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Development of a Cassava Peeling Machine for Cottage Industries

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Abstract

Timely processing of cassava tubers is important to prevent post harvest losses and ensure food quality. Several processing operations have been mechanised in the production line of cassava products. Peel removal, which used to be a major bottleneck, is receiving attention from design engineers in Nigeria, China and Brazil. Equipment for cassava peeling is now available for small, medium and large-scale cassava processors. However, majority of cassava processors in Nigeria operate cottage industries. Cottage industries in developing countries are generally characterised by low capital investment, manual labour, low production capacity and hence low income. Although cottage industry offers great advantage for developing countries in terms of employment opportunities, it is the most neglected from the viewpoint of credit facilities and mechanisation. In this study a cassava-peeling machine for cottage industries was developed and tested. The cassava peeler consists of a 0.75 kW electric motor, a rotary drum fitted with knives (5 cm long) and a protective hood. This prototype was first demonstrated at the joint African Union-Economic Commission for Africa exhibition in Addis Ababa, Ethiopia. Its simplicity, adaptability, potentials and low-cost attracted African leaders as well as captains of industries. The machine operates on the principle of shear force at relatively high angular velocity of the rotary knife-edge. The rate of peeling with the machine was in the range of 45 kg/h to 80 kg/h. Lower values occurred with lower operator's skill, poor tuber orientation during the peeling process and lower tuber diameter of < 6 cm. Machine capacity was also influenced by moisture content of tubers and variations in length and diameter. These values were higher than those obtained during manual peeling which varied from 20.3 kg/h to 23.3 kg/h and averages 20.3 kg/h. The proportion of peel in the cassava roots ranges from 0. 04 to 0.12 and averages about 0.15. The cost of the prototype was estimated at N 13,500 (100 US dollars) but the cost of the proposed commercial model was estimated at N 10,000 (74 US dollars). The machine operates best between a rotary speed of 1000 and 1400 rpm.

Keywords: Cassava Peeling, Cottage Industries

Introduction

Cassava, *Manihot esculanta crantz*(syn. *manihot utilisima* pohl), is a dicotyledonous perennial plant belonging to the botanical family Euphorbiaceae. It is a starchy root crop that is grown almost entirely in the hotter lowland and the tropics. The crop is by a variety of names according to the region in which it is cultivated; cassava in English-speaking countries of North America, Europe and Africa, manioc in French-speaking countries, tapioca in the English-speaking countries of south east Asia, mandioca in Brazil and in the Spanish-speaking countries of south America. Because it grows easily, has large yields and is little

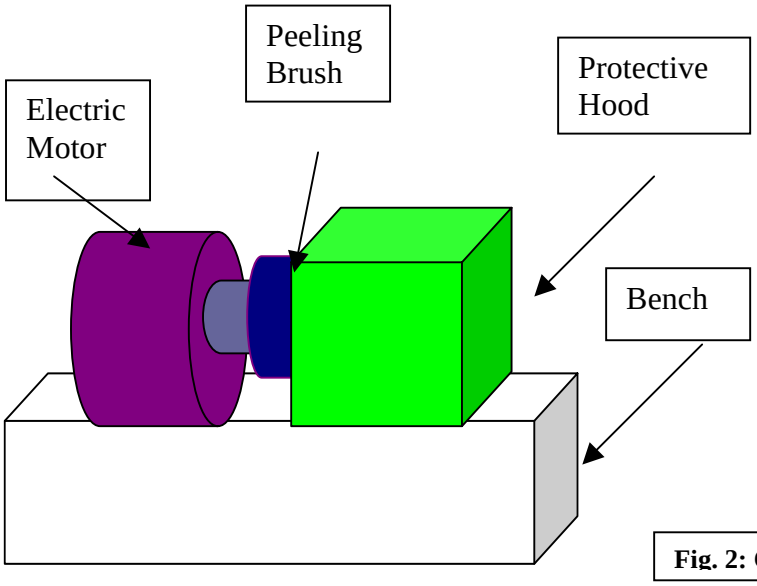
affected by diseases and pests the areas under cassava cultivation are increasing rapidly. Azan –Ali et al., (2003) reported that cassava and sugarcane are the most important root crops in developing world, with a combined total annual production of around 300 million tonnes. It is main source of energy for between 200 and 300 million people. Africa now produces cassava than the rest of the world combined with biggest increase from 22% to 35% (of African total production) in Nigeria and 4% to 8% in Ghana (IITA, 1997 and FAOSTAT, 2004). NEPAD (2006) reported that conversion of cassava into products for starch, food, plywood, paperboard, textile and pharmaceutical industries could contribute significantly to the transformation of rural African economies and thus improve livelihoods. Several needs were also identified particularly in the area of appropriate technologies for the conversion of cassava to value added products. In the recent years cassava production and processing received a major boost due to emerging areas of its utilisation particularly in the oil and gas sector and its consequent adoption by many developing countries as a crop for enhanced food security, foreign exchange earner and a tool for rapid industrialisation. However, the potentials of the crop can only be fully realised through adequate processing. Development of various machines for processing cassava is now in receiving attention in many cassava producing nations especially in Nigeria, China and Brazil. Some researchers Adetan et al (2003); Olukunle (2005), Olukunle et al (2006); Odighoh (1983) and Sherrif et al (1995) made appreciable research attempts on the properties of cassava as well as on design of appropriate mechanical devices and systems for cassava handling and processing. Equipment for cassava peeling is now available for small, medium and large-scale cassava processors. However, majority of cassava processors in Nigeria operate cottage industries. Cottage industries in developing countries are generally characterised by low capital investment, manual labour, low production capacity and hence low income. Although cottage industry offers great advantage for developing countries in terms of employment opportunities, it is the most neglected from the viewpoint of credit facilities and mechanisation. In this study a cassava peeling machine for cottage industries was designed fabricated and tested with a view to provide a sustainable solution for peeling cassava at the level of cottage industries.

Materials and Methods

An economic appraisal of existing cassava peeling machines in Nigeria was done in order to determine their suitability for cottage industries based on machine initial cost, operational cost and capacity. A cassava-peeling machine was designed, fabricated and tested. The machine was demonstrated first at the joint African Union- Economic Commission for Africa exhibition in Addis Ababa, Ethiopia. The machine was subjected to rigorous performance evaluation in order to assess its reliability. Varieties of cassava which thrive well on Nigerian soils were identified and used for the performance evaluation of the cassava. Tubers were graded into various diameters and length in order to determine the effect of these parameters on peeling efficiency and machine capacity. The effect of brush speed and tuber orientation on efficiency of the peeling process was determined. The rotary knife was mounted on a DC motor rotating at 3000 rpm to assess it suitability as a grater. Tubers were presented as cuttings of, 10 to 15 cm; 15 to 20 cm; 20 to 25cm and 25 to 30 cm long and at three different ranges of diameters as < 8 cm, 8-10 cm and> 10 cm. The results of the performance evaluation were compared with manual methods. Other parameters used to evaluate the performance of the peeler were the peeling efficiency, tuber loss and peel retention.

Machine Description

The machine (Fig. 1and 2) consists of rotary knife-edge mounted directly on a 0.75 kW (with rated speed of 1400 rpm) electric motor. It receives motion from the electric motor rotating at 850 to 1400rpm depending on the electric voltage input. A protective hood (made of hard wood) to prevent splashing of dust and peels on the operator and to protect the operator's fingers was provided. The hood also serves as a guide to direct the peel into the delivery chute. The machine is designed as desktop equipment. It is quite portable and hence very mobile for use in various locations as the need arises. The machine operates on the principle of shear force at relatively high angular velocity of the rotary knife-edge.



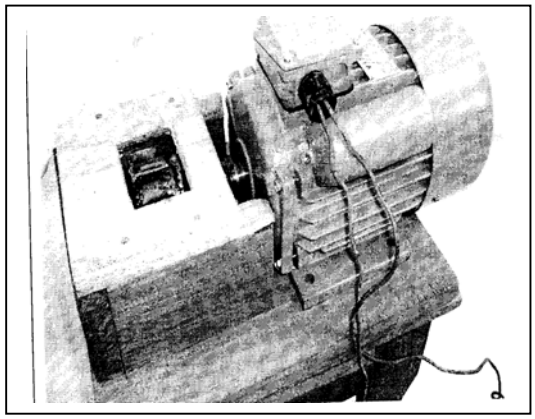


Fig. 2: Cassava Peeling Machine for Cottage Industries

Fig. 1: Schematic Diagram of Cassava Peeling Machine for Cottage Industries

Results and Discussion

The performance of the machine was adjudged satisfactory at various crop, machine and operational conditions. The cost of the prototype was estimated at N13, 500.00 (100 US Dollars). The cost of the commercial model was estimated at N10, 000.00. (74 US Dollars) It was discovered that the machine peels cassava tubers efficiently and presents tubers with excellent finish very similar to results obtained during careful manual peeling operations. The machine operates best between 1000 to 1400 rpm. It could be used to peel cassava and adapted to chip cassava tubers at various speed of the rotary knife. This is a major advantage over existing cassava peeling machines. Tubers were presented as cuttings of, 10 to 15 cm; 15 to 20 cm; 20 to 25cm and 25 to 30 cm long and at three different ranges of diameters as < 8cm, 8-10 cm and> 10 cm. during the peeling process; this was done to reduce/eliminate pronounced bends commonly found in cassava tubers. It is important to note that tubers less than 10 cm long would be difficult to handle from the viewpoint of operator's safety. It is advisable to ensure that tuber length is beyond 10 cm during trimming. The machine performs best as a peeler and chipping machine between 1000 to 1400 rpm. The width of the rotary knife-edge (0.3 cm) appeared to be very low and thus influenced machine capacity. It is recommended that the width of the knife-edge should be doubled for enhanced machine capacity. Capacity of the machine was also influenced by operator’s skill. Training

programmes should be provided for would-be operators of the machine in order to enhance operators' skill and reduce hazards associated with the operation of the machine.

The rate of peeling with the machine was in the range of 45 kg/h to 80 kg/h. Lower values occurred with lower operators skill, poor tuber orientation during the peeling process and lower tuber diameter of < 6cm. Machine capacity was also influenced by moisture content of cassava tubers and variations in tuber length and diameter. The values are higher than those obtained during manual peeling as reported by Atere et al (2007). They reported that the rate of manual peeling varied from 20.27 kg/h to 23.33 kg/h and averages 20.27 kg/h. It was also higher than 11.0 kg/h to 22.0 kg/h as reported by Sheriff *et al* (1995) when five varieties were investigated. The proportion of peel in the cassava roots ranges from 0.04 to 0.12 and averages about 0.15.

Conclusion

A cassava-peeling machine was designed, fabricated and tested by the author at the Federal University of Technology, Akure. The machine has a capacity of 45 to 80 kg/h and performs the roles of peeling and chipping. The performance of the machine was adjudged satisfactory at various crop, machine and operational conditions. The cost of the prototype was estimated at N13,500 (100 US Dollars) The cost of the commercial model was estimated at NI0,000 (74 US Dollars). The machine was first demonstrated at the joint African Union Economic Commission for Africa Exhibitions in Addis Ababa, Ethiopia. The performance of the machine was adjudged satisfactory. The machine is currently subjected to design for commercial production in preparation for commencement of large-scale production of the machine. The width of the knife-edge (0.3 cm) appeared to be very low and thus influenced machine capacity. It is recommended that the width of the knife-edge should be doubled.

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