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# Performance Evaluation of Vegetable Slicers for Perishable Vegetables

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## Abstract

The vegetables slices are used as salad in various types of parties or celebration in India continental. The slicing is brought about by mechanical means without change in chemical properties of the material and uniformity in size and shape of individual units of the end product. The unbranded slicers were procured from market of different manufacturing companies. The main objective of study was to evaluate the performance of vegetable slicers (i.e. slicing machine-I and slicing machine-II) that is affordable by small scale farmers, new entrepreneur and food caters. The performance of the slicers is evaluated with raw potato, radish, cucumber, turnip and carrot. Initial moisture content of potato, cucumber, turnip, radish and carrot was observed 82.91%, 94.58%, 95.16%, 94.25 and 86.19%, respectively. The average slicing capacity was observed highest in Slicer-II and slicing efficiency for Slicer-I.

***Key words*:** Vegetable slicers, Performance, Slicing capacity, Slicing efficiency, Slicing time

Fruits and vegetables are an important supplement to the human balanced diet as they provide the essential minerals, vitamins and dietary fibre (roughage) for maintaining the tear and wear of the over body [1-2]. Fresh fruits and vegetables are valued for their quick sources of available energy. Fresh fruits have high water content (70-96%), varying amount of carbohydrate (3-27%) and fibre (0.2-3.1%) and a low content of protein, fat and minerals. Fruits are important source of Pro-vitamin A and vitamin C. In addition, vegetables also supply fair amount of carbohydrates, protein and energy and add colour, flavour and aroma to human diet [3-4]. Fresh fruit and vegetables have a short shelf life under ambient conditions of temperature and humidity due to their highly perishable nature. They not only adorn the table, but also enrich health from the most nutritive menu and tore up the energy and vigour of man. Comparatively, vegetables are one of the cheapest sources of natural nutritive foods. Add maximum fruits and vegetable in your diet and keep yourself healthy [5-6]. They soon lose their freshness and become subjected to mould and bacterial attack, and consequently decay and become useless as articles of human diet. India is one of the largest producers of fruits and vegetables. Ideal climatic conditions ensure availability of broad range of fruit and vegetables in large quantities round the year [7-8].

Slicing is a form of size reduction and the general term "size reduction" includes slicing, cutting, crushing, chopping, grinding and milling [9-10]. The slicing is brought about by mechanical means without change in chemical properties of the material and uniformity in size and shape of individual units of the end product. Such processes as slicing of fruits or vegetables for canning, slicing sweet potatoes for drying, onion slicing for salad, slicing corn fodder, grinding grain for livestock feed and milling flour are size reduction operations [11]. Reducing the size of food raw materials is an important operation to achieve a definite size range. Slicing may help in the extraction of desirable constituents from raw materials easily due to its reduction in size e.g. for making of chips (wafers), crushing fruits for juice or for fermentation [12]. Slicing operation is achieved by cutting, which involves moving, pushing or forcing thin sharp blade or knife through the materials resulting in minimum rupture and deformation of the materials [13].

Most of the horticultural commodities are larger in size and therefore size reduction is a preliminary stage for various food processing activities. Depending on whether the material is solid or liquid, the operation of size reduction can be subdivided into two major categories. In the case of solids the operations are called grinding and slicing (cutting) while in the case of liquids the process is defined as emulsification or atomization. The selected vegetables used in this research are turnip, cucumber, carrots, radish and potatoes [14]. These vegetables are of great importance both as source of food for mankind as well as valuable raw materials for the industry [15].

## MATERIALS AND METHODS

Experiments were conducted to study the performance evaluation of different vegetable slicers with different vegetables at the laboratory of RKVY funded project "Establishment of Agro Processing Centre" at College of Post Harvest Technology and Food Processing, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh. Studies were also carried out to evaluate performance

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of slicers with potato, radish, cucumber, turnip and carrot vegetables.

Fresh vegetables were procured from the local market Meerut. Leaves and end portion were removed with a sharpened edge knife, washed with tap water to remove the dust and dirt over the surface. Peeled and again washed with water followed by slice with two types of slicers. The chips/slices were then weighed and achieved sliced weight samples.

The present investigation was undertaken to evaluation of slicer efficiency. The sliced sample (potato, radish, turnip, cucumber and carrot) was dried 150-180 minutes until the end of the drying period.

*Performance evaluation of slicer*

About 2 kg of vegetables were fed through the feeding section to be sliced by the slicer for each experimental run. The gap between the knife and the movable guiding plate allowed the cut slices to fall through the groove under gravity. The slices passing through the discharge outlet were then collected in a container. Slicing experiment was conducted for the slice thicknesses of 5 mm. The effect of thickness on various performance indices like slicing time, capacity of slicer, loss percentage, yield percentage (YP) and slicing efficiency were determined [16].

*Slicing time*

Slicing time (min) for vegetables was determined by noting the time required for slicing 2 kg of raw vegetables. A stop watch was used for the purpose.

*Slicing capacity*

The throughput of the machine was determined by calculating the time of operation and the mass of the vegetable sliced, and given by:

$$\text{Capacity of slicer } (Q)\ in\ \text{kg/h} = \frac{Total\ mass\ of\ sliced\ (kg)}{Total\ operating\ \ time\ (kg)}$$

*Broken percentage*

Broken was calculated by subtracting the sum of mass of total slices from the initial mass. The percentage of broken was expressed with respect to initial mass. Numerically, the loss percentage is given by:

$$\text{Broken (\%)} = \frac{Inital\ Mass\ of\ vegetable\ before\ slicing\ -\ Mass\ of\ vegetable\ slices}{Inital\ Mass\ of\ vegetable\ before\ slicing} x\ 100$$

*Slicing efficiency*: Since the objective was to achieve uniformity in thickness of the slices, the quality of the output of themachine was considered to be the number of standardslices made. Slicing efficiency is defined as the ratio of mass of standard slices to the mass of total number of slices [17] and given by:

$$\text{Slicing efficiency (\%)} = \frac{\text{Mass of sliced material, kg}}{\text{Total mass of material, kg}} x\ 100$$

## RESULTS AND DISCUSSION

Studies were carried out to evaluate performance of slicers (Type I & Type II) with potato, radish, cucumber, turnip and carrot vegetables. For the study, 2000 g of each vegetable were taken to evaluate performance of slicers for experimental run. The performance of slicers was analyzed by slicing time, slicing capacity, Uniform slicing percentage**,** broken percentage and slicing efficiency

*Slicing time*

The effect of the types of slicers and types of the vegetables on the slicing time was observed given in (Table 1-2). The slicing time for each vegetable of 2000 g was observed in second to slice them by two slicing machine I and II. Turnip was taken lowest time (54.66 s) followed by potato (57.30 s), radish (57.70 s), carrot (63.03 s) and highest by cucumber 61.39 s) by slicing machine-I (Table 1) while similar trend was observed in slicing machine-II. In this turnip was took lowest slicing time 48.50 s and highest by cucumber (53.16 s) showed in (Table 2) (Slicer II). From the (Table 1-2), the slicing machine-II was taken less slicing time as compared to slicing machine-I. It may be due to the sharp edge blade and RPM of the motor. Among the vegetables, turnip has highest moisture content and firm in nature so that it took lowest slicing time among the other vegetables. Cucumber reported highest slicing time among the vegetables because of thickness and hardness of green peel of the cucumber. Less moisture content and shrinkage of the skin of vegetables is also affected the slicing time of the slicers [18-20].

Table 1 Performance of slicing machine type-I

| Vegetables | Moisture content (%) | Slicing time (s) | Uniform slicing (%) | Broken (%) | Slicing capacity (kg/h) | Slicing efficiency (%) |
|---|---|---|---|---|---|---|
| Cucumber | 94.58 | 61.39 | 88.52 | 11.48 | 117.28 | 88.52 |
| Radish | 94.25 | 57.70 | 90.26 | 09.74 | 124.78 | 90.26 |
| Potato | 82.91 | 57.30 | 89.32 | 10.68 | 125.65 | 89.32 |
| Carrot | 86.19 | 63.03 | 91.72 | 8.28 | 114.23 | 91.72 |
| Turnip | 95.16 | 54.66 | 93.25 | 6.75 | 131.72 | 93.25 |
| Average | | 58.82 | 90.61 | 9.38 | 122.73 | 90.61 |

Table 2 Performance of slicing machine-II

| Vegetables | Moisture content (%) | Slicing time (s) | Uniform slicing (%) | Broken (%) | Slicing capacity (kg/h) | Slicing efficiency (%) |
|---|---|---|---|---|---|---|
| Cucumber | 94.58 | 53.16 | 87.65 | 12.35 | 135.50 | 87.65 |
| Radish | 94.25 | 52.80 | 88.50 | 11.50 | 136.42 | 88.50 |
| Potato | 82.91 | 51.50 | 91.28 | 08.75 | 139.86 | 91.28 |
| Carrot | 86.19 | 50.50 | 91.33 | 08.70 | 142.85 | 91.33 |
| Turnip | 95.16 | 48.50 | 92.68 | 07.32 | 149.25 | 92.68 |
| Average | | 51.29 | 90.29 | 9.72 | 140.78 | 90.29 |

*Slicing capacity*

The performance of slicing machine has been evaluated in term of uniform slicing, slicing capacity and broken percentage for potato, cucumber, radish, turnip and carrot. The performance of slicing machine type I & II is given (Table 1-2). The highest slicing capacity was found for turnip (131.72 kg/h) followed potato (126.65 kg/h), radish (124.78 kg/h), cucumber (118.00 kg/h) and lowest for carrot (12.67 kg/ h). Average slicing capacity of the slicer-I among all the horticultural vegetables was observed about 122.43 kg/hr. whereas in case of slicer-II, the highest slicing capacity was found for turnip (149.25 kg/h) followed by carrot (142.85 kg/ h), potato (139.86 kg/h), radish (136.42 kg/h) and lowest for cucumber (135.50 kg/h) (Fig 2). Slicing capacity of the machine-II for all the horticultural produce was observed about 140.77 kg/h (Table 2). From (Table 1-2), it reported that the slicing capacity of slicer type-II (140.77 kg/h) was observed well as compared to slicer type-I (122.43 kg/h). From the study revealed that the texture and physical structure of the turnip have less slicing and hard than the other commodity, because the moisture content of the radish is always higher than the other commodity, the radish is also soft in nature. Cucumber is found hard and sticky so slicing capacity is low than compared to using another horticultural commodity [21-22]. Slicing capacity of the machine will vary with the kind of produce as different produce has defect physical texture, physical and colour properties e.g., cucumber, radish, potato, carrot and turnip [23-24].

*Uniform slicing percentage*

The highest uniform slicing percentage for Slicer-I was observed in turnip (93.25%) and lowest in cucumber (88.52%). The slicing reveled that more uniform slicing is achieved turnip than other horticultural produce is due to the smooth length and diameter as compared and others. It is also depending upon the uniform feeding rate and operator skill for feeding. The size and shape of horticultural produce affect the uniform slicing capacity and size and slicing time [25].

The uniform slicing percentage for slicer –II was showed highest in turnip (90.29%) and lowest in cucumber (87.6%). The uniform slicing percentage was observed similar to slicer-I. However, slicer-I is found better than the slicer-II in case of slicing of turnip while slicer-II was better in case of slicing of potato (Table 2).

Uniformity sliced amount show best sliced sample have uniformity in thickness shape and size and explained how much machine is suitable for which type horticulture commodity is best suitable.

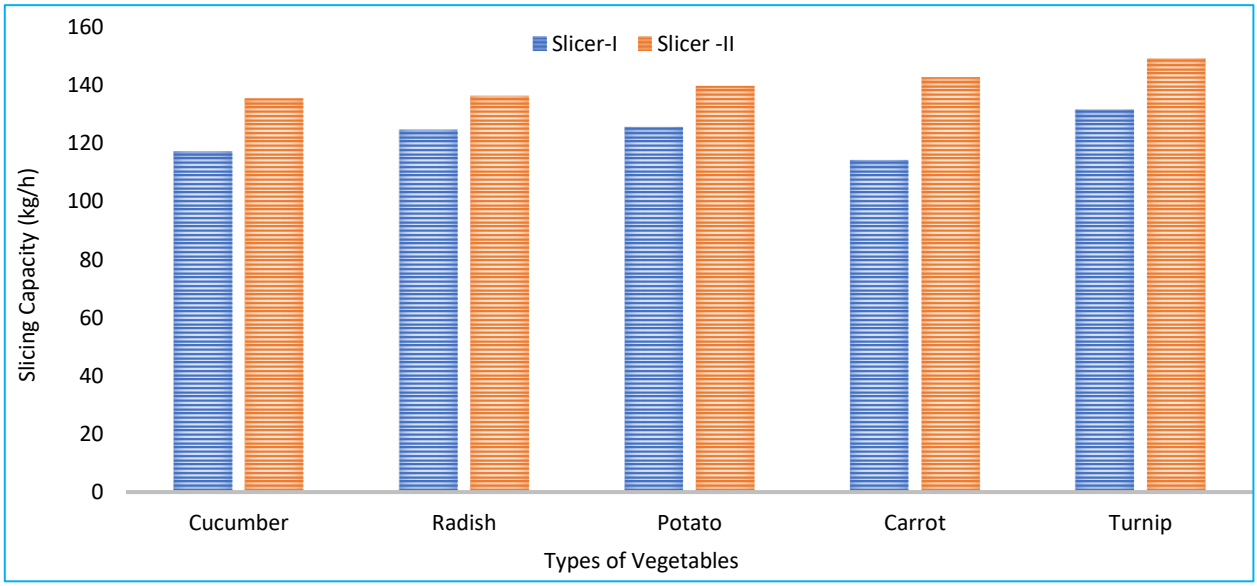


Fig 1 Effect of types of vegetables on the slicing capacity (kg/h) of slicers

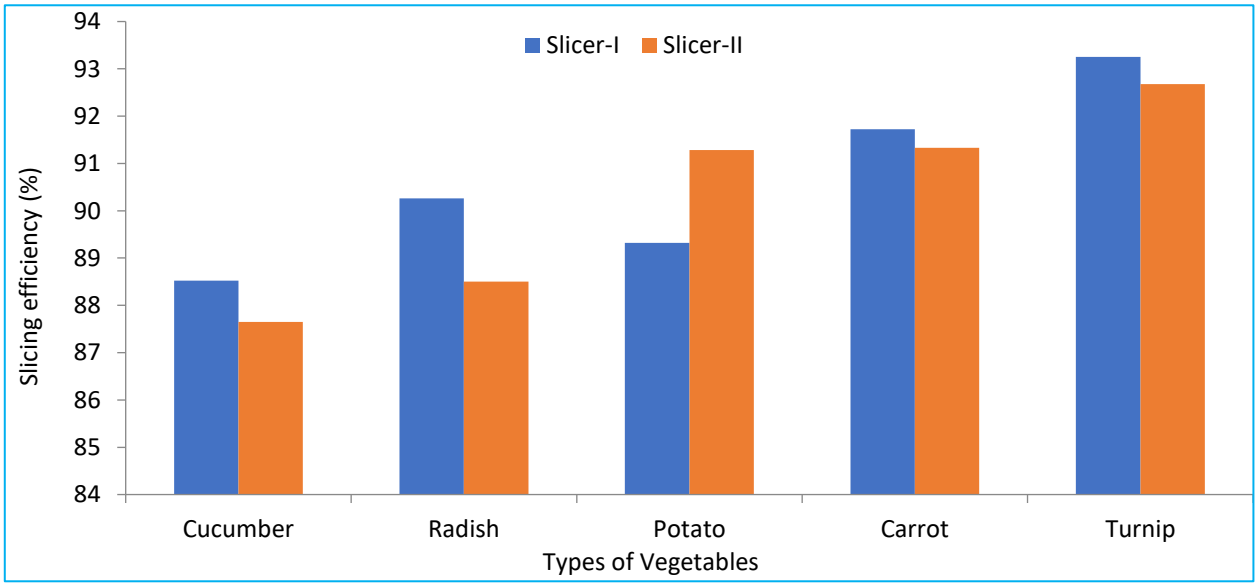


Fig 2 Effect of types of vegetables on the slicing efficiency (%) of slicers

*Percentage broken*

The percentage broken by slicer–I was found lowest in turnip (6.75%) and followed by carrot (8.28%), radish (9.74%), potato (10.68%) and highest in cucumber (11.48%). The percentage broken was found lowest in turnip (7.32%) and followed by carrot (8.70%), potato (8.75%), radish (11.50%) and highest in cucumber (12.35%) for slicer-II. From the (Table 1-2), it seems that the conical shape of horticultural produce showed highest productivity of slices.

*Slicing efficiency of Slicers*

Slicing efficiency (percentage) of slicer was defined as the mass of all slices minus mass of damaged slices to mass of all slices multiplied by 100. About 2.0 kg of each vegetable was taken to calculate the slicing efficiency of the both slicers. The highest slicing efficiency was recorded to turnip (93.25%) for slicer-I and 92.68 % for slicer-II. Among the slicers, slicer-I was found better than slicer-II among the vegetable crops. Lowest slicing efficiency was noted to cucumber (88.52%) for slicer –I and cucumber (87.65 %) for slicer-II also. The slicing efficiency of radish, potato, carrot was observed 90.26%, 89.32% and 91.72 % for Slicer-I while for Slicer-II it was observed as 88.50%, 91.28% and 91.33% respectively [26-27]. Slicer I was found better for radish as compared to slicer-II because the less damaged was recorded in radish during slicing. In case of potato, slicer –II was better than slicer-I, similarly also found in carrot also (Fig 2).

## CONCLUSION

Slicing operation is achieved by cutting with involving moving, pushing or forcing thin sharp blade or knife through the materials resulting in lowest rupture, broken and deformation of slices. The slices produces by traditional methods are not uniform and time consuming process and this may results in non-uniform drying or infected dried slices. Test results of performance the slicers with slicing materials viz., Carrot, cucumber, potato, turnip and reddish indicated satisfactory performance. The rotation speed of blades was found highest for slicer-II with highest Slicing capacity as compared to slicer-I. According the results of efficiency, both slicers performed best work with different types of vegetables. The slicing efficiency varies between 87.65 to 93.25% for both slicers.

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***Conflict of Interest***

*We, the authors of the article "Performance evaluation of vegetables slicers for selected vegetables" wish to state that there are no conflicts of interests in this our research articles.*

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