THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Design and Fabrication of Multi Powered Root Crop Washer

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Abstract:

The laborious cleaning off the soil and clay particles from root crops before transporting them to market causes drudgery and time wastage. This research work handled this by fabrication of root crop washer with locally sourced materials. This innovation was achieved by design, manufacturing process and proper material selection. It can be powered by either electric motor, internal combustion engine (ICE) or Tractor coupled. The machine cleaned root crops at a low time interval, irrespective of the source of power transmission. Here the procedure for production of this highly effective machine is stated.

Keywords: Root crop washer, manufacturing procedure, machinery, multi powered

1. Introduction

Research on postharvest biology and technology of fresh produce is primarily to reduce losses in quantity, quality and to maintain safety between harvest and consumption. It is known that when root crops are harvested, a large quantity of mud and dirt that cling to the surface of the root crops and materially increase the weight and displacement of root crops, thereby need to wash off the mud and dirt particles which would reduce the physical appeal in the market, aid in further processing and avoid contamination, (Whitemore et al 2009). One of the strategies to attaining these goals is using optimal postharvest handling practices to maintain quality and safety of the food products, (Lisa Kitinoja et al 2011).

Postharvest Innovations shows the beneficial impact of washing produce prior to taking it to market. The costs for washing can be very low if running water is available. Washed produce has enhanced cosmetic appeal and buyers are willing to pay extra for this labor-saving convenience. Sinyolo et al., (2014) informed us that Rinsing off any loose soil and debris improves aesthetic appearance and enhances food's market value, but the washing water should be neat to avoid contaminating the crops. Washing should therefore, only be done if the water is clean. Chlorination is needed to disinfect the harvested root crops; It is effective maximally when a carefully measured chlorine powder or liquid that is sodium hypo-chlorite is mixed with water, hypochlorous acid (HOCl) is produce which is the active compound that kills pathogens on the surface and reduces the spread of contamination during the washing. Chlorination is easily implemented, quick, inexpensive, and readily available. Organisms which can cause decay that spoils harvested Crops can be: microorganisms, Pathogens, Microbes, Bacterium and Fungi.

Recent studies and literature reviews confirm that postharvest losses are still high at the farm, wholesale and retail levels. Farmers have been losing their fruits and vegetables before they reach the final consumer in a less Physical and quality state which lead to loss of market value, concerns about food safety, and lower incomes for growers. Lisa Kitinoja, et al (July 2002). Earlier efforts had been made to tackle this challenge of cleaning off the soil before taking to market. Active horticultural education and research activities which give simple postharvest technologies and many practices that have the potential of meeting the special needs of small-scale food handlers and marketers, though need to improve on it.

In the present system at the southeast Nigeria, there is no washing equipment for these root crops adopted by farmers. The method of washing root crops is by trampling under feet and brooms in running water. This not only damages the product but also unhygienic. The operation requires more labour also exposed the labourers constantly to chill water during the washing operation. Some farmers involves in using of big perforated crates or tubs. The soiled crops are put in the perforated crates, washed manually using a jet stream of water, while the crops are shuffled regularly with hand for proper cleaning. This also a very time consuming process and causes drudgery.

Water sprays technology was used by some farmers. It is very effective since it physically remove firmly attached pieces of dirt. Spray varies from low pressure wide angle to very high pressure directed jets. The intensity and type of spray distribution must be carefully selected. Flood washing is done by a large quantity of water moving at a moderate to high speed over the product, Dawn C. P et al (2013). Washing efficiency in flood washing is very low due to non removal of thin layer of surface mud coating. Crops may be contaminated with *Escherichia coli* and hence they should be lifted from water rather than water poured or drained off, in which case soil remains in the container with the crops J. J. Luna-Guevara et al (2019).

Relatively little information is available in the research literature on mechanical root crops washers. The literature survey reveals that many designs have been proposed in the past for this problem.

(Lisa Kitinoja et al 2011) had reported a traditional methodology in which tanks are mounted on simple washing stand. The tank for washing produce is made from sheet metal. A baffle made of perforated sheet metal is positioned near drain pipe and helps to circulate water through the produce. Fresh water is added under pressure through a perforated pipe, which helps move floating produce toward drain end of the tank for removal after cleaning. Dawn C. P. (2013) Produced hand wheel operated washing machine and it was stated and fabricated for carrot washing only. This did not consider the labour in Manual operation.

Ghulam Siddique et al (2017) produced a carrot washing machine with a wooden drum and a continuous pressurized water supply by the PVC pipe stationed at the top, powered with electric motor only and the both sides of the drum were constantly open. Tehmena Rashid et al (2018) developed machine was specified for carrot washing only and operated only with tractor P.T.O shaft. The washing drum of his machine is octagonal shape made of iron strips, which makes it so heavy to be multi powered effectively. It also litters the environment while working.

Ganesh M. R. et al (2018) newly developed carrot washing machine mainly consists of circular wooden drum, main frame, power transmission unit and drive assembly, water supply unit and drain water collector tank and crank but it was pedal operated washing machine, that is manually operated. Barrel washer for cleaning root crops fabricated in Alaska by Mike Emers (2012) is open in both sides and operated only by electric motor.

Considering the existing machines, the benefits expected were not fully derived because its performance was deeply affected by inadequate. These methods need to be improved for the greater market value of the crop and proper use of resources. This machine is powered by Tractor PTO, ICT generator or electric motor. Designed on a considerable weight and water used are collected for irrigation purpose. Since no significant difference in contamination levels observed between crops irrigated with tap water, untreated greywater, and treated greywater.

Greywater which can be define as wastewater without any contribution from toilet water (Casanova et al. 2001). So water collected after washing root crops is inclusive. Universal problem of water shortage, high demand for water and high levels of fresh water pollution resulting from anthropogenic factors is impediment to be given attention. There is need to the development of alternative water management strategies. (Qureshi and Hanjra 2010; UNDP 2017). This innovation encompasses the constraints in having single source of powering, water management and drudgery in washing of root crops.

2. Materials and Methods

2.1. Production /Manufacturing Processes

Manufacturing processes of manufacturing products effectively, efficiently, economically and environment-friendly through the application of existing manufacturing process and system, Proper selection of materials, tools, machines and environments, Improvement of the existing materials and processes, that is technologically acceptable, technically feasible, economically viable and eco-friendly were implemented using locally available resources in this work.

3. Manufacturing Procedure of the Machine

This multipowered root crops washer was designed and fabricated. The production drawing is presented in the Fig 2 while the labeled diagram is shown in Fig 3 below, with chosen dimensions from the machine design process.

The drum is a regular hexagonal prism of 2.5m lengths with two hexagonal bases. Base height, base area and volume are 1.04m, 0.936m² and 2.34 m³ respectively calculated as shown in Fig 1 below. The drum bases are made up of 4mm thick mild steel plate. 15 strips of wood was fastened at 4mm spacing on each side of the hexagonal steel ends which is 0.6m of the drum making it total of 90 strips of wood used,

A mild steel pipe of 3.1meter length of 2.0inches diameter runs across the drum at the center of the drum were perforated so many, which serve to spray water in the drum. This pipe is welded at the ends of the hexagonal plates which makes the drum to rotate as the pipe turns by a power transmitter. Both sides fixed at the frame of the machine with Radial ball bearing of rolling contact, considering its advantages which include; Ability to withstand momentary shock loads, accuracy of alignment, Reliability, low cost of maintenance, easy to mount and low starting and running friction except at very high speed and such high speed is not required in this machine. The bearings are of 2.1inches diameter. The steel pipe is sealed at one side to avoid water pouring away, while the other side which comprises the power transmission unit, technically arranged pulleys with belts and Centrifugal pump. At this side, 0.3meter diameter pulley is attached and the delivery pipe of the pump is introduced inside the perforated mild steel pipe in a mechanism that the delivery pipe does not turn as the mild steel pipe turn together with the drum. The main transmission is a rod of 2.0 inches diameter and 10 inches length on two bearing of 2.1 inches diameter having two pulleys of which inner pulley is 0.15m diameter with single groove that drives the 0.3m diameter pulley on the mild steel pipe of the drum through a V belt. The outer pulley of the transmission is two grooved 0.2m diameter. The outer groove is for ICT power generator or 5 HP single phase electric motor which transmit power through pulley and belt while the inner groove is use to drive the Centrifugal pump pulley of 0.1m diameter. The transmission rod projected about 5 inches which the tractor OTP attached during tractor operated. The pump discharges 1.44 liters/sec of water with suction pipe of 1.5 inches and delivery pipe of 1.25inches. Pump is operated at 1500 rpm. Pressurized water is sprinkled on the root crops kept in the rotating drum. The drum is loaded through the door provided and properly locked before it starts to rotate.

Type A of V belt which is selected since power is to be transmitted from one pulley to another and the two pulleys are near to each other, its drive is positive, quiet in belt and pulley operation and can be easily installed or removed also

power range of 0.7 – 35 kw is required. Width of belt is in R10 series and the width of pulley/ face of pulley is 25% greater than the width of the belt. Rajput, R.K (1995)

Due to the rotation of the drum and sprinkling of pressurized water, the soil and clay particles are separated from the crops, thus, giving them a fine finish. Small pebbles and contaminated water falls down through slits

The main frame of multipowered root crop washer is rectangular in shape made by using 2×2 inches Square pipe with 0.8 inches thickness. The overall dimension of frame is 1.50 x 3.0x 0.9 meters. Main frame of the machine has two wheels and one hitch for the purpose of easy transportation.

The top cover is a concave shaped made by mild steel Sheet that covers more than half of the drum that projected up from the frame which prevents splashing of the water in the environment as the machine works.

4. Volume of the Drum (A Regular Hexagonal Prism with Two Hexagonal Bases)

Figure 1: Hexagonal Base of the Washing Drum

Volume=Base area (B) x Height of the hexagonal prism (washing drum)(H)

Volume=B.H

Area of Triangle = $\frac{1}{2} b.h$

$\frac{1}{2} .0.6.h$

But $h = b \cos 30 = \frac{\sqrt{3}}{2} \times 0.6 = 0.52 \text{ m}$

$K = 0.52 \times 2 = 1.04 \text{ m}$

Base Area of hexagon = $(\frac{1}{2} \times 0.6 \times 0.52)6 = 0.156 \times 6 = 0.936 \text{ m}^2$

$B = 0.936 \text{ m}^2$

VOLUME = $B \times H = 0.936 \times 2.5 = 2.34 \text{ m}^3$

Figure 2: The Production Drawing

Figure 3: Multi Powered Root Crop Washer

5. Conclusion

This machine was fabricated considering the stringency in a singular source of power in machine operation and water conservative. It increases farmers profit, improve the consumers' health and give a serene environment for the production process.

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Appendix

Figure 4