Original Research Article

Comparative assessment of microbial, proximate and sensory quality of bread produced from all-purpose flour and a blend of locally made flour

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Abstract

The nutritional and sensory quality of different flour blends for baked products has been investigated. However, there is paucity of information on the quality of the conventional all-purpose flour which is expected to be chiefly of wheat origin and thus very expensive. Comparative analysis of the microbial, proximate and sensory quality of bread produced from all-purpose flour and blends of locally made flour was undertaken. Composite breads were produced from all-purpose flour (APF) 100%, wheat flour (WF) 100%, potato flour (PF) 100% and WF:PF blend (50%:50%). The microbial, proximate and sensory qualities, as well as the shelf life of the bread samples were determined. Data was analyzed using SPSS software. The bacterial and fungal counts were less than the maximum of 100 cfu/g recommended by the Standard Organization of Nigeria. The moisture and ash content of the PF bread was significantly higher ($p < 0.05$) than the rest of the flour blends. Among the flour blends, APF recorded the lowest fiber, ash and protein content. There was no significant difference ($p > 0.05$) in the mean sensory scores of APF bread and WF:PF bread with respect to taste and overall acceptability. PF and WF:PF bread had the highest shelf life of 8 and 7 days respectively. The nutritional composition of the bread produced from 100% WF and 50%:50% WF:PF blends were higher than that produced using the conventional APF. Thus, PF could be blended with WF to improve the nutritional quality and minimize cost of bread and other baked products.

Keywords: Bread, colony count, protein, fiber, flour, taste

INTRODUCTION

Bread is a major food since prehistoric era. It is a baked product of flour that is moistened, kneaded and sometimes fermented, with the addition of a variety of ingredients such as milk, water, salt, sugar, among others. Amidst all the baked product of wheat, bread is the most common and it is consumed by everyone from diverse cultures and socio-economic background, thus leading to its high daily demand (Inyang and Asuquo, 2016). Ijah *et al*. (2014) reported that bread ranked second to rice in the category of the most widely consumed non indigenous food. Bread is highly nutritive and it is a rich source of energy, vitamins notably the B-vitamin, dietary fiber, macronutrients (carbohydrates, protein and fat) and micronutrients (minerals and vitamins) that are necessary for healthy growth (Malomo *et al*., 2012; Ayoade *et al*., 2020).

There was a recent campaign on healthy eating which was targeted at utilizing indigenous products such as whole wheat, local cereals and legumes in baking industries (Therdthai and Zhou, 2014). Among the cereals and legumes employed in baking bread and other aerated baked products, wheat flour seems to be unique due to its content of gluten necessary to make raised dough. However, in few developing countries including Nigeria, the production of wheat is limited by unfavourable climatic conditions (Ayele *et al*., 2017; Nwanekezi, 2013). As a result of the limited production of wheat in Nigeria, wheat is being imported from foreign countries where it is grown in abundance to meet the demand by the populace. In 2011, Nigeria imported 4.1 million metric tons of wheat as reported by the US Department of Agriculture (Ayoade *et al*., 2020). This has no doubt impacted negatively on the economy of the Nation and her foreign currency reserves. The use of a blend of locally made flour in producing bread and other baked products will undoubtedly minimize the importation of wheat and thus promote the economy of Nigeria.

Despite the fact that there are large numbers of bread produced from composite flour such as blends of tropical cereal grain flours and some tubers, such bread still needs substantial amount of wheat flour to be able to make raised loaves (Ayo *et al*., 2014). The use of composite flour of wheat, plantain and soybeans in baking of bread has been reported (Olaoye *et al*., 2007). Okorie and Onyeneke (2012) opined that composite flour can be produced from legumes, nuts, roots and tubers such as yam, cassava and sweet potatoes. Sensory properties of yam and sweet potatoes flour was also reported (Okorie and Onyeneke, 2012). Kabira and Imungi (1991) reported that uncooked potato flour could be useful in baking bread and other cereal-based foods due to its long shelf life and high nutritional quality. Sweet potato flour is also a source of energy and can impart natural sweetness, flavour, colour and dietary fiber to processed food products (Idolo, 2011), and this makes it a promising candidate for partial replacement of wheat in baking industry (Ijah *et al*., 2014).

All-purpose flour also known as plain flour is a versatile and generally used flour that is produced from hard red wheat or a blend of hard and soft wheat, usually in the ratio of 80:20 (Fda, 2019). It is suitable for all types of baked foods such as bread, biscuits, pizza, cookies, among others, and is available commercially. All-purpose flour can also be combined with other types of flour to produce a variety of baked products. The nutritional and sensory quality of different locally made flour blends has been investigated (Ijah *et al*., 2014; Nazir and Nayik, 2016; Ayoade *et al*., 2020). However, there is paucity of information regarding the nutritional and sensory quality of bread produced from all-purpose flour.

Comparative analysis of the microbial, proximate and sensory quality of bread produced from all-purpose flour and blends of locally made flour was undertaken with a view to improve the nutritional quality and minimize importation of wheat in Nigeria, thereby reducing cost of bread and other baked products.

MATERIALS AND METHODS

Sample collection

All-purpose flour, wheat grains (hard red variety) and fresh cultivar of sweet potatoes (yellow Hannah variety) were purchased from Ose-Okwodu Market in Onitsha, Anambra State, Nigeria. The samples were transported in clean polyethene bags to the Microbiology laboratory of Nnamdi Azikiwe University, Awka, Nigeria, for processing and analysis.

Processing of potato flour

The potatoes were washed thoroughly to remove debris and carefully peeled to remove the back and then sliced into tiny forms. It was then sun dried, ground into powder (using pestle and mortar) and sieved through a 2mm sieve. The final product (flour) was stored in air tight container at 25^{o}C for further use.

Processing of wheat flour

The wheat grains were sorted to remove stones, after which they were washed in a stainless bowl with clean water, sun dried and ground into powder using pestle and mortar. It was sieved through a 2 mm sieve to obtain uniform particles. Finally, the flour was packaged and stored in air tight plastic bags at 25^{o}C for further use (Ayoade *et al*., 2020; Papageorgiou and Skendi, 2018).

Baking procedure

The baking process was carried out following the straight dough method (Chuahan *et al*., 1992). The baking formulations were as follows; all-purpose flour (APF) 500 g (100%), wheat flour (WF) 500 g (100%), potato flour (PF) 500 g (100%) and WF:PF blend (250 g : 250 g) (50%:50%). Other ingredients used include: 2% sugar, 0.5% salt, 36% of warm water, 1% of lightly beaten eggs, 2% melted butter, 2% yeast and 1% vegetable oil. The blend formulations and all ingredients were mixed in Havells mixer (Premio-i, India) for 5 minutes. The dough was transferred into clean stainless bowls, covered with a foil and allowed to ferment at room temperature for 1 hour. After fermentation, the dough was punched (to release excess gas), and shaped into baking pan, allowed to proof for 45 minutes and baked in gas convection oven (Empava 24 in. 2.3 cu. Ft. Single Gas Wall Oven, USA) at 250^{o}C for 30 minutes. The baked bread samples were then de panned, allowed to cool and stored in Ziploc bags at ambient temperature (25^{o}C) prior to analysis.

Microbial quality of the bread produced

Microbiological analysis of the bread samples was carried out within 24 hours of production using the method described in American Public Health Association (APHA. 2015). 1g of the baked bread samples was aseptically collected and dissolved in 9 ml of sterile distilled water. A serial dilution of up to 10^{-2} of the homogenate was made and 0.1 ml of the final dilutions were placed on the surface of solidified nutrient agar (NA), sabouraud dextrose agar (SDA) and MacConkey agar (MCA) plates. The NA and MCA plates were incubated at 37^{o}C for 24 to 48 hours for the enumeration of total viable bacteria and coliforms, while the SDA plates were incubated at 28^{o}C for 72 hours for total fungal (mould and yeast) enumeration. Pure cultures of the isolates were also obtained by subculturing onto the surface of freshly prepared and solidified media used for primary isolation. The bacterial isolates were identified using gram reaction and biochemical tests conducted with reference to the Bergey's Manual of Systemic Bacteriology (Krieg and Holt, 1994). Fungal isolates were identified using cultural and microscopic characteristics (Barnett and Hunter, 2000; Watanabe, 2002).

Proximate composition of the bread samples

The percentage moisture content, ash content, crude protein, crude fat and crude fiber were analyzed using the standard method of the Association of Official Analytical Chemists (AOAC, 2010). Total carbohydrate was determined using estimation by difference.

Sensory evaluation of the bread samples

The loaf colour, flavour, crumb texture, taste and general acceptability were the parameters used to assess the sensory quality of the bread samples. A 10 member panellists were recruited and trained for this study. They were supplied with questionnaires to score using the 9-point Hedonic scale (9-like extremely, 8-like very much, 7-like moderately, 6-like slightly, 5-neither like nor dislike, 4-dislike slightly, 3-dislike moderately, 2-dislike very much, 1-dislike extremely). Drinking water was given to the participants to rinse their mouths between evaluations (Nazir and Nayik, 2016).

Shelf life of the bread samples

This was carried out by visual observation of the bread samples at ambient temperature, for the presence of spoilage microorganisms (especially mould), so as to ascertain the period the bread would remain whole for the consumers and as well retaining most of the organoleptic properties (Jideani and Vogt, 2015).

Statistical analysis

Proximate composition of the bread samples and sensory scores of the panelists were subjected to one-way analysis of variance (ANOVA) using SPSS software version 20. The least significant difference (LSD) and Duncan multiple range test was used to separate the means at $p < 0.05$ level.

RESULTS AND DISCUSSION

Microbial quality of the bread produced

The result of the microbial quality of the produced bread revealed low bacterial and fungal counts in the APF, PF and WF:PF bread. No bacterial and fungal growth was observed in the plates containing WF bread (Table 1). In addition, no coliform was observed in all the bread samples, indicating no contamination with microorganism of faecal origin. The bacterial and fungal counts observed in some of the bread samples may be attributed to contamination arising from the baking environment and poor handling. In spite of this, the counts observed in all the bread samples were within the limits set by the Standard Organization of Nigeria, which stipulates ≤ 100 cfu/g for aerobic bacteria and zero coliform in bread and other baked products (|Ijah *et al*., 2014). Microbial identification revealed the presence of *Staphylococcus* sp., *Aspergillus* sp., *Rhizopus* sp. and *Saccharomyces cerevisiae* in the bread samples. Similar organisms have been reported as potential contaminants of bread (Ayoade *et al*., 2020; Ijah *et al*., 2014; Dzomeku *et al*., 2012) and could arise from the skin of the bakers and the baking or storage environment. For instance, *Staphylococcus* species are widely distributed in the environment and are found in the skin and nostrils of humans from where they can contaminate foods (Talaro and Talaro, 1993).

Table 1: Microbial quality of the produced bread

Bread Samples	Total bacterial count (x 10^2 Cfu/ml)	Total coliform count (x 10^2 Cfu/ml)	Total fungal count (x 10^2 Cfu/ml)
APF	0.07	0	0.05
WF	0	0	0
PF	0.09	0	0.04
WF:PF	0.02	0	0.01

Proximate composition of the bread samples

Proximate composition of the bread samples (Table 2) revealed that the moisture content of the PF bread was significantly higher ($p < 0.05$) when compared to the other flour blends. In addition, the moisture content of the WF bread was lowest and that could be the reason for the zero microbial count observed in the sample. Foods with low moisture content have lower enzymatic activities and reduced microbial growth and vice versa, thus moisture dictates the keeping quality of the food (Ajani *et al*., 2012). This result was also supported by the findings of Olaoye *et al*. (2006) who reported that moisture content of composite breads increased with non-wheat flour substitution due to its water holding capacity compared to the wheat flour.

The ash content of the PF bread was also significantly higher ($p < 0.05$) compared to the other flour blends. This indicates that potato flour is a good source of minerals needed for the body. Ash is the mineral or inorganic material in flour and despite not being regarded as a flour quality parameter in some bakers' specifications; it is a good indicator of bran contamination in white or refined flours (Posner, 2011). The APF bread recorded significantly lowest ($p < 0.05$) fiber content compared to the other flour blends. However, there was no significant difference ($p > 0.05$) between the fiber content recorded in WF, PF and WF:PF breads. The reasons for the low fiber observed in APF bread could be attributed to the constituents of the flour and the processing method. Besides APF bread, the dietary fiber content observed for other flour blends was above the 1.5% maximum allowable fiber content of bread flour recommended by Omole, reported by Ijah *et al*. (2014), but fell within the 2.0% recommended by the Nigerian Raw Materials Research and Development Council (Olaoye and Onilude, 2008). Dietary fiber is considered a nutrient of public health concern because low intakes are associated with potential health risks (Fda, 2016).

The protein content of WF bread was significantly higher ($p < 0.05$) than the rest of the flour blends. This was closely followed by the protein content of WF:PF bread which was also significantly higher ($p < 0.05$) than that obtained in APF and PF bread, while the APF bread recorded the lowest percentage protein content (Table 2). The low protein content recorded in the conventional APF bread called for concern about the constituents of the flour which is expected to be chiefly of wheat origin. Only the protein content of the WF and WF:PF bread exceeded the 10% minimum value recommended by the Food and Agricultural Organization and the World Health Organization (Ifesan *et al*., 2020). This implied that the bread produced with a blend of WF and PF (50%:50%) retained its nutrient content similar to the bread produced with 100% WF. This finding could be adopted by bakers to reduce the cost of baked foods occasioned by high cost of wheat in Nigeria and other countries where cultivation of wheat is hampered by unfavourable climate. Moreover, protein works as dough conditioners, structuring agents and moisture controllers in baking and high protein in baked foods is essential due to the recent low carbohydrate trend; hence protein is being considered as one of the key nutritional ingredients in baked foods (Fenema, 2017).

The fat content of the WF:PF bread was significantly higher ($p < 0.05$) than the rest of the flour blends. This was closely followed by the fat content of WF bread with no significant difference ($p > 0.05$) with that of the APF bread. However, PF bread recorded the lowest fat content (Table 2). The highest fat content recorded in WF:PF bread could be as a result of the presence of fat in the germ of wheat which contributed to the high content of fat when blended with PF. Similar result was reported by Ijah *et al*. (2014). The carbohydrate content of the APF bread was highest compared to the rest of the flour blends. However, the LSD and Duncan multiple range test revealed that there was no significant difference ($p > 0.05$) in the carbohydrate content of the APF and PF bread samples. Moreover, the carbohydrate content of the APF and PF bread samples were significantly higher ($p < 0.05$) than the WF and WF:PF bread with no significant difference ($p > 0.05$) between the latter. The similarity in the carbohydrate content of the WF and WF:PF blend further suggests that the bread produced with a blend of WF: PF (50%: 50%) retained its nutritional composition similar to the bread produced with 100% WF, thus could be adopted in baking industry to improve the quality, minimize importation of wheat and reduce the cost of baked foods. In general, all the produced bread recorded high (> 77%) carbohydrate content. This is good in baking industry because on heating starch granules in water, it swells and forms a gel which was vital in maintaining the normal texture and structure of baked products (Okorie and Onyeneke, 2012).

Table 2: Proximate composition (%) of the bread samples

Parameters	APF	WF	PF	WF:PF
Moisture	11.19 ± 0.21^a	3.87 ± 0.19^b	15.23 ± 0.09^c	10.93 ± 0.15^a
Ash	2.08 ± 0.10^b	2.17 ± 0.06^b	3.47 ± 0.24^a	2.83 ± 0.12^c
Fiber	0.85 ± 0.03^a	1.56 ± 0.03^b	1.51 ± 0.18^b	1.89 ± 0.22^b
Protein	7.7 ± 0.15^a	13.3 ± 0.15^b	8.3 ± 0.12^c	11.2 ± 0.25^d
Fat	5.32 ± 0.12^b	5.50 ± 0.15^b	3.04 ± 0.14^a	6.82 ± 0.16^c
Carbohydrate	84.05 ± 0.21^a	77.47 ± 0.32^b	83.68 ± 0.26^a	77.26 ± 0.25^b

Values are mean ± SEM. Mean with different superscripts within the row are significantly different at $p < 0.05$ level.

Sensory evaluation of the bread samples

The sensory scores of the 10 panelists based on a 9-point hedonic scale are presented in table 3. The APF bread had mean higher ($p < 0.05$) sensory scores in terms of colour, flavour and texture compared to the rest of the bread samples. However, there was no significant difference ($p > 0.05$) in the mean sensory scores of APF bread and WF:PF bread with respect to taste and overall acceptability. Apart from the PF bread, the rest of the bread samples recorded mean score above 5, with respect to colour, flavour, taste and overall acceptability. This indicates consumer interest and acceptance of all the produced bread except PF bread. The reason for the rejection of the PF bread may be due to the absence of gluten in potato which is expected to impart the desired structure to the bread. This agrees with the report that bread produced from non-wheat flours has the tendency to have hard crust and crumb structure of cake unlike the conventional bread (Ayoade *et al*., 2020).

Table 3: Sensory evaluation of the bread samples

Parameters	APF	WF	PF	WF:PF
Colour	8.0±0.32^{a}	7.2±0.10^{b}	3.7±0.26^{c}	6.5±0.25^{b}
Flavour	7.0±0.17^{b}	4.5±0.25^{c}	5.5±0.24^{d}	6.0±0.17^{d}
Texture	7.5±0.40^{a}	5.5±0.17^{b}	3.1±0.20^{c}	6.5±0.21^{d}
Taste	7.0±0.10^{b}	6.0±0.10^{a}	4.5±0.17^{c}	7.0±0.26^{b}
Overall acceptability	8.0±0.24^{a}	6.0±0.40^{b}	4.1±0.21^{c}	8.0±0.12^{a}

Values are mean ± SEM. Mean with different superscripts within the row are significantly different at $p < 0.05$ level.

Shelf life of the bread samples

Figure 1 depicts that the PF bread had the highest shelf life of 8 days followed by the WF:PF bread with a shelf life of 7 days. Among the bread samples, APF bread had the lowest shelf life of 5 days. This suggests that the blending of WF with PF improved the shelf life of the bread and could be adopted in baking industry. The long shelf life observed in PF bread and WF:PF blend could be due to their ability to retain moisture and reduce staling that could encourage microbial growth. This finding was supported by the report that uncooked potato (though a tuber) flour has a long shelf life and high nutritional quality which could be exploited in cereal based human diet, including bread (Kabira and Imungi, 1991).

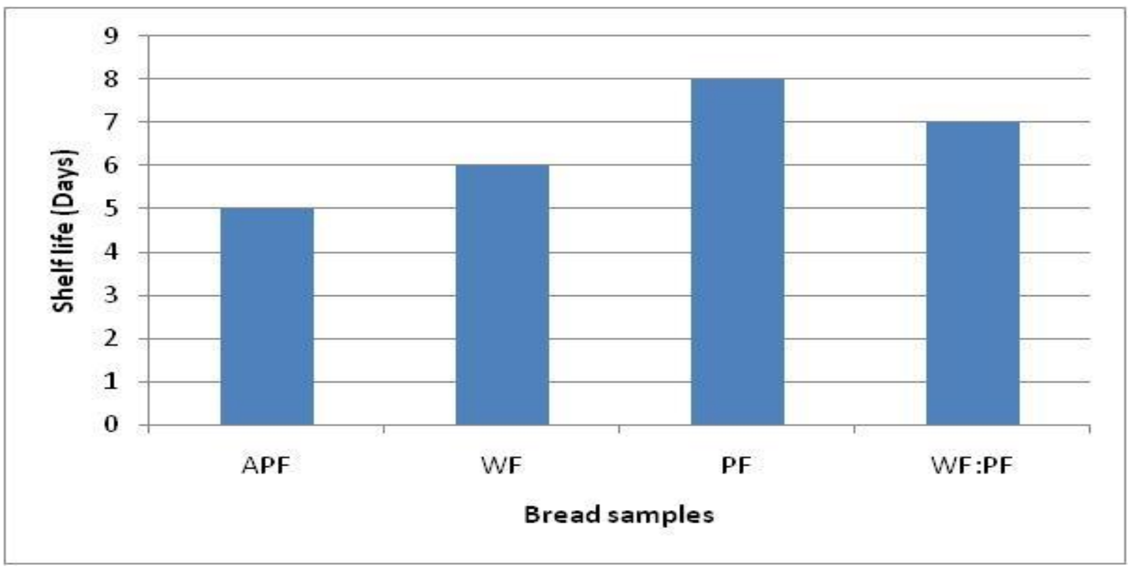

Figure 1: Shelf life of the bread samples

CONCLUSIONS

The bread produced in this study was generally safe for human consumption as there was no evidence of faecal contamination. However, adequate measures should be taken to improve the hygienic conditions of the bakers' and the baking or storage environment to eliminate microbial contamination. The nutritional compositions of the bread produced from WF and WF:PF blend were higher than that produced using the conventional APF. Thus, PF could be blended with WF in baking to improve the nutritional quality, minimize the importation of wheat and reduce cost of bread and other baked foods. This will also enhance the shelf life of the bread as well as the flavour, taste, texture and general acceptability.

Conflict of Interests
Authors declare that they have no conflict of interest

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