China Petroleum Processing and Petrochemical Technology

Catalyst Research Volume 23, Issue 2, October 2023 Pp. 2442-2451

DESIGN AND MODIFICATION OF MECHANISM FOR POTATO CHIPS CUTTING

[1]Prof. Avinash Rambhau Mankar, [2]Dr. Nandkishor Marotrao Sawai*, [3]Dr. Amol Rasane and [4]Prof. Yashraj Nandkishor Chopkar

[1,3,4]Assistant Professor, [2]Associate Professor

[1]Guru Nanak Institute of Technology, Nagpur,

[2]Sandip Institute of Technology and Research Centre, Nashik

[3]PVG's College of Engineering & S.S. Dhamankar Institute of Management, Nashik

[4]Swaminarayana Siddhant Institute of Technology, Nagpur,

Corresponding author [2]nandkishor_sawai@rediffmail.com,

Abstract:

The risk of food had borne illnesses rises when potatoes are chopped by hand since it takes longer and increases the possibility of food contamination. Automatic machines have become a necessity in today's industrialized world, helping to cut down on the time and effort needed to execute particular activities. However, there are considerable drawbacks to the current potatoes cutting machines, including their high initial investment costs, contamination hazards, and the extra labor and processing time needed for manual processing. To mimeses these problems, a potato chip slicing device design is developed utilizing components that are easily accessible in the area, such as mild steel and stainless steel. The system includes a hopper configuration, and pressing the potatoes is done effortlessly thanks to a spring-loaded pressure block. The potatoes are sliced into chips using an electric device with a spinning blade. The main goal of this research is to develop a slicing device that can operate in small- to medium-sized manufacturing facilities without the high costs and other drawbacks of manual processing. A potato chips cutting machine discusses the creation of a specialized device for efficiently slicing potatoes into uniform chips. The machine's design incorporates safety features, precise cutting mechanisms, and automation to enhance productivity. The resulting potato chips cutting machine aims to meet the demand for consistent and high-quality chips production while ensuring user safety and ease of operation.

Keywords: Potato, circular Cutting Blade, portable, design.

Introduction:

India is a significant potato producer, with Uttar Pradesh accounting for 31.26% of the total output. Despite the widespread use of potato chips, Maharashtra lacks small-scale processing enterprises since cutters and slicers for processing potatoes are expensive and inefficient. The farmers can build their own home- or business-based potato-slicing and frying equipment to boost productivity and income [1]. Potatoes are shrunk mechanically without changing their chemical composition, resulting in homogeneity in the size and shape of the finished product. Cast iron and mild steel are frequently utilized for fabrication, and manual machines are created for places without power. An everyday carbohydrate is potatoes, which are also frequently consumed as chips while traveling

Catalyst Research Volume 23, Issue 2, October 2023 Pp. 2442-2451

and during picnics. A slicing machine might be helpful to enhance the larger-scale manufacture of potato chips. Consequently, the goal of this study is to develop and build a portable potato chip maker that is capable of both small- and medium-scale manufacturing. Additionally, by utilizing an electric motor to drive the device, it seeks to improve earlier potato cutting procedures [2].

The potatoes are an essential vegetable crop, and hotel management heavily depends on the quality of the chips produced from them. However, using the wrong equipment frequently results in uneven slice thickness, which causes vegetable waste, decreased output, and other harms. Moreover, while they struggle to create the required slices, chip manufacturers run the danger of hurting their fingers. Various variables have been taken into consideration when designing vegetable cutters and slicers. Vegetable cutting and slicing technology has existed since the 1970s. The participants cut and sliced vegetables using conventional techniques, such as knives, which is thought to be the least expensive option since it doesn't require complicated processes. Nevertheless, accidents might happen when employing this technique since people might injure themselves while attempting to make the proper cuts [3]. Depending on the position of the shaft and bearing, slicers can be either horizontal or vertical. To do cuts like the brunoise and macedoine, highly qualified professionals are needed; otherwise, one is likely to get an injury. Because it costs more to train workers as a result of these issues, productivity in the food business may suffer. The length of time required by conventional procedures is their main drawback. The slicing apparatus consists of revolving blades that slice through food as it passes beneath them. While for meat slicing, the food is carried on a carriage as it passes over the blade, the centrifugal force holds the food against the blades [4].

A common and quick technique used in medium-sized enterprises is the automated potato slicing machine. Chips can be produced in large quantities by utilizing a motorized slicer. To slice the potato, it is forced against and moved across the machine's pointed blades. The potato cutting device is used to slice potatoes that are fed through the inlet hopper, and the chips are then sent through the output hopper. The machine is simple to operate, requires little maintenance, and can make slices in a variety of shapes. Rotating cutting knives that are presented on a vibrating belt to create parallel slices of the same width are typically used to cut potatoes [5]. The conventional method of slicing potatoes was carefully examined, and it was shown to be physically demanding and to produce unneeded waste. The slicing procedure needs to be automated in order to enhance the procedure and raise the level of cleanliness involved. In order to save time and energy, this study aims to design, build, and evaluate a potato chip slicing machine that may be used in small to medium-sized manufacturing facilities, like hotels and restaurants [6-9] A potato chips cutting machine discusses the creation of a specialized device for efficiently slicing potatoes into uniform chips. The machine's design incorporates safety features, precise cutting mechanisms, and automation to enhance productivity. The resulting potato chips cutting machine aims to meet the demand for consistent and high-quality chips production while ensuring user safety and ease of operation.

Literature review:

Catalyst Research Volume 23, Issue 2, October 2023 Pp. 2442-2451

The potato chip cutting machine is an amazing addition to any kitchen or food processing setup. This device, which was created to speed up the process of transforming potatoes into crispy, delicious chips, is incredibly effective and precise. We'll examine its features, functionality, and all-around worth. The hopper, the chopping unit, the conveying system, the drive, and the power transmission unit are all parts of the machine. The hopper is a storage container in which potatoes can be kept without difficulty. Potatoes will be supplied with the aid of a conveying system using power provided by the driving element. The potato is supplied directly to the chopper disk by the conveying system, where it is subsequently cut into slices. The compressive force of the spring attached inside the conveyer is obtained when the potato is fed through the chopper cutter (rotary cutter), which then produces slices [10]. In the described, the slicer uses three cutting blades and four feeding cylinders to produce twelve pieces of potato slices in a handle revolution. The slicer was seen to create slices that were more than 3 mm thick without grabbing the potatoes. An additional gripping arm with a load of 3.5 kg was suspended on the slicer to accommodate the additional gripping arm, which was necessary for the fine thickness (3 mm) of the slice [11]. The devices under discussion can be used for slicing up to (1.2mm) and have a straightforward construction. Making a simple potato cutter that can produce thin, even slices for chip makers is necessary. In order to move toward mass production, the vegetable slicer's productivity must increase very small slices that will impart additional flavor [12]. A rotating shaft for a machine that slices potatoes is attempted. The shaft's length (L) is 600 mm, its diameter is 20, its motor power is 1.1 kW, its tension at the tight side is 271.9 N, its tension at the slack side is 21.7 N, and its rotational speed is 467 revolutions per minute. They design statistics are also included in this thesis [13].

The rotational motion created by the electric motor serves as the technical foundation for the potato-slicing machine's design. The desired slice thickness is determined by the blade's angle and the slicing wheel's rotation. to figure out the greatest shear force needed to slice a potato. Due to its straightforward construction and affordable price, this machine can produce thin, consistent slices [14]. The machine operates on a very straightforward and fundamental concept. With the aid of the pedal's rotation, the machine receives its power. The shaft that connects the pedal and crank is rotated by the pedal. Here, the machine's actual operation starts. The chips and fries mechanism is concurrently attached to the crank. The fry’s mechanism is connected to the crank by a piston, while the chips mechanism is attached to it via a shaft [15]. The discussed in the aimed to build a potato slicing machine for Irish potatoes (Solanum tuberosum) to eliminate spoilage/losses and damages related to inadequate storage facilities for Irish potatoes to boost machine capacity using different cutter blades of sixes of four, five, six, and seven millimeters to obtain a uniform thickness of Irish potato chips produced for uniform drying [16].

Problem Identification:

Catalyst Research Volume 23, Issue 2, October 2023 Pp. 2442-2451

1. Complex machine designs take up more room and cost more to maintain, which drives up the price of the final product.
2. Despite a labor deficit, the food business is expanding quickly in this fast-paced world. The difficulties faced in the industry's work are what lead to this scarcity.
3. A challenge facing the sector: low production due to a shortage of people and cutting-edge technologies.
4. As a business owner, you frequently rely too heavily on employees, which might impede production.
5. Creating an inventive solution can help decrease this reliance and boost productivity.
6. In order to ensure the slicer's maximum efficacy, it's crucial to select the appropriate knives. Due to a lack of energy, businesses in rural areas can encounter delays in production and delivery.

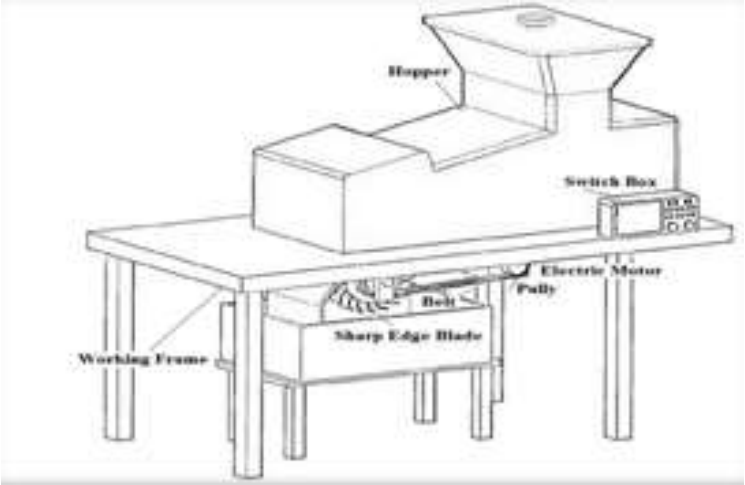
Aim and Objective:

The time-consuming operation of chopping a big quantity of potatoes into smaller pieces is the reason for the development of this automated potato-slicing machine. The device has numerous functions and is made to be simple and straightforward to operate for industrial application. Our goal is to develop a modified potato-slicing machine that satisfies these requirements.

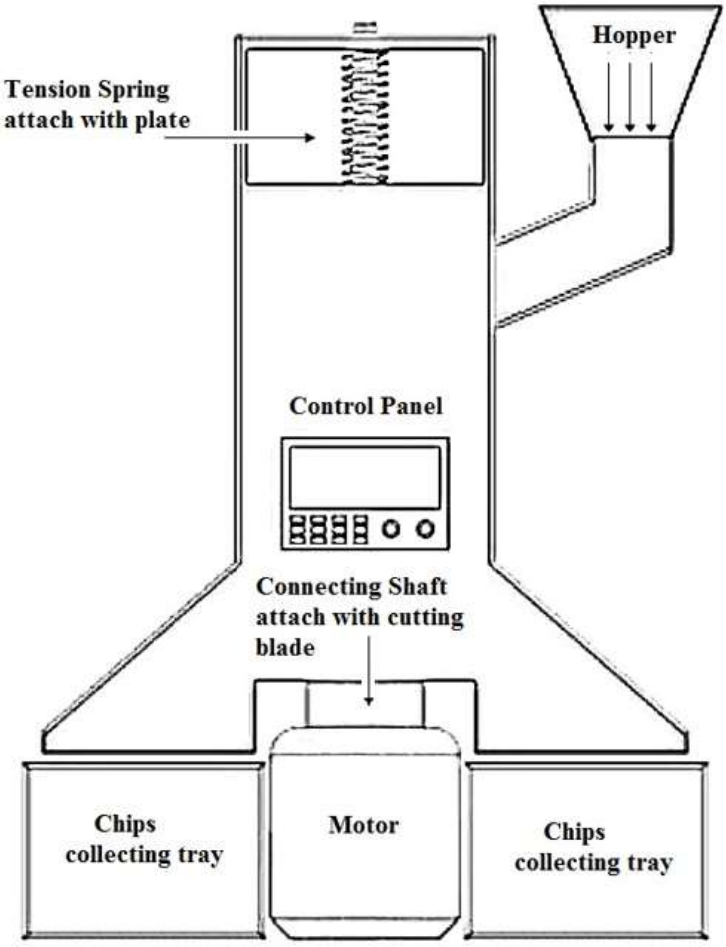
1. Lessening of human effort required for chopping vegetables
2. The use of a variable speed motor allows the user to alter the slicing speed in accordance with the type of vegetable being sliced.
3. The appliance uses mechanical parts to chop veggies of various sizes.
4. To guarantee the safety of vegetables for consumption, it's critical to maintain good cleanliness when choosing materials for veggies.
5. It's crucial to maintain hygiene and make sure that vegetables are safe to eat by using the right tools.

Conceptual Design:

Catalyst Research Volume 23, Issue 2, October 2023 Pp. 2442-2451



View of potato chips Machine for single tray



View of potato chips Machine for two trays

Method and Material:

A vital choice is selecting the appropriate material for a machine part or structural component. In this instance, austenitic stainless steel is mostly used to construct the machine. Due to its sanitary, non-porous surface and simplicity of cleaning, this material was selected as the best option for this particular application.

This substance possesses a number of outstanding qualities:

1. Outstanding ability to withstand corrosion
2. Outstanding toughness at very low temperatures
3. Extreme adaptability
4. Enhanced toughness and strength
5. Attractiveness

The electrically powered potato slicing apparatus was created, built, and tested. Figures display the machine's line and isometric drawings. Machine frame, Hopper, Cutting Blade, Power Transmission Unit, Tension Spring, V-Belt, and Pulley are some of the parts of the machine.

1. Machine frame

The machine's frame is the stationary section that supports the weight and load of the other parts. Gravity draws the potatoes toward the cutting blade from a hopper that is mounted on top of the frame and has a tension spring device for storing them. At the base of the frame, the cutting unit and power transmission units are assembled.

2. Hopper

The potato input into the cutting portion is controlled by the hopper. It has a square casing that serves as a potato holder in its design. To ensure the controlled and regulated entry of the potatoes, a tension spring mechanism is used in conjunction with the hopper.

3. Motor/Power Transmission

The system's primary means of power transfer is the electric motor. On the motor shaft and the shaft of the cutting blade, respectively, are mounted pulleys. Power is transferred from the driving shaft to the driven shaft using a V-belt.

4. V-belt system

Power is transferred from one shaft to another via a belt. The belt's longevity is greatly influenced by the material used in its construction. The main factors to take into account when choosing a V-belt are avoiding slippage and reducing energy losses.

5. Cutting Blade

As a slicing wheel, a circular blade with numerous cutting edges is used to cut potatoes. In order to maintain cleanliness and avoid chemical reactions, the blade is powder coated. Equal distances and angles separate the blades from the wheel. The cutting edges can cut several slices of potato

Catalyst Research Volume 23, Issue 2, October 2023 Pp. 2442-2451

in one rotation and are sharp to reduce shearing effort. The cutting device is constructed of stainless steel.

Considerations for Design:

The most important consideration in design is choosing the proper dimensions. We employ the subsequent equation to determine these dimensions and to guarantee effectiveness and safety in the working model.

1. **Ac Motor -** Speed N = 1440 rpm
   Power P = 1.5 horse power
2. **Torque** (cutting blade) **-** $\frac{60xP}{2X\pi XN}$
3. **Cutting velocity –** $V = \frac{\pi DN}{60}$
4. **Weight of the cutter blade -** $Wc = \rho\ Ac\ Lc\ g$
5. **Pulley Diameter -** $\frac{N1}{N2} = \frac{D2}{D1}$
6. **Shear stress –** $\tau_{xy} = \frac{16M_t}{\pi D^3}$
7. **Belt -** $2.3 \log(\frac{T_1}{T_2}) = \frac{\mu\theta}{sin\alpha}$
8. **The volume of material -** $V = \frac{\text{Mass of the material}}{\text{Bulk density of potato}} = \frac{m}{p}$
9. **Machine capacity -** $\frac{\text{Total weight of slicing potato (kg)}}{\text{Slicing time (hr)}}$
10. **Slicing efficiency (%) -** $\frac{\text{Total weight of slice potato} - \text{total weight of damaged potato}}{\text{Total seight of sliced potato}}$

Working Principle:

A potato chips cutting machine works by using mechanical, structural, and precision engineering concepts to quickly and accurately slice potatoes into thin, uniform pieces for potato chips. A hopper or conveyor system is used to feed whole potatoes into the machine. The device makes certain that the potatoes are positioned and aligned correctly before slicing. In order to achieve uniform slices, this step is crucial. Using mechanical grippers, belts, or clamps, the machine firmly holds each potato in position. This keeps the potatoes from moving while being chopped, resulting in precise cuts. The machine's slicing mechanism, which consists of a group of razor-sharp blades, is its beating heart. The blades organized circular blades that rotate. The cutting blades move in a regulated in a circular motion. The blades are pushed against the potato, creating thin slices as a consequence. The potato slices fall off the blades into a collection tray as the slicing process is taking place. The slices may be moved away from the cutting area using collecting trays. A potato chip cutting machine's operation entails accurate alignment, safe holding, regulated blade motion, thickness adjustment, collecting, and quality control. The design of the machine is centered on

Catalyst Research Volume 23, Issue 2, October 2023 Pp. 2442-2451

achieving uniform slices, upholding safety, and facilitating effective commercial potato chip production.

Conclusion:

The potato chip production process has improved greatly because to the potato chip cutting machine. By boosting productivity, consistency, and general efficiency, it has changed the industry. The end product is of higher quality because to the machine's capacity to accurately slice potatoes into uniform thicknesses, making for more visually pleasing and flavorful potato chips. The machine saves producers money by eliminating the need for manual labor during the cutting process. Additionally, by reducing human touch with the raw product, it ensures greater standards of food safety and hygiene. This is crucial for upholding strict standards of cleanliness and lowering the chance of contamination. The potato chip cutting machine also enables adjustment of chip thickness, taking into account consumer preferences for various flavors and textures. Its accuracy and speed help enterprises increase their production capabilities and fulfill market demand. It's important to remember that the use of such technology necessitates an initial financial outlay, appropriate maintenance, and qualified employees to oversee and operate the apparatus. To guarantee the machine's consistent operation and increase its longevity, regular maintenance procedures and quality checks are essential. The device for cutting potato chips is proof of the constant technological developments that are reshaping the food sector. These devices will probably grow even more advanced as technology advances, bringing with them new advancements in efficiency, accuracy, and sustainability. As a result, the invention of the potato chip cutting machine continues to be a major one that has changed how potato chips are made and consumed.

References

[1] Dr. A.H. Ingle, Shubham Ghaturle, Pawan Barsagade ,Mosam Giradkar, Vikesh Sonwane, “A Review paper on potato chips making machine”, International Conference on Management Practices, Innovations & Research 2019, ISSN (e): 2250-3021, ISSN (p): 2278-8719 ,Special Issue || Dec. 2019 || PP 22-25.

[2] M. A. Hoque and K. K. Saha, “Design and development of a manual potato cum sweet potato slicer”, J. Sci. Technol. Environ. Inform. 05(02): 395-401 | Hoque and Saha (2017) EISSN: 2409-7632.

[3] Mr. Kartika S.B, Mr.Arahanth, “Design And Development Of A Potato Slicer”, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684, PP: 21-26.

[4] Dr. Htay Htay Win, Dr. Myint Thein, Mg Chan Myae Aung, “Design and Performance Analysis of Potato Slicing Machine (Shaft Design and Rectangular Cutting Blade)”, IRE 1701544 Iconic Research And Engineering Journals, AUG 2019 | IRE Journals | Volume 3 Issue 2 | ISSN: 2456-8880.

Catalyst Research Volume 23, Issue 2, October 2023 Pp. 2442-2451

[5] Aung Ko Latt, Auntt Min Thaw, "Design and Construction of Potato Slicing Machine", IRE 1701433 Iconic Research And Engineering Journals, JUL 2019 | IRE Journals | Volume 3 Issue 1 | ISSN: 2456-8880.

[6] Dr. Vivek Bechuramji Vaidya, Saurabh Shende, Ankit Kushuwaha, Chetan Thote, Nikunj Sondawale, Rohit Kanhare, "Design And Development Of Manual Operated Potato Slicer And Fries Machine", e-ISSN: 2582-5208, International Research Journal of Modernization in Engineering Technology and Science, Volume:02/Issue:07/July-2020.

[7] Kingsley-Omoyibo Q. "A. Construction of A Potato Slicing Machine For Irish Potato (Solanumtuberosum) To Eradicate Damages And Boost Machine Capacity", SSRG International Journal of Mechanical Engineering Volume 6 Issue 11, 15-18, November 2019 ISSN: 2348 – 8360.

[8] Thomas Alias, Manu Eldhose, Navneeth Krishnan, Harikrishnan V K, "Design And Fabrication Of Peeling And Cutting Machine", International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 14, 2019 (Special Issue).

[9] Tony Thomas.A, Muthu Krishnan.A , Sre Nandha Guhan.K.S, "Design And Development Of Automated Vegetable Cutting Machine", 5th International & 26th All India Manufacturing Technology, Design and Research Conference (AIMTDR 2014) December 12th–14th, 2014, IIT Guwahati, Assam, India.

[10] Mr.G. Chandramohan, V.Raghuprakash**,** L.Sabareshwaran, K.Tamilarasan, "Design and Fabrication of vegetable Cutter Machine", International Journal of Engineering and Techniques - Volume 8 Issue 3, June 2022, ISSN: 2395-1303.

[11] Guide S Ganyani, Tawanda Mushiri, "Design of an Automated Vegetable Cutter and Slicer", International Conference on Industrial Engineering and Operations Management Pilsen, Czech Republic, July 23-26, 2019.

[12] Osama M. Abd El-Haq, El-Sayed G. Khater, Adel H. Bahnasawy and Hossam M.T. El-Ghobashy, "Design And Development Of A Potato Slicing Machine", Misr J. Ag. Eng., January 2016.

[13] S. Gokul, R. Ajith Velayudham, P. Deepak, W. Fredric Prem, "Design and Fabrication of Automatic Vegetable Cutting Machine", International Journal of Research in Engineering, Science and Management, Volume-3, Issue-3, March-2020 | ISSN (Online): 2581-5792.

[14] R. Ramakrishna Reddy, B. Venkata Chaitanya Kumar, B. Madhu, B. Pradeep, V. Sathish Kumar Reddy, S. Sayyed Saleem, K.Nagarjuna, "Fabrication Of Automated Vegetable Cutting Machine", International Research Journal of Engineering and Technology (IRJET) Volume: 08 Issue: 07 | July 2021,e-ISSN: 2395-0056 p-ISSN: 2395-0072.

[15] Nandkishor M. Sawai, Dr. V. G. Arajpure, Dr. C. C. Handa, "Development and Modification of Potter's Wheel by Using Sewing Machine Pedal Mechanism and Chain Sprocket", International organization of Scientific Research Journal of Engineering (IOSRJEN), ISSN (e): 2250-3021, ISSN (p): 2278-8719 Vol. 10, Issue 1, January 2020, ||Series -IV|| PP 11-18

Catalyst Research Volume 23, Issue 2, October 2023 Pp. 2442-2451

[16] Roshan M. Hatwar, Kunal T Rahandale, Mohan G. Trivedi, Concept, "Design and Development of Semi Automated Potato Slicing Machine", IJSRD - International Journal for Scientific Research & Development| Vol. 4, Issue 02, 2016 | ISSN (online): 2321-0613.