DEVELOPMENT OF MANGO DESTONER CUM CUBE CUTTING MACHINE FOR PICKLE PRODUCTION

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PROJECT REPORT

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DECLARATION

We here by declare that this project report entitled "**Development of Mango Destoner Cum Cube Cutting Machine for Pickle Production**" 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.

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CERTIFICATE

Certified that this project entitled "**Development of Mango Destoner Cum Cube Cutting Machine For Pickle Production**" is a bonafide record of project work done jointly by Amritha, V.L, Dhanesh, K.J, Nisha, S, and Remya, M.R under my guidance and supervision and that it has not previously formed the award of any degree, diploma, associateship or fellowship to them.

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DEDICATED TO OUR PROFESSION OF AGRICULTURAL ENGINEERING

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SYMBOLS AND ABBREVIATIONS

%	percentage
/	per
@	at the rate of
^{0}C	degree Celsius
ή	efficiency
^{0}F	degree farenheit
&	and
^{0}	degree
A	Ampere
AICRP	All India Co-ordinated Research Project
Al	Aluminium
APEDA	Agricultural and processed food Product export Development Authority
cm	Centimeter
DC	Direct current
et al.	And others
g	Gram
GI	Galvanised Iron
hr	Hour
ISA	Indian Standard Angle
K.C.A.E.T	Kelappaji College of Agricultural Engineering and Technology
kg	Kilogram
kg/hr	kilogram per hour
kN	kilo Newton
M	Million
M ha	million hectare

Mg	milli gram
mm	Millimeter
MS	Mild Steel
MT	million tones
N	Newton
NHB	National Horticultural Board
PHT and AP	post Harvest Technology and Agricultural Processing
pp	Page
Rs.	Rupees
s	Seconds
SS	Stainless steel
t	Tonne
V	Volt
Viz	namely

INTRODUCTION

Chapter I

INTRODUCTION

India is endowed with a wide spectrum of agro climate zones making it possible to grow almost all varieties of fresh fruits and vegetables. Fruits and vegetable are considered as important group of protective and nutritious foods as most of them are rich in carbohydrates, protein, vitamins, minerals, dietary fibre and trace elements. India is the second largest producer of fruits and vegetables in the world after China. The total production of fruits and vegetables in India during 2008-09 was 63.5 million tonnes and 125.8 million tonnes respectively (Anon 2010). Due to high water content in fresh horticultural crops, they are subjected to desiccation, mechanical injury and also susceptible to attack by bacteria and fungi, resulting as pathological breakdown. This results in changes in texture, colour, flavour and nutritional value of food. These changes can render food unpalatable and potentially unsafe for human consumption. Though India is the largest producer of fruits and vegetables after China, it process only less than 2.5% of the huge production as compared to70-83% in advanced countries. (Wikipedia) Therefore the thrust should be to process and convert such perishable commodities into value added products that can be stored for extended periods there by reducing losses and making them available throughout the year.

The long-term objective of our country's economic development is a good balance between a strong industrial sector and a resilient agricultural sector. The development of micro, small and medium scale rural agro industry is seen as a strategic step towards achieving this goal. There are large numbers of micro and small scale food processing enterprises run by farmers and Self Help Groups (SHG), which produce a wide variety of processed foods. Pickle making has already developed into a cottage and small scale industry in Kerala and the product is in high demand in India as well as abroad, especially in Middle East countries. There is great potential for this to be developed further, exploiting the domestic and fast increasing export demand.

Mango (*Mangifera indica* L.) belonging to family Anacardiaceae is the most important commercially grown fruit crop of the country. Mango, the king of fruits, is an evergreen tree grown under tropical and subtropical environments around the world. India is the largest producer of mango in the world accounting for about 50% of the world's mango production. In India, mango is grown in an area of 1.23 million ha with an annual production of 10.99 million tonnes, which accounts for 57.18 per cent of the total world production. In Kerala, it is cultivated in an area of 75,911 hectares with an annual production of 3.23 lakhs tones.

Pickle is one of the crucial groups of food in Indian cuisine. Pickle is a big group of food which differs with respect to its flavor, usage, textures, and ingredients. Nowadays many variety pickles are available commercially in both inside and outside of India. The major unit operations involved in the making of pickle is slicing and cutting, brining, salting and processing, and pasteurization operations (Linda et al.1976). Pickles are made from various fruits and vegetables viz., mango, lemon, amla, onion etc. Mango pickle is the most popular among them. The unripe mango of Nattumavu is widely used for making pickle.

The processing of raw mango for pickle making is done manually. It needs up to 100 labours for one ton per day capacity plant. One of the major problems in pickle industries is that the mangoes are to be cut in to pieces during the short mango season. At present, mango slicing and cube cutting is done manually by stainless steel knives. This conventional method poses danger to operator's finger by inflicting injury.

In order to eliminate the drudgery involved in manual slicing and cube cutting, avoid injury to workers, increase efficiency, and maintain high quality standards and hygiene to the prepared pickles, an attempt was made at Kelappaji College of

Agricultural Engineering and Technology, Tavanur to develop a mango destoner cum cube cutting machine with the following objectives.

- Study of the existing method used for mango destoner and cube cutting for pickle production.
- Development of destoner cum cube cutting machine
- Performance evaluation of destoner cum cube cutting machine.
- Comparative evaluation of traditional method and hand operated machine.

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REVIEW OF LITERATURE

Chapter II

REVIEW OF LITERATURE

2.1 Agronomy

The mango originated in Southeast Asia where it has been grown for over 4,000 years. Mango (mangifera indica L.) belonging to family Anacardiaceae it is naturally adapted to tropical lowlands. The best climate for mango has rainfall of 30 to 100 in (75-250 cm) in the four summer months (June to September) followed by 8 months of dry season. It is the most important commercially grown in southern and eastern parts of India. It is called the king of fruits. India ranks first among worlds mango producing countries accounting for about 50% of the world's mango production. In India, major states growing mangoes are Kerala, Karnataka, Andhra Pradesh, Uttar Pradesh, Orissa, Bihar, west Bengal, and Maharashtra. Kerala has the largest area of mango cultivation of about 75 911 ha and production around 323 517 tons. The mango tree is not too particular as to soil type, providing it has good drainage. Rich, deep loam certainly contributes to respond vegetative but will be deficient in flowering and fruiting. The mango performs very well in sand, gravel, and even oolitic limestone. This attractive large tree has glossy, dark green leaves and produces a very large, kidney-shaped often with a break at the apex and are usually more or less lop-sided. Mangoes normally reach maturity in 4 to 5 months from flowering. Thus matured fruit is selected for the pickle production.

2.2 Varieties Cultivated

In India, about 1,500 varieties of mango are grown including 1,000 commercial varieties. Each of the main varieties of mango has a unique taste and flavour.

Table 2.1 Classification of variety based on time of ripening

Early	Bombay, Bombay Green, Himsagar, Kesar, Suvarnarekha
Mid-season	Alphonso, Mankurad, Balgalora, Vanraj, Banganapalli, Deshehari, Langra
Late	Fazli, Fernandin, Mulgoa, Neelum, Chausa

2.2 .1**Hybrid varieties**

Amrapalli (Dashehari x Neelum), Mallika (Neelum x Dashehari), Arka Aruna (Banganapalli x Alphonso), Arka Puneet (Alphonso x Janardhan Pasand), Arka Neelkiran (Alpohonso x Neelum), Ratna (Neelum x Alphonso), Sindhu (Ratna x Alphonso), Au Rumani (Rumani x Mulgoa), Manjeera (Rumani x Neelum), PKM 1 (Chinnasuvernarekha x Neelum), Alfazli, Sunder Langra, Sabri, Jawahar, Neelphonso, Neeleshan, Neeleshwari, PKM 2 (very few of these hybrid varieties are grown commercially in the country).

Table 2.2 The important mango varieties cultivated in different states of India

State	**Varieties grown**
Andhra Pradesh	Allumpur Baneshan, Banganapalli, Bangalora, Cherukurasam, Himayuddin, Suvernarekha, Neelum, Totapuri
Bihar	Bathua, Bombai, Himsagar, Kishen Bhog, Sukul, Gulab Khas, Zardalu, Langra, Chausa, Dashehari, Fazli.
Goa	Fernandin, Mankurad.
Gujarat	Alphonso, Kesar, Rajapuri, Vanraj, Jamadar, Totapuri, Neelum, Dashehari, Langra.

Haryana	Dashehari, Langra, Sarauli, Chausa, Fazli.
Himachal Pradesh	Chausa, Dashehari, Langra
Karnataka	Alphonso, Bangalora, Mulgoa, Neelum, Pairi, Baganapalli, Totapuri
Kerala	Mundappa, Olour, Pairi.
Madhya Pradesh	Alphonso, Bombay Green, Langra, Sunderja, Dashehari, Fazli, Neelum, Amrapalli, Mallika
Maharashtra	Alphonso, Mankurad, Mulgoa, Pairi, Rajapuri, Kesar, Gulabi, Vanraj
Orissa	Baneshan, Langra, Neelum, Suvarnarekha, Amrapalli, Mallika
Punjab	Dashehari, Langra, Chausa, Malda
Rajasthan	Bombay Green, Chausa, Dashehari, Langra
Tamil Nadu	Banganapalli, Bangalora, Neelum, Rumani, Mulgoa, Alphonso, Totapuri
Uttar Pradesh	Bombay Green, Dashehari, Langra, Safeda Lucknow, Chausa, Fazli

2.3 Food value

Food value of mango is rich because of the presence of oxalic, citric, malic and succinic acids green or unripe mango contains a large protein of starch which gradually changes in to glucose, sucrose and maltose as the fruit begins to ripe. The raw mango is a valuable source of vitamin C.

Table 2.3.1 Food value of mango (value per 100 gram edible protein)

Moisture	81.0%
Protein	0.6%
Fat	0.4%
Mineral	0.4%
Fibre	0.7%
Carbohydrates	16.9%

Table 2.3.2 Minerals and vitamins present in raw mango

Calcium	14 mg
Phosphorous	16 mg
Iron	1.3 mg
Vitamin C	16 %
Vitamin B complex	1%
Calorific value	74

2.4 Food uses of raw mango

Mangoes should always be washed to remove any sap residue, before handling. Some mangoes are so fibrous that they cannot be sliced; instead, they are massaged, the stem-end is cut off, and the juice squeezed from the fruit into the mouth. Non-fibrous mangoes may be cut in half to the stone, the two halves twisted in opposite directions to free the stone which is then removed, and the halves served for eating as appetizers or dessert. Or the two "cheeks" may be cut off, following the contour of the stone, for similar use; then the remaining side "fingers" of flesh are cut off for use in fruit cups, etc.

If the fruit is slightly fibrous especially near the stone, it is best to peel and slice the flesh and serve it as dessert, in fruit salad, on dry cereal, or in gelatin or custards, or on ice cream. The ripe flesh may be spiced and preserved in jars. Surplus ripe mangoes are peeled, sliced and canned in sirup, or made into jam, marmalade, jelly or nectar. The extracted pulpy juice of fibrous types is used for making mango halva and mango leather. Sometimes corn flour and tamarind seed jellose are mixed in. Mango juice may be spray-dried and powdered and used in infant and invalid foods, or reconstituted and drunk as a beverage. The dried juice, blended with wheat flour has been made into "cereal" flakes; A dehydrated mango custard powder has also been developed in India, especially for use in baby foods. Green mangoes are peeled, sliced, parboiled then combined with sugar, salt, various spices and cooked, sometimes with raisins or other fruits, to make chutney; or they may be salted, sun-dried and kept for use in chutney and pickles. Thin slices, seasoned with turmeric, are dried, and sometimes powdered, and used to impart an acid flavor to chutneys. Some of these products, their uses and methods of preparation are described below.

2.4.1Chutney

Family recipes vary but it generally has sliced, skinned, green (read unripe) mangoes cooked with sugar and a dash of garam masala. This Madras Club adds a dollop of it in the soup it invented which the world knows as mulligatawny. Also available ready-bottled, western tables favour a recipe named after a mythical British progenitor, Major Grey.

2.4.2Aamchoor

Produced in north and south India,this souring condiment is made by slicing,salting and sun-drying unripe mangoes that are sometimes dusted with turmeric.Once fully desiccated,it can be stored whole or powdered, and used to flavour vegetable and fish dishes as well as fresh chutneys.It is also put in marinades to tenderise meats.

2.4.3 Pickle

A pan-Indian condiment; recipes vary according to regions and families. Unripe, unskinned mangoes, cut or whole, are mixed with different spice combinations and left in the sun to steep in strong oil usually mustard in the north and sesame in the south before being transferred to glass or ceramic jars.

2.5 Slicers

2.5.1 Banana slicer

A utensil or tool specifically adapted for slicing bananas includes a frame which circumscribes an area generally conforming to the shape and size of a typical banana. The frame has two opposing curvilinear longitudinal sides which are interconnected with a plurality of spaced, substantially parallel disposed ribs. The ribs are sufficiently thin to cut transversely through a banana when the utensil is pushed down on a banana. The utensil is held by a user through handles which are attached to ends of the frame. An elongated hole is provided in one of the handles to permit hanging of the utensil on a peg board or the like for storage.

2.5.2 Pineapple peeler, corer cum slicer

It has two concentric steel cylinders which on lowering, peels and cores the pineapple. In the slicing unit, blades move in between the rings of the holding unit and slice it. Peeling cylinder of different diameter can be used interchangeably to suit the size of the pineapple. The thickness of slices can increase by increasing the spacing between knives using bushes. The peeling efficiency is about 99%.

2.5.3 The cube dicer

The fully automated cube dicer is a machine which is used as a industrial machine. Not every filling of the process chamber has to be carried out individually. Boxes are emptied onto a conveyor belt. The rest of the work is carried out by the cube dicer itself.

This way the machine can cut up to 1500 Kg of cubes or strips per hour. The size of the process chamber of 100 mm x 100 mm x 350 mm as well as the overall dimension of 1200 mm x 800 mm is reminiscent of a compact machine for the trade.

Continuous operation properties and ease of servicing was a central subject of the new development. Large service hatches provide for easy access to all components. The same principle applies to the classic machine control which is confined to four easy understandable control knobs. The automatic filling of the process chamber is a real novelty which has nothing in common with the pre-filling funnels of the past. Two conveyor belts clamp the product and press it into the process chamber. This pressure is at the same time the lateral pre-compaction in the process chamber which provides for perfect filling and therefore for the preparation of the cutting process. All this would be to no avail if the perfectly filled process chamber would be closed by a cutting knife which partially pushes the product out of the chamber or disarranges the product. To prevent all this, a real novelty comes into play which can be seen for the first time at the IFFA in Frankfurt. One more point – the cube dicer cuts more beautiful than any other fully automated machine we have seen so far.

2.5.4 Carrot, Potato and Melon Dicer Model 1

Dicer for fruits and vegetables (potatoes, carrots, aubergines and courgettes) to cut into slices cubes or strips. It has a production capacity of 2200 to 4400 lb per hour. This machine has centrifugal rotation and the fruit or vegetable is pushed against a stator for strip shaping, then crosswise for slice shaping and longitudinally for dice shaping cuts.

2.5.5 Multipurpose Vegetable cutter

Vegetable cutter applies to cut various types of stem and leaf vegetables (celery, leeks, spinach, etc.) and to slice the slender type of hard vegetables (cucumber, carrots, Bottle Gourd etc). It is ideal equipment used commercial catering and kitchen equipment and for producing vegetable stuffing, cutting vegetable in suitable slices and also chop various vegetables like carrots, potatoes, ginger etc. The machine can produce variable sized slices which are then conveyed to the chopping section. The intermittent chopping blade action produces slices/chops/cuts/finger-cuts etc.

2.5.6 Raw mango slicer

The mango slicer slices the mangoes longitudinally. The mangoes are cut into 4, 6 or 8 slices based on the size. The width of the slices is 20 mm and thickness depend upon pulp thickness where as the length is as per the length of mango. The mangoes are cut by blade made of AISI 420 grade hard stainless steel. The feeding of mangoes to the cutting blade is under gravity and a particular orientation is required to facilitate cutting of mangoes into desired slices. The cut slices fall on nylon mesh and the cut pieces of kernel are separated from the pulp under impact. The cut slices and kernel pieces are collected on one side in a container of 50 liter capacity.

2.5.6.1Traditional method

The most widely practiced method of slicing mango in the country is done manually by stainless steel knives to produce thin slices. A few entrepreneurs use manually operated platform type manual slicer by holding plantain and moving across the sharp edge of the slicer.

2.5.6.2 Mechanical method

Nanda (1985) developed a hand operated vertical feed cassava chipping machine consisting of two concentric mild steel drums, the annular space between which is divided into compartments for feeding the tubers. The rotating disk at the bottom of it carries the knife assembly. A pair of bevel gear 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.

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Balsubramanian *et al.*, (1993) developed and evaluated a motorized cassava chipper. The machine consisted of 18 chipping discs with knives driven by a disc shaft from power source. The tubers can be vertically fed from top and chips are collected at bottom. The capacity of the chipper is 270kg/h. The chip recovery was assessed at 92% for 1mm chips at 295 rpm. The cost of chipping was estimated at Rs. 18/t.

Kachru *et al*., (1994) 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 SS rings (28 gauges) 7.5 mm in length were tied across the longitudinal side at 5mm above the bottom edge of the frame. During the experimentation, peeled banana was kept on a10 mm raised platform and the frame with strings moved down manually so as the string pierced into the fruit pulp to cut the slices Due to blunt edge of the string of about 28N was required to pierced a single string into the banana. So many strings acted over one fruit at a time, the force requirement for strings to pierced into the fruit was very high(3.5KN) which resulted in compression of fruit from the bottom leading to the distortion of pulp, removal of slices after cut was very difficult.

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 blade moves between the rings of holding unit and slices the pineapple. The thickness of cut slices can be varied by using bushes between knives. The machine can be used to peel pineapple of any size using peeling. There is a cylinder of varying diameter with minimum material loss. The peeling efficiency of machine is 99%.

K.J simoniyan *et al.* (2003) designed and developed a motorized ginger slicer. The machine consists of feeding unit, slicing unit, driving mechanism, frame and the housing.

Nehru *et al*. (2004) developed lab model mango slicer and cube cutter for mechanizing the cutting operations in a Pickle industry. The capacity and efficiency of the mango slicer and cube cutter were determined. The cost of operation of cutting of mango into cubes has reduced compared to manual cutting. The mechanical cutting is faster to handle larger quantities of mango in shorter period.

Shiv narain kala (2005) developed a simple and low cost potato chips making machine. The peeler operated with up and down movement of a piston, Potatoes are pressed down against a wire mesh which slices the potatoes.

Dayana Paul *et al.* (2007) developed a potato slicer which consists of feeding unit, a slicing mechanism and a driving mechanism. The potatoes, fed manually in to the hopper fall by gravity in to the cylinder at the bottom of the piston. They are pushed horizontally by the piston movement and thus sliced. The wooden bush on the piston helps in pushing all the slices out of blade assembly. The machine can be slices potatoes with minimum percent damage (about 4.02 %). The slicing efficiency of the machine is 95.93 %. The developed slicer could produce slices at capacity six times higher than manual slicing.

Aswathi, K.B and Indulekshmi (2010) developed a Plantain Peeler cum Slicer which consists of feeding unit, peeling unit, pushing unit, collection unit, slicing unit & frame assembly. The green plantain fed into the feeding cylinder was pushed down by a pushing mechanism. Peeling was achieved by the cutting action of circular shaped blade that would force the peel from the plantain as it passes through the mechanism. Slicing unit consist of a cylindrical guide, slicing disc and blade. Slicing was achieved by rotating the disc at an rpm of 300. The overall capacity, slicing efficiency and effective capacity of the plantain slicer was found to be 89.27kg/h. Average peeling efficiency and material loss were obtained as 88.94% and 13.69% respectively. The capacity of developed peeler cum slicer was four times higher than manual operation.

MATERIALS AND METHOD

Chapter III
MATERIALS AND METHODS

The fabrication procedure of the Destoner cum mango cube cutting machine, the details of the components and the procedures adopted for evaluation are described.

3.1 Study of the existing methods used for the cube cutting machine for pickle production

Prior to the development of destoner cum cube cutting machine, we analysed the existing methods used for mango destoning and slicing for pickle production.

3.2 Mechanical and Physical Properties

Before the fabrication, important physical and mechanical properties of mango were studied. The mangoes having a moisture content of 81.88 % were graded according to their size for the determination of properties. The moisture content of mango was determined by placing a sample of 10g in a hot air oven, at 70^0C for 24 hours. The size, thickness and diameter of the mango, thickness of stone, were measured and recorded.

Based on the physical and mechanical properties of mature mango, design parameters were obtained for the development of a mango destoner cum cube cutting machine.

3.3 Development of model

The mango destoner which was developed (Model I) was of a single destoner unit for a fixed sized mango. In order to make it more easy, effective and more human comfort, a machine was fabricated to destone 2 grades of mango (small, medium). For cube cutting of mango a blade assembly is made.

3.3.1 General Layout and Details of Machine

The machine consists of the following units

1. Destoner unit
2. Cube cutting unit
3. Frame assembly

Plate 3.1 Front view of mango destoner cum cube cutting machine

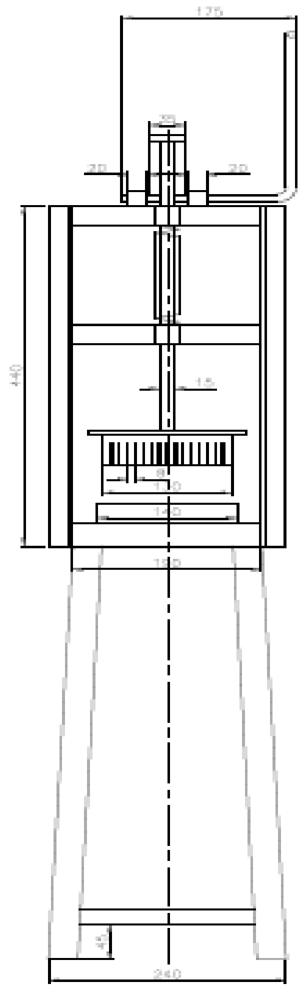


Fig 3.1 Front view

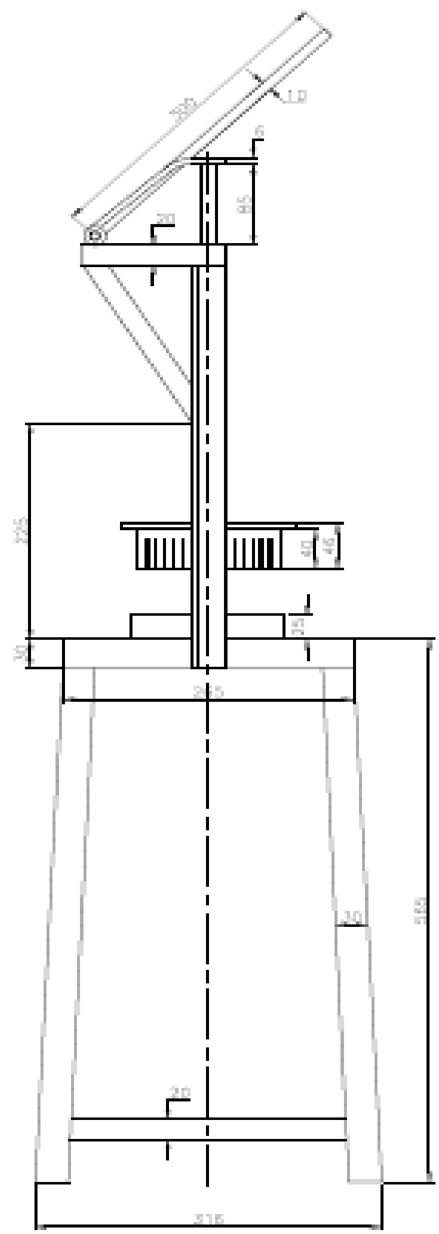
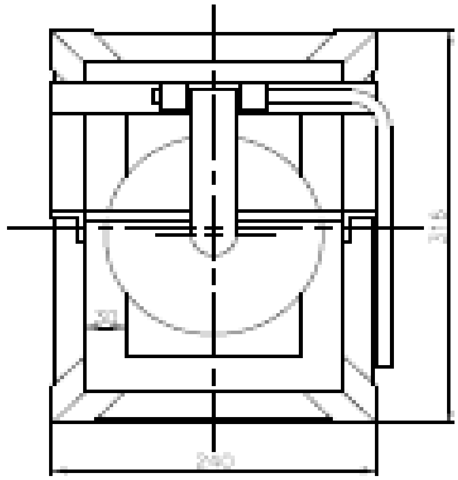


Fig 3.2 Side view



ALL DIAMENSIONS ARE IN MM

Fig 3.3 Top view of Mango Destoner Cum Cube Cutteing Machine

3.3.1.1 Destoner unit

It is the main unit of the destoner which separates the stone from the fruit. The destoner unit consists of an oval shaped blade; base plate and pusher which are connect to the main frame. Three sets of cast iron blades were bend to form an oval shaped opening having major and minor diameter (9 x 2) and (10.6 x 2.6) respectively for small and, medium grades of mango. The blade was connected to a MS base plate which collects the mango pieces after destoning. The MS pusher having 6.5 cm length, 0.5 cm thickness was connected to the handle shaft. The pusher pushes the mango placed above the blade. The stone was collected in the bottom.

Plate 3.4 Destoner Blades

Plate 3.5 Destoning operation

3.3.1.1 Cube cutting unit

Cube cutting unit consists of a circular mesh type blade having mesh size of 1×1 cm distances. The mesh was formed by joining spin steel, and stainless steel blade which is perpendicular to each other. The pushing unit consists of circular plate type pusher to which a nylon guide is fixed. This pushing unit pushes the mango piece through the blade set and enables the mango to get sliced. The sliced mango cubes was collected in the collector provided in the bottom.

Plate 3.6 Cutting blade unit

3.3.1.3 Frame assembly

The frame supports the entire machine component to perform its operation satisfactorily. It was fabricated using mild steel. On to this frame assembly, units like destoner unit, slicing unit, collection unit and a mechanically operated spring loaded handle were mounted

3.3.2 Performance evaluation of destoner unit

Matured mangoes procured from the local market were used for conducting the experiment. The mangoes were graded into three sets according to their size. Then the mango was placed over the respective size blade. Destoning was achieved by cutting action of oval shaped blade. The destoned mango pieces were collected in the base plate. The time required for the operation was noted and the capacity was calculated. All the experiments were replicated five times and average value was found.

3.3.2.1Capacity

The capacity of the destoner which is the kilogram of destoned mango produced by machine in one hour was calculated by noting the weight of destoned mango produced and the time taken for the same. It was then expressed in Kg/hr. For a skilled labour a time lag of 2 second was accounted between successive feeding and actual capacity was calculated in kg/hr.

3.3.2.2 Material loss

Material loss for each sample was calculated based on the following formula.

$$\text{Material loss (\%)} = Z / (W + Z)$$

Where,

Z = Weight of flesh obtained from the stone (g)

W = Total weight of mango after mechanical destoning (g)

3.3.1 Performance evaluation of cutting

The destoned samples were fed to the slicing unit to slice the mango into cubes. The mango cubes were collected in a tray which is kept below the blade set. The time required for the operation was noted and operating capacity was evaluated. For a skilled labour a time lag of 3 s was accounted between successive feeding

The operating capacity of the fabricated cube cutting unit was calculated by weighing all the sliced mango pieces and time taken for the same. It was then expressed in Kg/hr.

3.4 Comparative evaluation of the traditional method with hand operated machine

The performance of the fabricated machine was compared with that of traditional operation for which raw mangoes were destoned and sliced using conventional stainless steel knives.

Plate 3.7 Cube cutting operation

RESULTS AND DISCUSSIONS

RESULTS AND DISCUSSIONS

This chapter deals with the results of experiments conducted to evaluate the performance of the developed destoner cum cube cutting machine for mango and its comparative performance with manual method.

4.1 Study of existing method in pickle production

Pickle manufacturing industries were using knives for mango destoning and slicing. Some available machines for slicing are too costly to afford. So we decided to make simple and less costly equipment which could help the rural people in mango processing.

Plate 4.1 Traditional method of destoning

Plate 4.2 Traditional method of mango cutting

Plate 4.3 Traditional method of slicing

4.2 Physico-Mechanical properties of mango

The details of properties are shown in table 4.1

Table 4.1 Physico-Mechanical properties of raw mango

Sl. No.	Properties	Average value
1	Moisture content	81.88%
2	Flesh Thickness	150 mm
3	TSS	9° B
4	Maximum diameter with flesh	730 mm
5	Minimum diameter with flesh	625 mm
6	Maximum diameter of the stone	250 mm
7	Minimum diameter of the stone	200mm

4.3 Test models

The developed models were tested for different samples of mangoes and the results are discussed in terms of capacity, destoning efficiency and material loss.

4.3.1 Performance Evaluation of destoning unit

The fabricated machine was evaluated for its capacity and material loss.

4.3.1.1 Capacity

The overall capacity was found68.66, 76.68 kg/hr. The corresponding actual capacities were calculated as 54.92 59.47 kg/hr. Results are shown below in table 4.2 and 4.3

Table 4.2 Capacity of the destoner (Model - I)

Sl. No	Wt. of destoned mango piece(g)	Time taken for destining(s)	Overall capacity(kg /hr)	Actual capacity (kg/hr)
1	76.77	4	69.09	55.27
2	75.42	4	67.87	54.32
3	76.52	4	68.86	55.09
4	77.72	4	69.94	55.95
5	75.09	4	67.58	54.01
Average			68.66	54.92

Table 4.3 Capacity of the destoner (Model - II)

Sl. No	Wt. of destoned mango piece(g)	Time taken for destining(s)	Overall capacity(kg /hr)	Actual capacity (kg/hr)
1	104.27	4	93.84	75.00
2	92.88	4	83.59	66.87
3	74.33	4	66,89	44.51
4	73.97	4	66.57	53.00
5	80.63	4	72.56	58.00
Average			76.68	59.47

4.3.1.2 Material loss

The material loss during destoning mango was found using the formula given in. 3.3.2.3 and the results of the experiments is given in table 4.4 and 4.5

Table 4.4 Material loss during destoning operation (Model - I)

Sl. No.	Weight of mango (g)	Weight of destoned mango(g)	Weight of stone(g)	Material loss (g)	Material loss (%)
1	135	76.77	42.20	16.01	17.2
2	128.12	75.42	38.46	14.24	15.8
3	137.21	76.52	42.86	17.81	18.87
4	138.16	77.72	43.82	16.62	17.6
5	127.56	75.09	37.29	15.18	16.8
	Average				17.25

Table 4.5 Material loss during destoning operation (Model - II)

Sl. No.	Weight of mango (g)	Weight of destoned mango(g)	Weight of stone(g)	Material loss (g)	Material loss (%)
1	186.77	104.27	56.33	26.17	20.06
2	186.21	92.88	66.26	27.07	22.5
3	146.77	74.33	45.14	27.3	26.8
4	147.37	73.97	46.12	27.21	26.89
5	155.51	80.63	48.36	26.52	24.75
	Average				24.21

Table 4.6 Capacity of the cube cutting unit

Sl. No	Wt. of sliced cubes	Time taken for cutting(s)	Overall capacity(kg /hr)	Actual capacity (kg/hr)
1	52.13	7	26.80	18.76
2	46.44	7	23.88	16.71
3	37.16	6	22.29	14.86
4	36.98	5	26.62	16.641
5	40.31	7	20.73	14.51
Average			24.06	16.29

Plate 4.4 sliced mango cubes

The overall capacity of destoner, material loss of the destoner and capacity of the cube cutting were obtained as 59.47kg/hr, 24.21kg/hr, and 16.296 kg/hr.

4.4 Comparative evaluation of traditional method with hand operated machine.

Table 4.7 Comparison of traditional method with hand operated machine

Sl. No.	Total time required for destoning of 100g destoned sample (sec)		Total time required for cube cutting of 100g sample (sec)	
	Manual	Mechanical	Manual	Mechanical
1.	15	5	24	20
2.	18	4.5	26	22
3.	16	5	22	18
4.	19	5.5	22	20

As illustrated in the table result of traditional method of destoning indicate that a skilled labourer can destone 24 kg samples per hour and sliced cubes 15.42 kg/h. Under the same conditions, the fabricated destoner could destone 72 kg/h and sliced cubes 19 kg/h. Thus it was established that the destoning and slicing of samples using the fabricated machine is found to produce a capacity more effective than traditional destoning and slicing. Besides, destoning and slicing efficiency is high. Also, even and uniform sliced cubes can be obtained by the fabricated machine. This machine eliminates the drudgery involved in traditional destoning and sliced cube cutting operations and saves time. The machine is simple in construction and operation and requires only one person to operate it.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

India is the second largest producer of fruits and vegetables. But the post harvest loss of fruits and vegetables has 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. Mango is one of the commercially important fruit in India. The main unit operation during the pickling process is destoning and cube cutting. 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 hand operated mango destoner and cube cutting machine was developed.

The developed mango destoner and cube cutting machine consists of a destoner unit, a slicing unit and an operating mechanism. The destoner unit facilitates the removal of stone from the fruit. The destoner unit consists of pusher and destoning blade. The slicer unit consists of a pushing guide and blade assembly. The pushing guide press the raw mango placed over the blade assembly. In the operating mechanism the reciprocating movement of a hand lever causes the pressing action of the pusher. The destoning unit is attached to the frame assembly with a cutting blade fixed on the frame beneath the pusher. The mangoes are placed over the destoner blade and pressed with the pusher. The slicing unit replaces the destoner unit while cutting the destoned mangoes in to cubes. The slicing unit is fixed to the frame assembly with a pusher plate having a nylon guide having a diameter of 14 cm and the blade assembly is fixed beneath the pusher guide as in the destoner unit. They are pushed vertically through the stationary blades as the pusher moves down and thus sliced. The sliced mango cubes fall by gravity into the tray kept at the bottom. The nylon guide on the pusher helps in pushing all the slices out of the blade assembly.

The machine was evaluated for its throughput capacity, efficiency and loss percentage. The average throughput capacity of the destoner unit with model-I was found to be 68.66 kg/hr and that with model-II. The percent loss during the destoning operation with model-I was found to be 17.25% and for model-II it was 24.21%. It was concluded from the study that though no significant variations in the values of capacity and percent loss were observed among the trials conducted, the values of these parameters were influenced by the size, shape, variety of mango and skill of the worker not only in feeding the raw material uniformly over the blade assembly but also in applying a constant uniform pressure on the mangoes when they were pressed against the blade assembly. The developed slicer could produce slices at capacity two to three times higher than manual slicing. This machine produced uniform sized slices. The machine requires one person to operate. It is simple in construction and operation and therefore technically feasible and economically viable. The cost of the machine is about Rs 2000/-. Modifications of the machine can further improve the performance. Some suggestions that may help future research work are given below.

1. The machine could be equipped with a continuously feeding unit.
2. The slicer could be motorized so as to increase the capacity.
3. Blade set could be made adjustable so that slices of required size can be obtained.
4. By incorporating different type of blade assembly the machine could be used for different types of vegetables.

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APPENDICES

APPENDIX I

CALCULATION OF OPERATING COST

Initial cost (C)

Fabrication cost of mango destoner cum cube cutting machine including cost of material

	=	Rs 2000
Average life of machine	=	8 years
Working hours per year	=	2400
Salvage value	=	10% of initial cost

A) Fixed cost

1. Depreciation	=	C- S/LxH
	=	2000-200/ 8x 2400
	=	0. 0937 / hour
2. Interest on investment at 12%	=	(C +S) x 12 /(2x H 100)
	=	(2000+ 200) x 12/ 2x 2400 x 100
	=	0. 055/ hour

Total fixed cost =depreciation+ interest on investment at 12%

	=	0. 055+ 0. 0937
	=	0. 1487/ hour

B) Variable cost

1. Labour wages

Wages of a labour	=	Rs 400 / 8 hour
	=	Rs 50/hour

2. Repair and maintenance cost

@ 10% of initial cost per annum	=	(2000 x 10)/ (2400 x 100)

= 0. 0833/ hour

Total variable cost = 50.0833/ hour

Total operating cost = Total fixed cost + total variable cost

= 50. 0833 + 0. 1487

= 50.232/ hour

DEVELOPMENT OF MANGO DESTONER CUM CUBE CUTTING MACHINE FOR PICKLE PRODUCTION

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PROJECT REPORT

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ABSTRACT

Mango is one of the commercially important fruit crop in India. Raw mango available during the peak seasons can be used for the preparation of pickles, mango in brine solution etc. Pickle is one of the major item in Indian cuisines. Mango can be made available throughout the year by reducing losses and proper storage practices. The main unit operation during the pickling process is destoning and cube cutting. 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 this limitation, a hand operated Mango Destoner cum Cube Cutting Machine was developed. The developed mango destoner and cube cutting machine consists of a destoner unit and a mango slicing unit. The pushing guide press the raw mango placed over a blade assembly. Raw mangoes are pushed vertically through the stationary blades. As the pusher moves down they are sliced. The sliced mango cubes fall by gravity into the tray kept at the bottom. The nylon guide on the pusher helps in pushing all the slices out of the blade assembly. The average throughput capacity of the destoner unit with Model-1 blade was found to be 68.66 kg/hr and that with Model-2 was 72.68 kg/hr. The average efficiency and percent loss during the destoning operation with Model-1 was found to be 82% and 17.25% and that with Model-2 was 75% and 24.21% respectively. The developed slicer could produce mango slices at capacities two to three times higher than manual slicing. The cost of the equipment is about Rs.2000.