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RESEARCH ARTICLE

Effect of added wheat flour on physico-chemical and sensorial properties of "Bebergou"

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Abstract

Bebergou, named African pizza, is a traditional dish that is produced with bean flour dough. Although it is widely consumed in Togo, it is still considered as poor people food. The characteristics of the bean flour dough males it difficult to mix it with others ingredients. This study was carried out to evaluate the effect of added wheat flour on the physico-chemical and sensorial properties of bebergou. The amount of water used during the production, the physico-chemical and sensorial properties were assessed. The quantity of water was significantly ($p<0.05$) reduced from 150% to 43%. The hardness of the dough did not show any significant difference within the samples. The extensibility of the dough was improved with the addition of wheat flour from 13.21 mm for W0B5 (sample without wheat flour) to 26.47 mm for W3B2 (sample with high amount of added wheat flour). The sensory attributes were found to increase with the addition of wheat flour. The sample with the highest amount of wheat flour obtained more than 7 as score for the overall acceptability, which means that W3B2 was liked by the panelists. The improved quality of bebergou, African pizza, with added wheat flour might increase it consumption but it might be interesting to explore the nutritional quality in a way to increase again its acceptability.

Key words: Bebergou, water amount, texture, colour, sensorial attributes.

1. Introduction

Dry beans are an important food for the nutrition of people with low-incomes. *Phaseolus vulgaris* L., called common beans, is a widely grown crops food in many areas of African countries (Ferris & Kaganzi, 2008). Legumes are considered as the poor people meat due to the fact that it is cheap and rich in protein. It was reported that the consumption of grain legumes improved the protein profile in cereal-based diets (Iqbal et al., 2003). Beans are consumed in Africa through different cooking methods. Beans can be cooked in combination with rice (Wilk & Barbosa, 2012). The dish is named Atassi in Benin, Waakye in Ghana (Madodé *et al.,* 2011) or ayimolu in Togo (Teko *et al.,* 2022).

The beans can be cooked alone in different dishes with or without seasoning. Boiled beans, named veyi, in Ghana, Benin and Togo, are eaten with gari and oil (Quaye *et al.,* 2009). The decorticated beans were boiled to obtain a puree which is named adowè in Togo, Benin and Nigeria, and it is seasoned with salt and oil before eating. Dry beans can be milled or wet bean can be decorticated then milled to produce the dough which is fried to obtain Ata (Benin), Akara (Nigeria), or Koose (Ghana) and Gawù (Togo). The dry-milled flour is used to prepare alèlè (Benin, Togo), Moinmoin (Nigeria), or Koki (Cameroon) and Timbani (Togo) (Madodé *et al.,* 2011). The same flour is also used to prepare

another dish more popular in Togo. It's named bebergou in the village of Niantogou, in North Togo, (Prefecture de Doufelgou) where it seemed to have its origin. It's named kpedzigawu in éwé (South of Togo) and also katandéou in Kabye (North of Togo). Generally, it is called in French as "pizza africaine" which means "African pizza" in English. This dish is made with dough obtained by mixing bean flour with unknown quantity of salted water up to obtain a specific consistence according to each producer. Then the dough is cooked on a rounded metallic plate to obtain the bebergou. During the cooking water will be evaporated from the dough and the final product, bebergou, will have a particular consistency which is not standardized. According to the European pizza, others ingredients are used to have different tastes (Onderi, 2013). This is not possible in the case of the bean dough due to the fact it is to liquid. That doesn't allow improving the acceptability of this bebergou which is still considered as for poor people. Therefore, the aim of this study was to explore the effect of added wheat flour on the physico-chemical and sensorial properties of "bebergou", African pizza.

2. Materials and Methods

2.1. Materials

2.1.1. African pizza ingredients

African pizza dough formulation was made with bean flour, wheat flour, yeast, sunflower oil (Bonita, Monline, UK, Turkey) and salt. All the ingredients were bought in a local market at Lomé, Togo.

2.1.2. Samples preparation

The dough was made according to the modified method of Onderi (2013) (Table 1). Two controls were prepared and according to the total weight without water they were composed of: wheat flour (92.4%), yeast (2.1%), salt (0.8%) and sunflower oil (4.7%) (W5B0) and bean flour (92.4%), yeast (2.1%), salt (0.8%) and sunflower oil (4.7%) (W0B5). The others samples were made by adding 40, 50 and 60% of wheat flour (Table 1).

Table 1. African pizza dough and controls formulations with their symbols

Ingredients	W5B0 (%)	W0B5 (%)	W2B3 (%)	WB (%)	W3B2 (%)
Wheat flour (W)	92.4	0	37.0	46.2	55.4
Bean flour (B)	0.0	92.4	55.4	46.2	37.0
Salt	0.8	0.8	0.8	0.8	0.8
Yeast	2.1	2.1	2.1	2.1	2.1
Sunflower oil	4.7	4.7	4.7	4.7	4.7
Total	100	100		100	

2.2. Methods

2.2.1. Moisture content in African pizza dough

The quantity of water was measured using the precision balance, ADAM Nimbus NBL 423e scale 420g ± 0.001g. The amount of water used for the production of normal African pizza was weighted on the balance before using, in manner to have an idea concerning the amount of the water used to prepare the dough of the bebergou. At less 3 (three) replications were done.

2.2.2. Colour

The colour parameters L* (Lightness), a* (degree of redness) and b* (the degree of yellowness) of African pizza dough were measured with a CIELAB colorimeter (CM 2600d, Minolta Co., Osaka, Japan) equipped with D65 at 10° position of the standard observer. Differences of colour between samples (W5B0 vs W0B5; samples with added bean flour vs W5B0) were evaluated using the ΔE value that was calculated with the following equation:

$$\Delta E = \sqrt{(\Delta L*)^2 + (\Delta a*)^2 + (\Delta b*)^2}$$

The resulting ΔE value can be used to evaluate if the different colour is perceivable by the human eye; the higher the value, the higher the differences between samples due to addition of bean flour and the reference (STD) (Limbo & Piergiovanni, 2006). At least twelve measurements were taken for each dough sample.

2.2.3. Texture

Dough texture was measured using TA.TX2 Texture Analyzer equipped with a 25 kg load cell (Stable Micro systems, Goldalming, UK). The modified method of Bejosano *et al.* (2005) was used. The test was conducted in compression mode using a spherical probe which has 2 cm of diameter. Pre-test, test, and post-test speeds were adjusted to 2.0 mm/sec, 1.0 mm/sec, and 10.0 mm/sec, respectively. The distance was considered as a target mode and was fixed to 40 mm. Samples with 9 x 9 cm were subjected to the compression up to the complete rupture. Force at rupture (maximum force [N] required to shear the sample) and extensibility (deformation at breakage [mm]) were obtained. At less ten replications were done for each fresh dough.

2.2.4. Sensorial analysis

Sensory analysis of African pizza was done using a hedonic test. African pizza was nominated with three 3-digit random codes before being given to the panellists in a random way. The four African pizza were given to 34 untrained panellists asking them to assess the texture, flavour, colour and overall acceptability of samples using a 9-point hedonic scale where 1 = dislike extremely, 2 = dislike very much, 3 = dislike, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like, 8 = like very much and 9 = like extremely.

2.2.5. Statistical analysis

Significant differences ($p \leq 0.05$) among different samples were assessed by one-way-analysis of variance (ANOVA) with a Tukey and LSD post-hoc test. A SPSS software statistical analysis was (Version 29.0.1.0, IBM SPSS Statistics, Armonk, New York, USA) was used for all analyses.

3. Results and discussion

3.1. Moisture content in African pizza dough

The quantity of water used to prepare African pizza was measured and it resulted to be about 148.38 ± 2.81 % (g of water / 100 g of flour) according to the quantity of bean flour. This quantity of water content makes the dough very liquid and its consistency doesn't allow to addition other ingredients like it is done in European pizza. For that reason, we reduced the water content to 43% according to normal Italian pizza formulation (Onderi, 2013).

3.2. Effect of added wheat flour on the colour of African pizza dough

The colour of African pizza dough with different formulation is shown in table 2. The degree of yellowness, b*, for wheat and bean dough was 18.69 ± 0.95 and 19.49 ± 1.40, respectively, but it

was 18.43 ± 1.07, 18.81 ± 1.01 and 18.99 ± 0.65 for W2B3, WB and W3B2, respectively. However, the degree of yellowness did not show a significant difference amongst samples. Concerning the degree of redness, a*, the dough with wheat presented the smallest value (3.02 ± 0.25) and was significantly different compared to W2B3, WB and W3B2. These samples presented a low degree of redness as compared to W0B5 which had the highest value. The Lightness of the dough was increased by the presence the of wheat flour as it was expected. The changes in the colour parameters of the dough due to the presence of added wheat flour were also mentioned in the studies concerning the addition of different legumes to wheat flour (Anton *et al.,* 2008). However, these changes in the bean flour dough were positively accepted due to the improvement of the lightness parameter. The total colour difference, ΔE, highlighted the acceptability of the changes into the colour parameters due to the addition of wheat flour. The ΔE value was higher in W0B5 (13.81 ± 1.75). The other samples presented ΔE of 8.36 ± 1.14, 7.10 ± 1.37 and 6.11 ± 1.58 for W2B5, WB and W3B2, respectively. Concerning the highest ΔE value in W0B5, which was more than 12 (Limbo & Piergiovanni, 2006), it indicates that its colour was different as compared to W5B0. However, the others samples had their value between 6 < ΔE < 12 indicating that there was a strong difference. The difference in colour of bean flour dough might be associated to the presence of all constituents of the bean grain because the whole bean grains were grinded.

3.3. Effect of added wheat flour on textural attributes of bean flour dough

The textural attributes of the formulated and prepared pizza are reported in figure 1. The

Table 2. Colour parameters of African pizza dough with different formulations

	L*	a*	b*	ΔE
W5B0	79.45 (0.75) a	3.02 (0.25) c	18.69 (0.95) a	-
W0B5	65.78 (1.39) d	4.47 (0.26) a	19.49 (1.40) a	13.81 (1.75) a
W2B3	71.30 (1.18) c	3.70 (0.37) b	18.43 (1.07) a	8.36 (1.14) b
W B	72.51 (1.21) bc	3.64 (0.30) b	18.81 (1.01) a	7.10 (1.37) bc
W3B2	73.55 (1.58) b	3.48 (0.17) b	18.99 (0.65) a	6.11 (1.58) c

Standard deviations are given in parenthesis following the means values; different letters near the value indicate significant difference among samples ($p \leq 0.05$) due to the formulation

hardness measured as the force at the rupture, figure 1A, resulted to be significantly higher in samples containing wheat flour wheat flour than those with the bean flour. However, the hardness of W0B5 dough was lower than that of the others samples. There was not significant difference amongst samples containing wheat flour compared to W0B5. The extensibility, measured as the distance at the rupture, was significantly lower in W0B5 than other samples containing part of wheat flour. The dough became more extensible as the amount of wheat flour increases. However, it is important to report that the dough

of wheat flour did not break before the end of the all test, but we considered the maximal distance of the test, which was 40 mm. The difference might be associated to the fact that bean flour dough could not develop the gluten network because beans don't content glutenin and gliadin proteins which are able to form gluten network. Onderi, (2013), reported that pizza samples containing different gluten free ingredient showed lower hardness value than samples with wheat flour. According to Mohammed *et al.* (2012), the incorporation of chickpea flour in wheat flour dough induced a reduction of the extensibility of the dough. The improvement of the extensibility of bean flour dough with the addition of wheat flour might be important for the production of African pizza because it will be easy to manipulate and to extend in a way to have a pizza form like Italian pizza. These textural results, combined to the reduced amount of water during the preparation of the dough are going to be a relevant innovation in African pizza, due to the increase in nutrient properties. This might be associated to the important nutritional constituents into bean flour (Uebersax *et al.,* 2022; Sulieman et al., 2013; Ndife et al., 2011; Shehata *et al.,* 1988).

3.4. Effect of added wheat flour on sensorial analyses of African pizza

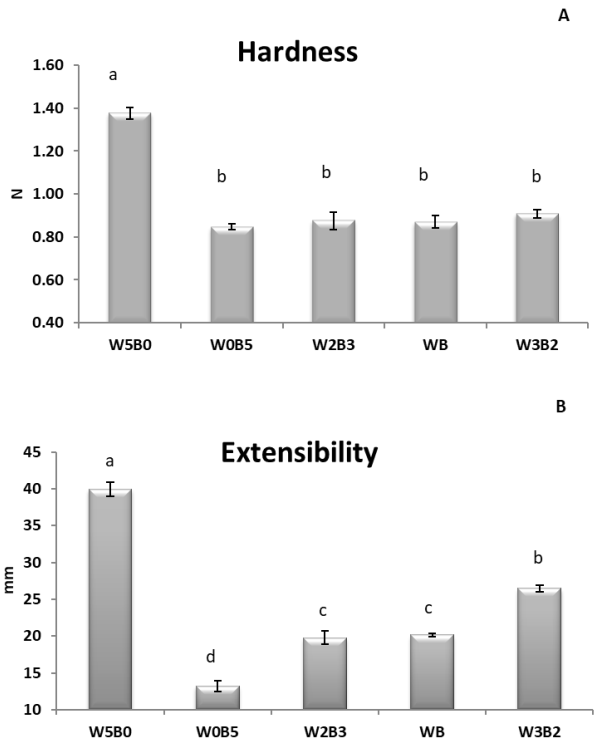
The results of sensory attributes of African pizza assessed by the panellists are shown in Table 3. The pizza W0B5 showed the lowest score for all sensorial attributes. All panellists disliked slightly (the score was more than 4 but less than 5) the texture, flavour and overall acceptability, but they neither liked nor disliked the colour. The addition of wheat flour improved all the sensorial attributes assessed in this study, and the value

Table 3. Sensorial parameters of African pizza dough with different formulations

	Texture	Flavour	Colour	Overall acceptability
W0B5	4.74 (1.93)	4.41 (1.67)	5.53 (1.73)	4.91 (1.75)
W2B3	5.71 (1.43)	5.35 (1.61)	6.15 (1.48)	6.18 (1.31)
W B	6.03 (1.38)	6.12 (1.15)	6.41 (1.16)	6.62 (1.13)
W3B2	6.79 (1.01)	6.56 (0.93)	6.82 (0.87)	7.29 (1.09)

Standard deviations are given in parenthesis following the means values

increased with increasing amount of wheat flour. The panellists slightly liked the colour and overall acceptability (score 6) but they neither liked nor disliked the texture and flavour of W2B3. All sensory attributes of WB obtained more than 6 as scores meaning that the panellists slightly liked the sample. The overall acceptability of W3B2 scored more than 7 indicating that the panellists liked that sample. The rest of attributes of W3B2 were liked slightly by the panellists but the score was more than 6.6 for these attributes. This result is interesting and suggests that the addition of wheat flour to bean flour during the production of African pizza might improve the acceptability of the product by consumers that consider African pizza as dish for poor people.



Different letters indicate significant differences among samples ($P \leq 0.05$).

Figure 1. The hardness (A) and the extensibility (B) of African pizza dough made with different level of added wheat flour.

4. Conclusion

The reduction of the water amount during the production of the bean flour dough might improve the quality of the dough with the possible addition of others ingredients, as cheese, tomato sauce, etc.... The addition of wheat flour to bean flour was found to enhance the physico-chemical and sensorial properties of African pizza. The acceptability of African pizza with added wheat flour might increase its consumption and this will be added value for this dish which was considered as for poor people. It might be interesting to explore the nutritional quality in a way to increase it acceptability.

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Conflict of interest

The authors declare that there are no conflicts of interest.

Ethics

This Study does not involve Human or Animal Testing.

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