



## Review

# Development of a yam peeling machine

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Almost all forms of yam tuber processing required that the yam be peeled. These peeling processes face a significant problem of time consuming and inefficiency due to loss of a substantial part of the yam by manual peeling. In order to ameliorate the resulting fatigue and to reduce the amount of time consumed and at the same time improve the peeling efficiency a mechanical yam peeler was designed, fabricated and tested. The peeler consists of a drum eccentrically mounted on a shaft rotating at various speeds ranging between 20 rpm and 50 rpm. This speed of rotation was achieved by means of pulley and belt arrangement. The spins on the drum serves as the abrasive where the peeling is done. The efficiency of the machine ranges 80% and 95% depending on the speed of rotation of the drum and the size and shape of the yam tuber.

**Keywords:** Yam, Peeler, Designed, Evaluation.

## INTRODUCTION

Yam belongs to the families called *Discoreaceae* and *Dioscorea*. These families contain about 600 species out of which ten are presently of economic importance. Most of the yams produced in various parts of the world are consumed within the country of production, although appreciable quantities are shipped to developed countries.

Yam for food, are consumed differently in forms of boiled yam, pounded yam, mashed, fried, baked, and roasted, also as yam flakes or chips. Wastes from peeling are often fed to livestock especially goats and sheep. However in many instances it constitute nuisance

Coursy (1967) estimated that yam production accounted for 41% or 18.2 metric tons and potato for 55% or 26.2 metric tons of the total 44.4 metric ton for yam and sweet potato production. According to Chan (1983), the major yam producing countries in West Africa, in order of importance are Nigeria, Ivory Coast, Ghana, Togo, Benin Republic and Republic of Guinea. This was corroborated by Olukunle et al (2006). Due to lack of adequate, reliable and faster means of processing, apart from the manual, most of these yams are wasted. This informs the design of this machine, for effective

informs the design of this machine, for effective processing of yam tuber into various food items.

The works done so far on the development of material peeling systems revealed five general methods of peeling: use of abrasive action; chemical; heat; manual; and mechanical peelings. This work can be grouped under mechanical peeling. This mechanical peeling can still be classified into manual and automatic, using abrasive methods.

The abrasion method has been used to peel tubers such as potatoes and ginger and sometimes on yam also. Jessica et al (2006) developed a cassava peeling machine. The machine was designed using brush as peeler; the machine was widely used on oval shaped fruits and vegetables. The machine consumes about 4kW of power.

Agrawal et al (1983) developed an abrasive brush type ginger peeling machine. The operation of which was improved upon by Agrawal et al (1987). The peeler consists essentially of two continuous brush belts being driven in opposite direction with a downward relative velocity by a variable speed electric motor. In the manually operated ginger peeler developed by Charan et

**Table 1.** Physical, rheological and mechanical properties of yam.

Property	Value	Method of determination
Shape of root	Fairly regular, oval, cylindrical	Comparison with known geometrical shapes
Roundness of traverse	0.65 – 1	AP/AC
Section of roots	0.85	AP = Actual area of section AC = Area of circumference
Length of root	10 – 55 cm	Direct measurement
Average straight length of roots	10 cm	Direct measurement
Diameter of root (average)	2.5 – 15 cm (10.1cm)	Direct measurement
Thickness of cortex	1.0 – 2.0 cm	Instron testing machine
Mean specific gravity of whole root moisture	1.025%	Water displacement
Constant (lowest basis)	Tail and mid portion 85 – 95% (90%)	Aerated oven

al (11993), brushes made of coconut fibre were used as abrasive material.

Ukatu et al (2005) developed industrial yam peeler. This machine make use of three peeler arms which are spring loaded and peeler blades fixed to the peeler arms and which scrape the tuber body to a pre-set depth. It also consists of a peeler ring on which the peeler arms are mounted and are driven through a chain drive and the peeler ring housing the peeler arms have toothed structures that acts as opener which initiate the opening of the aperture when in contact with tuber.

There are other tuber peeling machines; designed by researchers, such as: Odigbon (1976); Akinlere et al (1972); Olukunle et al (2010); Odesanmi (1988) and host of others. Most of these works are for cassava and other tubers and not for yam. This work is one of the attempts to develop yam peeler.

## MATERIALS AND METHOD

In order to design an effective machine, some physical rheological and mechanical properties of yam are required some of these properties are listed in Table 1 and how they are determined.

Some of the problems to tackle in the design is the wide variation in the size and shape of the tubers, others are the variation of the mechanical properties with the age of the tubers. Hence the followings are major parameters for effectiveness of the peeler, thickness of peel, time of harvest (age), feed of the cutter, and relative speed of rotation.

Some of the equations used in the design are given here:

$$F = \frac{mv^2}{r} + mg \quad (1)$$

$$F_n = F \cos \theta, \quad \text{and} \quad F_t = F \sin \theta \quad (2)$$

Where: F = the centrifugal force, m = mass, v = relative velocity.

$$n^2 = \frac{g}{4\pi^2 r} \quad (3)$$

Where; n = speed of rotation and r = radial distance  
Some of the estimated parameters are given in Table 2

$$S = \frac{\pi d N_1}{60} \quad (4)$$

$$P (0.45 - 0.09 - \frac{19.63}{kd} - 0.765 \times 10^{-4} S^2) s \quad (5)$$

Where: P = Power required and S = Belt speed.  
k = pulley correction factor, d = pulley diameter

$$\gamma = \frac{\lambda}{\mu} \quad (6)$$

Where:  $\gamma$  = required number of belt,  $\lambda$  = design horse power and  $\mu$  = connected rating of arc belt.

The whole design analysis cannot be presented here because of the volume. The machine developed is as shown in Figure 1

The machine was constructed using materials predicted by the design analysis. Tests were carried out using the machine. The machining can accommodate minimum of six tubers of yam at once. The result of tests is a as shown in Table 3.

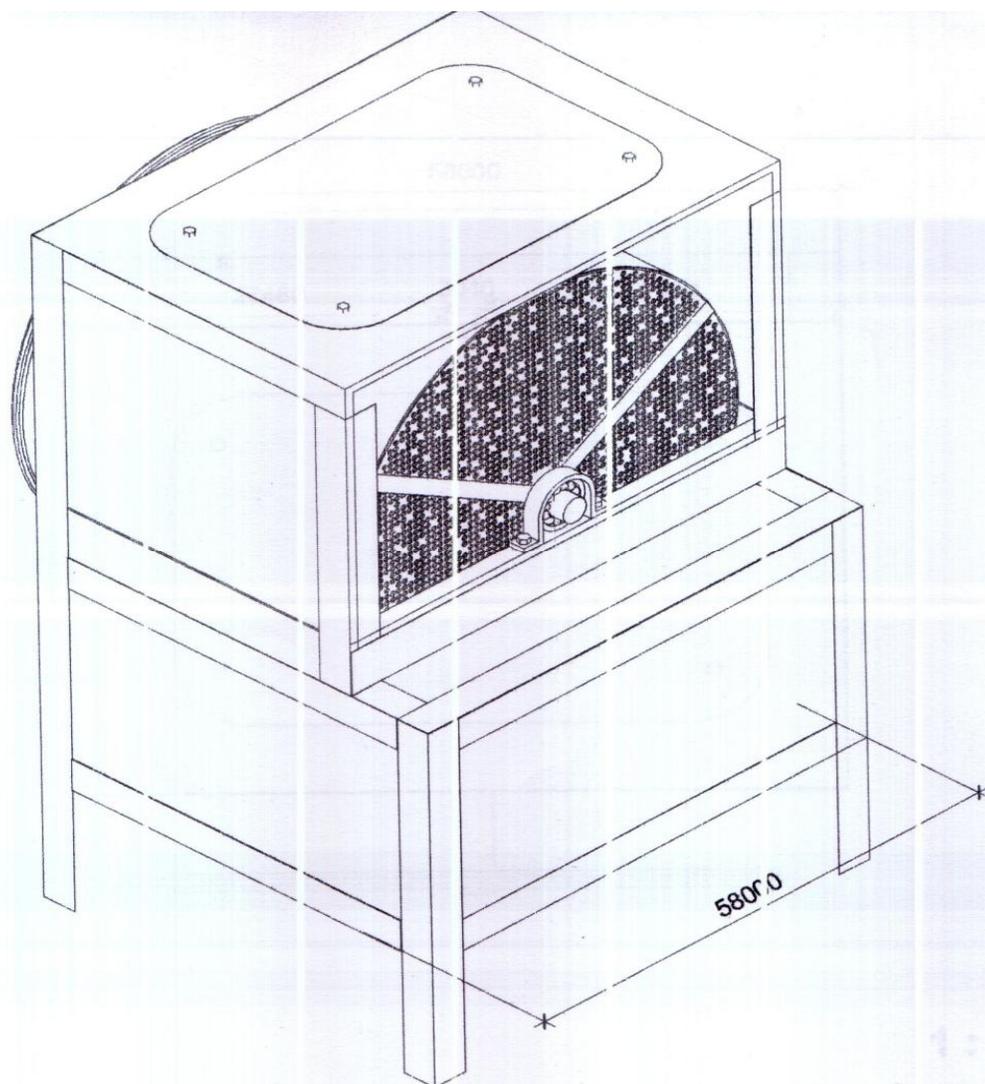
The average peeling time was measured to be 213 seconds. Average efficiency was determined to be 95.97%. Percentage loss after peeling 3.9%. The capacity of the machine was estimated to be 10.8 g/s

## CONCLUSION

In this work a yam peeling machine was developed and evaluated. The machine made use of punched holes in the drum to perform the peeling action. The punched holes can be adjusted by increasing the size of the centre punch. Peeling efficiency ranges between 80% and 85%.

**Table 2.** Calculated / designed parameters summary.

Parameters	Calculated value
Motor (selected)	1 hp (0.746 kW) speed = 1400 rpm
Speed ratio	28
Shaft diameter (D)	26 cm
Motor pulley diameter (d)	8 cm
S (Belt speed)	5.87 m/s
Volume of water	0.054 litre
Power	0.973 kW
Arc of contact	2.69°
Length of belt	174.76
Correction rate	1.028376 hp
Number of belts	1 (actual = 0.87)
Torque	150.71 kN-m
Maximum reaction	85.67 N
Maximum bending moment	73.69 N-m
Shaft diameter (main)	21.06 mm

**Figure 1.** Yam Peeling Machine.

**Table 3.** Test Results.

Tuber length (cm)	Average diameter (cm)	Weight ( $W_b$ ) before peeling (kg)	Weight ( $W_a$ ) after peeling n(kg)
23.5	8.91	0.95	0.9
28.5	10.00	1.96	1.51
27.0	8.18	1.05	1.03
23.0	9.36	1.20	1.15
22.5	9.87	1.19	1.15
22.0	8.91	0.95	0.89

The peeling loss is 3.9%. The functioning of the machine is independent of the tuber mass. It depends mostly on the age after harvesting, shape and size of the tuber. The average peeling rate was measured to be 0.0108 kg/s.

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