Utritional and sensory profiles of functional breads produced from partial substitution of wheat flour by pigeon pea flour (*Cajanus cajan*)

Abstract

The present study aims to formulate and develop functional breads from wheat and pigeon pea flour and evaluate their nutritional and sensory qualities. Indeed, different composite bread formulations have been made by partial substitution of wheat flour with pigeon pea flour in varying proportions (10%, 20% 25% 50%), and the nutritional and sensory characteristics of the different breads produced were evaluated. Results obtained indicated that the protein content of the composite breads significantly increases ($p < 0.005$) according to the rate of the pigeon pea flour incorporation. However, results from the evaluation of sensory characteristics indicated that only composite breads result from the incorporation rate of 10% of pigeon pea flours have organoleptic characteristics appreciated by the panel of tasters. These results therefore underline that the perception and opinion of consumers are very important parameters to be taken into account in any innovation process in the field of food technology.

Keywords : functional breads, pigeon pea, sensory profile, consumers perception, Benin

Introduction

According to Dewettinck et al. [1] and Alam et al. [2], bread is described as a fermented product obtained from wheat flour, yeast, water, and salt by a series of process involving mixing, kneading, proofing, shaping and baking. Nowadays, the consumption of bread is very

popular, but the low protein content of wheat flour, has been major concern in its utilization [3; 4]. Alam et al. [2] reported that the need of consumers to eat quality and healthy foods known as functional foods, which contains ingredients that can provide additional health benefits, is increasing nowadays. Therefore, researches should more focused on the production of specialty breads (functional foods) made from wheat flour and other functional ingredients such as proteins. In fact, according to the FAO [5], more than 850 million people suffer from undernourishment in the world. In sub-Saharan Africa, the problem of food arises in terms of quantity and quality for more than a third of the population [6]. Faced with this situation, it has been suggested that the diversity of food from plants origin which abound in African countries could be a solution [7]. Unfortunately, the large part of this important resource is underexploited or neglected [8]. However, several researches reported that these plant resources have considerable potential that could increase food production and contribute to poverty reduction [9]. Among these plant species, legumes are nutritious foods that could replace proteins from animal origin [10]. Legumes are also source of dietary fiber, with high levels of vitamins and minerals [11]. Pigeon pea (*Cajanus cajan* (L.) is an important legume cultivated in the tropics, including semi-arid areas [12]. It is mainly grown for its grains whose nutritional value, is comparable to that of beans (*Phaseolus vulgaris*) [13]. It is also known as an excellent source of protein (21.7%), a good source of energy, vitamins and essential amino acids such as lysine, phenylalanine, valine, leucine and isoleucine [12]. The seeds are rich in fatty acids, such as linoleic and palmitic acids; and are also a good source of iron and calcium [14]. Then, the fortification of bread with legume flours particularly in regions where protein utilization is inadequate, could help in reducing the incidence of malnutrition, and also encourage farmers to grow more legume [15]. Then, the aim of this study was to formulate and develop functional breads from wheat flours and pigeon pea flour

and to evaluate their nutritional and sensory qualities, as well as consumers overall acceptability.

Material and methods

Raw materials and preparation of composite flours

Wheat flour, pigeon pea flour, sugar, iodized salt, yeast, spice and other general ingredients were purchased from the local market. The composite flour was prepared by using wheat and pigeon pea flours in different proportions as described in Table 1.

Table 1. Quantity of ingredients (g) used for different bread samples

Sample	*Wheat flour*	*Pigeon pea flour*	*Salt*	*Sugar*	*Fat/ Shorting*	*Yeast*	*Spice*	*Water*
Control	100	00	2	6	4	2	1	65
Sample A	90	10	2	6	4	2	1	65
Sample B	80	20	2	6	4	2	1	65
Sample C	75	25	2	6	4	2	1	65
Sample D	50	50	2	6	4	2	1	65

Bread making

The method used for bread samples making is those described by Islam et al. [15] and Ndife et al. [16] as follow: wheat flour and pigeon pea flour were mixed and blended with other baking ingredients in a mixer. After kneaded into consistent dough, it was molded and placed in a pre-oiled baking bowl. The dough was after that proofed for 45 to 60 min at 35°C and 85% relative humidity and then baked in a reel oven for 35 min at 217°C.

Physicochemical and sensorial analyses

Physicochemical composition of the bread samples such as protein and ash contents were determined by methods described by AOAC [17]. Sensory evaluation of the composite bread

samples was carried out by 30 panelists on hedonic scale for different parameters such as colour, aroma, taste, texture and relative acidity as described by Ihekoronye and Ngoddy [18].

Statistical analysis

The data generated from these studies were analyzed using Statistical Analysis Software (SAS) and SYSTAT 5.05. The statistical analyses carried out were mean and standard deviation and analysis of variance.

Results and discussion

Table 2 presented the results of the protein and ash contents in the various functional breads produced. The analysis of these results indicated a significant variability ($p< 5\%$) at the level of the Protein and Ash contents in the different breads produced. Indeed, the highest levels of protein and ash are obtained with the breads having the highest proportions of pigeon pea flour. This increase in the protein and ash contents in breads produced could be due to the protein and ash contents of the pigeon pea flour used. Similar results are reported by Ndife et al. [16] and Alam et al. [2] in breads obtained by partial substitution of wheat flour by soybean flour. Diallo et al. [19] also reported an increase in protein content in breads obtained from partial substitution of wheat flour by Voandzou flour (*Vigna subterranea* L. verdc). Results of the sensory analysis of the different types of bread produced revealed that the incorporation of pigeon pea flour modified the sensory characteristics such as color, aroma, texture, taste and acidity of the breads obtained, compared to the control (Figures 1-6). However, the effect of these sensory modifications is depending on the proportion of pigeon pea flour used. Only the “A” bread samples have sensory characteristics close to the control samples (Figures 4 and 5).

These results therefore show that, whatever the parameter considered (color, aroma, texture, taste and acidity), the breads obtained with pigeon pea flour incorporation rates of 25% and 50% presented poor organoleptic characteristics (pronounced color and aroma, more

rigid texture, perceptible acidity), compared to the control. However, very pleasant acidity and texture were observed in the breads obtained with an incorporation rate of 10% pigeon pea flour. Similar results were reported by Olanipekun et al. [20] who pointed out that the incorporation of other types of flours in the manufacture of wheat bread affects the overall acceptability of the breads produced. The same remarks were reported by Ouazib [21] during the evaluation of the effect of the partial substitution of wheat flour by chickpea flour on the quality of bread.

The results of this study therefore show that despite the high protein levels observed in the breads obtained from the incorporation rates of 50%, 25% and 20% pigeon peas, the results of the sensory analyzes are not reassuring as to their consumer acceptability. This observation therefore raises the issue of the acceptability of new food products by consumers. Indeed, for a new product to be adopted, it must first be acceptable to consumers [22] and this acceptability must be assessed by taking into account sensory information and non-sensory information [23].

However, according to Masson [22], studying the acceptability of a new food product with a view to placing it on the market is not enough to predict its adoption, because the adoption of an innovation by consumers always involves a temporal dimension which makes its study more complicated. Thus, marketing research has most often involved unique and immediate measures of attitude, preference or purchase intention [24]. However, food science research has shown that immediate preferences are a weak predictor of final choice [25] and consumption behavior [26], because preference evaluations change over time [27]. Similarly, the different degrees of perceived novelty of the innovation can influence its evaluation and adoption by consumers [22]. Indeed, it has been shown that new products are tried more by people led by their own norms and values (individualists), than by people led by the values and norms of society (conformists). Thus, if the difference between innovation and the

products of the category is large, the greater will be the difference in the answers between the conformists and the individualists. This explains the fact that slightly different innovations are adopted more quickly because the compatibility is greater. As a result, everyday consumer goods very often have a stronger purchase intention for products perceived as very new.

Table 2. Protein and ash contents of different functional breads produced

Samples	***Protein (%)***	***Ash (%)***
A	15,75±1,06[a]	3,81 ± 0,32[a]
B	16,27±0,38[b]	3,84 ± 0,22[a]
C	17,22±1,38[c]	3,91 ± 0,12[b]
D	17,50±0,70[c]	3,92 ± 0,31[b]

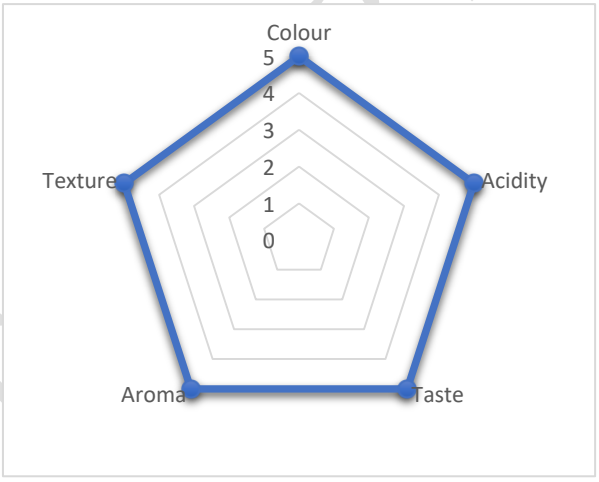

Figure1. Sensorial profile of functional breads produced from partial substitution (50%) of wheat flour by pigeon pea flour

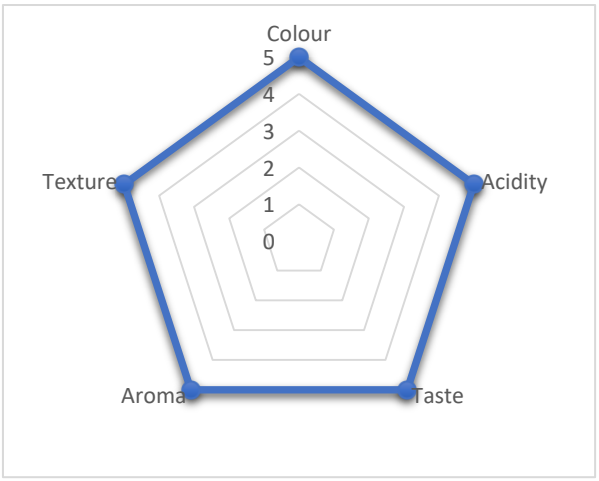

Figure 2. Sensorial profile of functional breads produced from partial substitution (25%) of wheat flour by pigeon pea flour

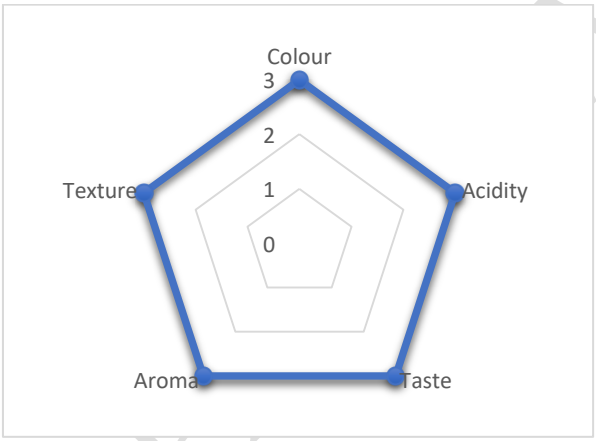

Figure 3. Sensorial profile of functional breads produced from partial substitution (20%) of wheat flour by pigeon pea flour

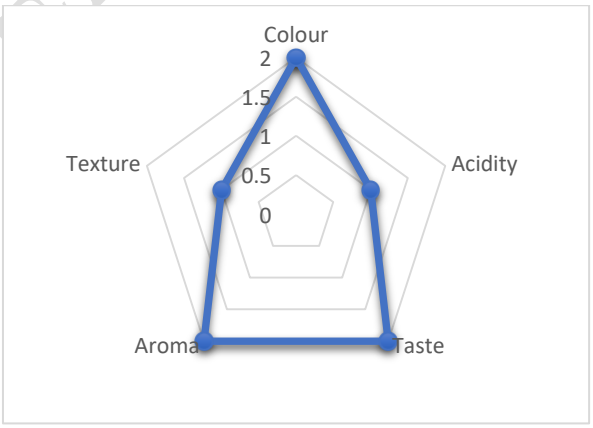

Figure 4. Sensorial profile of functional breads produced from partial substitution (10%) of wheat flour by pigeon pea flour

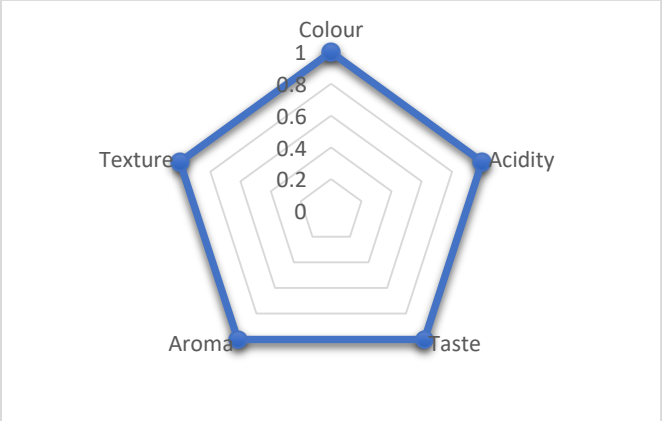

Figure 5. Sensorial profile of breads produced with wheat flour (Control)

Conclusion

Functional breads from wheat and pigeon pea flours were found to have a good nutritional profile. However, they presented poor organoleptic characteristics (pronounced color and aroma, more rigid texture, perceptible acidity), excepted for the breads obtained with an incorporation rate of 10% of pigeon pea flour which have a very pleasant acidity and texture. These results therefore underline that the perception and opinion of consumers are very important parameters to be taken into account in any innovation process in the field of food technology.

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