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RESEARCH ARTICLE

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DEVELOPMENT AND EVALUATION OF POWER DRIVEN CASSAVA GRATER AND CHIPPER MACHINE

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ABSTRACT

Cassava is utilized extensively for human and livestock consumption as well as for other industrial products such as starch. Most of the usages are in processed forms while only a small quantity is consumed directly. However, cassava processing includes washing, peeling, slicing, chopping, milling and soon. These processes are labor-intensive and require mechanization in order to meet up with current demand for cassava products. One major bottleneck in cassava processing in to flour was grating and chopping, hence the objective of this study was to present a recently developed cassava grater and chopper by fabricating and evaluation the machine. Cassava slicer and chopper machines were fabricated and evaluated in melkasa agricultural research center (marc) under agricultural engineering department. After the completion of design and fabrication data was collected on the grating and chipping capacity of the machine and fuel consumption of the machine. This machine was effective with grating capacity of 114.94 kg/hr with 325ml fuel consumption and chipping capacity of 30.3kg/hr with 150ml fuel consumption.
Keywords: Chipping, Cassava, Fuel, Grating, Capacity

1. INTRODUCTION

Ethiopia, with a total surface area of 1.1 million square kilometres and an estimated population of 82 million in 2011 and growing at 2.6% per year, is the second most populous country in sub-Saharan Africa. The country has great geographical diversity: its topographic features range from the highest peak at RasDashen, 4550 metres above sea level, down to Affar Depression, 110 metres below sea level. Ethiopia is administratively structured into nine regional states and two city administrations. With only 16 precent of the population living in urban areas, the country is one of the least urbanized countries in the world. Addis Ababa, the capital city, constitutes about a quarter of the urban population of the country. While 15% of the urban population lives in towns with populations more than 100,000 but less than 250,000 and 37% lives in medium size towns with populations between 50,000 and 100,000 and 23.3% live in urban centres with population size of less than 50000. Ethiopia is an agrarian country and agriculture accounts for 45 percent of the gross domestic product (GDP) (www.unce.org).

Cassava was first introduced to Ethiopia by the British. Although reliable statistical information on the area and production of cassava in Ethiopia is deficient, the crop has been cultivated, mainly, in the south, south west, and western parts of the country since its introduction. Its use as a potential food crop in Ethiopia has increased during and after the 1984 famine (Amsalu, 2003; Tewodros, 2012). The crop is well known in its principal ability to produce economic yields under relatively marginal rainfall and soil conditions.

It is not actually known when Cassava was introduced in to the country, but it is believed that it was introduced by GOs and Non GOs sometime in the 20th century due to repeated drought exhibited in the country. According to the report of Edossa, 1996Cassava is a hardy plant locally known in Ethiopia as yefurnoduketzaf. The consumption of cassava in Ethiopia rose during and after the 1984 famine. It is mostly cultivated and grown around fences and homestead. Farmers use cassava for food as a composite flour for baking with other cereals like maize, tef and wheat in the southern and south-western of the country.

Desalegn, 2007 reported that Cassava is now widely grown in Oromia and Southen Region of the country. Especially in Welaita and Gofa zones, it is one of the most important crops widely grown by the people. Ethiopia with its diverse agro-ecologies and suitable environments, allows the growth of numerous root and tuber crops many parts of the country's smallholder farmers. Cassava (Manihotesculenta C.) plant is exotically was introduced to Ethiopia at the middle of nineteenth century. Cassava is known in Ethiopia in different names such as "MukaFurno (Oromifa)", "YenchetBoye (Welayitigna)", and "Tesike/Mogo (Koreegna)". Cassava is an essential part of the diet for more than half a billion people in the world, important carbohydrate supply and source of income for farmers in several African countries (Nweke, 2004).

Cassava, Manihotesculantacrantz, a dicotyledonous perennial plant belonging to the botanical family Euphorbiaceae is of importance in many developing tropical economies such as the tropical parts of Africa, West India, Brazil, Malagasy, Indonesia, Philippines, Malay, Thailand and China. In tropical Africa, cassava and other tubers like yam form the most staple food crops which are the main source of carbohydrate in the diets of this region. Its high yield in poor soil and the ability to stay in the soil for long periods after maturity make cassava an important food- security crop in low-income countries. The cassava root tuber is the main economically useful part of the cassava plant. Apart from the importance of the cassava tuber as a constituent of human food, it has many non-food uses and it has become a foreign exchange earner for the producing countries. China, the second largest producer of cassava in the world, earns over 2 billion dollars per year from the crop. This commercial potential of cassava is currently being under-utilized in Nigeria which is the largest producer of the crop in the world with over 34 million tons of fresh tubers being produced annually (Ajibola, 2000).

Hahn, 1994 reported that Cassava must be processed into various forms in order to increase the shelf life of the products, facilitate transportation and marketing, reduce cyanide content and improve palatability. The nutritional status of cassava can also be improved through fortification with other protein-rich crops. Processing reduces food losses and stabilizes seasonal fluctuations in the supply of the crop. Traditionally, cassava roots are processed by various methods into numerous products and utilized in various ways according to local customs and preferences. Traditional cassava processing methods in use in Africa probably originated from tropical America, particularly north-eastern Brazil and may have been adapted from indigenous techniques for processing yams.The processing methods include peeling, boiling, steaming, slicing, grating, soaking or seeping, fermenting, pounding, roasting, pressing, drying, and milling

L.A.S. Agbetoye et al, 2009 reported that the main activities involved in processing of root and tuber crops include washing, peeling, size reduction (chipping, slicing and grating), drying and milling. There are also many processes involved in food size reduction this include grinding or grating for cassava and yam, dicing for potato, yam, and onion, slicing for carrot, onion, yam, onion and banana, milling for rice, corn and wheat, chipping for cassava, yam and banana. The type of crops, the end product desired and the machinery available often determines the type of size reduction method used.

Mechanization of cassava production and processing will develop human capacity in the rural areas leading to increase productivity as a result of harvesting, handling and appropriate machinery. More importantly, using mechanization reduces drudgery, making the food processing an attractive enterprise,

Therefor the purpose of development of cassava grating and chipping machine was to reduce the drudgery, to decrease the cost, to reduce food pollution during processing, to secure food sustainability and to make the cassava processing industry attractive.

2. MATERIAL AND METHOD

2.1. The Experimental Site

The Fabrication of prototype and laboratory experiments were conducted at Melkassa Agricultural Research Center(MARC), 17 km South of Adama, or it is located 117 km South East of Addis Ababa, Ethiopia. Melkassa has a highly variable rainfall that ranges between 500 and 800 mm annually. The agro- ecology is termed as Kolla (Warm, semi-arid lowlands). Any adjustment or maintenance of the proto type was conducted in AIRIC workshop, which is found in the center.

2.2. Materials used for Experiments

The materials and tools used for this project include, the mechanical engineer drawing instrument, angle iron, sheet metal, stainless steel, s, bearings, 5hp engine, drilling machine, grinding machine, lath machine and milling machine were used during the construction of the prototype.

2.3. Description of the cassava chipping and grating Machine.

The Cassava grating and chipping machine consists of six main parts, included:

Main frame	Hoper
Cheeping plate (abrasive plate)	Collection basin and.
Slicing blade	Power transmission

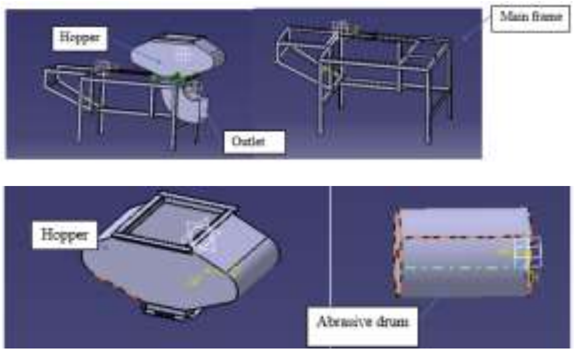

Fig.1: Main parts of cassava grating and chipper

Fig.2 Picture of cassava grating and chipper

2.4. Power Transmission System

The grating and chipping machine drum is driven by a 5hpengine. The motor is directly connected to the pulley of horizontal shaft and this horizontal shaft transfers the rotary motion to the abrasive plate and slicing blade.

2.5. Laboratory test

Laboratory test was mainly focus on physical parameters. This was done by taking five sample cassava tubers and measured physical parameters like length, root diameter, mid diameter, tip diameter and peel thickness by using caliper instrument.

2.6. Performance Test and Evaluation

The data were collected both in laboratory and at field by harvesting kelo verity cassava from Amarokelo and then we measure the dimension of the sample cassava root tuber.Finally we have tested the machine by making engine on.

Calculations used in the trial runs are as follows; Based on the collected data the capacity of the machine was calculated as follow:-

2.6.1. Capacity

Machine grating and chipping capacity (t/h) was defined as the batch load of the cassava divided by the total grating and chipping time (loading time+ grating and chipping residence time+ unloading time) in an hour, and could be calculated using (El-Ghobashy et al.,2016) equation

$$Cp = \frac{Lb}{T1+Tr+Tu} \times 60/1000 \ldots\ldots (2.1)$$

Where

C_p= machine grating and chipping capacity **(**ton/h)

L_b =batch load (kg)

T_l = loading time (min)

T_r = grating and chipping residence time (min)

T_u = unloading time (min)

2.6.2. Fuel consumption

Fuel consumption of the machine both during grating and chipping of the cassava tuber measured by using measuring cylinder. The measurements have been taken for both grating and chipping with three replications by running the machine with load.

3. RESULTS AND DISCUSSIONS

3.1. Laboratory Test Results

Laboratory test result includes physical parameters of the kelo variety cassava tuber like length, root diameter, mid diameter, tip diameter and peel thickness.

Table 3.1 physical parameters of the tuber

Variety Kello **Sample**	**Length (mm)**	**Root diameter (mm)**	**Mid diameter (mm)**	**Tip diameter (mm)**	**Peel thickness (mm)**
1	**550**	**80**	**80**	**40**	**4**
2	**500**	**60**	**70**	**40**	**3**
3	**430**	**30**	**80**	**60**	**5**
4	**440**	**60**	**60**	**40**	**3**
5	**400**	**60**	**50**	**40**	**3.2**

According to the result shown on the table the maximum length of the sample tuber is 550mm and the minimum length is 400mm.The maximum root diameter is 80mm and minimum root diameter is 30mm.

3.2. Fuel consumption

Table 3.2 the time taken and fuel consumption of the grater

	Tuber weight (kg)	**Time taken (min)**	**Fuel consumption (ml)**
1	**10**	**8:02.65**	**325**
2	**10**	**7:23.34**	
3	**10**	**7:19.02**	

According to the result of (table 3.2) the average fuel consumption of the grater is 325ml/0.13hr =2500ml/hr

Table 3.3 the time taken and fuel consumption of the chipper

Test	Tuber weight (kgs)	Time taken(min)	Ease of operation (rank)	Fuel consumption (ml)
1	**10**	**19:53.33**	**1**	**150**

According to the result of (table 3.3) the average fuel consumption of the grater is 150ml/0.32hr =468.7ml/hr

3.3. Capacity Test

3.3.1. Grater

The average capacity of the power operated cassava grater obtained from the trials grating capacity of 114.94 kg/hr with 325ml fuel consumption.

Table 3.4 capacity of the power operated cassava grater

Average weight(kg)	Average time taken(hr)	Capacity (kg/hr)	Fuel consumption (ml)
10	0.087	114.94	325

Grating capacity of this machine is a bit lower than the capacity of the grater machine of Anderson, U (2018) 150kg/hr.

3.3.2. Chipper

The average capacity of the power operated cassava chipper obtained from the trials chipping capacity of 30.3kg/hr with 150ml fuel consumption.

Table 3.5 The average capacity of the power operated cassava chipper

Average weight(kg)	Average time taken (hr	Capacity (kg/hr)	Fuel consumption (ml)
10	0.33	30.3	150

This machine was better than the manual chipper of Silayo V.C.K et al, 2007 machine (11-18 kg/h) and lower in capacity than engine-powered Silayo V.C.K et al, 2007(270 kg/h) grater machine

4. CONCLUSIONAND RECOMMENDATION

A prototype of power driven cassava grating and chipping machine was designed, manufactured and evaluated successfully for different varieties of cassava in Melkassa Agricultural Research center. The machine consists of six main parts, included: Main frame, Hoper, Cheeping plate (abrasive plate), Collection basin, Slicing blade and Power transmission system. The machine parts which have contact with cassava especially the hoper and the grater and chipper parts were manufactured using stainless steel to avoid contamination. This machine was tested in Melkassa Agricultural Research Center, Hawasa Agricultural Research Center and AmarokeloWereda.

A prototype of power driven cassava grating and chipping machine has the following draw backs: The outlet of the grating machine is not placed in the proper inclination, The feeder on the hopper of the grating machine does not have proper length, The inclined part of hopper is not positioned in the proper inclination this forced the users to use wood to push cassava, The chipping part of the machine did not give necessary slice instead it grates.For the future it will be designed and manufactured simpler, low cost, movable and attractive power driven cassava grating and chipping machine that is suitable for any shape and condition of cassavas.

The machine grating capacity of 114.94 kg/hr with 325ml fuel consumption and the machine chipping capacity of 30.3kg/hr with 150ml fuel consumption.Generally we can conclude that the machine is effective with some minor correction.

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