Physico-Chemical properties Of Bread From Wheat, Bambara Groundnut And Irish Potato Flour Enriched With Mushroom (Agaricus Bisporus)

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ABSTRACT

The physico-chemical properties of bread from bambara–irish potato-wheat composite flour enriched with mushroom was investigated. Bambara–irish potato-wheat composite flour was prepared by substituting wheat with 0%, 5%, 10%, 15% and 20% of bambara and irish potato flour each. Breads produced from the flour were analyzed for physical characteristics and the results revealed significant (P<0.05) decrease in bread specific volume . The proximate composition ; moisture, protein, fat, crude ash, crude fibre, carbohydrate and energy ranged from 29.03 -31.00%, 9.24 - 12.43%, 2.31 - 3.11%, 1.00 - 1.35%, 1.20 - 1.40%, 51.82 - 56.25% and 279.22 - 287.19 kcal respectively. Inclusion of composite flour increase nutrients of the bread. Bread produced from bambara/irish potato flour enriched with mushroom impact a very good nutritive value to the bread samples

Keywords: Physico-Chemical properties, Bread, Wheat, Bambara Groundnut, Irish Potato Flour Mushroom (Agaricus Bisporus)

1. Introduction

Over the years there have been increasing demands for convenience in consumed food by consumers. Amongst such foods, the demand for bread ranks the highest. This has been attributed to its low price, nutritive value, and simplicity of production (Martín et al. 2007). Bread can be described as a fermented confectionary product produced mainly from wheat flour, water, yeast and salt by a series of processes involving mixing, kneading, proofing, shaping and baking (Dewettinck et al, 2008). Bambara nuts are edible seed from the Leguminosae family (Basu *et al.,* 2007). It is a promising crop which needs more awareness as a food, it is ranked next to cowpea (Barimalaa *et al*., 2005) and has been described a complete food owing to its nutritional composition of an average 63% carbohydrate, 19% protein and 6.5% fat, thus making it a major source of dietary protein (Food and Agricultural Organization of the United States (FAO), 2005). It also has a high content of crude fibre and high level of sulphur containing amino acids which are limited in cereals (Okpala and Chinyelu, 2011). Irish potatoes contain 2 percent protein and 18 percent starch.

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They are an inexpensive source of carbohydrates and, when prepared properly, provide good amounts of vitamins and minerals (Motsa *et al*., 2015). Mushrooms are edible fungi that contain high quality digestible protein that varied between (10-40%), Carbohydrate (3-21%) and dietary fiber (3-35%) on dry weight basis depending on species (Mallavadhani *et al*., 2006Reducing under-nutrition and micronutrient deficiencies is high on the agenda of many developing countries and international partners, as it affects more than one-third of the global population (Allen *et al*., 2006). To overcome this challenge, many have resorted to bio-fortification. There is, therefore, the need to formulate nutrient rich shelf-stable food products that are convenient and accessible to all using under-utilized crops. Irish potato, Bambara groundnut and mushroom are among the potentially rich under-utilized food crops of high nutritious value. This work therefore aim to produce a healthy and more nutritionally beneficial composite bread from bambara groundnut, irish potato flours isolate to supplement wheat flour at different ratios and enriched with mushroom.

2. MATERIALS AND METHOD

2.1 Sources of raw materials: The raw materials were purchased from Sabo market in Ikorodu local government area of Lagos state Nigeria. The raw material was selected with absolute care to ensure wholesomeness freedom from diseases and defects.

2.1 Methodology

2.2.1 Preparation of Irish Potato Flour

Irish potato is processed into flour using a traditional method which involved; peeling of the tubers, slicing, drying in cabinet dryer (3 days) and milling (attrition). The dried irish potato samples were subsequently milled into 30 um particle size powder using a multi-purpose grinder. The powdered samples were then bagged in an air-tight container and were stored at 4°C till further analysis.

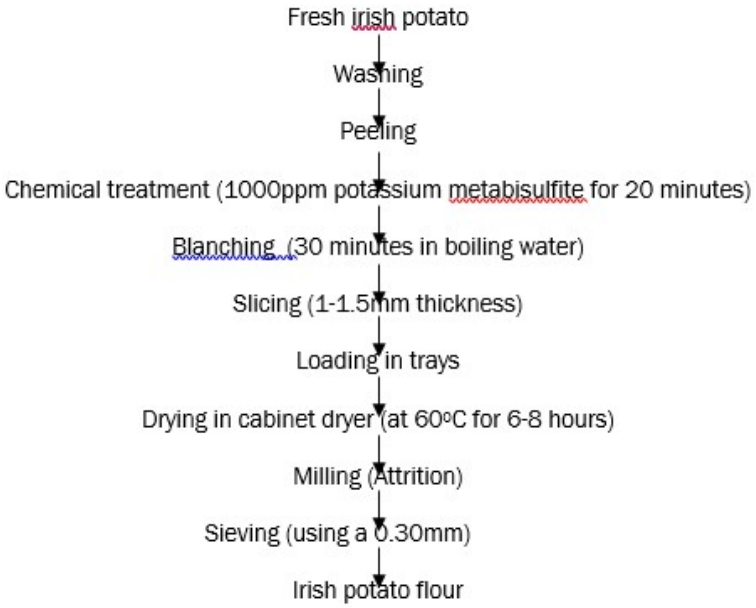

Figure 2 .1 Flow Chart for production of irish potato flour
Source: Singh *et al.,* (2008)

2.2.2 Preparation of Bambara Groundnut Flour

Bambara nut were fermented using the method of Frazier and Westholf (Ameh *et al*., 2013). Bambara nut was cleaned and washed. It was steeped in water for 24 h and dehulled. The steeped beans was boiled in the steeped water for 15 mins, drained and spread out to dry a little at room temperature. Dehulled Bambara nut were poured into the perforated polythene bag and an appropriate volume of 2 ml of spore suspension of *R. oligosporous*was carefully added, thoroughly mixed and tightly sealed. They were incubated at 320C for periods of time ranging between 0 and 48 h at regular intervals of 24 h. The seeds were dried in an oven maintained at 55^{0}C for 24 h, cooled and finely ground using hammer mill to obtain a fine particle flour. The flour samples were kept in airtight containers for further analysis.

Bambara groundnut

↓

Cleaning/sorting

↓

Washing in water

↓

Oven drying (50^{0}C for 24 hours)

↓

Milling/Decorticating

↓

Sieving(using a 0.30mm)

↓

Re-milling

↓

Bambara groundnut flour

Figure 2:2 Flow Chart for production of Bambara groundnut flour Source: Ameh *et al*., (2013).

2.2.3 Preparation of Mushroom Powder

The mushroom powder was prepared using the method described by (Okeke *et al*., 2003). The mushroom was washed and dried at 60°C in a mini oven (MO 4500). The dried mushroom was milled using an electronic table top milling machine (Hanzhong) and sieved by passing through a 60 mesh sieve (SS304 Grade). The powder was packaged in a low density polyethylene bag, sealed, stored in a refrigerator (4°C) until required.

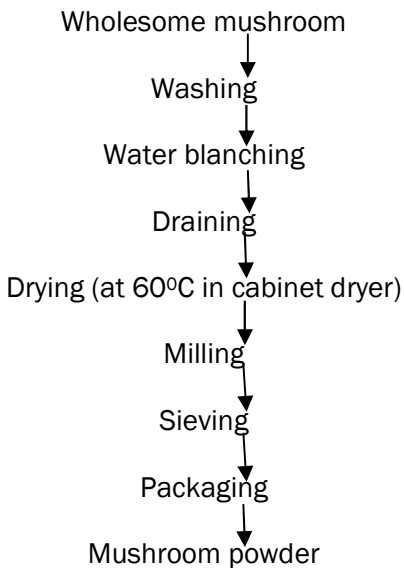

Fig 2.3: Flow chart for mushroom powder

2.2.3 Formulation of Composite Flour and Other Ingredients for Bread Production

Five different samples of bread were produced and coded as OM2, CA4, IJ8, SM6 and Q10. Sample OM2 served as the control and contained 100% wheat flour. Sample CA4, IJ8, SM6 and Q10 consisted of wheat, irish potato and Bambara groundnut flours enriched with mushroom and other ingredients for bread production are presented in Table 3.2.

Table 2.1: Formulation of Bread Produced From Bambara Groundnut, Irish Potato and Wheat Composite Flour Enriched With Mushroom

SAMPLES	OM2	CA4	IJ8	SM6	Q10
Wheat flour (%)	100	90	80	70	60
Irish potato flour (%)	_	5	10	15	20
Bambara nut flour (%)	_	5	10	15	20
Mushroom (g)	25	25	25	25	25

Table 2.2: Recipe Formulation for Bread Produced From Bambara Groundnut, Irish Potato and Wheat Composite Flour Enriched With Mushroom

	SAMPLES				
INGREDIENTS	OM2	CA4	IJ8	SM6	Q10
Wheat flour (g)	500	450	400	350	300
Orange flesh sweet potato flour (g)	0	20	40	60	80
Bambara groundnut flour (g)	0	20	40	60	80
Mushroom powder (g)	0	25	25	25	25
Salt (g)	5	5	5	5	5
Yeast (g)	12.5	12.5	12.5	12.5	12.5
Fats (g)	100	100	100	100	100
Sugar (g)	60	60	60	60	60
Improver (g)	2	2	2	2	2
Water (ml)	250	250	250	250	250

Source: (Islam *et al* 2011).

2.2.4 Bread Production by the Straight Dough Method

The straight dough method was used to produce the bread. This method involves the addition of all the ingredients (flour, salt, water, sugar, yeast e.t.c) at mixing stage and kneading same to obtain the dough. The different dough samples were placed in baking pans smeared with vegetable oil and was covered for the dough to ferment resulting in gas production and gluten development for about 1 hour. The dough was then baked in the oven at 200^{0}C for 30 minutes. The baked loaves were carefully removed from the pans and allowed to cool and packaged in polyethylene bags for analysis. The flow chart for bread production is shown in Figure 3.

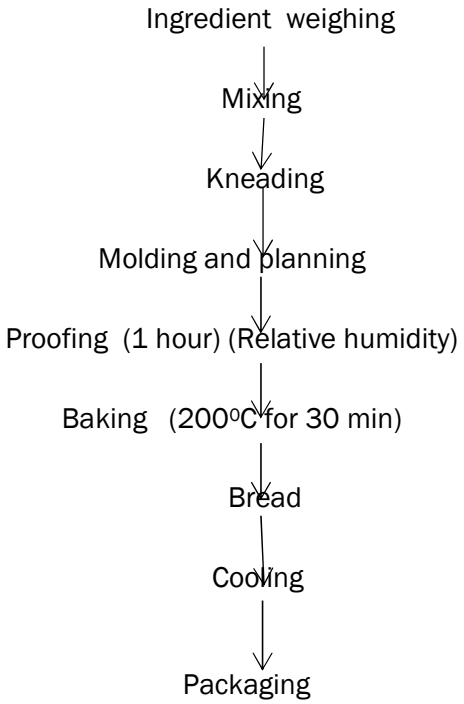

Fig 2. 4: Flow chat for production of bread
Source: American Journal of Food Science and Technology. (2014).

2.3.0 Determination of Physical Properties of The Bread Loaves

2.3.1 Determination of Loaves Weight

Weight of the loaves produced after baking were measured 1 hour after removal of the loaves from the oven simple weighing using an electronic balance by the method described by Maneju *et al*. (2011).

2.3.2 Determination of Loaves Height

Loaves height of the standard and composite flour breads were determined by a method of See *et al*. (2007).

2.3.2 Determination of Loaves Volume

Loaf volume was measured using the rapeseed displacement method as modified by 5660.37 cm3 was put in a tray, half filled with corn, shaken vigorously 4 times, then filled till slightly overfilled so that overspill fell into the tray. The box was shaken again twice and then a straight edge was used to press across the top of the box once to give a level surface. The seeds were decanted from the box into a receptacle and weighed. The procedure was repeated three times and the mean value for seed weight was noted (C g). A weighed loaf was placed in the box and weighed seeds (3500 g) were used to fill the box and leveled off as before. The overspill was weighed and from the weight obtained the weight of seeds around the loaf and volume of seed displaced by the loaf were calculated using the following equations by AACC (2000).
Seeds displaced by loaf (L) = C g + overspill weight –3500 g.
Volume of loaf (V)=L ×5660.37 Cm^3/Cm^3

2.3.4 Determination of Loaves Specific Volume

Specific volumes were measured by the method described by Maneju *et al*. (2011). The specific volumes were measured by dividing the volume with the weight. Thus, Specific volume = v / wt (Cm^3/g).

2.4 Functional Properties of Flour Blend From Wheat, Orange Flesh Sweet Potato Flour And Bambara Groundnut

The method of (A.A.A.C, 1995) was employed for the determination of Water Absorption Capacity. while other functional properties were determined by (AOAC,2005)

2.5 Proximate Composition of Quality Evaluation of Bread Produced From Blend of Wheat, Orange Flesh Sweet Potatoes and Bambara Groundnut Composite Flour Fortified with Mushroom were determined using (AOAC,2005)

2.5.1 Determination of Energy

The energy content was calculated by difference.
% Energy = (%Protein * 4 + % Fat * 9 + % Carbohydrate * 4).

3. RESULT AND DISCUSSION

3.1 The Physical Properties of Bread Produced from Wheat, Irish Potato and Bambara Composite Flour Enriched with Mushroom Powder

The physical properties of bread produced from wheat, irish potato and bambara groundnut composite flour enriched with mushroom powder are shown in Table 3.1. The weight of the bread ranged from 251.90-282.00g. The highest weight value was observed in sample Q10 while the lowest value was recorded in sample OM2. There was no significant difference ($p>0.05$) among the samples. The weight of the doughs after mixing is depicted in Figure 4A. These results revealed that loaf weight of bread samples increased with increasing level of bambara groundnut and irish potato flour. the loaf weight of bread samples increased with increasing level of non-wheat flour (cocoyam flour).

The volume ranged from 598.56-864.10cm^3. The highest value was observed in Q10 while the lowest value was observed in sample OM2. The loaf volume was observed to significantly ($P<0.05$) decrease with increasing bambara and irish potato inclusion. Decrease in loaf volume with subsequent addition of non-wheat flour might be due to less retention of carbondioxide (CO_2) in the samples (Shahzor, 2017). It is also obvious that substitution of wheat flour by other flour reduces the gluten fraction which is the source of elasticity in dough. This elasticity helps in retaining carbon dioxide produced during fermentation. Reduced gluten fraction in samples with non wheat flour (bambara groundnut and irish potato flour) caused a compact, compressed, less aerated texture and decreased raise in loaf size.

These results are similar to the result of (Gomez *et al*., 2003; Yusnita *et al*., 2011) in which they discovered that, addition of dietary fiber rich substances in baking products reduce loaf volume. This is also similar to previous reports by Okafor *et al*. (2012) and Agu *et al*. (2010) who reported decreased loaf volume on substitution with mushroom and fluted pumpkin flour, respectively. The specific volume of the bread ranged from 2.12-3.43cm/g. The highest value was observed in OM2 while the lowest value was recorded in sample Q10. There was no Significant difference ($p>0.05$) among the samples. A decreased specific volume was observed with increasing bambara groundnut and irish potato inclusion (Fig. 3). This can be attributed to the weight and volumes of the bread loaves as the specific volume are a function of both. This observation is similar to that of Okafor *et al*. (2012) who reported a decreased specific volume on wheat substitution and it contrasts the report of Kamaljit *et al*. (2011) who reported an increased specific volume with increase in oat flour inclusion. Present results are also in agreement with the findings of (Islam *et al*., 2007; Amir *et al*., 2013), who reported decrease in loaf volume and specific volume with the increased substitution of wheat flour with other flour. The loaf height ranged from 3.32-4.62 cm/kg.

3.2: The Proximate Composition of Bread Produced From Wheat, Irish Potato and Bambara Nut Composite flour Enriched with Mushroom Powder

The proximate composition of bread produced from wheat, irish potato and bambara nut composite flour enriched with mushroom powder are shown in Table 3.2. Proximate analysis included the moisture content, ash content, crude protein content, crude fat content and carbohydrates content. These analyses are important for determination of food quality, microbial stability and can be used for nutritional labeling. The moisture provides the measure of water content and total solid content of flour. It also determines the storage ability and quality of flour and susceptibility to microbial contamination (Frazier and Westhoff, 2005).

The higher moisture content above 14% attracts mold, bacteria, and insects all of which cause deterioration during storage. The moisture content of the bread ranged from 29.03-31.00%. The highest moisture content was observed in sample CA4 while the lowest value was recorded in sample IJ8. There was no significant difference ($p>0.05$) among the samples. This trend is contrary to the findings reported by Mepba *et al.* (2007), but similar from studies reported by Njintang *et al.* (2008) and Olaoye *et al*. (2006), who found out that, moisture content of the composite breads increased with increasing non-wheat flour substitution. And this was attributed to a greater water holding capacity of the non-wheat flour than the wheat flour. The implication is that the shelf life of the composite bread will be more susceptibility to microbial contamination. The higher the moisture content of food materials the lower the shelf stability (Aluge *et al.,* 2016). The protein content ranged from 9.24-12.43%. The highest value was observed in sample Q10 while the lowest value was observed in sample OM2. There was Significant difference ($p<0.05$) among the samples.

The protein content is a key specification for wheat and flour purchasers since it is related to many processing properties, such as water absorption. The result obtained for protein content showed significant differences ($p<0.05$) among the samples and increased as the substitution level increased. The significant ($p<0.05$) increase in the protein content of the composite breads with increasing levels of bambara nut and irish potato flour substitution enriched with mushroom powder could be attributed to the protein composition of these added materials. It was observed that the protein content of this study increased with increased in substitution level of bambara groundnut and irish potato flour. This is in contrary to the findings of Malomo *et al*. (2011) that the crude protein content decreased with increasing breadfruit and bread nut flour substitution. The fat content of the bread ranged from 2.31-3.11%. The highest value was observed in sample Q10 while the lowest value was recorded in sample OM2. There was Significant difference ($p<0.05$) among the samples.

The higher presence of fat in wheat bread, would help to increase the sources of fat soluble vitamins and precursors such as vitamin A and pro-vitamin A carotenoids as well as the total energy content as reported by Khating *et al.* (2014). Fat content determines the free fatty lipids of flour. This property can be used as the basis in determining processing temperatures as well as auto-oxidation which can lead to rancidity and can also affect flavor of the food. The significant increase in the fat content of the bread with bambara nut and irish potato flour inclusion could be as a result of the contribution of bambara groundnut and irish potato. Fats, especially the unsaturated fat are prone to oxidation and shorten shelf-life of food products (Borchers *et al*, 2000; Afoakwa *et al*, 2007). The ash content ranged from 1.20-1.40%. The highest value was recorded in sample Q10 while the lowest value was recorded in sample CA4. There was Significant difference ($p<0.05$) among the samples except sample CA4. Ash content is an indication of the mineral content of a food (Ndife *et al.,* 2013).

The crude fiber content ranged from 1.00-1.35%. The highest value was recorded in sample Q10 while the lowest content value was recorded in sample CA4. There was significant difference ($p>0.05$) among the samples. The carbohydrates content ranged from 51.82-56.25%. The highest value was recorded in sample OM2 while the lowest value was recorded in sample SM6. There was no significant difference ($p<0.05$) among the samples. The energy content ranged from 279.22-287.23 KJ/l00g. The highest value was recorded in sample IJ8 while the lowest value was recorded in sample CA4. There was no significant difference ($p<0.05$) among the samples.

The increase in the energy content of the bread samples could be attributed to the high fat contents. The ash and fibre content of the composite bread increased with increasing level of substitution and carbohydrate decreased with increasing substitution level as oppose to the findings of Malomo *et al.* (2011) that carbohydrate, crude fibre decreases with increasing substitution of breadfruit flour and bread nut flour. However, the variation observed in this study may be due to effect of different cultivars. Composite flour from wheat-bambara groundnut-irish potato composite flour could be used to manage cases of protein energy malnutrition which is prevalent in most developing countries of the world (Akinola *et al*., 2015).

3.3 Result Tables

Table 3.1: Physical Parameters of Bread Produced from Wheat, Irish Potato and Bambara Composite Flour Enriched with Mushroom Powder

Sample	Loaf Weight (g)	Loaf Volume (cm^3)	Specific Volume (cm/g)	Loaf height (cm)
OM2	251.90±0.05[a]	864.10±0.05[a]	3.43±0.05[a]	4.62±0.05[a]
CA4	263.78±0.05[a]	861.80±0.05[a]	3.27±0.05[a]	4.05±0.05[a]
IJ8	270.50±0.05[a]	723.19±0.05[a]	2.67±0.05[a]	3.84±0.05[a]
SM6	276.24±0.05[a]	629.78±0.05[a]	2.28±0.05[a]	3.54±0.05[a]
Q10	282.00±0.05[a]	598.56±0.05[a]	2.12±0.05[a]	3.32±0.05[a]

*Mean ± standard deviation with different superscripts along the column are significantly different at ($p>0.05$)

Key

Sample OM2: 100% wheat flour and 20 g of mushroom powder
Sample CA4: 90% wheat flour. 5% irish flour, 5% bambara nut flour and 20g of mushroom powder
Sample IJ8: 80% wheat flour. 10% irish flour, 10% bambara nut flour and 20g of mushroom powder
Sample SM6: 70% wheat flour. 15% irish flour, 15% bambara nut flour and 20g of mushroom powder
Sample Q10: 60% wheat flour. 20% irish flour and 20% bambara nut flour and 20g of mushroom powder

Table 3..2: Proximate Composition of Bread Produced From Wheat, Irish Potato and Bambara NuT Composite Flour Enriched with Mushroom Powder

SAMPLE	Moisture content (%)	Crude Protein (%)	Crude Fat (%)	Crude Fiber (%)	Crude Ash (%)	Carbohydrate (%)	Energy (Kcal)
OM2	29.83±2.57[a]	9.24±0.00[a]	2.31±0.00[a]	1.00±0.00[a]	1.37±0.06[ab]	56.25±2.52[a]	282.50±0.05[a]
CA4	31.00±1.32[a]	9.85±0.00[b]	2.46±0.00[b]	1.07±0.00[b]	1.20±0.10[a]	54.42±1.40[a]	279.22±0.05[a]
IJ8	29.03±2.43[a]	10.20±0.00[c]	2.55±0.00[c]	1.11±.0.00[c]	1.23±0.12[ab]	55.87±2.35[a]	287.23±0.05[a]
SM6	30.33±1.26[a]	12.13±0.00[d]	3.03±0.00[d]	1.32±0.00[d]	1.37±0.06[ab]	51.82±1.25[a]	283.07±0.05[a]
Q10	29.33±4.54[a]	12.43±0.00[e]	3.11±0.00[e]	1.35±0.00[e]	1.40±0.10[ab]	52.37±4.60[a]	287.19±0.05[a]

*Mean± standard deviation with same superscripts along the column are not significantly different at ($p<0.05$)

KEY

Sample OM2: 100% wheat flour and 20 g of mushroom powder;

Sample CA4: 90% wheat flour. 5% irish flour, 5% bambara nut flour and 20g of mushroom powder;

Sample IJ8: 80% wheat flour. 10% irish flour, 10% bambara nut flour and 20g of mushroom powder ;

Sample SM6: 70% wheat flour. 15% irish flour, 15% bambara nut flour and 20g of mushroom powder;

Sample Q10: 60% wheat flour. 20% irish flour and 20% bambara nut flour and 20g of mushroom powder

4. CONCLUSION

Substitution of wheat-bambara nut and irish potato flour with mushroom flour improve the nutritional qualities of composite bread . The inclusion of bambara nut and irish potato flour up to 20% in wheat-bambara nut-irish potato composite flour could give a confectionary product of high quality that is comparable with 100% wheat flour.sample Bread produced from sample Q10 (60:20:20) 0f wheat ,Bambara nut and irish potato flour has the highest nutritional value when compare with other bread samples. promotion, addition of bambara nut and irish potato helps to improved industrial use of bakery products.

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