RTB Working Paper

Assessment of the processability of improved cassava varieties into a traditional food product ("baton" or "chikwangue") in Cameroon

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Abstract

New cassava varieties were developed by IITA in order to improve their agronomic yield, pest and disease resistance, and micronutrient content (higher beta-carotene and other carotenoids). This study assessed the ability of 18 newly released varieties to produce a traditional cassava food product known as "baton" or "chikwangue" in Cameroon's central region, in order to maximize their chances of adoption by processors and consumers. The successive steps of the traditional process are described in detail, and data on processing yields, material balances, shaping and cooking conditions, as well as production capacity and product quality, are reported.

The results showed that "batons" with both better quality and productivity were obtained from varieties with lower fiber content and larger root size. The best profitability was obtained with varieties longer than 25 cm, with a diameter between 6 and 9 cm inclusive and weighing between 0.8 and 1.4 kg inclusive.

Additionally, a survey of processors highlighted the desired quality criteria for cassava varieties to make a good "baton". Eight varieties out of the 18 were ultimately identified as processable into a good "baton". Their acceptability by a large cohort of Cameroonian consumers will be tested in a further study.

Beyond these initial results, the originality of the approach was to assess performance and quality criteria for cassava processing under local conditions, which appears very effective to ensure that improved varieties have appropriate characteristics for traditional uses, and also to integrate market and consumer demands at an early stage into varietal improvement programs.

Keywords: Cassava baton, chikwangue, traditional process, processability, preferences, new varieties, quality criteria

Acknowledgments

The authors would like to thank all the transformers and people who made this work possible. They would also like to thank the IITA staff who helped set up these experiments and accompanied them in the field, shared their detailed knowledge of the context in order to collect these data.

Assessment of the processability of improved cassava varieties into a traditional food product ("baton" or "chikwangue") in Cameroon

GENERAL OBJECTIVES

As part of the CGIAR's RTB Post-harvest project, some new cassava varieties were developed with a view to adaptation for making traditional products. In order to maximize the chances of adoption of these varieties by their users, they are undergoing a set of studies and assessments throughout the value chain: in the agricultural sector, in the processing sector making the various traditional products, and with consumers in their processed and ready-to-eat form. The latter two aspects are more particularly studied within Case Study 3 of the RTB Post-Harvest project: "Ensuring acceptability of food products resulting from new varieties and new processing technologies for cassava".

STUDY CONTEXT

In these times, the global food system faces complex challenges. On the one hand, the supply required to meet future demands for sufficient, healthful and affordable food must be met. Assuring food security and ending hunger are high on the agenda of the international community (United Nations 2010). On the other hand, greenhouse gas emissions have to be reduced and biodiversity and ecosystem services maintained (The Government Office for Science 2011).

In Cameroon, this project required the establishment of trial plots within 3 distinct regions, where traditional processing and consumption modes had been identified in advance.

Figure 1: Trial plots and consumption locations of traditional Cameroonian products (Map sources: http // diplomatie.gouv.fr)

Eighteen new cassava varieties selected by IITA were grown on each of these plots, with the objectives both of monitoring their agronomic behavior, but also of providing the raw material required for the post-harvest trials conducted within the RTB Post-Harvest project.

Figure 2: Mbalmayo trial plot (Photo A. Bouniol)

The 3 regions corresponding to the traditional processing and consumption products selected for the purposes of the project are as follows:

- Central region (City of Mbalmayo: 40 km south of Yaoundé; GPS coordinates: 3° 31′ North 11° 30′ East) for traditional processing and consumption modes in the form of cassava batons

Figure 3: Cassava batons (Photo A. Bouniol)

- The Coastal region (City of Ekona: 300 km south-west of Yaoundé; GPS coordinates: 4°13'47.4"N 9°20'14.1"E) for traditional processing and consumption modes in the form of Gari

Figure 4: Cameroonian Gari (Photo D. Dufour)

- Western region (City of Bertoua: 350 km north-west of Yaoundé; GPS coordinates: 4° 34′ 30″ nord, 13° 41′ 04″ est) traditional processing and consumption modes in the form of Fufu

Figure 5: Cameroonian Fufu (Photo D. Dufour)

This is the context for the assessment of processability, alongside a processor and end consumer preferences assessment, ongoing in Cameroon, for the 18 new varieties.

Hence this assessment is being carried out for each processing and consumption mode, which requires in each case 3 distinct additional actions to be conducted:

- Processor field surveys, in order both to define the quality criteria of a cassava variety for the desired processing mode, but also to identify a so-called “champion” processor, i.e. one identified as specializing in the processing mode in question, and able for the purposes of the project to perform multiple production runs with several cassava varieties

- Carrying out the production runs, with a view to characterizing the processing mode, assessing the processability of the different varieties and providing finished products in order to conduct the consumer tests

- Conducting consumer surveys in order to draw up the questionnaires required for running the consumer tests on the products made by the “champion” processor.

SPECIFIC OBJECTIVES AND WORKING METHODOLOGY

Hence the mission conducted from 11 to 19 May 2015 (see Annex 1 Schedule) in the Central region near the city of Mbalmayo involved monitoring cassava baton production from 8 different varieties. Note that the latter were selected by means of an initial processing series (run from 4 to 9 May 2015) relating to all 17 varieties available on the trial plot. In the course of this initial production run, with quantities of 5 to 7 kg of raw materials per variety, 9 of them were able to discarded by the processors either because of excessive quantities of fibers, or because of a poor response to the steeping phase, with roots tending to “rot”, i.e. swell up with water and blacken, or conversely not to soften sufficiently after 72 hours’ steeping, i.e. not enabling the fibers to be extracted properly.

So the objectives in this second week were to:

- characterize in detail the processing mode and assess the behavior of each of the 8 selected varieties, by acquiring a dataset so as to be able to: characterize each of the unit processing operations, draw up material balances, and evaluate the productivity of the main unit operations employed. The tests involved quantities of approximately 12 kg of raw materials per variety, with the aim of producing between 15 and 20 batons; the quantity of finished product required to conduct the consumer tests.

- be able to contribute, in conjunction with the agronomic data and verdicts of the processors, to the final selection of batches of batons from 4 different varieties, which would then be presented to consumers. The methodological constraints of the consumer test conducted following these production runs would entail limiting the number of products tested by local consumers to 4.

RESULTS

DESCRIPTION OF PROCESSING MODE

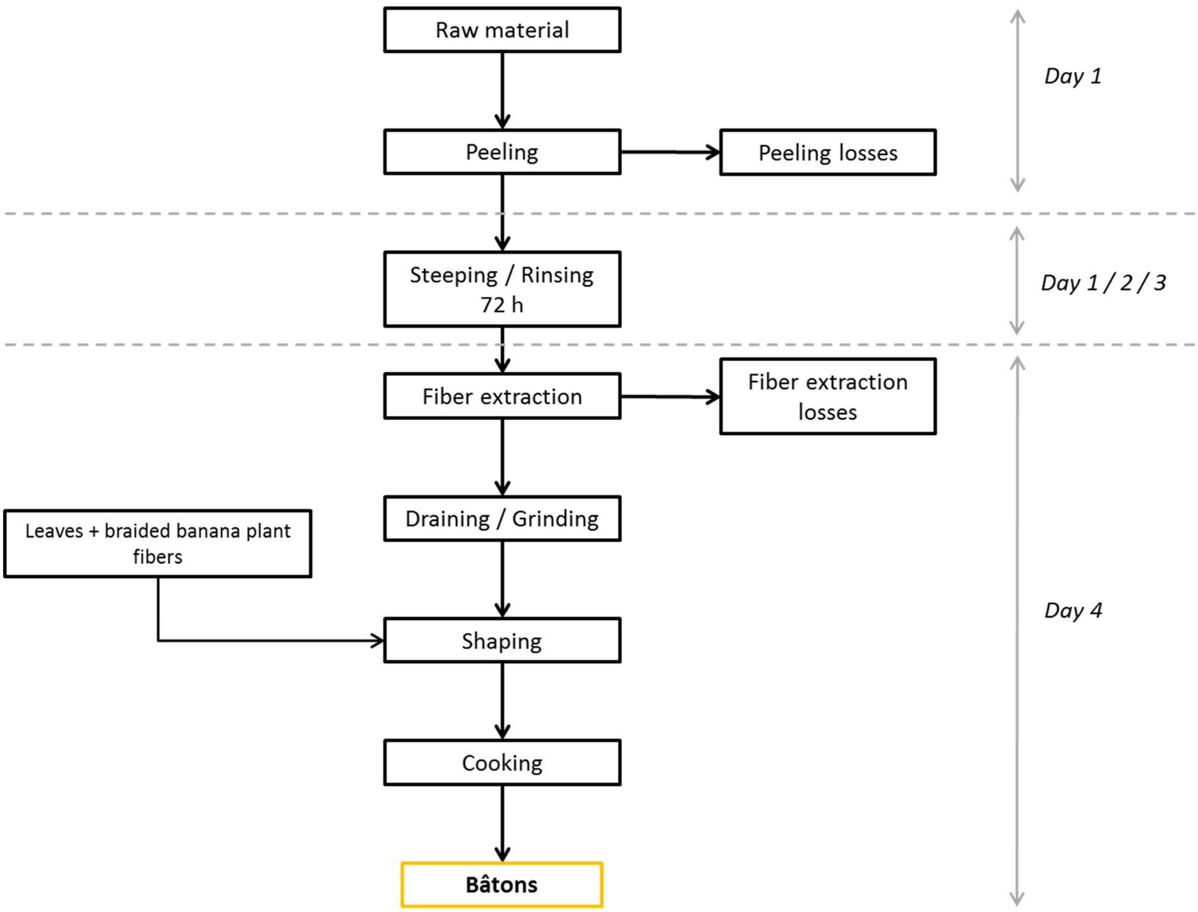

Figure 6: Cassava baton processing mode

RAW MATERIALS

The production runs involved 8 root varieties developed by IITA and planted in April 2014 on the Mbalmayo trial plot. Hence their physiological age for the tests conducted in 2015 was 13 months. These varieties were known by codes assigned by IITA, namely: 96/0023, 98/0581, 01/0098-36, 01/0040-27, 95/0109, TME 419, 8034 and 01/0098. With the objective of ultimately producing between 15 and 20 batons, approximately 12 kg of raw materials per variety were harvested the very morning of the 1st day of processing.

These varieties presented fairly varied physical characteristics which could be characterized according to observation criteria (flesh color and cortex color), physical quantities (length, diameter, volume, weight across a sample of 10 roots per variety) and their dry matter contents, reproduced below in Table 1.

Table 1: Physical characteristics of the 8 varieties studied

Varieties	Flesh color	Cortex color	Mean weight (g)	Mean length (cm)	Mean diameter (cm)	Volume (cm3; cylinder base)	Dry matter content (%)
01/0098	WHITE	Light yellow	848,4	31,8	5,9	869,0	40,16
96/0023	WHITE	Light yellow	1777,0	26,6	10,3	2215,3	38,16
8034	WHITE	Light yellow	1034,2	28,9	7,9	1419,5	37,86
98/0581	WHITE	Light yellow	456,0	25,4	5,5	603,2	43,53
01/0098-36	WHITE	Light yellow	670,2	30,0	5,8	792,2	44,17
01/0040-27	YELLOW	Red / pink	1320,4	29,4	7,7	1368,4	33,82
95/0109	WHITE	Light yellow	488,0	19,4	5,6	477,6	43,80
TME 419	WHITE	Light yellow	402,2	23,8	4,6	386,8	44,23

Hence we can observe the presence of just one "yellow" variety (01/0040-27), which is also the sole variety with a red/pink-colored cortex; the other 7 varieties have white flesh and a light yellow-colored cortex. The root formats are fairly diverse, with volumes varying by a factor of practically 8 between the smallest variety (TME 419) and largest variety (96/0023). As regards dry matter content, we can also observe that although cultivated under the same conditions, there is an 11-point difference between the wettest variety (01/0040-27) and the variety with the highest dry matter content (TME 419).

Hence this variability hints at fairly contrasting behavior and processability.

PEELING

Peeling is the first processing unit operation to make batons. Its objective is to remove the periderm and cortex from the roots, so that the flesh obtained is as clean as possible. It should be clear that one of the initial qualities of the finished product is a product free from black spots, or any other organic matter foreign to cassava.

This unit operation is performed entirely manually by operators simply using knives. It should be noted that the roots were judged "very fresh" by the operatives. They also were of the opinion that they were of a rather young physiological age, and had doubtless benefitted from a probably very rich cultivation plot in a forest environment. This observation was very accurate, since the Mbalmayo trial plot, not known to the processors, is indeed located in a recently cleared forest environment. The processors emphasized this point, since overall they judged all of these varieties relatively easy to peel.

In order to characterize this unit operation, two main criteria were evaluated, yield (% b.h) and productivity (kg/h/operative), the results of which are reproduced in Table 2.

Table 2: Yield (% b.h) and productivity (kg/h/operative) of the peeling unit operation

Varieties	Yield (% b.h)	Productivity (kg/h/operative)
01/0098	80,7	43,3
96/0023	64,2	72,1
8034	70,9	63,5
98/0581	67,3	45,1
01/0098-36	70,0	67,9
01/0040-27	72,9	58,4
95/0109	67,0	37,5
TME 419	65,6	44,0

From this table we can observe first of all that in conjunction with the processors' remarks, the yields of the peeling unit operation are fairly similar between varieties, thereby overall confirming their good peelability. These yields varied from 64.2 % (96/0023) to 80.7 %, with a standard deviation of 5.25 % b.h.

Nonetheless, by means of physical measurements collected relating to weight, length and diameter, we can provide further indications as to more favorable root formats with a view to optimizing this unit operation. Hence it seems preferable, as Figures 7, 8 and 9 show, for the roots to be somewhat elongated, with a diameter of between 6 and 9 cm inclusive, and weighing between 800 and 1400 grams inclusive. The latter two specifications clearly highlight that the yield of the peeling unit operation under these manual conditions is due to the ease of handling of the roots by the operatives.

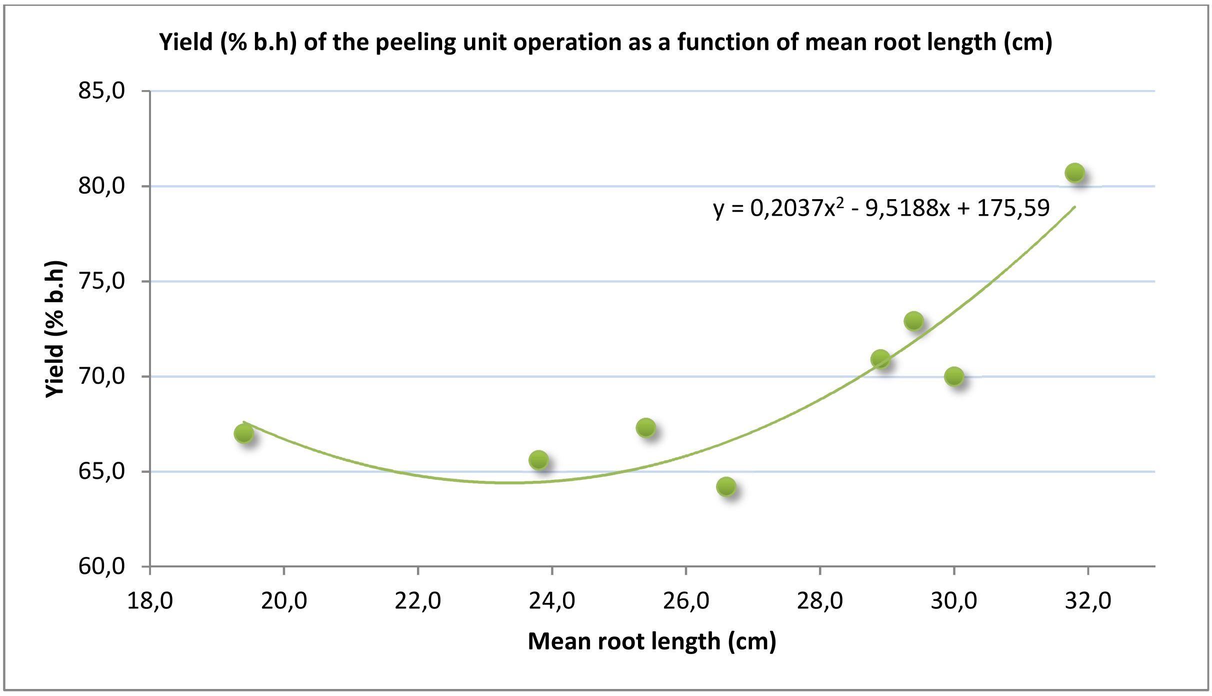

Figure 7: Evolution of yield (% b.h) of the peeling unit operation as a function of mean root length (cm)

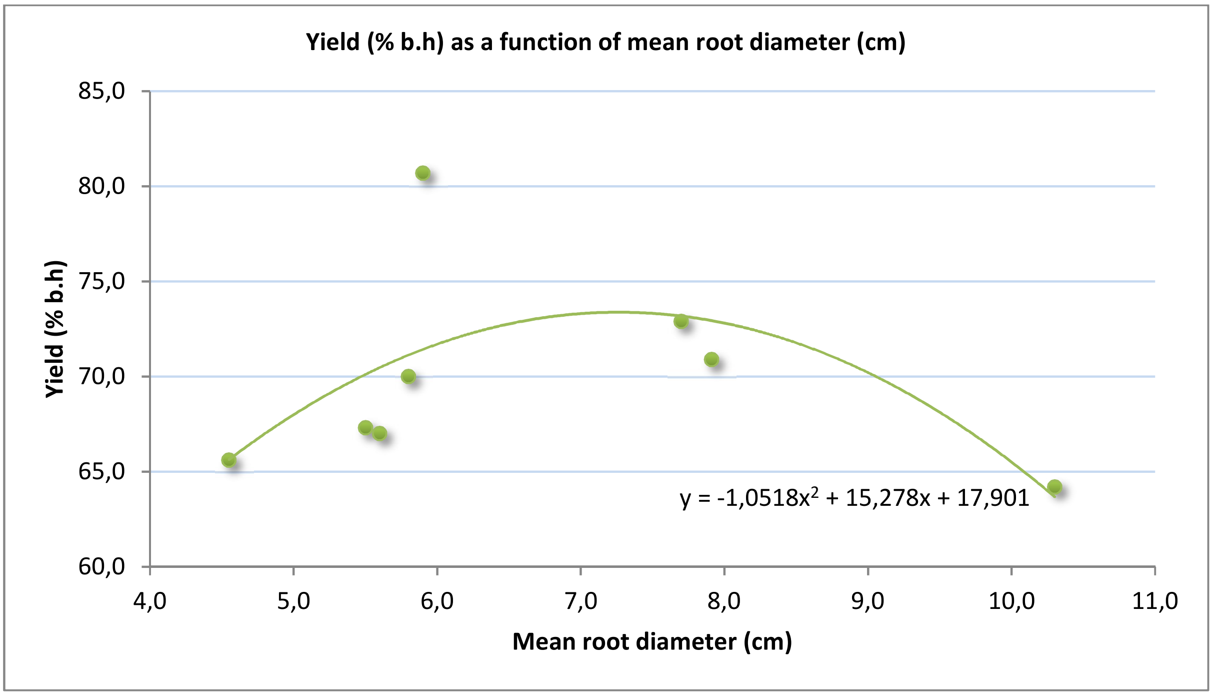

Figure 8: Evolution of yield (% b.h) as a function of mean root diameter (cm)

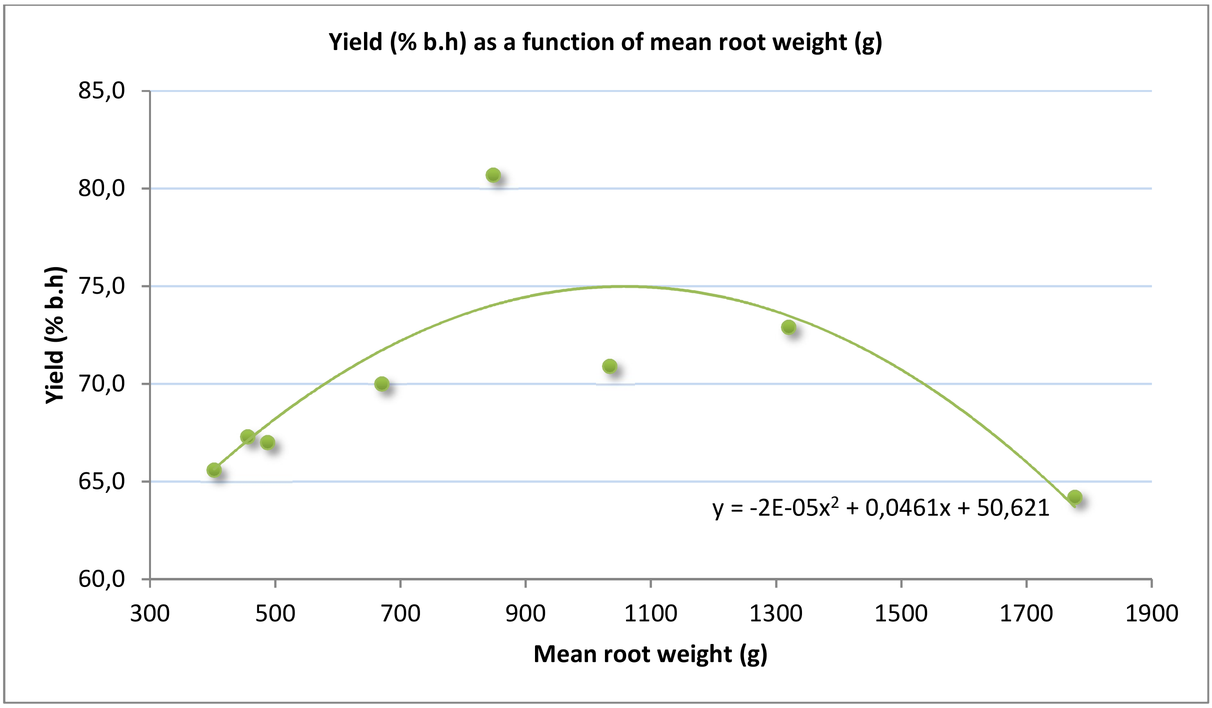

Figure 9: Evolution of yield (% b.h) as a function of mean root weight (g)

As regards productivity of the peeling unit operation, we can observe high variability with values varying by a factor of up to 2 between varieties 95/0109 and 96/0023, with productivity values of 37.5 and 72.1 kg/h/operative respectively. Quite logically, it is apparent as Figure 10 shows, that the larger the root size, i.e. the greater their mean volume, the more the unit operation productivity increases.

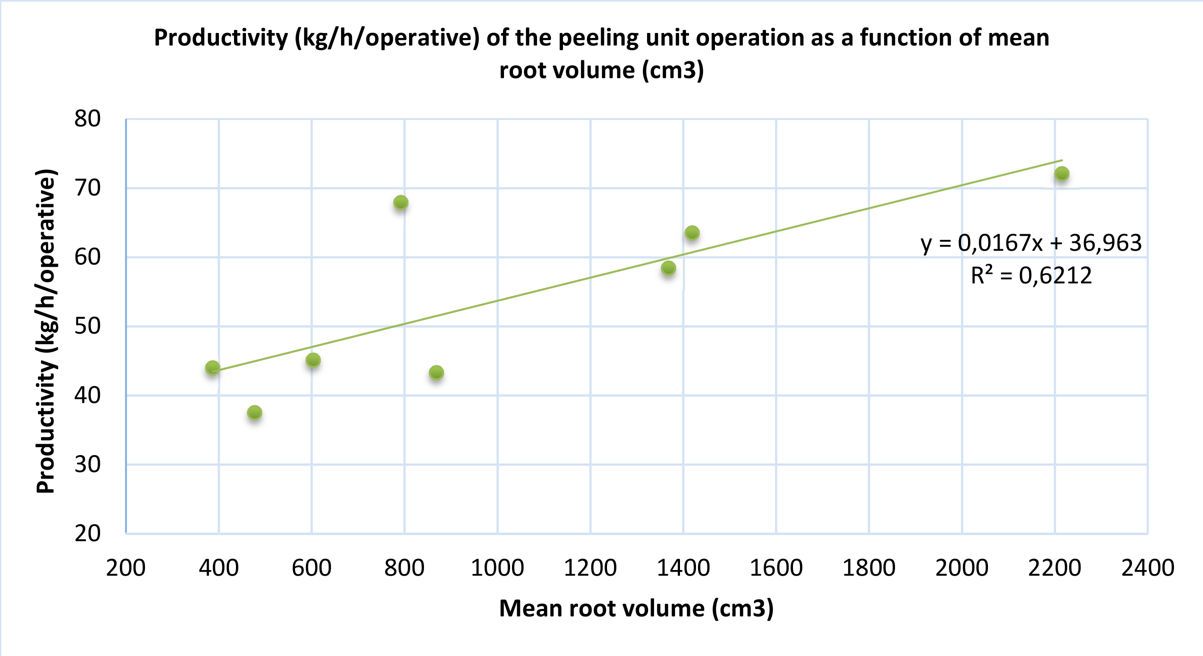

Figure 10: Evolution of productivity (kg/h/operative) of the peeling unit operation as a function of mean root volume (cm3)

STEEPING / RINSING

The steeping (or retting) unit operation is a traditional fermentation operation used to achieve several objectives:

- soften the flesh of the root with a view to facilitating subsequent fiber extraction,
- ensuring the characteristic baton flavor, derived from the presence of butyrates which are produced by anaerobic microbiological flora
- break down endogenous cyano-genetic compounds

For its implementation, this operation consists in immersing in water the peeled roots for 3 days (see Figure 11). Under tropical conditions the ambient temperatures, frequently of between 25 and 35 °C inclusive, cause the spontaneous start of lactic fermentation. The processors pay close attention to the behavior of cassava during this unit operation. Certain varieties seem to respond to this step poorly, with in particular very high risks of root softening, ultimately leading to “rotting” (according to comments by the operators), a black color appearing on certain parts of the root, which is deemed prohibitive.

As part of our tests, each cassava batch corresponding to each variety was immersed for 72 hours at ambient temperature in the following proportions:

Table 3: Conditions applied for the steeping (retting) unit operation

Steeping conditions			
Varieties	**V water (liters)**	**M dry matt.**	**Ratio**
01/0098	12,6	3,695	0,293
96/0023	10,0	3,282	0,328

8034	12,1	3,407	0,282
98/0581	12,2	3,278	0,269
01/0098-36	11,3	3,710	0,328
01/0040-27	11,6	3,179	0,274
95/0109	11,3	3,197	0,283
TME 419	10,5	3,538	0,337
		Mean	0,299
		Standard deviation	0,027

Figure 11: Steeping, + 24 h and + 72 h

To characterize this unit operation two main criteria were evaluated: yield and evolution of pH.

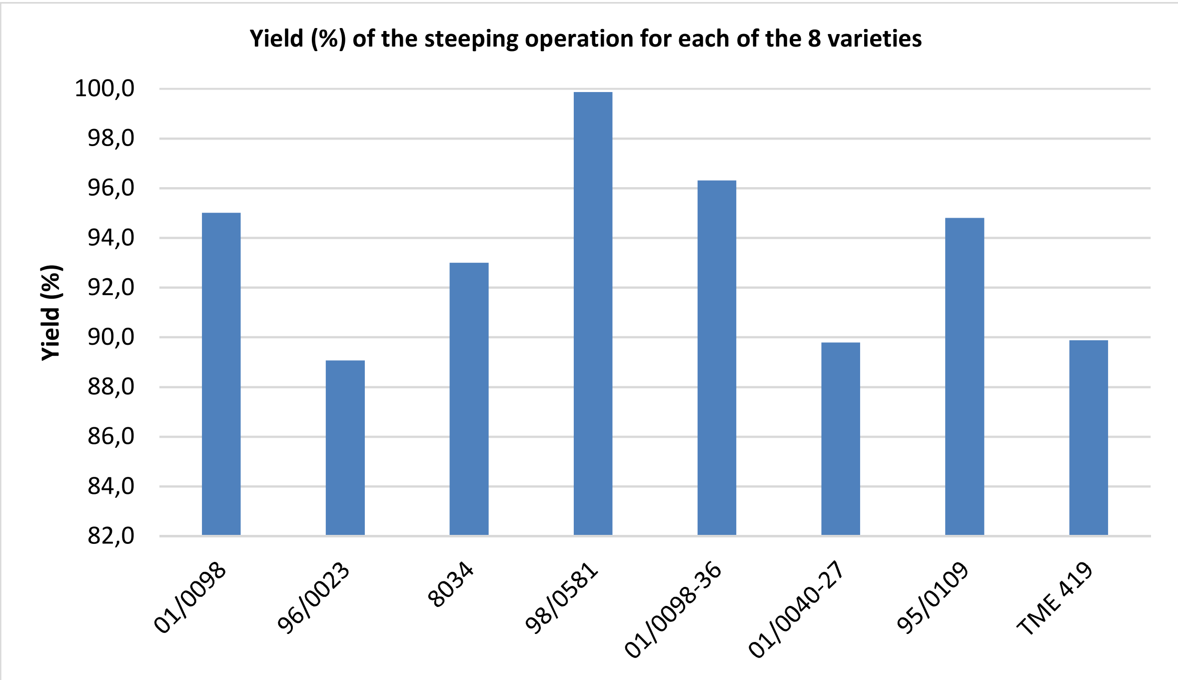

Figure 12: Yield (%) of the steeping operation for each of the 8 varieties

From Figure 12 we can observe that compared to the process' other unit operations, the steeping unit operation has little effect on yield. Nonetheless, we can observe differences between varieties with nearly no losses for variety 980581 and nearly 11 % losses for variety 960023.

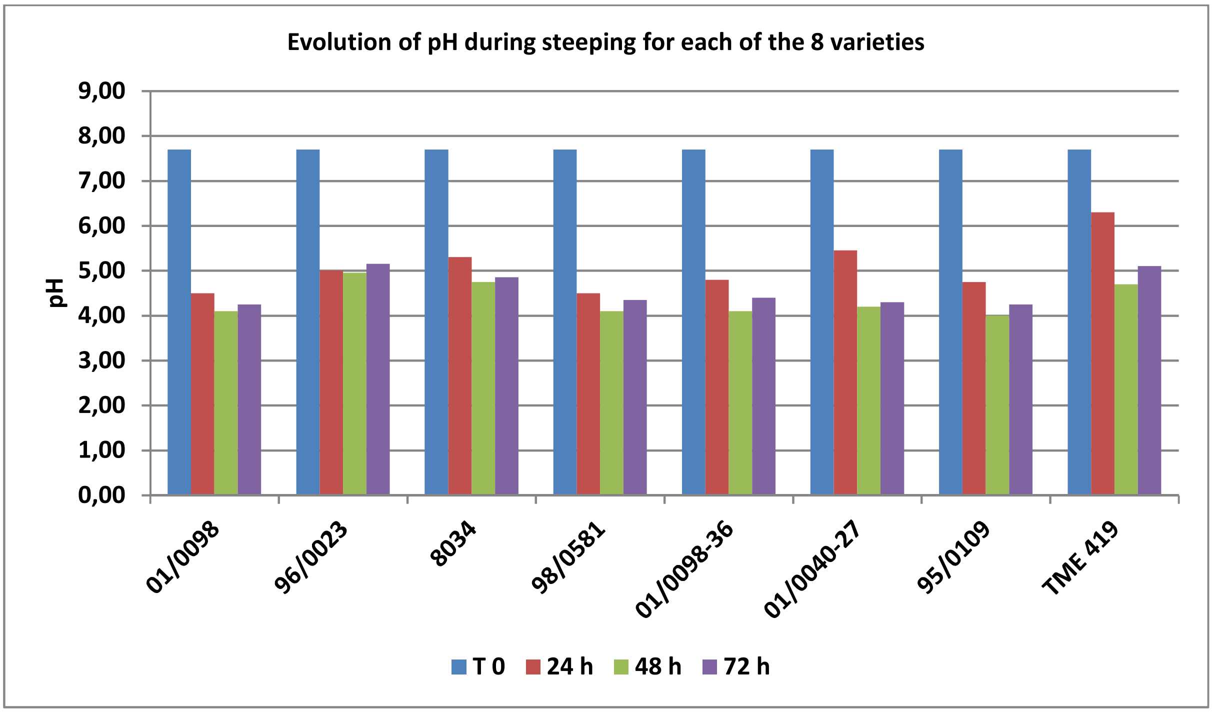

Figure 13: Evolution of pH during steeping for each of the 8 varieties

From Figure 12 we can observe that evolution of pH in the steeping system is the same for all 8 varieties. Hence pH falls very rapidly over the first 24 h, and then much more slowly over the next 24 h to reach values of between 4.10 and 4.95 inclusive. Then during the 3rd day we can observe a slight rise in pH with values of ultimately between 4.25 and 5.15 inclusive. This evolution confirms the data present in the literature, which explains this by successive developments of various lactic microbial flora, followed by the development of a yeast population.

After 72 hours' steeping, the root pieces are rinsed. This rinsing serves both to halt any fermentation and reduce the acidity.

FIBER EXTRACTION

Upon the end of the steeping operation, this operation consists in manually separating the fibers from the cassava pulp. The fibers can be separated from the root parts which have been softened by the steeping operation. The processors pay extra special attention to this operation, which can both prove very painstaking because of the abundance of fibers, and cause a fall in productivity, but which can also generate large losses in case of difficulty in separating the fibers and starch.

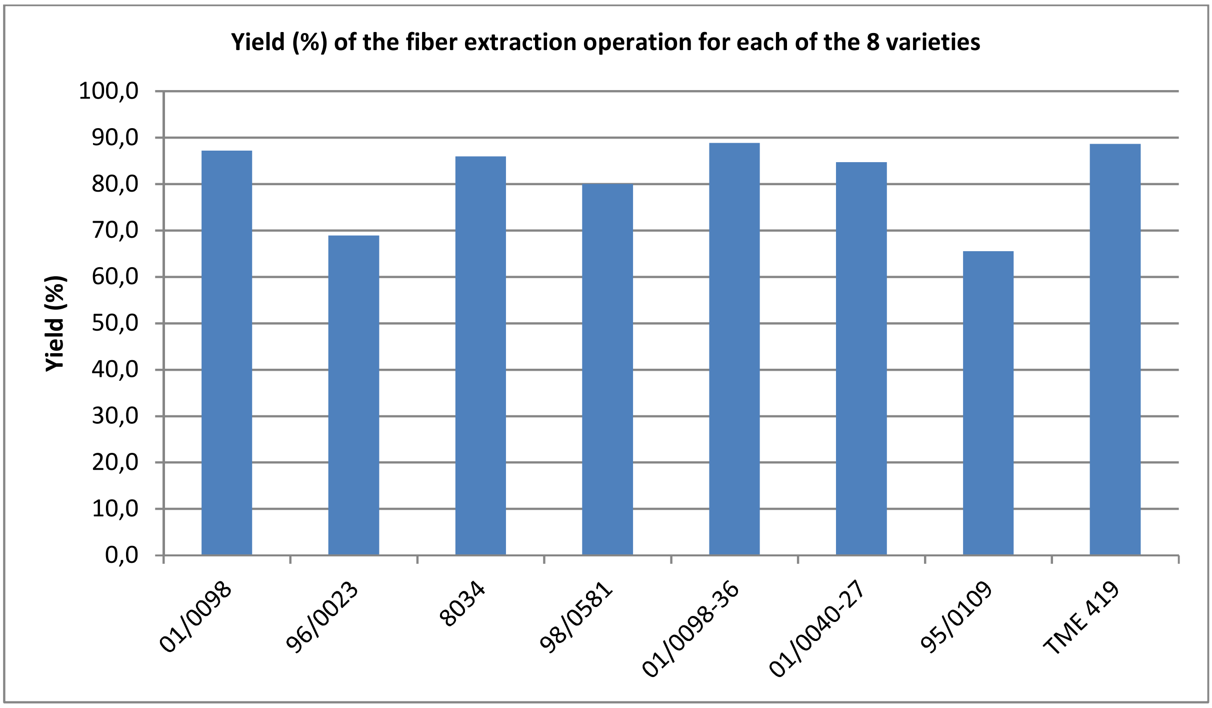

Figure 14: Yield (%) of the fiber extraction operation for each of the 8 varieties

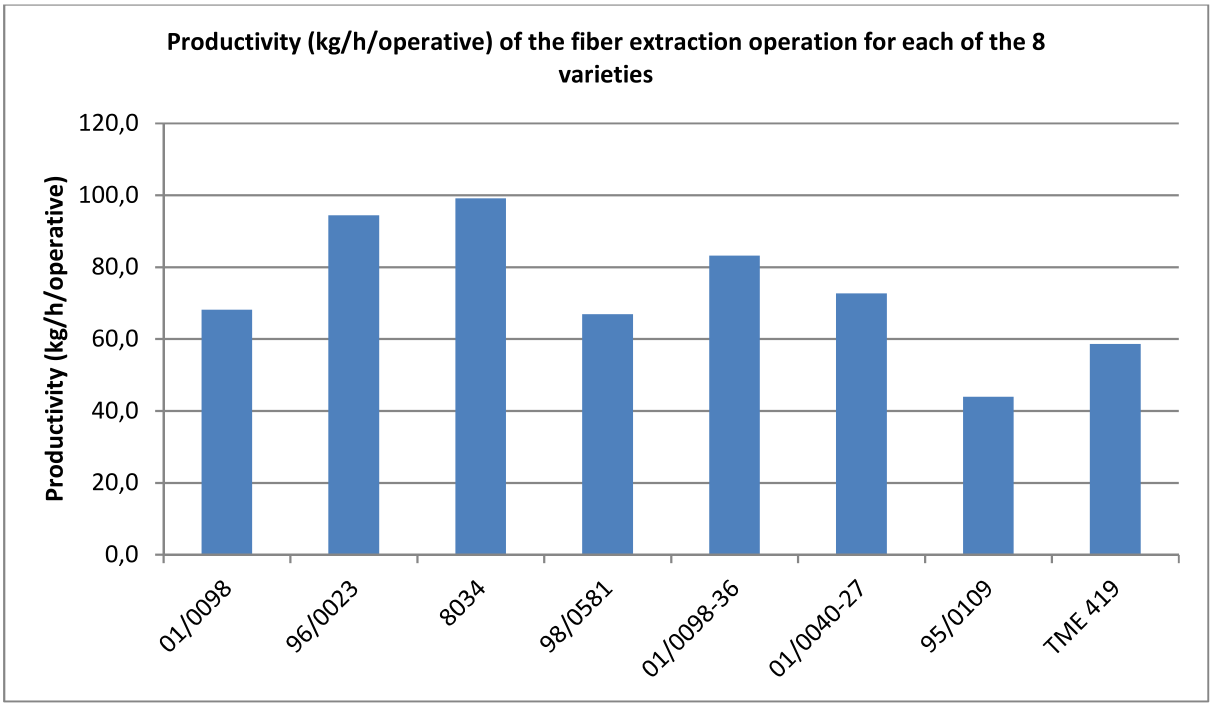

Figure 15: Productivity (kg/h/operative) of the fiber extraction operation for each of the 8 varieties

From Figures 13 and 14 we can observe that the yield of the fiber extraction operation and concomitantly its productivity may have big differences between varieties. Hence the yield may vary from 88.8 % for variety 01009836 to 65.5 % for variety 950109 (with a mean value across the 8 varieties of 81.2 %). Productivity meanwhile may vary by up to a factor of 2 between varieties 950109 and 8034, thereby going respectively from 43.9 to 99.1 kg/h/operative.

Hence we can realize this step is genuinely crucial regarding the profitability of this processing mode.

DRAINING / GRINDING

Following fiber extraction, the pulp is placed in braided polypropylene sacks stacked alongside each other, enabling the pulp to drain. We cannot really describe it as pressing of the pulp, but rather as draining, considering that this step also comprises temporary storage of the pulp before continuing its processing.

The fiberless and drained pulp is then heavily ground using traditional pestles (see Figure 16). The objective of this unit operation is to crush the pulp and achieve a particle size deemed optimal by the operatives when the pulp no longer sticks to the pestle. Due to its arduousness, this operation is reserved for men. Nonetheless in the absence of men or if there are large quantities to be ground, the processors may resort to using a customized disk mill (see Figure 17), which affects the financial profitability of the process.

Figure 16: Traditional pestle (Left, variety 01/0098; Right, variety 01/0040-27)

Figure 17: Disk mill

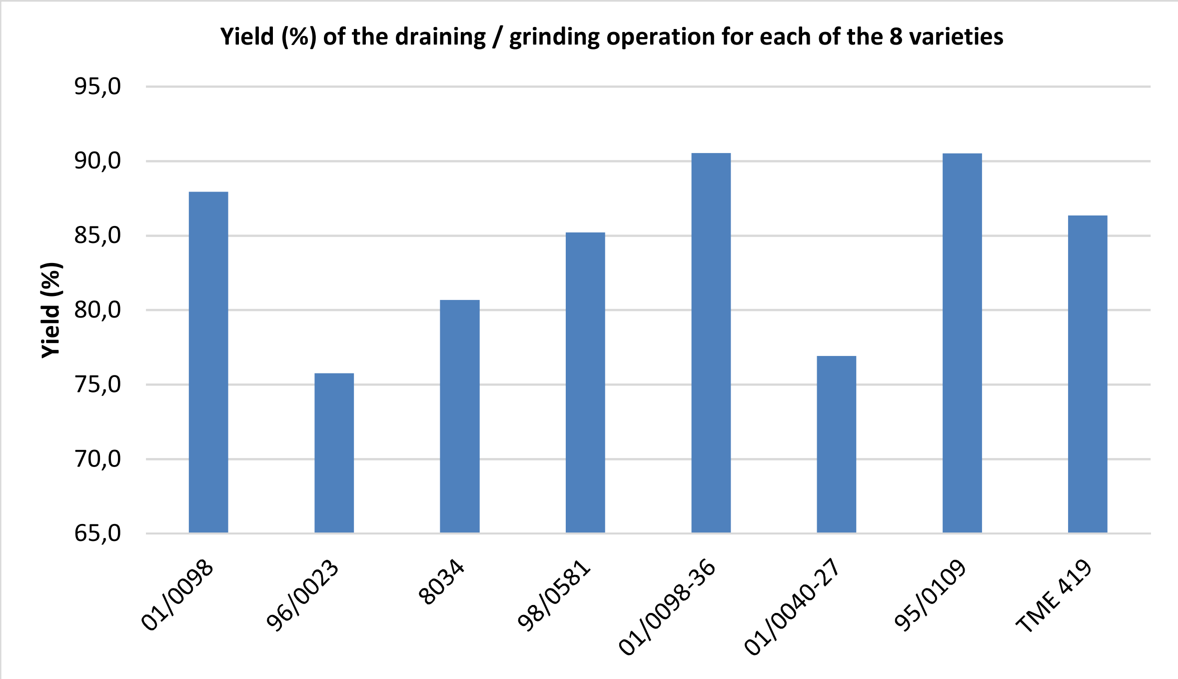

Figure 18: Yield (%) of the draining / grinding operation for each of the 8 varieties

From Figure 15 we can observe that during this step of the process, the yields vary between the varieties, with values of between 75.8 % and 90.5 % inclusive. The losses encountered here are mainly due to water loss from the product.

SHAPING

Upon the end of the grinding operation, the baton shaping step starts. This consists in placing the ground cassava pulp in leaves, so as to form a genuine package using braided banana plant fibers, which serves to protect the ground cassava pulp (see Figure 19). The type of leaf traditionally used, depending on the localities and local languages spoken, can be known by the following names: "Minken", "Nken", "Nyol", "Okendeng". They must be very fresh, and have no yellow coloration.

Figure 19: Baton shaping

This unit operation affects the process yield. This shaping has a real impact in terms of productivity. It is the unit operation with the lowest productivity, with a mean number of batons per production hour varying between the varieties from 15 to just 9 batons/h/operative. Depending on the mean weights measured, this corresponds to 4.3 and just 2.8 kg/hour/operative respectively.

The differences between varieties are due to the fact that during this painstaking task the operatives eliminate the residual faults present in the ground cassava pulp: pieces of coarse fibers, black spots etc. Hence we can observe that the variety with the best hourly productivity is 01/0098-36, which also corresponds to the variety with the best fiber extraction yield.

COOKING

The cooking operation is performed in pots heated over a wooden fire (see figure 20). This unit operation requires very good know-how, which only certain operatives have acquired and mastered. Hence the batons are placed on top of each other up to the top of the pot, and a quantity of water is then added. During our tests, the quantities of water added for each batch corresponding to each of the 8 varieties were 2 liters, with quantities of batons ranging from 4 to 7 kg. The flames are very high in order to rapidly bring the system to boiling point, to enable steaming and limit water intake by the batons placed at the bottom of the pot; since such a water intake is deemed prohibitive, giving the baton a darker color and a stickier texture. It should be noted that the conditions applied at the start of cooking are not homogeneous in the pot, since the batons placed at the bottom of the pot are practically completely immersed.

The cooking time is set and known by certain operatives, with in our case a specified cooking time of 40 minutes. In order to characterize this cooking operation, the temperature was monitored at various points of the cooking system, as shown in Figure 16.

From Figure 21 we can observe that the cooking time actually applied is 35 minutes. In terms of temperature applied, we can observe a baton heating time up to 100 °C of between 10 and 12 minutes inclusive, depending on the position of the baton (bottom vs. top of pot). Finally, we can also observe a logical difference between the peripheral (or surface) temperature of the batons and their core temperature. Nonetheless these differences remain small given the total cooking time, with a minimum time (baton positioned at the top of the pot and baton core temperature) at a temperature above 80 °C (gelatinization point of starch) of 18 minutes. Hence we can consider that the cooking time and conditions applied must enable good cooking and gelatinization of the starch.

Figure 20: Cooking system instrumentation

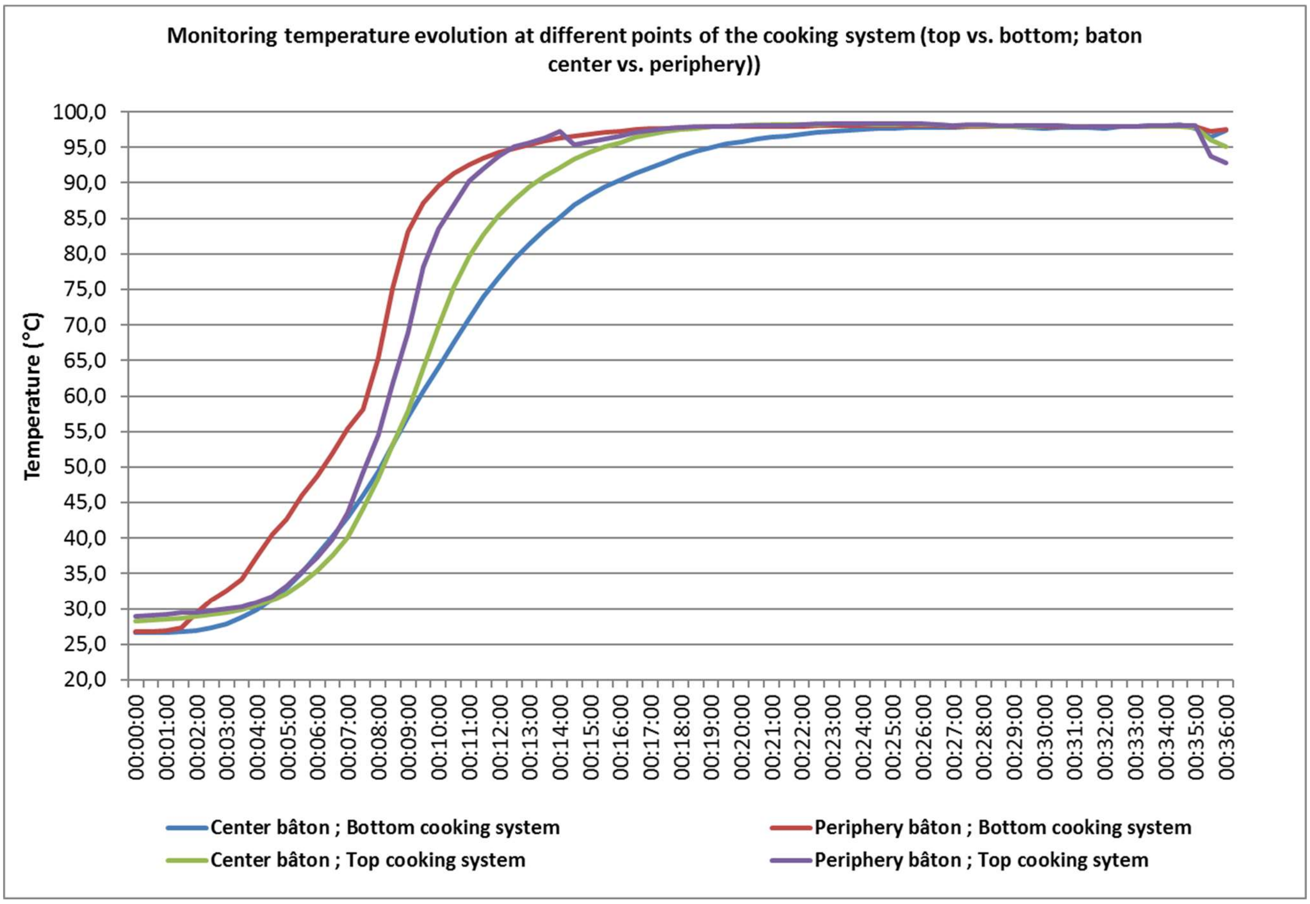

Figure 21: Monitoring temperature evolution at different points of the cooking system (top vs. bottom; baton center vs. periphery)

BEHAVIOR OF THE DIFFERENT VARIETIES

YIELD

Figure 22 reveals the evolution of overall yield (% b.h) over the course of processing. Hence we can observe that variety 01/0098 exhibits the best processing yield, obtaining nearly 64 kg of batons, i.e. a quantity of 206 ready-for-sale batons, from 100 kg of raw material.

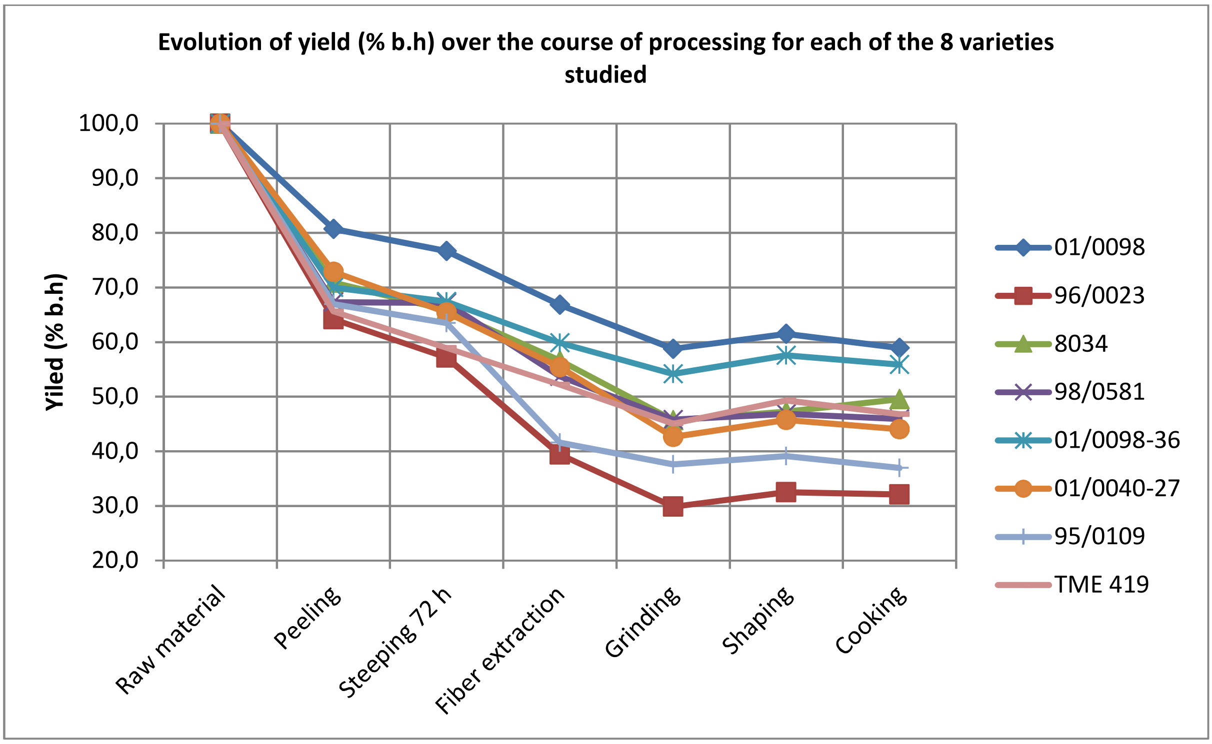

Figure 22: Evolution of yield (% b.h) over the course of processing for each of the 8 varieties studied

Figure 23 Highlights the weight of each of the unit operations on the overall yield (% b.h) of the process. Hence we can observe that the yield is affected mainly by the unit operations of peeling, fiber extraction and grinding/crushing.

Variety 01/0098 obtains the best overall yield, achieving this result thanks to handling the peeling operation very well. We can also note that variety 01/0098-36, with the 2nd best overall yield, is heavily penalized by this same peeling operation. This variety obtains very good yield results for the fiber extraction and grinding operations. The yield difference in peeling between these 2 varieties seems to be due to the fact that variety 01/0098-36 is smaller in size than 01/0098, with mean weights of 670 and 848 g respectively.

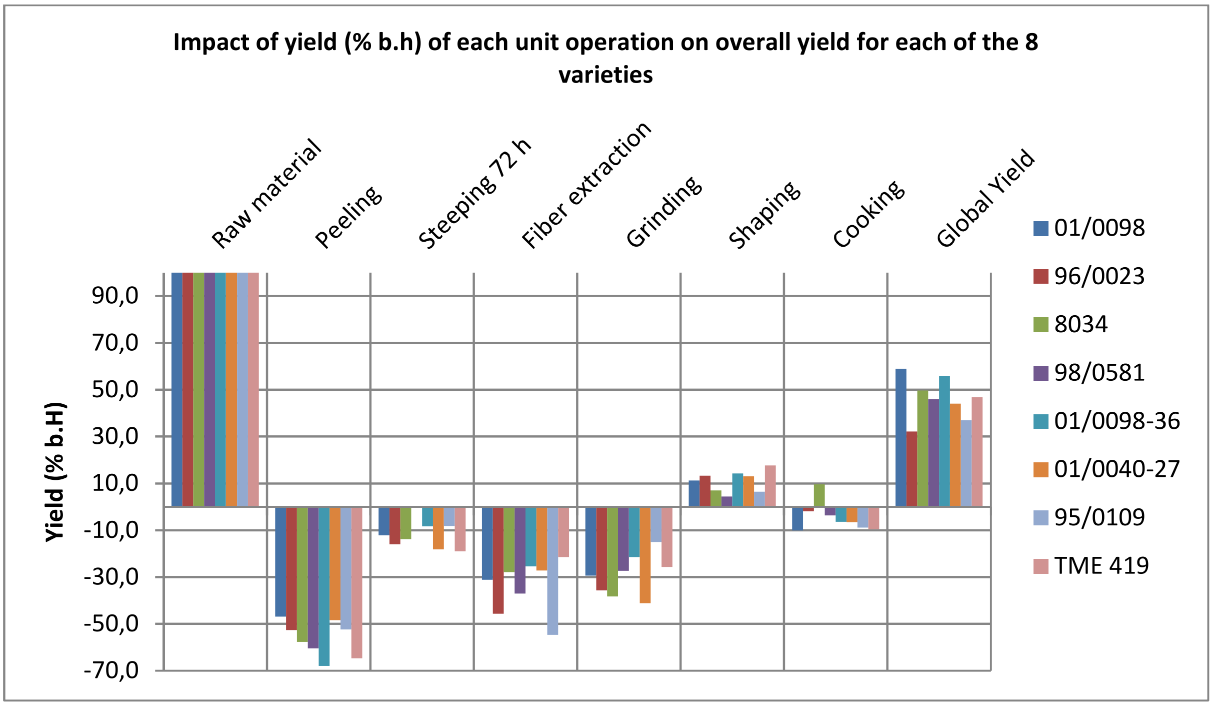

Figure 23: Impact of yield (% b.h) of each unit operation on overall yield for each of the 8 varieties

PRODUCTIVITY

From Figure 24 we can observe that the productivity of this process is low, with in particular 2 highly limiting unit operations, grinding and baton shaping, with mean productivity values of 12.9 and just 3.3 kg/h/operative respectively. The peeling and fiber extraction operations meanwhile are at higher productivity levels, and within the same range, with mean productivity values of 54 and 74 kg/h/operative respectively.

We can also observe that for the peeling operations, which heavily affect the overall yield, as well as for the fiber extraction operation, deemed very important by the operatives, varieties 8034, 96/0023, 01/0098-36 and 01/0040-27 stand out from the other varieties, with better productivities.

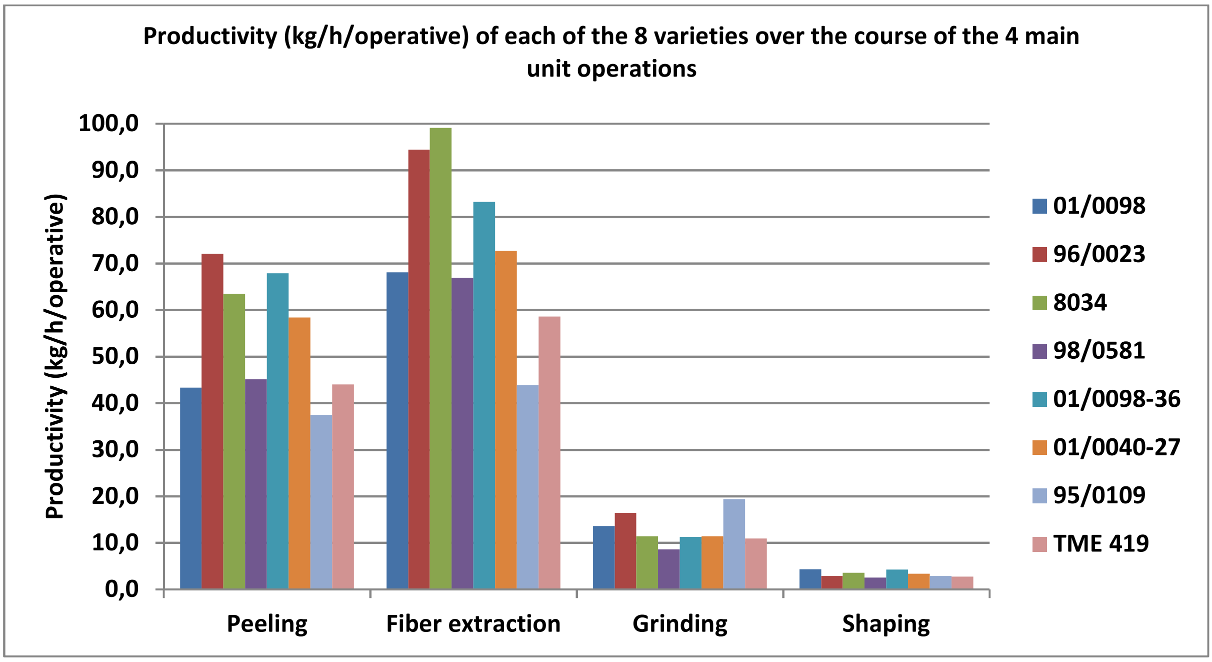

Figure 24: Productivity (kg/h/operative) of each of the 8 varieties over the course of the 4 main unit operations

The low productivity of this process is due to the fact that very few unit operations are mechanized, and that all of these remain manual. The processors offset this by employing a large workforce, which can enable them to produce up to 400 batons per production day.

To increase this productivity, the grinding and baton shaping operations would be the priority for improvement. Work on the grinding should make it possible to specify the particle size level obtained by the pestle, and make the link between the desired particle size and the textural and rehydration characteristics of the batons, which would give an objective to achieve by using mechanical crushers. Regarding the baton shaping operation, equipment development is yet to be studied, in order to facilitate traditional braiding using banana fibers.

As regards the peeling and fiber extraction operations, improvements could be made to this process by transferring certain technologies proven in other cassava processing modes. Fiber extraction could be improved in conjunction with the works conducted on grinding. The ability to fine-grind some of the residual fibers would enable less advanced fiber extraction, and so facilitate improving the productivity of this unit operation.

RANKING

In order to determine the varieties with the best processability under the yield and productivity variables measured, a score was constructed by adding the various standardized scores for each variable. The latter were obtained by dividing the score obtained by one variety (F) by the best score obtained among the 8 varieties (Fmax): S = F/Fmax

Table 4: Score obtained for each of the 8 varieties, under the main variables measured

Varieties	Peeling				Fiber extraction				Grinding		Shaping		Overall aggregate score	Classification
	Yield (% b.h)	Normalized score	Productivity (kg/h/operatrive)	Normalized score	Yield (% b.h)	Normalized score	Productivity (kg/h/operatrive)	Normalized score	Productivity (kg/h/operatrive)	Normalized score	Productivity (kg/h/operatrive)	Normalized score		
01/0098	80,7	1,00	43,3	0,60	87,2	0,98	68,1	0,69	13,6	0,70	15,5	1,00	4,97	**3**
96/0023	64,2	0,80	72,1	1,00	68,9	0,78	94,4	0,95	16,4	0,85	9,2	0,59	4,96	**4**
8034	70,9	0,88	63,5	0,88	85,9	0,97	99,1	1,00	11,4	0,59	13,0	0,84	5,15	**2**
98/0581	67,3	0,83	45,1	0,63	80,0	0,90	66,9	0,68	8,6	0,44	9,2	0,59	4,07	**8**
01/0098-36	70,0	0,87	67,9	0,94	88,8	1,00	83,2	0,84	11,3	0,58	15,3	0,99	5,22	**1**
01/0040-27	72,9	0,90	58,4	0,81	84,7	0,95	72,7	0,73	11,4	0,59	12,0	0,77	4,76	**5**
95/0109	67,0	0,83	37,5	0,52	65,5	0,74	43,9	0,44	19,4	1,00	9,5	0,61	4,14	**7**
TME 419	65,6	0,81	44,0	0,61	88,6	1,00	58,6	0,59	10,9	0,56	9,6	0,62	4,19	**6**

Hence we can observe that the 4 best varieties for baton production among the 8 studied are: 01/0098-36, 8034, 01/0098 et 96/0023

CONCLUSIONS

The production tests conducted in conjunction with the processors' observations have made it possible to describe in detail the cassava baton processing mode, and to consolidate this description by material balances and productivity measurements. Under these 2 main criteria and among the 8 varieties studied, the response to each unit operation varied in greater or lesser proportions. Hence four varieties, 01/0098-36, 8034, 01/0098 and 96/0023, stood out by exhibiting the best yield-productivity compromise. It should be noted that the yellow-colored variety 01/0040-27 came in fifth position, thereby giving it a relatively good processability. These tests also made it possible in the field to contribute to selecting baton batches aimed at consumer testing conducted immediately after the production runs, in order to have fresh batons sufficiently representative of the quality of the batons present on the market.

ANNEX 1 SCHEDULE

Lundi	Mardi	Mercredi	Jeudi	Vendredi	Samedi	Dimanche	Lundi	Mardi
11-mai	12-mai	13-mai	14-mai	15-mai	16-mai	17-mai	18-mai	19-mai
Arrivée Yaoundé	Planification mission Achat petit matériel Approche Mbalmayo	Récolte racines Epluchage Mise en trempe	Matin observation racines trempe Mbalmayo Après midi : Focus group Génération descripteur - Mbalmayo Rédaction V1 Questionnaire	Matin observation racines trempe Mbalmayo + repérage lieu pour réaliser test conso Après midi : Formation équipe test conso + achat matériel complémentaire test conso - Yaoundé	Fin trempe : rinçage	Matin Mbalmayo : séparation fibres / broyage / mise en forme / cuisson Après midi : sélection 5 variétés pour test conso	Test consommateur Mbalmayo (40 consommateurs) AB retour France	Test consommateur Mbalmayo (40 consommateurs)

RESEARCH PROGRAM ON
Roots, Tubers and Bananas

The CGIAR Research Program on Roots, Tubers and Bananas (RTB) is an alliance led by the International Potato Center implemented jointly with Bioversity International, the International Center for Tropical Agriculture (CIAT), the International Institute of Tropical Agriculture (IITA), and the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), that includes a growing number of research and development partners. RTB brings together research on its mandate crops: bananas and plantains, cassava, potato, sweetpotato, yams, and minor roots and tubers, to improve nutrition and food security and foster greater gender equity especially among some of the world's poorest and most vulnerable populations. www.rtb.cgiar.org

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