

Participatory Processing Diagnosis of Boiled Cassava in Uganda

Understanding the Drivers of Trait Preferences and the Development of Multi-user RTB Product Profiles, WP1

Kampala, Uganda, June 2020

Sophia HAMBAL, National Crops Resources Research Institute (NaCRRI), Kampala, Uganda

Ann Ritah NANYONJO, NaCRRI, Kampala, Uganda

Michael KANAABI, NaCRRI, Kampala, Uganda

Robert Sezi KAWUKI, NaCRRI, Kampala, Uganda

Alexandre BOUNIOL, Centre de coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Montpellier, France (Validator)



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Ethics: The activities, which led to the production of this document, were assessed and approved by the CIRAD Ethics Committee (H2020 ethics self-assessment procedure). When relevant, samples were prepared according to good hygiene and manufacturing practices. When external participants were involved in an activity, they were priorly informed about the objective of the activity and explained that their participation was entirely voluntary, that they could stop the interview at any point and that their responses would be anonymous and securely stored by the research team for research purposes. Written consent (signature) was systematically sought from sensory panelists and from consumers participating in activities.

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ABSTRACT

At NaCRRRI, activity four, a component of WP1, involved participatory processing of boiled cassava; this hinged on Step 2 that focused on gendered food mapping. Accordingly, key processing operations important for quality boiled cassava were identified by processors resident in Apac and Luweero districts in Uganda. Survey results indicated that the main processing steps were: peeling, trimming and steaming. However, there were variations in processing roots after trimming. For example, while sliced cassava roots in Luweero were wrapped in banana leaves and steamed, in Apac, sliced roots were immersed in water and boiled. Some consumers in Apac pounded boiled cassava slices into a mash.

No significant differences in yield were observed amongst cassava genotypes. Nonetheless, some varieties like “*Alanyo dyer*” and “*Nase 13*” which were susceptible to CBSD, had low yield after processing. End-user attributes preferred during processing cassava roots in Apac were: white flesh colour, ease of peeling and a firm root; least preferred attributes included hard to peel, spongy in the middle, and roots which do not cook easily. On the other hand, preferred attributes in Luweero included: easy to peel, white flesh colour, no fibres on the surface of peeled root, a non-lignified/woody (‘telina ekitti’), no bitter taste, smooth root surface, and a firm flesh; undesirable attributes included: lignified/woody root and spongy in the middle. This information was consequently incorporated into the consumer questionnaire that was used for Step 4.

Key words: Attributes, boiled cassava; end-users, processing; processing.

1 STUDY CONTEXT AND GENERAL OBJECTIVES

Within frameworks RTBfoods project, activity four of work package one (WP1) involved participatory processing and/or preparation demonstrations of boiled cassava. Step 3 constituted the second stage of boiled cassava profile following on from Step 2 which focused on gendered food mapping. Accordingly, during the activity, the key processing unit operations important for quality of boiled cassava were identified by processors, and consequently incorporated into the consumer questionnaire that was used for Step 4. Step 3 was done together with processors with the aim of getting a better understand of their quality characteristics preferences while preparing boiled cassava.

2 METHODOLOGY

2.1 Study area

A state of knowledge study conducted at the beginning of work package 1 (WP 1) revealed central and northern regions in Uganda as locations of high cassava production. Thus, Luweero and Apac districts were selected in central and northern regions as locations for Steps 2, 3 and 4 of WP 1 basing on UBOS 2010, data. Luweero is lies in central Uganda between 00 50N and 32 30E at latitude 0.8333 and longitude 32.500. While Apac lies in Northern Uganda between longitudes 32° East and 34° East and latitude 20 North and 30 North.

2.2 Raw material choice

Four to five cassava varieties (both landraces and improved) including the most preferred and least preferred varieties from each of the two districts as reported under Step 2, were used in this study. Accordingly, five varieties were selected in Apac (Bao, Alanyo Dyer, NASE 14, NAROCASS 1 and TME 14), while in Luweero four varieties (Bwanjule, NASE 13, NASE 14 and Nabwangu) were selected.

The varieties from Apac and Luweero were obtained from farmers in these localities. Generally, one varieties was obtained from a farmer's field. However, there were some cases where cassava roots from more than one variety would be obtained from the same field. Overall, the cassava roots were obtained from plants that had reached physiological maturity (twelve months). Three processor demonstrations were conducted in Apac while two were done in Luweero. For each demonstration, a processor processed one variety until production of the final product. The total number of processors from apac were 15 while 8 processors in participated in Luweero.

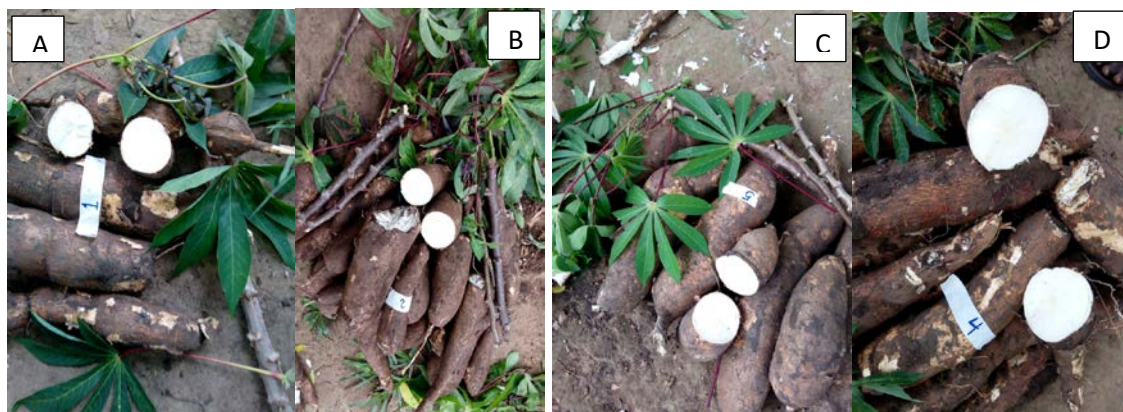


Figure 1. Some varieties processed into boiled cassava product. A) NAROCASS 1 (Improved variety); B) Alanyo dyer (Local variety); C) TME 14 (Improved variety) and D) BAO (Local variety from Apac)

2.3 Product profile processing

Cassava roots were processed following three major steps namely, peeling, slicing/trimming and boiling. In order to determine yield and productivity of each variety during processing, cassava roots were weighed at different processing steps. Accordingly, cassava roots were weighed when they were raw (before peeling), after peeling, chipping and boiling using a portable balance. Moreover, time taken to complete each processing step was measured using a stop clock. Therefore time taken to peel, chip and boil cassava roots was measured.

For each variety, 2 kg of fresh cassava roots were processed. Most of the varieties were prepared on the day they were harvesting apart from a few scarce ones such as Alanyo dyer, Nabwangu and Njule which were kept for a night before processing. It suffices to note that cassava roots were processed between 30 to 60 minutes after harvest. Timely processing was done to minimise deterioration since cassava roots are highly perishable.

Yield (Y) and productivity (P) were determined by the formulas below.

$$Y = \frac{\text{weight of boiled cassava roots}}{\text{Raw cassava roots}} * 100$$

$$P = \frac{\text{Quantity of processed cassava (kg)}}{\text{Time X n operator}}$$

3 RESULTS

3.1 Apac district

3.1.1 Product profile process description

Unit operations of product profile process

The schematic process for preparation of boiled cassava in Apac is shown in Figure 2. Generally, boiled cassava was prepared in the same way by immersing roots in water and thereafter boiled until when roots were ready Figure 3. In Apac, there is variation in preparing boiled cassava. Indeed boiled cassava is either consumed as slices of cassava or a product called “mogo myeno” is prepared by further size reduction of the boiled slices, followed by boiling and mashing. This report gives an account of the product consumed as slices of boiled cassava roots.

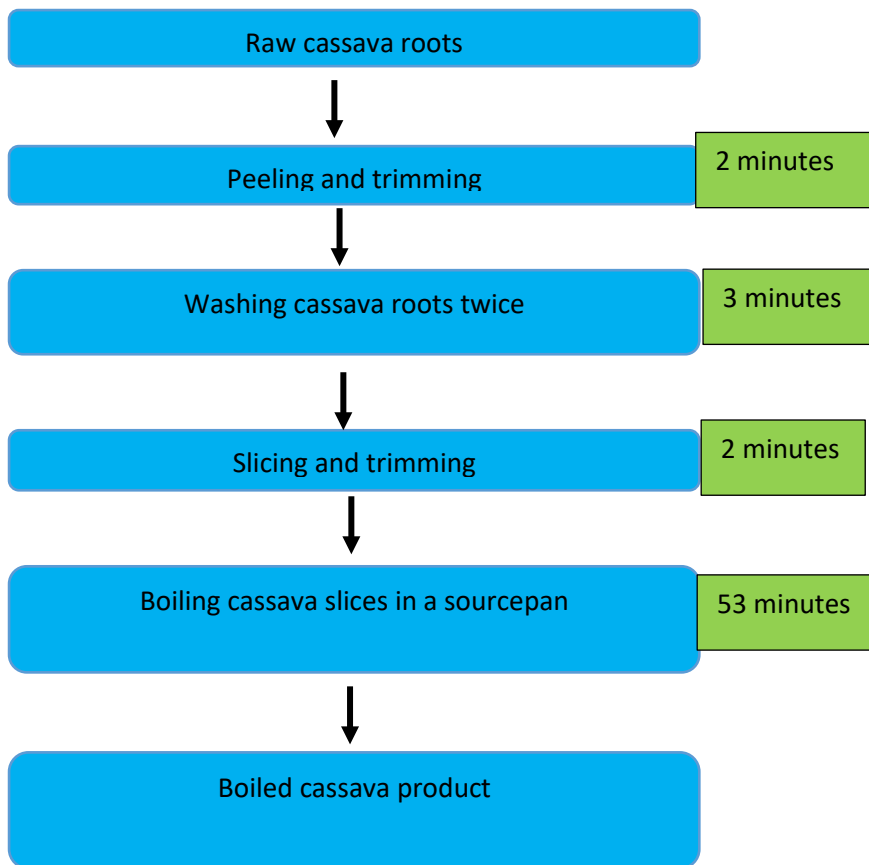


Figure 2. Schematic flow of preparing boiled cassava in Apac, northern Uganda



Figure 3. Pictorial illustration of the process of preparing boiled cassava product in Apac, northern Uganda. A) Peeling and Trimming; B) Washing; C) Slicing and Trimming; D) Immersion in water; E) Boiling; F) Boiled cassava product

Unit operations characterization

Material losses during preparation of boiled cassava

Inevitably, during the process of boiled cassava preparation, materials losses occurs at various stages (Figure 4). Highest material loss occurred at root peeling and/or trimming stage (28 % w.b), followed by size reduction i.e., at chipping and/or trimming stage where 11% w.b of material is lost. Although, the process involves addition of water prior to boiling, there was a net weight loss of ~ 4% w.b after boiling. This is probably a case of amylose leaching, where loss in amylose from the root due to direct interaction with water lead to a net loss in weight. The leached amylose oozes out of the starch granule and goes into the solution. Overall, 43% (w.b) of the original cassava root was lost during the preparation of boiled cassava in Apac.

Yield of different varieties during different processing steps

Data on yielding ability of the different cassava varieties during processing is presented in Figure 5. It was evident that NASE 14 had the highest overall yield followed by Bao, NAROCASS1, TME14, and Alanyo dyer. However, anova results done using SAS at $P>0.05$ showed no significant differences in yield (% w.b) for all of the varieties. This trend was consistent with material loss during processing, with NASE 14 and Alanyo dyer registering the lowest and highest losses respectively. Alanyo dyer is susceptible to cassava brown streak disease thus its cassava roots had visible brown streaks. These brown streak patches needed were trimmed during peel. Such trimming of roots with visible symptoms of contributed to loss of materials as observed in Alanyo dyer

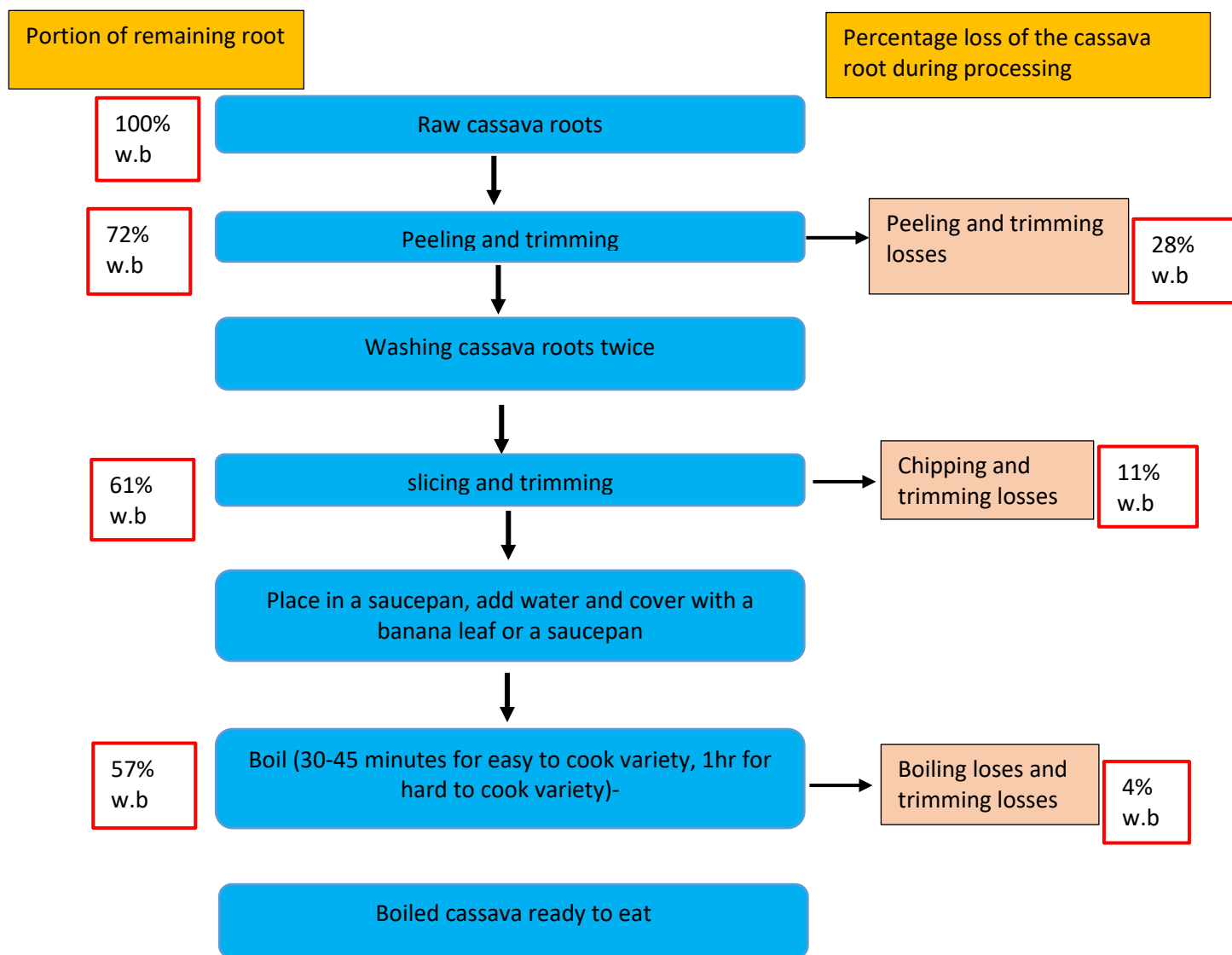


Figure 4. Schematic flow of loss (w.b) of material during the preparation of boiled cassava in Apac, northern Uganda

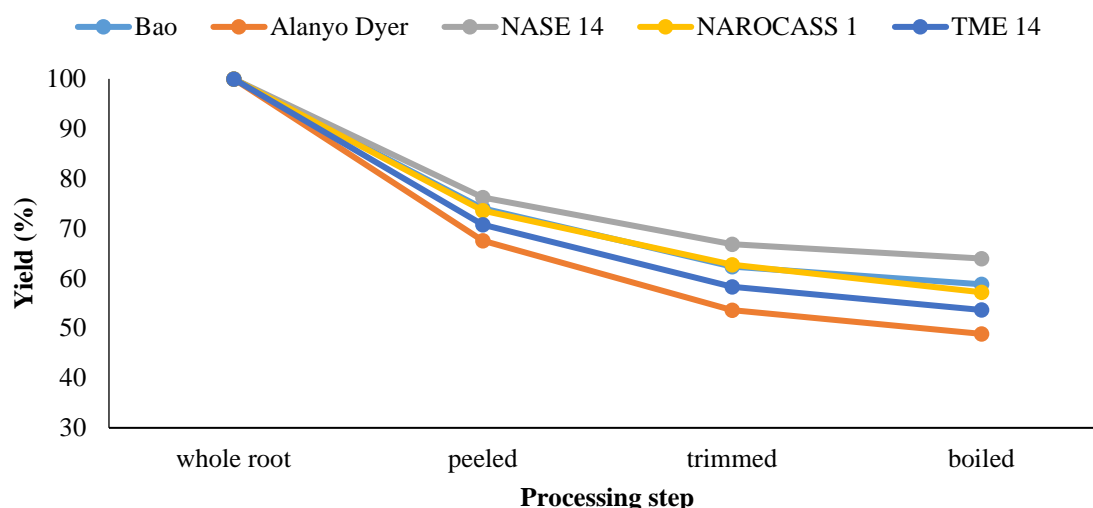


Figure 5. Yielding ability of different cassava varieties during processing in Apac, northern Uganda

Cassava varietal productivity during processing in Apac

Preparation of boiled cassava is a simple process which has three main unit operations namely peeling, trimming and boiling. Peeling and trimming productivity was not significantly different for varieties as shown by anova results processed with SAS at $P > 0.05$. However, both steps had a significantly higher productivity compared to boiling for all the varieties (Figure 6). This is mainly attributed to a shorter peeling time compared to the duration of boiling. Peeling productivity for the five varieties in descending order was TME 14, NASE 14, Bao, Alanyo dyer and NAROCASS 1. This could be used as an indicator of the ease of peeling for the respective varieties. In regards to trimming productivity, TME 14 had a higher productivity than the rest of the varieties Figure 6.

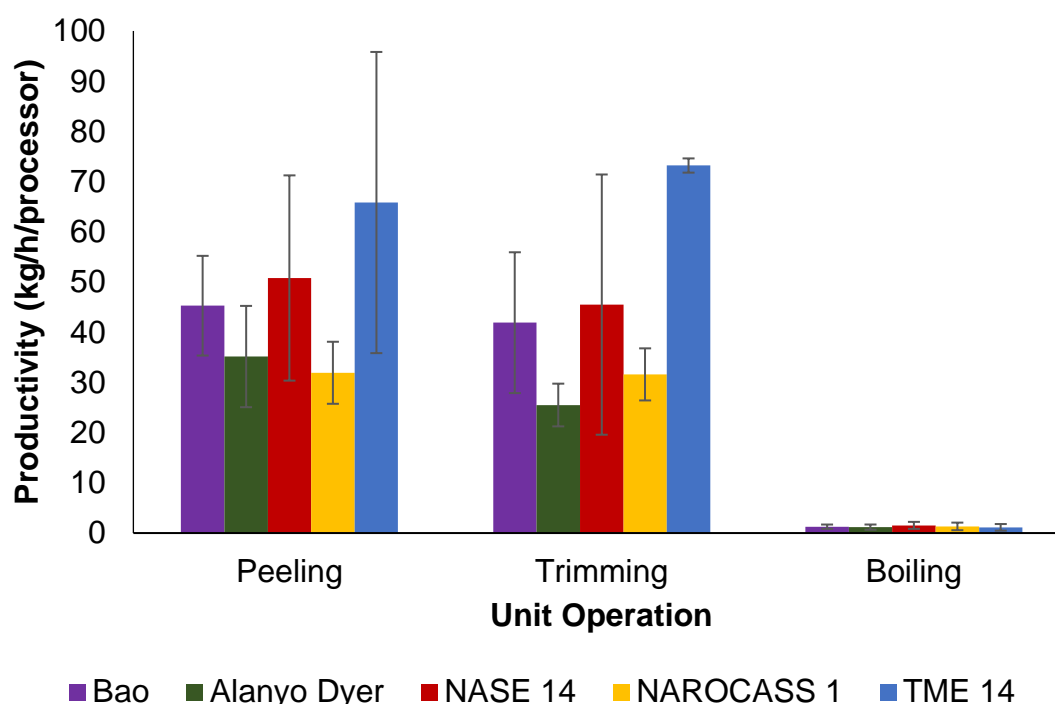


Figure 6. Productivity (kg/h/processor) performances of cassava varieties during peeling, trimming and boiling operations in Apac, northern Uganda

3.1.2 Cooking time of varieties processed

Cooking time for the varieties processed in Apac is shown in Figure 7. It was measured from the time the raw cassava (immersed in water in a saucepan) was placed on fire to the time the processor deemed it ready to eat. Cooking time was not significantly different among the varieties ($p>0.05$). According to the processors, the cooking ended when cassava was ready to eat. This was determined when 'the boiling sound' dies down gradually indicating that boiling water is almost dried up and, one could press the boiling roots with a fork to make sure it is soft and ready. Also a good smell of boiled cassava was indicative of readiness though it was hard for the processors to describe the smell.

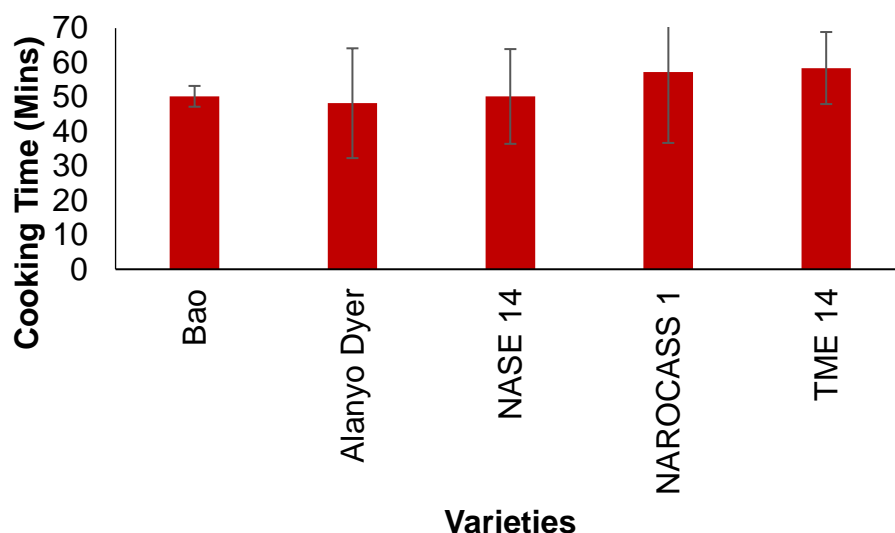


Figure 7. Cooking time of cassava varieties in Apac

3.1.3 Quality characteristics of raw and boiled cassava during preparation in Apac district

Preferred end-user traits for boiled cassava before, during and after preparation are presented in Table 1. Regarding raw cassava roots, the most preferred end-user root quality characteristics are smooth skin, white flesh colour and little sweet taste, while the undesirable characteristics are bitter taste, hard and dry skin, and yellowish flesh colour. During processing, preferred end-user root quality characteristics were white flesh colour, ease of peeling and firm root. On the other hand, least preferred characteristics were hard to peel, spongy in the middle, and roots which do not cook easily. For the final product, preferred end-user root quality traits are stickiness, softness, white colour, and sweet taste. On the other hand, least preferred traits were not mealy, fibrous, bitter taste, yellowish colour, hard and glassy texture ('muwuta').

Table 1. End-user root quality characteristics of raw and boiled cassava for 15 processors in Apac

Quality characteristics of raw cassava roots		Quality characteristics of boiled cassava roots	
When buying or after harvesting	At each step of process/preparation		Final ready to eat product
<p>List of the most liked characteristics</p> <p>Appearance</p> <ul style="list-style-type: none"> -smooth skin (3)- no fibre (1) -no brown spots (1) -big root (1) -white colour (3) -not rotten (1) <p>Odour</p> <ul style="list-style-type: none"> -fresh odor (2) <p>Texture when touching</p> <ul style="list-style-type: none"> -firm (2) -not spongy (1) -brittle (1) <p>Taste when Biting</p> <ul style="list-style-type: none"> -not bitter (1) -little sweet (3) 	<p>Peeling</p> <ul style="list-style-type: none"> -Easy to peel (3) -sappy (sticky) (1) -white colour (3) -smooth peel (2) -no fibre (1) -firm (1) <p>Washing</p> <ul style="list-style-type: none"> -no spots (2) -no black/brown stripes (2) -smooth root (1) -white colour (2) -glossy (1) <p>Chipping</p> <ul style="list-style-type: none"> -firm (3) -white colour (1) -not watery (2) <p>Boiling</p> <ul style="list-style-type: none"> -cassava odor (2) -cooks easily (1) -no colour change (1) 	<p>Appearance</p> <ul style="list-style-type: none"> -White colour (5) <p>Odour</p> <ul style="list-style-type: none"> -cassava odor (2) <p>Texture when Touching</p> <ul style="list-style-type: none"> -soft (5) -sticky (7) -no fibres (1) <p>Taste</p> <ul style="list-style-type: none"> -not bitter (2) -sweet (5) <p>Texture in mouth</p> <ul style="list-style-type: none"> -mealy (1) -soft (5) -sticky (1) 	

List of the least liked characteristics

-brownish flesh

(1)
-yellowish flesh

(2)
-rotten (1)
-rough skin (1)
-watery/glassy

(1)
-has fibres (1)

Texture when Touching

- hard & dry skin (2)
-spongy flesh (1)

Taste when Biting

- bitter taste (3)

Peeling

colour-Hard to peel

colour

Appearance

-non homogeneous colour (1)
-watery/glassy (4)
-has fibres (5)
-yellowish colour (4)

Chipping

- spongy in the middle
-no cassava odor (1)

Boiling

Does not cook fast-hard
Uniform texture (2)
Watery/glassy (4)

Odour

Texture when touching

Taste

-bitter taste (4)
-flat taste (kiir) (3)

Texture in mouth

-hard (2)
-not mealy (6)
-has fibres (3)

Figures in parentheses represent number of citations of characteristic

3.2 Luweero district

3.2.1 Product profile process description

Unit operations of product profile process

Steaming is the predominant method of boiled cassava preparation in Luweero Figure 8. This involves wrapping of roots in banana leaves prior to steaming Figure 9. Thus, the wrapped roots are not in direct contact with water during the boiling. Cassava was also prepared by conventional boiling by immersion in water and thereafter, mixed with other sauce (especially beans), and thus boiled together (“katogo”). The schematic process for preparation of steamed, boiled cassava and/or cassava mixed with beans “katogo” is presented in Figure 8.

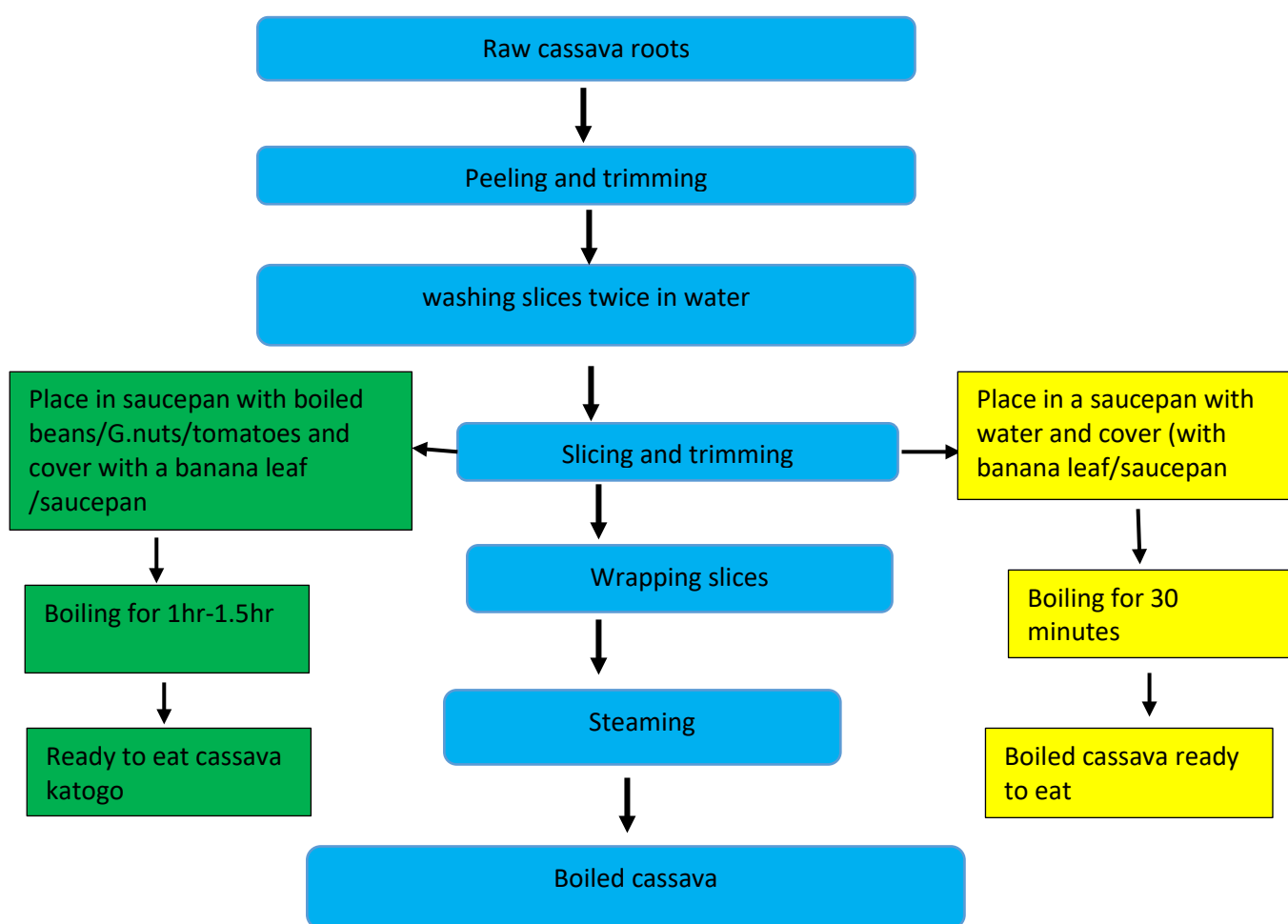


Figure 8. Schematic flow of process for preparation steamed, boiled cassava, and that mixed with beans (“katogo”) in Luweero, central Uganda.



Figure 9. Pictorial illustration of preparing cassava roots into boiled product by steaming in Luweero. A) Peeling; B) preparing source pan; C) placing Wrapped in source pan; D) wrapped cassava in source pan covered with banana leaves; E) cooking by steaming; F) cassava slices after steaming

Unit operations characterization

Material losses during preparation of boiled cassava

Material losses involved during the preparation of boiled cassava in Luweero is presented in Figure 10. Again, highest losses were observed during peeling (34% w.b) and followed by chipping and/or trimming (12% w.b). Just like in Apac, boiled cassava preparation involved addition of water prior to steaming. The steaming processes also registered a net loss of weight (6% w.b). This could be due to amylose leaching where loss in amylose from the root due to direct interaction steam may cause loss in weight. However, a follow up investigation needs to be done to make conclusions. Overall, 52% of original cassava root weight was lost (Figure 10)

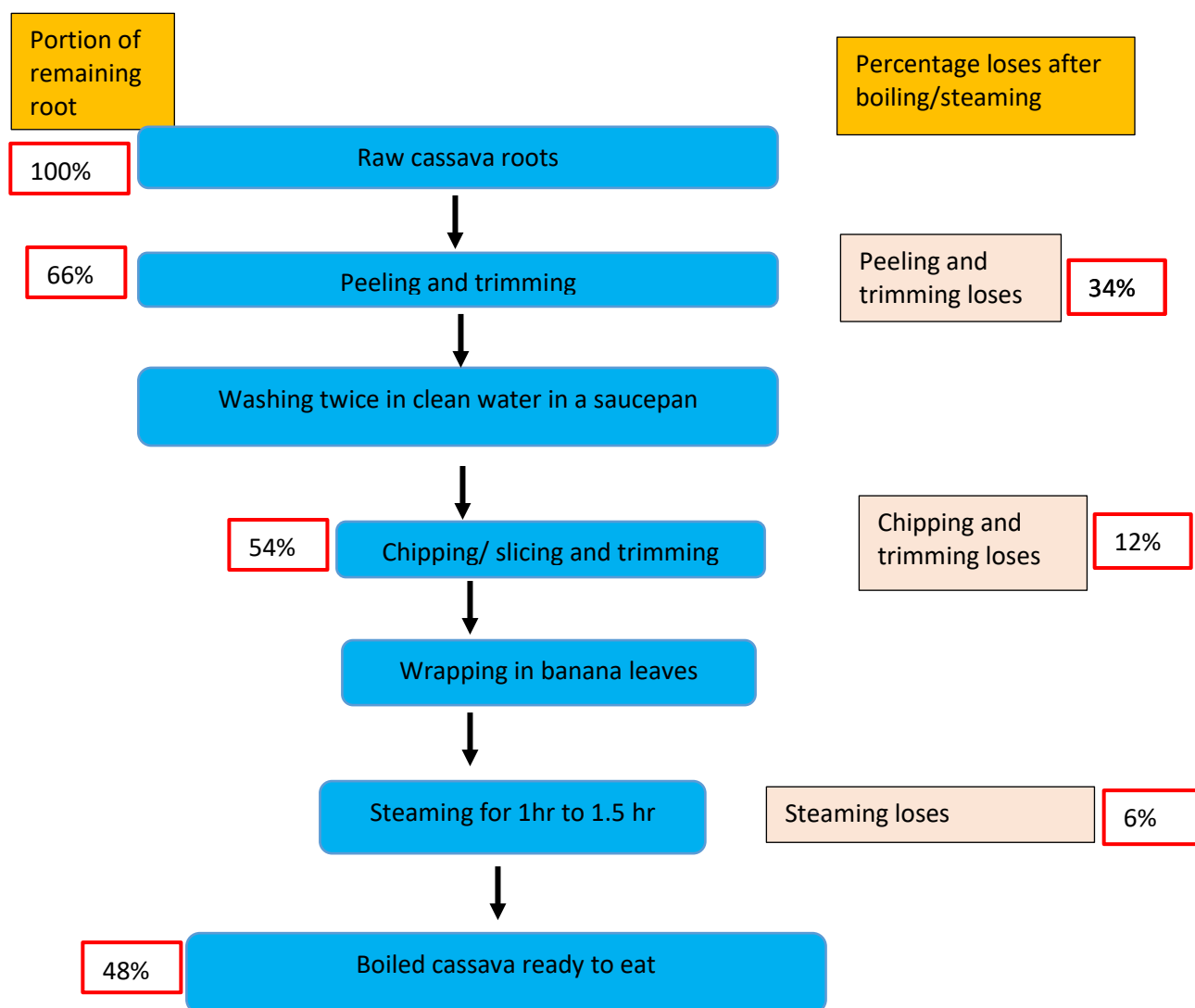


Figure 10. Schematic flow of loss (% w.b) of material during the preparation of boiled cassava in Luweero, central Uganda.

Yield of different varieties during different processing steps

Yield of different varieties during processing is presented in Figure 11. The local variety Bwanjule had the highest yield, followed by Nabwangu, NASE 14 and NASE 13. Nonetheless, there were no statistical differences ($P < 0.05$) with regard to yield after peeling and steaming. However, yield after trimming for Bwanjule was significantly higher than NASE 13 ($P < 0.05$). This could be attributed to greater trimming of NASE 13 usually associated with removal of woody or infected parts. Overall, less weight loss from peeling to trimming was observed for NASE 14 (Figure 11). The local variety Nabwangu marginally gained weight during the steaming process. The local variety Nabwangu marginally gained weight during the steaming process. It can be hypothesized that Nabwangu has more friable roots that easily absorb water. On the other hand, the starch granules of NASE 14 had the lowest ability to absorb water thus lowest yield.

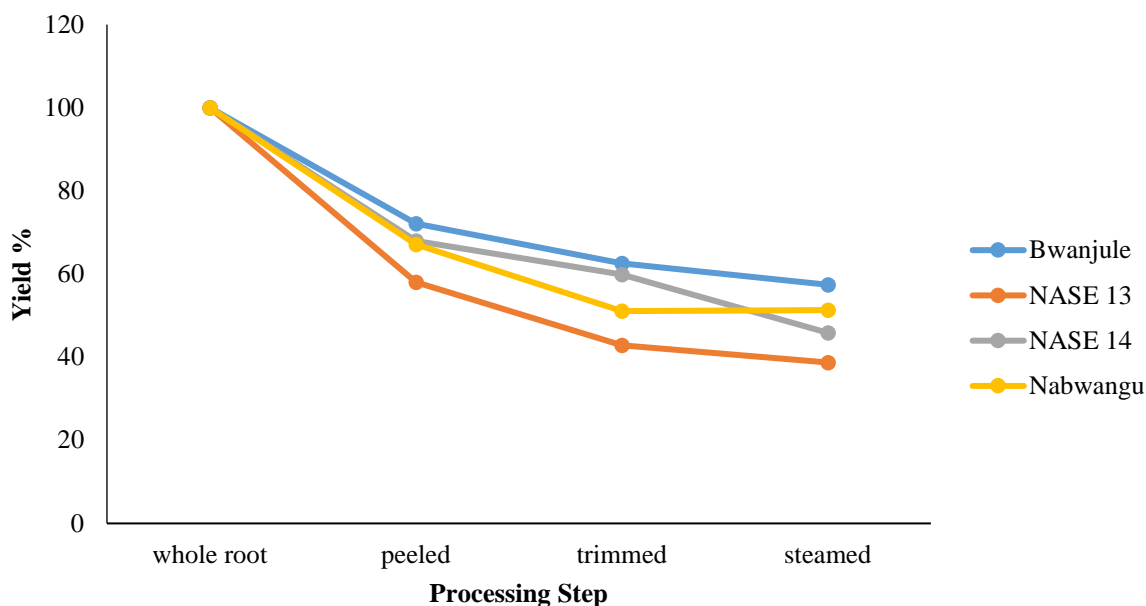


Figure 11. Yielding ability of different cassava varieties during processing in Luweero, central Uganda

Cassava varietal productivity during processing in Luweero

Just like in Apac, preparation of boiled cassava in Luweero largely consisted of three main unit operations, peeling, trimming and steaming. Overall, peeling and trimming productivity were not significantly different ($P > 0.05$). However, both had a significantly higher productivity than steaming, with local varieties Nabwangu and Bwanjule having higher productivity (Figure 12).

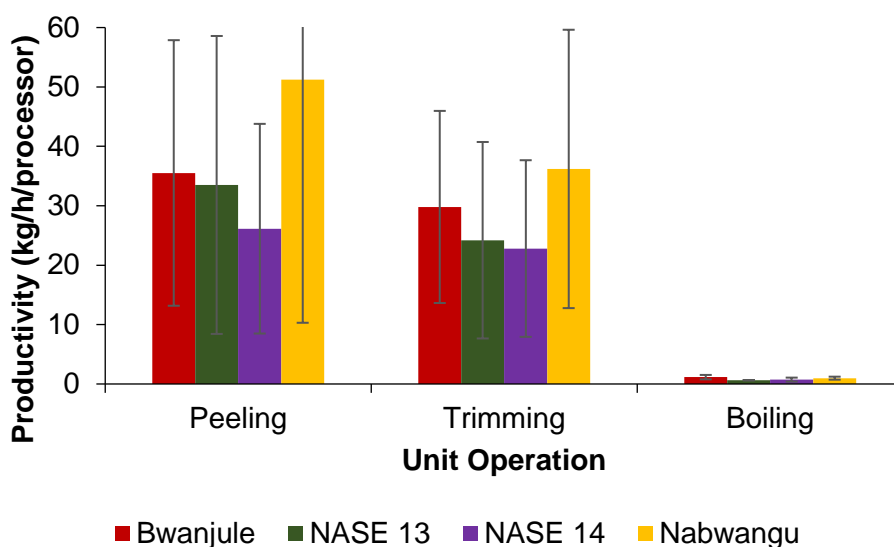


Figure 12. Productivity (kg/h/processor) performances of cassava varieties during peeling, trimming and boiling operations in Luweero, central Uganda.

3.2.2 Cooking time

Cooking time for the varieties processed in Luweero is shown in Figure 13. It was measured from the time the source pan with raw cassava (wrapped in banana leaves) was placed on fire to the time the processor deemed it ready to eat. Cooking time was not significantly different among the varieties ($p > 0.05$), but the local varieties Bwanjule and Nabwangu had a relatively shorter cooking time. End of cooking/steaming was determined by the brown coloration of the banana leaves used for

steaming, reduced cooking sound and water in the pan. Steamed cassava is soft when pressed with a fork.

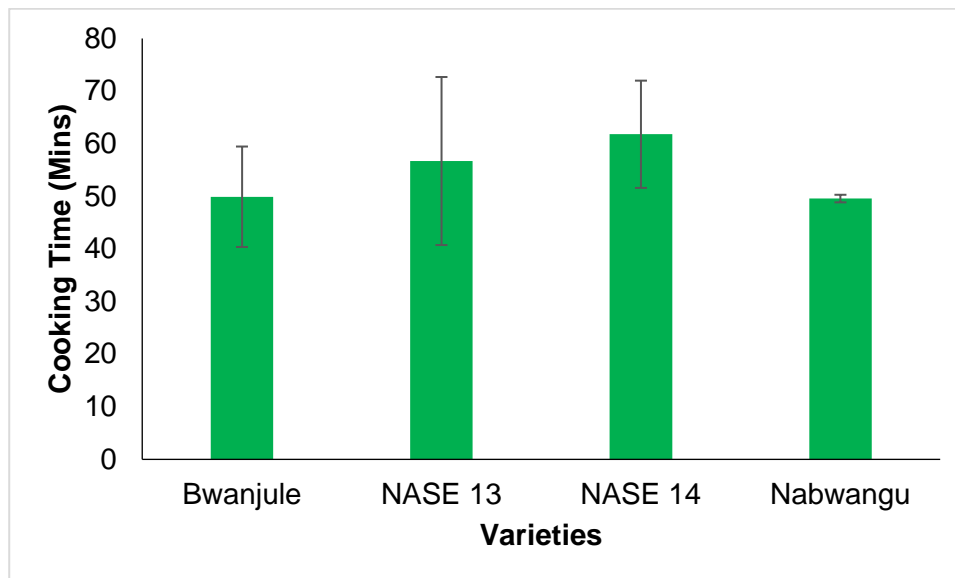


Figure 13. Cooking time of cassava varieties in Luweero

3.2.3 Quality characteristics of raw and boiled cassava during preparation in Luweero district

Preferred end-user characteristics for boiled cassava before, during and after preparation are presented in Table 2. For raw cassava roots, the most preferred end-user characteristics included roots that are not watery/glassy, not lignified/woody and have a sweet taste, while the undesired characteristics included bitter taste, lignified/woody root surface and watery/glassy roots. During processing, the preferred characteristics were; roots which are easy to peel, white flesh colour, no fibres on the surface of peeled root, a non-lignified/woody ('telina ekitti'), no bitter taste, smooth root surface, has a firm flesh, non- spongy especially in the middle and good smell of the steaming cassava. On the other hand, least preferred characteristics were lignified/woody root and spongy in the middle. Preferred end-user characteristics of boiled cassava were white colour, soft, sticky, good taste and mealy. On the other hand, least preferred characteristics were steamed cassava with yellow colour, is hard, has fibres, is watery/glassy and has a bitter taste.

Table 2. End-user root quality characteristics of raw and boiled cassava for 8 processors in Luweero, central Uganda.

	Quality characteristics of raw cassava roots	Quality characteristics of boiled cassava roots
List of the most liked characteristics	When buying or after harvesting Appearance -no brown flesh colour (1) -no fibres (1) -smooth skin (1) -white flesh colour (1) -big root (1) Odour -good odour of cassava (1) Texture when Touching -not watery (not “muwutta”) (2) -Not lignified/woody (“ekitti”) (2) Taste when Biting -sweet taste (2) -Not bitter (1) - Appearance -watery/glassy (2) -yellow colour (1) -has fibres (1)	At each step of process/preparation Peeling -easy to peel (2) -white flesh colour (2) -no fibres on surface of peeled root (2) -not lignified/woody (ekitti) (2) -no bitter taste (2) Washing -smooth root surface (2) -glossy root surface (1) -white flesh colour (2) Chipping -Firm flesh (2) -Not spongy especially in the middle (2) -white flesh colour (2) Steaming -good smell/aroma of the steaming cassava (2) Peeling -not easy to peel (1) -lignified/woody root (2) -rough/corrugated skin (1) -yellow/black/brown flesh (1)
		Final ready to eat product Appearance - white colour (4) Odour - cassava odour (1) Texture when Touching - soft (5) - sticky (2) Taste - good taste (4) Texture in mouth - mealy (6) - soft (2) Appearance - yellow colour (3)

List of the least liked	Odour	Chipping	Odour
		- spongy in the middle (2) -non-homogeneous colour (1) steaming	-no cassava odour (1)
	Texture when Touching		Texture when Touching
	-lignified/woody root surface (2)		-hard (2) fibres (2)
			-watery/glassy (2)
	Taste when Biting		-not sticky (1)
	-bitter taste (2)		Taste
			-bitter taste (3)
			-no cassava taste (1)
			Texture in mouth
			-hard (2) -not mealy (1)

*Number of citations of characteristic in bracket

4 CONCLUSION

Cassava in Uganda is processed into the boiled product following three major steps namely; peeling, trimming, boiling/steaming. There is variation in the boiled cassava product processed from central and northern Uganda. Accordingly, in northern Uganda, cassava is immersed in water and boiled while in central Uganda it is wrapped in banana leaves and steamed. This can influence the trait preferences of boiled cassava product processed in both regions. Results on yield showed higher losses at peeling and trimming thus, breeders need to release varieties with attributes that can reduce yield losses especially at such processing steps. This will enable women to have enough food on the plate for their families after processing the boiled product. Moreover, productivity results revealed the need for breeders to release cassava varieties that cook fast in order to increase productivity at boiling step. This will enable the women to reduce the cost of processing boiled cassava in terms of reduced amount of fuel needed. Key trait preferences in Apac and Luweero are similar but ranked differently. For example for raw cassava roots in Apac, smooth skin, white flesh are key while in Luweero, not glassy, not woody, not fibrous and bitter are key. This confirms the importance of product profile based breeding in order to release varieties that suit the needs of men and women who process cassava differently.

5 APPENDICES

5.1 Appendix 1. Summary table of quantitative data

Varieties/Location	Processing quantitative data								
	Peeling unit operation						Boiling unit operation		
	Peeling time (min)	Yield (%)	Productivity (kg/h/op)	Trimming time (min)	Yield (%)	Productivity (kg/h/op)	Boiling time (min)	Yield (%)	Productivity (kg/h/op)
APAC									
Bao	2.0	74.0	45.3	2.0	62.3	41.9	50.2	58.8	1.3
AlanyoDyer	2.5	67.6	35.2	2.5	53.6	25.5	48.2	48.9	1.2
NASE 14	2.3	76.2	50.8	2.3	66.9	45.5	50.2	64.0	1.5
NAROCASS 1	2.7	73.6	31.9	2.7	62.7	31.6	57.3	57.2	1.3
TME 14	1.2	70.7	65.8	1.2	58.3	73.2	58.4	53.6	1.1
LUWEERO									
Bwanjule	4.7	72.1	35.5	4.7	62.5	29.8	49.9	57.4	1.2
NASE 13	3.5	58.0	33.5	3.5	42.9	24.2	56.7	38.7	0.6
NASE 14	6.1	68.0	26.1	6.1	59.9	22.8	61.8	45.8	0.7
Nabwangu	3.4	67.1	51.3	3.4	51.1	36.2	49.6	51.3	1.0



Institute: Cirad – UMR QualiSud
Address: C/O Cathy Méjean, TA-B95/15 - 73 rue Jean-François Breton - 34398 Montpellier Cedex 5 - France
Tel: +33 4 67 61 44 31
Email: rtbfoodspmu@cirad.fr
Website: <https://rtbfoods.cirad.fr/>