishwarya and Anandharamakrishnan, 2017). This is achieved through thermal processing which results in the breakage of the structure of starch granules, increasing the swelling power of the granules (Laura *et al.*, 2015). Liquid can easily penetrate into the space by capillary action and allows large volumes of water to come into contact instantly with the powdered particles (Tamime, 2009). Since instant food products require a good wetting and sinking properties, this is possible through heat treatment that will gelatinize starch granules to absorb water and swell which is required for a high quality instant product (Majzoobi *et al.*, 2016; Sindawal *et al.*, 2014).

Given the importance of *kunun gyada* in African child nutrition, the aim of this research, therefore, was to produce a nutritionally improved instant *kunun gyada* powder from blends of rice, germinated soybean, sesame flours and groundnut paste which will be acceptable to consumers and can be produced commercially eventually.

2. Materials and methods

2.1. Materials

Soybean, white polished rice, groundnuts and sesame seeds were purchase from a supermarket in Malaysia. Standards of fatty acid methyl esters (C8-C24) and α-amino butyric acid (AABA), were purchase from Supelco (Bellefonte, Pennsylvania, USA). Zinc metal (Z1091-50) and calcium carbonate (precipitated, CA041-00) from SYSTERM Chemicas.com, Chempur Malaysia. Acetonitrile and methanol were all HPLC grade and approximately 99 %, were purchase from OREC (Asia) SDN BHD Selangor, Malaysia. Laboratory Nitrogen gas generator from PEAK SCIENTIFIC (Inchinnan, Scotland, UK).

2.2. Germination of soybean

Soybean seed germination was conducted according to the method described by Huang *et al.* (2014) with some modifications. The seeds were first sorted manually to remove broken and unwanted materials. Then, 450 g of the sorted seeds were washed and rinsed with distilled water and drained. Distilled water (1500 ml) was added to the seeds and allowed to stand for 12 hours in a plastic container (2.9 liter capacity) with lid covered overnight. The water was then drained and the seeds were rinsed with fresh distilled water. The seeds were then spread over a sterilized wet towel on a perforated plastic tray (38.5×23.5 cm) and kept in a room were light was allowed and at 24 ±2 ^{o}C to germinate for 24. Sterilized distilled water was used to sprinkle every morning and evening to keep the seeds moist. The germinated seeds dehulled manually and together with their hypocotyls were rinsed and oven dried at 45 ^{o}C for 15 hours to a final moisture content range of 6.10 %. The dried germinated and dehulled seeds were ground using a home blender (Pensonic Model PB-3205DJ, Malaysia) into powder for use in the production of instant *kunun gyada*.

2.3. Preparation of Instant *kunun gyada* powder

The preparation of instant *kunun gyada* powder was carried out as follows: groundnuts were first sorted to remove rotten and moldy nuts. Then, approximately 3 kg of the sorted groundnut were roasted at 100 ^{0}C for 10-15 minutes in an oven and turning the seeds after every 1 minute to have even roasting and avoid burning, it was peeled after cooling and ground into a paste using a home blender. Sesame seeds were also sorted and then roasted in an oven at 100 ^{0}C for 10 minutes, the seeds were turned the after every 1 minute to avoid burning cooled, and later ground into flour. Soybean flour germinated for 24 hours were used in the formulation. Polished white rice was washed using distilled water and oven dried at 40 ^{0}C for 15 hours and grounded into flour. The formulations used to prepare instant *kunun gyada* is shown in Table 1. A slurry of each formulation was made by adding distilled water (1:5 w/v) to the composite flour and after gentle mixing, the slurry was drum dried at a drum temperature of 100 ^{o}C, pressure of 3 bars and drum rotation of 2 rotations per minutes. After cooling the dry flakes were ground into powder using a home blender, it was sieved (0.5 mm mesh size) and 50 g of the powder were placed in aluminum laminated polyethylene (ALP) pouches (18×9 cm) with thickness of 86 µm purchased from Good and Well Sdn. Bhd. (Selangor, Malaysia). This was followed by flushing with nitrogen gas (1 minute of flushing per package) before heat- sealing at 150 ± 1^{0}C using a vertical continuous band sealer (GW-FRB-980II,Good and Well, Selangor, Malaysia)

Table 1: Formulation of ingredients for *kunun gyada*

Ingredients (%)	KGP1 (Control)	KGP2	KGP3	KGP4	KGP5
Groundnut paste	60	60	60	60	60
Rice flour	40	30	30	25	25
Germinated soybean flour	0	5	10	10	15
Sesame flour	0	5	0	5	0

KGP1 (control) = 60:40(Groundnut paste & Rice flour), KGP2 = 60:30:5:5(Groundnut paste, Rice flour, germinated soy bean flour and roasted sesame flour), KGP3 = 60:30:10(Groundnut paste, Rice flour and germinated soy bean flour), KGP4 = 60:25:10:5(Groundnut paste, Rice flour, germinated soy bean flour and roasted sesame flour) and KGP5 = 60:25:15(Groundnut paste, Rice flour and germinated soy bean flour)

2.4. Iron, Zinc and Calcium content

The content of iron, zinc and calcium of instant *kunun gyada* powders were analyzed using the method described by Nielsen (2003). Powdered samples of Instant *kunun gyada* power was oven dried at 100 ^{0}C for 16 hours and 1g of the dried samples was weight into crucible and ashed at 550 ^{o}C for 18 hours in a furnace. The ash following cooling in a dessicator was dissolved in 10 ml of HCL solution (1:1, HCl: H_2O) and appropriate delusions with deionized water were made (0.06 ml of stock:14.94 ml of deionize water, 0.03 ml stock:14.97 ml deionize water and 0.015 ml stock:14.985 ml deionized water) in a volumetric flask of 50 ml. LaCl3 was added to a final concentration of 0.1% and filtered using 0.2 µm nylon filter into a 15 ml plastic centrifuge test tube for analysis.

Quantification was done using a Perkin Elmer atomic absorption spectrophotometer Model 3300 equipped with an S10 auto sampler and a lumina lamp N30501XX (Perkin Elmer lumina lamp, San Jose, California, USA). The gas flame was a mixture of acetylene gas and compressed air. The standards were prepared by dissolving 2.4973 g of calcium carbonate in 25 ml of 1 M HCl added drop wise and diluted to 1 liter in a volumetric flask using deionized water

, 1 g of zinc metal was dissolve in 30 ml of 5 M HCl and diluted to 1 litre in a volumetric flask using deionized water.

2.5. Water activity of instant *Kunun gyada* powder

The water activity (aw) of the samples was determined using a water activity analyzer (Model TE8309, Series 3 Decagon Devices, Inc. Aqua Lab. NE Hopkins Ct, Pullman, USA. One 1 g of dry powder was placed in the sample dish with a sample capacity of 7.5 ml (15 ml full), the machine was then closed and automatically reads the water activity of the sample. The reading is displayed on the screen and expressed as aw measured at a temperature of 25± 2 ^{0}C. The instrument is calibrated when a linear offset occurs which may be as a result of contamination in the sensor chamber, the instrument is cleaned and calibrated using calibration standard solutions from Decagon with specific water activity. Distilled water (1.000 aw), 0.5 M KCl (0.984 aw), 6.0 M NaCl (0.760 aw), 8.57 M LiCl (0.500 aw) and 13.41 M LiCl (0.250 aw) are used to adjust the water activity using calibration buttons on the instrument. Checking for linear offset is to be verified daily as recommended by the company for accuracy of the instrument.

2.6. Bulk density

The bulk density of the instant *kunun gyada* samples was determined using the method describe by Mbaeyi-Nwaoha and Onweluzo (2013). Twenty gram of sample was place into a 100 ml-graduated measuring cylinder, the cylinder was tapped gently against the palm 10 times. The final volume was express in g/ml, analysis was done in triplicate.

2.7. Water absorption capacity (WAC)

The water absorption capacity (WAC) of instant *kunun gyada* power was determined by the method described by Mao and Hua (2012). One gram of dried sample was weight into 15 ml pre-weight centrifuge tube and 10 ml of distilled water was added gently with continuous stirring using a glass rod. The mixture was held at 24^{o}C ±2 for 30 minutes and centrifuged using a Hermle centrifuge (Model Z200A, Gosheimer Wehingen, Germany) at 2000 x *g* at 25 ^{0}C for 20 minutes. The volume of the supernatant was recorded. The WAC was expressed as grams of water per gram of sample. Analysis was conducted in triplicates.

WAC =

W_0= weight of dry sample (in grams), w_1 = weight of the tube plus the dry sample (g) and w_2 = weight of tube plus sediment (in grams).

2.8. Reconstitution Time (RT)

Reconstitution time was determined using the method described by Nwanekezi *et al.*, (2001) where 2 g of instant *kunun gyada* powder was weighed and dispersed in a 150 ml graduated measuring cylinder containing 50 ml of distilled water. The time that it took for the powder to completely sink without stirring was recorded. The analysis was conducted in triplicate, and the result was express in seconds.

2.9. Peroxide value of instant *kunun gyada* powder

The peroxide value was determined by the method described by AOCS (1989), 5 g of powered sample after production was weight into a conical flask containing 30 ml of acetic acid-chloroform solution (3:2 v/v) and swirled to dissolve the sample. 0.5 ml of saturated potassium iodide solution (KI) was then added and allowed to stand with occasional shaking for 1 minute, followed by addition of 30ml distilled water. The preparation was then titrated with 0. 1 N sodium thiosulfate with constant agitation until the yellow iodine colour has almost disappeared, then 0.5 ml of starch indicator solution is added, the titration was continued drop-wise until the blue grey colour disappears indicating the titration end point. Blank test was also conducted and the Peroxide value was calculated using:

$$PV=\frac{)\,N \times 1000}{W}$$, express in meq/kg

Where Vs = volume (ml) of sodium thiosulfate used in titration of sample, V_b = volume (ml) of sodium thiosulfate used for the blank titration, W = weight of sample used and N = normality of the sodium thiosulfate.

2.10. Yeast and mold counts

The yeast and mold count was determined using potato dextrose agar (Merck, Darmstadt, Germany) according to the method described by Akoth et al., (2012). One gram each of instant *kunun gyada* powder samples were suspended in 10 ml sterilized distilled water and vortexed. Then 1 ml of the resultant homogenous mixture was serially diluted through a series of tubes containing 9 ml sterile diluents (sterilized distilled water) up to five dilutions (10-5). One ml each of the diluent was also inoculated on potato dextrose agar in triplicate and incubated for 72 hours at 35 oC. Plates with colonies were expressed as colony forming units per gram (CFU/g). Same method was used to plate for coliforms using MacConkey Agar.

2.11. Sensory evaluation of *kunun gyada* porridge

The five samples of instant *kunun gyada* powder (KGP1, KGP2, KGP3, KGP4 and KGP5) were reconstituted into porridge using 25 g of sample mixed with 350 ml of boiled water and 13 g table sugar was added. The porridge was kept separately in thermos flasks to keep the product warm and each porridge sample was coded using 3-digit random numbers and randomly served warm to 30 untrained panelists comprising postgraduate student from Nigeria who were familiar with the product for over 20 years. The panelists were instructed to taste the products and evaluate the liking for colour, taste, texture, aroma attributes including overall acceptability.

A 9- points hedonic scale was used with scores ranging from 1 (dislike extremely) to 9 (like extremely). The panelists were given water to rinse their mouth after tasting each sample. The sensory evaluation was done in a sensory Laboratory at the Faculty of Food Science and Technology, Universiti Putra Malaysia.

2.12. Statistical analysis

Measurements were done in triplicate and results were presented as mean ± standard deviation. The statistical analysis was done using MINITAB 2. MTW, version 17. One way ANOVA was used to evaluate the significant difference between the means.

3. Results and discussion

3.1. Proximate composition of instant *kunun gyada* powder

Table 2 indicates the proximate composition of instant *kunun gyada* powder. The protein, total fat and carbohydrate contents varies from 9.02-14.44 %, while the control had 3.61 % protein, fat content of 14.23-24.97 % and carbohydrate in the range of 55.43-63.33 %. The product's nutrient composition were within the recommended range by WHO/FAO, (2000) expert consultation on diet, nutrition and prevention of chronic diseases report (protein between 10-15 %, carbohydrate, 55-75 % and fats, 15-30 %) as reported by Nishida *et al*. (2004).The moisture content of the product was very low with the highest moisture value of 6.50 % for the control, while product KGP5 recorded the lowest moisture content of 4.47 %, and significant difference was observed in moisture content between the products. Inclusion of germinated soybean flour also decrease the moisture content of products as seen in KGP5 which had the highest soy flour of 15 %. The crude protein content of products was higher when compared to the control, the protein increased from 3.61 % in the control to 14.44 % in KGP5.This is as a result of supplementation with germinated soybean flour. (Terna *et al*., 2002; Filli *et al.*, 2011) reported an increase in protein content of *kunun zaki* from 3.19% to 7.86% when soybean was added to the product, while millet fortified with cowpea showed an increment in protein content from 11.23 to 16.23 %. Product KGP4 had the highest value of crude fat of 24.97 % and this is attributed to the addition of 5 % sesame when compared to the control which had no sesame. The fat content of a food can affect its storage stability, foods with high fat content may result in oxidative instability during storage. Lanna *et al*. (2005) reported that high intake of saturated fatty acids is reported to increase the level of cholesterol in the blood, however the fats found in soybean and cereals are unsaturated. There is a significant difference in the fat content between the control and product KGP4 and the other products with KGP1 having the lowest crude fat value of 14.23 %. There was no significant difference ($P<0.05$) in ash content between the control and other products. Product KGP5 was significantly different in ash, with a highest value of 2.00 % and the results for ash content was higher than the values reported by Nahemiah *et al.* (2016) in extruded rice porridge ranging from 0.80 and 1.10 %. They also reported the carbohydrate value of 72.21 % as the highest in their study. The *kunun gyada* had a highest value of carbohydrate of 74.25 % in the control and this value is significantly different from the other products. The control (KGP1) had the highest percentage of rice flour (40 %). It is also observed that the addition of soy flour decreased the carbohydrate content of the products as evident from the results obtained when compared with the control. The FAO/WHO, (1994) reported the Codex Alimentarius standard of carbohydrate of weaning foods range 14.13 to 73.79 %. The control product had a carbohydrate value of 74.25 % which is slightly higher than the Codex standard; however the other products recorded values within the Codex limits.

Table 2: Proximate composition of instant *kunun gyada* powder (%)

Composition	Formulation				
	KGP1 (Control)	KGP2	KGP3	KGP4	KGP5
Moisture	6.50 ± 0.20^{a}	6.20 ± 0.17^{b}	4.87 ± 0.15^{bc}	5.10 ± 0.17^{b}	4.47 ± 0.21^{c}
Crude Protein	3.61 ± 0.67^{c}	13.29 ± 0.28^{a}	9.02 ± 0.53^{b}	12.97 ± 0.72^{a}	14.44 ± 0.14^{a}
Crude Fat	14.23 ± 0.14^{c}	21.86 ± 0.13^{b}	21.31 ± 0.26^{b}	24.97 ± 0.52^{a}	22.81 ± 1.56^{b}
Ash	1.40 ± 0.00^{b}	1.40 ± 0.20^{b}	1.47 ± 0.12^{b}	1.53 ± 0.23^{b}	2.00 ± 0.00^{a}
Carbohydrate	74.26 ± 0.47^{a}	57.25 ± 0.88^{c}	63.33 ± 0.23^{b}	55.43 ± 0.46^{c}	56.28 ± 1.53^{c}

Means within the same column having a common superscript are not significantly different ($P \geq 0.05$)

KGP1 (control) = 60:40(Groundnut paste & Rice flour), KGP2 = 60:30:5:5(Groundnut paste, Rice flour, germinated soy bean flour and roasted sesame flour), KGP3 = 60:30:10(Groundnut paste, Rice flour and germinated soy bean flour), KGP4 = 60:25:10:5(Groundnut paste, Rice flour, germinated soy bean flour and roasted sesame flour) and KGP5 = 60:25:15(Groundnut paste, Rice flour and germinated soy bean flour)

3.2. Functional properties of instant *Kunun gyada* powder

The results on the functional properties of instant *kunun gyada* powder are presented in Table 3. There was no significant difference in bulk density (BD) between products; the control (KGP1) had the maximum value of (BD), 31.33 g/ml. It was observed that addition of soybean flour decrease the bulk density which was also reported by Abioye *et al.* (2011) in soy-plantain flour. Bulk density is very important when considering the type of packaging material. There was a significant decrease in reconstitution time (RT) as soybean flour was added, RT indicates the ease of dispersibility of the powder, the RT ranges between 98.67 seconds in the control to 18.33 seconds in KGP5, the decrease in RT may be due to the addition of germinated soybean flour, germination of soy bean seeds has the advantage of improving the functional, textural and nutritional quality of soybean (Bau *et al.,* 2000). Same trend was also observed for water absorption capacity (WAC), whereby the control (KGP1) had the highest value of WAC of 3.47g/g and the control absorbs more water than the other product's. High WAC is related to the extent of starch gelatinization, indicating that gelatinize starch imbibes water readily than the soy flour. Water absorption capacity indicates the volume of water required to form gruel with suitable consistency. The values obtained were close to the values reported by Tiencheu *et al.* (2016), ranging from 2.00 to 3.30 for instant weaning foods processed from maize, pawpaw, red beans and fish meal. Water activity for the *kunun gyada* product was very low, the values obtained ranges from 0.61 to 0.56. There was no significant difference between the (a_W) of the product, the low water activity is an added advantage for storage stability of the product. Mbaeyi-Nwaoha and Onweluzo, (2013), reported water activity of sorghum-pigeon pea flour and flaked breakfast formulations to be between (0.435 and 0.785), the product was stable for 3 months. Results for viscosity indicated that increase in substitution with soy flour in the formulation of the product, resulted in decrease in the viscosity of the reconstituted porridge. Viscosity values ranges from 50.75 (mPa.s) in the control (KGP1) to 14.05(mPa.s) in product KGP5. A similar finding was reported by Abioye *et al*. (2011) in soy-plantain flour formulations, as soy flour was added to the formulation, the viscosity decreased. The decrease in viscosity may be an indication that more quantity of flour can be added without necessarily increasing the viscosity of the resulting porridge during reconstitution as observed by Mbaeyi-Nwaoha and Onweluzo, (2013).

Table 3: Functional properties of *Kunun gyada* samples

Formulation	Functional property				
	BD(g/ml)	RT (s)	WAC(g/g)	a_W	Viscosity(mPa.s)
KGP1(control)	31.33 ± 0.58^{b}	98.67 ± 0.58^{a}	3.47 ± 0.05^{a}	0.61 ± 0.07^{a}	50.75 ± 2.47^{a}
KGP2	30.33 ± 0.58^{b}	60.66 ± 0.58^{b}	3.14 ± 0.06^{ab}	0.56 ± 0.02^{a}	24.15 ± 1.06^{b}
KGP3	30.31 ± 0.58^{b}	44.33 ± 0.58^{c}	3.37 ± 0.20^{a}	0.56 ± 0.01^{a}	18.60 ± 0.28^{bc}
KGP4	30.31 ± 0.58^{b}	21.67 ± 0.58^{d}	2.67 ± 0.09^{b}	0.56 ± 0.02^{a}	15.75 ± 0.05^{c}
KGP5	30.30 ± 0.58^{b}	18.33 ± 0.58^{e}	2.62 ± 0.17^{b}	0.56 ± 0.01^{a}	14.05 ± 0.07^{c}

Means within the same Colum having a common superscript are not significantly different ($P \geq 0.05$)

BD= bulk density, RT= reconstitution time, WAC= water absorption capacity and a_W = water activity

KGP1 (control) = 60:40(Groundnut paste & Rice flour), KGP2 = 60:30:5:5(Groundnut paste, Rice flour, germinated soy bean flour and roasted sesame flour), KGP3 = 60:30:10(Groundnut paste, Rice flour and germinated soy bean flour), KGP4 = 60:25:10:5(Groundnut paste, Rice flour, germinated soy bean flour and roasted sesame flour) and KGP5 = 60:25:15(Groundnut paste, Rice flour and germinated soy bean flour)

3.3. Peroxide value of instant *kunun gyada* powder

The results for the peroxide value of instant *kunun gyada* powder is presented in Table 4. Peroxide value measures the hydroperoxides content which are used as an indicator of lipid oxidation (Tarmizi and Ismail, 2008). The peroxide value of instant *kunun gyada* powder range from 0.19-0.47 mEq/kg and the control sample had the highest peroxide value of 0.47 mEq/kg. This value is low and is within the acceptable limit of less than 10 mEq/kg (Gunstone, 2008). The low peroxide value is an added advantage to the product and if properly stored it may last longer without getting rancid.

Table 4: Peroxide (mEq/kg)

Samples	Peroxide Value
KGP1(control)	0.47 ± 0.02[a]
KGP2	0.25 ± 0.02[c]
KGP3	0.31 ± 0.02[b]
KGP4	0.20 ± 0.01[d]
KGP5	0.19 ± 0.01[d]

3.4. Mineral content of instant *kunun gyada* powder

The mineral content of instant *kunun gyada* samples is presented in Table 5. The results obtained showed that calcium has increased from 53.01 mg/l in the control (KGP1) to a maximum of 64.29 mg/l. Zinc also improved when compared with the control (0.81mg/l) to 2.72 mg/l and the same was recorded for iron which also increased from 1.80 mg/l in the control (KGP1) to a maximum of 2.61 mg/l. It was also observed that products added with sesame flour (KGP2 and KGP4) had increased content of minerals more than the products that has no sesame flour added as ingredient Anon, (2006) reported that, 100 g of sesame will provide 100 % of the recommended daily allowance (RDA) for manganese and potassium, 57-65 % of the RDA of phosphorus and iron, and 13- 35 % for zinc, calcium and copper while its recommended daily intake is 25 to 50 grams. Nzikou *et al.* (2009), also reported the mineral profile (mg/100 g) of sesame seed for Calcium 415.38 mg/100 g and 6.8 % protein.

Minerals are grouped into major (macro-minerals) which includes calcium and trace minerals (micro-minerals) example zinc and iron. Less amount of the trace minerals is needed in the body as compared to the macro-minerals (Lukaski, 2004). Many micro-elements like iron and zinc among others play a vital role as a structural part in many enzymes. Zinc is an important element and is needed for making protein and genetic material, it functions in wound healing, immune system health and improves digestion. Iron is needed for the formation of hemoglobin in red blood cells and energy metabolism (Gharibzahedi and Jafari, 2017).

Table5: Mineral concentration of *kunun gyada* samples (mg/L)

Products	Mineral content		
	Calcium	Zinc	Iron
KGP1(control)	53.01 ± 0.01	0.81 ± 0.01	1.80 ± 0.01
KGP2	56.32 ± 0.02	2.50 ± 0.01	1.95 ± 0.03
KGP3	54.95 ± 0.02	2.03 ± 0.01	1.89 ± 0.05
KGP4	64.29 ± 0.01	2.72 ± 0.01	2.61 ± 0.01
KGP5	51.53 ± 0.01	2.30 ± 0.01	2.40 ± 0.04

3.5. Microbiological analysis of instant *kunun gyada* powder

There was no growth of bacteria, coliforms, yeast and molds in the instant *kunun gyada* powder, figure 1. After the incubation period there was no growth of yeast and molds in the product. The results obtained could also be attributed to the drying method used during production of instant *kunun gyada* product and low moisture content of the powder, lower than 7 %. The moisture content is lower than the one reported by Rahman *et al.*, (2016) for germinated soy flour. They also reported that there was no E coli, salmonella, staphylococcus and spore forming bacteria after a storage period of six months for the germinated soy flour with a moisture content below 9 %. The water activity of the product was also low. This could be an advantage to restrict the growth of microbes. The water activity range between 0.56 and 0.61 (Table 4.9). This value is lower than the values reported by Marin *et al.*, (2002) for bakery products with water activity ranging between 0.70 and 0.85, they concluded that the water activity did not allow any fungal growth.

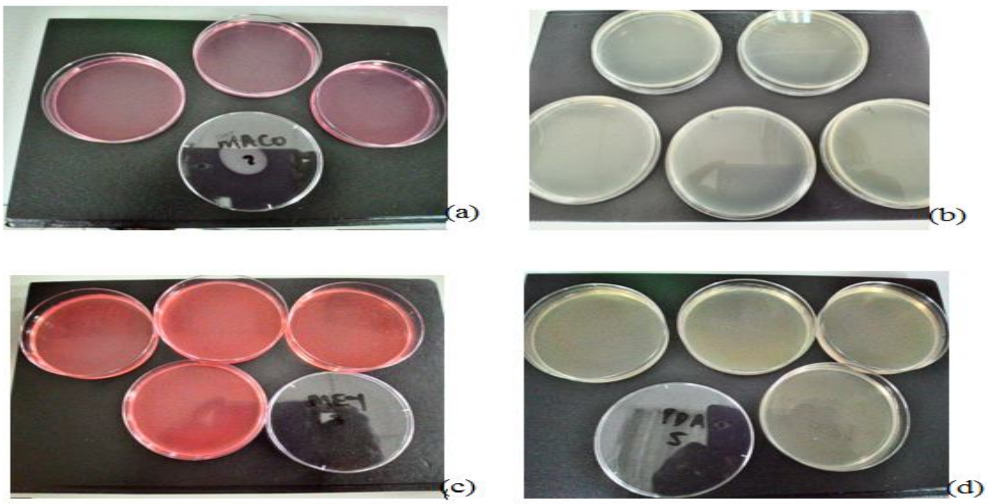

Fig 1: The media used for plating were: (a) MacConkey agar, (b) Mueller-Hinton agar, (c) Plate count Agar (d) Potato dextrose agar

3.6. Sensory evaluation of *Kunun gyada* porridge

The sensory evaluation of *Kunun gyada* porridge is presented in Table 6. There was no significant difference in the mean scores of sensory attributes tested for all the product. The incorporation of soybean and sesame flours had no significant (P<0.05) effect on the colour, taste, aroma, texture and overall acceptability of the *kunun gyada* porridge samples. Product KGP2 had the highest score for overall acceptability of 6.92, texture 7.47 and colour 7.32 on a 9 point hedonic scale. The control (KGP1) had the highest score for aroma (6.58). The acceptability scores for all sensory attributes ranges within 5.70 to 7.62 indicating that all samples were within like slightly to like very much by the panelist.

Table 6: Mean score of sensory attributes for *kunun gyada* porridge using hedonic test

Sensory attributes	Formulation				
	KGP1 (control)	KGP2	KGP3	KGP4	KGP5
Colour	6.50[a]	7.32[a]	6.40[a]	6.30[a]	5.77[a]
Taste	7.62[a]	7.62[a]	6.12[a]	5.88[a]	5.70[a]
Texture	6.65[a]	7.47[a]	6.45[a]	6.08[a]	5.93[a]
Aroma	6.58[a]	6.42[a]	6.28[a]	6.18[a]	5.82[a]
Overall Acceptability	6.48[a]	6.92[a]	6.43[a]	6.22[a]	6.08[a]

Means within the same row having a common superscript are not significantly different (P> 0.05

KGP1 (control) = 60:40(Groundnut paste & Rice flour), KGP2 = 60:30:5:5(Groundnut paste, Rice flour, germinated soy bean flour and roasted sesame flour), KGP3 = 60:30:10(Groundnut paste, Rice flour and germinated soy bean flour), KGP4 = 60:25:10:5(Groundnut paste, Rice flour, germinated soy bean flour and roasted sesame flour) and KGP5 = 60:25:15(Groundnut paste, Rice flour and germinated soy bean flour)

4. Conclusions

This study showed that the addition of germinated soy flour resulted in a significant (P≤0.05) increase in the nutritional composition of the instant *kunun gyada* powder. The protein content of the product has significantly improved. Addition of germinated soy flour lead to improvement in the nutritional composition and some of the functional properties (reconstitution time and water absorption capacity) of the product. Germinated soy flour produced added advantage to the instant powdered cereal products, the mineral content was also improved when compared to the control product. The acceptability of the product by panelist and the low moisture content could be an indication that the instant *Kunun gyada* powder has a commercial potential and will have a longer shelf life respectively. This study has made the product convenient, by reducing the time for preparation and is ready to be reconstituted into a nutritionally improved porridge. It is also assumed that the utilization of soybean will be increased in Nigeria especially in the Northern part where soybean is cultivated in large scale.

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