FABRICATION AND PERFORMANCE EVALUATION OF A TRACTOR OPERATED CARROT WASHING MACHINE

Tehmena Rashid[1], Ghulam Siddique[2], Abdul Aleem[3]
[1]Agricultural Mechanization Research Institute Multan, Agriculture Department, Punjab
aaetehmena.rashid@gmail.com
[2]Agricultural Mechanization Research Institute Multan, Agriculture Department, Punjab amrimultan@gmail.com
[3]Agricultural Mechanization Research InstituteMultan, Agriculture Department, Punjab
abdul.aleem17@yahoo.com

***ABSTRACT**: Carrots after harvesting from the field need to be pre-cleaned of soil and other foreign particles before processing or transporting to the market. Currently, farmers in Pakistan use the traditional method in which carrots are washed by hand. A tractor operated carrot washing machine was developed to give the best solution to this problem. The carrot washing machine consist of Octagonal Dum made of mild steel strips and mild steel rod and a center pipe made of GI with holes drilled on it for water spraying. The carrot washing machine was put to test against manual washing in the agricultural field and the machine proved to be time efficient. The appropriate rotation of the drum was found to be 21 rpm at 1500 rpm of tractor and washing capacity is 2.75 ton/hr. Performance trial on the machine shown that the average washing efficiency is approximately 98%. This machine can also be used for washing of other root crops to make these vegetables ready for market.*

***Key Words**: Traditional Methods; Carrots; Carrot Washer; Market Price*

INTRODUCTION

Carrot (Daucus carota) is vegetable that belongs to Umbelliferea (apiaceae) family [1]. Carrots have a maturity period of about 100-120 days and is sown on area of 13500 hectare with 235.9 thousand tons production in Pakistan [2]. It is cultivated in many countries throughout the world. Such as America, Europe, South-west Asia and Africa and this is mainly due to carrots have high nutritional value [3-4]. The edible roots are nutritional and contain water, protein, ash, vitamins and mineral [5]. Carrots are the major source of vitamins and minerals in the human diet [6].There is no substitute of carrots in our food [7]. Carrots after harvesting from field needs to be cleaned before transporting to the market. Being a root crop its washing after harvesting is necessary in order to get good market price [8].Immediate washing of root crops is very necessary after harvesting to avoid from contamination due to drying of soil on crop surface to enhance the crop quality [9-10]. Most farmers in Pakistan use a traditional method (manually) to clean their harvested carrots in which the carrots are washed manually. Manual washing is done alongside the canals and water channels and it requires huge labor. It is expensive, time consuming and inefficient. A case study conducted by Asamoah [11] at Asante Mampong municipality and he showed that 84% washed carrots using metal sponge, 14% used brush to scrape and 2% wash with bare hand. This is as a result of expensive nature of washers. These methods are laborious and time consuming. It is with this reason we have looked into a mechanized way of designing a low cost and time efficient washing machine for carrots. Charley [12] reported that vegetables are washed thoroughly to remove particles of soil and microorganism that are present in soil. Vegetables may be contaminated with Escherichia coli and hence they should be lifted from water rather than water poured or drained off, in this case soil remains in the container with vegetable. Henderson and Perry [13] reported that manual washing of crops is done by a large amount of water moving at medium to high speed over root crops. Le Bohec [14] concluded that conventional method of washing of carrots tends to damage the carrots. The washing procedure of farmer is very poor at farm level [15] and there is a need to improve these methods to get good market price. Murry and Judy [16] reported there is a need of efficient vegetable washer to remove foreign material from the tractor mounted carrot washing machine for root crop growers. Surface of vegetables especially root crops. According to demand of root crops. According to the demand of root growers it was necessary to develop a machine which can help the famers in washing of root crops at farm level. Therefore, Agricultural Mehanization Research Institute (AMRI), Multan has designed and developed tractor mounted carrot washing machine for root crops.

MATERIALS AND METHODS:

The carrot washer design was consists of Main Frame, Octagonal Drum, Water Supply Unit, Power Transmission Unit and Tray (see Fig. 1).

1. Main Frame: The main frame of carrot washer is rectangular in shape made by using 3”×3”×5/16” angle iron. The overall dimension of frame is 9×5.25×3 ft. Main frame of the machine have two wheels and one hitch for the purpose of easy transportation in the field. Fig.2 shows drawing of main frame.

2. Water Supply Unit: Centrifugal pump having discharge of 1.44 liters/sec is used to supply water in the washing drum. The suction pipe of 1.5 inches and delivery pipe of 1.25inchs are attached with pump. Pump is operated with tractor at 1500 rpm.

3. Power Transmission Unit: Carrot washer is operated by tractor. To obtain the required rpm of washing drum different sizes of pulley and V type belts are used in this machine as shown in figure 3.

4. Drum: An Octagonal mild steel drum having size (8×4×4) ft^3, 64 mild steel strips having 2inch width and 62 mild steel rod having 4.5mm diameter used in this machine. Distance between mild steel strips and mild steel rod is 4mm. Carrots are continuously fed in rotating mild steel drum through opening at one side on circumference of drum. Water is

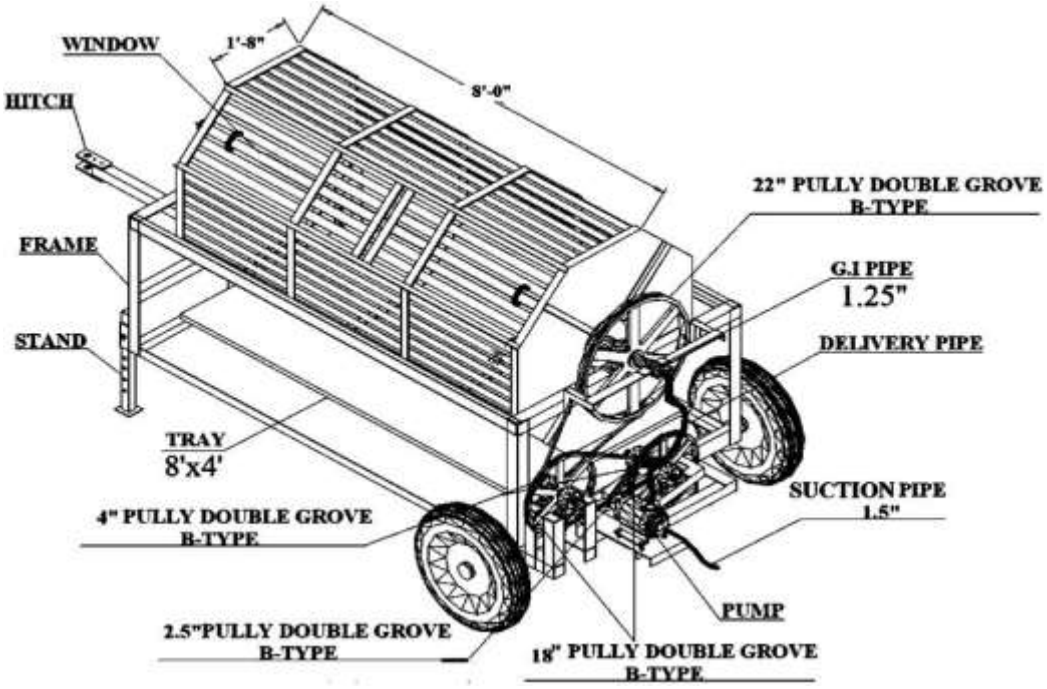

Fig 1: "Detailed Drawing of Tractor Operated Carrot Washer"

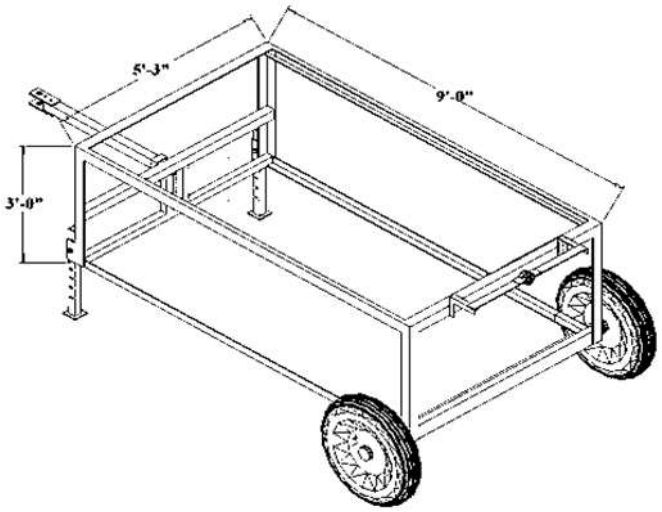

Fig. 2: Main Frame

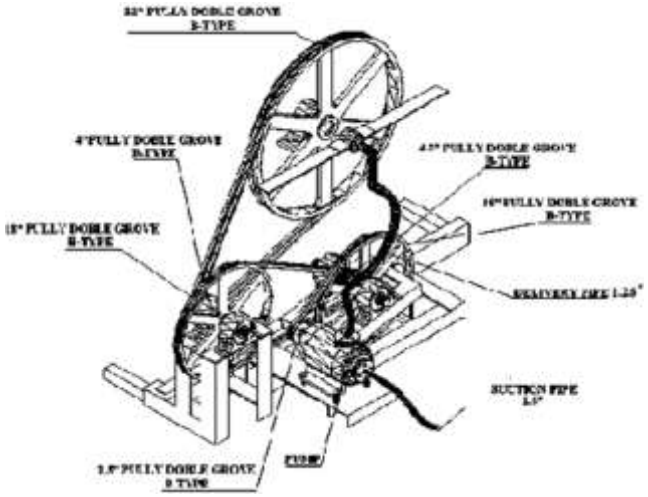

Fig. 3: Power Transmission Unit

sprayed in the drum by a galvanized iron (GI) pipe having length of 10ft having diameter of 1.25inch. The pipe is placed in the center by the support of MS hollow pipe 13 holes are inbuilt in the MS hollow pipe. The inner diameter of MS hollow pipe is 2inch and outer diameter is 3inch.

5. Tray: The tray of carrot washer is rectangular in shape made by MS Sheet. The overall dimension of tray is 8×4 ft. During washing of carrots, the water is falls down on the tray through spacing provided between the MS strips and MS rod of the washing drum. Tray drains out the water at specific place (one side of carrot washer). The tray is also used to collect the carrots after washing.

The detailed specifications of the carrot washer and pump are described in table 1 and 2 respectively.

Design Calculations and Mathematical formulas:

Volume of Drum = Area × Length

a= 20 inch

Area of Octagon = $2\times a^2\times (1+\sqrt{2})$

$= 2\times (20)^2\times (1+\sqrt{2})$

$= 1931.37\ in^2 = 13.41 ft^2$

Inside Volume of Drum= $13.41\times 8 = 107.3\ ft^3 = 3.04\ m^3$

Discharge of Pump:

To calculate the discharge of pump volumetric method is used. Water is collected in the cylindrical shape collector and time required to fill the collector is noted.

Dimension of cylinder

Diameter of collector=D=22.25" =1.85416 ft

Length of collector=L= 23.5" = 1.958 ft

Circular Area of cylinder $= A = \pi r^2 = 2.70\ ft^2$

Volume of cylinder =V= 2.69×1.958=5.28ft^3=0.150 m^3=150L
Time=T=1 min 44 sec = (1×60) +44 = 104 sec. Discharge of pump=V/T=150/104 =1.44 liters/sec

Washing Efficiency:

Washing efficiency is the ratio of the weight of carrots before washing to the weight of carrots after washing and it can be calculated by using the following formula:

$$\text{Washing Efficiency} = \frac{\text{Weight after washing}}{\text{Weight before washing}} \times 100$$

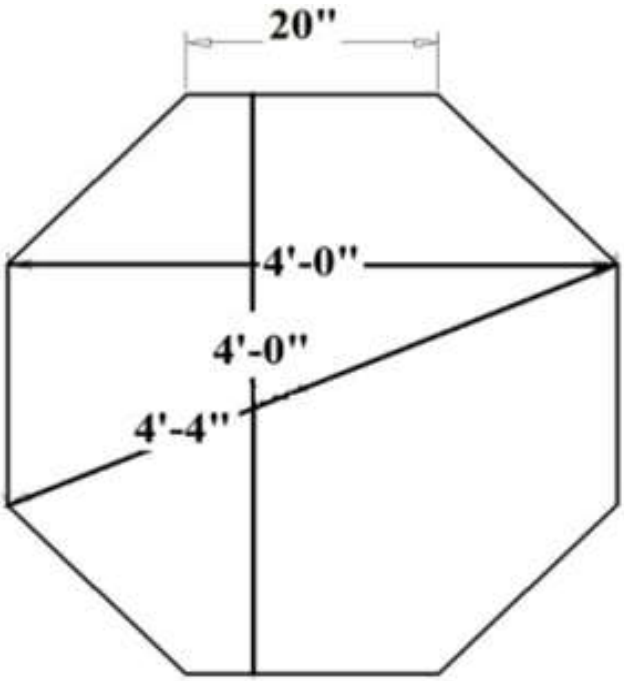

Fig. 4: Side View of Octagonal Drum

Table 1: Specifications of Tractor Operated Carrot Washer

Washing Capacity	2.75 ton/hr
Prime Mover	Tractor
RPM of Washing drum	21 rpm at 1500 rpm of tractor
Length of washing drum	8 feet
Area of washing drum	13.41 ft^2
Overall machine dimension (L×W×H)ft	8×4×4

Table 2: Specifications of Pump

Type Of Pump	Discharge (lit/sec)	Suction (inch)	Delivery (inch)	RPM
Centrifugal pump	1.44	1.5	1.25	3515

RESULTS AND DISCUSSION:

The carrot washer was tested under different conditions and data was collected carefully to check the performance of carrot washer.

Testing for Efficiency

The initial weight of the carrots was first determined before placing into the carrot washing machine for washing. This was done at Agricultural Mechanization Research Institute (AMRI). The weight was again determined after washing and the corresponding efficiencies are calculated as shown in Table 3.

Table 3: Summary of Weighing Results

Sr. No.	Weight before washing (Kg)	Weight after washing (Kg)	Washing Efficiency
1	75	73	0.973
2	100	97.25	0.9727
3	125	122	0.976
4	150	146	0.9733
5	175	170	0.9714
6	200	196	0.98
7	225	220.5	0.98

Figure 5 shows the actual view of tractor operated carrot washer. Figure 6 shows that the machine is more time efficient as compared to the traditional method of washing.

Fig. 5: Tractor Operated Carrot Washer

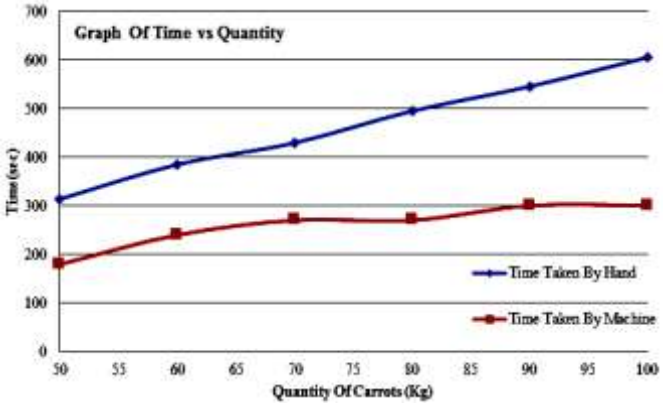

Fig. 6: Graph of Time of Washing vs Carrot Quantity

CONCLUSIONS

From the graph in figure 5 the machine proved to be more time efficient as compared to the traditional method of washing. The average washing efficiency of the machine is found to be 98% and washing capacity is 2.75 ton/hr. increasing the speed of the drum beyond 21rpm resulted in an increase in fuel consumption and wastage of energy.

RECOMMENDATIONS

To achieve an efficient wash with lowest fuel consumption, the revolution per minute of the washing drum should be maintain between 20 to 21rpm at 1500 rpm speed of tractor.

REFRENCES

[1] Manosa, N. A., "Influence of temperature on yield and quality of Carrots (Daucus carota var. sativa)" *University of the Free State Bloemfontein. Retrieved rom* http://etd.uovs.ac.za/ETD-db/theses/available/etd-08152012 150556/unrestricted/ManosaNA.pdf, (2011)

[2] *Government of Pakistan. Agricultural statistics of Pakistan 2010-11. Economic advisor's wing Finance Division Islamabad* ,(2011)

[3] Al-Harbi, A.R, Alsadon, A.A. & Khalil, S.O,. "Influence of planting date upon growth and objective component of two carrot cultivars grown in Riyadh region of Saudi Arabia" J. King Saudi. Univ. Agric. Sci. 9(2): 257-266 (1997)

[4] Munro, D.B. & Small, E., "Vegetables of Canada"*National Research Council of Canada*. Canada (1997)

[5] Norman, J. C. "Tropical Vegetables Crops" *Arthur, H. Stockwell Ltd. Elms Court Ilfracombe, Devon, UK*, pp. 232. (1992)

[6] Pamplona, R., "Healthy Foods" *Madrid Ibergraphi Publications*, pp. 5, 6, 19 (2008)

[7] Drechel, P., Quansah, C. & Penning D.V. "Urban Agriculture and Changing Food Market"*UEP Report Series*, p 19-40 (2010)

[8] Shakeel, A., H.K.W. Aslam, M. Shoaib, H.A. Skandar and R. Ramzan.. "Effect of various hydrocolloids on cloud stability and nutrition of carrot juice" *J. Glob. Innov. Agric. Soc. Sci.* **1**(22-27) (2013)

[9] Whitemore, A.P. and W.R.J. Whalley. "Physical effects of soil drying on roots and crop growth" *Int. J. Exp. Bot. Oxford University Press.* **60**(2845-2857) (2009)

[10] Aslam, H.K.W., A. Shakeel, M.Shoaib, H.A.Sikandar, N.Naheed and M.S Raza. "Effect of carbonation on the chemical composition and shelf lofe of carrot juice" *J.Glob. Innov.Agric Soc. Sci.* **2(**11-15). (2014). DOI:10.17957/JGIASS/2.1.439.

[11] Asamoah, E., "Assessment of postharvest handling of carrots (Daucus Carota L.)" a case study in the Asante Mampong *Muncipality. Retrieved from* http://ir.knust.edu.gh:8080/handle/123456789/5793 (2012)

[12] Charley, H., *Food Science. John Wiley & Sons, New York. 2nd edition*(1982)

[13] Henderson S.M., R.L. Perry., "Agricultural Process Engineering" *The AVI Publishing Company, Inc., Westport, Connecticut, USA* (1980)

[14] Le–Bohec J., "Development of gentle washers for carrots grown in sandy soils" *In Acta Horticulturae 354, First International Workshop on Carrot, Wageningen: Intl. Soc. Hort. Sci.* pp. 235-240 (1993)

[15] Ahmad, T., M. Amjad, A. Nawaz, Q. Iqbal and J. Iqbal. "Socio-economic study of carrot cultivation at farm level in the Punjab province of Pakistan" *Afr. J. Agric. Res.* **7**(867-875). (2012)

[16] Murray and Judy" Carrots, Fruit and vegetable facts and pointers" United fresh fruit and vegetable association, N.W. Washington. (1996).