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RESEARCH ARTICLE

New retting method of cassava roots improve sensory attributes of *Bobolo* and *Chikwangue* in Central Africa: An approach through just about right (JAR) test

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ABSTRACT

Aim: the aim of this study was to determine sensory profile, through the use of just-about-right (JAR) scales and penalty analysis, of *Bobolo* and *Chikwangue* from the cassava roots fermented with previously cassava-fermented chips powder (PCFCP). Furthermore, retting time, cyanide content and pasting properties of retted roots were evaluated. **Methods:** for that, two samples of *Bobolo* and *Chikwangue* obtained from two cassava retting methods were studied: a control made from the retting without PCFCP and a product made from retting with PCFCP. **Results:** retting time was carried out in 48 hours less with PCFCP and 60% of cyanide reduction more than control. No major modifications occurs in pasting properties of paste fermented with PCFCP. The sensory analysis indicated high levels of acceptability for products made from retting with PCFCP. The penalty analysis showed that attributes "too sour" and "too much fermented odor" affected the acceptability of the *Bobolo* from retting without PCFCP significantly. **Conclusion:** fermentation of cassava through the use of PCFCP is suitable to improvement of sensory characteristics of fermented cassava by-products.

Keywords: Cassava sticks; Hydrocyanic acid; JAR test; Pasting properties; Retting

INTRODUCTION

Cassava (*Manihot esculenta* Crantz), is a tropical root crop, native to the Amazon basin, which provides the staple food to about 700 million people around the world (Wang et al., 2014). With an annual production estimated at around 168 million tons, Africa alone produces more than half of the world's cassava production and almost all (70%) of its production is processed for human and animal food (FAOSTAT, 2018). Fermented products, and more specifically those resulting from the retting of cassava, are by far the most demanded in Africa markets (Falade and Akingbala, 2011). *Chikwangue* from Congo and *Bobolo* from Cameroon, also known as Cassava sticks, are among the most popular fermented products in Central Africa which have been the subject of significant exports to Europe and China (Flibert et al., 2016; Trèche and Massamba, 1996). *Chikwangue* and *Bobolo* are produced from a fermented paste obtained by cassava retted roots. During the retting operation, the metabolic activity of several microorganisms causes the roots to soften and contributes to the development of several aromas characteristic of retting products. In addition, softening leads to a reduction in the content of poisonous cyanogen compounds in cassava roots (Apeh et al., 2021; Njankouo et al., 2019; Nkoudou et al., 2016) and makes them more suitable for other technological operations.

Despite the strong potential as major sources of income for the rural and urban populations of Central Africa, *Chikwangue* and *Bobolo* face two main limits which hamper their development. This is their seasonal availability in the markets due to the long duration of retting (3-5 days) and their organoleptic characteristics, which vary from one ethnic group to another, from one producer to another and from one production to another. This variation is mainly due to the lack of control of the microbial flora of retting during which, several groups of microorganisms intervene, some of which produce undesirable aromas (Brauman et al., 1996). In order to reduce the natural duration of retting and therefore the

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development of certain unwanted microorganisms, several studies have proposed the use of a starter consisting of one or more strains of microorganisms during retting (Flibert et al., 2016; Kimaryo et al., 2000; Nkoudou et al., 2016). Nkoudou et al. (2016) showed that the addition of previously fermented cassava chip powder (PCFCP) as a mixed microbial starter to the retting medium at the start of fermentation reduced the duration of retting process to more than 50% and cyanide compounds of cassava roots to more than 95%. However, very few or no studies have focused on the sensory properties of the products resulting from the acceleration of the retting process. In addition, most of these work took place in the laboratory and has not been tested on a pilot scale.

The reduction of retting duration and controlling the sensory characteristics responsible for reducing consumer acceptability for *Bobolo* and *Chikwangue* could be essential for improving their quality, reformulation of these products and optimization of manufacturing processes (Ares et al., 2017). In this process, it is about knowing what the consumer is looking for and how this can be changed in order to increase the acceptability of the product (Popper et al., 2004). For this, "consumer" type studies usually include questions about the sensory characteristics of the product. Assessment techniques such as the JAR (Just about Right) scale and acceptability questions are most often used to obtain information concerning the perception of the sensory attributes of a product by consumers (Ares et al., 2010). The JAR scale helps determine the optimal intensity of a sensory attribute by asking consumers to rate whether they consider a sensory attribute to be: "too strong", "too weak", or "Just what" it is necessary". While the acceptability test is performed on a 5, 7 or 9 point hedonic scale ranging from extremely bad to extremely good (Harry et al., 2010). When the JAR test is combined with the overall acceptability test, a penalty analysis is used, which aims to penalize a product in terms of "Just Right Deviation (JAR)." Penalty analysis therefore appears to be an emerging method in food science that opens up avenues for product development and optimization (Narayanan et al., 2014). This research examine the effect of using previously cassava-fermented chips powder (PCFCP) as mixed microbial starter, on retting time and cyanides reduction of cassava roots, pasting properties of retted roots and sensory profiles of *Bobolo* and *Chikwangue* through the use of just-about-right (JAR) scales and penalty analysis.

MATERIAL AND METHODS

This work was carried out with 10 agricultural cooperatives, five of whom are affiliated to the Congo peasant confederation (COPACO) in Democratic republic of Congo (DRC) and five other affiliated to the National consultation of farmers' organizations of Cameroon (CNOP-CAM) Cameroon. Each cooperative was made up of an average of 15 members. To each of them, 50kg of fresh cassava roots of the variety TMS 92/023 were given, for the production of *Chikwangue* in DRC and *Bobolo* in Cameroon. The productions were carried out in each cooperative according to the production protocols described below.

Production of previously cassava-fermented chips powder (PCFCP)

Cassava roots were peeled, cut into cylinder of approximately 4 cm length × 5 cm diameter, washed and weighed to obtain a 5 kg set of washed roots. This set was submerged with five liters of clean water at the ambient temperature (between 28 and 32°C) and fermentation was stopped after 96 hours. Softened cassava roots obtained were then dewatered and dried in sun for two days, when water content of samples was inferior to 15% (w/w). The dried cassava chips obtained were crushed in a blender and flours got from it, constituted the PCFCP and also called "Starter".

Cassava processing into Chikwangue ("Kwanga")

Chikwangue was produced according to (Taleon et al., 2019) with little modifications (Fig. 1). Fifty kilograms of

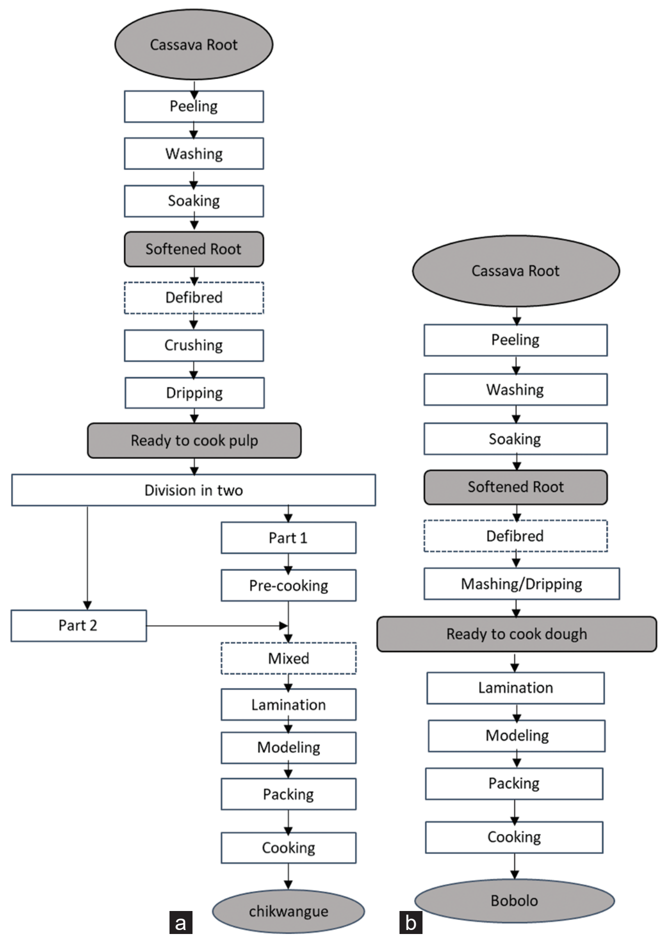

Fig 1. Production diagrams of Chikwangue (a) and Bobolo (b).

cassava roots of TMS92/023 variety were peeled, cut into large chunks (15-20cm) using knifes. The chunks were divided into two equal parts and washed twice. One part were inoculated with 1% (w/w) of previously cassava-fermented chips powder (PCFCP) prepared according to (Nkoudou et al., 2016) while the second, were not inoculated (control). Each group were soaked in water contained in a large plastic drums. After fermentation (when roots were softened), water was drained, roots were crushed by hand, and large pieces of fibers were removed, resulting in a fermented cassava paste. This paste was sieved with excess water to remove small pieces of fiber residues, sedimented, decanted to remove free water, drained in polypropylene sacks under mechanical press for 2 h to remove excess water, and finally pounded to obtain a uniform fine paste (ready to cook pulp). Approximately 2 kg of the fine paste was partially cooked in boiling water for 20 min. the partially cooked paste were mixed with the rest of uncooked paste and kneaded to form a homogeneous paste. The paste was molded into pieces of approximately 700 g, then wrapped in leaves (*Megaphrynium marostachyum*), and finally steamed for 40 min to obtain the cooked *Chikwangue*.

Cassava processing into Bobolo ("Bâton de Manioc")

Bobolo was produced according to fig. 1. Fifty kilograms of cassava roots of TMS92/023 variety were prepared and fermented in the same conditions described in the processing of Chikangue. After softening, roots were removed from soak water, manually defibrated, mashed and dripped for an hour. The pastes obtained were ground in an electric mill. They were later wrapped in large leaves (*Megaphrynium macrostachyum*), bound with dried banana strings and steam cooked for 1 h to obtain *Bobolo*.

Evaluation of cassava roots softening and determination of the retting time

Retting time (the duration from the soaking of the roots to their softening) was determined by periodical measure of the degree of cassava roots softening with a penetrometry instrument (*RPN10 Berlin*) according to Nkoudou et al., (2016).

Two types of sample were obtained: samples fermented with PCFCP and samples fermented without PCFCP (Control). Fermented paste were used in measurement of pasting properties and cyanides content. Sensory analysis were done with *Chikwangue* and *Bobolo* samples.

Determination of the total cyanide content

The B2 Kit (Australian National University-RSB, Canberra) was used to determine the total cyanide content of cassava paste samples as described by (Nkoudou and Ngang, 2017). For this purpose, 100 mg of fermented cassava paste samples was placed in a screwable plastic flask on top of a filter paper soaked with the phosphates buffer of pH 6 and *Linamarase*. A volume of 0.5 ml distilled sterile water was then added in the flask as well as a yellow colored picric acid paper. The flask was hermetically sealed immediately closed using a screwed plug and placed at 30°C for 18 hr. The following day, the yellow-orange paper was taken out of the flask and introduced in a test tube containing 5 ml of sterile water and the test tube was boiled for 5 min. The paper was taken out and the absorbance of the solution was measured at 510 nm after cooling. The total cyanide content expressed in ppm (parts per million) was calculated by multiplying the absorbance by 396.

Pasting properties of the cassava fermented pastes

The pasting properties of different paste were determined with a Rapid Visco Analyser (RVA-4, New Port Scientific, and PETERN Instrument-Australia). Paste suspension 12.5% (w/v) was equilibrated for 1 min at 50°C, heated to 95°C for 5 min. at the rate of 9°C/min. The samples were thereafter held at 95°C for 2 min, cooled to 50°C for 5 min at 9°C/min and held again at 50°C for 1 min. The stirring speed was 160 rpm. From the resulting curve, the Pasting temperature (temperature at the onset in viscosity rise) was determined. The Peak viscosity; the Breakdown viscosity (difference between the peak viscosity and the minimum viscosity during the holding phase at 95°C), the final viscosity and the Setback viscosity (difference between the minimum viscosity at 95°C and the end viscosity) were recorded.

Sensory evaluation

Seventy five (75) consumers of *Chikwangue* in RDC and ninety six (96) consumers of *Bobolo* in Cameroon aged between 18 and 60 years took part in the experiment. They were recruited as volunteers according to their knowledge of the products and their habit to consume it at least once per week. The test was carried in a quiet room prepared for the occasion. The panelists were distanced from each other of about a meter. As the room can only hold a maximum of 25 panelists, analysis were carried out in small groups in each country. Two samples were presented to consumers following a balanced order for each participant. The samples were served in odorless plastic containers, codified with three-digit random numbers. After evaluating each sample, consumers were provided with a 1-min timed rest interval to cleanse their palates with water. In each sensory test, panelists evaluated overall acceptability and JAR levels for the product attributes. Especially for overall acceptability, panelists were asked to score each sample using a 9-point hedonic scale (1= "Extremely dislike"; 5= "Neither like or nor dislike" and 9= "Extremely like"). For JAR, panelists rate the same samples on a 3-point JAR scale (1 = "not enough", 2= "Just About Right" and 3 = "too much") for color, sourness, sticky texture, fermented flavor and elasticity. The panelists were also asked to describe with a free vocabulary the five organoleptic characteristics of the products.

Analysis of sensory evaluation data by penalty analysis

The consumers' overall acceptability ratings and ratings on the JAR attributes were required in order to conduct penalty analysis. The mean drops were plotted versus percentage of the consumers giving each response in a so called mean drop plot. An attribute was only considered to affect the acceptability of the product when the mean drop was higher than 1(Ortega-Heras and Gómez 2019).

Statistical analysis

All measurements were performed in quintuplets according to experiment plan. The comparison of the mean values obtained was done by ANOVA and pairwise comparison at α level = 0.05, using Tukey honest significant difference statistical feature. For penalty analysis, results from both sensory analysis tests were analyzed for a significant differences using a 2-sample t-test ($P<0.05$) in XLSTAT 2019 software (Addinsoft, New York).

RESULTS AND DISCUSSION

Physicochemical properties of cassava fermented products

A comparative retting time in hours between fermentation does with or without previously cassava-fermented chips powder (PCFCP) is presented in Table 1. The results showed use of PCFCP in fermentation reduced by more than 60% of the duration of spontaneous fermentation (Control) both in DRC and in Cameroun. This reduction retting time percentages is slightly above of those obtain at the laboratory in our previous work (Nkoudou et al., 2016) and proved that, previously cassava-fermented chips used as mixed-microbial starter can be performed in different geographic areas and produce the same results. Table 1 also presented a comparative cyanide content in mg/kg both for *Chikwangue* and *Bobolo* produced. Generally, the results showed lower cyanide contents (falls below 10 mg/Kg recommended by the FAO/WHO, 1991 food standard program) among de products (Njankouo et al., 2019). The cyanide content for *Chikwangue* ranges from 2.5 mg/kg to 6.3 mg/kg and for *Bobolo*, from 3.1 mg/kg to 7.9 mg/kg. The use of PCFCP culture in fermentation process contributed to reduce more cyanides. This remarkable reduction of cyanides during cassava fermentation is due to the microbial load, provided by PCFCP, at the beginning of fermentation and the effect of enzymes/acid hydrolysis of the cellular wall that allows endogenous linimarase to come in contact with linimarin releasing hydrocyanic acid during the fermentation (Nkoudou and Ngang, 2017).

Pasting properties of fermented pastes

The pasting characteristics (Table 2) of cassava paste made from cassava roots after fermentation were evaluated. The pasting temperatures of paste samples obtain from fermentations with and without PCFCP were 72.9°C and 72.7°C, respectively. These results indicate a strong granular structure of cassava compare to cocoyam (Ejoh, 2013). The pasting time and breakdown viscosity with PCFCP and Control samples were not statically different, and indicates no major modifications occurs in cooking time of cassava starch granules with addition of PCFCP to the fermentation. Whoever, peak viscosity, Final viscosity and Setback viscosity of the samples fermented with PCFCP, where lower than samples obtained from cassava roots fermentation without PCFCP. (Demiate et al., 2005; Dos Santos et al., 2020) suggested that the lower viscosity of products could be related to higher solubility in hot water, which has been attributed, mainly to higher amylopectin solubility. Thus paste from fermented roots with PCFCP will have a low thickening capacity and week ability to withstand severe processing conditions.

Sensory attributes of Bobolo and Chikwangue

Overall acceptability

Significant differences in the overall liking scores were found both in *Chikwangue* (F= 164.5; P < 0.0001) and *Bobolo* (F=146.61; P < 0.0001) samples. As shown in Table 3, cassava products With PCFCP were the must preferred by consumers with an average score over 8 (« very pleasant »). While the Control sample of *Chikwangue* and *Bobolo* were considered « little nice » (score around 5.5) by the consumers.

Just about right

Table 1: Mean retting time and cyanides contents of fermented products

Parameters	*Chikwangue*		*Bobolo*	
	With PCFCP	Control	With PCFCP	Control
Retting time (hrs.)	28.0 ± 5.1^{a}	75.6 ± 8.0^{b}	30.0 ± 3.5^{a}	78.4 ± 7.4^{b}
Cyanides (mg/kg)	2.5 ± 0.7^{a}	6.3 ± 1.8^{b}	3.1 ± 0.9^{a}	7.9 ± 3.1^{b}

Mean retting time in the same line with different superscripts are significantly different according to Tukey's test for a confidence level of 95%

Table 2: Mean pasting parameters for fermented paste used to produce *Chikwangue* and *Bobolo*

Pasting parameters	Fermented paste samples	
	With PCFCP	Control
Pasting time (Pt)	72.9 ±2.2^{a}	72.7 ±2.1^{a}
Peak viscosity (Pv)	3041.0 ±91.2^{a}	3674.0 ±110.2^{b}
Breakdown viscosity (Bv)	1668.0 ± 50.0^{a}	1638.0 ± 49.1^{a}
Final viscosity (Fv)	2387.0 ± 71.6^{a}	3724.0 ± 111.7^{b}
Setback viscosity (Sv)	1014.0 ± 30.4^{a}	1444.0 ± 43.3^{b}

Mean pasting parameters in the same line with different superscripts are significantly different according to Tukey's test for a confidence level of 95%.

Just about right (JAR) scale was used to determine the optimum level of intensity for color, sourness, stickiness, fermented odor and elasticity of *Chikwangue* and *Bobolo* (Table 4). Such "attribute diagnostic" may help to understand why consumers like or dislike this product. Whatever attribute, consumers were satisfied with cassava products from accelerated fermentation. Those fermented samples were scored "Just About Right, as I like" by hundred percent of consumers for sourness, stickiness and fermented odor. Only thirteen percent of consumers found them too bright. It should also be noted that, thirteen percent of consumers found that the *Bobolo* produced whit PCFCP, was too elastic. Unlike products from accelerated fermentation, consumers found that Control products « smell bad » (strong fermented smell) for sixty nine percent and eighty one percent of answers respectively for *Chikwangue* and *Bobolo*; and have dark color (75% of answers). More than sixty percent of responses note that these products were acidic (63% answers) and have a sticky texture (81%) as it should be. However, it is important to emphasize that 38% find them too acidic. Only elasticity was considered «Just-about-right » by 100% of panelists. The addition of PCFCP in fermentation is useful in flavoring foods. Thus, PCFCP reduced the characteristic odor and color of cassava sticks by enhancing the wider acceptability of the Bobolo and Chikwangue samples as compared to the control samples. This could be explained by the presence in this starter, of lactic acid bacteria that are found to be useful in inhibiting spoilage bacteria and pathogens that are responsible of strong fermented smell and dark color of cassava fermented by-products (Sobowale et al., 2007).

Table 3: Mean overall liking scores for *Chikwangue* and *Bobolo* samples evaluated in this study

Samples	Overall liking	Significativity	
		F	P-value
Chikwangue (n=75)			
With PCFCP	8.73 ± 0.46[a]	164.50	< 0.0001
Control	5.56 ± 0.81[b]		
Bobolo (n=96)			
With PCFCP	8.73 ± 0.46[a]	146.61	< 0.0001
Control	5.50 ± 0.89[b]		

Mean overall liking scores with different superscripts are significantly different according to Tukey's test for a confidence level of 95%.

Attribute adequacy and its relation to liking-penalty analysis

Penalty analysis was carried out to understand which of the attributes under evaluation affected the acceptability of the product to a greater or a lesser extent. The penalizations indicate how much the overall liking of a product drops when a particular attribute fall into non-JAR categories that is, «too much» or «not enough», in such a way that the higher the values that are obtained, the greater the impact of the afore mentioned acceptability (Popper et al., 2004; Ortega-Heras and Gómez, 2019). As shown the fig. 2, in those categories where the number of responses was below the threshold of 20%, the penalizations were not taken into account (Plaehn and Horne, 2008). *Chikwangue* and *Bobolo* from fermentation without PCFCP were penalized for being « too sour », « too much fermented odor » and « not clear enough or too dark », unlike those of fermentation products with PCFCP. The reduction of retting time by the using PCFCP, could therefore limit the multiplication of sulphite-reducing bacteria that are responsible of butyrate acid odor

Table 4: percentage of panelists giving consumer ratting for selected attributes of *Chikwangue* and *Bobolo*

Characteristics	JAR levels	*Chikwangue*		*Bobolo*	
		With PCFCP	Control	With PCFCP	Control
Color	Too bright	13.3%	0.0%	13.3%	0.00%
	JAR	86.7%	31.3%	86.7%	18.7%
	Too dark	0.0%	68.7%	0.0%	81.3%
Sourness	Not enough	0.0%	0.0%	0.0%	0.00%
	JAR	100.0%	62.5%	100.0%	62.5%
	Too acidic	0.0%	37.5%	0.0%	37.5%
Stickiness	Not enough	0.0%	0.0%	0.0%	0.0%
	JAR	100.0%	81.3%	100.0%	81.3%
	Too sticky	0.0%	18.7%	0.0%	18.7%
Odor	Not enough	0.0%	0.0%	0.0%	0.00%
	JAR	100.0%	25.0%	100.0%	25.00%
	Too fermented	0.0%	75.0%	0.0%	75.00%
Elasticity	Not enough	6.7%	0.0%	0.0%	0.0%
	JAR	93.3%	100.0%	86.7%	100.0%
	Too elastic	0.0%	0.0%	13.3%	0.0%

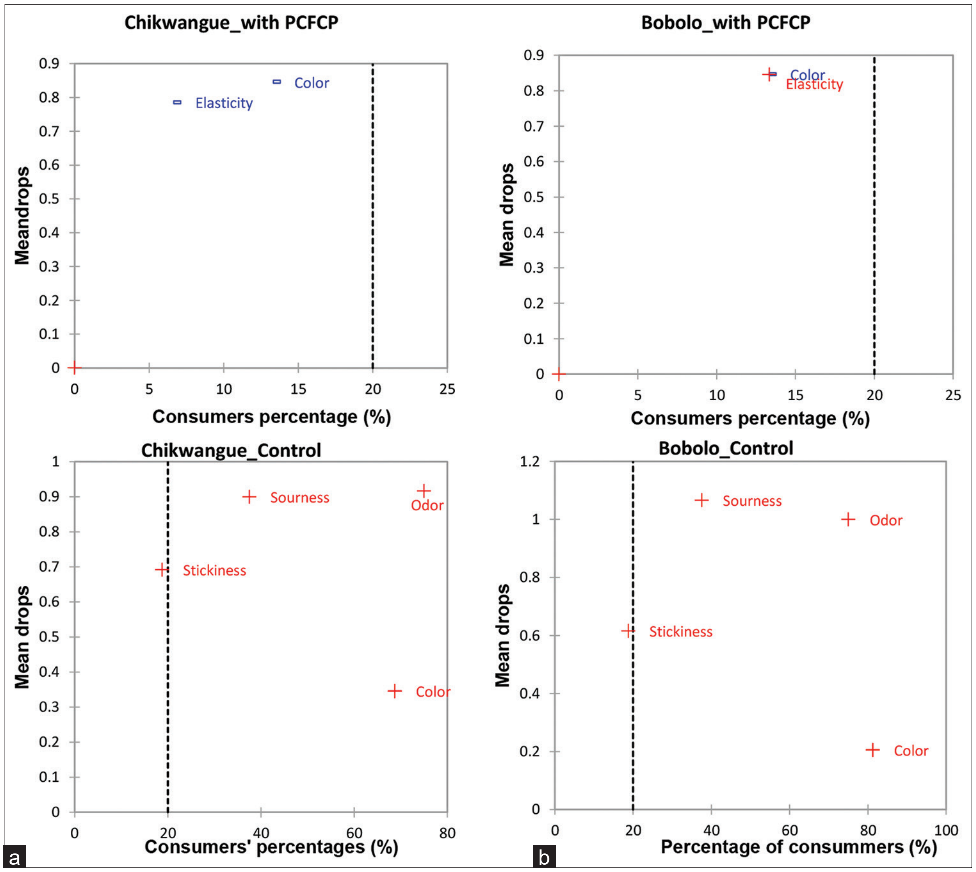

Fig 2. Mean drop plots of *Chikwangue* (a) and *Bobolo* (b). The too strong endpoint of the JAR scales are highlights with red, the too low endpoint of the JAR scales are highlights with blue.

not very appreciated by cassava by-products' consumers. However, only " too much sour " and " too much fermented odor " affect acceptability of *Bobolo* significantly (mean drop over 1), which means that, those two attributes affect acceptability significantly. This fact highlighted that, none of the attributes under evaluation affected the overall liking of product elaborated from paste obtained of cassava roots fermented with the starter. The attributes of those products were found " Just-About-Right " by the majority of consumers (more than 85% of response). The fact that, consumer's penalized control products could be explain by the long-time taken to the fermentation to be accomplish. During this long period, more acid is produced.

CONCLUSION

The use of previously cassava-fermented chips powder (PCFCP) as a starter of cassava root retting for Bobolo and Chikwangue production has enabled, at pilot scale, to reduce the fermentation time to more than half and to significantly detoxify cassava roots without significant modification of pasting properties of the fermented paste. In addition, sensory analysis indicated that products (*Bobolo* and *Chikwangue*) from fermentation with PCFCP obtained better overall acceptability scores than those from fermentation without PCFCP. The penalty analysis revealed that the acceptability of *Bobolo* and *Chikwangue* produced without PCFCP is affected by their "too sour flavor" and "too fermented odor". This study shows that the new retting accelerator (PCFCP) improves the sensory characteristics of *Bobolo* and *Chikwangue* and therefore effectively contributes to making them more competitive and easy to access profitable markets.

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Authors' contributions

Nardis Nkoudou Ze: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing-original draft, Writing-review and editing; **Marie-joseph Medzeme Engama,** Funding acquisition resources and Investigation,**; Jean Justin Essia Ngang:** Conceptualization, Validation, Visualization, Writing-review and editing.

DECLARATION OF COMPETING INTEREST

The authors declare no conflict of interest in this work.

NOVELTY IMPACT STATEMENT

The sensory attributes of *Bobolo* and *Chikwangue* which decrease their acceptability with respect to consumers are known through this work. Moreover, it shows how the use of Previously Cassava Fermented Chips Powder makes it possible to improve the sensory and physicochemical quality of these products with the impact of making them more competitive in more profitable markets.

REFERENCES

Apeh, D. Ojochenemi, M. Omachoko, O. V. Ojogbane, M. Awotunde, O. Taiwo, C. Precious and H. A. Makun. 2021. Hydrogen cyanide and mycotoxins: Their incidence and dietary exposure from cassava products in Anyigba, Nigeria. Food Control. 121: 107663.

Ares, G., J. C. de Andrade, L. Antúnez, F. Alcaire, M. Swaney-Stueve, S. Gordon and S. R. Jaeger. 2017. Hedonic product optimisation: CATA questions as alternatives to JAR scales. Food Qual. Prefer. 55: 67-78.

Ares, G., R. Deliza, C. Barreiro, A.Giménez and A. Gámbaro. 2010. Comparison of two sensory profiling techniques based on consumer perception. Food Qual. Prefer. 21: 417-426.

Brauman, A., S. Keleke, M. Malonga, E. Miambi and F. Ampe. 1996. Microbiological and biochemical characterization of cassava retting, a traditional lactic acid fermentation for foo-foo (cassava flour) production. Appl. Environ. Microbiol. 62: 2854-2858.

Demiate, I. M., G. Wosiacki, M. P. Cereda and C. Mestres. 2005. Viscographic characteristics of chemically modified cassava starches assessed by RVA. In: Publitio UEPG-Ciências Exatas e da Terra No. 11, pp. 7-17.

Ejoh, S. I. 2013. Extending the use of an underutilized tuber I: Physicochemical and pasting properties of cocoyam (*Xanthosoma sagittifolium*) flour and its suitability for making biscuits. Afr. J. Food Sci. 7: 264-273.

FAOSTAT. 2018. Available from: http://www.fao.org/faostat/zh/#data. [Last accessed on 2020 Dec 10].

Falade, K. O. and J. Akingbala. 2011. Utilization of cassava for food. Food Rev. Int. 27: 51-83.

Flibert, G., A. Tankoano and S. Aly. 2016. African cassava traditional fermented food: The microorganism's contribution to their nutritional and safety values-a review. Int. J. Curr. Microbiol. Appl. Sci. 5: 664-687.

Harry, T. L. and H. Heymann. 2010. Sensory Evaluation of Food. Library of Congress Cataloging-in-Publication Data. Springer, Berlin, Germany.

Kimaryo, V. M., G. A. Massawe, N. A. Olasupo and W. H. Holzapfel. 2000. The use of starter culture in the fermentation of cassava for the production of "kivunde," a traditional Tanzanian food product. Int. J. Food Microbiol. 56: 179-190.

Narayanan, P., B. Chinnasamy, L. Jin and S. Clark. 2014. Use of just-about-right scales and penalty analysis to determine appropriate concentrations of stevia sweeteners for vanilla yogurt. J. Dairy Sci. 97: 3262-3272.

Njankouo, Y. N., P. Mounjouenpou, G. Kansci, M. J. Kenfack, M. P. Fotso, Meguia, N. S. N. Eyenga, M. M. Akhobakoh and A. Nyegue. 2019. Influence of cultivars and processing methods on the cyanide contents of cassava (*Manihot esculenta* Crantz) and its traditional food products. Sci. Afr. 5: 1-5.

Nkoudou, Z. N., S. Kamdem, H. Agnia, F. Mengo and J. J. Ngang. 2016. Assessment of cassava (*Manihot esculenta* Crantz) fermentation and detoxification using previously cassava-fermented chips. Br. J. Appl. Sci. Technol. 13: 1-10.

Nkoudou, Z. N. and J. J. E. Ngang. 2017. Cyanides reduction and pasting properties of cassava (*Manihot esculenta* Crantz) flour as affected by fermentation process. Food Sci. Nutr. 8: 326-333.

Ortega-Heras, M. and I. Gómez. 2019. Application of the just-about-right scales in the development of new healthy whole-wheat muffins by the addition of a product obtained from white and red grape pomace. Foods. 8: 1-15.

Plaehn, D. and J. Horne. 2008. A regression-based approach for testing significance of "just-about-right" variable penalties. Food Qual. Prefer. 19: 21-32.

Popper, R., W. Rosenstock, M. Schraidt and B. Kroll. 2004. The effect of attribute questions on overall liking ratings. Food Qual. Prefer. 15: 853-858.

Dos Santos, T. P. R., M. Leonel, M. M. Mischan and C. Cabello. 2020. Study and application of photo-modified cassava starch with lactic acid and UV-C irradiation. LWT Food Sci. Technol. 139: 110504.

Sobowale, A. O., T. O. Olurin and O. B Oyewole. 2007. Effect of lactic acid bacteria starter culture fermentation of cassava on chemical and sensory characteristics of fufu flour. Afr. J. Biotechnol. 6: 1954-1958.

Taleon, V., D. Sumbu, T. Muzhingi and S. Bidiaka. 2019. Carotenoids retention in bio-fortified yellow cassava processed with traditional African methods. J. Sci. Food Agric. 99: 1434-1441.

Trèche, S. and J. P. Massamba. 1996. Modalités de transformation et de consommation du manioc dans les différentes zones écologiques du Congo. In: Hladik, C. M., A. Hladik, H. Pagezy, O. F. Linares, G. J. A. Koppert and F. Alain, (Eds.), L'Alimentation en Forêt Tropicale: Interactions Bio-culturelles et Perspectives de Développement: 2. Bases Culturelles Des Choix Alimentaires et Stratégies de Développement. UNESCO, Paris, pp. 717-730.

Wang, W., B. Feng, J. Xiao, Z. Xia, X. Zhou, P. Li, W. Zhang, Y. Wang, B. L. Møller, P. Zhang, M. C. Luo, G. Xiao, J. Liu, J. Yang, S. Chen, P. D. Rabinowicz, X. Chen, H. B. Zhang, H. Ceballos, Q. Lou, M. Zou, L. J. C. Carvalho, C. Zeng, J. Xia, S. Sun, Y. Fu, H. Wang, C. Lu, M. Ruan, S. Zhou, Z. Wu, H. Liu, R. M. Kannangara, K. Jørgensen, R. L. Neale, M. Bonde, N. Heinz, W. Zhu, S. Wang, Y. Zhang, K. Pan, M. Wen, P. A. Ma, Z. Li, M. Hu, W. Liao, W. Hu, S. Zhang, J. Pei, A. Guo, J. Guo, J. Z, Z. Zhang, J. Ye, W. Ou, Y. Ma, X. Liu, L. J. Tallon, K. Galens, S. Ott, J. Huang, J. Xue, F. An, Q. Yao, X. Lu, M. Fregene, L. A. B. López-Lavalle, J. Wu, F. M. You, M. Chen, S. Hu, G. Wu, S. Zhong, P. Ling, Y. Chen, Q. Wang, G. Liu, B. Liu, K. Li and M. Peng. 2014. Cassava genome from a wild ancestor to cultivated varieties. Nat. Commun. 5: 5110.

SUPPLEMENTARY INFORMATION

Photograph 1. Previously cassava-fermented chips powder packed in plastic.

Photograph 2. Addition of previously cassava-fermented chips powder on peeled cassava roots.

Photograph 3. Dripping of fermented paste in Democratic Republic of Congo.

Photograph 4. Cooked *Chikwangue*.

Photograph 5. Processing of *Bobolo* by one Cooperative in Cameroon.

Photograph 6. Bobolo in pan before cooking.