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Nutritional and sensory quality of two types of *Ablo* from local cereals of which sorghum (*Sorghum bicolor*) and millet (*Pennisetum glaucum*) largely cultivated in Benin

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Abstract

Ablo is wet bread, slightly salty and sweet, steamed and sold in the form of pellets. The study aims to assess the nutritional and sensory quality of two types of Ablo from local cereals of which sorghum and millet widely cultivated in Benin. The methodology adopted was to perform production test followed by analyses in the laboratory. The results showed that both Ablo (millet-based Ablo and sorghum-based Ablo) were acid and respectively had an average pH of 4.23 ± 0.15 and 4.26 ± 0.09. They did not contain lead or cadmium. The two new types of Ablo manufactured had very strong energy values (68.02 ± 1.53 to 187.62 ± 2.30 Kcal/g) and contain essential nutrients for the body including the proteins (7.84 ± 0.18 to 12.83 ± 0.578 mg/g), the sugars (162.33 ± 2.68 to 457.65 ± 1.53 mg/g), the iron (207.25 ± 0.75 to 360.30 ± 4.72 mg/g) and the vitamins (A, B1, B2 and C). They had an acceptable nutritional quality and were generally accepted by the tasters. In the light of the results, the millet-based Ablo and the sorghum-based Ablo can be recommended to consumers.

Keywords: *Ablo, millet, nutritional value, sorghum, Benin*

1. Introduction

A well-fed body resist to most diseases and external aggression (UNICEF, 1998). Often, the first remedy to combat certain diseases is to feed the sick well. This is even more true for preventing disease. The best preventative medicine for a population is first to be well fed. In addition, if the population is well-fed, actions of public health and prevention (hygiene, vaccinations, deworming, etc.) have increased efficiency. Mortality also depends on feeding. A good diet has a positive effect on the life expectancy of a population (Laure, 1983).

Benin, peopled of about 10 million inhabitants according to the Census of 2013 (INSAE, 2013) extends over an area of 114 673 km². It knows a strong demographic growth, and its economy is based on agriculture, which contributes to 38% interior raw program by occupying 80% of the active population. Fermented foods are much consumed. Fermented food products are particularly used as products of weaning for small children (C. M. Kalui *et al.*, 2008, C. K. C. Tchekessi *et al*., 2013)

The fermentation process increases the food conservation. These fermented foods have nutritional assets and, in some cases, provide protective elements towards the bacterial agents eventually present. There are a multitude of products, forms and presentations: Gowé, *Ablo*, Dèguè, Akpan, Abotin or even Akassa are only a few examples of multiple local varieties (C. K. C. Tchekessi, 2015; A. I. Angelov *et al*., 2017).

This study focused on *Ablo* which is a moist bread shaped ball, very consumed in Benin, especially in large cities (A. N. R. Ahoyo *et al*., 2013; V. Dansou, 2013; P. Houssou *et al*., 2014; A. Aboudou *et al*., 2014; P. Houssou *et al*., 2015). The study aims to assess the nutritional and sensory quality of two types of *Ablo* from local cereals of which sorghum grain and millet grain widely cultivated in Benin.

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2. Materials and methods

The productions were made at the research unit in safety health food (URSSA) of the laboratory of Microbiology and of the food Technologies (LAMITA) at the Faculty of Science and Technology (FAST) of the University of Abomey-Calavi (UAC).

2.1 Materials

2.1.1 Plant material

Sorghum (*Sorghum bicolor)* of red color designated in local language fongbé by "abokun" and the small millet (*Pennisetum glaucum*) of greenish color called "likun" in fongbé language were used. Wheat flour also served as plant material. These cereals were purchased at Dantokpa, Cotonou's international market.

2.2.2 Biological material

The instant yeast (*Saccharomyces cerevisiae*) of trademark PASHA made in Turkey by DOSU MAYA MAYACILIK A.S. Company certified ISO 9001: 2008 has been used. It was purchased at the Dantokpa, Cotonou's international market. It is used as a leaven in the manufacturing technology of the *Ablo* (K. F. Ahokpe, 2005; A. M Aholou-Yeyi, 2007; I. Y. Bokossa *et al*., 2013).

2.1.3 Laboratory equipment

The equipment consisted of classical material used for physico-chemical handling.

2.1.4 Other materials

The material used for the different manufacturing consisted of ingredients (sugar, salt) and standard production equipment of the *Ablo* such as basins, plastic buckets, pots, spatula, whip, mill, one sieve and a fireplace. The water of the national water society of Benin (SONEB) was also used.

2.2 Methods

2.2.1 Experimental method

The production tests were conducted according to the original method described by A. M. Aholou-Yeyi (2007) modified. The difference in this technology was the use of other types of cereals such as millet and sorghum and the reduction of the fermentation time. Each test was repeated three times in the laboratory. The samples were taken from finished products and the various analyses were performed on these samples.

2.2.2 Physico-chemical analysis

They consisted in the determination of the dry matter, water content, pH, titratable acidity; the dosage of proteins, total sugars, reducing sugars, lipids, zinc, copper, cadmium, of lead, iron, and vitamins (A, B1, B2 and C). The physicochemical analyses were performed in three repetitions on each sample.

2.2.2.1 Rate of dry matter and water content

The dry matter content was determined according to the method AACC44-15A (AACC, 1984). The water content has been deducted by the above formula:
Dry water (%) = 1 - matter content (%)

2.2.2.2 pH and titratable acidity

The pH and titratable acidity were determined according to the modified method described by M. J. R. Nout *et al*. (1989).

2.2.2.3 Protein content

The crude protein content was determined according to the Kjeldahl method (AACC, 1984).

2.2.2.4 Determination of total sugars

Total soluble sugars were determined according to the method of M. Dubois *et al*. (1956).

2.2.2.5 Determination of reducing sugars

The reducing sugars were determined by the method of Y. N. Njintang and C. M. F. Mbofung (2003).

2.2.2.6 Determination of the rate of fat

The lipid content was determined in the Soxlhet according to the AACC method (1984).

2.2.2.7 Content of heavy metals and micro elements

The amounts of heavy metals and microelements contained in the two types of *Ablo* were determined according to the method described by L. B. Lawani (2007).

2.2.2.8 Levels of vitamins A and C

The levels of vitamins A and C were determined by the method described by C. K. C. Tchekessi *et al*. (2014).

2.2.2.9 Vitamins B1 and B2 levels

The levels of vitamins B1 and B2 were determined by the method described by A. Benmoussa *et al.* (2003).

2.2.2.10 Estimation of the energy of the products value

The energy value of products was determined by the method described by V. J. Zannou-Tchoko *et al.* (2011).

2.3 Sensory analysis

The test of acceptability of various manufactured products has been done under the terms of the comparison test and preferably described by (E. Larmond, 1977; I. Y. Bokossa *et al.*, 2011 and C. K. C. Tchekessi, 2015).

2.4 Statistical analyses of the data

The collected data were analyzed using SPSS 16 and MINITAB 14 software. MINITAB 14 software had been used to check the conditions of application of the statistical tests. These were made with the software SPSS 16 which helps to do the analyses of variance (ANOVA) and Tukey test for the comparison of averages. The chosen significance level was 5% $p < 0.05$.

3. Results and discussion

3.1 Results

The average values of pH, titratable acidity and dry matter of millet-based *Ablo* were lower than those of the sorghum-based *Ablo* (table 1). But this difference was not significant statistically. On the other hand, the values of the water between the two types of *Ablo* content varied significantly on the threshold of 5%. The millet-based *Ablo* and the sorghum-based *Ablo* respectively had a pH mean of 4.23 ± 0.15 and 4.26 ± 0.09 (table 1).

Table 1: Average values of pH, titratable acidity, dry matter and water content of the millet-based *Ablo* and the sorghum-based *Ablo*

Types of *Ablo*	Average values of the search parameters			
	pH	Titratable acidity (%)	Dry matter(%)	Moisture content (%)
Millet-based *Ablo*	4.23 ± 0.15[a]	2.01 ± 0.16[a]	37.57 ± 1.39[a]	62.43 ± 1.39[a]
Sorghum-based *Ablo*	4.26 ± 0.09[a]	2.2 ± 0.17[a]	38.06 ± 1.46[a]	61.94 ± 1.46[a]
P-value	0.14	0.19	0.19	0.00

The average values of the same letter in the same column are not significantly different at the 5% threshold.

Table 2 showed the results of the nutritional analysis of the millet-based *Ablo* and the sorghum-based *Ablo*. It is from this table that the average values of the content in proteins, total sugars, reducing sugars, and energy of the millet-based *Ablo* were significantly higher than those of the sorghum-based *Ablo*. The average protein of the millet-based *Ablo* was more than 1.64 times higher than the average value of the protein content of the sorghum-based *Ablo* (table 2). The millet-based *Ablo* was 2.82 times richer in total sugars, 1.39 times in reducing sugars than the sorghum-based *Ablo* (table 2). The average energy content of the millet-based *Ablo* was 2.76 times higher than the average energy value of sorghum-based *Ablo* (table 2).

Table 2: Average values in protein, total sugars, reducing sugars, lipids, and energy of the millet-based *Ablo* and the sorghum-based *Ablo*

Types of *Ablo*	Average values of the search parameters				
	Proteins (mg/g)	Total sugars (mg/g)	Reducing sugars (mg/g)	Lipids (mg/g)	Energy (Kcal/g)
Millet-based *Ablo*	12.83 ± 0.578[a]	457.65 ± 1.53[a]	192.12 ± 0.15[a]	0.22 ± 0.01[a]	187.62 ± 2.30[a]
Sorghum-based *Ablo*	7.84 ± 0.18[b]	162.33 ± 2.68[b]	138.10 ± 0.66[b]	0.22 ± 0.01[a]	68.02 ± 1.53[b]
P-value	0.00	0.00	0.00	1.00	0.00

The average values of the same letter in the same column are not significantly different at the 5% threshold.

The average values of the content in zinc, copper and iron of the millet-based *Ablo* were significantly higher than the mean values of the content of zinc and iron of the sorghum-based *Ablo* (table 3). Both types of *Ablo* manufactured contain neither cadmium nor lead (table 3). The average level of copper in the sorghum-based *Ablo* (11.70 ± 3.06 10^3µg/Kg) was 1.94 times smaller than that of the millet-based *Ablo* (22.74 ± 4.97 10^3µg/Kg). The millet-based *Ablo* was 2.20 times as rich in zinc and 1.74 times in iron as the sorghum-based *Ablo* (table 3).

Table 3: Average values in zinc, copper, cadmium, lead, and iron of the millet-based *Ablo* and the sorghum-based *Ablo*

Types of *Ablo*	Average values of the search parameters				
	Zinc (10^3µg/Kg)	Copper (10^3µg/Kg)	Cadmium (µg/Kg)	Lead (µg/Kg)	Iron (mg/Kg)
Millet-based *Ablo*	13.93 ± 1.71[a]	22.74 ± 4.97[b]	< LOD	< LOD	360.30 ± 4.72[a]
Sorghum-based *Ablo*	06.33 ± 0.67[b]	11.70 ± 3.06[a]	< LOD	< LOD	207.25 ± 0.75[b]
Criteria	-	-	100	200	-
P-value	0.00	0.00	-	-	0.00

The average values of the same letter in the same column are not significantly different at the 5% threshold.
Legende: LOD = wavelength of detection; **Criteria**: MAEP, 2007

The content of vitamins (A, B1, B2, and C) millet-based *Ablo* and sorghum-based *Ablo* products was presented by table 4. The dosage of vitamins has revealed that both types of *Ablo* manufactured contained vitamins A, B1, B2 and C (table 4). The sorghum-based *Ablo* was respectively 1.19, 1.11 times and 1.17 times richer in vitamins A, B1 and B2 as the millet-based *Ablo* (table 4). But these differences were not significant at the 5% threshold. On the other hand, we noted a significant difference in vitamin C. Indeed, the millet-based *Ablo* was 1.84 times richer in vitamin C content than the sorghum-based *Ablo* (table 4)

Table 4: Composition in vitamins of the millet-based ablo and the sorghum-based *Ablo*

Types of *Ablo*	Average values of the search parameters			
	A (mg / 100g)	B1 (mg / 100g)	B2 (mg / 100g)	C (mg / 100g)
Millet-based *Ablo*	08.42 ± 0.23[a]	0.47 ± 0.04[a]	0.6 ± 0.05[a]	39.61 ± 2.15[a]
Sorghum-based *Ablo*	10.06 ± 1.42[a]	0.52 ± 0.12[a]	0.7 ± 0.03[a]	22.53 ± 3.22[b]
P-value	0.05	0.24	0.28	0.00

The average values of the same letter in the same column are not significantly different at the 5% threshold.

The result of the sensory analysis of millet-based *Ablo* and of the sorghum-based *Ablo* was translated by figure 1. The figure showed that tasters liked better the color, smell and consistency of sorghum-based *Ablo* as the color, the smell and consistency of millet-based *Ablo* (Figure 1). They also found that the millet-based *Ablo* had a sweeter taste than the sorghum-based *Ablo* (Figure 1). The sorghum-based *Ablo* was more acidic than the millet-based *Ablo* (Figure 1). The results of the sensory analysis showed that both types of *Ablo* developed were generally accepted by the tasters. However, panelists most preferred the sorghum-based *Ablo* (Figure 1).

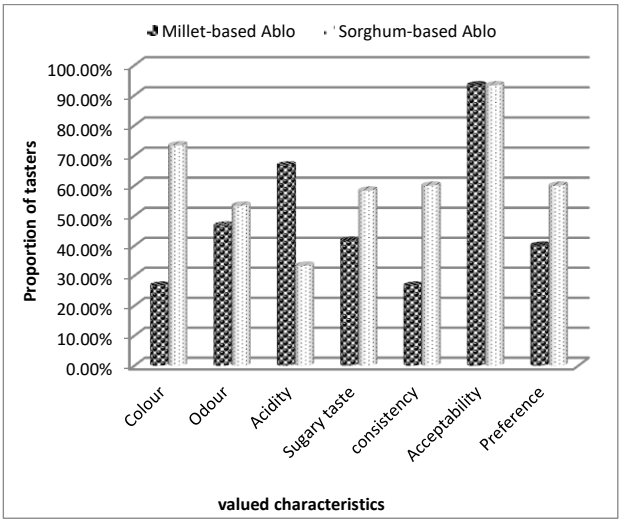

Figure 1: Comparison of the different sensory characteristics of the *Ablo* to base of millet and the *Ablo* at base of sorghum

3.2 Discussion

The millet-based *Ablo* and the sorghum-based *Ablo* respectively have an average pH of 4.23 ± 0.15 and 4.26 ± 0.09. In fact, all of the pathogenic microorganisms thrive in environments where the pH is higher than 4.5. Below this value, all life becomes impossible for these kinds of microorganisms (H. Leclerc *et al.*, 1977; M. J. R. Nout *et al.,* 1989; R. Adjigbey-Tasas, 2003).

The acid pH preserves fermented foods against microbial contaminants and ensures a good conservation of these foods. With an acid pH, the two types of *Ablo* will inhibit further development of pathogenic microorganisms.

Results showed a significant difference ($p < 0.05$) between the two types of *Ablo* protein. The average value of the protein content of the millet-based *Ablo* is 1.64 times greater than the average value of the protein content of the sorghum-based *Ablo*. These results are similar to those obtained by S. Serna-Saldivar and L. W. Rooney (1995), who stressed that grain of millet contains close to 1.08 times more protein than grains of sorghum. The millet-based *Ablo* is 2.82 times richer in total sugars, 1.39 times in reducing sugars than the sorghum-based *Ablo* (table 2). This difference can be explained by the fact that millet and sorghum have different biochemical characteristics (N. D. Vietmeyer, 1996). The average energy value of the millet-based *Ablo* is 2.76 times higher than the average energy value of sorghum-based *Ablo*. Thus, the millet-based *Ablo* provides more energy than the sorghum-based *Ablo*. This difference is due to the low-protein and total sugar of the sorghum-based *Ablo*.

The Two types of *Ablo* manufactured contain neither cadmium nor lead; we can say that the two products developed, meet chemical standards and guarantee the safety of consumers in nutritional terms. The average level of copper in the sorghum-based *Ablo* (11.70 ± 3.06 10^3µg/Kg) is 1.94 times smaller than that of the millet-based *Ablo* (22.74 ± 4.97 10^3µg/Kg). The millet-based *Ablo* is 2.20 times richer in zinc and 1.74 times in iron than the sorghum-based *Ablo*. These variations between the mineral elements of both types of *Ablo* are justified by the richness of the grain of millet in these elements (M. Kone, 2011). In addition, M. A. Stuarts *et al*. (1987), N. Khetarpaul and B. N. Chauhan (1989) reported a significant improvement in the availability of minerals during the fermentation. G. Sripriya *et al*. (1997) made the same observations by noticing an improvement of bioavailability of copper, zinc, magnesium, calcium, phosphorus and iron during the fermentation of millet.
Furthermore, results show that the sorghum based *Ablo* is richer 1.19, 1.11 times and 1.17 times respectively in vitamins A, B1 and B2 than the millet-based *Ablo*. The millet-based *Ablo*, is 1.84 times richer in vitamin C than the sorghum-based *Ablo*. These different vitamins are essential to the proper functioning of the body. The results are consistent with those of R. Jeantet *et al.* (2008) and C. K. C. Tchekessi (2015) which stressed that the vitamins A, B1, B2 and C can be found in the fermented grain foods and intervene for the good functioning of metabolism at the level of energy production (B1 and B2 vitamins), eyes and skin (vitamin A). The vitamins C have antioxidant actions and keep better foods that contain it (F. Yildiz, 2010). H. A. Dirar (1993) showed that fermentation allows to increase the content of vitamins of group B in the African fermented cereal and that three days of fermentation can increase vitamin B12, riboflavin and folic acid levels in the fermented porridge.

According the results of the sensory analyses, the tasters more prefer the sorghum-based *Ablo* to the millet-based *Ablo*. The preference of sorghum-based *Ablo* by tasters is justified by the food habit in the South of Benin, where the population is much more familiar with this cereal. The same comments were made on the dèguè by K. S. Agbanzoume (2005), C. Broutin *et al*. (2005), F. Hama *et al*. (2009), N. Y. Zinzerdorf *et al*. (2009), C. K. C. Tchekessi (2015) and A. I. Angelov *et al*. (2017) who have showed that the millet-based Dèguè is the preference of consumers because the traditional Dèguè widely consumed in many countries of the West Africa (Benin, Burkina Faso, Niger, Mali, Côte d'Ivoire) is made from millet and fermented milk.

Conclusion

The study shows that both types of *Ablo* (millet-based *Ablo* and sorghum based *Ablo*) set-up are very rich in nutriments (vitamins, proteins and iron) and have a good quality of health. The two types of *Ablo* are all accepted by the panelists. However, in terms of the richness in nutriments the millet-based *Ablo* and the sorghum-based *Ablo* and their availability throughout the national territory, it would be preferable to promote these cereals for the production of the *Ablo*. We recommend the consumption of these new products therefore to people of all age of preferences to the pregnant women, the children and the elderly.

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