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Design and Fabrication of Root Vegetable Washer

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Abstract: ***Washing is the primary and an essential operation in the production and distribution of fresh root vegetables. Root vegetables like carrot, radish, ginger etc. needs to be pre-cleaned before transporting from field to market. At present there is no primary and an economical processing unit for small scale farmers. A stainless steel, portable pedal operated vegetable washer was developed. After harvesting the Root vegetables like potato, carrots, radish, etc. have to be cleaned off the soil, remove the clay particles and other microbial contaminants for a healthy and acceptable produce for the consumers. Normally the Farmers in India use the Traditional methods to clean the root vegetables which are found to be less effective in cleaning process and also it is a time consuming process which involves additional labour. Hence to avoid these problems our project could the best possible solution in order to solve the problem of small scale farmers***
Keywords: Root Vegetables, Small Scale, Washing, Pedal Operation, Health, Economical

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I. INTRODUCTION

In India, agriculture is facing serious challenges like scarcity of agricultural labour. This is mainly due to migration of farmers towards the cities in search of non-farming jobs having higher wages There are attractive opportunities for entrepreneurs in the field of fruit and vegetables processing in India. An attempt was made by to develop a small-scale carrot washer for research sample purpose. The primary motivation for development of a mechanical fruits and vegetables washer which can give improved fruits and vegetables quality, time and labor savings, and improved speed and efficiencyof sample handling. This article presents the need and design considerations for a small–scale mechanical fruits and vegetables washer and its performance evaluation.

II. LITERATURE REVIEW

R. N. Kenghe [1] have discussed about the Design, Development and Testing of Small-Scale Mechanical Fruit Washer. Fruits and vegetables sample from field research must be cleaned prior to weighing, grading and processing for value addition and basic hygiene. Soil and other foreign materials must be removedas they are attached to the fruits. The objective of this study was to develop a low–cost mechanicalfruit and vegetable washer to reduce the labour and time requirements. A Prototype of mechanicalfruit washer was designed, developed and performance was evaluated.

Ganesh M.R [2] published in the International Journal of Information and Computing Science about the Fabrication of Root Vegetable Washer. Root vegetables like carrot, radish, ginger etc. need to be pre cleaned before transporting from field to market. At present there was no primary processing equipment like vegetable washers available for small farmers which were economical. In an attempt to improve upon the traditional cleaning methods of root crop vegetables, it has expressed a need for an innovative processing approach to the cleaning of their harvested organic produce to meet their special needs. The Automatic Root Crop Washer is a machine which could find its use in the agricultural fields. The root crops like potatoes, carrots, radish, etc., after harvesting have to be cleaned off the soil and clay particles before transporting them from field to market. Normally the farmers of Punjab (INDIA) follow a traditional method of cleaning the carrots, radish in which the roots are washedmanually by hands and feet.

V.K Sehgal [3] here discussed the Development of Farm Level Washing Machine. Stainless steel, portable, electric power (1 hp) operated vegetable washing machine wasdeveloped. The inner rotary drum of the washer is made of stainless steel with 1.5 mm thickness,760 mm length and 620 mm diameter. The machine is provided with a timer and an electronic device to regulate precisely the rotational speed of the drum up to 60 rpm. The performance of thewashing machine was evaluated in terms of capacity, bruising percentage and washing efficiencyfor various vegetables viz. carrot, potato, radish, turnip, ginger, okra, tomato and spinach. The capacity of the machine at optimum washing parameters varied from 1-6 qph, depending upon thetype of vegetable washed. The washing efficiency ranged from 90.2 to 95.5%.

Ritikant Maitai [4] “Post-Harvest Management of Agricultural Produce The minimization of loss or wastage of agricultural produce remains the ultimate goal of post harvest management strategies. The post harvest management has attained the central stage in the present situation of increasing population and shrinking agricultural land and other resources.

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Presently, the main global challenge is to ensure food security 138 in a sustainable manner safe tomankind and environment. According to the FAO, food production will need to grow by 70% to feed world population which will reach 9 billion by 2050. Hence, there is need for thorough understanding of agro-ecosystem functions. The value chain for processing has become a necessity to improve the food safety and strengthen national food security. The value chain in post-harvest management of horticultural crops mainly comprise of pre-harvest factors, harvesting, market preparation (pre-cooling, sorting, grading, packaging and on-farm storage), transportation, storage,value addition/processing and by-product waste management

Sunkara Mukesh [5] "Performance Evaluation of Vegetable Washer" The vegetable crop especially root crop must be washed before the transportation from field to market. For a small scale farmer, it is a labour consuming process. A vegetable washing machine was evaluated for carrot crop. The performance parameters of machine such as mechanical washing efficiency, microbial efficiency and bruising percentage were determined. The speed of the rotor drum was 25 rpm. The performance results showed that the mechanical washing efficiency, microbial efficiency and bruising percentage were varied from 72.80 to 78%, 88 to 92% and 5.80 to 8.50%, respectively. The fuel consumption was found to be 1.8 to 2.2 l h.

Michelle Choi [6**]** "Design of small scale crop washer" Applying engineering design concepts and analysis, this report outlines the development of a small scale root crop washer from computer model simulation to a working prototype. The methodologies of mechanical design, material acquisition, construction and prototype testing are addressed. Prototype success, assessed through adequate testing, has enabled the validation of the efficacy in the cleaning of root crop vegetables. Using these success parameters and the working prototype a scaled-up model will effectively be constructed by using food grade brushes, in order to meet the needs of MSEG and their agricultural practices.

Yousry Shaban [7] "Development of a small scale washing machine for root crops" small scale washing machines with a rotating drum and a continuous pressurized water stream was developed and evaluated for root crops washing at farm after harvesting process. The performance of the developed washing machine was evaluated in potato tubers washing under three different drum speeds of 10, 20 and 30 rpm, three different batch loads of 12, 24 and 36 kg and four different retention times of 2, 4 ,6 and 8 min. Results revealed that the proper washing performance in terms of washing efficiency (93.07%), bruising percentage (5.33 %) and microbial washing efficiency (85.8 %) was achieved when the machine was operated at 20 rpm rotor drum speed, 36 kg batch load and 4 min retention time

III. PROBLEM DEFINITION

The small scale farmers had been facing various problems during the harvesting of the root vegetables one of the problems was the cleaning of root vegetables using traditional methods is not easy for small scale farmers and the cost labor is also high for the process. process. The old method which is being followed by small scale farmers is not effective and hence, the contaminants from the soil stay on the vegetables which may cause problems to the consumer.

IV. OBJECTIVES

The objective of this project is to:

1) Design and develop a root vegetable washer, which can be a replacement for manual washing of vegetables and reduce the time consumption
2) The Primary motivation for development of root vegetable washer is to give improved vegetable quality with simple handling techniques and improved efficiency of washing.

V. METHODOLOGY

1) *Field Survey:* A detailed survey on the properties of vegetables and the requirements of the washer was analyzed.
2) *Design and Calculations:* The design calculations were done to analyze the strength and capacity of vegetables it can with hold
3) *CAD Model:* A 2D/3D CAD Model of the Root vegetable washer is to be designed

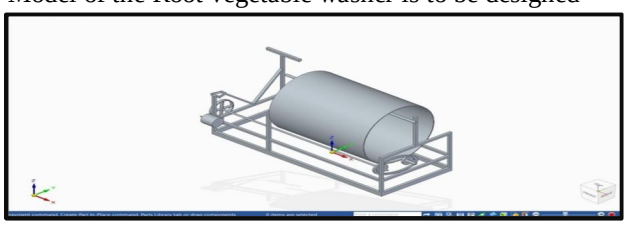


Fig 1: 3D CAD model of root vegetable washer

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4) *Selection of Raw materials:* The raw materials for the further process were done accordingly as per their physical properties and compatibility with vegetables.
5) *Fabrication:* The designed model is to be fabricated with the suitable and economical materials.
6) *Testing:* The Performance test of the root vegetable washer was done with the various vegetables accordingly and the mechanical washing efficiency was achieved for these vegetables.

VI. EXPERIMENTATION /FABRICATION DETAILS

A. Design and Calculations

1) Design of Drum

The volume of the drum can be found out by the formula Volume = Area*Length
Where,
V = Volume in mm^3
A = Area in mm^2
L = Length in mm^2
Here,
D = Diameter of drum in mm
D = 18inch = 457.2mm
L = 3foot = 914.4mm
Now,

$$A = \frac{\pi * D^2}{4}$$

$$A = \frac{\pi * 457.2^2}{4}$$

$A = 164.17 * 10^3 mm^2$
Hence,
V = A*L
$V = 164.17 * 10^3 * 914.4$
$V = 150.11 * 10^6 mm^3$

2) Calculation of frame

For the Calculation of the drum let us assume the whole frame structure to be a simply supported beam carrying a uniform load throughout its surface, the load distribution is mentioned accordingly.
Let us assume the Approximate Values for load as:
Mass of the Drum, m_1 = 8Kg = 78.453N
Maximum load of vegetables acceptable by drum,
m_2 = 15Kg = 147.099N
Load due to Mass of Water, m_3 = 5Kg = 49.033N
Total Load which is exerted on the frame uniformly,
$W = m_1 + m_2 + m_3$
W = 28Kg = 274.585N
Bending Moment (B.M) = $(\frac{wl}{4})$
Where,
B.M = Bending moment, N-mm
w = total weight on frame, N
l = total length of frame, mm

$$B.M = \frac{(274.585) * (914.4)}{4}$$

$B.M = 56.597 * 10^3$ N-mm

3) Calculation of Shaft

For the calculation of shaft we have took the speed of the shaft N, as 40Rpm as it is done manually, we checked with a similar project with load to fine the approx human effort on the pedals by the help of a Tachometer.
Considering the Diameter of the Shaft, d = 23.94mm

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Let us take speed, N = 40Rpm
To find the Torque we know,

$T = \frac{9.55*10^6}{N}$

$T = \frac{9.55*10^6}{40}$

T = 238.7 N-mm

Radius of the shaft, $R = \frac{d}{2}$

$R = \frac{23.96}{2}$

R = 11.98mm

Power Transmitted by shaft:

$P = \frac{2\pi NT}{60}$

$P = \frac{2*\pi*40*238.7}{60}$

P = 0.99kW

B. Fabrication Details

The below given figure is the fabricated view of Root Vegetable washer. The frame was first made according to the calculations and the dimensions which were instructed, the drum was fixed to the frame with the help of supporting bearings the drum is further connected to a pulley which is further connected to a shaft which transmits required power from the pedals which is manually operated. The vegetables are fed into the washer from the side of the drum carefully, further the nozzles are fixed to the side from where the water jet is sprayed on to the vegetables where they are cleaned the vegetables are then taken out from another side of the drum, the water flows through the mesh where it is again re-circulated to the drum through the pipe.



Fig 2: Fabricated Model of Root Vegetable Washer

VII. RESULTS AND DISCUSSIONS

The Result is analyzed by comparing the various root vegetables with each other considering their speed of rotation, washing time, capacity and the efficiency of mechanical efficiency of the machine after testing for which the calculation for one vegetable i.e. carrot is shown below:

The Mechanical washing efficiency of the machine was determined as the ratio of the difference of the weights of vegetables before and after washing to the weight before washing on percentage basis.

Mechanical Washing Efficiency =

$$\frac{\text{Weight of the Carrot before Washing} - \text{Weight of the Carrot after Washing}}{\text{Weight of the Carrot before Washing}}$$

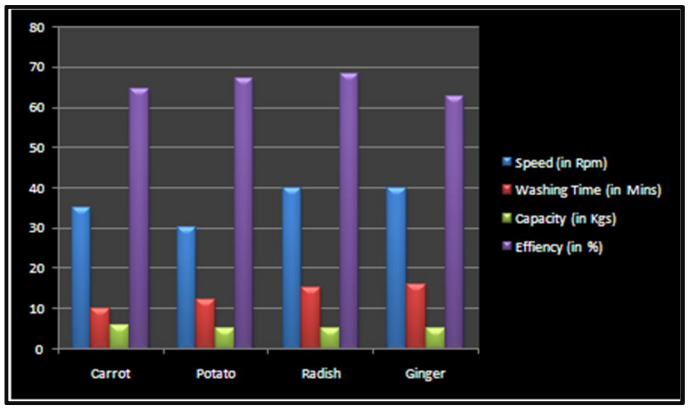
Mechanical Washing Efficiency = $\frac{5.0-4.4}{5.0}$

Mechanical Washing Efficiency = 0.12*100 = 12

Total Mechanical Efficiency Achieved = 100 – 12 =88%

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Root Vegetables	Speed (in Rpm)	Washing Time (in Mins)	Weight before Washing (in Kgs)	Weight after washing (in Kgs)	Mechanical Washing Efficiency (in %)
Carrot	35	10	5	4.4	88
Potato	30	12	5	4.6	92
Radish	40	15	5	4.2	84
Ginger	40	16	5	4.5	90

VIII. CONCLUSION

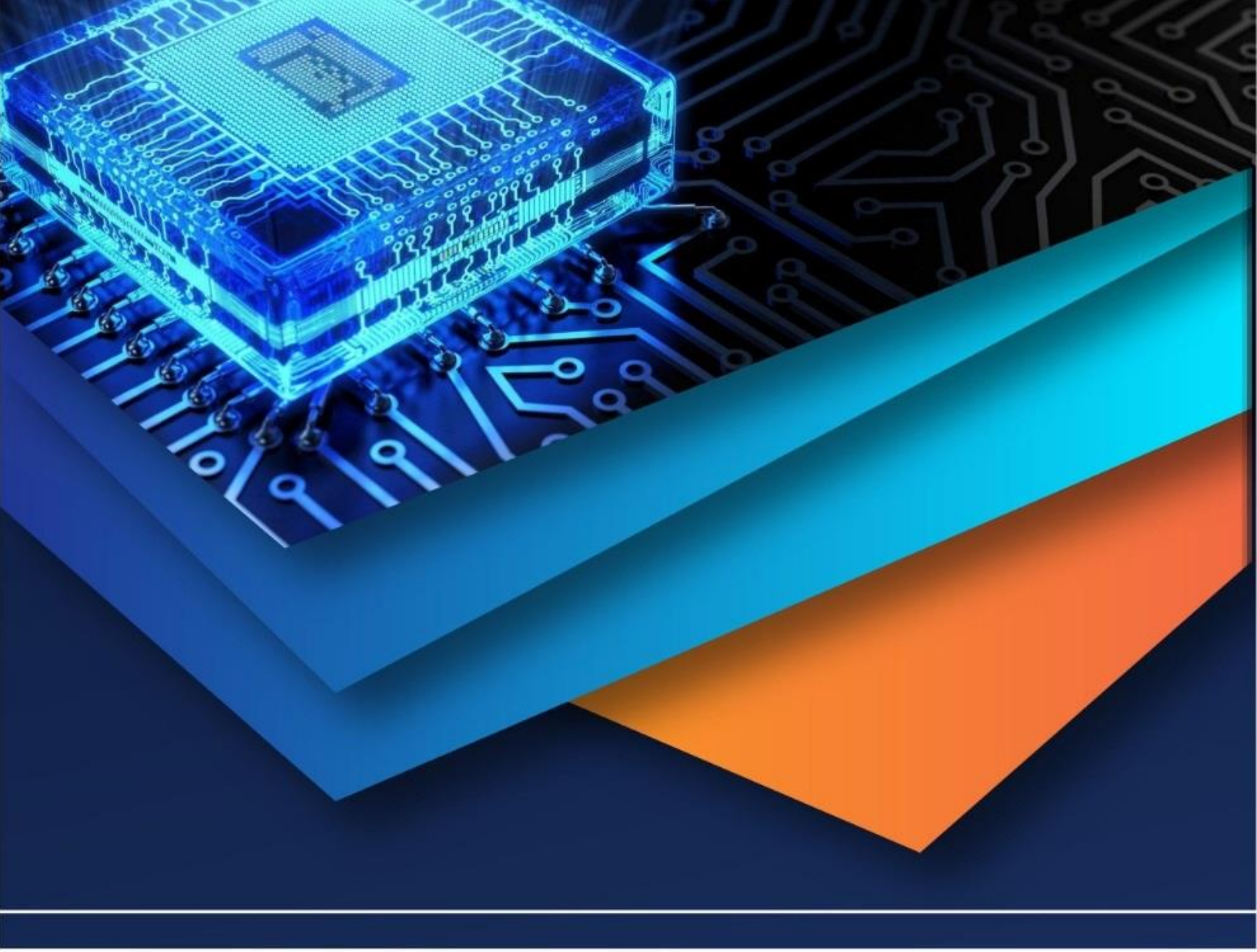
1) The root vegetables carrots, radish grow on heavy soil that are coarser and rougher, as they grow under the soil the chances of having physical damage, bruising, cracking cuts etc. also increases and can become a vital place for the impurities to have shelter, due to which the need of intense washing and cleansing by an equipment specially designed for this purpose is very essential.
2) The pedal operated vegetable washer were tested for various vegetables like carrots, radish, potato and ginger and it was found that the overall washing efficiency was close to an average of 88.4%
3) The cost and maintenance is economical and can be used by small scale farmers

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