RE-ENGINEERING AND DEVELOPMENT OF DRIED CASSAVA LEAVES PROCESSING

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ABSTRACT

The objective of this study was to minimize the energy used during cassava leaves processing and to assess acceptability of new product developed by addition of cow foot in the recipe.

Cassava leaves were processed in two methods. In the traditional method they were ground, cooked for 3-5 hours and dried into powder. In the re-engineered method they were only blanched and dried into powder. A triangle test conducted on the 2 powders with a panel of 21 members showed that panelists failed significantly ($p > 0.05$) to distinguish them. The Qualitative Descriptive Analysis on both samples showed that the re-engineered powder presented higher values of priority criteria previously defined by the panelists: odor, cow foot odor, green color, and dark green colour.

The traditional and the re-engineered powders were cooked into soups. A third sample was prepared by cooking the traditional powder with cow feet. The panelists' preference increased in the following order: traditional soup < re-engineered soup < cow foot flavored -traditional soup.

These findings are, for processors, an opportunity of cassava leaves process re-engineering and new product development.

KEYWORDS: *Analytical Hierarchy Process, Cassava Leaves, Cow Foot, Quantitative Descriptive Analysis, Re-Engineering & Triangle Test*

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1. INTRODUCTION

The cassava is popular in tropical countries and particularly in sub-Saharan Africa. Both sweet (*Manihot dulcis*) and bitter varieties (*Manihot utilisima*) produce tubers and foliage used as food. The wild variety (*Manihot glaziovii*) does not yield tubers, but its foliage is appreciated as a leafy vegetable. The use of cassava leaves is widespread in West, Central and East Africa, where each country has its own recipe and process (Achidi et al, 2005).

The nutritional importance of cassava leaves was discovered very soon. Though the chemical composition is dependent on geographic location (Wobeto et al, 2006) they are a source of proteins, fiber, Ca, Zn, Ni and K (Fasuyi, 2005). The dry matter of cassava leaves contains 20-30% crude protein and the essential amino acids proportion is close to that of soybeans (Atchara et al, 2007). This makes cassava leaves an abundant source of food for humans and animal feed (Atchara et al, 2007; Bokanga, 1995; Latif and Muller, 2015; Oresgun et al, 2016; Umuhozariho et al, 2011).

However, the presence of antinutrients and toxic cyanogenic gluco sides are the major drawbacks in cassava leaves, which limit their human consumption. The cyanide content of cassava leaves is higher than in

cassava root (Eggum, 1970; Guira et al, 2016; Oresgun et al, 2016). The content can be reduced by sun drying, oven drying, steaming and steeping, or their combination (Fasuyi, 2005).

The wild variety is the most preferred in Rwanda as a leafy vegetable. The home preparation method includes selecting and harvesting tender leaves, pounding, cooking in water with spices, adding oil and salt (Umuhozariho et al, 2011). This preparation technique is common in the Great Lakes Region, including the Democratic Republic of Congo, Uganda, Tanzania, Burundi and Rwanda. Usually the recipe is flavoured by adding cow feet de-haired by burning in a fire flame and scraping with a knife.

A few companies have adapted the above cassava leaves home preparation to a semi industrial level without addition of cow feet. Cassava leaves are harvested, transported to the processing facilities, trimmed, ground, cooked with spices in kettles, dried and packaged in paper bags. The final product is sold locally and exported to Europe and USA where it is well appreciated by African communities because of its extended self-life.

Processors are facing challenges due to the use of a large quantity of firewood with direct impact on the environment. Some customers' feedbacks request the popular cow foot flavour in the recipe. The objective of this research was to address the double request of cassava leaves 'processors: re-engineering the process to reduce the quantity of firewood used, and assessing the acceptability of the new product developed with cow foot in the recipe.

2. MATERIALS AND METHOD

2.1 Materials

Raw materials including fresh cassava leaves, onion, leak, sweet pepper, rock salt, spinaches, garlic and cow's foot were purchased from a local Kigali market and were stored at room temperature in the laboratory of Food Processing of the College of Science and Technology of Kigali for 24h.

2.2 Methods

2.2.1 Cassava Leaves Cooking

Two different methods were used for cassava leaf powder processing. In the first, the traditional method, fresh cassava leaves, sweet pepper, leak and spinach were trimmed, washed with tap water, ground with a blender and cooked with rock salt at 98°C in an aluminium pan for 3 hours. The cooked mixture was then dried with an electric air dryer at 65°C for 14 to 15 hours and packaged in biodegradable plastic bags.

In the second, the re-engineered method, whole cassava leaves were trimmed, and blanched for 5 min in boiling water at 98°C, drained, dried with the same electric air dryer as above and packaged in biodegradable plastic bags.

Both traditional cassava leaves powder and re-engineered cassava leaf powder was subjected to sensory analysis and Quantitative Descriptive Analysis (QDA) as shown in the paragraph 2.2.3.

A new product was prepared as follows: cow feet, beforehand de-haired by the use of fire, flame followed by knife scraping, were steamed, de-boned with a stainless steel knife, cut into small pieces (around 2 cm), cooked with the same ingredients used in the traditional method, dried and packaged.

2.2.2 Sensory Evaluation

2.2.1.1 Focus Group

Raw traditional and re-engineered cassava leaves, powders, cooked traditional cassava leaves powder alone and cow foot flavoured were presented to a focus group of 21 members. The members were asked to choose objective words to describe them. The samples were analyzed using all senses except the taste for raw samples. A primary list of words for each sample was produced.

The list produced was reduced by using one single word for those with the same meaning, and discarding, after discussion, those which were found reasonably not appropriate to describe the samples. A secondary list was found by grouping the parameters describing the same criteria. Finally, each parameter was broken down into relevant sub criteria.

2.2.2.2 Analytical Hierarchy Process (AHP)

The main quality criteria and the corresponding sub criteria, produced by the focus group were subjected to the Analytic Hierarchy Process (AHP) following the methodology already used for potatoes (Nkunda and Niyonzima, 2015) to determine the weights of consumers' preference.

2.2.2.3 Triangle Test

The triangle test followed the methodology described by Ennis and reported by O'Sullivan (2012). It involved three coded samples simultaneously, two of which were identical. Each assessor was given one set of three coded samples and was asked to select the odd sample. Samples were presented an equal number of times in each of the two sets of three distinct permutations of order: BAA, AAB, ABA and ABB, BBA, BAB. Assessors were asked specific relevant question(s) referring to the difference and their confidence in their answers. "No-difference" replies were allowed. Four difference tests were performed: Traditional powder versus re-engineered powder, Traditional soup versus re-engineered soup, re-engineered soup versus traditional soup flavoured by cow foot, traditional soup versus traditional soup flavoured by cow foot. For no-difference replies, they were allocated randomly to each of the categories of replies.

The difference tests followed the following protocols:

- Cooked samples when the panelists were not blindfolded (appearance, odour, taste and texture).
- Raw samples when the panelists were not blindfolded (appearance).

The panelists were asked to identify the odd sample out of the three presented in a random order.

2.2.3 Quantitative Descriptive Analysis (QDA)

The QDA was conducted on traditional cassava leaves powder, re-engineered cassava leaves powder, cooked traditional cassava leaves soup, cooked, re-engineered cassava leaves soup, and cooked traditional cassava leaves soup flavoured by cow foot. The samples were scored by a semi-trained sensory panel composed of 21 members. Panelists were given a card score with NOT on the left and VERY on the right, joined by a line showing the increasing intensity from NOT to VERY. To score each sub criterion previously defined by the focus group, with a pencil, the panelist showed the relative intensity of the criterion on the line joining NOT to VERY. The intensity was then measured in millimeters with a ruler and the mean of the 21 panelists was recorded.

2.2.4 Data Analysis

Data were analysed by using MS Excel descriptive statistics.

3. RESULTS AND DISCUSSIONS

The 21 panelists found the words shown in the Table 1 to describe raw and cooked cassava leaves. The primary list led to the secondary list of criteria which were broken down into sub criteria. The definition of each criterion was agreed upon by consensus and is shown in the same Table 1.

Table 1: Words Found to Describe Raw and Cooked Cassava Leaves

Primary List	Secondary List	Sub Criteria	Definition
<ul style="list-style-type: none"> • Fineness • Spices • Odor • Color • Viscosity • Shelf life • Bones • Water holding capacity • Not fully cooked • Appropriate variety • Nutrients • Taste • ready to eat • Freshness • Not sour 	Fineness	Fine	Finely ground
		coarse	Coarsely ground
		Not ground	Not ground or with large pieces of cassava leaves
	Thickness	Firmness	The soup is firm
		Softness	Flows easily
		Stickiness	Sticks to fingers
	Odour	Natural odour	Natural odour of cassava leaves
		Spice odour	Odour of garlic, green pepper, leak, celery
		Odour cow foot	Odour of burned cow foot
		odour bone	Odour of bone marrow
	Taste	sourness	Cassava leaves have a sour taste
		saltiness	Salty taste
		burning taste	The cassava leaves have a burning taste
		sweetness	sweet taste
	Colour	green	green colour
		dark green	dark green colour
		Green yellow	Green yellow colour
	Level of doneness	Well done	Situation of cassava leaves high tenderness due to prolonged cooking
		Just done	Situation of cassava leaves of fair tenderness due insufficient cooking
		Not done	Situation of cassava leaves of lack of tenderness due to very poor cooking

The results of the pair wise comparison of the 6 quality attributes for cassava leaves through the AHP are shown in table 2.

Table 2: Consolidated Matrix of Pair Wise Comparison of Quality Attributes of Cassava Leaves (AHP)

		Fineness	Thickness	Odour	Taste	Colour	Doneness
		1	2	3	4	5	6
Fineness	1	1	1	1/4	1/4	5/9	1/4
Thickness	2	1 1/9	1	1/5	1/5	5/6	2/7
Odor	3	3 7/8	4 3/4	1	7/9	3 2/5	1
Taste	4	3 5/7	5	1 2/7	1	2 4/5	1 7/8
Color	5	1 7/9	1 1/5	2/7	1/3	1	3/7
Doneness	6	4 1/5	3 2/5	3 2/5	1/2	2 1/3	1

The normalized principal Eigenvector gave the weights or priorities of the quality attributes as shown in the Table 3. The weights had a large consensus of the four assessing groups (72.9%) and the Consistency Ratio (CR) was 1.2%. A

CR higher than 10% is usually unacceptable because it reflects a high rate of transitivity contradictions. The priorities found were an important guidance for cassava leaves product development and relative resources allocation.

Table 3: Weights of Quality Attributes for Cassava Leaves as Assessed by Panelists through the AHP

Criteria	Definition	Weights	Rank
Fineness	Level at which the leaves are ground	6.10%	6
Thickness	Level of firmness of the cooked soup of cassava leaves	6.40%	5
Odour	How the cassava leaves are smelling	25.50%	2
Taste	How the leaves are tasting when swallowed	30.60%	1
Colour	The colour of cassava leaves	9.20%	4
Doneness	Level of tenderness due to cooking	22.30%	3

In the triangle test, visually the panelists failed significantly ($p > 0.05$) to distinguish from each other the traditional and the re-engineered cassava leaves powders and therefore no significant preference was observed. Nor did they recognize significantly ($p > 0.05$) the two from each other and from the cow foot flavored traditional flavor when cooked into soups. This means that processors can skip the steps of grinding and cooking of the traditional processing, saving the related investment, reducing the firewood with a positive impact on forestry conservation, and increasing the productivity through reduction of processing time. The 3-5 hours cooking step is replaced by 5-10 min of blanching. The re-engineered process does not change anything on the product perception by the consumers.

The results of the QDA of the traditional cassava leaf powder and the re-engineered cassava leaf powder are presented in Figure 1.

Figure 1: QDA Results for Traditional and Re-Engineered Cassava Leaves' Powders

They display some inconsistency reflected by large standard deviation values. This low consensus is to be imputed to the training level of panelists and insufficient accuracy of criteria definitions. However the priority criteria defined by the focus group have higher values in the re-engineered powder than in the traditional powder. That is the case for spice odour, cow foot odour, green colour, and dark green colour.

The same remarks were observed for the three cooked soups as shown in Figure 2.

Figure 2: QDA Results for Traditional Soup, Re-engineered Soup and Traditional Soup Flavoured by Cow Feet

Like the cassava leaf powders the cooked soups attributes had large levels of dispersion for the same reasons invoked above. The panelists' preference increased in the following order: traditional soup < re-engineered soup < cow foot-traditional flavoured soup. This was obvious for fineness, thickness, spice odor, cow foot odor, bone marrow odor, sourness, sweetness, and doneness. These are then, for processors, opportunities of process re-engineering and new product development.

4. CONCLUSIONS

The cassava leaves process can be re-engineered to save energy used for grinding and firewood used for the long cooking. In this re-engineered process cassava leaves are not ground, but simply blanched and dried. The cooking step is done by the end user who usually cooks with a clean energy which does not harm the forest integrity. The re-engineered process was proven to keep the sensory perception of the final product.

The potential of cow foot flavouring give opportunities for new product development of industrialization of the home preparation. Indeed the flavored product has displayed higher values of the priority criteria defined by panelists.

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