DEVELOPMENT AND TESTING OF HAND OPERATED BRUSH TYPE GINGER PEELING MACHINE

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PROJECT REPORT

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DECLARATION

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

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9th December, 1994.

CERTIFICATE

Certified that this project report, entitled **"DEVELOPMENT AND TESTING OF A HAND OPERATED BRUSH TYPE GINGER PEELING MACHINE"** is a record of project work done jointly by **Mr. Jiji Emmanuel, Miss Sandhya, K.V. and Miss Sheeja J. Thaikkattil** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to them.

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SYMBOLS AND ABBREVIATIONS USED

Agrl.	-	Agricultural
cm	-	centimetre(s)
Co	-	Company
°C	-	degree celcius
Dept.	-	Department
Dia	-	diameter
et al.	-	and others
Fig.	-	Figure
GI	-	Galvanised Iron
G.L.C.	-	Gas Layer Chromatograph
gm	-	gram(s)
ha	-	hectare
hp	-	horse power
hr	-	hour(s)
i/c	-	in-charge
ICAR	-	Indian Council of Agricultural Research
i.e.	-	that is
IIT	-	Indian Institute of Technology
IS	-	Indian Standards
KCAET	-	Kelappaji College of Agricultural Engineering and Technology
kg	-	kilogram(s)
lb	-	pounds

m	-	metre(s)
min	-	minute(s)
m.c.	-	moisture content
ml	-	millilitre
mm	-	millimetre(s)
M.S.	-	Mild Steel
M.T.	-	Metric tonnes
No.	-	number
Publ.	-	publication
rpm	-	revolutions per minute
Rs.	-	rupees
sec.	-	seconds
US$	-	United States Dollars
Vol.	-	Volume
W.b.	-	Wet basis
&	-	and
%	-	percentage
"	-	inch(es)

INTRODUCTION

Agriculture is the source of perpetual creation on which civilization depends. It has a dominant role in the Indian economy. The success of Indian agriculture has been the envy of many developing countries. The increased production that has been realised during the recent past must be credited to a large extent to the increased use of high yielding varieties, irrigation facilities fertilizers, better crop management and also to the effective utilization of machines and implements in agriculture. Agriculture contributes nearly 34 per cent of the national income and provides employment to about 70 per cent of the working population in India.

Among the agricultural products, spices are the most important which accounts for sizable share of country's foreign exchange. Eventhough India is now advancing as an industrial nation and is slowly and steadily staking her claims to advanced technology, the world still looks upon India as the "Home of spices". The reason is not far to seek as the quality of the spices produced and exported from India has been and continues to be undisputedly on of the best.

In India spices were in use as a flavouring agent in food for the last 2500 years. It has made man's food more palatable and appealing more than anything else. Spices have been defined by the food and administration as aromatic or savory vegetable substance used to impart special taste or relish to food, or to serve as appetisers or seasoning agents.

The favourable climatic and soil conditions make our country a leading producer in spices like pepper, ginger, cardamom, chilli, turmeric and cloves. Pepper is the leading spice in international trade and is known as the 'King of Spices'. Cardamom the 'Queen of spices' comes in second position. Ginger has a prominent position next to pepper and cardamom.

With a production of 20 lakh tonnes of different spices India tops both in out put and export in the world. Spices exports during 1992-93 came down to 1.23 lakh tonnes from the previous year's all time high of 1.31 lakh tonnes. However, the earning was higher Rs.382.06 crores compared to 1991-92's Rs.362.04 crores. The export of different types of spices in 1992-93 is given in Appendix-I.

Ginger derived from the rhizomes of Zingiber officinale Rosc. which is a herbaceous perennial usually grown as an annual. It is a plant of very ancient cultivation and

the spice has long been used in Asia. It is used in medicine as a carminative and aromatic stimulant to the gastro-intestinal tract and externally as a rubefacient and counter irritant. It has a reputation as an aphrodisiac. It is widely used in medicine in India and far east.

The largest ginger producing country is India both in area and tonnage. The area under cultivation of ginger in India is about 0.56 lakh ha and the production is 1.6 lakh tonnes. This comes about 50 per cent of the world's total production. In 1992-93 India exported 8220 tonnes of ginger and earned Rs.15.70 crores. Kerala is the state which producers highest amount of ginger i.e. more than 50 per cent of the total production of ginger in India. In 1989-90 the area under cultivation of ginger in Kerala was 13830 ha and the production was 46390 metric tonnes.

The two type of Indian ginger entering the international market are Cochin and Calicut, named after the two major production areas on the Malabar coast of Kerala. The bulk of Indian exports are of rough scraped, whole rhizomes. Some times coated ginger in exported. However the main exporting form is dried ginger.

The main unit operations in the preparation of dried ginger are harvesting, cleaning peeling and drying. The

harvesting is clone at 8-9 months after planting. The moisture content at this time is about. The leaves at this time turns yellow and pseudostems begin to dry. Rhizomes are lifted with digging fork and cleaned of roots and adhering soil particles. Then it is peeled and dried. The drying may be sun drying which takes 7 to 8 days or may be mechanical drying using artificial dryers.

Peeling of ginger is one of the most important unit operation in the processing. Cleanly peeled dried ginger posses the best appearance and it is the only type acceptable for sale in the whole form by the grocery trade in the U.K. market. The skin constitute a barrier to evaporation or transportation of moisture from the rhizome. Thus peeling helps for proper drying and it also gives an attractive appearance to the final product. Peeling should be done with great care and skill. The essential oil which gives ginger the aromatic character is present in the epidermal cells and excessive and careless scraping will result in damaging these cells leading to the loss of essential oils. Since this oil is a prime factor in fixing the price of ginger, it's economic value will also reduce.

Usually in India peeling is done manually. Green ginger is soaked in water to facilitate the removal of the skin. The skin is scraped off with pieces of bamboo sharpened

at one end or bits of sea shells. Steel knives are not used as they are found to stain the produce.

The conventional method of manual peeling is highly labour intensive, time consuming and above all uneconomical. Peeling machines even for small scale are not available commercially and the machines developed so far are not fully successful in meeting the requirements of peeling.

As an attempt to overcome the problems associated with peeling of ginger a study was conducted at KCAET Tavanur with the following objectives.

1. To fabricate a hand operate brush type ginger peeling machine.

2. To study the performance of the machine with samples of different soaking time.

3. To finalise the optimum soaking time for the newly fabricated ginger peeling machine by estimating the volatile oil percentage from the peel and analysis of soaking water with solvent hexane.

REVIEW OF LITERATURE

A brief review of the general characteristics of ginger, it's origin, distribution, cultivars, harvesting and main products are given in this chapter. Also a review of the traditional and mechanical peeling methods of ginger are given.

2.1 General characteristics

Ginger, Zingiber officinate Rosc. is a monocotyledon, belonging to the family Zingiberaceae, grows well in areas of higher elevation upto 1500 m approximately and the optimum elevation is about 800-900 m. It is a slender perennial herb, usually grown as an annual, 30-100 cm tall, with a robust branched rhizome borne horizontally near the surface of the soil, bearing leafy shoots close together. In most areas of India, ginger is planted at the beginning of the south west monsoon i.e. April to May, occasionally until June, as a rain fed crop. Under irrigated conditions ginger may be planted at any time.

2.2 Origin and distribution

Ginger was one of the first oriental spices known in Europe, having been obtained by the Greeks and Romans from

Arab traders, who kept a secret of their origin of the spices is India.

India is the major ginger producing country in the world in 1991-92 the area under cultivation of ginger was about 0.56 lakhs ha and the yield was 156180 tonnes. This comes about 50 per cent of the world's total production of ginger. The area of cultivation and production of ginger in India are given in appendix II. In India the major ginger producing states are Kerala, Karnataka, Andhra Pradesh, Mizoram, Assam etc. The total area of cultivation and production of ginger in these and other states are given in appendix III.

Among the ginger producing states of India, Kerala produces the largest quantity of ginger. Guptha (1974) stated that Kerala accounts for over 60 per cent of the total cropped area and about 90 per cent of India's ginger export trade. In 1989-90 ginger was cultivated in 13830 ha and the yield was 46390 metric tonnes.

2.3 Varieties of ginger

Ginger is always propagated vegetatively and the number of clones are limited. Each centre of production tends to produce a distinctive type but this may be due to soil,

climatic and cultural differences as well as methods of preparation.

The major varieties of ginger in the world are Indian varieties, Jamaican varieties and West Malaysian varieties.

2.3.1 Indian varieties

The major Indian varieties are Maran, Nadia, Wynad Manantody, Kuruppam padi, Ernad, Thodupuzha etc. Indian varieties are usually more pungent and fibrous.

2.3.2 Jamaican varieties

Major ones are white or yellow ginger some times known as the turmeric ginger and Blue or flint ginger. These varieties are comparatively easy to peel completely and so it is the most valuable in international market.

2.3.3 West Malaysian varieties

They are haliya betal or true ginger, haliya bara or haliya padi and haliya udang.

Among the these varieties Indian varieties are most superior in pungency level and volatile oil content. Poulose (1973) gives the names of some of the commonly grown cultivars and the areas in which they are popularly cultivated as listed in appendix IV.

In Kerala, according to Natarajan et al. (1970) three cultivars of ginger are recognized. They are Kuruppam padi, Thodupuzha and Calicut or Wynad Manantody (Guptha, 1974). Furthermore, ginger from Malabar are divided into three quality groups i.e. Chernad, Ernad and Wynad. Kuruppam padi ginger is well dried and has more 'fingers'. It is considered to be one of the best and in very good demand for export.

2.4 Harvesting and yield

For the manufacture of preserved ginger, the rhizomes are harvested before they are fully mature about 7 months after planting, after which they become more fibrous and more pungent and are better suited to the production of dried ginger. early crop for the preparation of preserved ginger is pulled by hand and is stored in brine until required for processing. For the production of dried ginger harvesting is done 8-10 months after planting when the leaves begin to turn yellow and and the stems begin lodging. Aiyadurai (1966) states that in India results so far obtained have shown that the optimum time for harvesting ginger is 245-260 days after planting. If the rhizome remain too long in the field they become more fibrous and thus their market value reduces. In most countries, harvesting of the mature ginger is done by hand using a spade, hoe or digging fork. Care is required during harvesting to damage the rhizome as little as possible.

As mentioned above, the stage of maturity of the rhizome has a significant influence on it's quality characteristics and it's suitability for processing into preserved ginger or dried ginger. Maistre (1964) gives the yields on the south western coast of India as 9-11 tonnes per ha of green ginger which gives 1.3-1.8 tonnes of dried ginger per ha. In 'Wealth of India' (Anon. 1976) it is stated that the average yield of green rhizomes on a all India basis varies between 7 to tonnes per ha. The same source collected yield values reported by Kannan and Nair (1965) Thomas (1966) and Poulose (1970) on 20 cultivars of Indian and foreign ginger, but these and other cultivars were cultivated under controlled, pilot conditions at CHRS, Ambalavayal, Kerala. The results the study is given is given Appendix V.

2.5 Moisture content

Usually in the case of spices the M.C is determined by toluene distillation method. In this method 100 ml of toluene is added to a round bottom flask which contains 25 gm of ground sample and is attached to Dean stark apparatus with a reflux condenser. The flask is then heated with a heating mentle. The water vapour distilled from the flask is condensed and collected in the apparatus. The volume of water collected is coated and moisture content of sample is calculated by a formula

m.c. % (w.b) = V/W x 100

where

V = volume of water collected, ml

W = weight of sample taken, g

A moisture content of % (w.b) is obtained for the sample.

2.6 Composition of ginger

Indian standard Institution specification for ginger whole and ground require the ginger to be a rhizome of Zingiber Officinale Roscoe, in pieces of irregular in shape and size not less than 20 mm in length or in small cut piece, pale brown in colour and fibrous with peel not entirely removed, washed and dried in sun. The material may be garbled by removing pieces that are too light and it may also be ground to such a fineness that the whole of the material passes through is sieve 120.

A typical analysis of a market sample of green ginger gave the following values in %

Moisture	- 80.9
Protein	- 02.3
Carbohydrate	- 12.3
Fibre	- 02.4
Minerals	- 01.2

The principal minerals and vitamins in mg/100 g are as follows

Minerals		
Ca	-	20
P	-	6.0
Fe	-	02.6
Vitamins		
thiamin	-	0.06
riboflavin	-	0.08
niacin	-	0.06
ascorbic acid	-	6.00

In addition to starch, the dominant carbohydrate, the rhizome contains 7.6 per cent pentoses on a dry weight basis and small quantities of free sugars, glucose, fructose and sucrose.

Ginger contains 1.6 to 2.5 per cent nitrogen on dry weight basis of which monoterpene nitrogen is roughly one third. About 18.6 per cent of the protein remains unextracted. The extracted protein contains 35.6 per cent albumin, 16.9 per cent globuline, 11.0 per cent prolamine and 17.9 per cent glutelin, on total proteins.

The lipid content of the ginger varies greatly among varieties of ginger, from 5.8 per cent to 11.0 per cent, but is generally around 7 per cent.

2.7 Products

Following are the main products of ginger.

2.7.1 Fresh ginger

Fresh ginger, consumed as a vegetable is harvested both mature and immature. This is of lesser importance in international trade but is the main form in which ginger is consumed in producing areas.

2.7.2 Preserved ginger in syrup or brine

This is one of the main form in which ginger is internationally traded. The main industrial use of syruped ginger is in the manufacture of marmalade and jam, sauces etc.

2.7.3 Dried ginger

Dried ginger is prepared usually in the following 3 forms.

2.7.3.1 Coated ginger

The ginger is dried with the skin whole or partly scraped.

2.7.3.2 Uncoated ginger

Skin completely peeled and dried to provide a light colour smooth looking product.

2.7.3.3 Bleached ginger

Coated with lime, with or without skin and dried (Guenther, 1975).

For the preparation of dried ginger the procedure followed is described below. Soon after harvest the rhizomes are trimmed to remove roots and are washed to remove the adhering earth, they are then spread on cemented yards to dry. The layers are turned occasionally and heaped into lots in every evening. The drying is continued for 7 to 10 days depending on weather conditions.

2.7.4 Ginger oleoresin

Ginger oleoresin is obtained by extraction of powdered, dried ginger with solvents such as ethanol, aceton and trichloroethane etc. It is a dark brown viscous liquid, with a volatile oil content which can vary from 15 to 35 per cent. Well dried ginger is ground or pulvarized to a coarse powder about 30 to 40 mesh and is extracted with a selected solvent. Fractions of extract, containing not less than 10 per cent soluble solvents, are drawn and distilled under reduced pressure. One of the critical steps in the processing is the removal of last trace of solvent so that the product conforms to regulation like ISI, Food and Drug Administration, USA, etc. The maximum solvent residues allowed in ppm are 30

for aceton and all chlorinated solvents, 50 for methanol and isopropyl alcohol and 25 for hexane. Clevenge (1928) found that the yield of oleoresin was 3.5-7.1 per cent containing 34-42 per cent of volatile oil.

2.7.5 Ginger oil

Ginger oil is distilled from the dried spice. This product possesses the aroma and flavour of the spice but lacks the pungency. It is a pale yellow to light amber mobile liquid whose viscosity increases on aging or exposure to air. The major constituents identified in the ginger oil is given in appendix VI.

2.8 Importance of peeling

Natarajan et al. (1970) stated that peeling of ginger is necessary to reduce the time of drying. Unpeeled ginger took 40 to 50 hrs to dry whereas peeled ginger took only 18-20 hrs. Peeling not only reduces the drying time but also it gives a more attractive appearance to the final product. The peel acts as a barrier for removing the moisture from the rhizome. The extend of cleaning the rhizome prior to drying has a considerable influence on the volatile oil and fibre content of the end product. The removal of cork skin not only reduces the fibre content but also enhances the volatile oil losses through the rupture of the oil cells which are near the

skin. Shankarikutty et al. (1982) reported that the peel of ginger contain 0.8 per cent volatile oil whereas rhizome contains 1.9 per cent. Elsdon and Mayne (1937) have suggested that the peeling might also influence the pungency level somewhat as their studies indicated that the pungent constituents, assessed as the non-volatile ether extract, are mainly located in the outer layers of ginger rhizome.

2.9 Traditional methods of peeling

Usually in India peeling operation is done manually. Green ginger is soaked in water to facilitate the removal of the skin. The skin is scraped with pieces of sharpened bamboo or bits sea shells. Steel knives are not used since they are found to stain the produce.

Ginger in Jamaica is a small holder's crop and is usually processed by the farmers family, so that it is necessary to dig no more ginger that can be peeled in one day. Peeling is done by means of a special knife consisting merely of a narrow straight blade above 7.5 to 10 cm long rivetted to a wooden handle. According to Guenther (1959), a skilled person can peel upto 18 kg of fresh rhizomes per day; 100 kg of fresh rhizomes yield about 80 kg of peeled rhizomes.

In Sierra Leone the peeling is done as follows. The plants are carefully dug up with forks and the roots removed

and the rhizomes are washed cleanly. They are then scraped with spoons. This is done some what perfunctorily the cork being partly removed from the flat side of the rhizomes or not at all.

The manual peeling is very time consuming and laborious. Only skilled persons can do the work properly. Above all it is uneconomical. Some attempts are made to mechanise the peeling operation and they are described below.

2.10 Mechanical methods of peeling

Investigations of mechanising the peeling operation have been reported by Natarajan et al. (1972) as a part of their studies on 26 cultivars of indigenous and exotic gingers grown at the Central Horticultural Research Institute, Ambalavayal, Kerala. The Hobart Abrasive peeler, in which the hands of ginger are fed into a wire mesh lined revolving drum was found to be quick and effective in peeling ginger. Peeling for 60 sec. in this machine was conductive to the production of a high grade ginger with satisfactory drying characteristics and gave a product equal in volatile oil content to the laboriously hand peeled ginger. But hand peeling was found to be superior to mechanical peeling in obtaining a dried product uniform in appearance, size and colour.

An abrasive brush type ginger peeling machine was developed by Agarwal et al. (1991). The machine consisted of an abrasion unit, transmission systems, belt tensioner, hopper and frame. Abrasion unit consisted of 2 endless canvas belt 370 cm long, 30 cm wide and 1 cm thick giving an effective abrasive surface area of 135 x 30 cm each when mounted on a 25 cm dia and 35 cm wide cast iron pulleys. The brushes made by threading 20 steel wires of 32 gauge at a spacing of 1.9 x 1.9 cm and 2 cm length. The power was provided by a 1 hp, 1440 rpm single phase motor through a V-drive. The movement of the belt in opposite direction with different speed caused the peeling of the ginger rhizome.

Peeling efficiency and material loss of the machine was found out using the following formulae.

$$\text{Peeling efficiency (\%)} = \frac{(y-x)}{y} \times 100$$

y = theoretical weight of skin on ginger gm

x = weight of skin removed by hand trimming after mechanical peeling gm

$$\text{Material loss (\%)} = \frac{(W_1-y) - (W_2-x)}{W_1} \times 100$$

W_1 = Total weight of ginger before peeling, gm

W_2 = Total weight of ginger after mechanical peeling, gm

Peeling efficiency of the machine was found to be 83.46 per cent and material loss was 4.33 per cent. The capacity of machine was 200 kg/hr.

This machine is found to be unsuitable for as Indian farmer because of the following reasons.

1. The cost of machine is very high i.e. approximately US $ 1500 including motor which is beyond the reach of an Indian farmer.
2. The machine consists of brush made by steel wires. So there may be chances of high material loss and also brush may be rusted.

Radha Charan et al. (1993) developed and abrasive ginger peeling machine for application at individual farmers level. It operates on the principle of abrasive peeling. This machine had the following components, moving abrasive surface, stationary abrasive surface, frame and hopper and a driving mechanism.

The moving abrasive surface was made of coconut fibre brushes mounted on an endless canvas belts of 40 mm width and 5 mm thick with the help of 2.5" x 0.25" bolts and nuts. The flexibility of the fibre helps in minimising the loss of ginger meat along with the proper cleaning of grooves on

irregular surface of the ginger pawn. Wooden pulley were selected to provide movement to the abrasion surface. Pulleys were mounted on 20 mm dia. M.S. shafts keeping 160 mm apart. The stationary abrasion surface was also developed with the same brushes arranging them side by side on a wooden plank of 780 x 240 x 15 mm size. A uniform gap of 15 mm was maintained between the moving and stationary surface so as to accommodate ginger pawns between them. This peeling machine had an efficiency of 71% with 1.3% material loss. Capacity of machine was about 24 kg/hr. The main disadvantage of this machine was that the strength of coconut fibre would lost after a number of operations.

The processing of turmeric is almost same as that of ginger. But in the case of turmeric the peeling is done after the drying process whereas in the case of ginger it is before drying. Peeling is the final unit operation in the processing of turmeric which is known as polishing. The thoroughly dried product is cleaned off the the outer skin, rootlets and remaining particles of soil, and transformed from the rough coated, dirty brown condition into relatively smooth, bright yellow rhizomes.

Polishing was done formerly by rubbing with the hands or feet, suitably protected by wrapping them in several folds of gunny cloth, or shaking the rhizomes, mixed with stones in

a long, narrow gunny bag or in a bamboo basket, or by rotating them in a polishing drum. This may be made from a wooden cask or barrel closed at both ends. It is provided with a small door in the side and is perforated all round with holes about 7 mm in dia. and 10-15 cm apart. The barrel is fitted with a central axle in the form of an iron rod long enough to project beyond both ends enabling the barrel to be mounted horizontally on two wooden posts. A charge of 20 lb of cured turmeric can be polished in 1 hr by one man operating the drum (Anonymous, 1932).

An improved polishing drum made by the Madras Agro. Department (Charley, 1938) was formed of expanded metal fixed to solid, circular and plates and was provided with a handle at each end of the axle to permit operation by two men. It had a removable section in the side for charging and discharging. A small rhizome or finger might fall through the apertures of the expanded metal, the drum was covered with a tight wrapping of woven wire, the mesh of which was small enough to retain the turmeric but large enough to allow dust, dirt and rootlets to escape during the operation of the drum. A machine of this type is still used at the present time, and a drum 2 feet long, 8 feet in dia. will take a charge of about 70 lb of boiled and dried turmeric, which is cleaned and polished in 30 min at the normal working speed of 30 rpm. Its

normal output is about 522 kg of polished turmeric per day of 8 hr, with 2 men working on it (Shankaracharya and Natarajan, 1973).

In most of the assembling centres of turmeric it is now polished in power driven drums. In this method, turmeric receives a higher degree of polishing. The capacity of the drum is about 598 kg of cured turmeric and this weight requires about 1.5 to 1.75 hr for polishing. Usually 5.8 per cent of the weight of turmeric is the polishing wastage during full polishing and 2 to 3 per cent during half polishing (Shankaracharya and Natarajan, 1973).

MATERIALS AND METHODS

The constructional details of each part of the hand operated brush type ginger peeling machine and the test procedure adopted for the performance evaluation are described in this chapter.

3.1 Design location

The fabrication and performance evaluation of the hand operated brush type ginger peeling machine was done at KCAET, Tavanur.

3.2 Constructional details

The constructional details of the machine are explained under the following heads.

1. Frame
2. Drums
3. Abrasion unit
4. Feeding unit
5. Receiving unit
6. Side cover
7. Cover
8. Driving unit

3.2.1 Frame

The frame was made of GI pipe, angle iron and M.S. flat. The G.I. pipes having 2.5 cm dia is coupled to threaded sockets and these sockets were welded to two M.S. flats having 100 cm length and 0.6 cm thickness. The horizontal distance between the flats is 20 cm. These were connected together by means of M.S flat pieces of same thickness. The GI pipes were of different heights of 90 cm and 60 cm and were fixed at a distance of 60 cm on each M.S flat. The pipes were connected with angle iron of 3.5 x 3.5 x 0.4 cm and was bolted. Slots were provided on the angle iron for adjusting the tension of the canvas belt.

3.2.2 drums

The drums having 20 cm dia were made of 16 gauge GI sheet. They were attached in between the angle iron with the help of shafts. The centre to centre distance between the shafts was 40 cm. These shafts were attached to the angle iron by means of bushes and bearings so that a free rotation of the shafts as well as the drums are possible.

3.2.3 Abrasion unit

This is the most important part of the brush type ginger peeling machine which actually performs the peeling

operation. It consisted of two abrasion surfaces, one moving and the other stationary.

3.2.3.1 Moving abrasive surface

The moving abrasive surface was made of an endless canvas belt of 10 cm width and 0.4 cm thickness. Nylon threads of 1.5 cm length was mounted on this belt in a zig-zag manner. The belt had enough strength and flexibility for trouble free operation of the machine. It is readily available in the local market and the ends can be joined together easily. This belt is mounted on the drums.

3.2.3.2 Stationary abrasive surface

The stationary abrasive surface was also developed with the same threads arranging them on a wooden plank of 45 x 10 x 1.6 cm size. A uniform gap of 3 cm was maintained between the moving and stationary surfaces so as to accommodate ginger pawns between them. Provision was given for the adjustment of spacing so that easy cleaning of machine and accommodation of ginger pawns of different size and shape is possible.

The brush was made manually. The spacing of the threads on brush was as shown in Fig.1. This particular

Plate 1. Hand operated brush type ginger peeling machine

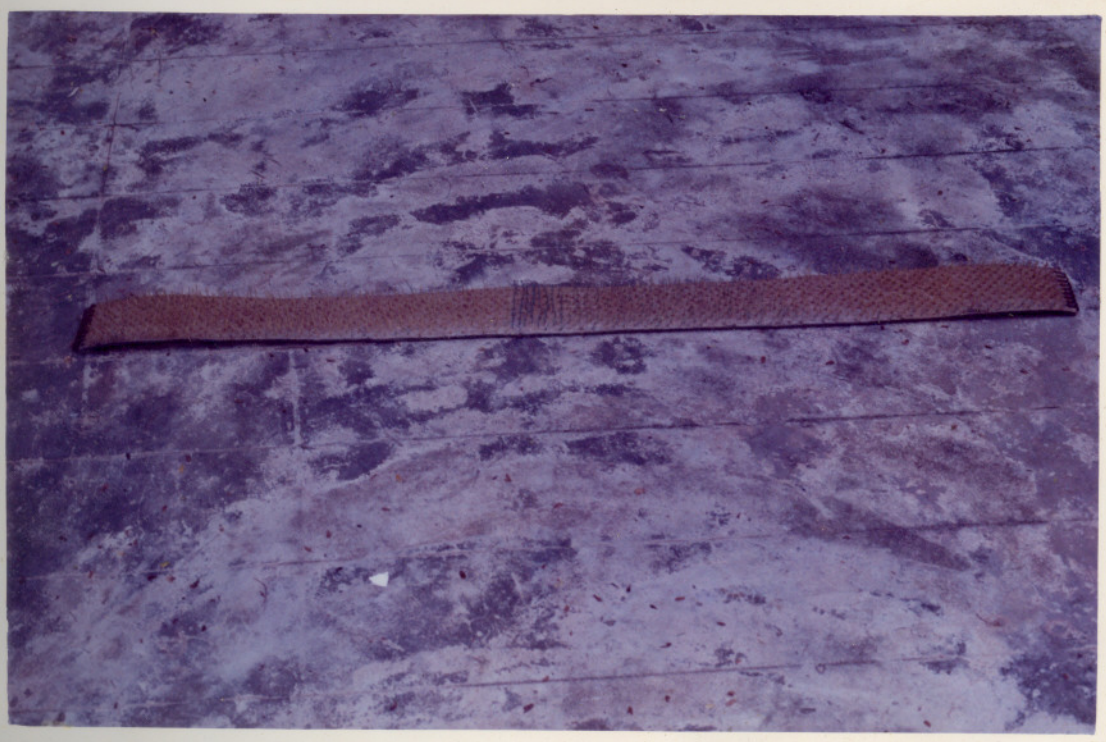

Plate 2. Moving abrasive brush

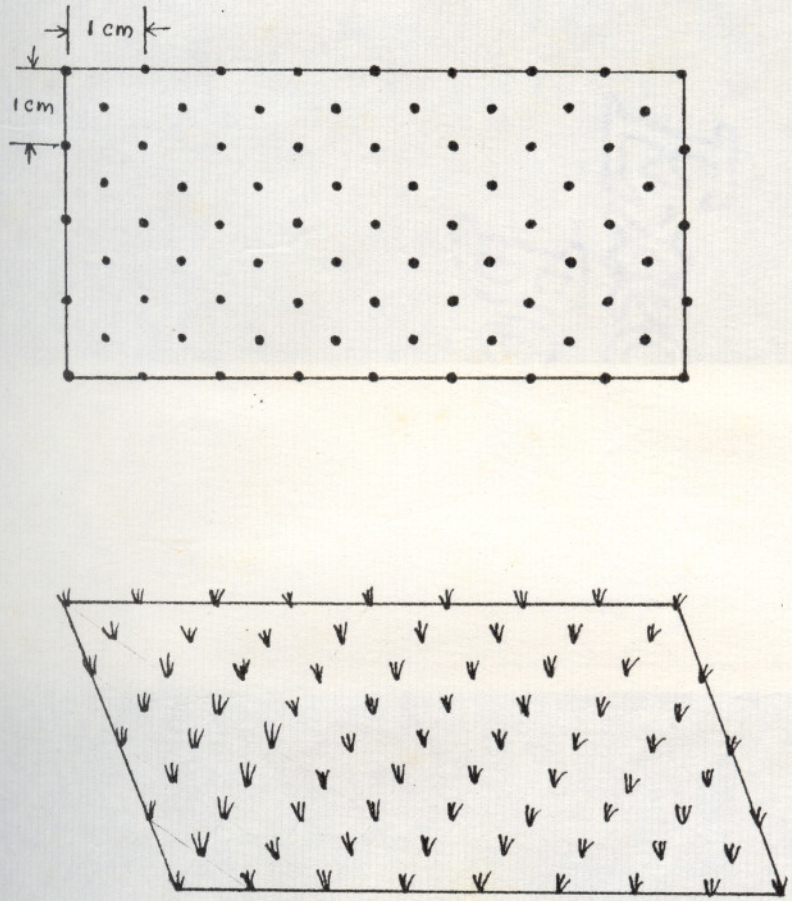

FIG.1 ARRANGEMENT OF NYLON THREADS ON CANVAS BELT

Plate 3. Side ~~Front~~ view of the machine

Plate 4. Top view of the machine

arrangement gave a thread density of 20000 sets per square metre which inturn gave a better removal of the peel.

3.2.4 Feeding unit

A feeding unit of 22 x 11 cm size made of G.I sheet was mounted at the driven end of the machine to feed the unpeeled ginger between the abrasive surfaces. It was kept slanting to prevent any back flow of ginger.

3.2.5 Receiving unit

This unit was provided for receiving the peeled ginger. It was fined on the downside of the stationary unit and was made up of GI sheet. Size of unit was 21 cm x 12 cm.

3.2.6 Side cover

The sides of the stationary surfaces are covered with GI sheet in order to restrict the side throw of ginger pawns and to advance the pawns downward.

3.2.7 Cover

A covering was provided with GI sheet to protect the abrasion unit when the machine is out of work.

3.2.8 Driving unit

A provision for manual drive was provided at the

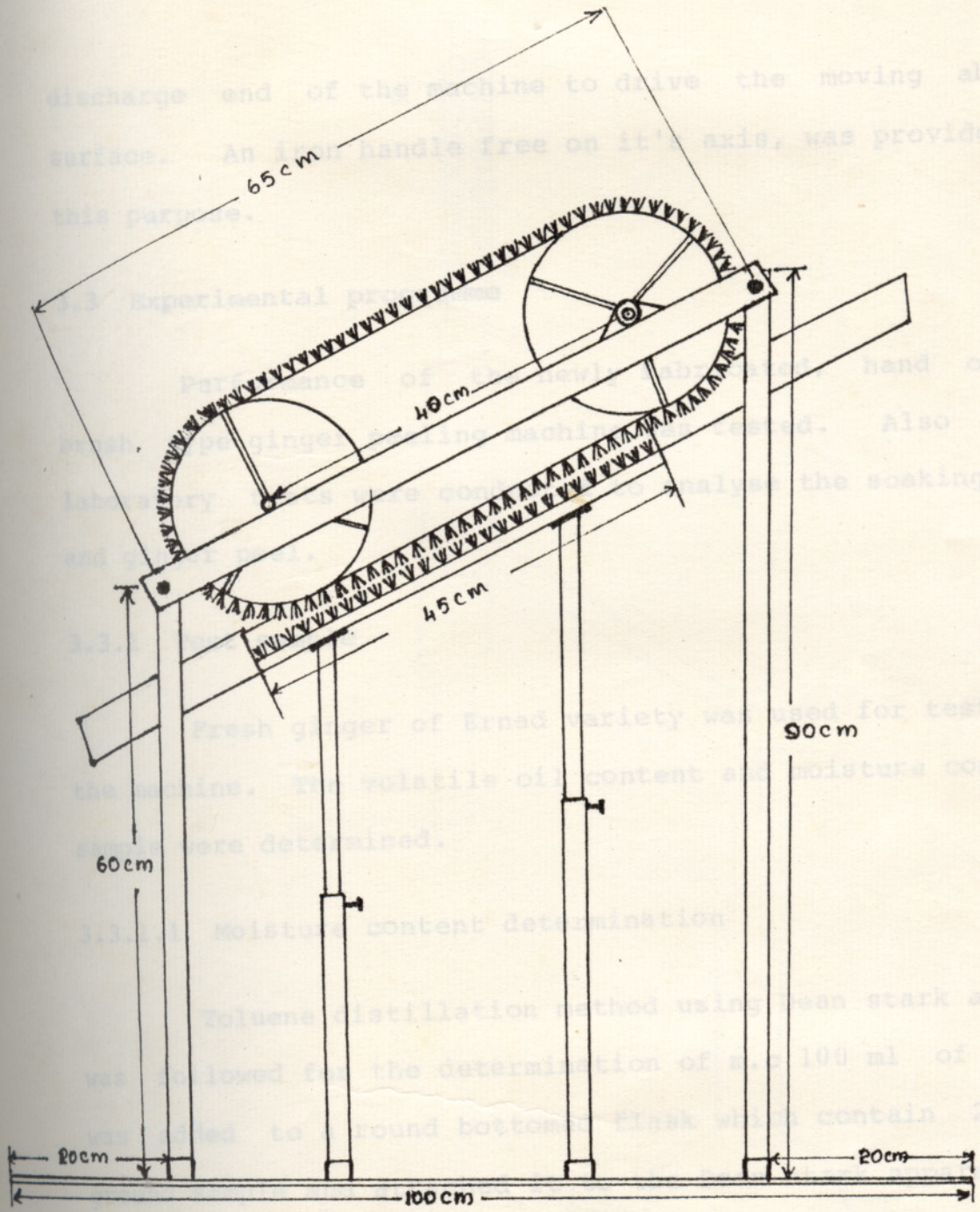

FIG.2 SIDE VIEW OF THE MACHINE

discharge end of the machine to drive the moving abrasion surface. An iron handle free on it's axis, was provided for this purpose.

3.3 Experimental programme

Performance of the newly fabricated, hand operated brush type ginger peeling machine was tested. Also various laboratory tests were conducted to analyse the soaking water and ginger peel.

3.3.1 Test sample

Fresh ginger of Ernad variety was used for testing of the machine. The volatile oil content and moisture content of sample were determined.

3.3.1.1 Moisture content determination

Toluene distillation method using Dean stark apparatus was followed for the determination of m.c 100 ml of toluene was added to a round bottomed flask which contain 25 g of ground sample and attached it to the Dean stark apparatus with a reflux condenser. The flask is heated with a heating mantle. On boiling, the water vapour along with toluene distilled from the flask and condensed when it was trapped in the apparatus and toluene flowed back with the flask. The distillation was continued till the volume of water collected

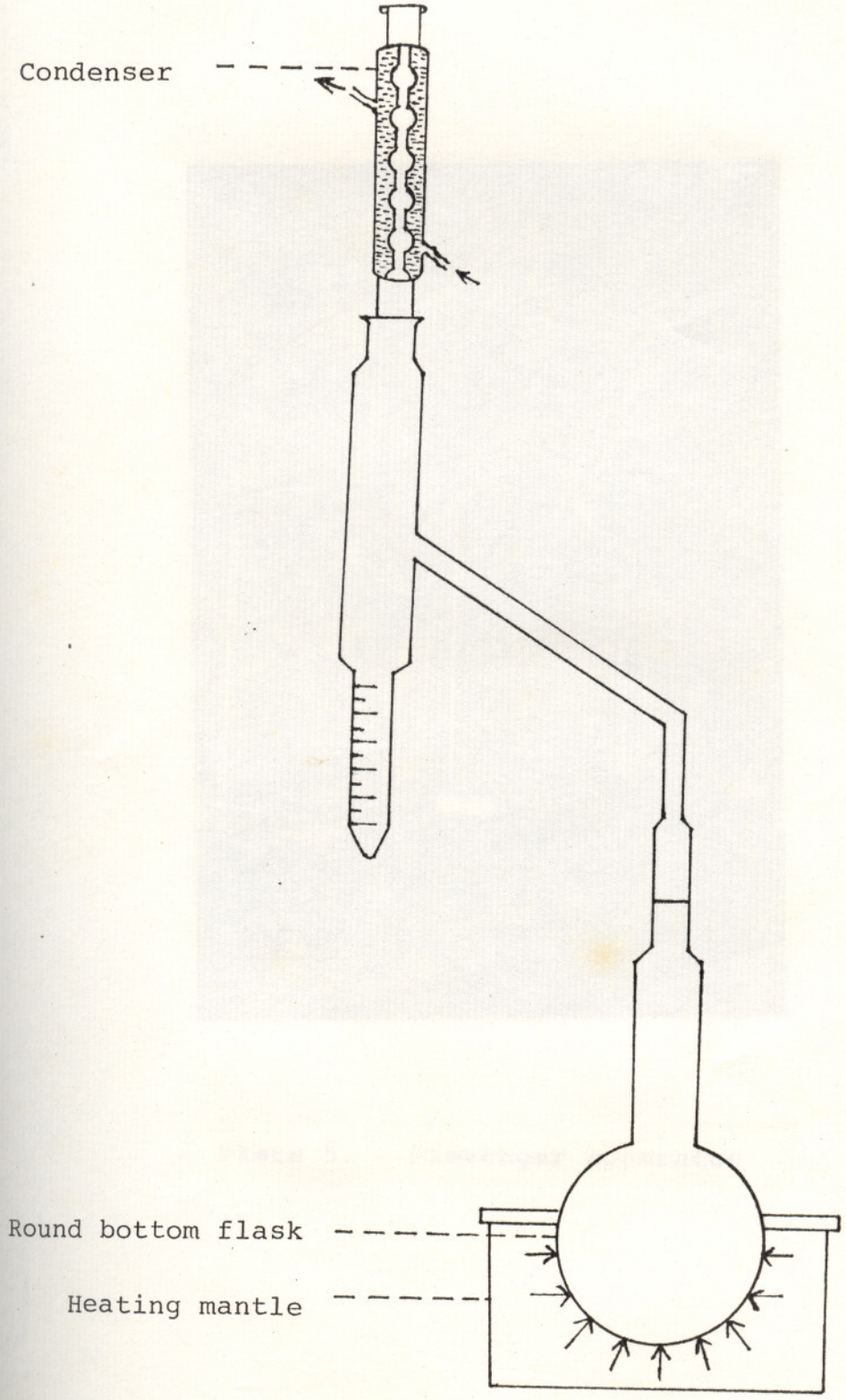

FIG.3 DEAN STARK APPARATUS

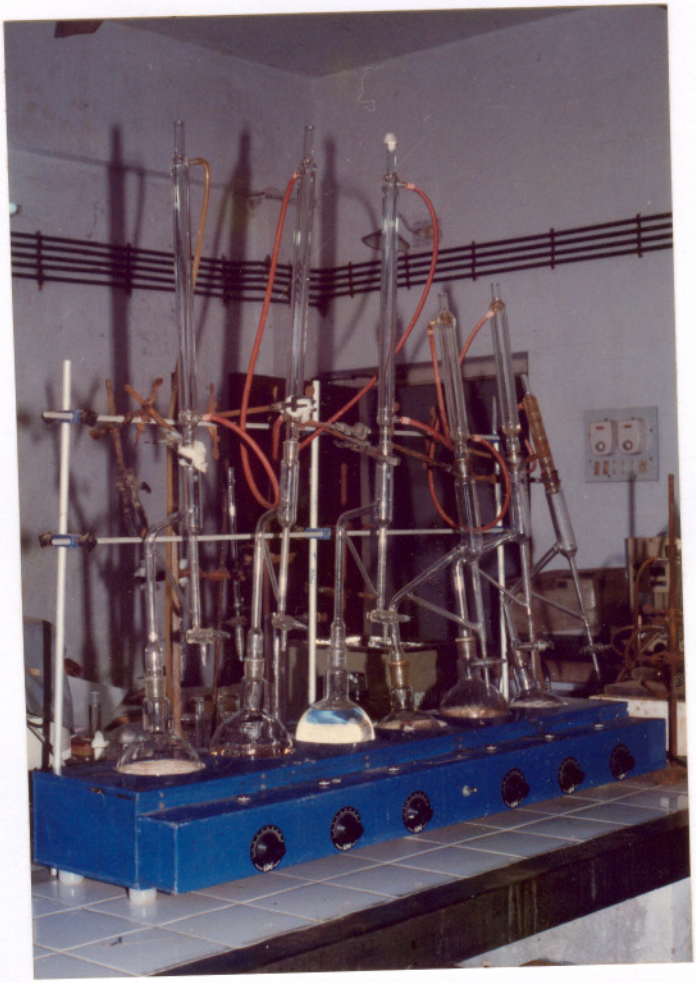

Plate 5. Clevenger apparatus

in the apparatus was constant. The apparatus was cooled and the volume collected was noted. The moisture content of the sample was calculated using the formula given in 2.5. Experimental set up is shown in Fig.3.

3.3.1.2 Volatile oil determination

It was estimated by using clevenger apparatus which is shown in plate no. 5, 20 g of sample weighed and taken in a round bottomed flask. 500 ml of water was added to it and the clevenger apparatus was attached to it. The mixture was heated in a heating mantle to it's boiling point. The volatile oil along with steam was condensed, when the water flowed back to the flask while the oil was retained in the trap. The distillation was continued to 3 hrs. Volatile oil content of the material was calculated as

Volatile oil content = V/W x 100 ml/100 g

3.3.2 Performance evaluation of machine

Six sample each of 1 kg weight, with different soaking times of 24, 12, 6, 3, 2 hr and without soaking time were used for testing. Each sample were given two passes.

3.3.3 Analysis of ginger peel

The ginger peel of each sample in collected carefully

and it's weight was taken. It is then analysed in the laboratory using clevenger apparatus to find out the amount of volatile oil lost due to removal of peel.

3.3.4 Analysis of soaking water

Each sample of soaking water in analysed in the laboratory using solvent hexane of boiling point 69°C. This was done to find whether any constituent is lost during the soaking. The traces of solvent is evaporated from the extract using a vacuum pump. Extraction was done with the help of a separating funnel. The experimental set up is shown in Fig.4.

GLC of the extract obtained from 24 and 12 hr soaking water was taken. Since 12 hr GLC contained no peak GLC of 6, 3, 2 are not taken based on the assumption that there was no constituents lost by these soaking times. Also GLC of whole ginger and peel oil is taken for analysis.

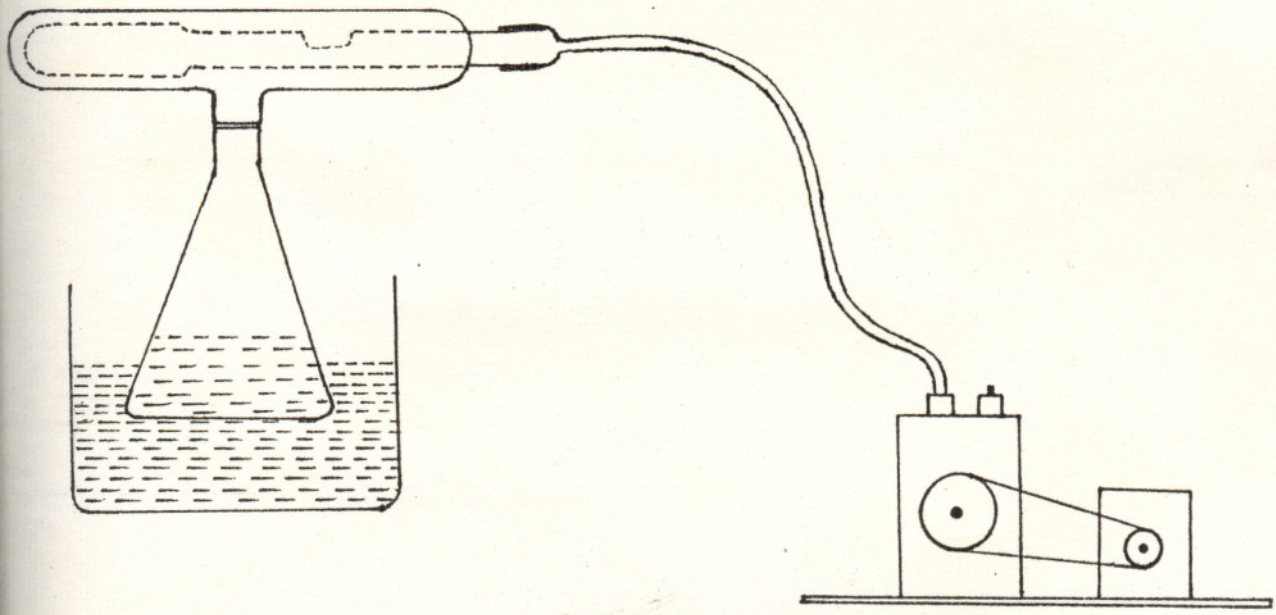

FIG.4 VACUUM PUMP AND SEPARATING FUNNEL

RESULTS AND DISCUSSION

Results of the laboratory tests conducted on the extraction of volatile oil of the peel, the analysis of soaking water and the performance evaluation of hand operated brush type ginger peeling machine are discussed in this chapter.

4.1 Moisture content of test sample

The moisture content of the test sample determined by toluene distillation method is 90.6 per cent.

4.2 Volatile oil content

The volatile oil content of test sample is 0.2 ml per 100 gm of whole ginger. This low value may be due to the incomplete extraction of oil from ginger.

4.3 Testing of brush type ginger peeling machine

The performance evaluation of the machine with 1 kg of sample by giving different socking times of 24, 12, 6, 3, 2 hrs and without soaking is conducted as explained under 3.3.2. The results are given in Table 1.

The increasing trend of the Fig.5 shows that max peel is removed by giving 24 hr soaking time whereas the peel

Table 1. Amount of peel removed at different soaking times

Weight of sample (kg)	Soaking time (hr)	Amount of peel removed (gm)
1	24	38.55
1	12	36.305
1	6	33.10
1	3	21.46
1	2	19.00
1	0	13.06

Table 2. Extraction of oil from peel at different soaking times

Weight of peel (gm)	Soaking time (hr)	Amount oil extracted (ml)
100	24	0.195
100	12	0.138
100	6	0.050
100	3	0.020
100	2	0.020
100	0	0.020

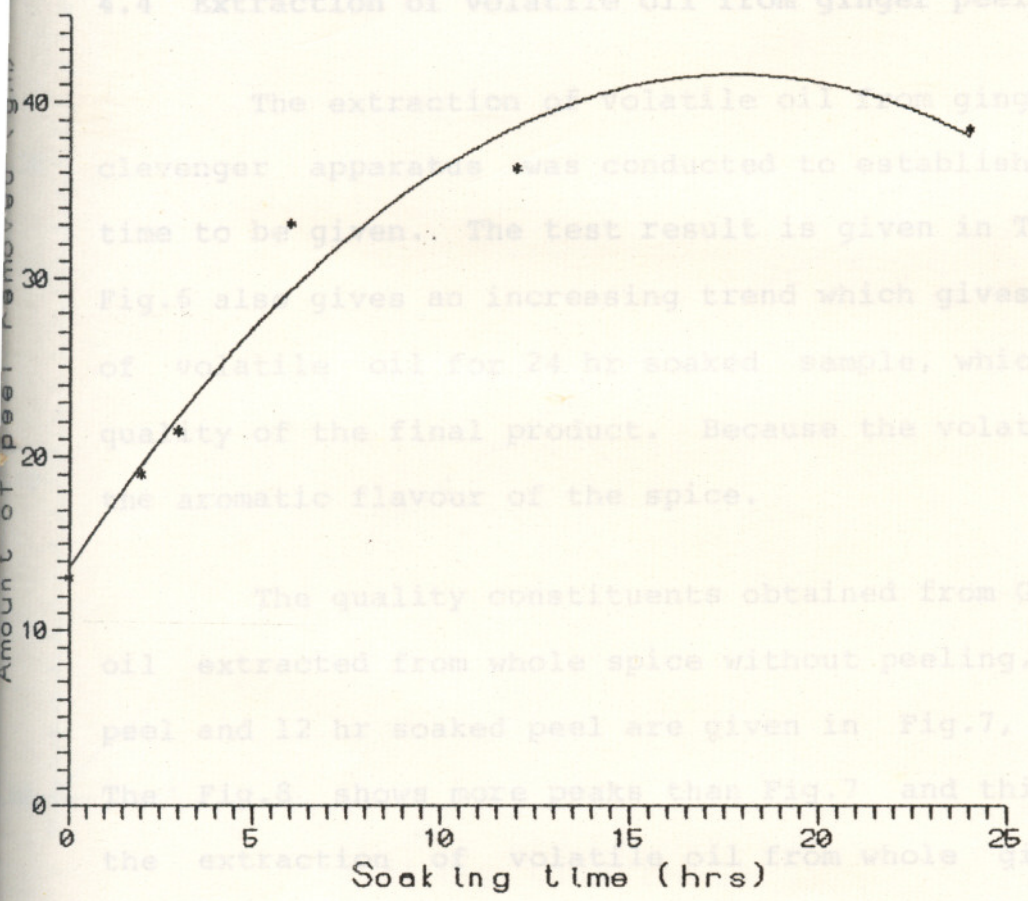

FIG.5 AMOUNT OF PEEL REMOVED AT DIFFERENT SOAKING TIMES

removed from the ginger which was without soaking is minimum. So it is clear that soaking is essential for better removal of peel from ginger. The maximum amount of peel for 24 hr soaking may be due to the addition of extra flesh in the ginger peel.

4.4 Extraction of volatile oil from ginger peel

The extraction of volatile oil from ginger peel using clevenger apparatus was conducted to establish the soaking time to be given. The test result is given in Table II. The Fig.6 also gives an increasing trend which gives maximum yield of volatile oil for 24 hr soaked sample, which effect the quality of the final product. Because the volatile oil gives the aromatic flavour of the spice.

The quality constituents obtained from G.L.C of ginger oil extracted from whole spice without peeling, 24 hr soaked peel and 12 hr soaked peel are given in Fig.7, Fig.8, Fig.9. The Fig.8 shows more peaks than Fig.7 and this is because the extraction of volatile oil from whole ginger was not complete. Figure 8 shows several peak points when compared to Fig.9, that means some of the flavour constituents may be lost by giving 24 hr soaking time.

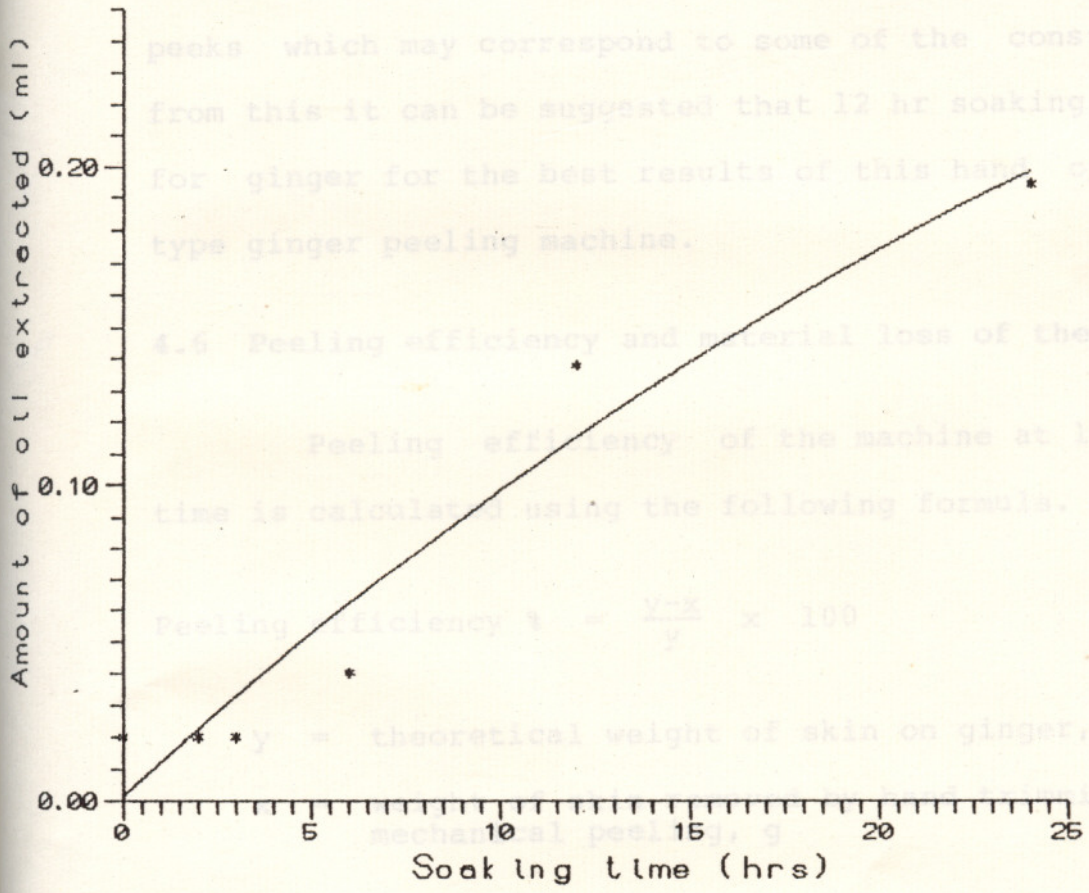

FIG.6 EXTRACTION OF OIL FROM PEEL AT DIFFERENT SOAKING TIMES

4.5 Analysis of soaking water

Analysis of soaking water was conducted by using the solvent hexane (Boiling point 69°C). The removal of solvent was using a vacuum pump with a pressure of 20-25 mm of Hg. The Fig.11 and Fig.12 shows the G.L.C of soaking water. Figure 12 shows no particular peak and Fig.11 given three peeks which may correspond to some of the constituents. So from this it can be suggested that 12 hr soaking is preferable for ginger for the best results of this hand operated brush type ginger peeling machine.

4.6 Peeling efficiency and material loss of the machine

Peeling efficiency of the machine at 12 hr soaking time is calculated using the following formula.

$$\text{Peeling efficiency } \% = \frac{y-x}{y} \times 100$$

y = theoretical weight of skin on ginger, g

x = weight of skin removed by hand trimming after mechanical peeling, g

The peeling efficiency of machine is 77.31 per cent at 12 hr soaking time which is satisfactory.

$$\text{Material loss, } \% = \frac{(W_1-y)\ (W_2-x)}{W_1} \times 100$$

W_1 = total weight of ginger before peeling, g

W_2 = total weight of ginger after mechanical peeling, g

The material loss of machine is 1.2 per cent which is very less.

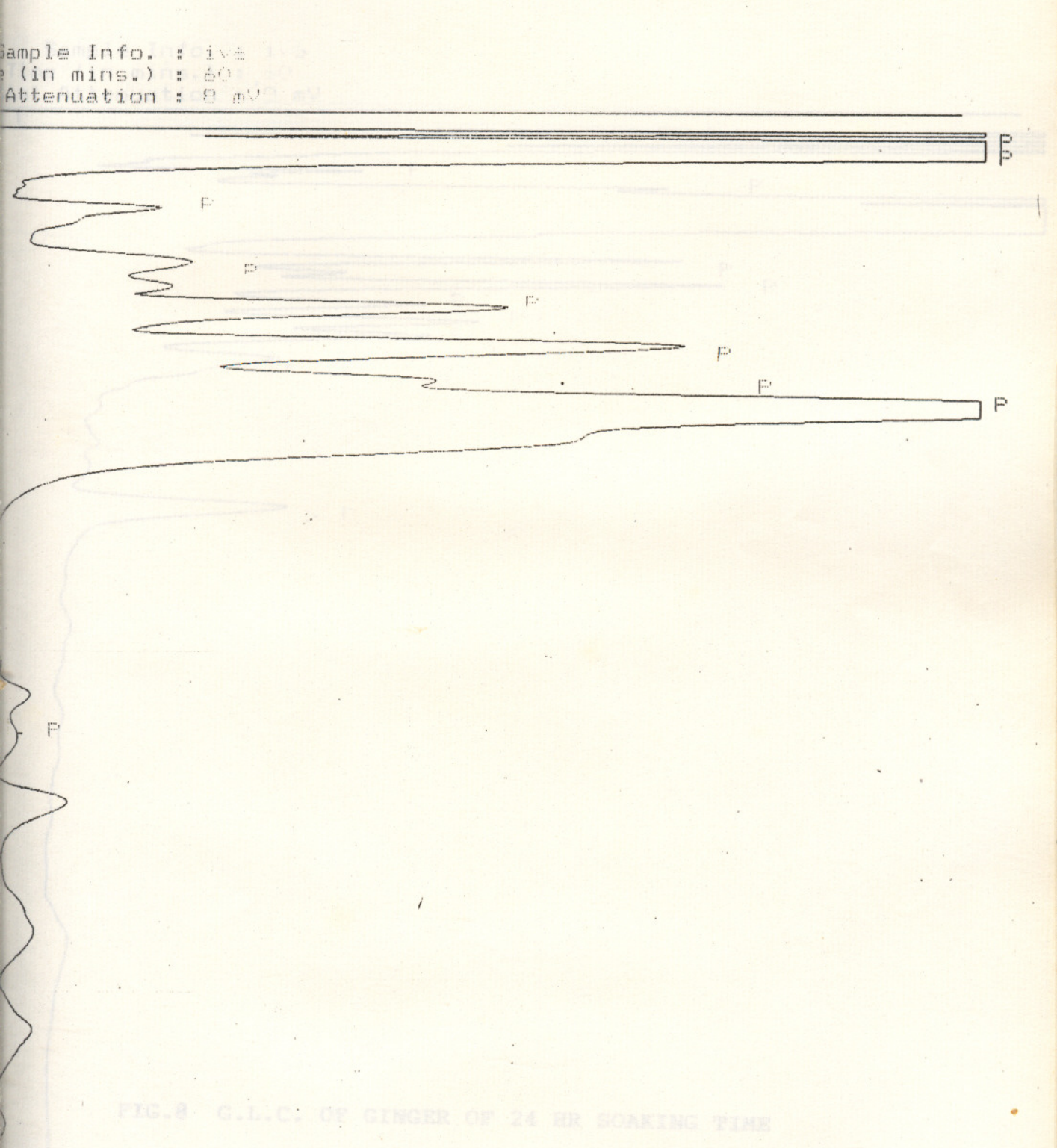

FIG.7 G.L.C. OF WHOLE GINGER OIL

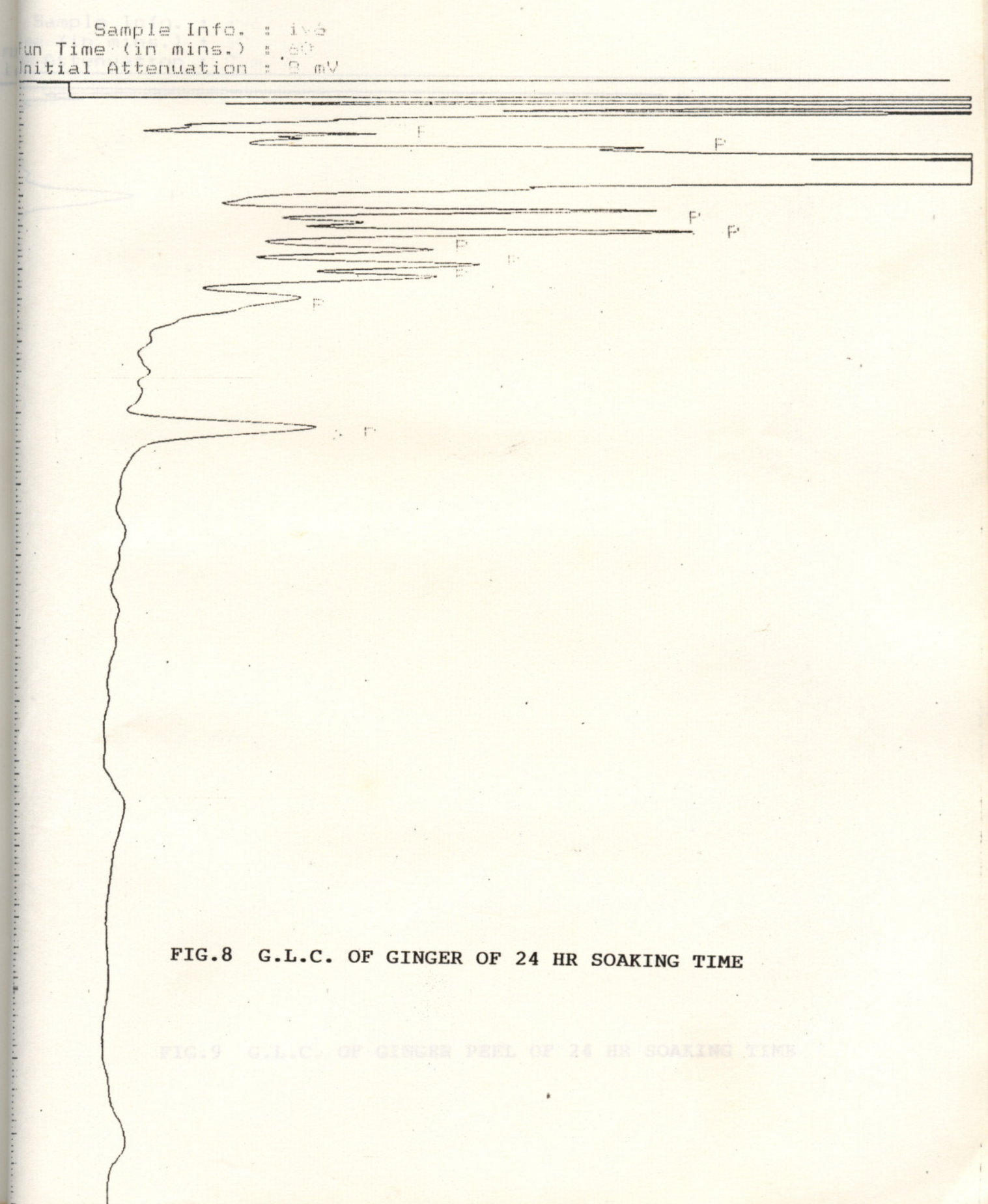

FIG.8 G.L.C. OF GINGER OF 24 HR SOAKING TIME

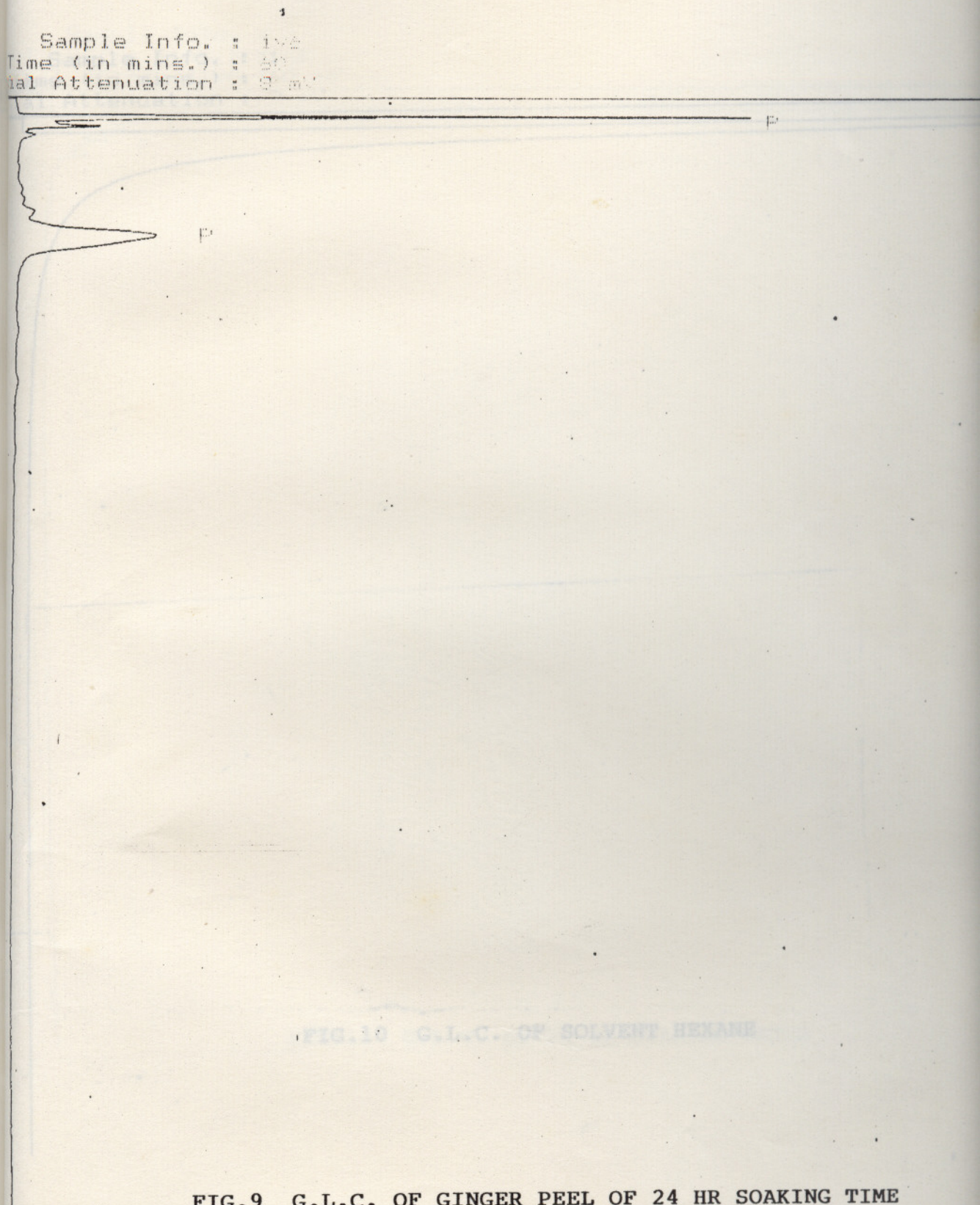

FIG.9 G.L.C. OF GINGER PEEL OF 24 HR SOAKING TIME

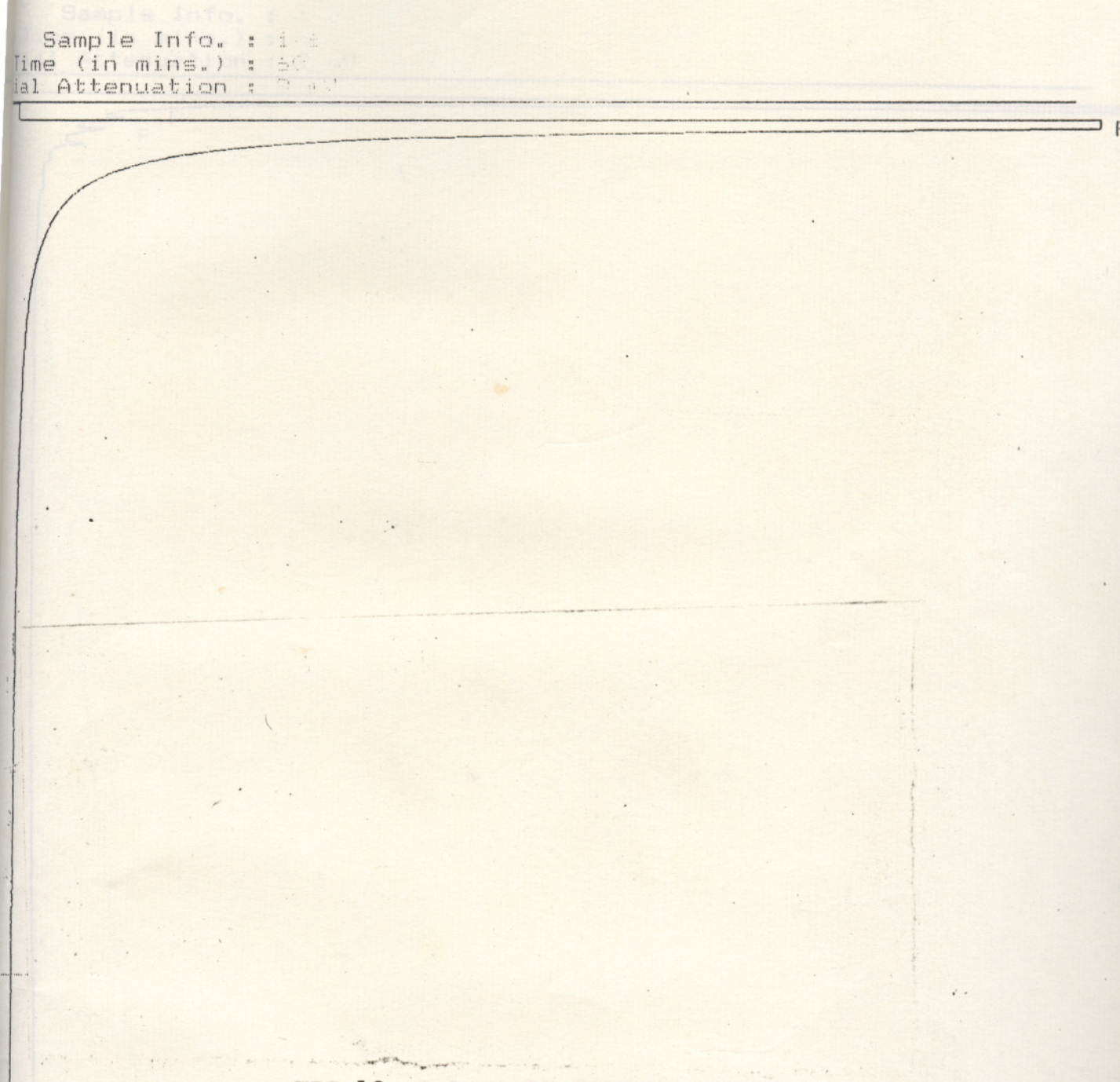

FIG.10 G.L.C. OF SOLVENT HEXANE

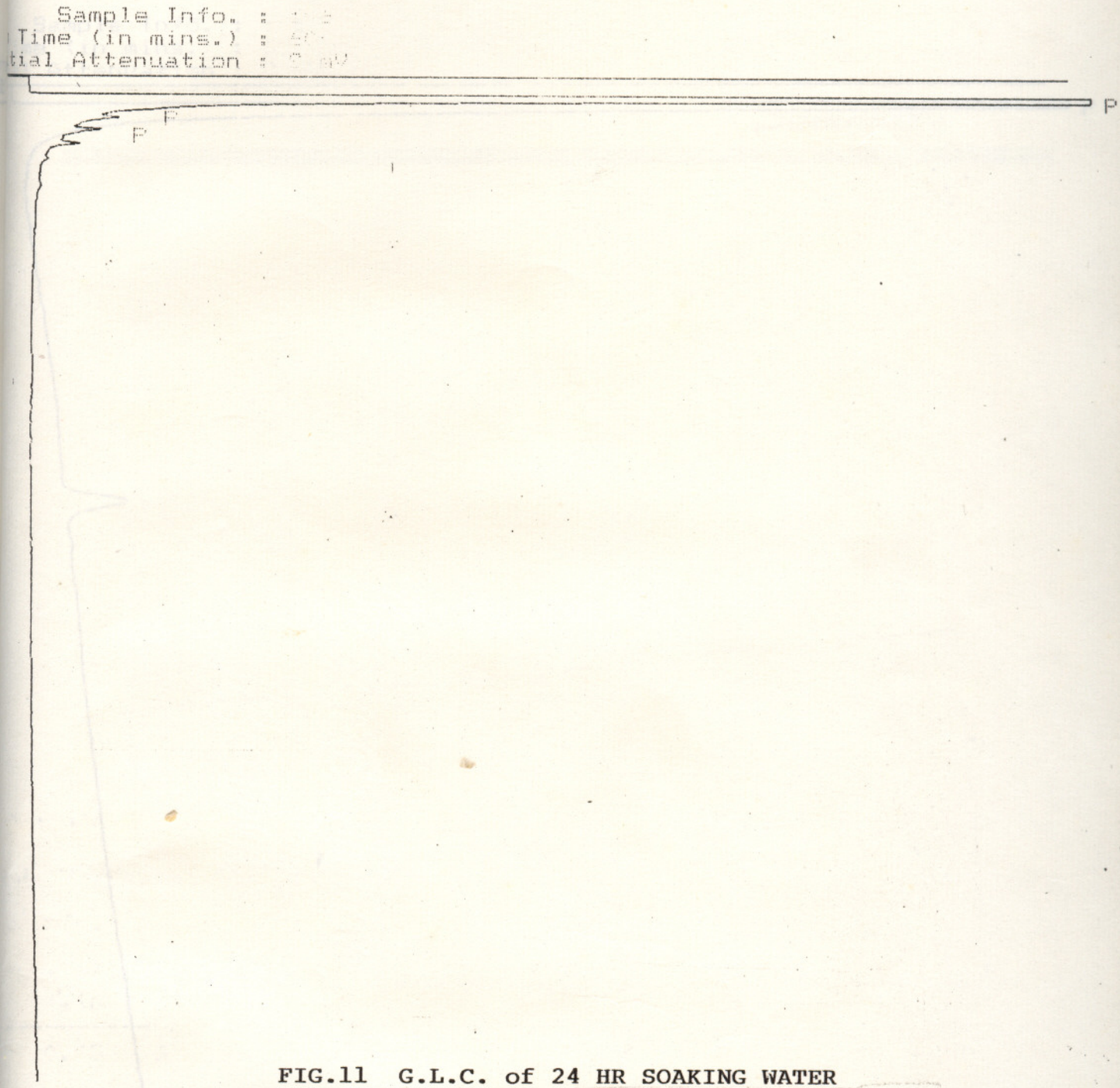

FIG.11 G.L.C. of 24 HR SOAKING WATER

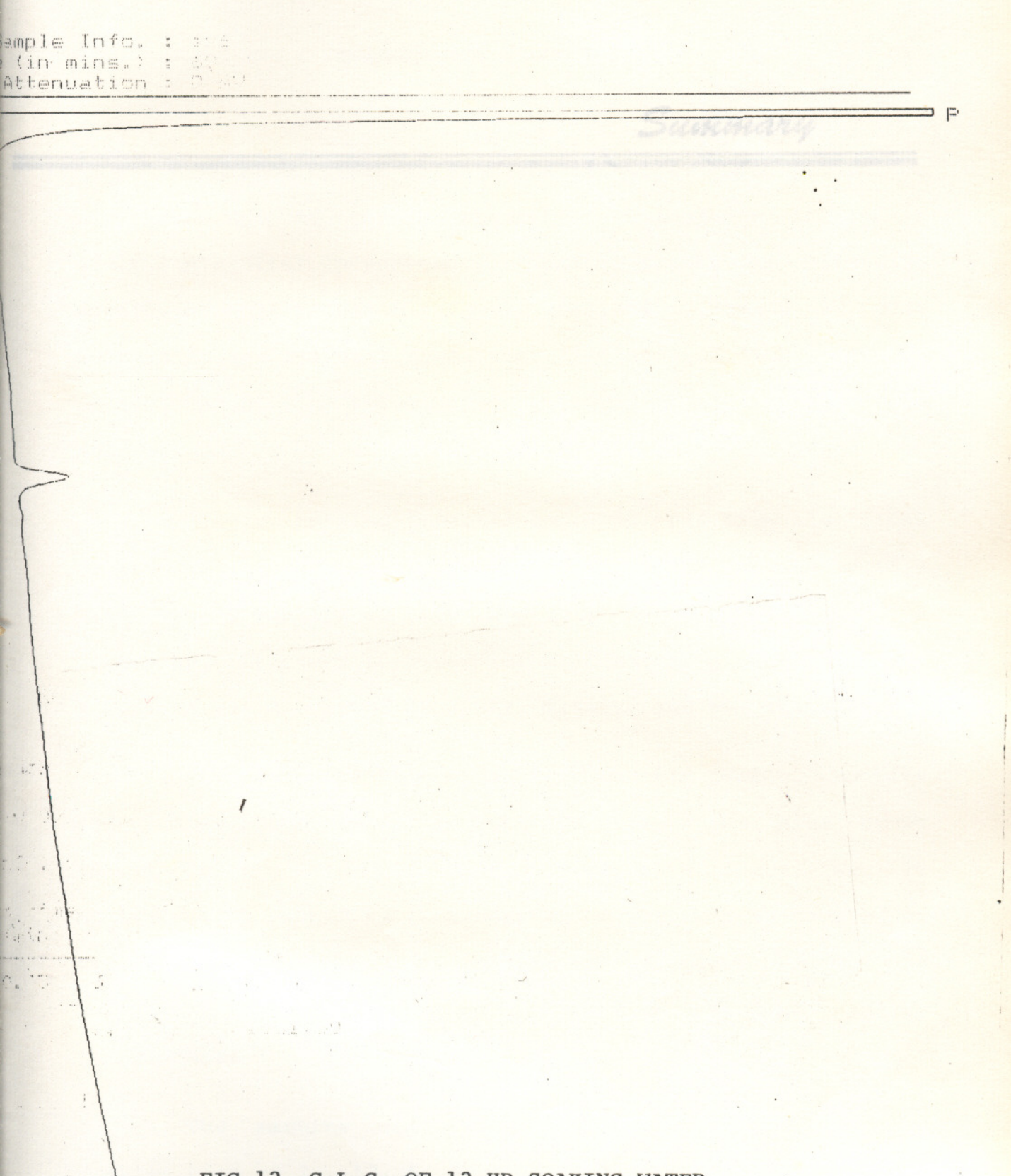

FIG.12 G.L.C. OF 12 HR SOAKING WATER

SUMMARY AND CONCLUSIONS

The application of machines to agricultural production has been one of the outstanding developments in Indian agriculture after independence. India's constantly expanding population has required and will continue to demand an ever increasing agricultural production for food and fiber. It can be achieved only by introducing new machines and implements to agriculture.

Ginger peeling is still a manual operation in India eventhough it is one of the major source of foreign money. This manual peeling is very laborious uneconomical and time consuming. In order to avoid the problems of ginger peeling, a machine was developed at KCAET, Tavanur and was tested.

The hand operated brush type ginger peeling machine essentially consisted of an abrasion unit, frame, side cover and a driving unit. Of the two abrasion surfaces, one is moving and the other is stationary. Moving unit is mounted on two drums and these drums are rotated by means of driving unit. When ginger is fed to the abrasion unit the peeling takes place.

The machine was tested with ginger samples with soaking time of 24, 12, 6, 3, 2 hrs and without soaking time.

The machine was found working satisfactorily at 12 hr and 24 hr soaking times. But for 24 hrs high material loss was occurred.

The peel and soaking water was analysed in the laboratory to find out the optimum soaking time for this particular peeling machine. The volatile oil content of peel samples were determined and the G.L.C of 12 hr and 24 hr soaked peel oil were taken. On comparing the two G.L.C it was found that 12 hr soaking is better than 24 hr soaking. On the comparison of G.L.C of extract of soaking water, it also gave the result that 12 hr soaking is suitable for this peeling machine. Peeling efficiency of the machine at 12 hr soaking was 77.3 per cent and material loss was 1.2 per cent. Capacity of the machine was about 20 kg/hr.

SUGGESTIONS FOR FUTURE WORKS

1. Since a constant speed is required for the efficient operation of the machine, make it a power operated one.

2. The length of the nylon threads mounted on the belt can be reduced.

3. Increase the width and length of the canvas belt in order to increase the abrasive area.

4. If both abrasive surfaces move in opposite direction with different speeds, peeling efficiency may be increased.

5. The brush can be made more uniformly so that material loss may be reduced.

6. By solvent extraction with hexane only dissolved constituents can be determined. Other tests may be conducted to find out whether any more constituents are lost due to soaking.

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APPENDIX I

Spices export in India

Item	Export in 1992-93 (tonnes)	Value (Crores)
Pepper	25480	8.17
Cardomom small	175	6.80
Cardomom large	1270	8.08
Chillies	16850	67.87
Ginger	8220	15.70
Turmeric	18950	46.32
Coriander	13550	19.91
Cumin	2080	11.77
Garlic	7700	7.17
Celery	2750	4.18

APPENDIX II

Area and production of ginger in India

Year	Area in ha	Production in tonnes
1980-81	40450	82440
1981-82	41110	89710
1982-83	43830	94170
1983-84	48960	121310
1984-85	51510	133860
1985-86	53520	138020
1986-87	52630	136010
1987-88	54240	142840
1988-89	57870	152120
1989-90	53560	156120
1990-91	53930	153450
1991-92	55500	156180

APPENDIX III

Total area of cultivation and production of ginger in different states in India

Major growing states	Year	Area (ha)	Production (M.T)
Andhra Pradesh	1989-90	2520	10570
Himachal Pradesh	1989-90	1440	640
Karnataka	1989-90	2230	2940
Kerala	1989-90	13830	46390
Madhya Pradesh	1989-90	2010	2930
Meghalaya	1989-90	6280	28980
Mizoram	1989-90	1760	10200
Orissa	1989-90	8800	13350
West Bengal	1989-90	5280	9060

APPENDIX IV

Main ginger cultivars in India

Name of cultivar	Area under cultivation
Thingpui	Assam
Jorhat	Assam
Nadia	Assam
Thinladium	Assam
Maran	Assam
Burdwan	West Bengal
Wynad local	Kerala
Wynad Manantody	Kerala
Kuruppam -padi	Kerala
Ernad	Kerala
Thodupuzha	Kerala
Karakkal	Karnataka
Narasapattam	Andhra Pradesh
Reo-de-Janeiro	Exotic cultivar from Brazil

APPENDIX V

Yield and percentage of dry ginger of cultivars cultivated at Ambalavayal, Kerala

Type	Average yield (tonnes/ha)	% of dry to green ginger
Reo-de-Janeiro	36.5	16.2
China	18.8	15.0
Maran	17.23	21.1
Ernad (Chernad)	17.8	24.4
Wynad Manantody	16.9 (17-18)	17.8
Narasapattam	16.8 (16-20)	21.1
Burdwan	16.4	21.9
Mysore	15.9	19.4
Valluvanad	15.0	21.9
Bajpai	14.6	18.7
Ernad Manjeri	14.2	21.2
South Kanara	11.4	23.1
Karakkal	8.10	23.0
Thodupuzha	7.6	18.7

APPENDIX VI

Constituents identified in ginger oils

Sesquiterpene hydrocarbons

(-) - - zingiberene

B - zingiberene

(+) - ar - curcumene

(-) - B - bisabolene

B - elemene

B - furnesene

- selenene

(-) - B - sesquiphellandrene

sesquithyjene

sesquiterpene alcohols

Cis - B - eudesmol :
: zingi-
trans - B - eudesmol : berol
nerolidol :

Cis - B - sesquiphellandrol

trans - B - sesquiphellandrol

Cis - Sabinene hydrate

Zingiberenol

Monoterpene hydro carbons

d - camphene

A - 3 - Caren

Oxygenated monoterpenes

d - boroneol

borny acetate

1:8 - cineole

citrals a and b

citronellyl acetate

geraniol

linalol

- terpineol

miscellaneous compounds

n - heptane

n - octane

n - propanol

2 - neptanol

n - nonanol

2 - nonanol

acetaldehyde

propionaldehyde

n - bytyraldehyde

isovaleraldehyde

n - nonanal

DEVELOPMENT AND TESTING OF HAND OPERATED BRUSH TYPE GINGER PEELING MACHINE

By

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SANDHYA.K.V.

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ABSTRACT OF THE PROJECT REPORT

Submitted in partial fulfilment of the requirement for the degree of

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Faculty of Agricultural Engineering & Technology
Kerala Agricultural university.

Department of Agricultural Processing & Structures

Kelappaji College of Agricultural Engineering & Technology
TAVANUR - 679 573, MALAPPURAM

1994

ABSTRACT

A hand operated brush type ginger peeling machine was developed and it's performance at different soaking times are evaluated. The machine essentially consists of a stationary abrasive unit, a moving abrassive unit, a driving mechanism, a feeding unit and a frame. The stationary and moving abrasive units are made by means of canvas belts. The brush was made manually with nylon threads of. 1.5 cm long pieces mounted on the canvas belt. The brushing action resulted from the movement of moving belt over the stationary belt causes the peeling operation. The machine was tested with ginger samples of soaking time 24, 12, 6, 3, 2 hrs and without soaking time. The peel and soaking water are analysed in the laboratory and it is found that 12 hr soaking is suitable for this particular type of peeling machine. Results of testings showed that, for 12 hr soaking time, the machine had a peeling efficiency of 77.31 per cent and material loss of 1.2 per cent. The capacity of machine is about 20 kg/hr.