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Organoleptic Profile of *Mbala-pinda* Formulated with Cassava, Corn, Taro and Peanut Pastes

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Abstract The objective of this study is to evaluate the organoleptic qualities of *Mbala-pinda* formulated by substituting retted cassava paste for fermented corn and fermented taro pastes while adding spices and fish in certain cases. To do this, several types of *Mbala-pinda* were formulated from basic foods (cassava, corn and taro) consumed in Congo. Thus, nine (9) *Mbala-pinda* were formulated at the rate of three (3) formulations per basic food. A rating test was carried out on the *Mbala-pinda* formulated by a panel made up of 50 tasters on a scale of 1 to 4. The results of the test on the formulations of cassava (E1, E2 and E3), corn (E4, E5 and E6) and taro (E7, E8 and E9) revealed that E3, E1 and E9 were more appreciated with a respective average of 3.2; 2.86 and 2.74 followed by E2 (2.56), E6 and E8 have the same appreciation 2.54, followed by E5 (2.50) and E7 (2.06) but E4 was the least appreciated either 1.94. In short, all the *Mbala-pinda* were well appreciated, because all the averages are above 2 except the E4 which could not reach the average.

Keywords: *Organoleptic profile, Mbala-pinda, formulated, pastes*

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1. Introduction

Malnutrition is a condition characterized by an imbalance, that is to say an insufficiency or excess in the intake of essential nutrients. Acute malnutrition (AM) is a global challenge, affecting 45 million children under 5 years of age and is an underlying cause of 800,000 deaths annually. A third of children under 5 were stunted and 5.7% suffered from acute malnutrition (AM) in 2022, with large disparities in Africa [1]. Despite progress in some areas of health in recent decades, the persistent prevalence of malnutrition in many parts of the continent hampers efforts to improve the well-being and quality of life of millions of people. This complex condition results from multiple interacting factors, including dietary habits, socioeconomic conditions, access to food resources, and physical and cultural environments. To compensate for this malnutrition, we are witnessing the improvement of dietary pathways which can consist of the formulation of dishes from a mixture of a starchy food and a legume in order to increase the biological values of proteins: This is the case of couscous enriched with soy [2], yam porridges enhanced with squash, soy and Urera trinervis leaves [3], corn-based porridges, soy, peanut and fry [4].

In Congo, the inhabitants of the departments of greater Niari (Bouenza, Niari, Lékoumou), use a traditional food called *Mbala-pinda* obtained by combining retched cassava paste with peanut paste. This product, rich in energy and proteins [5,6], plays a crucial role in the food and nutritional security of local populations. The Congo, having a diversity of starches and legumes, can take advantage of it to make other *Mbala-pinda* from these foods. Our choice was oriented towards starchy foods such as cassava, taro and corn as cereals as well as legumes including peanuts. This choice is justified by the availability of these foods at the national level. However, the creation of a new product requires that it be accepted by consumers while taking into account their eating habits. The question we ask ourselves is the following: could the formulation of *Mbala-pinda* based on cassava, corn, taro, peanut paste, spices and fish improve the organoleptic characteristics of this dish traditional?

Thus, our study aims to describe the organoleptic profile of formulated *Mbala-pinda*. This is specifically about:

- Formulate *Mbala-pinda* with other foods of the same nature as cassava (corn and taro) while adding spices and fish;
- Determine the organoleptic qualities of these formulated *Mbala-pinda*.

2. Material and Methods

Material

Target population

The target population consisted of students from the Faculty of Science and Technology, Marien NGOUABI University.

Food material

The food material used consisted of chives (a), taro tubers (b), cassava roots (c), Channa striata fish (d), peanut seeds (e), onion (f), corn seeds (g) and salt (h). These different foods were used in the making of the different *Mbala-pinda* and the leaves of Megaphrynium macrostachyum (i) were used for the packaging of the *Mbala-pinda* (Figure 1).

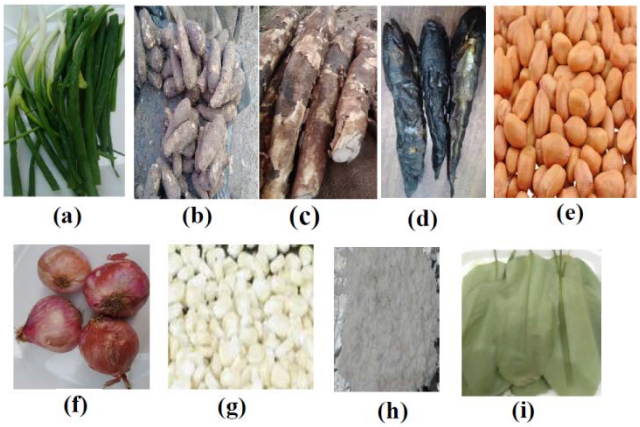

Figure 1. Different ingredients used for making *Mbala-pinda* from (a) to (j)

Didactic material

It consisted of a sensory evaluation sheet in which information relating to the organoleptic quality of *Mbala-pinda* was mentioned.

3. Methods

Formulation of *Mbala-pinda*

Mbala-pinda were formulated from retted cassava paste, fermented corn paste and fermented taro.

Pasta production

Production of cassava retted paste

The cassava roots were retted following the methods described by [7,8], with some modifications. They were purchased at the total market in Brazzaville then transported to the INRSIIT Agro-Food Technology laboratory where they were peeled, cut into small slices and soaked in water for 4 days. These retted cassava roots were defibrated, sifted and decanted. The supernatant was discarded and the deposit at the bottom was poured into a muslin cloth for draining to obtain a retted cassava paste.

Production of retted corn dough

The white variety corn seeds called *Nzanzaku* (Lari) purchased at the Total market in Brazzaville were transported to the Agro-Food Technology laboratory of INRSIIT for the production of fermented corn paste [9,10].

Production of retched taro paste

The taros were purchased at the Brazzaville total market and transported to the laboratory for the production of fermented taro paste. The taros were washed, peeled and soaked in water for 5 days to obtain the retted taros. The red taros were manually crushed, sifted, decanted and drained to obtain the fermented taro paste.

Peanut paste production

The white variety peanut seeds were purchased at the Total market in Brazzaville and then transported to the INRSIIT Agri-Food Technology laboratory. The sorted, roasted, peeled and winnowed peanut seeds were crushed in a mill to obtain peanut paste.

Description of *Mbala-pinda* production processes

After the production of the pastes, *Mbala-pinda* based on retted cassava, maize and taro paste was formulated by adding spices and fish (Channa striata) according to table (1). Considering the manufacturing process of *Mbala-pinda* [11], nine (9) *Mbala-pinda* were formulated by improving the cassava-based *Mbala-pinda* by adding spices and fish (Table 1) and replacing cassava with maize and taro with the addition of spices and fish (Table 2 and Table 3).The proportions of the different ingredients used in the making of *Mbala-pinda* formulated with cassava (E1, E2, E3), corn (E4, E5, E6) and taro (E7, E8, E9) are presented respectively in the tables 1, 2 and 3

Table 1. Composition of types of mixture of *Mbala-pinda* with cassava

Settings	Cassava	Peanut paste	Sal	Spicy	Fish
E1	40 g	60 g	1 g	-	-
E2	40 g	60 g	1 g	9 g	-
E3	40 g	60 g	1 g	9 g	15 g

Table 2. Composition of types of mixture of *Mbala-pinda* with corn

Settings	Corn	Peanut paste	Sal	Spicy	Fish
E4	40 g	60 g	1 g	-	-
E5	40 g	60 g	1 g	9 g	-
E6	40 g	60 g	1 g	9 g	15 g

Table 3. Composition of types of mixture of *Mbala-pinda* with taro

Settings	Taro	Peanut paste	Sal	Spicy	Fish
E7	40g	60g	1g	-	-
E8	40g	60g	1g	9g	-
E9	40g	60g	1g	9g	15g

Sensory analysis of *Mbala-pinda*

An organoleptic test was carried out on a panel of 50 tasters. Indeed, nine (9) *Mbala-pinda* E1 to E9 were submitted to tasters, in order to identify the organoleptic characteristics of these formulated products. The tasters were placed in boxes to avoid communication between them. An acceptability test by rating was carried out and the assessments were recorded using a sensory assessment sheet including the following rating:

1= I don't like it, 2= I like it a little, 3= I like it, 4= I like it a lot.

The numbers from 1 to 4 were noted in a table for each *Mbala-pinda*, which allowed us to classify these *Mbala-pinda* ;

The reasons which justified the rating of each *Mbala-pinda* by the taster were collected through the following criteria:

1= taste, 2= smell, 3= consistency, 4= nothing

The taster was asked, according to the number he assigned to a *Mbala-pinda*, to say what he likes and what he does not like in this *Mbala-pinda*.

The tasters were provided with a single-use fork, a paper towel, a disposable plastic glass in which the mineral water was served to allow the evaluator to rinse their mouth after the tasting of each *Mbala-pinda*. The nine (9) *Mbala-pinda* were distributed in nine (9) single-use plates per taster.

The tasters appreciated the *Mbala-pinda* using their sense organs. Indeed, the smell was appreciated by the nostrils, the taste and consistency by the mouth.

Treatment of data

The processing of the data collected as well as the entry and production of the raw tables were carried out using the epi-infos 6 fr, Minitab and Word software. The quantitative and qualitative variables were expressed as numbers and percentages. They are sometimes accompanied by extreme values (minimum; maximum). The significant difference perceived between two percentages is verified through classic tests of differential statistics. The comparison of more than two percentages is carried out using the Student test (1995), represented by the comparison value χ^2; with a significance threshold set at 5%. It makes it possible to decide whether the difference observed between the two movements is attributable to a systematic cause or whether it can be considered as the effect of a fluctuation due to chance.

4. Results and Dicussion

Figure 2 presents the different *Mbala-pinda* formulated during this study.

Organoleptic characteristics of *Mbala-pinda* made from cassava

Table 4 shows the tasters' assessments of *Mbala-pinda* made from cassava. It follows from this table that all the *Mbala-pinda* were well appreciated because the average appreciation of the *Mbala-pinda* is above two (2). *Mbala-pinda* E3 (3.20), is more appreciated than E1 (2.86) which is more appreciated than E2 (2.56). According to the assessment criterion; the tasters appreciated the taste of these *Mbala-pinda* more following the order E3 (80%), E1 (70%) and E2 (60%). The other classes are poorly represented. The difference is very significant in all cases, because, $p<0.001$.

Organoleptic characteristics of *Mbala-pinda* made from corn

The organoleptic qualities of *Mbala-pinda* made from corn are presented in Table 5. It follows from this table that *Mbala-pinda* E6 (2.54) and E5 (2.50) were well appreciated because their average is higher at 2.00. On the other hand, E4 was poorly appreciated with an average of 1.94. According to the assessment criterion, the tasters appreciated the taste of E6 and E5 more, respectively 56%. On the other hand, the tasters did not distinguish anything in E4 (70%) because no criterion attracted them. The difference is very significant in all cases, because, $p<0.001$.

Organoleptic characteristics of taro-based *Mbala-pinda*

Table 6 shows the evaluations of *Mbala-pinda* made from taro. It follows from this table that all the *Mbala-pinda* were well appreciated, because they all have an average above two (2), following the order of appreciation below: E9 (2.74), E8 (2.54) and E7 (2.06). According to the appreciated criterion, the tasters appreciated the taste of E9 and E8 more, 66% and 52% respectively. On the other hand, the tasters did not distinguish anything in E7 (60%). The difference is very significant in all cases, because, $p<0.001$.

Figure 2. photos of the different *Mbala-pinda* formulated

Table 4. Appreciation of *Mbala-pinda* made from cassava

CASSAVA												
	Mbala-pinda E1				*Mbala-pinda* E2				*Mbala-pinda* E3			
Settings	Workforce	Percentage (%)	95% confidence interval (%)	Statistical value	Workforce	Percentage (%) (%)	95% confidence interval (%)	Statistical value	Workforce	Percentage (%) (%)	95% confidence interval (%)	Statistical value
I don't like	3	6.0	1.3-16.5	$\chi2$=25.017 ddl = 49	11	22.0	11.5- 36.0	$\chi2$=17.863 ddl = 49	5	10.0	3.3- 21.8	$\chi2$=22 .862 ddl = 49
I like a little	11	22.0	11.5-36.0	Average =2.86	8	16.0	7.2 - 29.1	Average =2.56	5	10.0	3.3- 21.8	Average =3.20
I like	26	52.0	37.4-66.3	Standard deviation =0.808	23	46.0	31.8- 60.7	Standard deviation =1.013	15	30.0	17.9- 44.6	Standard deviation =0.99
I like it a lot	10	20.0	10.0-33.7	Value of p = 0.00000	8	16.0	7.2- 29.1	Value of p = 0.00000	25	50.0	35.5- 64.5	Value of p = 0.00000
Total	50	100.0			50	100.0			50	100.0		
Criterion appreciated in each *Mbala-pinda*												
Taste	35	70.0	55.4-82.1	$\chi2$=9.740 ddl = 49	30	60.0	45.2- 73.6	$\chi2$=10.511 ddl = 49	40	80.0	66.3- 90.0	$\chi2$=9.333 ddl = 49
Consistency	1	2.0	0.1 - 10.6	Value of p = 0.00000	1	2.0	0.1 - 10.6	Value of p = 0.00000				Value of p = 0.00000
Nothing	14	28.0	16.2-42.5		19	38.0	24.7- 52.8		10	20.0	10.0- 33.7	
Total	50	100.0			50	100.0			50	100.0		

Table 5. Appreciation of *Mbala-pinda* made from corn

CORN												
	Mbala-pinda E4				*Mbala-pinda* E5				*Mbala-pinda* E6			
Settings	Workforce	Percentage (%)	95% confidence interval (%)	Statistical value	Workforce	Percentage (%) (%)	95% confidence interval (%)	Statistical value	Work force	Percentage (%) (%)	95% confidence interval (%)	Statistical value
I don't like	19	38.0	24.7 - 52.8	$\chi2$=15.412 ddl = 49	11	22.0	11.5 - 36.0	$\chi2$=18.147 ddl = 49	8	16.0	7.2 - 29.1	$\chi2$=18.864 ddl = 49
I like a little	17	34.0	21.2 - 48.8	Average =1.94	9	18.0	8.6 - 31.4	Average =2.50	15	30.0	17.9 - 44.6	Average =2.54
I like	12	24.0	13.1 - 38.2	Standard deviation =0.89	24	48.0	33.7 - 62.6	Standard deviation =0.95	19	38.0	24.7- 52.8	Standard deviation =0.95
I like it a lot	2	4.0	0.5 - 13.7	Value of p = 0.00000	6	12.0	4.5- 24.3	Value of p = 0.00000	8	16.0	7.2 - 29.1	Value of p = 0.00000
Total	50	100.0			50	100.0			50	100.0		
Criterion appreciated in each *Mbala-pinda*												
Taste	14	28.0	16.2 - 42.5	$\chi2$=16.381 ddl = 49	28	56.0	41.3 - 70.0	$\chi2$=10.885 ddl = 49	28	56.0	41.3 - 70.0	$\chi2$=10.905 ddl = 49
Smell				Value of p = 0.00000	1	2.0	0.1 - 10.6	Value of p = 0.00000				Value of p = 0.00000
Consistency	1	2.0	0.1 - 10.6		1	2.0	0.1 - 10.6					
Nothing	35	70.0	55.4 - 82.1		20	40.0	26.4 - 54.8		22	44.0	30.0 - 58.7	
Total	50	100.0			50	100.0			50	100.0		

Table 6. Appreciation of *Mbala-pinda* based on taro

TARO												
	***Mbala-pinda* E7**				***Mbala-pinda* E8**				***Mbala-pinda* E9**			
Settings	Workforce	Percentage (%)	95% confidence interval (%)	Statistical value	Workforce	Percentage (%) (%)	95% confidence interval (%)	Statistical value	Workforce	Percentage (%) (%)	95% confidence interval (%)	Statistical value
I don't like	18	36.0	22.9-50.8	$\chi2$=15.959 ddl = 49	10	20.0	10.0 -33.7	$\chi2$=18.453 ddl = 49	9	18.0	8.6- 31.4	$\chi2$=18.521 ddl = 49
I like a little	12	24.0	13.1-38.2	Average =2.06	10	20.0	10.0 - 33.7	Average =2.54	8	16.0	7.2 - 29.1	Average =2.74
I like	19	38.0	24.7-52.8	Standard deviation =0.91	23	46.0	31.8- 60.7	Standard deviation =0.97	20	40.0	26.4 - 54.8	Standard deviation =1.05
I like it a lot	1	2.0	0.1-10.6	Value of p = 0.00000	7	14.0	5.8 - 26.7	Value of p = 0.00000	13	26.0	14.6 - 40.3	Value of p = 0.00000
Total	50	100.0			50	100.0			50	100.0		
Criterion appreciated in each *Mbala-pinda*												
Taste	20	40.0	26.4-54.8	$\chi2$=13.336 ddl = 49	26	52.0	37.4 - 66.3	$\chi2$=11.481 ddl = 49	33	66.0	51.2 - 78.8	$\chi2$=9.950 ddl =49
Consistency					4	8.0	2.2 - 19.2					
Nothing	30	60.0	45.2-73.6	Value of p = 0.00000	20	40.0	26.4- 54.8	Value of p = 0.00000	17	34.0	21.2 - 48.8	Value of p = 0.00000
Total	50	100.0			50	100.0			50	100.0		

Overall appreciation of *Mbala-pinda*

Table 7 reveals the classification of the *Mbala-pinda* into distinct groups. It appears from this table that four (4) groups were designated by the letters A, B, C and D, the means sharing the same letter in a column do not reveal any significant difference. Thus, *Mbala-pinda* E3, E1, E9 and E2 are grouped in class A and do not present any significant difference between them. *Mbala-pinda* E1, E9, E2, E8, E6 and E5 are grouped in class B without significant difference. Similarly, *Mbala-pinda* E2, E8, E6, E5 and E7 constitute class C without significant difference, while E2, E8, E6, E5, E7 and E4 form class D, also without significant difference. However, a significant difference is observed between E3 and *Mbala-pinda* E8, E6, E5, E7 and E4. In addition, a significant difference is noted between E1, E9 and *Mbala-pinda* E7 and E4.

Table 7. classification of improved *Mbala-pinda*

Factors	Numbers (N)	Average	Group			
E3	50	3.200	A			
E1	50	2.860	A	B		
E9	50	2.740	A	B		
E2	50	2.560	A	B	C	D
E8	50	2.540		B	C	D
E6	50	2.540		B	C	D
E5	50	2.540		B	C	D
E7	50	2.060			C	D
E4	50	1.940				D

This study was carried out with a view to making our contribution to improving the organoleptic quality of these *Mbala-pinda*. To do this, retted cassava paste and peanut paste were used to make *Mbala-pinda*. The retted cassava paste was substituted with corn and taro. In order to determine the proportions of starches and peanut paste to use to obtain a *Mbala-pinda* whose quality is close to that of traditional *Mbala-pinda*, different mixtures were tested.

The products used in the production of *Mbala-pinda* provide information on the starchy-legume combination [12,13].

The sensory evaluation of the nine (9) improved *Mbala-pinda* allowed consumers to express their appreciation.

Concerning the improved cassava-based *Mbala-pinda* (E1, E2 and E3), the results showed that these were well appreciated, as the difference was not significant ($p < 0.001$). The tasters mainly based their appreciation on the taste of *Mbala-pinda* E1, E2 and E3, with respective percentages of 70%, 60% and 80%. Overall, E3 was the most appreciated, garnering 80% approval. The preference tests, based on the ratings, revealed that all *Mbala-pinda* obtained a rating above the average of 2. However, the addition of legumes in cereal dishes improves the taste [14]. These results are in agreement with the study on kluiklui where this product is appreciated for its taste at 88% by buyers [15]. This could be explained by the diversity of spices added.

Regarding corn-based *Mbala-pinda* (E4, E5 and E6), the evaluations showed that E5 (2.56) and E6 (2.52) have averages greater than 2, unlike E4 which was less appreciated with an average of 1.94, thus justifying the improvement of this *Mbala-pinda* by E5 and E6. The appreciation is essentially based on taste with a percentage of 56. Thus, spices improve and modify the taste of food [16]. These results are comparable to the study that was conducted on the formulation of composite flours, one based on rice (Oryza Sativa) and the other based on corn (Zea mays) for children of weaning age and found an acceptability score of 7.33 FRSHS and 6.33 FMHHS. With FRSHS the flour composed of rice and soybeans enriched with palm oil and sugar and FMHHS the flour composed of corn and beans enriched with palm oil and sugar [17].

Concerning the taro-based *Mbala-pinda* (E7, E8 and E9), the tasters most appreciated the E9 (2.74) followed by the E8 (2.54) and finally the E7 (2.06). These three *Mbala-pinda* have an average greater than 2. They most appreciated the taste of the E9 (66%) followed by the E8 (52%). These results are not in agreement with the studies on fermented yam flour enriched with soybeans which increased the nutritional quality of the flours but the porridges were slightly accepted [18,19]. This difference could be explained by the fact that soybeans differ from peanuts in terms of taste. On the other hand, these results are comparable to the study on composite flours FT25 (flour containing taro, roasted soybean and baobab pulp in the respective ratio of 70/25/5) and FT35 (flour containing taro, roasted soybean and baobab pulp in the ratio of 60/35/5) where the FT35 formulation was more appreciated than FT25 [20].

Overall, the *Mbala-pinda* E3, E1, E9 and E2 are the most popular. The *Mbala-pinda* made from corn and taro, namely E4 and E7, are identified as different from E1 because the tasters immediately noticed a change with E4, believing that it was lighter and did not respond sufficiently to E1, reason for which they did not like well in E4 but the change was not very noticeable with E7, despite the substitution of cassava by taro.

The participants estimated that these *Mbala-pinda* were more similar to the first ones (E1, E2 and E3). This difference could be explained by the starchy nature of each starch.

5. Conclusion

This study revealed that *Mbala-pinda* can be formulated not only with cassava but also with corn and taro. Likewise, the addition of spice and fish to *Mbala-pinda* contributed to its improvement and appreciation.

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Conflict of Interest

The authors declare no conflict of interest.

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