Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(3): 706-710
Received: 18-03-2020
Accepted: 22-04-2020

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Performance evaluation of continuous types carrot washer for different roots crops

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Abstract

Fresh fruits and vegetables are important component of human diet because they are rich source of various types of nutrient. Washing is the first essential primary unit operation for value addition of vegetable at farm level as well as for processing. This unit operation becomes very cumbersome when we take it with different root crops such as Carrot, Ginger, Turmeric, Shatavari and Taro because of their different shape and size. Soil and other foreign materials must be removed, especially for medium and heavy textured soil in which a pre-harvest irrigation is used to loosen the soil. The washing of these roots crops are done manually by farmers and agricultural labour which consumes lot of time and money. The objective of this project was to evaluate the performance of continuous type carrot washer in terms of mechanical, microbial washing efficiency and bruising percentage. The machine was operated at 25 rpm with feed rate of 400 kg/h and power was given with 0.5 horse power motor. Then the result were analyzed and maximum mechanical washing efficiency was found in case of the carrot which was 80.46% followed by Ginger (78.79%), Taro (76.70%) and Shatavari (74.18%) and least in turmeric (63.73%).The microbial washing efficiency was found maximum in case of carrot (79.64%) followed by Turmeric (76.16%), Ginger (70.58%), Taro (66.94%) and least in case of Shatavari (59.70%). The bruising efficiency was found minimum in case of Taro (3.60%) and maximum in case of carrot (8.41%). The minimum retention time was in Taro (1.20 min) and maximum in Ginger (2.11min).

Keywords: Continuous type carrot washer, Mechanical washing efficiency, Microbial Washing efficiency, Bruising, Taro, Shatavari

1. Introduction

India is the second largest producer of fruits and vegetables in the world after china but large quantity of this produced lost due to unavailability of postharvest facility. Fresh vegetables form an important and essential component of human diet and are good sources of vitamins. Well balanced diets, rich in vegetables, are especially valuable for their ability to prevent vitamin C and vitamin A deficiencies and are also reported to reduce the risk of several diseases. Most of the vegetables are consumed at the unripened stage. Vegetables are widely exposed to microbial contamination through contact with soil, dust and water and by handling at harvest or during postharvest processing. They therefore have a diverse range of microorganisms including plant and human pathogens (Nguyen-the and Carlin, 1994) [11]. The quality of vegetables is thus of utmost importance. The number of bacteria present on fresh vegetables at harvest can be in the range of 105 to 106 per gram. Microflora of any food is of great concern since both food spoilage and safety are involved (Mangnuson *et al.* 1990) [8]. Differences in microbial profiles of various vegetables result largely from unrelated factors such as resident microflora in the soil, application of nonresident microflora via animal manures, sewage or irrigation water etc. (Ray and Bhunia, 2007) [14]. This adversely affects the quality of the produce, which leads to reduced profits and self-life. Prevention of contamination is the most efficient way to ensure food safety and prevent food borne illness. Thus, every effort should be made to protect food from primary sources of contamination. Raw foodstuffs, particularly vegetables grown close to soil, may be contaminated with various foodborne pathogens (Beuchat, 1999) [4]. Turmeric was evaluated for mechanical washingand for optimized parameter such as 2.2 min washing time at 47.2 rpm rotational speed of the machine, the microbiological efficiency was 87.2% with negligible bruising. At optimum polishing (7 - 8%) performance parameters of 40 rpm rotational speed for 20 min, the color improved from dark yellowish brown to desirable olive color (2.5 YR 6/6, Munsell color chart rating), with increase in the surface smoothness (Coefficient of external friction on G. I. sheet reduce from 0.487 to 0.436), and also resulted in improvement in the microbiological quality. Mechanical polishing reduced the surface microflora by half. The total fungi reduced from 7050 to 3220 cfu/g, bacterial count decrease from 1500 to 770 cfu/g and coli forms reduced from 200 to 110 cfu/g thus enhance the final quality of turmeric rhizomes

(Arora *et al.* 2007) [2]. Mechanical washing of ginger by using ginger rhizomes in a rotary mechanical vegetable washer were conducted at three peripheral washing drum speeds of 2.83, 3.45 and 4.08 $m.s^{-1}$ for three varying washing durations of 5, 10 and 15 min. The performance of ginger washer was evaluated based on bruise index, mechanical washing efficiency, microbial washing efficiency and colour of washed ginger. For microbial washing efficiency to be above 80%, washing speed of 3.45$m.s^{-1}$ for 5 min duration corresponding to microbial washing efficiency of 92% was considered as optimum. At the optimum washing condition, the bruise index and mechanical washing efficiency were 7.5% and 97.8%, respectively (Jayashree and Visvanathan 2010) [6].
Performance Evaluation of vegetables washer for carrots crops was evaluated on three parameters and it was found 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 (Narender *et al*. 2018) [9]. The Washing is used not only to remove field soil, dust, pesticides but the surface microbial load also and removes spores of heat resistant bacteria. Washing of vegetables generally reduces the microbial load by 100 to 1000 fold. This prevents pathogens from being transferred from the rind or skin to the inside of fruit or vegetable when it is cut (Laanen and Scott 2004) [7]. To prevent spoilage and mold growth during storage, it is necessary to wash fresh vegetable.
Carrot (*Daucus carota*) is a root vegetable, usually orange in colour, though purple, red, white, and yellow varieties exist. It has a crisp texture when fresh. The most commonly eaten part of a carrot is a taproot. In Haryana area under this crop is 18870 ha and production of 369495 ton in year 2014-15 and Haryana is the largest producer of carrot in India followed by Andhra Pradesh and Rajasthan.
Shatavari (*Asparagus racemosus*) is also a root crop, mainly used for the medicinal purposes. It belongs to family Liliaceae and commonly known as Satawar, Satamuli, Satavari found at low altitudes throughout India. The dried roots of plant are used drug. The roots are said to be tonic and diuretic and galactgogue, the drug has ulcer healing effect probably by strengthening mucosal resistance (Alok *et al*. 2013) [1]. In Ayurveda, this amazing herb is known as “Queen of herbs”, because it promotes love and devotion. The seed rate of the shatavari is 2.5 to 3 kg per hectare.
Taro (*Colocasia Esculent*) also a root crop which is eaten in the form of vegetables it is known as Eddoes or Taro in English. It is vegetative propagated tropical roots having its origin from South-east Asia and is widely cultivated in high rainfall areas usually by small farmers. Taro tubers are important sources of carbohydrates and mainly consumed in tropical and sub-tropical countries. Taro is rich in digestible carbohydrates and micronutrients. Taro contains nutrient factors such as: oxalate, Phytate and tannin (Rashmi *et al*. 2018) [13]. Taro deteriorates rapidly as a result of its high moisture and has been estimated to have a shelf-life of up to one month if undamaged and stored in a shady area. Taro foods are useful to persons allergic to cereals and can be consumed by infants/children who are sensitive to milk.
Ginger (*Zingiber officinale*) belongs to Zingiberaceae family. It is a flowering plant whose rhizome or root is commonly used in folk medicine and as a spice. Ginger is reported to originate from the tropical rainforests of the Indian subcontinent to Southern Asia where ginger plants show some genetic variation. Ginger is widely cultivated all over many countries such as Nigeria, Taiwan, India, Jamaica and Bangladesh. It is reported to grow in warm climates. Ginger has been reported as one of the wildly used herbs in traditional medicine in many countries. Mendi *et al.* (2009) [10] investigated the microflora on fresh ginger (*Zingiber officinale* Roscoe) rhizomes and ginger powder in North-West Region of Cameroon. Thirty-six (36) rhizome samples were collected, and samples of powder were produced using four different treatments. All rhizome and powder samples were analysed for total colony counts of bacteria, yeasts and moulds. The total colony counts of bacteria were higher (x10^9cfu/g) than those reported in the literature (x10^6cfu/g). The colony counts of all microorganisms for the rhizomes were significantly different (P< 0.05) across locations and in different sites within the same locations. Ginger was reported to have been used to treat baldness, snakebite, toothache and respiratory conditions.
Turmeric (*Curcuma longa*) is extensively used as a spice, food preservative and coloring material in India. Turmeric is a perennial, erect and leafy plant with very large, lily like leave up to 1.2 m long. It has oblong, pointed leaves and funnel-shaped yellow flowers. The rhizome, the portion of the plant used medicinally, is usually boiled, cleaned, and dried, yielding a yellow powder. Dried Curcuma longa is the source of the spice turmeric, the ingredient that gives curry powder its characteristic yellow colour. Turmeric is root crop which is propagated with the help of the rhizome known as seed rhizome. India is the largest producer, consumer, exporter country of the turmeric and ginger in the world, contributing 34 percent in ginger and 69 percent in turmeric of the total production in the world. India total production of the Ginger is 3 lakh tonnes covering an area of about 47641 ha of land and as far as production of Turmeric is concerned India produces about 5 lakh tonnes of turmeric yearly over an area of 149410 ha of land. Andhra Pradesh, Tamil Nadu and Orissa are the largest producer of Ginger and Turmeric in India.

2. Material and Methods
The experimental methodology including raw material procurement, sample preparation, instruments, chemicals, and reagents used, experimental design applied to obtain specific targets, analytical methods different analytical and modeling tools used in the study. The entire work of washing root crop was done in one day. Each roots crop was washed for 60 minutes.

2.1 Construction features of Continuous type carrot washer
A cast iron, portable, electrically operated continuous type carrot washer was used for mechanical washing of carrot. The carrot washer consisted of a rotary drum which was made of cast iron 87 inch length 5×5 mm bar was welded on circular strip of cast iron of approximately 19 inch diameter and mounted between two bearings fixed at a frame through a solid shaft. The overall width of the machine is 23 inch whereas overall height of the machine is 32 inch. A 43 inch long pipe fixed 8 inch height from frame is provided for spray of water. The drum is rotated with the help of tooth made on the inlet face periphery, which were messed with gear drive by a 17 inch diameter pulley. The overall length of the drum was 50 inch whereas its diameter is 19 inch. The machine is operated with the help of 0.5 horse power motor. Stainless steel pipe carrying water is mounted on one side of the rotating drum. A centrifugal pump is used for spraying water through pipe on the sample in the drum so that the carrots are cleaned. Rotating parts and moving belts are covered with

guard for operational safety. From one end of the rotor, the vegetable is fed through the feeding chute.

2.2 Sample Preparation
Freshly vegetables were purchased from the local supplier who used to grow theses five selected root crops which includes Carrot, Ginger, Turmeric, Taro and Shatavari. Five kilograms of each sample were procured from the farmers directly from the field. Each sample was kept in polybag without removing soil and then sample were transported to place of washing. The water used for washing the sample was pure and free from any types of bacteria and pathogens.

2.3 Mechanical washing efficiency
The ability of machine to remove the soil which was attached with the sample was calculated in terms of mechanical washing efficiency. The mechanical washing efficiency of machine was determine as the ratio of the difference of weight of different sample before and after washing to the weight before washing on the percentage basis. The mechanical washing efficiency was determined for each sample with the help of following equation.

Mechanical washing efficiency (%) = (Weight of sample before washing- weight of sample after washing) 100/ Weight of sample before washing

2.4 Microbial washing efficiency
The samples were analyzed for total plate count (Colony forming units, cfu) before and after washing of sample and it was determined by serial dilution technique as enumerated by Ranganna (1991). A sample of 5 g was aseptically cut from washed and unwashed sample of same duration and macerated with 45 ml distilled water (0.1%) in a sterile glass mortar and was then serially diluted up to 5 dilution (1:5) per sample. Tryptone glucose agar was made by mixing 24 g in 1000 ml of distilled water. One ml of suitable dilutions was pour plated on tryptone glucose agar and plates were incubated at 37 °C for 36-38 h. All samples were analyzed in duplicates and results were expressed as colony forming unit per gram (cfu/g) of sample. Total mesophilic viable counts psychrophilic viable counts were determined. For analysis five-fold dilution series of sample were prepared. The microbial washing efficiency was calculated using the following equation.

Microbial washing efficiency (%) = (Initial microbial load – Final microbial load) X 100/(Final microbial load)

2.5 Bruising percentage
Bruised samples means those sample in which there were some damaged occurs or in which the outer most tissues of the sample came out or bruised simply means skin came out which might be due to either by striking with sample itself or due to rubbing action while being conveyed on the revolving drum. It is defined as ration of weight of bruising sample after washing to the total weight of the sample.

Bruising percentage (%) = (Weight of bruised sample x 100)/ Total weight of sample after washing

2.6 Retention time
The time for the particular samples remain inside the rotating drum, or it is time when the sample was fed from the hopper to the time when it comes out from the outlet. For calculating the retention time one sample from each root crop was taken and it was marked permanently by making cut in some portion of the sample for identification at the outlet.

3. Results and Discussion
Results obtained from experiments conducted for fulfilling the objectives of the study with scientific reasoning and support of the findings from published literature. The continuous types carrot washer was evaluated for the three different analysis parameters (Physical, Microbiological washing efficiency and bruising percentage) which are discussed below.

Practical test of continuous type carrot washer was conducted for the entire five root crops sample at Village Behbalpur, District Hisar (Haryana) for 15 hours consisting of 3 trials for each sample and mean of the three trails was included in the final results.

The feeding rate (400kg/h) and rpm (20 rpm) of the machine was kept constant throughout the experiments for all the crops. The experiments were performed in triplicate and the average was taken in final results. The retention time for different crop was found to be different. The maximum retention time was found in case of ginger (2.11 min) followed by turmeric (2.09 min), carrot (1.55 min), shatavari (1.45 min) least in case of taro (1.20 min). The difference in retention time of different crops was due to different shape and size of the sample. Taro is having maximum sphericity due to this it is having least retention time.

The maximum mechanical washing efficiency was found in case of the carrot which was 80.46% followed by Ginger (78.79%), Taro (76.70%) and Shatavari (74.18%) and least in turmeric (63.73%) which is shown in figure 1. At same operating condition the of the machine the microbial washing efficiency was found maximum in case of carrot (79.64%) followed by Turmeric (76.16%), Ginger (70.58%), and Taro (66.94%) and least in case of Shatavari (59.70%). Thus results clearly show that this carrot washing machine can effectively use for the all the roots crops because mechanical as well as microbial washing efficiency are good. It is also supported by previous results.

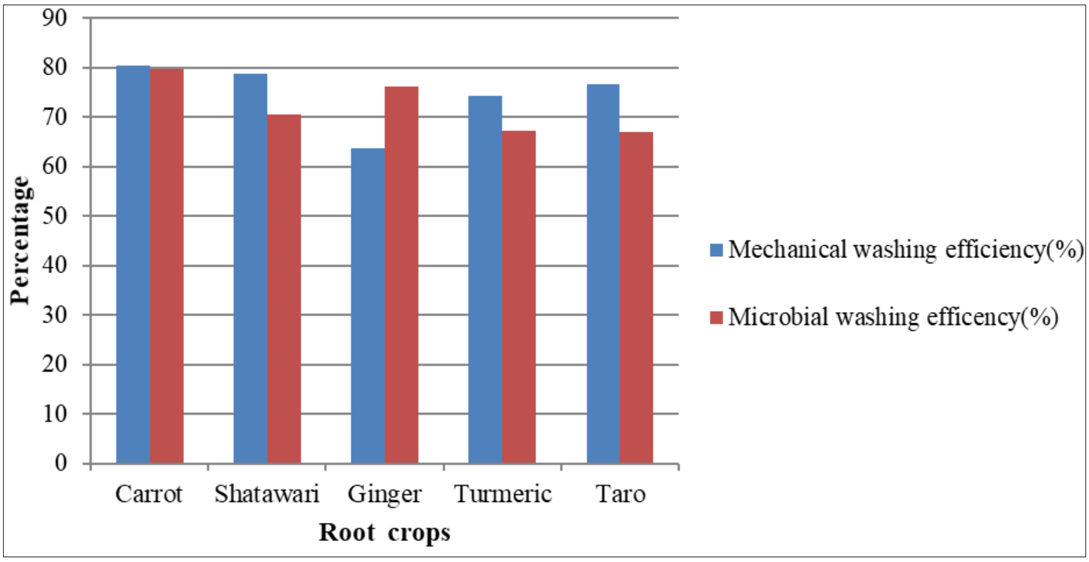

Fig 1: Showing mechanical and microbial washing efficiency of different root crops.

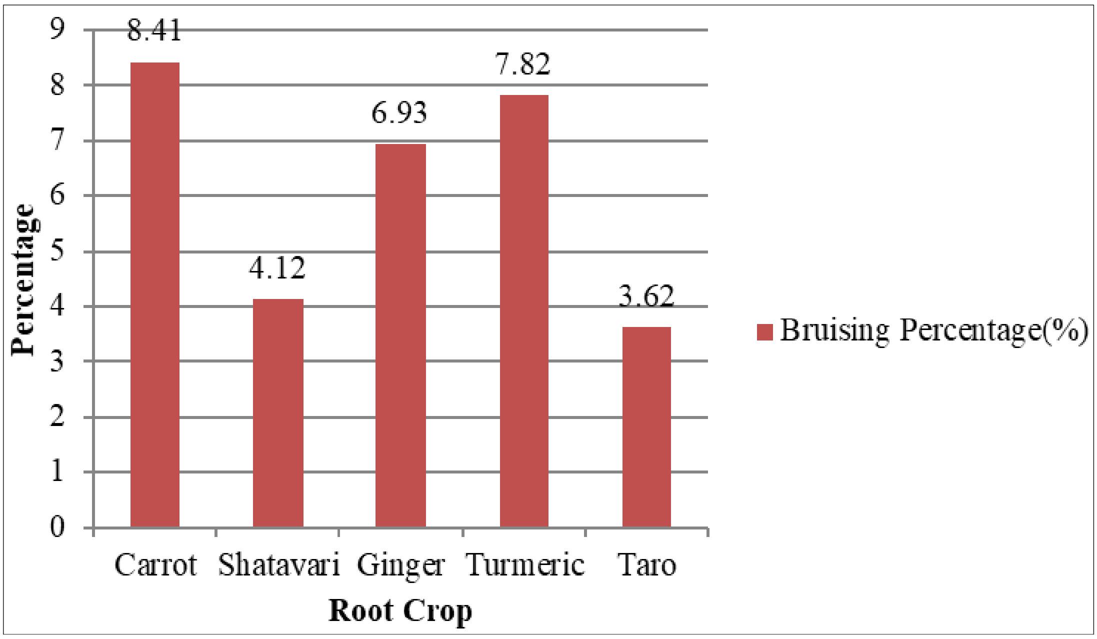

Fig 2: Showing the bruising percentage of different root crops

The bruising efficiency was found minimum in case of Taro (3.60%) followed by shatavari (4.12%) ginger (6.93%) turmeric (7.82%) and carrot (8.41%) as shown in figure 2. The bruising efficiency was maximum in carrot because of it shape size. The bruising efficiency of all the root crops was found below 9% however it can be further reduced by decreasing the rpm of the machine and also by reducing the feeding rate but it would increase the time of washing.

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