DEVELOPMENT AND EVALUATION OF A POTATO SLICER

By

DAYANA PAUL

RAJESH MOHANAN

SIMI POULOSE

PROJECT REPORT

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DECLARATION

We hereby declare that this project report entitled "**Development and Evaluation of Potato Slicer**" is a bonafide record of project work done by us during the course of project and the report has not previously formed the award of any degree, diploma, associate ship, fellowship or other similar title of any other university or society.

Dayana Paul

Rajesh Mohanan

Simi Poulose

Place: Tavanur

Date :

CERTIFICATE

Certified that this project entitled "**Development and Evaluation of Potato Slicer**" is a bonafide record of project work jointly done jointly by Dayana Paul, Rajesh Mohanan and Simi Poulose under my guidance and supervision and that it has not previously formed the award of any degree, diploma, associate ship or fellowship to them.

Er. Prince.M.V.
Assistant Professor
(Project Guide)
Department of PHT & AP
KCAET, TAVANUR

Place: Tavanur

Date :

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Dayana Paul

Rajesh Mohanan

Simi Poulose

Dedicated To

Our Loving Parents

SYMBOLS AND ABBREVIATIONS

%	-	Percentage
cm	-	Centimetre
et al	-	And others
g	-	Gram
ha	-	Hectare
hr	-	Hour
KCAET	-	Kelappaji College of Agricultural Engineering and Technology
kg	-	Kilogram
M	-	Million
mm	-	Millimetre
MS	-	Mild Steel
º	-	Degree
φ	-	Diameter
ºC	-	Degree Centigrade
PHT and AP	-	Post Harvest Technology and Agricultural Processing
pp	-	Page
rpm	-	Rotations Per Minute
Rs.	-	Rupees
s	-	Seconds
t	-	Tonne

Introduction

INTRODUCTION

The name potato is derived from the word ‘Batata’ that comes from the Spanish language, meaning sweet potato. Of all kinds of fresh vegetables grown all over the world, none is so valuable as the potato in terms of agreeable flavour, nutritive value and medicinal qualities. Potato is an important crop of the world grown on around 18.3 million hectares with a production of 295 million tonnes. India ranks fifth in both area and production. Potato contributes about 1.23% to the gross production from agricultural and allied activities in India. The present area under potato in India is about 1.4 million ha and produces a total of about 25- 28 million tons of potatoes every year .Potato is one of the principal cash crops. On an average it gives a net profit of about Rs.5000 –8000 per ha. *(Textbook of Vegetables, Tuber crops and Spices, Tamburaj, S. et al ,2001)*

China tops the list with around 23% of the world’s potato produce that is around 322 million metric tons. This total production makes this crop the fifth largest produced agricultural crop and the largest produced tuber and root crop in the world. Potatoes are grown over 18 million hectares of land throughout the world. The production level of potatoes has constantly increased during the last decade to take it beyond the 100 million tonnes mark. *(http:// www.research.cip.cgiar.org)*

India is placed 3rd in the list of major potato producing countries of the world. It produces around 25 million metric tonnes of potatoes that contribute to approximately 7.75 % of the world’s total produce. This crop is grown over 14 lakh hectares of land in India. The yield rate per hectare in India is quite low and stands at 17.86 tonnes per hectare as compared to the productivity in the European countries that ranges between 30-40 tonnes per hectare.

Uttar Pradesh produces the maximum yield of potatoes in India with a production of 98.21 lakh tonnes during 2004-05 on 4.40 lakh ha of land. Though this state has the highest

potato production level in the country, it does not enjoy the highest productivity level, which is bagged by Gujarat.

As for the history of potato, Peruvian Indians were the first to cultivate potatoes during 200B.C but it was not until 1621 before they were introduced in North America. Potatoes were introduced to India from Europe in the early 17 th century. Potato is grown in India in all most all the states. It is possible to see the crop in field round the year in one part of the country or other. About 82% of area under potato crop lies in plains where the crop is grown during the short days of winter from October to March. About 10% area lies in the hills where the crop is grown during the long days of summer from April to December. During the last 25-30 years, potato exports have ranged from 0.01-0.07% . There is great potential for exporting them, both for seed and table purposes to our neighbouring countries of South-East Asia and Middle East countries. ***(http://www.crnindia.com)***

One of the main products from potato is French fries. French fries were first introduced to US when Thomas Jefferson served them in the White house during the first decades of 1800s. Then in 1853, potato chips were created when Chef George Crum sliced some potatoes, paper thin, fried them, salted and served them.

Increase in the standard of living, education of women, cost of living etc. have made women become earning members of the family and therefore housewives have only less time to spare in the kitchen. Consumer demand for packaged ready-to-eat convenience food is increasing year by year. Food processing industry is now being called sun-rise industry, taking into consideration their vast scope in an atmosphere of diversified food habit from state to state and huge market as India ranks second in terms of population. Though Kerala is nowhere in the

production of potato, Keralites consume a good amount of potato fries in one form or other in spite of the obvious presence and preference for banana chips.

Potato fries in french fry form is now available only in modified atmosphere packaged form from established companies and the unit price is high. There exists wide scope of preparation of french fries at a small scale level and marketing such products in various combinations of taste, in and around Kerala could earn profit. The raw material could be brought from states which produces potato abundantly.

At small scale level, potato is sliced manually with the use of a knife. This is time consuming, labour intensive and involves drudgery. There must be an alternative way of cutting potatoes for French fries, which not only looks more attractive and uniform but is also more economical and cost effective for the food service industry. To make processed products available to a large section of population at an affordable prize and also to make smaller scale processing viable, it is imperative to develop appropriate low cost technologies for the production of diversified potato product. Therefore a project was undertaken at Kelappaji College of Agricultural Engineering and Technology on Development and Evaluation of the potato slicer with the following objectives

1.To develop and fabricate a manually operated potato slicer for production of french fries.

2. Evaluation of the fabricated machine regarding its capacity and efficiency.

Review Of Literature

REVIEW OF LITERATURE

2.1 Origin and Agronomical Aspects

Potato (*Solanum tuberosum L.*) is a dicot plant belonging to family Solanaceae and the genum *Solanum*.

Potato is a native of tropical South American Region where it grows wild in nature. It is believed that cultivated potato originated from its wild ancestors near the lake Tritica basin in Peru Bolivion region in high mountains. The potato was introduced in India from Europe in early 17 th centuries. The Portuguese who opened the trade routes from Europe to India were probably the first to bring this important plant in our country. Potato is grown in India in all most all states. It is possible to see the crop in field round the year in one part of the country or the other. About 82% of area under potato crop lies in the plains where the crop is grown during short days of winter from October to March. About 10% area lies in the hills where the crop is grown during long days of summer from April to September. ***(****http://www.crnindia.com****)***

Potato is a short duration crop and fits well in different multiple and inter cropping systems. High yield potential and success of cropping systems depends upon appropriate management of agronomic practices and judicious use of inputs like seed, fertilizers, and water and plant protection chemicals through their efficient utilization. ***(****http://www.crnindia.com****)***

Potato is traditionally propagated through tubers. The eyes on the surface of tubers contain auxiliary buds. Potato tubers have a dormancy of nearly 8 – 10 weeks. When the

dormancy is over the auxiliary buds start germinating producing sprouts. Such sprouted tubers when planted in soil put up fast and vigorous crop. ***(****http://www.crnindia.com****)***

Since seed tubers are a major factor of production costs, farmers have to weigh the relative benefits of larger tubers, which produce faster initial growth and higher potential yields, but at higher cost. Generally recommended practice (again, not necessarily typical practice) is to plant tubers of 30 to 40 grams at a spacing of around 60 by 20 centimeters. Since the cropping season of the Gangetic plains is short, a common practice is to pre-sprout seed tubers prior to planting. Tubers are removed from cold storage and kept for ten to fifteen days in diffused light to ensure that sprouts will be short, thick, and green. *(http:// www.research.cip.cgiar.org)*

Potatoes are grown in all types of soil (alluvial, hill, black, red and laterite) having pH in the range of 5.5 – 8.0 .Deep alluvial soils with almost neutral or alkaline soil reaction are more suitable. Saline and sodic soils are not congenial for potato production. Soil should be fine, loose and without compact layers that hinders root penetration. Compacted layers soils also restrict drainage of water. Well drained coarse or sandy loam to loamy soils, rich in organic matter ensures sufficient oxygen for the growth of roots and tubers, retain moisture and are helpful in drainage of excess water and allows production of well formed tubers.

The following three crops are raised per year in the country pertaining to different weather conditions in different areas

Summer crop –Planting is done in the months of March and April and harvesting is done in the months of August and September.

Autumn crop – Planting in the months of August and September and harvesting in December and January.

Spring crop - Planting in the months of January and February and harvesting in May and June.

Potato is basically a crop of temperate region but there is large variation in the gene pool with respect to crop's response to thermo periods. Generally potato crop is raised in India when maximum day temperatures are below 35ºC and night temperatures are not above 20ºC. Good crop growth is observed when days are sunny and nights are cool. *(http:// www.research.cip.cgiar.org)*

Potatoes planted during the spring and summer in the mountains and plateaus to the north and northeast are usually grown under rainfed conditions, but the predominant winter rabi crop cultivated across the Indo-Gangetic Plains is grown with irrigation. Furrow irrigation is the most common method, based on long furrows where mechanical cultivation is practiced. Shorter and more tightly spaced furrows are more common under manual operation. Sprinkler systems are sometimes used where conditions do not favor furrow irrigation, e.g. undulating topography or very sandy soils. Sprinklers also offer the advantage of more even water distribution and generally result in higher yields, though the cost of a sprinkler system is beyond the means of most farmers. Drip irrigation has been introduced, with impressive results in terms of enhanced efficiency of irrigation water. About fifty percent less water use has been reported, with twenty to thirty percent higher yields relative to furrow irrigation. However, drip irrigation is also an expensive option for the time being. Mulches have been proven to conserve water in experimental treatments. *(http:// www.research.cip.cgiar.org)*

Green manuring is recommended for potato, especially in the northern plains, though the actual extent of the practice is not reported. Commercial fertilizers are widely used, although typical applications rates and practices are not reported. The most appropriate use of fertilizer

varies by locale, but the general range of recommended applications for the northern plains area by kilograms per hectare (kg/ha) is: Nitrogen 180-240; Phosphorous 80-100;Potassium 100-150. Effective use of fertilizer is sometimes cited as a reason for intercropping. As potato roots are shallow, fertilizer dissolved in water can leach below the potato root zone, but might subsequently be recovered by a deeper rooting crop such as wheat.(*http:// www.research.cip.cgiar.org)*

Ideally, haulms are cut about ten days prior to harvest to promote maturation of the potato skin and therefore minimize bruising and damage during harvest. This is not always possible when a crop is to be sold immediately after harvest and is not expected to be in storage for an appreciable time. Harvesting is done either by hand picking or using the various potato harvester machines. This crop is harvested before the frosty and extreme cold weather begins and the top of the plant starts to wither. ***(****http://www.crnindia.com****)***

2.2 Varieties

Potato varieties are primarily distinguished based on their habit, pigmentation on stem, structure of leaf, flower, fruit colour and tuber characters like shape, size, colour, depth of eyes, flesh colour etc.

Kurfi Sindhuri was released in 1967 for cultivation in North Indian plains. It is late maturing(120 -140 days) variety. Tubers are medium in size, round in shape, red in colour with medium deep eyes. Average yield is 30 – 35 t/ha.

Kurfi Chandramukhi was released in 1968 .It is an early maturing (75 days) variety with large, white, oval, flattened tubers with shadow eyes. It has an average yield of 23 - 25 t/ha.Kurfi Jyothi is a medium maturing (100 days) variety which was released in 1968.Tubers are

medium,oval,white with shallow eyes and have tendency to crack. It has an average yield of 25 – 28 t/ha.

Kurfi Badshah is also a medium maturing variety .It was released in 1979 and has an average yield of 30 – 35 t /ha.The tubers are large, white, oval with fleet eyes.

Kurfi Bahar released in 1980 is a medium maturing variety and has an average yield of 30 -34 t/ha.It produces tall, erect, medium compact and vigorous plants with white flowers.

Kurfi Swarna is a late maturing variety having tubers of medium, white, round – oval with fleet eyes and they do not show cracking.It has an average yield of 27 – 28 t/ha.

Kurfi Jawahar is a medium early (80 days) maturing variety producing short, erect, compact and vigorous plants with white flowers. It has an average yield of 20 - 30 t/ ha. *(Textbook of Vegetables, Tubercrops and Spices,Tamburaj, S. et al ,2001)*

2.3 Food value

Potato can supplement the food needs of the country in a substantial way. It is an important crop for high population areas of Asia because it produces more dry matter, well balanced protein and more calories from unit area of land and time than other major food crops. The problem of malnutrition and under nutrition can be largely solved if potato is accepted as major food not merely as a vegetable in our country. Potato is a nutritious food. It contains practically all essential constituents like cereals, carbohydrates which are major constituents of potato. It also contain essential nutrients as proteins and minerals like calcium, phosphorus , iron and vitamins. It is used as stable diet in many of countries especially in west. *(Textbook of Vegetables, Tubercrops and Spices,Tamburaj, S. et al ,2001)*

2.4 Constituents of potato

Table 2.1 Approximate crude composition (% fresh weight)

Constituent	Percentage(%)
Water	63 – 80
Available carbohydrate	18 – 33
Crude protein	1 – 3
Fat	Trace
Fibre	1 – 2

(Source: Post Harvest Phisiology of Food Crops, Burton, W.G.)

Table 2.2 Vitamin Content (mg/100 mg) of potato

Vitamin	mg/100g of potato
Carotene	Trace
Thiamine	0.11
Riboflavin	0.04
Nicotinic acid	1.20
Vitamin C	8.20
Vitamin E	0.10
Vitamin B_6	0.25
Folic acid	0.01
Pantothenic acid	0.30

(Source: Post Harvest Phisiology of Food Crops, Burton, W.G.)

Table 2.3 Mineral content (mg/100 mg) of potato

Mineral	mg/100g of potato
Calcium	10
Phosphorus	40
Iron	0.70

(Source: Post Harvest Phisiology of Food Crops, Burton, W.G.)

2.5 Products

Potatoes containing more than 20 % dry matter with mealy texture are preferred for dried and dehydrated products while small size potatoes containing dry matter between 18 – 20 % with waxy texture are preferred for canning. The ideal reducing sugar content for processing in to chips is generally accepted to the less than 0.1 % of tuber fresh weight, while for french fries upper limit may be as high as 0.5 %.

Broadly potato processed products are classified in to fried, dehydrated, canned and miscellaneous products. Depending upon the status of production of processed products in India, it will be relevant to classify them into following categories.

1. Products of industrial production like potato chips, frozen french fries, soup thickener.
2. Products of small scale and cottage industry level production such as dehydrated chips, cubes, papad etc.
3. Products of fast food outlets and restaurants such as alu samosa, freshly prepared french fries etc.
4. Products of domestic production like potato jam, potato pickle. *(Manwaha, R.S et al,2006)*

Procedures for the preparation of some of the important processed products are discussed below

a. *Potato chips*

Potato chip is a popular fried snack food .For the preparation of chips, the potatoes are washed, peeled and sliced to about 1-1.8 mm thickness in to flat or wavy or ridged shape, blanched sometimes, washed in cold water, blown dry and fried in cooking oil about 180-200 ^{0}C for 2-3 minutes. The fried chips are salted at the rate of 1.5-2.0 %. *(Manwaha, R.S et al,2006)*

b. *French Fries*

They are potato strips of 0.7 × 0.7 cm or 1 ×1cm in cross section having straight or crinkle cut at 7-8cm in length. These are either par–dried or finish-fried at 180-200 ^{0}C. For the preparation of french fries, the potatoes are cut into strips lengthwise. The fries are then sorted to remove slivers and any other defective part. Blanching is done at 75-82^{0}C for 4-5 min to leach excess sugars from fry strips, partially cooked strips will improve the texture, reduce frying time and oil absorption by gelatinizing the surface layer of starch on strips and to produce light,

uniform colour. Good quality fries have a uniform light cream to golden colour. The fried strips, while still hot are moved along vibratory shakers or blowers to remove excess oil. French fries are then moved to the freezing tunnel at about -18^{0}C, filled and packaged. *(Manwaha, R.S et al,2006)*

c. *Dehydrated chips, dices*

The procedure for preparation consist of cutting 2mm thick raw slices with a hand slicer in cold water, followed by blanching in hot water and then spreading in sun to dry. Dried product can be stored in air tight containers or sealed in polythene bags for 6 months. *(Manwaha, R.S et al,2006)*

d. *Potato flakes*

Potato flakes can be easily reconstituted with cold water or hot milk. As a thickener, they enhance creamy frozen deserts and gravies. Peeled potatoes are cut into slices of about 15 mm thickness and washed to remove starch. They are then heated in water at 71 – 74 ^{o}C for 20 minutes and in cold water below 24^o C for 20 minutes. Slices are then cooked in steam cooker for 30 minutes. Slices are mashed by mixer immediately after cooking and additives are added. The mash is dried quickly on a single drum drier. The dry layer is removed as a sheet and broken into flakes and packed in a laminated packaging material. *(Manwaha, R.S et al,2006)*

e.*Potato shreds*

For the preparation of sticks, peeled potatoes are passed through square die of 3 × 3 mm to form sticks of 5 – 6 cm in length. These are blanched in boiling water for 2 – 3 minutes and dried in sun. The dried product is fried in oil before consumption. The dried sticks and shreds can be stored for several months after proper packaging. *(Manwaha, R.S et al,2006)*

2.6 Mechanical slicers

Nanda, (1981) Central Tuber Crop Research Institute, developed a hand operated vertical feed cassava chipping machine which consists of two concentric mild steel drums, the annular space between which is divided into compartments for feeding the tubers. The rotating discs at the bottom of it carry the knife assembly. A pair of bevel gears is provided to operate the

machine manually with a crank handle. Later on a pedal operated machine has been developed to increase the output as well as operational convenience.

Telis and Sakhpromenergonaladka, (1988) designed a centrifugal beet slicer,which uses a drum within which a central vertical hollow axle rotates a scroll carrying knives and tubes for applying steam for cleaning the knives.

Shcherbakov, (1989) developed a knife frame for a centrifugal beet slicer. A rectangular body includes a static part to which a control strip (15) bevel is fixed and a moving part for gap adjustment having a support surface to which ribbed knives are attached in a row and an inclined surface for exit of cosettes.To improve cosette quality, on the support surface is made a longitudinal groove and in to it are fixed strips with gap relative to the knife face,which are softer than the knives and act as shock absorbers if foreign materials enter the slicer.

Brockhans, (1989) developed a bolting device for blade boxes of drum slices. The drum slicer for sugar beet includes an arrangement, which enable the knife box to be inserted or removed easily. The construction is such that the position of the bolting device can be seen while it is being adjusted. This device and the spring, which acts, on it are situated outside the slicing drum. Hence beet particles cannot fall on to them and hinder their movement.

Balasubramanian et al, (1993) developed a motorised cassava chipper and tested at Tamil Nadu Agricultural University. The machine consisted of a chipping disc with knives driven by shaftwhich derives power from a motor. The tubers can be vertically fed from top and chips are collected at the bottom. The capacity of the chipper is 270 Kg/hr .The chip recovery was assessed at 92% for 1 mm chips at 295 rpm. The cost of chipping was estimated at Rs.18/t.

Kachru et al, (1994) Central Institute of Agricultural Engineering, Bhopal developed a multiple string banana slicer to avoid the drudgery and injury to workers and enhance the

capacity and maintain quality gadgets within stainless steel string arrangement. This had a hollow frame of mild steel; 250 mm length, 130 mm wide and 70 mm height. About 126 stainless steel rings (28guage) 7.5 mm in length were tied across the longitudinal side at 5 mm above the bottom edge of the frame.

During the experimentation, peeled banana was kept on a 10 mm raised platform and the frame with strings moved down manually so as the strings pierced in to the fruit pulp to cut the slices. Due to the blunt edge of the string, a force of about 28 n was required to pierce a single string into the banana. When so many strings acted over one fruit at a time, the force requirement for strings to pierce into the fruit was very high (about 3.5 Kilo Newton) which resulted in compression of fruit from the bottom distortion of pulp. Also due to the pulp, removal of slices after cut was very difficult.

Kachru et al, (1996) developed an electrically operated rotary slicer for raw banana and tested at CIAE, Bhopal. The horizontal type- chipping machine consists of a slicer disc attached with blades of 120 0 apart. An ms shaft is used to drive the slicing disc. A stainless steel semicircular feeding chute is used for feeding the peeled banana and chips are directly discharged into the pan by centrifugal action. It has an efficiency of 90 % and produces chips of uniform thickness.

Liju, (1997) developed a vertical feed mechanical chipper for banana. The feeding mechanism has a pressing attachment which consists of a mild steel rod with a wooden end plate at disc end which is lifted up. The raw peeled banana is fed through the slots made in the feeding pipes. The pressing mechanism is then released and the rotary disc with blade cuts the banana into round slices of uniform shape and thickness. The stopper attachment on the pressing mechanism prevents the wooden end plates from damaging the plates. Chipping efficiency of the machine is 96 % and effective capacity of slicing is 223 kg peeled raw banana per hour.

Vidhu et al,(1999) developed an experimental model of pineapple peeler , corer cum slicer .The peeling and coring unit consisted of two concentric stainless steel cylinders which on lowering peels and cores pineapple. In slicing unit the blades moving between rings of holding unit and slices pineapple. The thickness of cut slices can be varied by using bushes between knives. The machine can be used to peel pineapples of any size using peeling cylinders of varying diameter with minimum material loss. The peeling efficiency of the machines is 99%.

K.J.Simoniyan et al,(2003) designed and developed a motorized ginger slicer. The reciprocating principle with fixed blades was adopted. The machine consists of feeding unit, slicing unit, driving mechanism, frame and the housing.

Shiv Narain Kala, (2005) developed a simple and low cost potato chip, making machine. It is pedal operated. With up and down movement of piston, potatoes are pressed down against wire mesh which slices the potato.

Society of Science and Technology applications in rural shelters developed a proto type of cassava chipping machine. On the moving platform cutting blades are fixed in rectangular slots 1 cm deep. The continuous forward and backward movement of platform with cutting edges slices the tapioca tubers, which are delivered on to platform through a feeder mechanism. *(Food Digest, Oct-Dec 2005,28(4). pp:17)*

A potato peeler and slicer is reported to be developed by Bajaj Machineries Private Limited (2004) . This potato peeler consists of a cylindrical drum having rotating blades and special internal lining that peels of potato skin. Potato is fed from top and water is continuously added during operation to wash away peels. Slicer is having rotating disc with cutting blades attached to it. When peeled potatoes are pressed by hand lever against rotating disc they are sliced as per clearance between the disc and blade. The sliced parts are collected at the bottom. *(Food Digest, Oct-Dec 2005,28(4). pp:16)*

Materials and Methods

MATERIALS AND METHODS

The fabrication procedure of the potato slicer, the details of the components and the procedures adopted for evaluation are described in this chapter

3.1 General Layout and Details of Machine

The machine consists of the following units

1. Feeding unit
2. Slicing mechanism
3. Driving mechanism
4. Frame assembly

The front view, side view and plan of the machine are shown in **Fig 3.1, 3.2 and 3.3 and plate 3.1, 3.2 and 3.3.** The machine with hopper attached and covered is shown in **plate 3.4**

3.1.1 Feeding unit

The feeding unit consists of an opening dimensioned 105 × 60 mm. This facilitates easy and safe feeding and free movement of potato into the slicing chamber. It is constructed from a 2 mm thick sheet metal. The potatoes are fed through the hopper to the cylinder by gravity.

3.1.2 Slicing unit

Slicing unit consists of a cylinder, piston and blade assembl

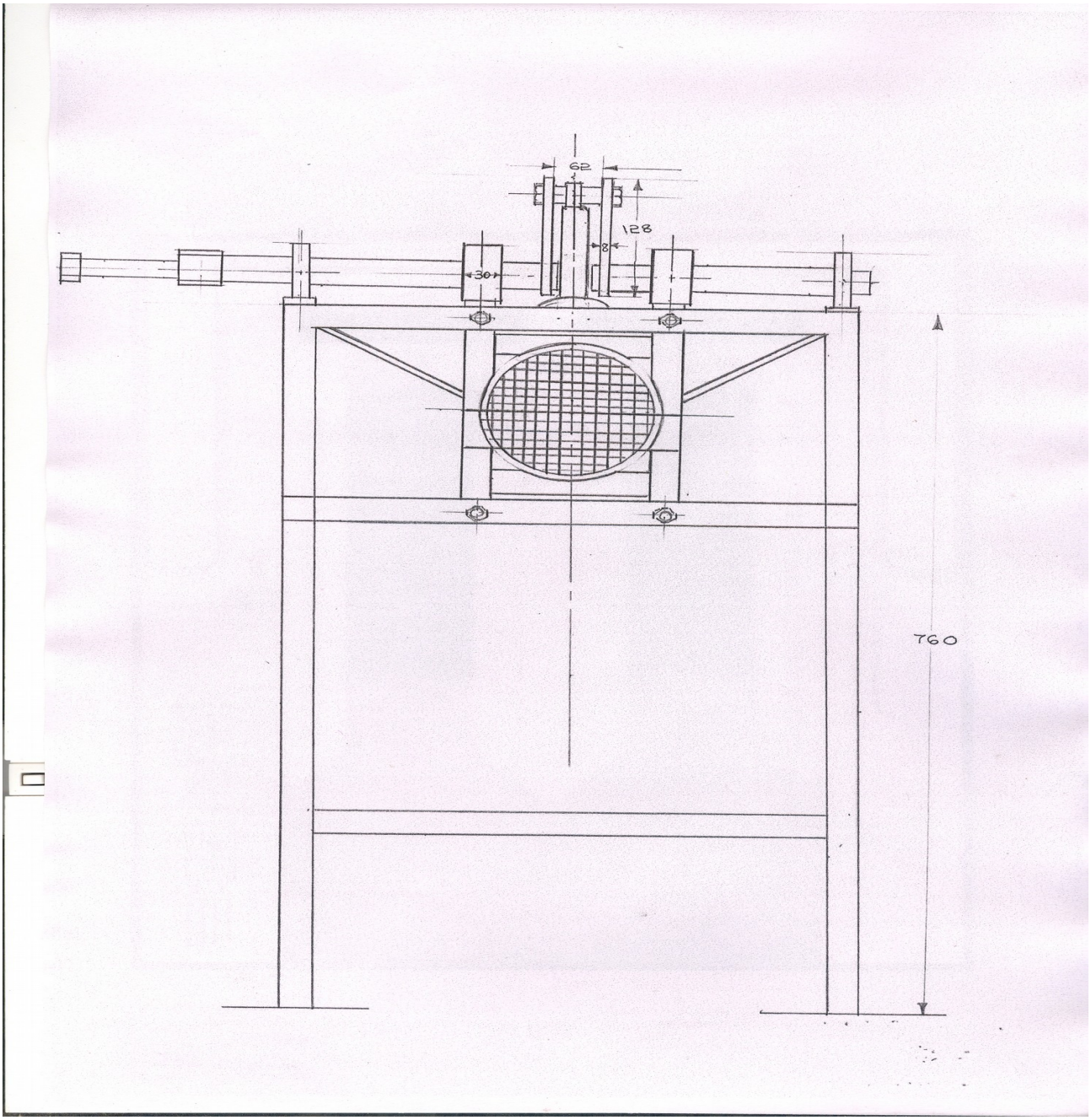

Fig3.1 Front view of potato slicer

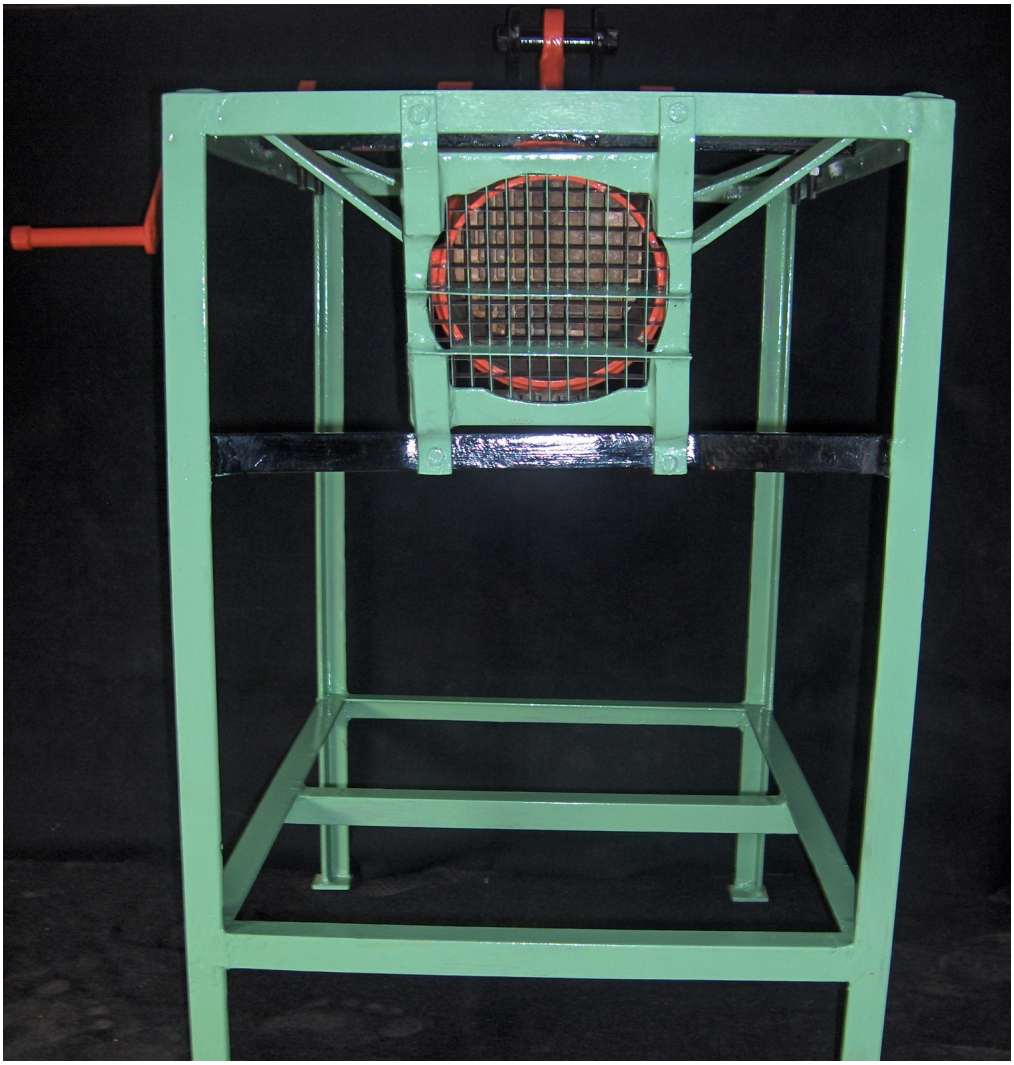

Plate 3.1 Front View of Potato Slicer

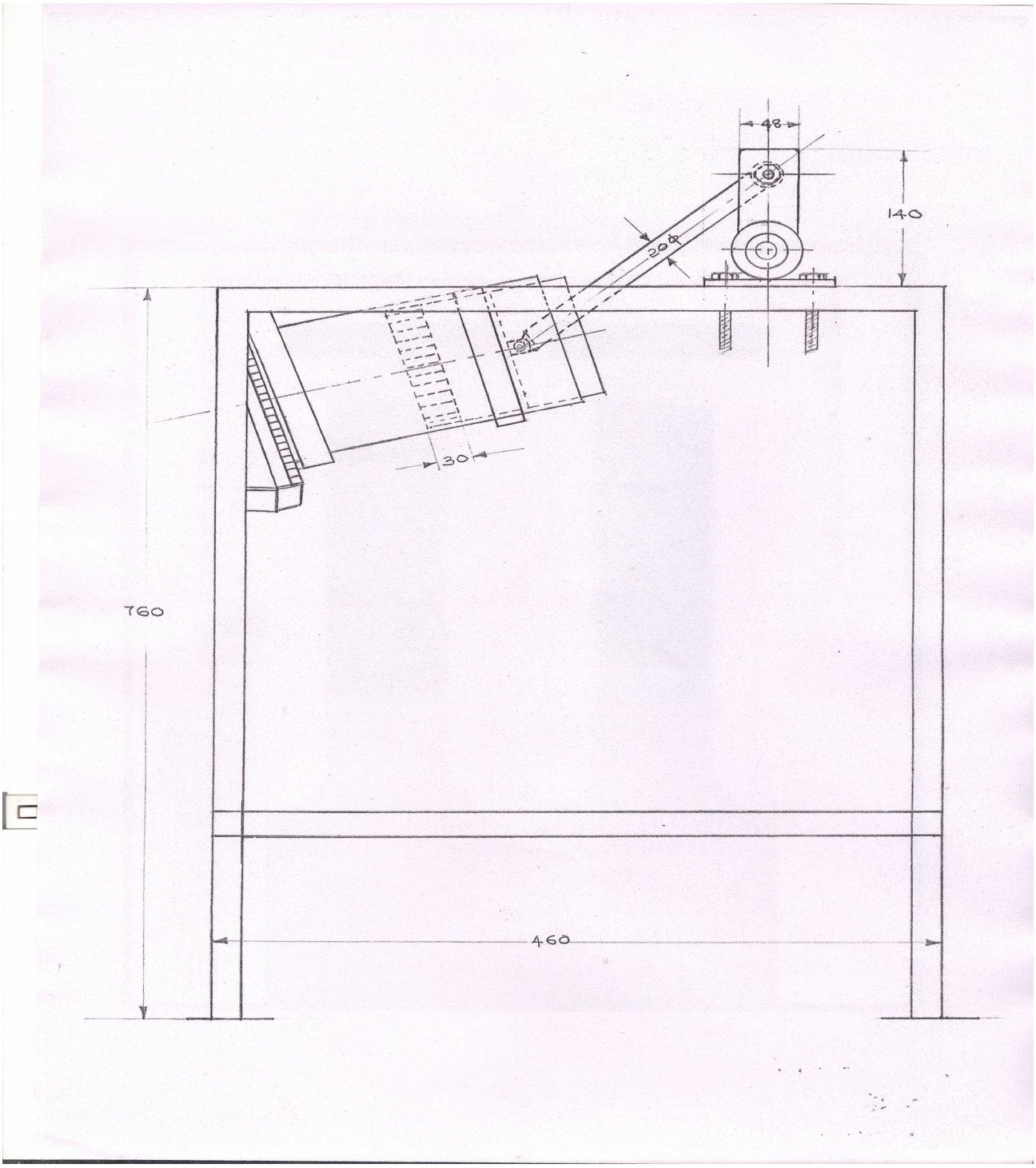

Fig 3.2 Side view of potato slicer

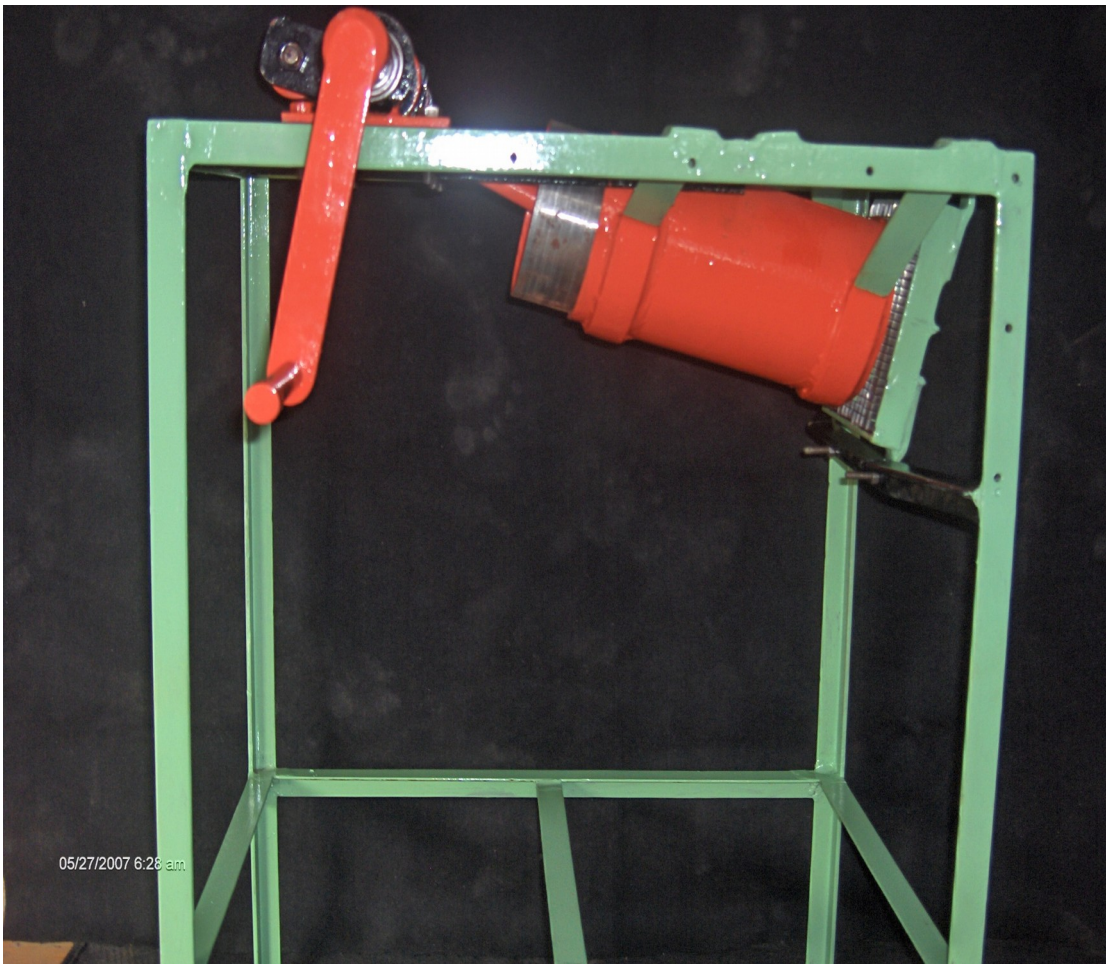

Plate 3.2 Side View of Potato Slicer

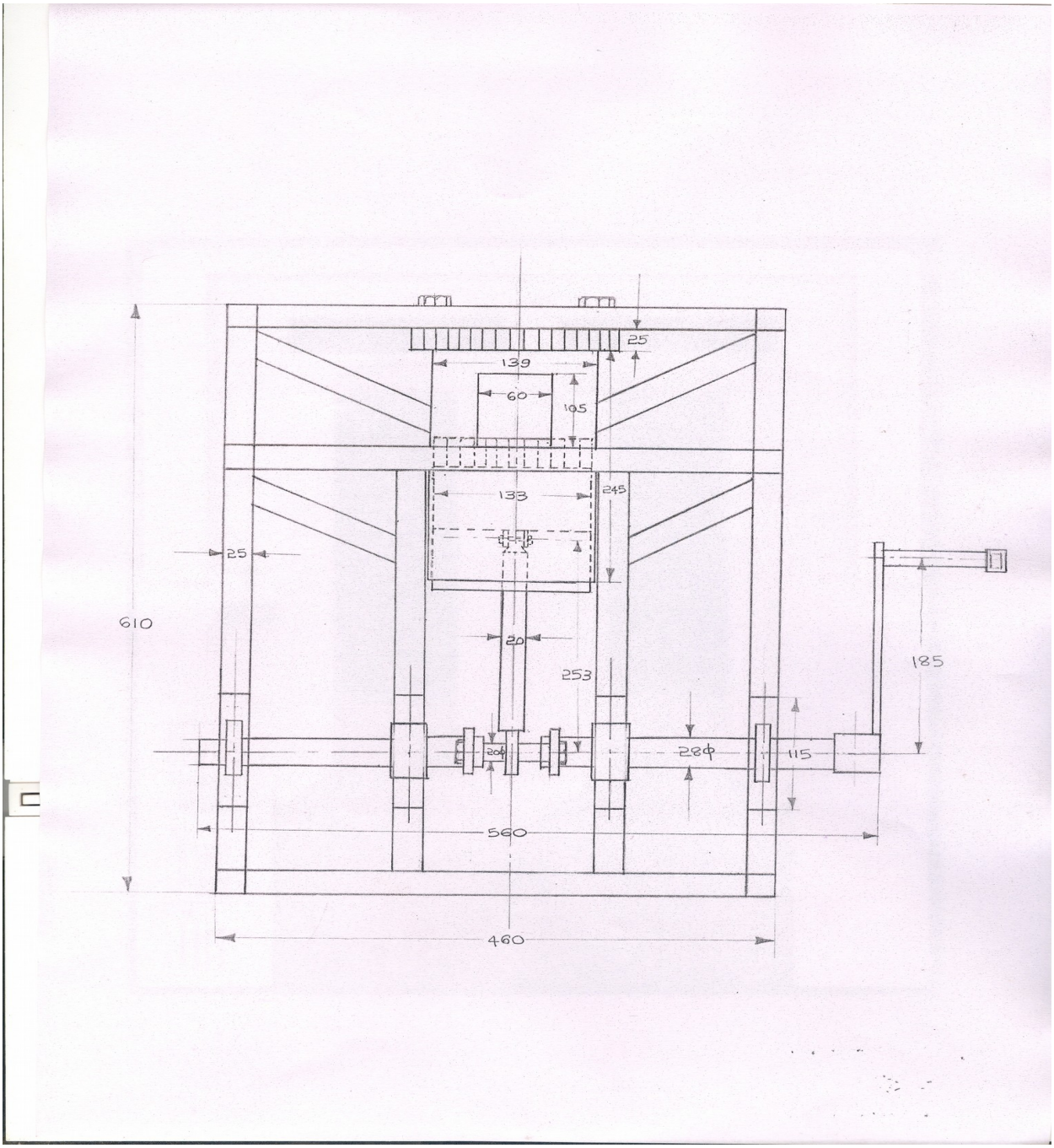

Fig 3.3 Plan of potato slicer

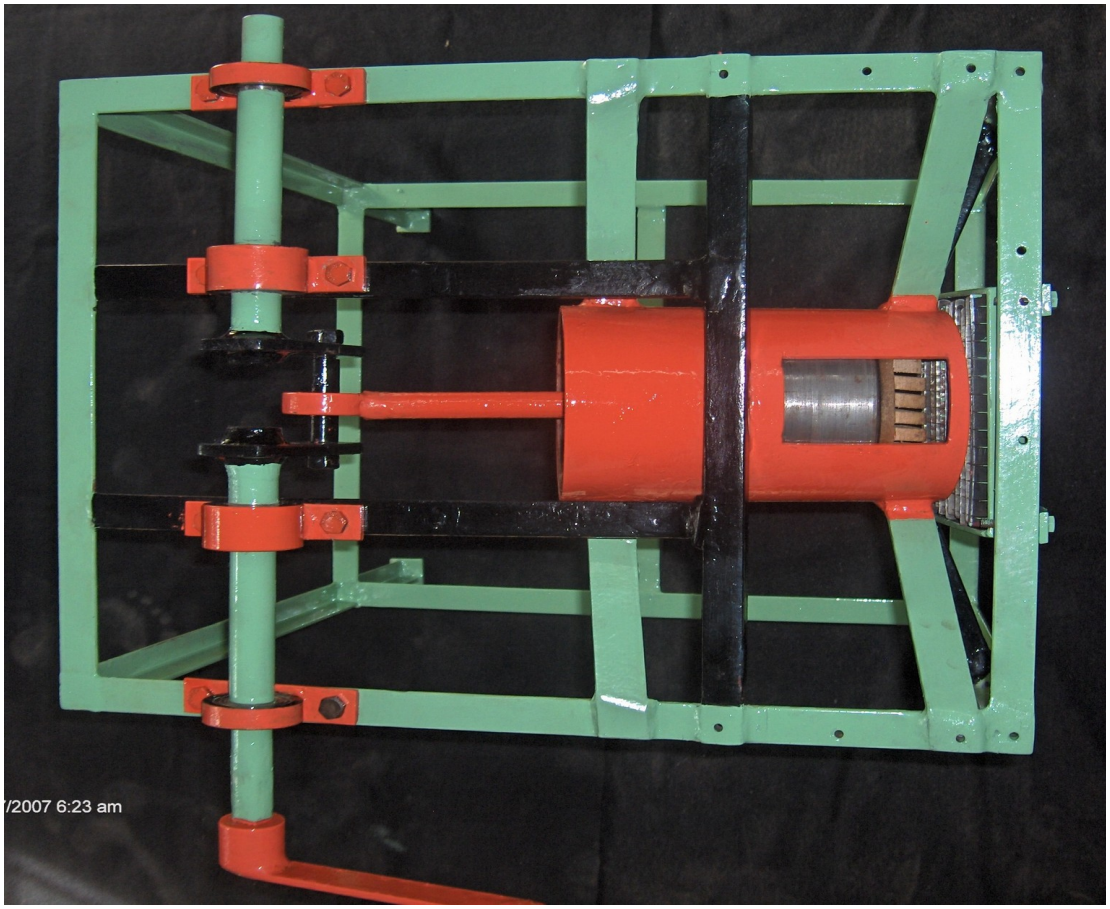

Plate 3.3 Plan of Potato Slicer

Plate 3.4 The Potato Slicer

3.1.2.1 The cylinder

The cylinder is a G.I. pipe of 139 mm OD and length 245 mm. A rectangular opening of 105 × 60 mm is cut on it at a distance of 12 mm from the front end which will form the inlet opening for the potato fed through the hopper into the cylinder.

3.1.2.2 The piston

The piston forms the main component of the slicer **(plate 3.5).** The piston reciprocates within the cylinder from the Top Dead Centre (TDC) to the Bottom Dead Centre (BDC). It facilitates the inlet opening to receive potatoes from the hopper to the cylinder at the

Bottom Dead Centre of its intake stroke. During its forward travel, the piston closes the inlet space, pressing and forcing the potato against the fixed blades for slicing and then ejecting the slices at the Top Dead Centre of the compression stroke. No clearance is provided between the TDC and the blades. A wooden bush with projections of square cross section is attached to the front end of the piston to enable the complete ejection of cut slices.

The cylindrical MS piston having a diameter of 133 mm is carefully machined to permit easy and smooth movement inside the cylinder. The piston is provided with a gudgeon pin on which the connecting rod turns when transmitting power from the crank shaft. The travel of the piston is 150 mm.

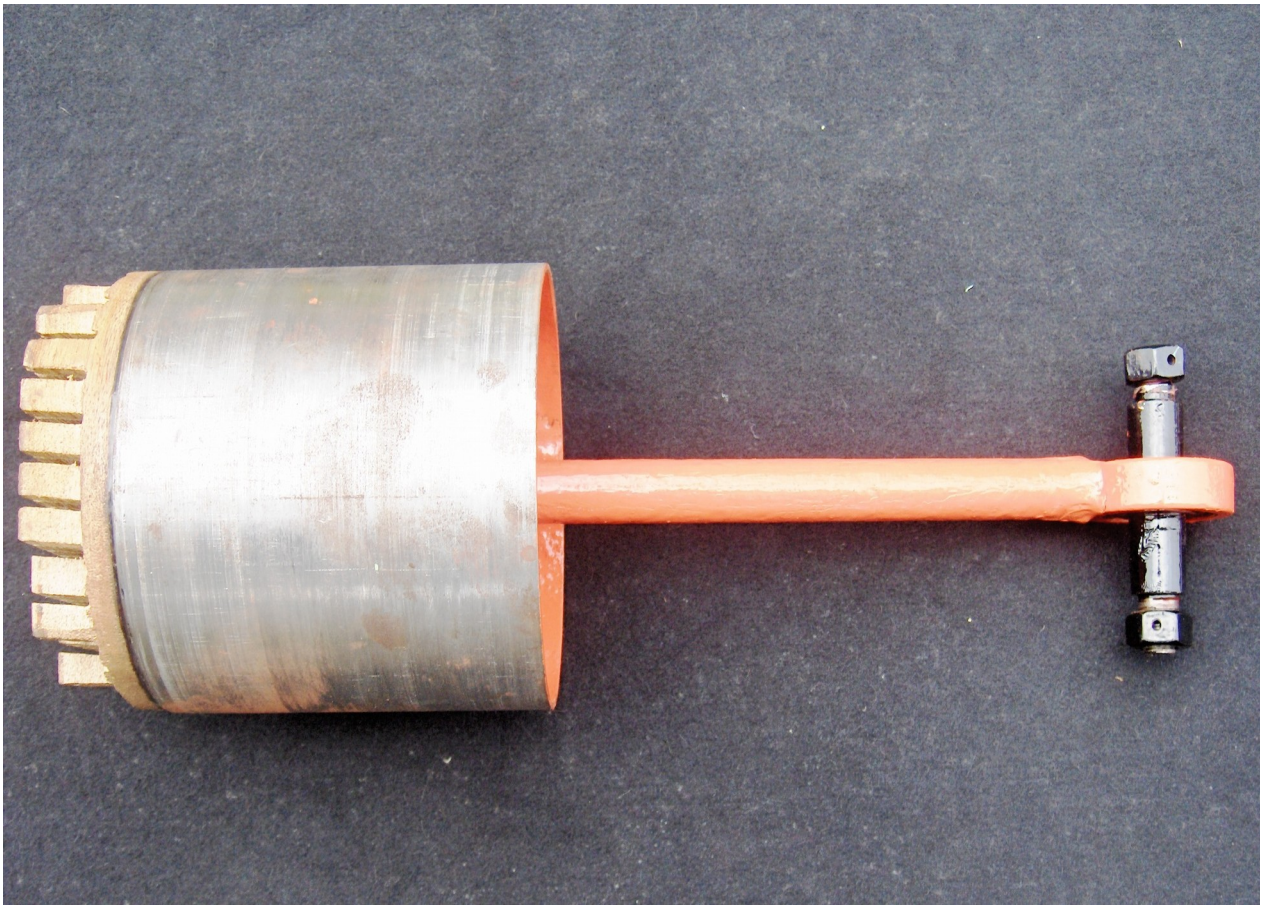

Plate 3.5 The Piston

3.1.2.3 The blade assembly

The slicer has fixed stationary blades in horizontal and vertical direction for cutting the potato into slices of square cross section. The MS blades are cut from a 24 guage sheet **(plate 3.6)**. The vertical blades have a width of 22 mm and the horizontal blades have a width of 10 mm.Cuts are made on vertical blades to a depth of 10 mm at 11 mm interval so that the horizontal blades can be inserted into the vertical blades so as to form a square type openings by the blades through which potato passes during the cutting operation thereby effecting the formation of potato slices for french fries. The blade set is placed in a blade holder with the sharp ends towards the piston and then bolted to the frame.

3.1.3 Driving mechanism

The fabricated slicing unit is manually operated. The rotary movement of a hand lever is transmitted to the reciprocating motion of the connecting rod of the piston moving inside a cylinder by means of a crank shaft **(plate 3.7)** . The crank shaft is an MS rod of length 560 mm well lathed without any bending. The shaft is fixed over the frame assembly through four bearings, two of which are ball bearings and two bush bearings so that it turns smoothly without any wobbling and enables the smooth movement of the piston inside the cylinder. The crank shaft is cut at the centre for a gap of 72 mm and two MS flats of 128 × 48 × 8 mm are welded at right angles to the shaft axis and the bearing is mounted in this gap which acts as the cam on to which the end of the connecting rod is welded. The connecting rod is a well lathed rod of length 253 mm and diameter 20 mm. One end of the connecting rod is connected to the piston with a pin and the other end is welded to the bearing of the crank shaft. The connecting rod translates the rotary motion of the crank shaft to the reciprocating motion of the piston.

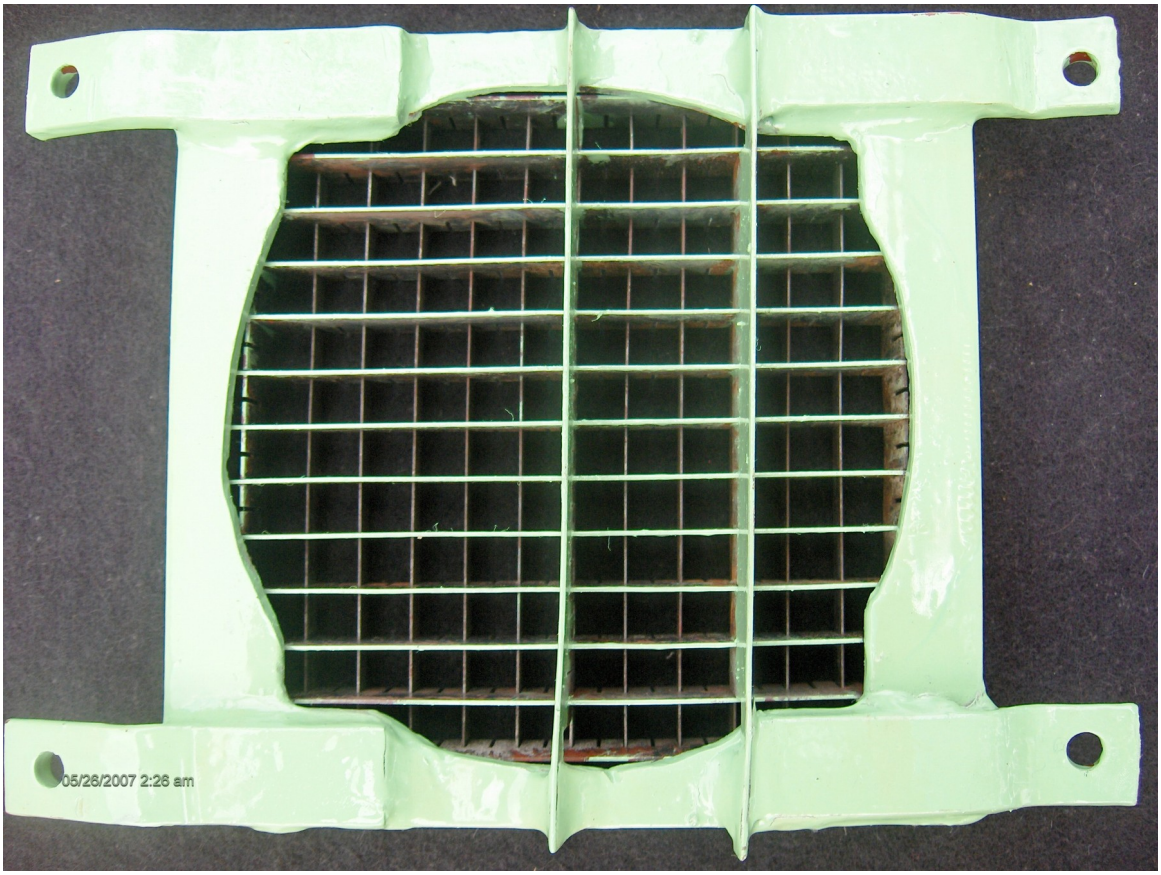

Plate 3.6 The Blade Assembly

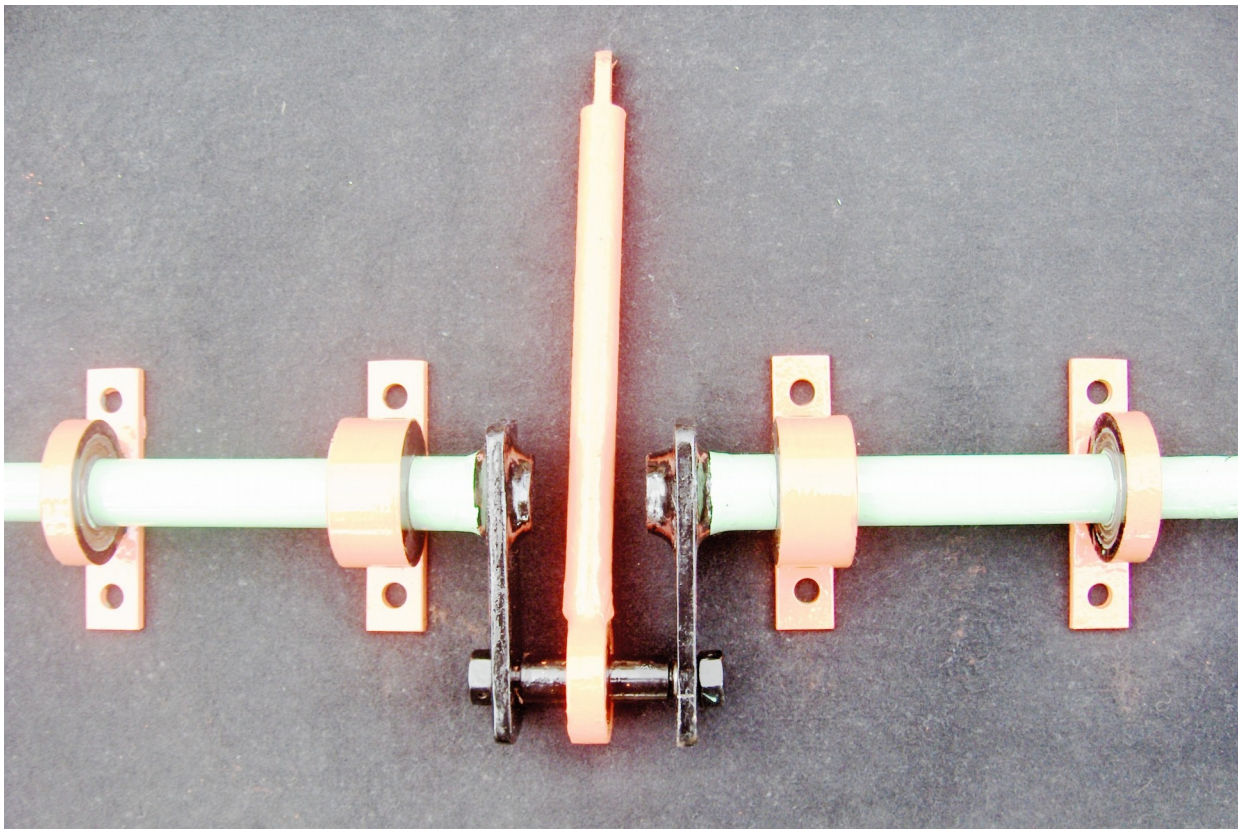

Plate 3.7 The Crank Shaft

3.1.4 The Frame assembly

The frame positions the entire machine component to perform its operation satisfactorily. It was fabricated using an ISA 25 × 25 × 6 mm MS section. On to this frame

assembly, the main units like the cylinder and the crankshaft were mounted. The slicing mechanism which consisted of the cylinder and the piston was mounted at an angle of 25 degrees with the horizontal, with the knife assembly pitching downwards. This is for the easy rolling of the potato towards the knife assembly.

3.2 Performance Evaluation

Matured potatoes brought from the local market were used for conducting the experiment. The potatoes were peeled using a stainless steel knife and were fed to the hopper. They fell by gravity in to the cylinder through the opening on the cylinder when the piston reached its bottom dead centre. It was pushed horizontally towards the stationary blade assembly as the piston moved towards the top dead centre and pressed against the blades effecting slicing. The wooden bush on the piston caused all the cut slices to get through the blades. The slices were then collected in a tray kept below the blade set. The time required for the operation was noted. The capacity, slicing efficiency, percent damage etc were then calculated. All the experiments were replicated five times and the average value was found. A comparison between manual and mechanical slicing was also carried out.

3.2.1 Capacity of the machine

The capacity of the potato slicer, which is the number of kilograms of sliced potato produced by the machine in one hour was calculated by noting the weight of sliced potato produced and the time taken for the same. It was then expressed in Kg/hr.

3.2.2 Slicing efficiency

Peeled potato of known weight was subjected to the slicing action. After slicing, the slices which got damaged in the process were separated and there weight was recorded. The total weight of slices obtained was also noted. The slicing efficiency was then calculated using the formula.

$$\text{Slicing Efficiency (SE)(\%)} = \frac{(W - W_d)}{W} \times 100$$

where,

W = Weight of all slices

W_d = Weight of damaged slices

3.2.3 Percent damage

The percent damage for each sample of potato was calculated based on the following formula

$$\text{Percent Damage (PD) (\%)} = \frac{W_d}{W} \times 100$$

where,

W = Weight of all slices

W_d = Weight of damaged slices

3.3 Preparation of french fries

For the preparation of french fries, the potatoes were sliced into strips of cross section dimension 11 × 11 mm as obtained from the machine. The fries were sorted to remove slivers and any other defective parts. Blanching was done at 75 - 82 ^{0}C for 4 – 5 min to leach excess sugars from fry strips to produce a light uniform colour. Salt and chilly powder were added to the required quantity and these were then oven heated to get fried products **(plate 3.8).**

Plate 3.8 Prepared French Fries

Results and Discussions

RESULTS AND DISCUSSIONS

This chapter deals with the results of experiments conducted to evaluate the performance of the developed potato slicer and its comparative performance with manual method.

4.1 Performance Evaluation

The experimental model was evaluated for its overall capacity, slicing efficiency and percent damage.

4.1.1 Capacity of the machine

The throughput capacity of the machine was found when the crank shaft was rotated at a speed of 24 rpm which caused 24 number of strokes per minute of the piston. This speed was chosen after the preliminary trials which were the average rotational speed without causing fatigue for the worker. The average throughput capacity of the machine was found to be 121.42 Kg/hr. The results are shown in Table 4.1.

Table 4.1 Throughput capacity of the machine at a crank shaft handle speed of 24 rpm

Sl No.	Weight of sliced potato (g)	Time taken for slicing (s)	Capacity (Kg/hr)
1	1000	30.2	120.00
2	1000	28	128.60
3	1000	29	124.10
4	1000	30.5	118.03
5	1000	31	116.13
		Average	121.42

Though there was no significant variation in the throughput capacity of the machine, a slight variation of 10 to 12 kilogram per hour was noticed in the five lots tested. Though this is not significant compared to the total capacity per hour, this variation can be attributed to the non uniformity of size and shape of the peeled potato and also the skill of the worker in maintaining a uniform continuous feeding of the potato into the cylinder. It was also revealed from the trials conducted that any attempt to increase the capacity by increasing the rotational speed of the crank shaft handle will not only result in an increase in fatigue of the average worker but also reduce the efficiency of the slicing operation and increase the percent damage. Therefore the crank shaft handle speed of 24 rpm may be taken as optimum.

4.1.2 Slicing efficiency

Slicing efficiency of the machine was calculated using the formula given in section 3.2.2. The average slicing efficiency of the developed slicer was found to be 95.93 % . The results are shown in Table 4.2

Table 4.2 Slicing efficiency of the potato slicer

Sl No.	Weight of all slices (g)	Weight of damaged slices (g)	Slicing efficiency (%)
1	1000	39.50	96.05
2	1000	42.03	95.70
3	1000	41.27	95.80
4	1000	35.60	96.40
5	1000	42.83	95.70
		Average	95.93

It was revealed from the results that there is no significant variation in the efficiency of the slicing operation. The values were more or less uniform. However, the slicing efficiency depends on factors such as size, shape and variety and skill of the worker in not only feeding the raw material uniformly to the cylinder, but also in applying a constant uniform pressure on the potato when it is pressed against the blade assembly. For an average worker this can be achieved through the trial and error experience.

4.1.3 Percent damage

Percent damage was calculated using the formula given in section 3.2.3. It was revealed that damage during slicing process was influenced by the size of potatoes. More damage was caused to small sized potatoes. This may be because the piston could not apply uniform pressure on the potato due to its small projected area. Besides, the shape of the potato and skill of the worker also determine the percent damage. More damage was observed for small sized potatoes. Average percent damage was 4.02%. The results of the experiments carried out to determine percent damage are presented in Table 4.3.

Table 4.3 Percent damage of potato during slicing operation

Sl No.	Weight of all slices (g)	Weight of damaged slices (g)	Percent damage(%)
1	1000	39.50	3.95
2	1000	42.03	4.20
3	1000	41.27	4.13
4	1000	35.60	3.56
5	1000	42.83	4.28
		Average	4.02

4.4 Comparison between manual and mechanical slicing

The results are presented in Table 4.4

Table 4.4 Comparison between manual and mechanical slicing

SL NO.	Total time required for slicing one sample of 1000 g (s)	
	Manual	Mechanical
1	163	29
2	172	28

From the study, it was established that the slicing of potatoes using the fabricated machine is found to produce a capacity six times effective than manual slicing. Besides the slicing efficiency is high and percent damage is negligible. The machine produces even and uniform sized slices. This machine eliminates the drudgery involved in manual slicing operations and saves time. The machine is simple in construction and operation and can be locally fabricated. Only one person is required to operate the machine and since it is manually operated, the energy requirement is quite low. The approximate cost of this prototype is Rs 4000/-

4.5 Preparation and packaging of fried products

Fries are prepared as in section 3.3. They are then packed and sealed in polyethene covers for storage.

Summary and Conclusions

SUMMARY AND CONCLUSION

India is the second largest producer of fruits and vegetables. But the post harvest loss of fruits and vegetables have been roughly estimated as 35%. This is mainly due to inadequate facilities for the processing and storage of the produce. A substantial return can be obtained by processing and marketing these products on a small scale basis in India. Potato is one of the commercially important vegetables in India which is exploited in value added form such as canned potato, potato chips, french fries etc. The main unit operation during the value addition process is slicing. In small scale processing industries, slicing is carried out manually with sharp knives. The manual slicing is labour intensive, time consuming and involves drudgery of work. To overcome these limitations, a manually operated potato slicing machine was developed.

The developed potato slicer consists of feeding unit, slicing mechanism and driving mechanism. The feeding unit facilitates easy and safe feeding for free movement of potatoes into the slicing chamber. The slicing chamber consists of a cylinder, a piston and a blade assembly. In the driving mechanism the rotary movement of a hand lever is transmitted to the reciprocating motion of the connecting rod of the piston moving inside the cylinder by means of a crank shaft. The slicing unit is attached to the frame assembly with a pitch of 25^{o} with a cutting blade end at the lower side of the frame. The potatoes, fed manually in to the hopper, fall by gravity into the cylinder at the bottom dead centre of the piston. They are pushed horizontally to the stationary blades as the piston moves towards the top dead centre and thus sliced. The wooden bush on the piston helps in pushing all the slices out of the blade assembly.

The machine was evaluated for its throughput capacity, efficiency and percent damage. The average throughput capacity of the machine at crank shaft handle speed of 24 rpm was found

to be 121.42 kg/hr. The average efficiency and percent damage during the slicing operation was found to be 95.93 % and 4.02 % respectively. It was concluded from the study that though no significant variations in the values of capacity, efficiency and percent damage were observed among the trials conducted, the values of these parameters were influenced by the size, shape, variety of potato and skill of the worker not only in feeding the raw material uniformly into the cylinder but also in applying a constant uniform pressure on the potatoes when they were pressed against the blade assembly.

The developed slicer could produce slices at capacity six times higher than manual slicing. Besides, the slicing efficiency is high and percent damage is negligible. This machine produced even uniform sized slices. The machine requires one person to operate. It is simple in construction and operation and therefore technically feasible and economically viable.

Modifications of the machine can further improve the performance. Some suggestions that may help future research work are given below.

1.The slicer could be motorized so as to increase in capacity can be obtained.

2. Blade set could be made adjustable so that slices of required size can be obtained.

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Appendices

APPENDIX - 1

CALCULATION OF OPERATING COST

Initial cost(C)

Fabrication cost of potato slicer = Rs.4,000.00

Average life of machine = 10 years

Working hours per year = 1200

Salvage value = 10 % of initial cost

= Rs.400.00

A) Fixed cost

1. Depreciation = C–L/L×H

= 4000 – 400/10×1200

= Rs. 0.30/hr.

2. Interest on investment @ 15 % = (C+S) ×15/2×H×100

$$= \frac{(4000+400)}{2\times1200\times100} \times 15$$

= Rs.0.275/hr

Total fixed cost = Rs.0.575/hr

B) Variable cost

1. Labour wages

Wages of a labour = Rs.120/day of 8 hr

= Rs.15/hr

2. Repair and Maintenance cost

@ 10 % of initial cost p.a. = 4000×10/1200×100

= Rs.0.33/hr.

Total variable cost = Rs.15.33/hr.

Total operating cost = Rs.0.575/hr +
Rs.15.33/hr

= Rs.15.91/hr

DEVELOPMENT AND EVALUATION OF A POTATO SLICER

By

DAYANA PAUL

RAJESH MOHANAN

SIMI POULOSE

ABSTRACT OF THE PROJECT REPORT

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Kerala Agricultural University

Department of Post Harvest Technology and Agricultural Processing

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

TAVANUR-679573, MALAPPURAM

KERALA

2007

ABSTRACT

Potato is one of the commercially important vegetables in India which is exploited in value added form such as canned potato, potato chips, french fries etc. The main unit operation during the value addition process is slicing. A prototype model of potato slicer was developed to make the process easy and less time consuming. The developed potato slicer consists of a feeding unit, a slicing mechanism and a driving mechanism. The potatoes, fed manually in to the hopper, fall by gravity into the cylinder at the bottom dead centre of the piston. They are pushed horizontally to the stationary blades as the piston moves towards the top dead centre and thus sliced. The wooden bush on the piston helps in pushing all the slices out of blade assembly. The machine can be used to slice potatoes with minimum percent damage (about 4.02%). The slicing efficiency of the machine is 95.93%. The average throughput capacity of the machine at crank shaft handle speed of 24 rpm was found to be 121.42 kg/hr. The developed slicer could produce slices and capacity six times higher than manually slicing.