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Evaluation of techno-economic feasibility of the developed multipurpose vegetable slicer cum shredder

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Abstract
Slicing and shredding are the well-known processes of reducing size, commonly used for fruits and vegetables. The process of slicing involves pushing or rather forcing any sharp object through the material to be sliced. Similarly, Shredding involves pushing the material to be shredded through or across any shredding surface to make long and narrow strips or pieces out of it. The processes of size reduction involves a large amount of physical activity and labor and also due to uneven slicing by manual cutting leads to wastage of the material that is being sliced. Thus, to improve the processing method and enhance its productivity, a multipurpose vegetable slicer cum shredder has been designed. The mechanism of the multipurpose vegetable slicer cum shredder is to ease the hardships involved in both the processes. The present paper aims at evaluating the same at techno-economic front to have an analysis on how much feasible it is to use the multipurpose vegetable slicer cum shredder when it comes to trade-off between its technological and economic feasibility front.

Keywords: Slicing, Shredding, multipurpose vegetable slicer cum shredder, technology, economic feasibility

Introduction
With the constantly changing lifestyle and modernization, the machines to automate the maximum work has become the basic necessity. These types of machines tend to ease the work and reducing the time needed to accomplish it. Thus, automation, made possible by the technology, has been able to save to save the human effort and time to a large extent. Today, homes can also be seen as mini industries where a large number of different machines are used and needed on daily basis and in that, kitchen is a major workplace. One such machine that can reduce the human labor and time thus increasing the efficiency and effectiveness of time is a multipurpose vegetable slicer cum shredder.

Fruits and vegetable needs slicing, shredding or any other size reduction process frequently for different purposes. Slicing involves pushing or forcing a thin, sharp object such as knife through the product that is to be cut or sliced (Ezeanya, 2020) [5]. This process holds a lot of importance in specially the snack industry where the quality of slices being produced matters. So, there was a need to design and develop a quick, safe, and easy to use way to slice the vegetables to increase productivity and cost effectiveness. Similarly, shredding is the process of pushing the food across or through a shredding surface to make long, narrow strips out of it (Talapatra *et al*. 2014) [12]. The chopping of vegetables is often seen as a form of stress that is put on the vegetables or fruits thus wounding their cells and triggering injury-based responses by the plant cells. The common and different types of fruits or vegetables (Weiss, 2006) [15] that go through these types of size reducing processes are potatoes, carrot, bottle gourd, cucumber, watermelon, melon etc. The major parameters that are necessary to be considered while designing and constructing the machine for the intended application is the method of processing with minimum productivity loss and maintaining the hygiene without contaminating the product being sliced or shredded. However, it is crucial to evaluate the performance of the developed slicer cum shredder for a particular set of selected vegetables and its techno-economic viability.

Literature review
Ezeanya (2020) [5] in the study developed an efficient and safe slicing machine, which is affordable even to small farmers. The machine having two slicing blades was powered by a single phase electric motor of 0.25hp.

Different vegetables were grouped in small and medium-sized samples, at four different machine speeds of 53, 58, 62, and 69 rpm. The highest mean slicing efficiency of 87.6% was achieved while slicing small-sized Irish potatoes at a speed of 58 rpm; while the lowest mean slicing efficiency of 60.7% was achieved while slicing medium-sized onion bulbs at a speed of 69 rpm.

Latt *et al*. (2019) [8] in their research, designed and constructed a potato slicing machine for the chips manufacturing industry. This electrically operated device was used to cut the raw potatoes into thin slices of approximately 3 mm thickness for the purpose. The capacity of the machine was found to be of 4.3 Kg potatoes per minute. The materials used in its manufacturing were cast iron, mild steel and stainless steel which are easily and locally available.

Kuruba (2017) [7] did a techno-economic feasibility analysis of a tomato processing pilot plant. The main objective of the research was to study production economics associated with the process of production of tomato sauce. It was found that for the production of 1,20,000 units of 1 Kg bottle of tomato sauce, the breakeven quantity was found to be about 147492.06 kg and its sales Rs. 11799364.8 in 1.01 Years. From the benefit cost ratio (B/C) it was observed that for every one rupee used in tomato sauce production, it will yield 1.14 rupees.

Chand *et al*. (2013) [3] in their work designed and developed a pedal operated integrated potato peeler and slicer. The product had major parts as a peeling unit, a water spraying unit, a slicing unit, a piston (used to transfer the peeled potato from peeler to slicer) and a power transmission system. The peeling drum had a projection on its inner which rotated and was used to detach the peel from the potatoes. Further, its unit for water spraying was used to wash the potatoes and remove peel from the drum with the flow of water. The machine developed was found to work at a speed of 45 rpm with a capacity of peeling and slicing 65 kg potatoes per hour.

Chatthong *et al*. (2011) [4] designed and constructed a semi-automatic sliced ginger machine. It was easy to use machine which was used to reduce the physical labor and increase the speed of slicing. The machine was found to produce sheet ginger at the rate of 81.8 kg per hour which was 6.2 times of labor and line ginger at the rate of 17.9 kg per hour (2.5 times that of labor).

Materials and Method

The present paper is a quantitative research in which the supporting data is gathered from different literatures based on the researches of many authors like Kuruba (2017) [7], Shekhawat *et al*. (2016) [9, 10, 11], Ali *et al*. (2019) [2], Weiss (2006, 2005) [15, 16], Talapatra *et al*. (2014) [12], Chand *et al*. (2013) [3], Hoque *et al*. (2017) [6] and others. The economic analysis was done with reference to a potato processing plant. In this, the total cost of the plant was calculated by adding different costs of machinery, equipments, raw material, utilities and other related expenses. The plant that is setup is expected to return the benefits in each of the subsequent years of its operation. So, it is important to know the present net worth of this future income to make out how much it will be justified to invest in that venture in the present time.

Results and Discussion

The techno-economic analysis of the feasibility of the developed multipurpose vegetable slicer cum shredder was done by calculating its present net worth, benefit cost ratio and payback period.

Some of the assumptions made for the purpose were:

- Life of the machine developed as well as other machines procured to be 10 years.
- Annual repair and maintenance cost to be 7 per cent.
- The discount rate of interest is assumed to be 5 per cent.
- The approximate purchasing price of fresh potatoes is Rs. 8/- per kg and that of final dried potato chips is Rs. 200/- per kg. Hence, 15 per cent recovery of final product is assumed.
- Labor required for various operations at the rate of Rs.10,000/- per month.
- Assuming the developed machine to be operated 300 days in a year.

So, the final product cost comes out to be

- Rate of potato chips- Rs. 200 per kg.
- Amount of final product- 33.75 ton per year.
- Total cost of final product- 67.50 Lakhs per year.

The present net worth for the potato processing plant was calculated on the basis of the present investment and the interest rate assumed for various operations and the profit achieved in each year and was found to be Rs. 22481376/- for 10 years. The cost benefit ratio was found to be 2.28 with a payback period of 4 years.

Conclusion

For the last some years, researchers have been putting their efforts towards developing a technically feasible and economically viable multipurpose vegetable slicer cum shredder. Already existing slicers and shredders were not actually able to meet the requirements of the changing scenario both in domestic use as well in small scale industries. So, there arose the need to design the machine with improved processing method and hygiene in terms of contamination of the product being sliced or shredded. In the end, the techno-economic viability of the slicer cum shredder was also analyzed in terms of its present net worth, cost benefit ratio and the payback period.

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