

Mechanization & Development of potato peeling machine: A Review

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Abstract: Peeling variety of fruits or vegetable is a basic need of present era. Potato peeling processes face a numerous problems of time consuming and became inefficient during weekly breakdown maintenance. It is very important for food process industry as well as domestic point of view. Mechanization of processing operations will no doubt play a pivotal role in removing the negative attributes of the traditional processing techniques and promote timely large scale production with desired quality. This paper shows the chronological development of mechanical peeling and also highlights on new concept of potato peeler which would be the basic requirement under breakdown maintenance.

Keywords: potato, peeling, peeling machine.

I. INTRODUCTION

Peeling of vegetables and fruits is one of the most frequent operations at hotels, canteens and restaurants even at household purposes. Potato is probably the most popular food and widely consumed item in the Indian diet. It is grown all over the country with Uttar Pradesh growing the maximum quantity. The other major producers were West Bengal, Bihar, Punjab, MP, Gujarat and Assam (Directorate of Economics & Statistics, Government of India, 2011-12). Potato is the only crop that can make an impact on the highly populated Indian nation for feeding the people. India ranks fourth in area and third in global potato production. It produces around 8 % of the world's total produce (Anonymous, 2011).

Potato is a very rich source of starch. It also contains phosphorus, calcium, iron and some vitamins. Apart from use of fresh potatoes for the purpose of making vegetables and gravy, they are dehydrated in the forms of slices, sticks, cubes or powder to impart better shelf life. Yet another popular use is to make wafers or chips that are why potato became popular food item not in home but also in hotels, canteens, restaurant, etc. Hence peeling method of potato is point of interest.

Peeling method are broadly classified into three types of categories. This includes

- Thermal peeling
- Chemical peeling
- Mechanical peeling

A. Thermal peeling

Thermal peeling is done by wet heat (steam, refrigerant) or dry heat (fire, hot gases). This type of methods are particularly for tough and thick skin fruits and vegetable. Temperature, pressure and electronic devices are used to minimize the

peeling losses and increase peeling efficiency. Generally thermal cooling is done for short period of time but relatively at high temperature. First, the building up of internal pressure because of high temperature causes mechanical failure of the cell. Second, the effect of heat on the tissue which results in loss of rigidity due to biochemical changes. This dry methods causes cauterizing of surface and small pieces of charred skin which when removed gives poor appearance. While wet method uses superheated steam which causes the skin puff and cracks

B. Chemical peeling

Chemical process of peeling generally used in factories and industries. It involved use of caustic soda. Once the caustic solution of NaOH(Lye) comes in contact with the surface of the fruit, it dissolves the epicuticular waxes, penetrates the epidermis, and diffuses through the skin into the fruit. It provides chemical reaction which smoothen the skin of vegetable. Outer surfaces of vegetable or fruits are gets loosed when they are immersed in alkaline solution for short period of time under high temperature. The loosen the outer surface which are unwashed away by high striking water. However, the physical properties were important for the result. Color is the most significant physical property as the temperature of the lye solution increases. The color darkens as the temperature increases and even it gets a brownish color as the temperature reaches to 80-90 °C [2-3]. The disadvantage of this method includes

- i. It acquires cost of alkaline solution or medium.
- ii. It affects the vegetable and fruits due to chemical action
- iii. The difficulty in the removal of chemical traces as it may be poisonous

C. Mechanical peeling

There are different types of mechanical peelers. Based on the mechanism used for peeling, system uses knife or blade, abrasive, rollers, milling cutters and rotary cutters. In mechanical peeling quantity of peeling is high but quality of peeling is high. Only rotary cutters are flexible one which are most popular among all even on different uneven surfaces. Ideal peeling process suggested by Radha Krishnan et.al (1993) possess following characteristics such as

- Minimize product losses
- Minimize energy
- Less chemicals usage
- Minimize pollution load
- Minimize heat ring formation

Among the current peeling methods, mechanical peeling can attract the customer satisfaction because of its benefits. The mechanical peeling becomes so popular because they produced fresh peeled product. As view of customer became more important for food processing industries hence more researchers have showed interest towards mechanical peeling process.

II. METHOD, MATERIALS AND PROCESS

1. **Design theory and principle:** The apparatus was design for peeling the potatoes. The peeling action is done by rotating the abrasive lower plate which is mounted on main shaft. The main shaft is coupled to electric motor through sets of pulley and v -belt.

2. Design and construction

The potato peeling machine consists of cylindrical drum, abrasive lower plate, top lid, side chute, electric motor and steel frame.

2.1 Drum as a main body

Drum is a main body constructed in cylindrical shape with flat round bottom. Inside surface of drum is coated with silicon grid for abrasive action. Generally silicon powder with 16 grit is recommended. A removable top lid with recess is provided on top of the main body to facilitate the loading and prevent potatoes from falling outside. A chute of sufficient size is made on side of it for removing peeled potatoes. A latch is provided for locking the machine while in operation for safety purpose. Medium carbon steel was used because of its machine ability and rigidity.

Picture 1: Cylindrical Dum (Outer and Inner Side)



2.2 Abrasive disc or lower plate

An abrasive disc of appropriate design fitted inside the drum. The design of the disc is such that while rotating, the full surface area of potato shall be evenly rubbed on the inner surface of drum. Generally silicon powder with 16 grit is recommended. Abrasive powder shall be bonded with proper binding compound for long life. The inside surface of drum coated with abrasive powder for better efficiency. It shall be easily removable for routine maintenance.

Picture 2: Abrasive Lower Plate



2.3 Drive for Abrasive Disc

A machine that converts electrical energy into mechanical energy is called as motor. A single or three phase induction motor with rating 0.37 kw(0.5HP), 50 Hz and 1440 rpm was used. The disc shall be driven with motor directly driving through pulley and 'V' belt

Picture 3: Electric Motor



2.4 Water Inlet Water drain

Water inlet connection will be provided to the machine. Provision is made for draining of water along with potato skins. The drain shall be large enough to prevent any chance of its being clogged with waste potato skin.

Picture 4: Water Drain



2.5 Pulley and V-belt

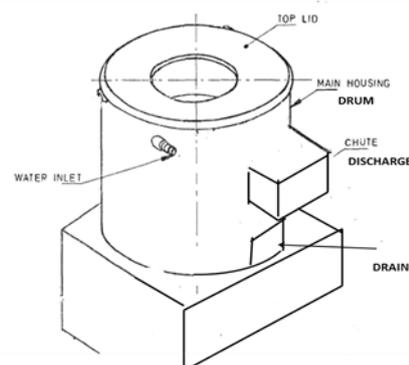
A pulley is a wheel on an axel or a shaft that is designed to support a movement and change of direction of belt along its circumference Cast iron was chosen for this purpose as the pulley would be subjected to tension forces from the belt as well as torque and speed variations from Electric motor:

Picture 5 Pulley and V-belt



The schematic diagram of potato peeler is shown in Picture 6

Picture 6. Potato Peeler



III. SIGNIFICANCE AND MOTIVATION OF RESEARCH : NEEDS OF RESEARCH

Potato peeling by human is time consuming and tedious process and may require several workers to carry out operation which ultimately increases operating cost.

Involvement of more labour and consumption of time encourage the variety of peeling methods[5]Peeling as the preliminary and main stage of post harvest processing is currently conducted mechanical, chemical, and thermal methods [6] Each method has its own merits and demerits. The quality of final products in market is lot more depend on peeling process stage . Traditionally this operation is done with appropriate sharp knife edge by applying suitable pressure. Even peeling vegetables with hand tool is toughest and time consuming process.

Picture 7 Manual and Semi automatic Peeling



It also causes for the loss of vitamins and become contaminated with the atmospheric air. Over the years several researcher have worked on different methods of peeling. Chemical peeling using a hot solution of sodium hydroxide to loosen and soften the skin was developed for peeling sweet potatoes in processing industries [7] But lye in chemical peeling process makes its tough surface and looks surface dark in color after process. Steam peeling subjected to high pressure over short period of time results partial cooking of potatoes and cauterizing of surface which gives poor appearance.

While mechanical peeler is further classified based on mechanism used in it for peeling. Commercial mechanical peeling uses knife and blades which leads to high quantity loss. While use of abrasive brush type peeler leads to maximum peel losses.

Picture 8: Abrasive brush



While when abrasive silicon grit studied in inner surface of drum particularly undergoes weekly breakdown maintenance which results in production loss. Some machine undergoes maintenance for whole day. But quality of final product is good which is the characteristic feature to study. Although each method has own benefits and limitations, but mechanical methods are preferred because of keeping edible portions of produce fresh and damage free. Little efforts have been made in this area which resulted in the production of prototype machines but with low performance.

Because of its typical shape, the mechanical peeling of potato is still untouched by process engineers. Further, this unit operation requires special care and skill to reduce material damage and avoid weekly maintenance . This has led to the invention of a machine which peels the potatoes with less effort and good quality. Keeping this in view, a study was undertaken with the main objective of development of a potato peeler. The proposed development of a potato peeler could alleviate the problems faced by traditional potato peeling methods and aid in boosting the processing and export of potato products.

IV. PRESENT SCENARIO : LITERATURE REVIEW

Peeling potato is a process of removing the skin which normally protects it from flesh or pulp thereof. Since different type of fruits have different shapes and sizes hence different machine are to process them. Peeling of food or vegetable is usually carried out by particular machine. [8]. Hence development in is very much required to promote timely large scale processing and to overcome unhygienic environment problems which resulted in the development of various types of peeling machines.

Literature review is arranged on the basis of technique used according to latest work. Each machines and mechanisms had advantage and defect. For example, optical and machine vision graders were not economical for some users because of heavy cost. Some had much construction cost due to complex mechanism and at some, required workers was high and so on.[Potato grater][9]

The abrasion method has been used to peel tubers such as potatoes and ginger. The machine developed a cassava peeling machine. The machine was designed using brush as peeler; the machine was widely used on oval shaped fruits and vegetables. But the machine consumes more power about 4kW [10]

Suter 2002 developed roller type potato peeler. It uses set of abrasive roller. The motion of roller is controlled by means of sensor. The focus was only on electronic and drive control system. The drawback of such type of peeler neither achieved high efficiency nor reduces peel losses [11].

Barry ryan 2000 realized that abrasive peeler are suitable for root vegetable. But it bruises and damages the underlying tissue of outer surface which leads the leakage of cellular fluid which are responsible for biological growth[12].

Abrasion, method of peeling used by potato chip manufacturers, results in more starch and less dietary fiber than the steam peeling method used in the production of dehydrated potatoes. Potato peels with either abrasive brush or steam peeling methods were extruded [13]

The method of peeling is always key factor which decide its suitability for further utilization. Compared the influence of peeling method on its composition of Peeling Potato. [14] Potato peeling is based on different characteristics like weight, dimensions, density and volume, shape and size that which may be the peeling criterion and many researchers have been done in this field

Agrawal et.al highlighted on brush type abrasive peeler. The opposite direction of movement of belt causes abrasive action. But it is tested for ginger only. The peeling efficiency reported is 75-80% [15]

Electrical power potato peeler with drum was operated along with water spraying unit. The inner surface of drum was protruded which help for peeling operation. It is suitable for batch of 20 kg. Singh 1995 recorded peeling efficiency in the range of 70 %.[16]

V. RESEARCH METHODOLOGY

The research methodology cover as follow –

- Identification of design parameters.
- Design of Potato Peeling Machine.
- Fabrication of Potato Peeling Machine.
- Testing of machine.

VI. CONCLUSION

The main conclusion will be drawn to find out whether it is possible to automate and mechanize manual process which would avoid worker fatigue and avoiding weekly breakdown maintenance. Also the future scope for developing the generalized machine for any shape and condition of potatoes. It would result into good efficiency with less peel loss.

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