Utilization of Cassava Leaves as a Vegetable in Rwanda

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Abstract

Cassava (Manihot esculenta Crantz) leaves is an important vegetable in Rwanda. The objectives of this study were to determine cassava species from which leaves are harvested as vegetable and identify leaf preparation methods, consumption rate, price variation, storability and perception of post-harvest losses. A pre-tested structured questionnaire with closed and open-ended questions was administered to stratified groups of cassava leaves producers and consumers in four purposively selected sectors of Ruhango District and retailers in the main markets of Ruhango and Kigali city. In total, 171 respondents were interviewed from 11 to 26 August 2011. Cassava leaves are highly consumed in Ruhango District as 96.0 % of families harvested leaves for food. On average, 17.5 % of farmers sell cassava leaves that are retailed in markets of towns and cities including Kigali City. Sweet (Manihot dulcis), bitter (Manihot utilissima) and wild (Manihot glaziovii) are the cassava species from which leaves are consumed as vegetable, but the leaves of wild cassava are preferred by 66.0 % of consumers. Prices of cassava leaves varied significantly (p=0.0182) according to season with higher prices in the dry than rainy season. Prices of leaves at farm gate and retail levels were highly different (p= 0.0016), averaging 32 and 65 Frw by bunch in the rainy season, respectively. Despite the high consumption and trade of cassava leaves, post-harvest losses were high, especially in the rainy season. Cassava leaves were mainly cooked fresh, but 15.4 % of households processed leaves by sun drying. The storage period was extended to two months by sun-drying. In each case and, prior to cooking, cassava leaves were pounded. Cassava leaves are considered as a favourite and nutritive vegetable and technologies to improve storability, value and trade are needed. Assessment of effects of processing on nutritional quality and safety is also important.

Key words: *cassava species, leaves, vegetable, preparation methods, Rwanda*

1. Introduction

Cassava (*Manihot esculenta* cranz) is one of the most important staple food crops grown in tropical Africa. It is a food security crop and source of income in many tropical African countries, including Rwanda. Tolerance to extreme stress makes cassava adapt to different agro-ecological zones of Rwanda (MINAGRI, 2002). Cassava plays a major role in efforts to alleviate the African food crisis because of its efficient production of cheap food energy, year-round availability, tolerance to unsuitable ecological and soil conditions in comparison with other crops, and suitability to present farming and food systems in Africa (Cock, 1985). Nutritionally, the starchy root of cassava is poor in nutrients, but leaves are a good source of proteins and micronutrients (Ayodeji, 2005).

Cassava leaves dishes, known as *sombe* in Rwanda and Burundi; *pondu*, *sakasaka*, *matamba* and *sombe* in different languages of DRC; *nkwen* in Cameroun, *kisamvu* in Tanzania, *chigwada* in Malawi, *ravitoto* in Madagascar, *mathapa* in Mozambique, and so on, are favorite green vegetable and thus constitute a major part of the family's daily food in almost all tropical Africa (Achidi et *al.*, 2005). They are used as side-dishes or soup to accompany rice, cassava or maize paste. Elsewhere in the world, young cassava leaves are used as a vegetable. In Indonesia, the leaves are used to reduce the prevalence of protein deficiency and anemia because of their high protein and micronutrient contents, and are cheap and readily available in rural, remote and marginal communities (Hidayat *et al*, 2002).

Despite its nutritional quality, cassava leaves, just as the roots, contain cyanogenic glucosides, linamarin and lotaustralin that are hydrolyzed by endogenous enzyme, linamarase, to hydrocyanic acid (HCN). The hydrocyanic acid is responsible for potential toxicity associated with inadequately processed cassava foods (CCDN News, 2007). Siritunga and Sayre (2004) reported cyanogens levels of 200-1.300 mg HCN equivalents/kg dry weight in leaves and 10-500 mg HCN equivalents/kg dry weight in roots. Generally, HCN levels in leaves are higher than maximum levels of 10 mg HCN equivalents/kg dry weight recommended for foods by the FAO (1991) and CCCDN (2005). Therefore, cassava leaves must be

processed to remove cyanogens prior to consumption. Various traditional methods according to local customs and preferences to improve palatability and reduce the toxicity are used.

This study was conducted to assess the extent of cassava leaves utilization as green vegetable in Rwanda, determine processing methods from leave-picking to serving the cooked dish, rate of consumption, price variation, perception of postharvest losses, as well as cassava species from which leaves are harvested.

2. Materials and Methods

2.1. Location and description of the study area

The study was undertaken in Rwanda, a country that is located between latitudes 1° 04'S and 2° 51' S, and longitudes 28° 53' E and 30° 53' E (Fig. 1). The country is characterized by dramatic contrasts in temperature and rainfall as the elevation changes from the lowland savannah areas of the east to the mountain chains in the west (MINITERE, 2004). The temperature ranges between 16 to 24 °C with the highest temperatures in the lowland regions of the eastern and south-western parts of the country and the rainfall varies from about 900 mm in the east and south to 1500 mm in the north and north-western volcanic highlands (Twagiramungu, 2006).

The economy of Rwanda is heavily dependent on rain-fed agriculture and its variability leads to decrease in agricultural productivity due to droughts in eastern and southern parts and floods or landslides in areas experiencing heavy rains such as Northern and Western Provinces (REMA, (2007). Based on physical factors (temperature, rainfall and soil), agro-climatic regions have been defined, crops prioritized by regions and crop regionalization have been implemented throughout Rwanda (MINECOFINE, 2007). Cassava is produced all over the Eastern and Southern Provinces of Rwanda as a priority crop, but the major production area is located in Ruhango District and was purposively chosen as the study site. As typical of Rwanda, altitude decreases from west to east in Ruhango and the lowland areas experience low rainfall of, averaging 900 mm per annum (Twagiramungu, 2006). As cassava tolerates a relatively long period of drought once the crop is established (El-Sharkawy, 2007),

it is grown more extensively in the semi-arid regions of Rwanda including some sectors of Ruhango District. Households of producers and consumers were randomly sampled in four eastern sectors of the district and these were Ruhango, Mbuye, Ntongwe and Kinazi. During the survey, it was observed that cassava leaves from the sampled sectors were sold in the main markets of Ruhango and Kigali, usually by intermediaries. Therefore, retailers were selected in these markets to estimate the final price of the leaves.

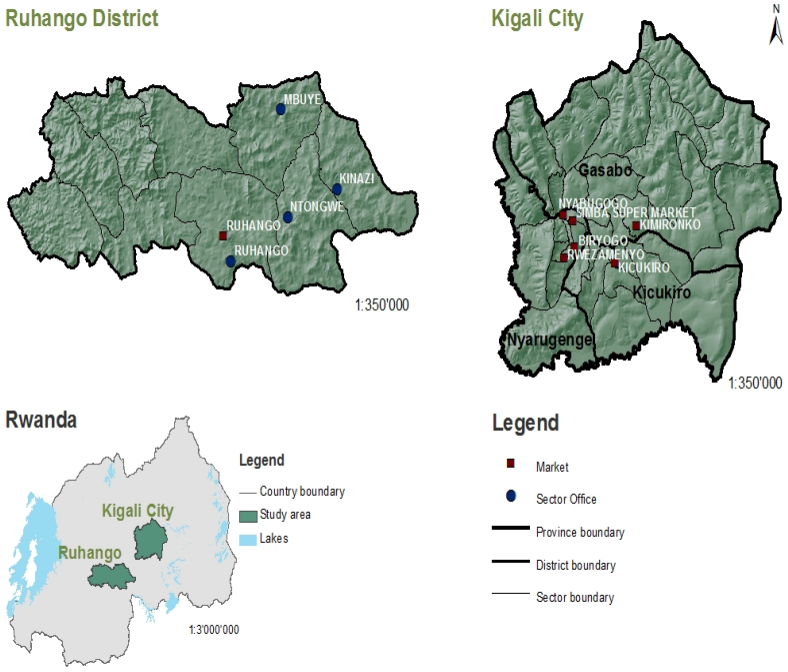

Figure 1: Map showing the location of the study areas in Rwanda

2.2. Data collection

Geographical Position System (GPS) instrument (RINO 130-GARMIN) was used to locate the selected sectors (Ruhango, Mbuye, Ntongwe and Kinazi). The geographical coordinates of markets of Ruhango, Kicukiro, Kimironko, Nyabugogo, Nyamirambo, and Simba Super market were also determined and maps were drawn to

show the location of sectors and markets in Ruhango District and Kigali City (Fig. 1).

A cross-sectional design was used in the survey and a pre-tested structured questionnaire with closed and open-ended questions was administered to respondents in the four sectors in Ruhango District. The population was stratified in three groups, namely cassava leaves producers, consumers and retailers. In each sector, 25 producers and 13 consumers were interviewed, except in one sector where only 11 consumers were questioned. A total sample size of 100 producers and 50 consumers were, therefore, interviewed. A list of households within each sector was used to systematically choose the required number of individuals in each stratum. Price of cassava leaves was assessed at farmer level and in the main markets of Ruhango and Kigali City. Therefore, a total sample size of 21 retailers, 50 consumers and 100 producers was used as the population was homogenous.

2.3. Statistical analysis

Data collected on species of cassava from which leaves are harvested for food, rate of consumption and post-harvest losses of the cassava leaves were coded and analyzed using Statistical Analysis Systems (SAS) software, version 9.2 (SAS Institute, 2008). Prices at different levels (farm and market) and during different seasons (dry and rainy seasons) were compared using student test (t-test). Storage techniques and storage periods were cross-tabled.

3. Results and Discussion

Cassava cultivation is widespread in Ruhango Disrtict as all the 100 households surveyed grow cassava (Table 1). More than half (58 %) of households produce *Manihot dulcis* with sweet roots, *Manihot utilissima* with bitter roots and *Manihot glaziovii* or wild cassava for which roots are not consumed (Table 1). Sweet cassava was mostly produced in the area as it was cultivated by 99 % of households (Table 1). In 2006 and 2009, eight sweet cassava varieties (TIME 14, 192/0057, 95/NA/000, MH95/0414, MM96/36, MM96/5280, MM96/0287 and MM96/7204) that are resistant to CMD (Cassava Mosaic virus Disease) and Green Mite were released in the low and

middle altitude ecological zones of Rwanda (MINAGRI, 2005). For this reason, pest resistant sweet cassava varieties have been widely adopted by farmers.

Table 1: Distribution of households for cassava, cassava species, reasons and frequency of harvesting, preparing and eating cassava leaves

Determinants	**% Households**
Cassava cultivation	100
Cassava species	
Sweet alone	10.20
Bitter alone	1.02
Sweet and Bitter	26.53
Sweet, Bitter and Wild	58.16
Sweet and wild	4.09
Cassava leaves harvesting	96.00
Reasons for harvesting cassava leaves	
Selling	3.03
Selling and cooking at home	13.13
Selling, cooking at home and feeding livestock	1.01
Cooking at home	75.76
Cooking at home and feeding livestock	7.07
Frequency of harvesting cassava leaves	
One time a week	29.59
Two times a week	26.53
Three times a week	13.27
More than three times a week	1.02
Frequency of preparing cassava leaves	
One time a week	71.43
Two times a week	12.24
Three times a week	4.08
Frequency of eating cassava leaves	
One time a week	14.00
Two times a week	42.00
Three times a week	28.00

Ninety-six percent of the surveyed households harvested cassava leaves as vegetable (Table 1). The reasons for cassava leaves harvesting were different from household to household and included cooking at home, selling as fresh vegetables and feeding livestock (Table 1). The results of the survey revealed that cassava leaves were harvested principally for meals preparation at home (97 %) and selling as fresh vegetables (17 %). Cassava leaves were not much used as livestock feed except for pigs after the leaves have been cooked. Consumption of cassava leaves was high in the study area and most families prepare leaves for food once a week to be served more than two times per week (Table 1).

Cassava leaves were harvested from all three species (sweet, bitter and wild) and in harvesting, young leaves were plucked or branches were cut according to the species (Table 2). Farmers reported that branches were not cut from sweet and bitter cassava that are still growing as this would negatively affect productivity and quality of roots. Hence, for sweet and bitter cassava species, it is only at the root harvesting stage that branches with leaves were cut. For wild cassava species, branches were cut regularly to promote growth of new branches and leaves.

Table 2: Mode of harvesting cassava leaves and proportion of used mode according to cassava species

Determinants	**% Households**
Mode of harvesting	
Leaf selection	23.47
Branch cutting	31.63
Leaf selection and branch cutting	44.90
Mode of harvesting by cassava species	
Sweet cassava	
Leaf selection	89.66
Branch cutting	10.34
Biter cassava	
Leaf selection	79.01
Branch cutting	20.99
Wild cassava	
Leaf selection	1.96
Branch cutting	98.04

At farmer's level, prices by bunch of cassava leaves varied significantly (p=0.0182) according to seasons with higher prices in dry seasons (Table 3). In addition, prices at production and retail levels (final price) differed significantly (p=0.0016) in the rainy season, averaging 32.9 and 65.0 Frw by bunch, respectively (Table 4). In the dry season, prices were not different (p=0.197), averaging 65.0 and 86.8 Frw by bunch for farmer and retailer, respectively (Table 4). Farm gate and retail prices were both high in the dry season because of scarcity of leaves during this period.

Most consumers (80.0 %), retailers (88.9 %) and farmers (79.4 %) indicated that wild cassava leaves were preferred over leaves from other species. They stated good taste, easier pounding, nutritive and year-round availability as the reasons for preferring leaves from wild species (Table 5).

Table 3: Comparison of prices of cassava leaves at farmer and retailer levels by season

Prices		Mean	t value	P value
Farmers' price	Dry season	65.0000	2.52	0.0182*
	Rainy season	32.9412		
Retailers' price	Dry season	81.4286	1.96	0.0578
	Rainy season	51.8750		

*, ** = Significantly different at 0.05 and 0.01 levels of probability, respectively

Table 4: Comparison of prices of cassava leaves between farmers and retailers in different seasons.

	Dry season			Rainy season		
Prices	Mean	t value	p-value	Mean	t value	p-value
Farmers' price	65.0000	-1.32	0.1967	32.9412	-3.44	0.0016**
Retailers' price	86.8421			65.0000		

*, ** = Significantly different at 0.05 and 0.01 levels of probability, respectively

Table 5: Reasons for preferring wild cassava leaves and perception of losses.

Determinants	Proportion in %		
	Farmers	**Consumers**	**Retailers**
Preference by groups	79.4	80.0	88.9
Reason of preference			
Easy to pound	6.67	5.00	-
Liked by consumers	6.67	-	15.79
Nutritive	5.00	5.00	5.26
Year- round availability	13.33	32.50	36.84
Good taste (not bitter)	26.67	45.00	15.79
Losses of leaves per year			
None	17.05	-	10.00
A quarter	4.55	-	35.00
Between a quarter and a half	9.09	-	25.00
A half	4.55	-	15.00
More than a half	55.68	-	15.00

Despite the high rate of consumption and trade of cassava leaves, post-harvest losses were not negligible, especially in the rainy season (Table 5). Losses were higher at farmer than retailer level because retailers purchased leaves according to present demand.

Methods of preparation and storage of cassava leaves

Many recipes from cassava leaves were identified in the surveyed area. The preparation method did not vary much and commonly consisted of four main steps. The first step was selection and harvesting of tender cassava leaves, tender growing shoots and soft growing stems. This step was similar to that reported by Katz and Weaver (2003). The second step was pounding, usually in a woody mortar with pestle, but vegetable grinders made by local manufacturers were popular and were usually used in markets. Cooking was the following step and was done by boiling in water with spices, oil and salt. The last step was serving cooked leaves with rice, maize/cassava paste or with roots/tuber foods. Before pounding, cassava leaves were sometimes blanched.

Table 6: Main constraints across strata

Constraints	% of Households
Farmers	
Low price in rainy seasons	8.2
Low price in rainy season and lack of buyers	2.35
Low price in rainy season, lack of buyers and lack of technology for storing	5.88
Low price in rainy season and lack of technology for storing	5.88
Lack of buyers	49.41
Lack of buyers and technology for storing	12.94
Lack of technology for storing	8.24
Retailers	
Scarcity in dry season	10.53
Scarcity in dry season and lack of buyers in rainy season	10.53
Scarcity in dry season, lack of buyers in rainy season and lack of technology for storing	5.26
Scarcity in dry season and lack of technology for storing	10.53
Lack of buyers in rainy season	52.63
Lack of buyers in rainy season and technology for storing	10.53
Consumers	
Scarcity and high price in dry season, and hard and time consuming preparation	22.24
Scarcity and high price in dry season	8.16
Scarcity, high price in dry season and bitterness in rainy season	6.12
Scarcity in dry season and time consuming preparation	8.16
High price in dry season, hard and time consuming preparation	8.16
Hard to prepare	12.24
Time consuming preparation	10.20
Hard and time consuming preparation	16.32

Un-pounded cassava leaves were kept for one to two days by frequent sprays of water, one to two days in cool place, and three days in refrigerators after leaves are pounded. In dry seasons, most

consumers and retailers experienced problems of scarcity of cassava leaves (Table 6). At farmer's level, few households preserved cassava leaves by sun drying; whole leaves were dried by 7.7 % of households and pounded leaves also by 7.7 % before prolonged storage. In contrast to recommendation of Kendal et *al.* (2010), cassava leaves were not blanched before drying and drying was done before or after pounding. Lack of technology for preserving cassava leaves was the most crucial constraint reported by farmers and retailers (Table 6).

4. Conclusion and Recommendations

Cassava leaves are a major vegetable in Ruhango District and most families consumed it as vegetable at least once per week. Three species of cassava are cultivated, namely sweet, bitter and wild cassava and leaves from all the three are consumed. There was variation in the preference for particular species as vegetable and, wild cassava is believed to taste good and easy to pound. Mode of harvesting cassava leaves varied for species. Branches were cut from wild cassava that do not produce edible roots, but for sweet and bitter cassava, leaves were picked from branches to preserve quantity and quality of roots. Cassava leaves are a source of income in Ruhango District, but prices varied significantly according to season, even though cassava leaves are said to be available all year-round.

Despite the high consumption, post-harvest losses of cassava leaves are considerable because of their high perishability. Sun-drying to extend the shelf life is practiced by very few families. Processing methods need to be improved to preserve cassava leaves for prolonged storage and value addition. Assessment of the effects of processing methods on nutritional quality and food safety is also recommended.

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the survey on cassava leaves as food in Ruhango. We also acknowledge the cooperation given by the local authorities, farmers, consumers and retailers of cassava leaves during the survey in the four sectors and six main markets.

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