

Effect of Germinated Soybean Flour Supplementation on the Physico-Chemical, Functional and Sensory properties of Instant *Kunungyada* powder (Country)

Abstract

Kunungyada is a traditional Nigerian cereal porridge commonly made from rice flour and groundnut milk. Instant *kunungyada* powder was developed from blends of flours from rice, germinated soybean, sesame and groundnut paste. Five different formulations of instant *kunungyada* 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 *kunungyada* powder increased from 3.61% - of 14.44%. In terms of microbiological quality no *Salmonella*, coli-forms or yeast & molds growth was detected in the finished product. The water activity was 0.54 while the peroxide value ranged from 0.19 – 0.47mEq/kg. The product was acceptable to consumers, in all sensory attributes evaluated.

Key words: Instant *kunungyada*, germinated soybean flour, sensory, nutritional and microbial quality. (To exchange

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. *Kunungyada* is a cereal-based Nigerian porridge which is usually prepared from a cereal flour base in combination with groundnut milk (Nkamaet al., 1995). Information on the ratio and formulation of ingredients of *kunungyada* is lacking; however, Nkama (1994) reported the ratio of the major ingredients in *kunungyada* preparation as follows: maize-groundnut (50:50); millet-groundnut (60:40) and wheat-ground nut (60:40). The traditional *kunungyada* is mostly prepared from single whole cereal grain which has low (2.30%) protein content (Nkamaet 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 (Ndidiet al., 2014).

The preparation of *kunungyada* is time consuming and there is a great deal of variation in its production (Nkamaet al., 1995). Therefore, any research efforts to standardize the production process of *kunungyada* 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 (Nkamaet al., 1995) and can easily go bad when stored unrefrigerated. When refrigerated the product can only be kept for a maximum of four days (Gaffaet 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-ascorbic 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; Bauet *al.*, 2000). Germination of soybean has been shown to induced modification of biologically active components such as lecithin, saponins, phytosterols and oestrogenic compounds (Bauet *al.*, 2000). Germination of soybean has also been found to increase the protein and fibre contents, decreased lipid and increased γ -aminobutyric 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 gentle 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 (Majzoub *et al.*, 2016; Sindawal *et al.*, 2014).

Given the importance of *kunungyada* in African child nutrition, the aim of this research, therefore, was to produce a nutritionally improved instant *kunungyada* 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 SYSTEM Chemicas.com,

Chempur Malaysia. Acetonitrile and methanol were all HPLC grade and approximately 99%, were purchase from OREC (Asia) SDN BHD Selangor, Malaysia. Laboratory Nitrogengas 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, 450g of the sorted seeds were washed and rinsed with distilled water and drained. Distilled water (1500ml) 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 where light was allowed and at 24 ± 2 °C to germinate for 24. Sterilized distilled water was used to sprinkle every morning and evening to keep the seeds moist. The germinated seeds were dehulled manually and together with their hypocotyls were rinsed and oven dried at 45°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 *kunungyada*.

2.3. Preparation of Instant *kunungyada* powder

The preparation of instant *kunungyada* 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 °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 °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 °C for 15 hours and grounded into flour. The formulations used to prepare instant *kunungyada* 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°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 °C using a vertical continuous band sealer (GW-FRB-980II, Good and Well, Selangor, Malaysia)

Table 1: Formulation of ingredients for *kunungyada*

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 *kunungyada* powders were analyzed using the method described by Nielsen (2003). Powdered samples of Instant *kunungyada* powder was oven dried at 100°C for 16 hours and 1g of the dried samples was weighed into crucible andashed at 550°C for 18 hours in a furnace. The ash following cooling in a desiccator was dissolved in 10ml of HCL solution (1:1, HCl: H₂O) and appropriate dilutions with deionized water were made (0.06ml of stock:14.94ml of deionize water, 0.03ml stock:14.97ml deionize water and 0.015ml stock:14.985ml deionized water) in a volumetric flask of 50ml. LaCl₃ was added to a final concentration of 0.1% and filtered using 0.2µm nylon filter into a 15ml 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 dissolved 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 *kunungyada* powder

The water activity (a_w) 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 $a_{w\text{measured}}$ at a temperature of 25 ± 2 °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 a_w), 0.5 M KCl (0.984 a_w), 6.0 M NaCl (0.760 a_w), 8.57 M LiCl (0.500 a_w) and 13.41 M LiCl (0.250 a_w) 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 *kunungyada* samples was determined using the method describe by Mbaeyi-Nwaoha and Onweluzo (2013). Twenty gram of sample was place into a 100ml-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 *kunungyada* 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 10ml of distilled water was added gently with continuous stirring using a glass rod. The mixture was held at $24^\circ\text{C} \pm 2$ for 30minutes and centrifuged using a

Hermle centrifuge (Model Z200A, GosheimerWehingen, Germany) at 2000 x g at 25°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.

$$\text{WAC} = \frac{w_2 - w_1}{w_0}$$

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 Nwanekezie *et al.*, (2001) where 2 g of instant *kunungyada* powder was weighed and dispersed in a 150ml graduated measuring cylinder containing 50ml 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 expressed in seconds.

2.9. Peroxide value of instant *kunungyada* powder

The peroxide value was determined by the method described by AOCS (1989), 5 g of powdered sample after production was weighed into a conical flask containing 30ml of acetic acid-chloroform solution (3:2 v/v) and swirled to dissolve the sample. 0.5ml 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 0.5ml 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:

$$PV = \frac{(V_s - V_b) N \times 1000}{W}, \text{ express in meq/kg}$$

Where V_s = 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 *kunungyada* 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 °C. 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 *kunungyada* porridge

The five samples of instant *kunungyada* powder (KGP1, KGP2, KGP3, KGP4 and KGP5) were reconstituted into porridge using 25g 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 \pm 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 *kunungyada* powder

Table 2 indicates the proximate composition of instant *kunungyada* 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 (Enter the F-value, degrees of freedom, and probability)** 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; Filliet *et al.*, 2011) reported an increase in protein content of *kununzaki* 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. Lannaet *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 (Enter the F-value, degrees of freedom, and probability)** 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 Nahemiahet *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 *kunungyada* 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 *kunungyada* 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 *Kunungyada* powder

The results on the functional properties of instant *kunungyada* 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 (Bauet *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 *kunungyada* 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 Abioyeet *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 *Kunungyada* 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 Column having a common superscript are not significantly different (P≥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 *kunungyada* powder

The results for the peroxide value of instant *kunungyada* 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 *kunungyada* 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 *kunungyada* powder

The mineral content of instant *kunungyada* 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, 100g 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. Nzikouet *al.*(2009), also reported the mineral profile (mg/100g) of sesame seed for Calcium 415.38 mg/100g 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 *kunungyada* 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 *kunungyada* powder

There was no growth of bacteria, coliforms, yeast and molds in the instant *kunungyada* 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 *kunungyada* 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 *Escherichia coli* ((Theodor Von Escherich (1885) (Enterobacteriales: Enterobacteriaceae) Species in italics and full name, author, year of description, Order and Family) *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.

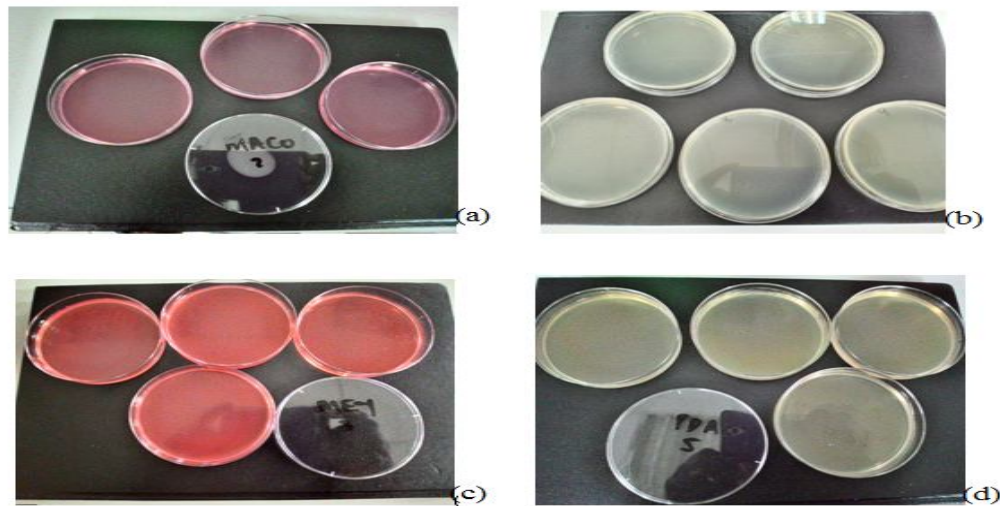


Fig 1: The media used for plating were: (a) MacConkey agar, (b) Mueller-Hinton agar, (c) Plate count Agar (d) Potato dextrose agar

3.6. Sensory evaluation of *Kunungyada* porridge

The sensory evaluation of *Kunungyada* 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 *kunungyada* 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 *kunungyada* 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 ($P \leq 0.05$) increase in the nutritional composition of the instant *kunungyada* powder. The protein content of the product has significantly improved. Addition of germinated soy flour led 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 *Kunungyada* 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.

References

- Abioye, V. F., Babarinde, G. O., & Adesigbin, M. K. (2011). Chemical , physico-chemical and sensory properties of soy-plantain flour. *African Journal of Food Science*, 5(April), 176–180.
- Akoth, O. C., Oduor, S., Mwasareu, M. A., Ochieng, J. K., and Mathooko, F. M. (2012). Development of instant breakfast cereals from optimized flour of pearl millet red and white sorghum. *Journal of Applied Bioscience*, 51: 3559-3566.
- AOCS (1989). Official methods and recommended practices of the American oil chemist's society, 4th edition, AOCS Press Champaign, Illinois UAS
- Bau, H. M., Villaume, C., & Méjean, L. (2000). Effects of soybean (*Glycine max*) germination on biologically active components, nutritional values of seeds, and biological characteristics in rats. *Die Nahrung*, 44(1), 2–6.
- Black, C., Heo, Y., Laplante, T., Westfall, P., Lamb, C., Engle, M., & Rangavajla, N. (2017). *U.S. Patent Application No. 15/328,248*.
- FAO (2017) *Cereal Supply and Demand Brief*. <http://www.fao.org/worldfoodsituation/csdb/en/.02/11/2017>
- FAO/WHO, Food and Agricultural Organization of the United Nations', (1994). Fats and oils in human nutrition. *Report of a joint expert consultation*. Rome, (FAO Food and nutrition paper No. 57.
- Filli, K. B., Nkama, I., Jideani, V. A., & Abubakar, U. M. (2012). The Effect of Extrusion Conditions on the Physicochemical Properties and Sensory Characteristics of Millet–Cowpea Based Fura. *European journal of Food Research & Review* 2(1): 1-23.
- Gaffa, T., Jideani, I. A., & Nkama, I. (2002). Traditional production, consumption and storage of Kunu - A non alcoholic cereal beverage. *Plant Foods for Human Nutrition*, 57(1), 73–81.
- Gandhi, N., Singh, B., Sharma, S., & Kapoor, S. (2018). Extrusion Process Optimization of Corn Starch to Develop Instant Vegetable Soup Mix. *Int. J. Curr. Microbiol. App. Sci*, 7(2), 2886-2910.
- Gharibzahedi, S. M. T., & Jafari, S. M. (2017). The importance of minerals in human nutrition: Bioavailability, food fortification, processing effects and nanoencapsulation. *Trends in Food Science & Technology*.
- Gunstone, F. D. (2008). Disappearance. *Lipid Technology*, 20(2), 48-48.
- Huang, X., Cai, W., & Xu, B. (2014). Kinetic changes of nutrients and antioxidant capacities of germinated soybean (*Glycine max* L.) and mung bean (*Vigna radiata* L.) with germination time. *Food Chemistry*, 143, 268-276.

Ishwarya, S. P., & Anandharamakrishnan, C. (2017). Spray Drying. *Handbook of Drying for Dairy Products*, 56.

Kim, S. L., Lee, J. E., Kwon, Y. U., Kim, W. H., Jung, G. H., Kim, D. W., ... & Hwang, T. Y. (2013). Introduction and nutritional evaluation of germinated soy germ. *Food chemistry*, 136(2), 491-500.

Kouton, S. E., Amoussa-Hounkpatin, W., Ballogou, V. Y., & Soumanou, M. M. (2017). Nutritional, Microbiological and Rheological Characteristics of Porridges Prepared from Infant Flours Based on Germinated and Fermented Cereals Fortified with Soybean. *Int. J. Curr. Microbiol. App. Sci*, 6(10), 4838-4852.

Kumar, V., Rani, A., Pandey, V., & Chauhan, G. S. (2006). Changes in lipoxygenase isozymes and trypsin inhibitor activity in soybean during germination at different temperatures. *Food chemistry*, 99(3), 563-568.

Lanna, Anna Cristina, Ines, C.J, Maria, Goreti de Almeda Oliveira, Everaldo, G.B and Maurillio, A.M (2005) Effect of temperature on polyunsaturated fatty acid accumulation in soybean seeds. *Brazilian Journal of Plant Physiology* 17.2 (2005): 213-222.

Lukaski, H. C. (2004). Vitamin and mineral status: effects on physical performance. *Nutrition*, 20(7), 632-644.

Mao, Xiaoying, and Yufei Hua (2012) "Composition, structure and functional properties of protein concentrates and isolates produced from walnut (*Juglans regia* L.)." *International journal of molecular sciences* 13.2 (2012): 1561-1581.

Majzoobi, M., Kaveh, Z., & Farahnaky, A. (2016). Effect of acetic acid on physical properties of pregelatinized wheat and corn starch gels. *Food chemistry*, 196, 720-725.

Mbaeyi-Nwaoha, I.E. and J.C. Onweluzo (2013) Functional properties of Sorghum (*S. bicolor* L)- Pigeonpea (*Cajanus cajan*) Flour blends and Storage Stability of Flaked Breakfast formulated from blends. *Pakistan Journal of Nutrition*. 12 (4):382-397

Marin, S., Guynot, M. E., Neira, P., Bernado, M., Sanchis, V., and Ramos, A. J. (2002). Risk assessment of the use of sub-optimal levels of weak-acid preservatives in the control of mould growth on bakery products. *International Journal of Food Microbiology*, 79(3), 203-211.

Nahemiah, Danbaba, IroNkama, and MamuduHaliduBadau. (2016) "Application of response surface methodology (RSM) for the production and optimization of extruded instant porridge from broken rice fractions blended with cowpea." *Int J Nutr Food Sci* 5: 105-116.

Ndidi, U. S., Ndidi, C. U., Olagunju, A., Muhammad, A., Billy, F. G., & Okpe, O. (2014). Proximate, antinutrients and mineral composition of raw and processed (Boiled and Roasted) *Sphenostylis stenocarpa* seeds from Southern Kaduna, Northwest Nigeria. *ISRN nutrition*, 2014.

Nielsen, S. S. (2003). *Food analysis laboratory manual*(3rdEdition). New York: Kluwer Academic/plenum publication, Pp 69-71.

Nishida, C., Uauy, R., Kumanyika, S., & Shetty, P. (2004). The joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases: process, product and policy implications. *Public health nutrition*, 7(1A; SPI), 245-250.

Nkama, I., Iliyas, A., & Jato, A. (1995). Studies on the preparation and nutrient composition of kunungyada, a traditional Nigerian groundnut-cereal-based weaning food. *Energy (kcal)*, 72(62), 59-60.

Nkama, I. (1994) Traditional Methods of Production of High Protein Energy Foods from grains Legumes in the North-Eastern States of Nigeria. *Annals of Borno* 10, Pp 138-148. University of Maiduguri press.

Nwanekezi, E. C., N. C. Ohagi, and Afam-Anene OC. (2001) "Nutritional and organoleptic quality of infant food formulations made from natural and solid state fermented tubers (cassava, sprouted and unsprouted yam)-soybean flours blend. *Nig. Food j* 19 (2001): 55-62.

Nzikou, J. M., Matos, L., Bouanga-Kalou, G., Ndangui, C. B., Pambou-Tobi, N. P. G., Kimbonguila, A., ... & Desobry, S. (2009). Chemical composition on the seeds and oil of sesame (*Sesamum indicum* L.) grown in Congo-Brazzaville. *Advance Journal of Food Science and Technology*, 1(1), 6-11.

Oduro, I., Ellis, W. O., Sulemana, A., & Oti-Boateng, P. (2007). Breakfast meal from breadfruit and soybean composite.

Ogbonna, A. I., Akueshi, E. U., Aguiyi, U. B., Onosemuode, A., Emefiene, M. M., & Okunuga, D. O. (2010). Nutrient Analysis of Indigenous Fortified Baby Weaning Foods from Nigerian Cereals. *Nigerian Journal of Biotechnology*, 21(1), 41-45.

Paucar-Menacho, L. M., Berhow, M. A., Mandarino, J. M. G., Chang, Y. K., & De Mejia, E. G. (2010). Effect of time and temperature on bioactive compounds in germinated Brazilian soybean cultivar BRS 258. *Food Research International*, 43(7), 1856-1865.

Rahman, M. M., Shahjadee, U. F., Rupa, A. Z., and Hossain, M. N. (2016). Nutritional and microbiological quality of germinated soy flour. *Bangladesh Journal of Scientific and Industrial Research*, 51(3), 167-174.

Shin, D. J., Kim, W., & Kim, Y. (2013). Physicochemical and sensory properties of soy bread made with germinated, steamed, and roasted soy flour. *Food Chemistry*, 141(1), 517-523.

Sindawal, Siddeswari, and Suwendu Bhattacharya. (2015) "Instantization and Agglomeration of Foods." *Conventional and Advanced Food Processing Technologies* (2015): 313-336.

Tamime, A. Y. (Ed.). (2009). *Dairy powders and concentrated products*. John Wiley & Sons.

Tarmizi, A. H. A., & Ismail, R. (2008). Comparison of the frying stability of standard palm olein and special quality palm olein. *Journal of the American Oil Chemists' Society*, 85(3), 245-251.

Terna G., J. I. A. N. I. (2002). Nutrient and sensory qualities of kunun zaki from different saccharification agents. *International Journal of Food Sciences and Nutrition*, 53(2), 109–115.

Tiencheu, B., Achidi, A. U., Fossi, B. T., Tenyang, N., Ngongang, E. F. T., & Womeni, H. M. (2016). Formulation and Nutritional Evaluation of Instant Weaning Foods Processed from Maize (*Zea mays*), Pawpaw (*Carica papaya*), Red Beans (*Phaseolus vulgaris*) and Mackerel Fish Meal (*Scomberscombrus*). *American Journal of Food Science and Technology*, 4(5), 149-159.

UNDER PEER REVIEW