DEVELOPMENT AND PERFORMANCE EVALUATION OF A BANANA CHIPPER

By

FELIX JOHN

RAJASREE MADHAVAN

PROJECT REPORT

Submitted in partial fulfilment of the requirement for the degree

Bachelor of Technology in Agricultural Engineering

Faculty of Agriculture

Kerala Agricultural University

Department of Post Harvest Technology and Agricultural Processing

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

TAVANUR - 679573, MALAPPURAM.

1997

DECLARATION

We hereby declare that this project report entitled "**DEVELOPMENT AND PERFORMANCE EVALUATION OF A BANANA CHIPPER**" is a bonafide record of project work done by us during the course of project and that this report has not previously formed the basis for the award to us of a degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Felix John

Rajasree Madhavan

CERTIFICATE

Certified that this project report entitled **"DEVELOPMENT AND PERFORMANCE EVALUATION OF A BANANA CHIPPER"** is a record of project work done jointly by **Mr. Felix John and Miss. Rajasree Madhavan** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, associateship or fellowship to them.

31/5/97

Er. Prince, M.V.
Assistant Professor
Department of Post Harvest
Technology & Agricultural
Processing
K.C.A.E.T., Tavanur

Tavanur,
31/5/97.

ACKNOWLEDGEMENT

Words are no substitute for thoughts and feelings. It is more so when we, the project team, wish to express our sincere thanks to our project guide, Er. Prince, M.V., Asst. Professor, Department of Post Harvest Technology and Agricultural Processing, K.C.A.E.T., Tavanur. Without his constant encouragement, timely advice, patience and readiness to spare and share his treasure of knowledge and experience, this project work would not have progressed to the stage of completion in time. It is with a deep sense of gratitude that we express out heartfelt thanks to him.

We express our sincere thanks to Dr. John Thomas, Dean, K.C.A.E.T., Tavanur, Prof. C.P. Mohammed, Head of Department of FPME, Er. Jippu Jacob, Associate Professor (FPME), Dr. V. Ganeshan, Associate Professor (PHT & AP) who extended their timely advice for the completion of this project.

We are immensely thankful to Sri. V.P. Kannan, Sri. T.P. Aboobaker, Sri. C.S. Krishnan (Rtd.), Mr. Narayanan, Technical Supervisors and our special thanks to Mr. Ranjan, Mr. James, Mr. Joy for helping us in this endeavour.

We express our sincere thanks to Er. Rajmohan, C.K., Er. Gigimon, T., Mr. Liju, K., Er. Bijukumar, K., Er. M.P. Jyothi, Mr. Pramod, A.P., Mr. N.D. Gawas, Mr. Dhalin, O. and to all our friends who have helped us in different stages of work.

On this occasion we remember with respect and gratitude, the blessings of all our teachers whose invaluable guidance and support have enabled us to have every thing at all reach of our life.

At this moment, we also extend our heartfelt gratitude to our parents for their help and encouragement.

Above all we bow our head before God Almighty for his blessings which enabled us to complete this work.

Felix John

Rajasree Madhavan

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LIST OF ABBREVIATIONS USED

Ac	-	Area of the circumscribed circle
Al	-	Aluminium
Ap	-	Projected area of the circle
Co	-	Company
EC	-	Effective Capacity
Fig	-	Figure
gm	-	Gram
hr	-	hour
ICAR	-	Indian Council of Agricultural Research
ISA	-	Indian Standard Angles
KAU	-	Kerala Agricultural University
KCAET	-	Kelappaji College of Agricultural Engineering and Technology
Kg	-	Kilogram
Kw	-	Kilowalt
mm	-	millimetre
MS	-	Mild Steel
OC	-	Overall Capacity
PVC	-	Poly Vinyl Chloride
rpm	-	revolution per minute
Rs.	-	Rupees
Sec	-	Second
Tec	-	Technology
TEFC	-	Totally Enclosed Fan Cooled
Wt	-	Weight
%	-	Percentage
	-	efficiency

Chapter I

INTRODUCTION

Food is the basic necessity of human beings for survival and health. Its production and processing have been the traditional occupation of the countrymen from time immemorial, as is evident from ancient mythological and historical literatures.

Fruits and vegetables play an important role in human diet and nutrition. They are indispensable sources of essential dietary nutrient vitamins and minerals besides providing crude fibre and bulk. They provide colour, flavour and variety to the otherwise monotenous diet. Due to high moisture contents (above 80%) they are highly perishable. Losses estimated at 40-50 per cent occur in many developing countries in tropical and subtropical regions due to inadequate post harvest technology. Therefore the thrust should be to process and convert such perishable commodities into stable products that can be stored for extended periods there by reducing losses and making them available in times of shortage and out of season and at places away from sites of production.

Processed foods/snack foods may be described as minimeals in between main meals, Snacks like banana chips are light to

eat and serve a variety of useful purposes in our day to day life. It encompass an indescribably vast variety of foods like banana chips, potato chips, wafers and so on. Major ingredients used by snack food industry include salt, spices, oils, flavour, colours, antioxidents etc. Their proximate composition vary depending upon the processes used. The moisture ranges from 2 to 35 per cent, fat 6 to 40 per cent, protein 6 to 40 per cent, ash 1 to 6 per cent and starch 5 to 48 per cent.

Manufacture and marketing of snack foods such as banana chips face quality problem due to moisture ingress, flavour loss, rancidity, discolouration, browning, infection and infestation which can be overcome by the use of optimum quality raw materials, correct process parameters and appropriate packaging materials and modes.

The number of units in small scale and unorganised sector engaged in the manufacture of snack foods far exceeds that in organised sector. The industry has not been yet developed into an organised sector since there has been very little development and application of our own technology an commercial scales to make products economically and market them on large scale.

To promote exports we need to focus on traditional Indian products with excellent keeping qualities, develop process

technology to manufacture these on commercial scale and pack these to appeal to overseas buyers.

Banana chips making has now grown into a small scale industry in Kerala and the product is in high demand in India as well as abroad, especially in Gulf countries. There is a great scope for further development of this industry by modifying the product quality.

Ripe and unripe banana (Kadali) is a delicate and highly perishable fruit of tropics, and has probably originated in the Assam-Burma-Indo China region. It is one of the most important commercial fruit and occupies the first place amongst the fresh fruit and vegetables trade in the world.

Banana (Musa paradisiaca) cultivation is distributed throughout the warmer countries between 30° South and 30° North of the equator. In world production of fruits, banana is second to grapes and is one of the biggest single items in the international fruit trade. The greatest acreage of banana is in Africa.

India ranks third in banana production in the world. it is estimated of being 5.79 Million tonnes from an area of 0.33 Million hectares against the world production of about 23 million tonnes.

Among the Indian states, Kerala has the largest area under banana cultivation. But its productivity is low. Gujarat stands first in productivity followed by Karnataka. The area and production of banana in India is shown in Table 1.1.

Though Kerala has the largest area under Banana cultivation the productivity is low. The Nendran variety grown on a commercial scale under better management is the only medium yielder. Area and production of Nendran and other varieties in different districts of Kerala are shown in Table 1.2.

Though banana (Nendran variety) is the most popular and widely accepted fruit, the unripe banana of proper maturity is widely used for making chips. Banana wafers is a popular snack food and liked in South India especially in Kerala. It has good internal as well as external demand. The wafers can be prepared throughout the year since banana is available at cheap price all throughout the year. Nendran which is leading in the commercial chip preparation involves mainly four unit operations such as peeling, slicing to small wafers, frying and packaging. Each of these unit operations are done manually in small house hold sectors. Banana chips making had not emerged as a large scale industry though it has a large

Table 1.1 Area and production of banana in India (1982-83)

States	Area ('000 ha)	Production ('000 tonnes)	Yield/ha (in tonnes)
Andhra Pradesh	23.20	389.50	16.79
Arunachal Pradesh	0.50	1.40	2.80
Assam	25.35	320.18	12.63
Bihar	21.84	436.80	20.00
Gujarat	21.40	536.00	25.05
Karnataka	40.63	1015.75	25.00
Kerala	51.87	393.47	7.58
Maharashtra	45.00	1032.00	22.93
Madhya Pradesh	12.30	217.00	17.64
Manipur	1.00	16.70	16.70
Mizoram	0.80	1.20	1.50
Meghalaya	4.00	50.00	12.50
Orissa	18.10	180.50	9.97
Tripura	3.48	24.00	6.89
Tamil Nadu	47.28	1040.33	22.00
Uttar Pradesh	0.60	4.30	8.00
West Bengal	14.00	120.00	8.57
Andaman	0.80	7.00	8.75
Total	332.15	5786.63	17.42

Table 1.2 Area and production of banana and other plantain in different districts of Kerala

Districts	Area (ha)		Production (tonnes)	
	Nendran	Others	Nendran	Others
Thiruvananthapuram	808	5249	9623	19997
Kollam	1406	2479	16715	11093
Pathanamthitta	959	1919	12828	8188
Alapuzha	646	1542	9651	4713
Kottayam	1690	321	29085	16355
Idukki	275	2377	3708	9596
Ernakulam	2130	3340	26851	17083
Trichur	1327	3853	16017	8469
Palakkad	1574	2409	20349	11566
Malappuram	2586	2359	29967	7054
Kozhikode	1083	2746	14484	10238
Wynad	566	12006	8142	6418
Kannur	1188	2240	14938	8693
Kasaragod	262	1562	3338	6062
Total	16600	36502	215696	145430

market potential because of the lack of appropriate mechanical systems for peeling and slicing.

Chipping the well matured unripe green banana is the most difficult and time consuming unit operation in the preparation of banana chips. Chipping is carried out to reduce the size of product so as to enable it to suit the processing and consumer requirements. A preliminary survey in the areas of intensive chips making revealed that commercial scale chipping of banana is carried out manually using stainless steel adjustable wooden platform hand slicer or by stainless steel knives.

This conventional method poses danger to operators finger by inflicting injury, especially while slicing the fag-tail end of the fruit. Frying quality of chips depends greatly on the uniformity of the wafers. The existing conventional method does not produce chips of uniform size. The efficiency of the system is less, the process is time consuming and labour intensive.

In order to eliminate the drudgery involved in manual chipping, avoid injury to workers, increase efficiency, maintain high quality standards and hygiene to the prepared chips, an attempt was undertaken at Kelappaji College of

Agricultural Engineering and Technology, Tavanur with following objectives.

1. To develop a mechanical banana chipper.

2. To evaluate the performance of the machine.

3. To compare the performances of the machine with manual chipping.

Chapter II

REVIEW OF LITERATURE

2.1 Agronomical characteristics

Banana is strictly a tropical plant. It grows and crops luxuriantly in the warm, humid and rainy climate of tropical regions on both sides of the equator. Heavy rain fall and constant high temperature are ideal for banana cultivation. The only regions in India where the climate can be called excellent for growing of banana are Kerala, parts of Tamil Nadu, Maharashtra and West Bengal. It also flourishes throughout Bihar, parts of South India and Assam.

Banana requires a rich, free working, soft, deep and retentive soil containing plenty of organic matter. All important agricultural soils of India are suitable for growing banana provided they are sufficiently deep and well drained with uniform crumb structure. The land should be deeply ploughed, harrowed and levelled and pits of half cubic meters should be dug at required distance for planting the crop. The distance of planting varies according to the height and spread of variety and growth conditions. The beginning of south west monsoon in June is the best time for planting banana in most parts of western and northern India.

Cultivated forms of banana is propagated vegetatively from their suckers. The plant matures its fruit from 12 to 18 months after planting depending upon the variety and dies soon after harvest. Under favourable conditions the plant starts flowering in 9 to 12 months after planting and takes 3-4 months to mature its fruit. The fruit ripens best if picked green at full maturity.

2.2 Varieties

There are about 60 varieties of banana grown in India, but only a dozen of these are of commercial importance. Other varieties are grown in small areas and are consumed by growers themselves or are disposed off in local markets. Reported by Aravindakshan *et al.* (1996) the cultivated forms can be divided into two main groups, namely

1. Edible when raw - musa paradisiaca var sapientum and Musa nana

2. Plantains or cooking bananas - Musa paradisiaca

Some important commercial varieties of banana are,

Poovan of South India
Basari dwarf of Maharashtra
Harichal or Bombay green

Rasthali of South India

Lal kel or Red banana

Hill bananas

Tella chakkrakeli of South India

Nendrans of South India

Monthan of South India

2.3 Food value

Banana is of great nutritional value. It has a rare combination of energy value, tissue building elements, proteins vitamins and minerals. It is a good source of calorie being richer in solids and lower in water content than any other fresh fruit. A large banana supplies more than 100 calorie. It contains a large amount of easily assimilable sugar, making it a good source of quick energy and an excellent means of recovery from fatigue. The food value of raw banana per 100 g edible portion as reported by V.H. Potty *et al.* is represented in table.

Table 2.1 Food value (per 100 g edible portion)

Moisture	- 70.1%
Protein	- 1.2%
FAt	- 0.3%
Minerals	- 0.8%
Fibre	- 0.4%
Carbo hydrates	- 27.2%
Calcium	- 17 mg
Phosphorus	- 36 mg
Iron	- 0.9 mg
Vitamin C	- 7 mg
Calorific value	- 116

Law banana contains mostly starch which is converted to sugar during ripening. The changes in carbo hydrates during ripening is represented in the table as reported by Jacob (1952)

Table 2.2 Carbohydrate change during ripening

Stage	Total carb (%)	Soluble carb (%)	Insoluble carb (%)
Green	25.56	1.30	25.26
Ripe	19.00	17.02	1.98

2.4 Nendrans of South India

Nendrans are bananas of moist tropical sea coast. It is the most important variety grown in Kerala from time immemorial. There are many types in Nendran namely, Attu Nendran, Nana Nendran, Thiruvodan, Nedu Nendran, Chengazhikodan, Kudiravali, Valethan, Kelethan and Myndoli. It is known as plantain in most parts of the world.

Nendran fruit is large, being about 9 to 10 inches long with thick skin representing the biggest sized edible fruit in banana. The fruits are loosely packed in bunch, lind is thick, flesh is firm and starchy. The fruit has fairly good keeping quality and can be used for both culinary purposes and as dessert.

Jacob (1952) reported a lower moisture content for dual purpose Nendran variety compared to other varieties represented in table.

Table 2.3

	Nendran (%)	Other varieties (%)
Moisture content	64.20	73.75 - 78.16
Reducing sugars	23.00	10.02 - 19.76
Non-reducing sugars	2.52	0.20 - 5.02
Acid	0.41	1.00 - 1.22

Nendran contains the greatest amount of sugars and much less acid content compared to other varieties. Many delicious products can be prepared from ripe as well as unripe Nendran. Some of these products, their uses and methods of preparation are described below.

Banana Fig

It is prepared out of all Nendran varieties. Preparation involved throughly ripening their skin until their skin gets blackened. They are then peeled, spread on bamboo mats and exposed to sun for 7 days on high platforms. The dried fruits make a delicious sweet meal or they may be made into jam.

Ripe fruits

Ripe fruits of Nendran are consumed after steaming or frying in oils. The 'halwa' made out of Nendran is a great delicacy. The ripe fruits are peeled, cut into chunks or split into two longitudinal halves and fried in oil.

Banana flour

Banana flour also known as banana meal is made from fully mature, unripe bananas. The unripe green fruits are dipped in scalding water for five minutes to enable easy peeling of green skin. The peeled fruits are then split into halves and dried. When the moisture is reduced to 15 per cent or less,

the dried fruit is ground and run through sieves of 120 mesh to the inch.

It is rich in carbohydrate and minerals and more easily digestible than any cereal starch. The flour is utilized as food for children.

Banana chips

Banana chips is a delicious product which has international acceptance. This is made by cutting the unripe fruit into thin wafers and frying in oil. They keep well for 2-3 months without deterioration in quality. The four main unit operations in the preparation of banana chips are:

Peeling of fruit
Cutting the fruit into slices
Frying the wafers
Packaging

Peeling

Peeling is the first unit operation to be carried out for processing of banana. It involves the removal of outer skin of the fruit when raw. In India, peeling is performed manually with a stainless steel scouring knife. There is every chance of loss of flesh if peeling is not done accurately. Thus it should be performed carefully.

Chipping

Chipping or slicing of banana into thin wafers of about 1.0 to 1.5 mm thick is one of the important unit operations. The quality of chips depend upon the size and uniformity of the wafers. Crispness of product is one of the textural characteristics which determines the consumer acceptance of the product (Krishnankutty *et al.*, 1981). Crispness can be controlled by maintaining uniformity of chip thickness and proper frying.

Frying

After slicing, frying of the cut wafers is performed to produce the banana chips. Frying is done by heating coconut oil in frying pan and putting the cut wafers and cooking until required texture is attained. Quality of the wafers depends upon the time, quality of oil used, temperature of oil as well as flame used. Crispness depends on the quality of frying.

Packaging and storage

Until recently, the objective of packaging of food stuffs in India was to protect against spoilage, spillage and evaporation. It is now increasingly recognised that packaging can be effective marketing tool and can add substantial value

to the product through extended shelf life or in other ways. New forms of packaging are gradually introduced in the market.

Banana wafers can remain unaffected for 2-3 months if proper packaging and storage standards are adopted. These are usually packed in transparent air tight polythene bags. This does not possess much consumer acceptance but maintain the desired qualities such as crispness, texture etc.

2.5 Traditional Methods of Chipping Banana

The most widely practised method of chipping banana in the country as reported by Krishnanakutty 1981 is by means of stainless steel knives sharpened to produce thin wafers when cut manually.

A few enterpreneurs use a platform type manual slicer holding 3-4 bananas at a time in between the fingers and moving across the sharp edge of the slicer.

2.6 Works on Mechanical Chipping

Nanada (1981) Central Tuber Crop Research Institute, developed a hand operated vertical feed cassava chipping machine which consists of two concentric mild steel drums, the annual space between which is divided into compartments for

feeding the tubers. The rotating disc at the bottom of from carries 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 output as well as operational convenience.

The pedal operated chipping machine consists of a feeder assembly with two concentric mild steel cylinders. It has partition walls in annular walls to form feed compartments, a cutting disc with blades which is driven with a driven shaft and pulley. The capacity of the machine is 768 kg/hr with chip thickness of 6.2 mm. The cost of operation per hour is Rs.18.80.

Balasubramanian *et al.* (1993) developed a motorized cassava chipper and tested at Tamil Nadu Agricultural University. The machine consisted of a chipping disc with knives driven by a disc shaft from a power source. The tubers can be vertically fed from the top and chips are collected at the bottom. The capacity of chipper is 270 kg/h. The chip recovery was assessed at 92 per cent for 1 mm chips at 295 rpm. The cost of chipping was estimated at Rs.18/ton.

An electrically operated rotary slicer for raw banana was designed, fabricated and evaluated at Central Institute of Agricultural Engineering, Bhopal by Kachru *et al.* (1996).

The horizontal type peeling machine consists of a slicer disc attached with blades at 120° apart. A mild steel shaft is used to drive the slicing disc. A stainless steel semi-circular feeding chute is used for feeding the peeled banana and chips are directly discharged into the pan by centrifugal action.

Chapter III

MATERIALS AND METHODS

The banana chipper developed is a vertical feed type motorised unit. The fabrication procedure of chipper, test procedure adopted for performance evaluation are described in this chapter.

3.1 General layout and details of the machine

The machine consists of the following units.

Frame assembly

Power source

Chipping disc with blades

Disc shaft

Feeding cylinders and attachments

Chip outlet

3.1.1 Frame assembly

The main frame assembly was fabricated of ISA 25x25x3 MS section and a motor frame of ISA 35x35x5 MS section. In this frame assembly, other subassemblies like bearing mountings, feeding cylinders and outlet were mounted.

3.1.2 Power source

A 3-phase, 440 V, 50 hertz, 1370 rpm, TEFC motor rated at 0.5 HP was used as prime mover. Motor was mounted inside the frame assembly by nuts and bolts. The drive was transmitted through a V-belt pulley with 6 times speed reduction so as to obtain 200 rpm at the chipping disc. The motor weight provided stability to machine.

3.1.3 Chipping disc and blades

A chipping disc of 300 mm diameter and 5 mm thickness was cut out from M.S. sheet and was machined properly to make it smooth. Four holes of 42 mm diameter were drilled in it at 90° apart as shown in figure 4. Blades of different widths and profiles with 2.5° bevel angle were attached using nuts and bolts along these holes with proper clearance to permit easy flow of chips to the outlet washers of different thicknesses were used for adjusting the clearance between slot and blade to vary the thickness of chips.

3.1.4 Disc shaft

A mild steel shaft of 25 mm diameter and 610 mm length was mounted vertically on two bearings. Top end of the shaft was connected using a sleave and nut to the chipping disc. At

the bottom end, drive was transmitted to the shaft through a V-belt pulley of 600 mm diameter.

3.1.5 Feeding cylinders with pushing mechanism

Four PVC cylinders of 50 mm diameter and 250 mm length was used to feed the raw bananas for efficient cutting. All the cylinders were fastened to the main frame by means of clamps and screws. In order to facilitate a uniform feeding of raw peeled banana to the slicing disc, an attachment was fabricated which consists of four M.S rods of 5.0 mm diameter each welded on to a disc 90° apart. Round M.S sheets of diameter 40 mm was welded to the other end of the rods.

3.1.6 Chip outlet

The sliced raw bananas were collected at the outlet. The outlet chute was made of 24 gauge Al. sheet. To facilitate easy discharge of chips, the chute was made at 45° inclination towards the horizontal.

3.2 Performance evaluation

Raw green bananas of proper maturity bought from the local market was used for conducting the experiment. The bananas were peeled manually using a sharp knife. The machine was then turned on. As the chipping disc attained a set speed

of 200 rpm, peeled raw bananas were fed into the cylinder, and uniformly pressed with the pressing mechanism over it. The time taken for chipping these bananaswere noted. The operating capacity, roundness of chips and chipping efficiency of the chipper was then evaluated.

3.2.1 Operating capacity

The operating capacity of the fabricated chipper was calculated by weighing all the cut slices irrespective of damage per unit time.

3.2.2 Efficiency of chipper

The efficiency of chipper was evaluated by weighing the damaged and round slices separately and using the expression.

$$= \frac{\text{Wt. of all slices - Wt. of damaged slices}}{\text{Wt. of all slices}} \times 100$$

3.2.3 Effective capacity

After having noted the efficiency and overall capacity of the machine, the effective capacity can be found out by the expression.

$$EC = OC \times \eta / 100$$

3.2.4 Roundness of chips

Randomly selected slices from each of the above experiment was used to asses the roundness of the slices. The profiles of these chips were drawn on a graph paper and these projected area (Ap) was calculated. A circumscribing circle was drawn for each of these profiles touching maximum possible edges of the profile. Area of circumscribed circle (Ac) was calculated for each of these profiles. The roundness was then calculated using the expression.

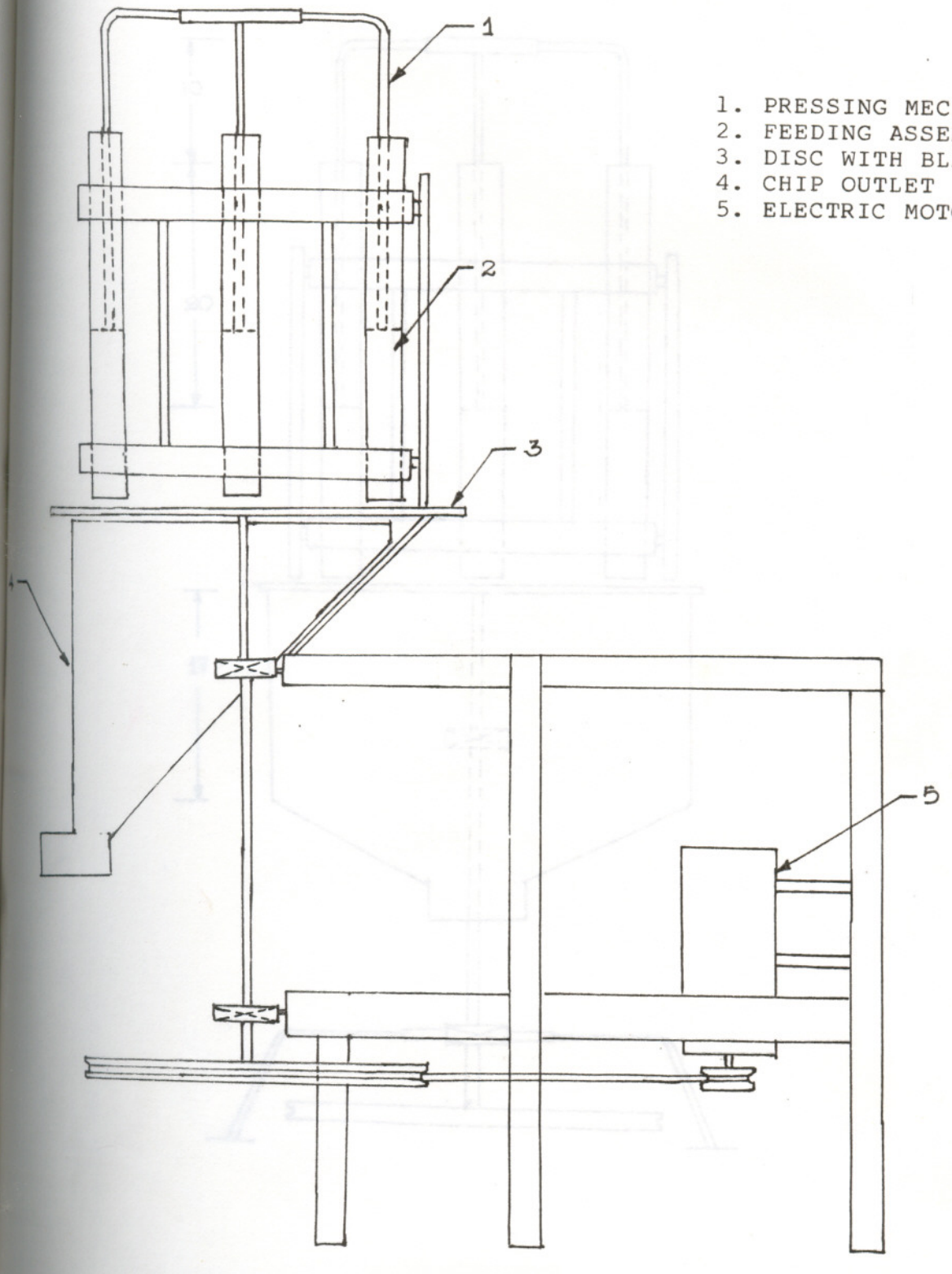
Roundness = Ap/Ac

The experiment was repeated for two different blade configurations such as flat wide and flat slender with four different throttle clearance (chip thickness) such as 0.5 mm, 1 mm, 1.5 mm and 2.0 mm. Specifications of blades are given in appendix I.

3.3 Comparative Evaluation of Mechanical and Manual Chipping Methods

The performance of the fabricated chipper was evaluated in terms of operating capacity, Chipping efficiency and roundness of chips attained. The performance was then compared with that of manual chipping for which peeled raw bananas were sliced using conventional stainless steel hand

slicer by holding three bananas at a time in between the fingers and moving across the sharp edge of the slicer. The time required to chip these three bananas were noted. The chipping efficiency and operating capacity were found out adopting the same procedure. The results of comparison are presented in the following chapter.



1. PRESSING MECHANISM
2. FEEDING ASSEMBLY
3. DISC WITH BLADE ATTACHMENT
4. CHIP OUTLET
5. ELECTRIC MOTOR

FIG. 3.1 DETAILS OF BANANA CHIPPER

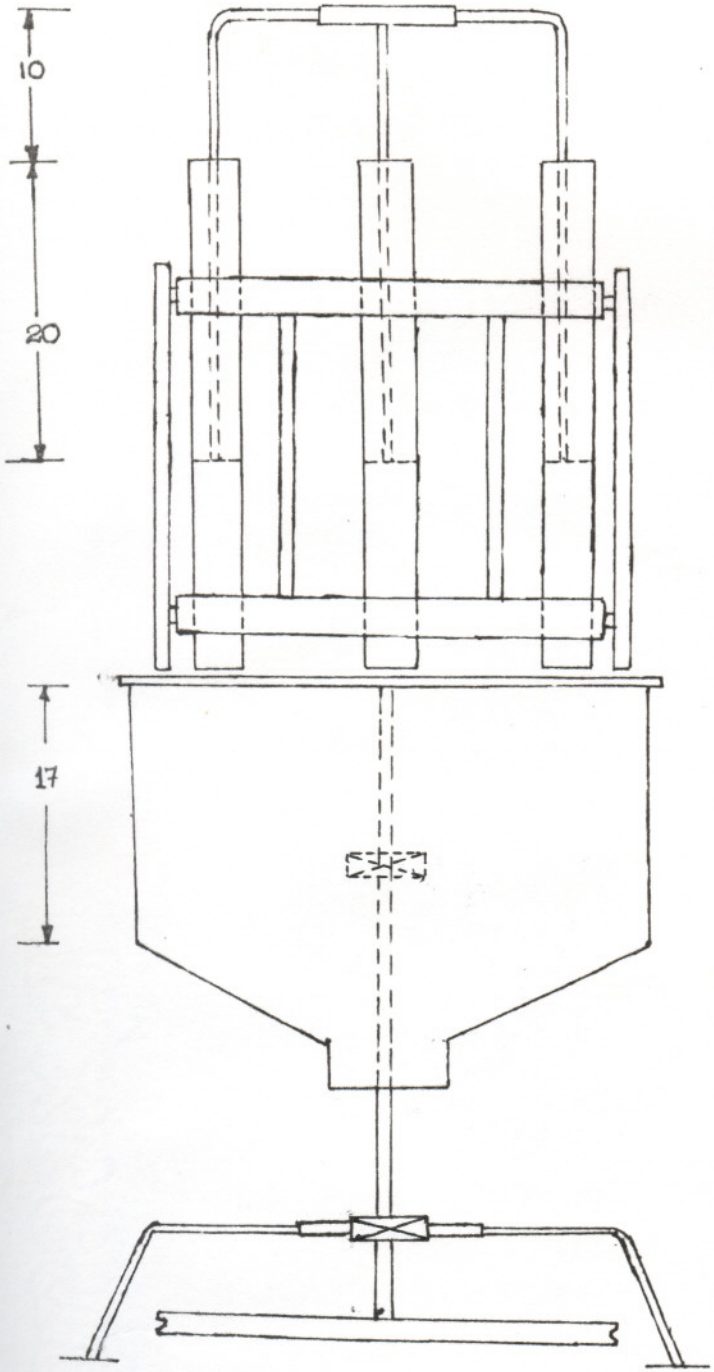


FIG. 3.2 SIDE VIEW OF BANANA CHIPPER

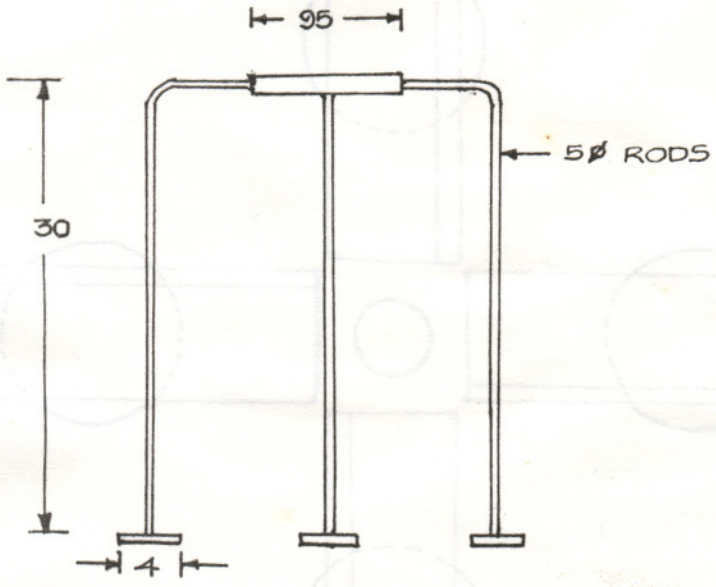


FIG. 3.3 PRESSING MECHANISM

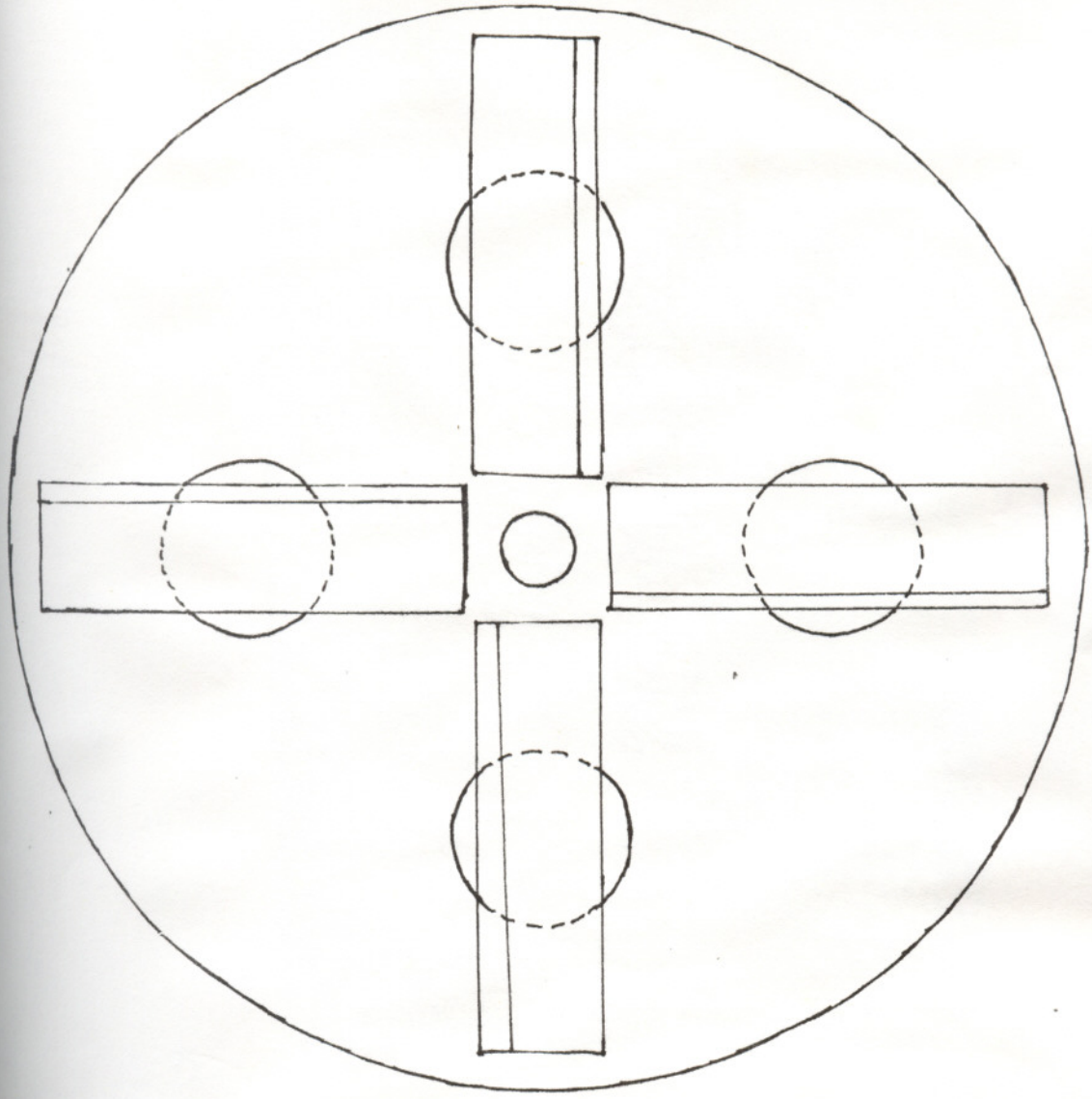


FIG. 3.4 ROTATING DISC WITH BLADE ATTACHMENT

Chapter IV

RESULTS AND DISCUSSION

This chapter deals with the results of experiments conducted to evaluate the performance of the chipper and its comparative performance with manual chipping.

4.1 Test details

The study was conducted with two different sets of blades at a disc speed of 200 rpm. The specifications of each of these blades are given in Appendix. the throttle clearance (thickness of chips) was varied using washers of different thicknesses. The thickness of washers used were 1.0 mm, 1.5 mm and 2.0 mm.

4.2 Performance evaluation

The experimental model was evaluated for its overall capacity, chipping efficiency and roundness of slices. The results are furnished in the following tables.

Table 4.1a. Overall capacity of chipping machine with different blades and throttle clearance

Blade type	Throttle clearance (mm)	Time (Sec)	Wt. of slices (gm)	Overall capacity (kg/hr)
Wide	0.5	18.00	487.00	97.40
	1.0	7.20	479.32	240.00
	1.5	6.40	631.68	355.00
	2.0	6.10	670.72	395.83
Narrow	0.5	20.5	520.92	91.41
	1.0	8.32	539.28	233.34
	1.5	7.96	640.92	289.86
	2.0	7.53	580.56	325.36

Referring to the test results the overall capacity of themachine is found to vary from 91.41 kg/h to 395.83 kg/h under different test conditions of the machine. The maximum overall capacity of 395.83 kg/h is obtained with wide blade when the disc blade gap is 2 mm.

Table 4.1b Chipping efficiency of the machine with different blades and throttle clearance

Blade type	Throttle clearance (mm)	Wt. of all (gm)	Wt. of damaged slices (gm)	Efficiency (%)
Wide	0.5	327.80	61.12	81.35
	1.0	386.04	39.84	89.67
	1.5	607.64	18.40	96.97
	2.0	600.52	17.16	97.14
Narrow	0.5	337.44	96.52	71.39
	1.0	466.96	86.92	81.38
	1.5	582.44	82.44	85.84
	2.0	650.96	88.52	86.40

The chipping efficiency of the machine varied between 71.39 per cent for different machine set up as depicted in Table 4.1b. Maximum chipping efficiency of 97.14 per cent is observed with wide blade having a disc blade gap of 2 mm.

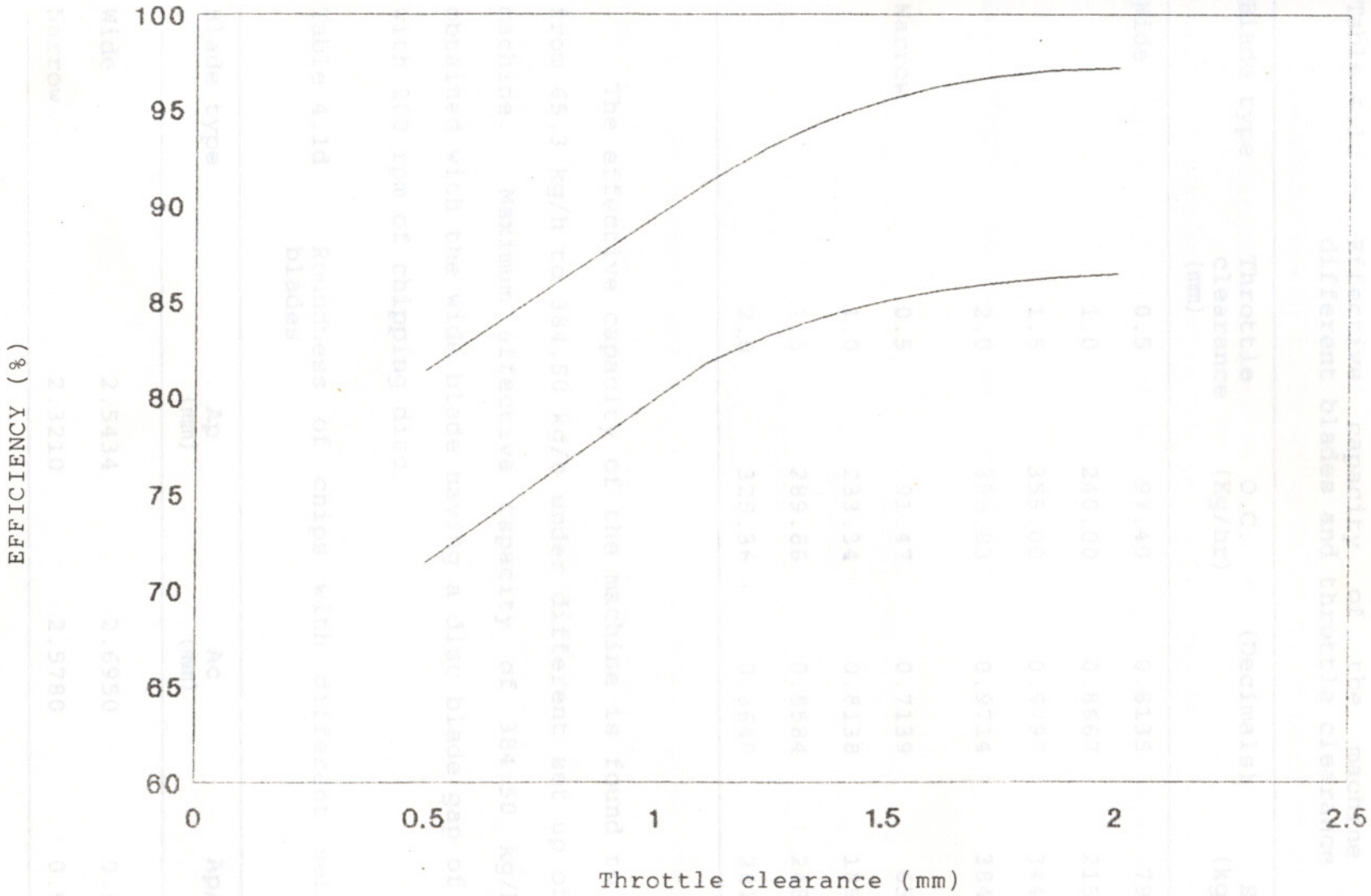


FIG. 4.1 : EFFICIENCY OF THE BANANA CHIPPER WITH DIFFERENT BLADES AND THROTTLE CLEARANCE.

Table 4.1c Effective capacity of the machine with different blades and throttle clearance

Blade type	Throttle clearance (mm)	O.C. (Kg/hr)	(Decimals)	E.C (kg/hr)
Wide	0.5	97.40	0.8135	79.23
	1.0	240.00	0.8667	215.20
	1.5	355.00	0.9797	344.24
	2.0	395.83	0.9714	384.50
Narrow	0.5	91.47	0.7139	65.30
	1.0	233.34	0.8138	189.89
	1.5	289.86	0.8584	248.81
	2.0	325.36	0.8640	281.11

The effective capacity of the machine is found to vary from 65.3 kg/h to 384.50 kg/h under different set up of the machine. Maximum effective capacity of 384.50 kg/h is obtained with the wide blade having a disc blade gap of 2 mm with 200 rpm of chipping disc.

Table 4.1d Roundness of chips with different sets of blades

Blade type	Ap (mm)	Ac (mm)	Ap/Ac
Wide	2.5434	2.6950	0.94
Narrow	2.3210	2.5780	0.90

The roundness of chips using different sets of blades and different throttle clearance were recorded. The average values of roundness with the two different sets of blades is presented in the table. The roundness is found to vary between 0.90 to 0.94.

4.3 Time loss between feedings

The effective capacity obtained was noted by taking the time required to slice four bananas at a time for different sets of blades and different throttle clearance. But when the machine is operated continuously for hours together some time is lost in between the successive feedings. As an average, the time required for a labourer to feed 1 kg of banana is 10 sec. So, the actual effective capacity for chipping differs from that already obtained. The actual effective capacity is represented in table.

Table 4.2 Actual effective capacity of the chipping machine with different blades and throttle clearance

Blade type	E.C (Kg/hr)	Actual EC (Kg/hr)
Wide	79.23	64.94
	215.20	134.60
	344.24	175.63
	284.50	185.75
Narrow	65.30	55.34
	189.89	124.11
	248.81	146.36
	281.11	157.93

Assuming a time gap of 10 s/kg between successive feeding, the actual effective capacity of the chipper is found to vary between 55.34 kg/h to 185.75 kg/h for different sets of blades and different throttle clearance for a chipping speed of 200 rpm. Maximum capacity obtained is 185.75 kg/h with a wide blade for a 2 mm throttle clearance.

The wide blade has performed well than narrow blade in terms of capacity and efficiency. This may be due to the increased support which the cutting chips receive while getting cut when compared to narrow blades. When the support area increases the chances of chips getting broken or sheared

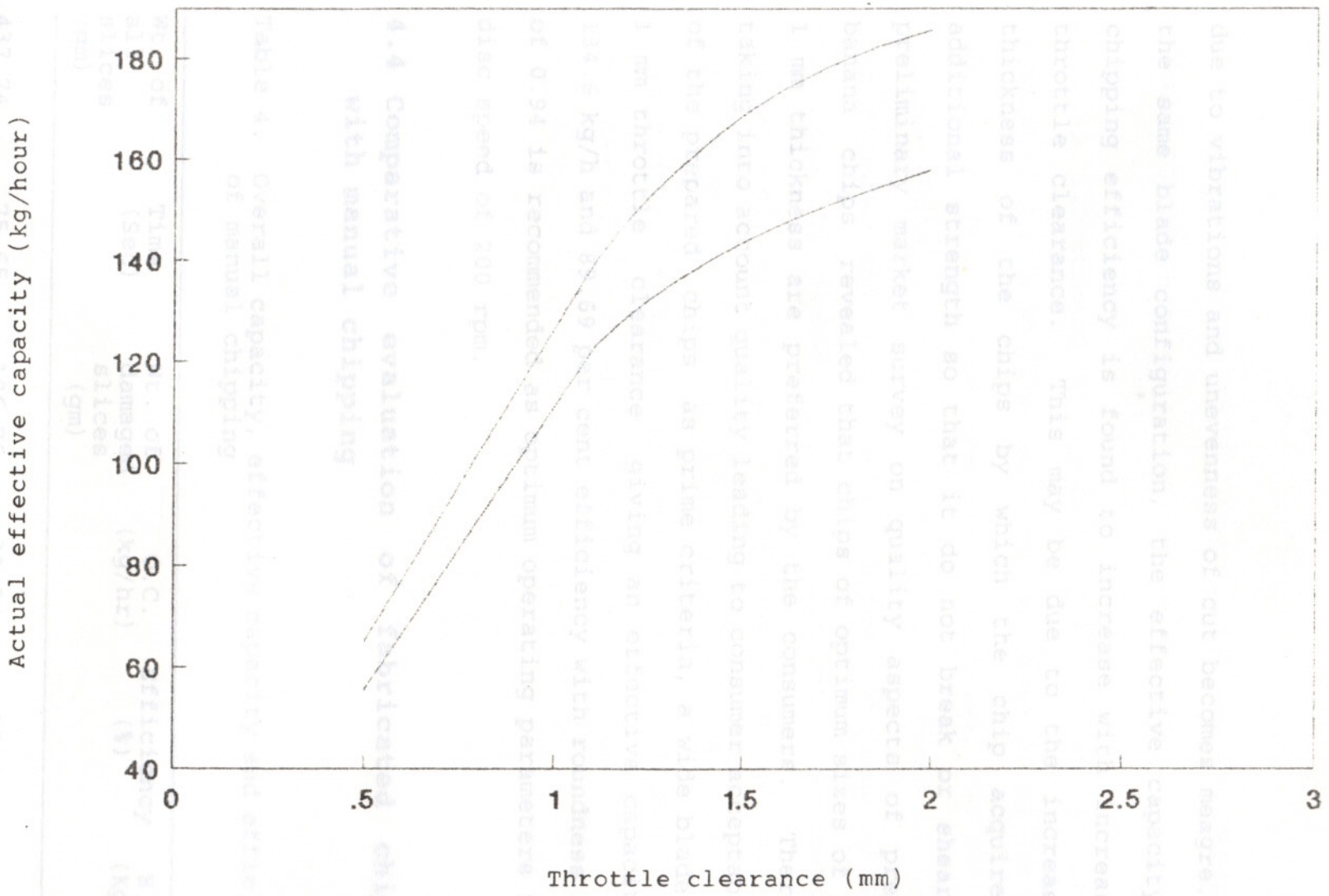


FIG. 4.2 : ACTUAL EFFECTIVE CAPACITY OF THE BANANA CHIPPER WITH DIFFERENT BLADES AND THROTTLE CLEARANCE.

due to vibrations and unevenness of cut becomes meagre. For the same blade configuration, the effective capacity and chipping efficiency is found to increase with increase in throttle clearance. This may be due to the increase in thickness of the chips by which the chip acquires an additional strength so that it do not break or shear. A preliminary market survey on quality aspects of prepared banana chips revealed that chips of optimum sizes of about 1 mm thickness are preferred by the consumers. Therefore taking into account quality leading to consumer acceptability of the prepared chips as prime criteria, a wide blade with 1 mm throttle clearance giving an effective capacity of 134.6 kg/h and 89.69 per cent efficiency with roundness index of 0.94 is recommended as optimum operating parameters for a disc speed of 200 rpm.

4.4 Comparative evaluation of fabricated chipper with manual chipping

Table 4. Overall capacity, effective capacity and efficiency of manual chipping

Wt. of all slices (gm)	Time (Sec)	Wt. of damaged slices (gm)	O.C. (kg/hr)	Efficiency (%)	E.C. (Kg/hr)
437.74	75.65	106.76	20.83	75.6	15.74

Assuming a time lag of 10 sec in between the feeding the actual effective capacity reduces to 15 kg/h.

As illustrated in table results of manual chipping indicates that a skilled labourer can slice 15 kg raw peeled banana per hour. Under the same conditions, the fabricated chipper could slice 134.6 kg/h at a disc speed of 200 rpm. The capacity and efficiency of chipper is found to be more than that of manual chipping. Besides, with mechanical chipper the thickness of slices may be varied as per the requirement. Also even the tail end of the banana can be sliced easily which is difficult in manual chipping because this may inflict injury to the operators finger.

Chapter V

SUMMARY AND CONCLUSION

Banana chips making has grown into a small scale industry in Kerala and the product is acquiring high demand in India as well as abroad. There is a great scope for further development of this industry by modifying the product quality.

The conventional method of chipping raw banana is manual slicing using conventional knife or using stainless steel adjustable wooden platform hand slicer by holding three bananas at a time in between fingers and moving across the sharp edge of slicer. These methods are cumbersome, labour intensive, time consuming and inflict injury to hand. As per the new technique, a motorised raw banana chipper was developed. This machine has capacity to slice 134 kg raw banana per hour. The machine essentially consists of a prime mover, feeding cylinders and attachments, chipping discs with blades and chip outlet. In operation, power from motor is taken to the disc shaft through a V-belt pulley. The disc shaft connected to a chipping disc attached with blades is rotated. Raw peeled bananas fed through the feeding cylinders are cut during the rotation of the disc. The cut chips are then collected at the chute outlet.

Experimental trials were conducted at Kelappaji College of Agricultural Engineering and Technology, Tavanur to evaluate the performance of the banana chipper. The experiments were conducted using two different sets of blades and varying the throttle clearance at a set speed of 200 rpm. The different throttle clearance yields chips of different thickness. The results indicated that besides being more efficient and higher in capacity, the fabricated chipper has more advantages over manual chipping. It was analysed that a wide blade giving 1 mm chip thickness performed well in terms of efficiency, operating capacity and product quality. It had a capacity to produce 134 kg of raw banana slices per hour.

From the experimental results, it is obvious that the newly developed machine is technically and economically suitable for small scale industries.

Suggestions

1. We can improve the performance of the chipping machine by finding out the optimum speed for cutting.

2. Machine performance can be tested for the curved profile of the blade.

3. Feeding mechanism can be made automatic to reduce the drudgery in manual feeding.

4. Chip outlet can be modified using slated chutes to reduce the surface area of contact.

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APPENDIX I

Specifications of blades used

Blade type	Bevel angle	Length (mm)	Width (mm)
Wide	2.5°	105	35
Narrow	2.5°	105	12

APPENDIX II

Specification of 3 phase Induction Motor

Ampere	:	1.2
Volt	:	4.5
Cycles	:	50 Hz
KW	:	0.37
rpm	:	1370

Made by Kirloskar Electric Co. Ltd., Bangalore

APPENDIX III

Specification of energy meter

Ampere	:	3x10'
Volt	:	4x400
Cycle	:	50 Hz
1 KW-h	:	112.5 revolution of disc made by General Electric Co. India (Pvt. Ltd.) Calcutta

APPENDIX IV

Calculation of operating cost

Initial cost (C)

Fabrication cost of chipping machine including cost of material = Rs.2000/-

Initial cost of motor = Rs.3500/-

Average life of chipping machine = 10 years

Average life of motor = 20 years

Working hours per year = 2400

Salvage value = 10% of initial cost

For motor = 350/-

For machine = 200/-

A. Fixed cost

I. Depreciation = (C-S)/(LxH)

For chipping machine = (2000-200)/(10x2400)

= Rs.0.075/h

For motor = (3500-350)/(20x2400)

= Rs.0.066/h

II. Interest on investment at the rate of 15% = $\frac{(C+S)x15}{2xHx100}$

For machine $= \frac{(2000+200)\times 15}{2\times 2400\times 100}$

$= \mathbf{Rs.0.069/h}$

For motor $= \frac{(3500+350)\times 15}{2\times 2400\times 100}$

$=$ Rs.0.12/h

Total fixed cost $=$ Rs.0.075+0.066+0.069+0.12

$=$ Rs.0.33/h

Variable cost

(i) Labour wages

Wages of a labourer $=$ Rs.60.00/day of 8 h

For 2 labourers $=$ Rs.15.00/h

(ii) Cost of electrical energy

Unit cost of electricity $=$ Rs.1/KW-h

Energy consumption of machine $=$ 0.15 KW-h

Cost of electricity $=$ Rs.0.15/h

(iii) Repair and maintenance @ 10% of initial cost per annum

For machine $= \frac{2000\times 10\times 1}{100\times 2400}$

$=$ Rs.0.083/h

For motor $= \frac{3500 \times 10 \times 1}{100 \times 2400}$

$= Rs.0.15/h$

Total variable cost $= Rs.15+0.15+0.083+0.15$

$= Rs.15.383/h$

Total operating cost $= Rs.0.33/h + 15.383$

$= Rs.15.713/h$

DEVELOPMENT AND PERFORMANCE EVALUATION OF A BANANA CHIPPER

By

FELIX JOHN

RAJASREE MADHAVAN

ABSTRACT OF THE PROJECT REPORT

Submitted in partial fulfilment of the
requirement for the degree

Bachelor of Technology
in
Agricultural Engineering

Faculty of Agriculture
Kerala Agricultural University

Department of Post Harvest Technology and
Agricultural Processing
KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
TAVANUR - 679573, MALAPPURAM.

1997

ABSTRACT

In India, chipping of raw peeled banana is carried out manually and no means of mechanical chipping device had been commercialised till the present day. The conventional method of slicing using a platform type hand slicer has many draw backs. To overcome the defects of conventional method a new vertical feed mechanical chipper was developed at K.C.A.E.T. and the performance was evaluated. the machine consists of a chipping disc mounted with four blades and rotated at 200 rpm by a prime over. The peeled raw bananas were fed manually to feeding cylinders and are pushed gently from top by a pushing mechanism. By suitably adjusting the throttle clearance, chips of varying thickness and uniform sizes are collected at the discharge end. The chipping efficiency of machine is 90% with a capacity of slicing 134 kg peeled raw banana per hour. The machine can be suitably used to slice raw bananas, carrots, potatoes and commodities of such type. It can be economically and efficiently used by small scale industries.