STANDARDISATION OF VANILLA CURING TECHNIQUES

By

MANJUSHA MATHEW
ROSHNI RAJU
SHAILESH KUMAR SINGH

Department of
Post Harvest Technology & Agricultural Processing
KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
TAVANUR- 679 573 , MALAPPURAM
KERALA , INDIA
2005

STANDARDISATION OF VANILLA CURING TECHNIQUES

By
MANJUSHA MATHEW
ROSHNI RAJU
SHAILESH KUMAR SINGH

PROJECT REPORT
Submitted in partial fulfilment of the requirement for the degree

Bachelor of Technology in Agricultural Engineering

Faculty of Agricultural Engineering
Kerala Agricultural University

Department of
Post Harvest Technology & Agricultural Processing
KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
TAVANUR- 679 573 , MALAPPURAM
KERALA , INDIA
2005

CERTIFICATE

Certified that this project report entitled ***"Standardisation of Vanilla Curing Techniques "*** is a record of project work done jointly by Manjusha Mathew, Roshni Raju and Shailesh Kumar Singh under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associate ship to them.

Dr. K. P. Sudheer
Assistant Professor
Dept. of PHT & AP
K.C.A.E.T, Tavanur

Place : Tavanur
Date :

DECLARATION

We hereby declare that this project report entitled ***"Standardisation of Vanilla Curing Techniques "*** 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, associate ship, fellowship or other similar title of any other university or society.

Manjusha Mathew

Roshni Raju

Shailesh Kumar Singh

Place : Tavanur
Date :

ACKNOWLEDGEMENT

It gives us immense pleasure to express our deep sense of gratitude and indebtedness to Dr. K.P Sudheer, Chairman of the project and Assistant Professor, Department of Post Harvest Technology and Agricultural Processing, for his valuable guidance, profound suggestions and constant encouragement and advice throughout the project work.

We are also greatly indebted to Professor C.P Muhammad, Dean, K.C.A.E.T. and Dr. K. I. Koshy, Professor and head of Department of SAC.

We are grateful to Dr. Santhi Mary Mathew, Associate Professor and head of Department of PHT& AP , Er. Prince M.V., Asst. Professor, Dept. of PHT& AP, for the valuable guidance.

We also remain indebted to all our friends at K.C.A.E.T, who helped us in completing this work successfully.

At this moment, we thankfully acknowledge the blessings of our loving parents for their stable support throughout the work.

Above all, we bow our head before the Almighty, whose grace has made us complete this task successfully.

Manjusha Mathew
Roshni Raju
Shailesh Kumar Singh

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

SYMBOLS AND ABBREVIATIONS

cm	**- Centimetre(s)**
db	- Dry bulb
et al.	- And others
etc.	- etcetera
Fig.	- figure (s)
g	- gram(s)
h	-hour (s)
K.C.A.E.T	- Kelappaji College Of Agricultural Engineering And Technology
min.	- minute (s)
MC	-moisture content
R.H	-Relative humidity
Rs.	-ruppees
s	- second (s)
viz.	-namely
wt	-weight
&	- and
%	- Per cent
°C	- degree centigrade
@	- at the rate of

DEDICATED TO OUR

PROFESSION OF

AGRICULTURAL ENGINEERING

INTRODUCTION

INTRODUCTION

Vanilla, an important and popular flavoring material and spice, is the fully-grown fruits of the orchid *Vanilla planifolia.* Vanilla is used extensively to flavour ice cream, chocolate, beverages, cakes and other confectionary. It is also used in the perfumery and to a small extent in medicine.

The fragrance and flavour of vanilla beans is due to numerous aromatic compounds produced during the curing operation, among which vanillin is the most abundant. The flavour of vanilla from different parts of the world varies due to climate, soil, extent of pollination, and degree of ripeness at harvesting and method of curing.

Vanillin was first isolated from vanilla by Gobley in 1858. It was first produced artificially by Tiemann and Haarmann in 1874, from the glucoside Coniferin, which occurs in the sapwood of certain conifers. Synthetic vanillin is much cheaper than natural vanilla flavour. Synthetic vanillin is produced from the waste sulphite liquor of paper mills, from coal-tar extracts and from eugenol obtained from clove oil. Nevertheless, the flavour of vanilla beans from V.*Fragrans* is far superior to that of synthetic vanillin, due to the presence of other flavour compounds in the natural product. This seems to be the deciding factor in the favour of the natural product as flavouring by the gourmet. It is necessary to use natural vanilla flavour according to the United States Drug Administration labelling regulations for frozen desserts, which has been strengthened and stabilized the natural vanilla industries.

World production of vanilla beans in 2001 was 5583 tonnes (Anon., 2003). Indonesia provides about 50% of the world supply and the rest from Madagascar, Mexico, Tonga as well as Comoro and Reunion. Mainly three countries dominate vanilla imports viz. the United States of America, France and Germany. Importers in Germany and France are suppliers to other countries especially in Europe.

India has just entered the production market of vanilla beans. Our production in the year 2001 was 100 tonnes (Anon., 2003), which is quite insignificant in global scenario. Karnataka occupies the largest area of vanilla cultivation in India with 1,465 hectares followed by Kerala (812 hectares) and Tamil Nadu (268 hectares) (Anilkumar, 2004). Presently, the green beans are being sold at the rate of Rs.300 per kg; where as the processed vanilla fetch a price of around Rs.10,000 per kg (Anilkumar, 2004). But processing technologies for vanilla are still primitive in India, and many farmers are satisfied with growing and supplying green beans. Considering the fact that the cost of production is low, farmers are finding vanilla cultivation very attractive.

Immature vanilla beans are dark green in colour. They would be ready for harvest in about 9 to 11 months (Pruthi, 2000). When fully matured they have a pale yellowing at the distal end. If unharvested the bean fully turns yellow and starts splitting, giving out a small quantity of oil, reddish brown in colour called the Balsam of vanilla. Eventually they become dry, brittle and finally become scentless. Therefore, artificial methods are employed to cure vanilla (Pruthi, 2000).

The fresh vanilla beans do not have any flavour or aroma because vanillin and other chemical substances responsible for imparting the peculiar fragrance and flavour are not present in the free form at the time of harvesting. During process of curing, free vanillin is developed in the beans as result of series of enzymatic action on several glucosides. Simultaneously various aldehydes, aromatic ester, protocatechic acid, benzoic acid, vanillic acid and anisic alcohol are also formed and together gives the fragrance of natural vanilla well distinguishable from synthetic vanillin. If proper facilities are available and training given to farmers, vanilla curing can be done as an on-farm operation. This would ensure better returns by producing vanilla beans with export quality.

With this in view, an attempt has been made at K.C.A.E.T, Tavanur with the following objectives.

1. To conduct a survey among vanilla growers to identify the various constraints in vanilla cultivation and processing.
2. To determine the physical properties of fresh and cured vanilla beans.
3. To standardise the parameters responsible for curing of vanilla.
4. To compare the results with traditional curing technique.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Extensive work has been done on the various processes involved in vanilla cultivation and processing. This chapter deals with some of the works that have been done on this subject during the past years.

2.1 Crop Management

2.1.1 Vanilla Crop:

Natural vanillin is obtained from the cured pods (fruits) of the vanilla plant *Vanilla planifolia* (Family: *Orchidaceae*). Vanilla is a perennial climbing orchid with sessile leaves and succulent green stems, producing aerial roots at the nodes. It is a native of Mexico and was introduced to India as early as 1835. Karnataka has the largest area under vanilla in the country. There are three important cultivated species of vanilla namely, *Vanilla planifolia* (Mexican vanilla) *V. pompona* (West Indian vanilla), and *V. tahitensis* (Tahitian vanilla). V. *planifolia* is predominantly cultivated for production of vanillin. V. *tahitensis* and V. *pompona* also yield vanillin, apart from V. *planifolia,* but of inferior quality. Some of the important commercial varieties are: Bourbon vanilla, Seychelles and Mauritius vanilla, South American vanilla and Tahiti vanilla (www.gnujake.med.yale.edu/herbmed).

2.1.2 Climate and Soil

Vanilla is adapted to a wide range of soil types rich in humus and having good drainage. It thrives well in humid tropical climate with an annual rainfall of 200-300 cm from sea level to 1500 m above sea level (Anon., 2004). A warm humid climate with temperature ranging from 21 to 32°C is ideal for the plant. The rainfall should be well distributed for a period of 9 months and there should be a dry period of 3 months for flowering (Purseglove *et al*. 1998). In India, parts of Kerala, Karnataka and Tamil

Nadu, northeastern region and Andaman and Nicobar Islands are suitable for vanilla cultivation. Clayey soils and waterlogged areas are not suitable for the plant.

2.1.3 Propagation

Vanilla is usually propagated by stem cuttings. Cuttings of 60-120 cm long can be selected as planting material for direct planting in the field (Purseglove *et al.* 1998). The stem cuttings after collection should be washed thoroughly and dipped in Bordeaux mixture 1% or copper oxychloride 0.2% for killing pathogenic fungi, if any. Then the cuttings are stored in a cool shaded place for 2-3 days for partial loss of moisture, a process that enhances rooting. Tissue cultured plantlets can also be utilized for planting.

2.1.4 Planting and After Care

Vanilla can be raised either as mono-crop or intercrop in coconut and arecanut gardens. It is usually trailed on low branching, rough barked trees like Glyricidia maculata, Plumeria alba, jack (*Artocarpus heterophyllus*), Erythrina sp., etc. or on dead standards. The standards have to be planted well in advance at a spacing of 1.2-1.5 m within rows and 2.5-3.0 m between rows. The vanilla plants should be allowed to trail horizontally on poles tied to trees after trailing to a height of 1.5- 2.0 m or coiled around the branches so as to facilitate pollination and harvesting. The cuttings should be planted with two nodes below the soil surface and at the rate of two cuttings per standard. The cuttings sprout within 4-8 weeks (Pruthi, 2000).

2.1.5 Manuring

The quantity of fertilizers to be applied may vary based on the fertility status of the soil. However, 40-60 g of N, 20-30 g of P_2O_5 and 60-100 g of K_2O should be given to each vine per year besides organic manures such as vermi compost, oil cakes, poultry manure, wood ash etc (Anon., 2001).

2.1.6 Flowering and Pollination

Vanilla usually starts flowering in the third year of planting. The flowers are to be artificially pollinated (hand pollination) for fruit set. Since the flowers last only for a day, pollination must be done on the same day. The remaining flower buds are nipped off. In hand pollination method, a pin or needle or small piece of pointed wood or a toothpick is ideal to apply pollen on the stigma of the flower. For pollination, the stamen cap is removed by a needle exposing the pollinia. Then the flap like rostellum is pushed up and the pollinia are brought into contact with the stigma (Madhusoodanan *et al*.2003).

2.1.7 Plant Protection

Vanilla is susceptible to many fungal and viral diseases. Fusarium sp, Sclerotium sp, Phytophthora sp and Collectrotricum sp cause rots of various plant parts, namely, root, stem, leaf, bean and shoot apex which could be controlled by spraying Bordeaux mixture (1%), Bavistin (0.2%) and Copper oxychloride (0.2%) (Thomas *et al*., 2003). The disease spread can be managed by soil application of Trychoderma @ 0.5kg/plant in the rhizospheres and foliar application of Pseudomonads @ 0.2%. Mosaic, leaf curl and Cymbidium mosaic potex virus are the common vanilla viral diseases. The insect pests of vanilla include beetles and weevils (Anilkumar, 2004).

2.1.8 Harvesting

The beans or pods are ready for harvest 6-9 months after flowering. The beans can be considered as mature when they change from green to pale yellow. At this time, the pods may be 12-25 cm long (Pruthi, 2000). The right picking stage is when the distal end of the pod turns yellow and fine yellow streaks appear on the pods. Daily picking of mature pods is essential. The pods can be harvested by cutting with a knife. A good vanillery yields 300-600 kg of cured beans per hectare per year (Pruthi, 2000).

2.2 Post Harvest Technology

2.2.1 Quality Requirements

The primary quality determinant for cured vanilla beans is the aroma/flavour character. Other factors of significance in quality assessment are the general appearance, flexibility, the length and the vanillin content. The relative importance of these various quality attributes is dependent upon the intended end-use of the cured beans. Traditionally, the appearance, the flexibility and size characteristics have been of importance since there is fairly close relationship between these factors and the aroma/flavour quality. Top quality beans are long, fleshy, supple, very dark brown to black in colour, somewhat oily in appearance, strongly aromatic and free from scars and blemishes. Low-quality beans are usually hard, dry, thin, brown or reddish-brown in colour and possess a poor aroma. The moisture content of top grade beans is high (30 to 40 per cent), whereas it may be as little as 10 per cent in the lower grades. At one time, the presence of a surface coating of naturally exuded vanillin crystals ('frosting') is regarded as an indicator of good quality.

2.2.2 Curing

The curing of vanilla pods has been defined as their controlled ripening. It the is process of alternatively sweating and drying of the pods until they have lost most of their moisture as much as 80 %. It is extremely important stage in production since during curing they undergo the enzymatic reaction responsible for the characteristic flavour of vanilla. The full flavour of the cured pods is obtained only towards the end of the curing process (Havkin-Frenkel *et al*., 2003).

A number of procedures have been evolved for the curing of vanilla but they are all characterized by four phases (Anon., 1998):

1. **Killing**: This stops further vegetative development in the fresh bean and initiates the onset of enzymatic reaction responsible for the production of the aroma and flavour. Killing is indicated by the development of a brown colouration in the bean.

2. **Sweating:** This involves raising the temperature of the killed beans to promote the desired enzymatic reaction and to provoke a first, fairly rapid, drying to prevent harmful fermentations. During this operation, the beans acquire a deeper brown colouration and become quite supple, and the development of an aroma becomes perceptible.

3. **Slow drying:** The third stage entails slow drying at ambient temperature, usually in the shade, until the beans have reached about one third of their original weight.

4. **Conditioning**: The beans are stored in closed boxes for a period of three months or longer to permit the full development of the desired aroma and flavour.

There are several methods of treating vanilla pods.

a) Peruvian Process

In Peruvian process (Anon., 2004) curing is done by hot water. In this process pods are dipped in boiling water. The ends are tied and hung in the open. They are allowed to dry for 20 days. Later they are coated with castor oil and afterwards tied up in bundles.

b) Guiana Process

In Guiana process (Anon., 2004) the pods are collected and dried in sun till they shrivel. Later they are wiped and rubbed with olive oil. The ends are tied up to prevent splitting and then bundled.

c) Alcohol Method

In alcohol method, killing is done by cutting the beans into small pieces and soaking successively in hot alcohol having a concentration of 65 to 70%.

d) Indonesian process

In Java (Indonesia) & Uganda, (www.swsbm.com) the curing process is done much more quickly, with the beans being cured over a smoky fire. This results in an inferior bean that is used only in lower-grade extracts, as with split beans.

e) Bourbon method

In Bourbon process (Purseglove *et al*., 1988) bamboo baskets with the beans are immersed in hot water (63-65°C) for 3 minutes. After rapidly draining the water when the beans are still hot, they are kept in wooden boxes lined with blankets. The beans acquire chocolate brown colour the following day. They are then spread in the sun on dark colour cotton covers for 3-4 hours and later rolled up to retain the heat and stored in wooden boxes. This process is repeated for 6 to 8 days, during which the beans lose some weight and become very supple. Later the beans are dried by spreading them out in wooden trays under shade in an airy location. The duration of drying varies according to the size of the beans and usually lasts for 15-20 days. Properly dried beans are kept in closed containers where the fragrance is fully developed. Finally they are graded according to size and kept in iron boxes lined with paraffin paper. Properly cured vanilla beans contain about 2.5% vanillin.

f) Mexican Process

In the Mexican process (Anon, 2004), the two main traditional forms of curing employed are the sun-wilting and the oven-wilting procedures. The former is the oldest known method of curing and the latter was introduced around 1850. Both methods are still widely used by the specialist curing firms in Mexico which process the vast bulk of the vanilla crop.

Sun-wilting - On arrival at the curing house, the fresh beans may be set aside in a store for a few days until required and during this time the beans start to shrivel. The beans are killed by exposing them to the sun for a period of about five hours on the day after sorting. The fresh beans are spread out on dark blankets resting on a cement ratio or on wooden racks. In the afternoon, the beans become too hot to hold by hand and are then covered by the edges of the blanket. In the mid-to late afternoon before the beans have begun to cool, the thick ends of the beans are laid towards the center of the blanket and rolled up. The blanket rolls are immediately taken indoor and are placed in blanket-lined, airtight mahogany boxes to undergo their first sweating. Blankets are placed over the sweating boxes to prevent loss of heat. After 12 to 24 hours, the beans are removed and inspected. Most of the beans will have begun to acquire a dark-brown colour indicating a good killing. Beans, which have retained their original green colour or which have an uneven colouration are separated and are subjected to oven-wilting. Those beans, which have been properly killed, are next subjected to a process involving periodic sunning and sweating. Sunning entails spreading the beans on blankets and exposing them to the sun for two to three hours during the hottest part of the day when weather conditions are favourable. During the remaining part of the day, unless a sweating is to be undertaken, the beans are stored indoors on wooden racks in a well-ventilated room.

There are two distinct phases to this sunning/sweating stage. The first phase involves a fairly rapid drying in which the beans are given sunning virtually every day and several overnight sweating until they become supple. This takes about five to six days. A preliminary sorting into lots corresponding to the various grades is usually carried out at this juncture. This is followed by further sunning and additional but less frequent sweating. In practice, sunning is not carried out every day in this second phase since, apart from constraints imposed by the weather, too rapid drying is considered to be detrimental to quality. Some 20 to 30 days after killing, most of the beans become very supple and acquire characteristics close to those of the final product and are ready for the next stage of very slow drying indoors. The total number of sweating undertaken during the sunning/sweating' operation can vary between four and eight. Those beans, which require a large number of sunning and sweating generally, provide a low-quality product.

Very slow drying indoors lasts for approximately one month and a further sorting into grades is usually carried out during this time. The beans are regularly inspected and those, which have achieved the requisite state of dryness, are immediately removed from the racks for conditioning. The overall sweating and drying operation may take up to eight weeks from the time of 'killing', according to the prevailing weather conditions. Small and split beans are usually ready for conditioning earlier than perfect, large beans. Beans removed for conditioning are sorted again and are straightened by drawing them through the fingers. This operation is also useful in that it spreads the oil, which exudes during the curing process and gives the beans their characteristic luster. The beans are next tied into bundles of about fifty with black string. The bundles are wrapped in waxed paper and are placed in waxed paper lined, metal conditioning boxes. Conditioning lasts for at least three months and during this period the beans are regularly inspected. At the end of the conditioning period, the beans are given a final grading and are packed for shipment.

Oven-wilting- In this procedure, use is made of a specially constructed brick or cement room, known as a calorifico, which serves as an autoclave. The room measures approximately 4 x 4 x 4 metres and incorporates a wood-fired heater, which is stoked from the outside. It is fitted with a small access door and has wooden racks fitted along the walls. The beans to be killed by this method are divided into piles of up to 1000 and are then rolled up in a blanket, which is finally covered with matting to form a malleta. The malletas are moistened with water and are placed on the shelves in the calorifico. Water is poured onto the solid floor to maintain a high humidity, the door is closed and the heating fire is lit. In about 12 hours, the temperature inside the calorifico reaches 60°C. After a further 16 hours, a temperature of 70°C is attained and this is maintained for another 8 hours. The malletas are removed after a total of 36 hours in the calorifico. If the temperature cannot be raised above 65°C, then the total period of autoclaving is extended to 48 hours. On removal from the calorifico, the matting is quickly stripped from the malletas and the blanket wrapped beans are placed in sweating boxes. After 24 hours, the beans are removed and inspected. The killed beans are then subjected to repeated sunning and sweating, as described above under Sun-wilting.

2.2.1.1 Research Highlights

Balls and Arana (1941a) conducted the sweating of vanilla beans by holding them at high humidity and high temperature (45 to 65^{0}C) for 7 to 10 days. They concluded that the purpose of sweating is to retain enough moisture to allow enzymes to catalyse various hydrolytic and oxidative processes.

Arana (1943); Theodose (1973) concluded that the stated purpose of the various killing methods is to bring out the cessation of the vegetative life of the vanilla bean and allow contact between enzymes and substrates.

Arana (1944) compared traditional sun-drying/sweating procedures with an electric oven set at 45 ^{0}C in which the humidity was kept high. Oven sweating and drying was found to have advantages in that the incidence of mould was less, a shorter time was required and the procedure was less labour-intensive.

Arana (1944) and Jones and Vincente (1949c) showed that the common practice of harvesting green beans does not flavour the production of cured vanilla with a fine aroma and flavour or a high vanillin content. The best results are obtained with beans harvested at the blossom-end yellow phase.

Arana (1944) compared traditional sun drying/sweating procedures with an electric oven set at 45ºC in which the humidity was kept high. Oven sweating and drying was found to have advantages in that the incidence of mould was less, a shorter time was required and the procedure was less labour intensive. He considered the optimum moisture content for cured beans to be 30-35%.

Cernuda and Louistalot (1948) studied the use of infrared lamps for sweating of vanilla but found it to be a costly method of heating with no marked advantages and as one that could initiate considerable deleterious oxidations.

Jones and Vincente (1949a) carried out a study of the conditioning temperature effects on quality. Temperatures in the range of 35-45ºC were found to accelerate conditioning and to provide a product, which was considered to have a superior aroma to those, conditioned at 13ºC or 27ºC.

Corell (1953); Bouriquet (1954) developed a system of seven grades for export of whole beans, in descending order of quality as: Extra, Superior, Good Superior, Good, Medium Good, Medium and Ordinary. This was based on the moisture content, colour, general appearance and aroma quality.

Theodose (1973) reported a curing method in which beans are not chopped until after killing by scalding and an initial sweating. The killed beans are then sliced into 2-3 cm in lengths and are subjected to hot-air drying at 65ºC in a tunnel drier. Then they are sweated in boxes for 24hrs at 50ºC, for 12 days. The moisture content of the product obtained was found to be 20-25%.

Ansaldi et al. (1990) developed a method of killing in which the beans are frozen by dipping in liquid Nitrogen or by holding the beans for a few hones in a freezer (0^0 C to – 80 ^{0}C).

Havkin-Frenkel et al. (2000) studied the inter-relation of curing and botany in vanilla (v. planifolia) bean. The studies revealed that flavour precursors are found in the bean interior, whereas hydrolytic or other degradative enzymes, which catalyze the release of the flavour precursors to flavour compounds, are localized mostly in the outer fruit wall region. This suggests that the objective of killing is to disorganize the bean tissue, such that contact is created between substrates and their respective enzymes. Sweating provides conditions for enzyme-catalyzed production of flavour compounds and also for non-enzymatic reactions. The objective of the final curing steps, including drying and conditioning, is to dry the cured beans to preserve the formed flavoured compounds.

Dignum *et al*. (2001) conducted vanilla curing under laboratory conditions in which the cured vanilla beans were analysed for enzyme activity and aroma. The activity of the enzyme was highest in green beans. They concluded that the normal scalding leads to inactivation of non-specific glucosidase while the prolonged scalding also inactivates the specific glucosidase.

Dignum *et al*. (2001 a) proved that the storage of frozen beans must be carried out at -70^{o}C or below to preserve the viability of enzymes that are involved in the curing process.

Anon. (2003) investigated the presence of β -D-glucosidase formed during the curing process of vanilla beans. The kinetics of β-glucosidase activity from green vanilla beans towards and glucosidase naturally occurring in vanilla and towards P-nitrophenol were investigated.

Havkin-Frenkel *et al*. (2003) conducted studies on the botany of vanilla beans which revealed that flavour precursors are found in the bean interior while the enzymes which catalyse the release of the flavour precursors to the flavour compounds are localized mostly in the outer fruits wall region.

Abdulla (1997) conducted studies on drying of vanilla pods using a green house effect solar dryer, and found, at RH of 34 % and temperature range of 50 to 60 ^{0}C time needed for drying vanilla pod from moisture content 80.9 %(wb) initial to 37.8 % (wb) was 51.3 hours or seven days as compare to 12 to 15 days in sun drying.

Anon. (1998) analysis of moisture and vanillin content was studied at Quality Laboratory, Spices Board, Kochi, and concluded that in high ranges, vanilla curing yield more vanillin in raised platform.

2.2.2 Constituents of Cured Vanilla

The chief constituent of vanilla is the aromatic, crystalline substance vanillin, which is the aldehyde of methyl-protocatechuic acid; good beans contain from 2 to 2.75 %. Other constituents are vanillic acid, resin (4 %), fat (11 %), sugar (10%) etc. (Anon, 1998).

2.3 Products and By-products

2.3.1 Vanilla Extract

Vanilla extract is hydro alcoholic solution containing the extracted aroma and flavour principle of vanilla beans and may also contains added sweetening / thickening agents such as sugar and glycerin. Conventional vanilla extract have a minimum ethyl alcohol content of 35%. Vanilla extract is made by chopping the beans, then immersing them in a mixture of alcohol & water, which is continuously re-circulated through the beans until the essential flavour components are dissolved into the liquid. Which takes about 48 hours (Pruthi, 1998). The resulting perk is then filtered into a holding tank, where it is aged, like wine. Sugar or corn syrup is added to mellow the alcohol and to assist in ageing. Once bottled, the ageing process can continue for two to three years. Imitation vanilla extract is any vanilla that contains other than natural vanilla flavours.

2.3.1.1Research Highlights

Swami (1947) suggested that vanillin is produced in the glandular hairs, whose presence can be casually noted by previous investigators.

Childers *et al*. (1959) observed that vanillin crystals formed during curing appear mostly on the blossom end of green vanilla pod (40 %).

Menory (1968) described an operation to prepare 379 litres of twofold vanilla extract with a 35% ethanol content.

Ranadive *et al.* (1983) conducted research on vanillin biosynthesis in vanilla beans and found that, when protected against protrolysis, β-glucosidase activity expressed as µg product/hr/µg protein was as follows: 75.2% in green outer fruit tissue, 32.3 % in the placental tissue and 11.1 % in the glandular hair cells.

Leong *et al* (1989) conducted research on the glucoside fraction of vanilla beans and found glycosyl conjugates of vanilla or other phenolic compounds conjugated to mannose, galactose and rhamnose in trace amounts in the developing vanilla pod.

2.3.2 Vanilla Flavouring

This is similar to vanilla extract but contains less than 35% ethyl alcohol by volume (Pruthi, 2000).

2.3.3 Vanilla Tincture

This is prepared by maceration from one part of vanilla beans by weight to ten parts of aqueous alcohol by volume and contains added sugar. It differs from vanilla extract in having an ethyl alcohol content of at least 38% (Felter and Lloyd, 1898).

2.3.4 Vanilla Oleoresin

Oleoresin is the solid or semisolid residue obtained by the solvent extraction of vanilla followed by complete removal of the solvent by distillation under vacuum. Extraction is carried out either in a percolated vessel or in a sealed vessel. The prepared solvents are 50% ethanol and 50% aqueous iso-propanol (Purseglove et al., 1988).

2.3.5 Vanilla Powder

It is a mixture of vanilla oleoresin with sugar, food starch or gum acacia (Pruthi, 2000).

2.3.6 Vanilla Absolute

This is prepared by direct alcohol extraction of vanilla beans followed by solvent stripping or by alcohol washing of an oleoresin prepared by extraction with a hydrocarbon solvent. This is most concentrated form of the vanilla aroma, being 7to 13 times stronger than good quality vanilla beans (Purseglove et al., 1988).

MATERIALS AND METHODS

MATERIALS AND METHODS

This chapter deals with the experimental set up, the methods employed for curing and the measurement of various objective functions. Details of materials, techniques used for measurement and test procedures have been given under different heads.

3.1 Materials Used

3.1.1 Data Collecting Material

Schedules for data collection was prepared both in Malayalam and English, each containing 52 questions, were used for conducting survey among vanilla growers (Plate No.1 - 3) to identify various constraints in vanilla cultivation and processing. The schedules contain 16,30,3 questions regarding cultivation, processing, and marketing respectively. Format of the schedule used is given in Appendix- I.

Plate No.1 Vanilla Growers Conducting Curing

Plate No.2 Sorting of Fresh Vanilla Beans

Plate No.3 Sun Drying by Farmers

3.1.2 Raw Material

Fully matured, fresh vanilla beans (variety *V. planifolia*) purchased from Kalpetta, Wayanad district were used for curing, under different treatments, maturity was justify by observing the yellow colour at tips of the beans (Plate No.4).

Plate No.4 Fresh Vanilla Beans

3.2 Experimental Setup

The experimental set up for curing vanilla beans mainly includes the following components viz. Water, Ethyl Alcohol, Black Blanket, White Cloth, Convective drier, Wooden box, Wooden Shelf, Bee-wax paper, Thermometer, Hygrometer.

3.2.1 Water

Hot water was used for killing the vanilla beans.

3.2.2 Ethyl Alcohol

Ethyl alcohol of concentration 65 – 70 % was used for killing of vanilla beans.

3.2.3 Black Blanket

Three black woolen blankets each having dimensions 370 x 160 cm were used for sweating of vanilla beans. Each blanket was cut into four parts each of size 135 x 80 cm.

3.2.4 White Cloth

A white mill cloth of size 1200 x 115 cm was used for sweating of the beans. This was cut into twelve equal parts each of dimensions 115 x 100 cm.

3.2.5 Convective Drier

The convective drier available in Agricultural Processing lab (Royal Scientific Inst. Co., Chennai) was used for drying the vanilla beans (Plate No.5). Three trays each having dimensions 82 x 41.8 cm were fabricated by using wire mesh, of size 15 x 15mm. Using a vernier caliper, of LC 0.02mm, the diameter of the wire was obtained as 1.6mm.

The perforated area was calculated as follows (Sahay and Singh,1994):

$$P = \frac{O^2}{(O+D)^2} \times 100$$

Where, 'P' is the open area (%)

'O' is the size of opening (mm)

'D' is the wire diameter (mm)

Plate No.5 Convective Drier

3.2.6 Wooden Box

A wooden box made of teak having dimensions 152 x 60 x 60 cm was used for sweating and conditioning of beans (Plate No.6 & fig.3.1)

3.2.7 Bee-Wax Paper

Bee –Wax paper of dimensions 450x350 mm was used for bundling the vanilla beans during the conditioning process.

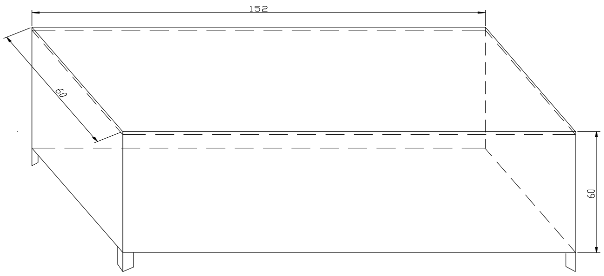

Fig.3.1.Isometric View of Wooden Box

Plate No.6 Wooden Box

3.2.8 Thermometer

A mercury thermometer with LC of 1^0C was used to measure the temperature at various stages of curing.

3.2.9 Wooden Shelf

A wooden shelf of dimensions 122 x 30 x 182 cm was used for slow drying of the beans. It consisted of five racks with each rack made of nylon mesh (opening size- 3mm & diameter of wire - .75 mm), enclosed within a wooden frame of dimensions 122 x 30 cm (Plate No.7 & fig.3.2)

Plate No.7 Wooden Shelf

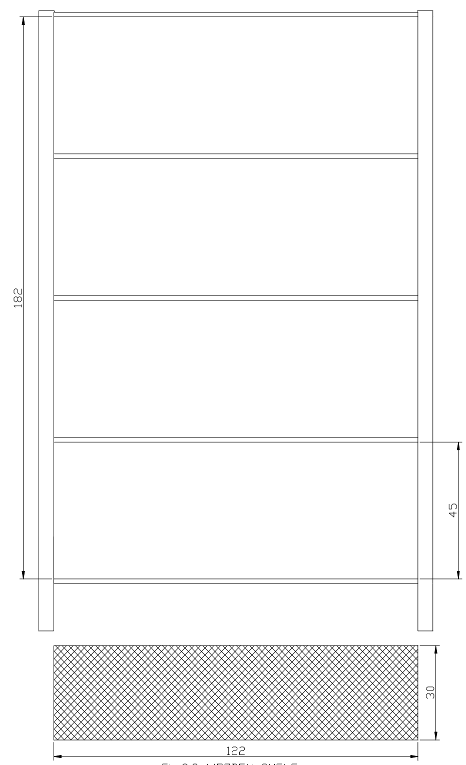

Fig.3.2 WOODEN SHELF
Scale 1cm=10cm

3.2.10 Hygrometer

A hair hygrometer of LC 1% was used to determine the RH at various stages of curing.

3.2.11 Vernier caliper

A vernier caliper of LC 0.02 mm was used to measure the breadth and thickness of the vanilla beans.

3.3 Curing

3.3.1 Preparation of Samples

The beans were washed and sorted based on their length into three grades viz. A, B and C. The 'A grade' beans were having a length greater than or equal to 20 cm. The 'B grade' beans were with a length varying from 15 – 19 cm and the 'C grade' beans had lengths less than 15 cm. Then each of these grades was again divided into 1, 2, 3 and 4 groups for curing them with four different methods. Thus 12 samples were prepared.

3.3.1.1 Measurement of Physical Properties

The physical properties such as length, breadth and thickness of the representative bean from each of the 12 samples were measured using a vernier caliper. The total weight of each sample was also measured using the electronic balance (LC 0.01g).

3.3.1.2 Determination of Initial Moisture Content

The moisture content of three beans each from A B and C grades were determined using oven dry method. The beans were kept in the oven at 105°C for 24h. This process was continuing till constant weight was achieved.

$$\text{Moisture content at wet basis (\%)} = \frac{Wm}{(Wm + Wd)} \times 100$$ (Sahay and Singh,1994)

where,

Wm = weight of moisture (gm)

Wd = weight of dry matter (gm)

3.3.2 Curing Procedure

3.3.2.1 Treatment Details

The curing of vanilla beans was done using different methods:

Method I: Bourbon method of curing consisting of hot water killing followed by sun drying, slow drying and conditioning.

Method II: Curing consisting of killing of beans using alcohol followed by sun drying slow drying and conditioning.

Method III: Curing consisting of hot water killing followed by high temperature mechanical drying slow drying and conditioning.

Method IV: Curing consisting of hot water killing followed by low temperature mechanical drying slow drying and conditioning.

The initial stage of curing, ie. killing was performed by two methods viz. hot water killing and alcohol method of killing. Second step i.e drying was tried by sun drying, mechanical drying at low temperature and mechanical drying at high temperature. The flowchart for the entire curing procedure is shown in Fig. 3.3. The details of the procedure are as follows:

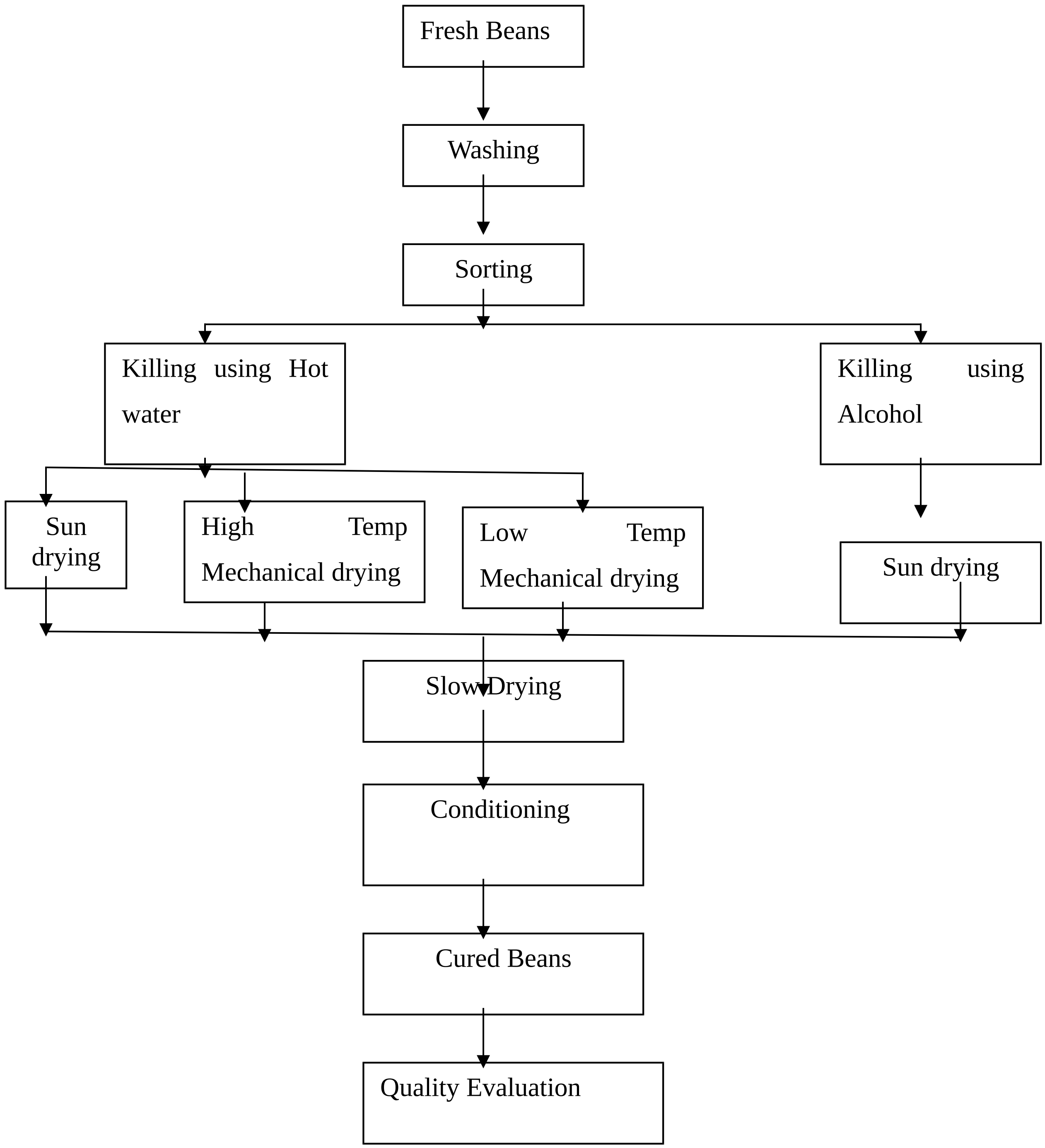

Fig. 3.3 Flow Chart Showing Vanilla Curing Process

3.3.2.2 Killing

Two different killing methods were adopted.

3.3.2.2.1 Killing Using Hot Water

This method was adopted for killing the first (A1, B1, C1), third (A3, B3, C3) and fourth (A4, B4, C4) sets of samples. Killing was achieved by dipping the beans in hot water at 65ºC (Plate No.8). The duration of killing was 3.5min, 3min and 2.5min for the A, B and C grade beans respectively. After killing the excess water was wiped off using a muslin cloth.(Purseglove *et.al.*1998)

Plate No.8 Killing Using Hot Water

3.3.2.2 .2Killing Using Alcohol

The second set of samples (A2, B2, C2) was killed by dipping in Ethanol of concentration of 65-75% for 10min (Plate No.9).

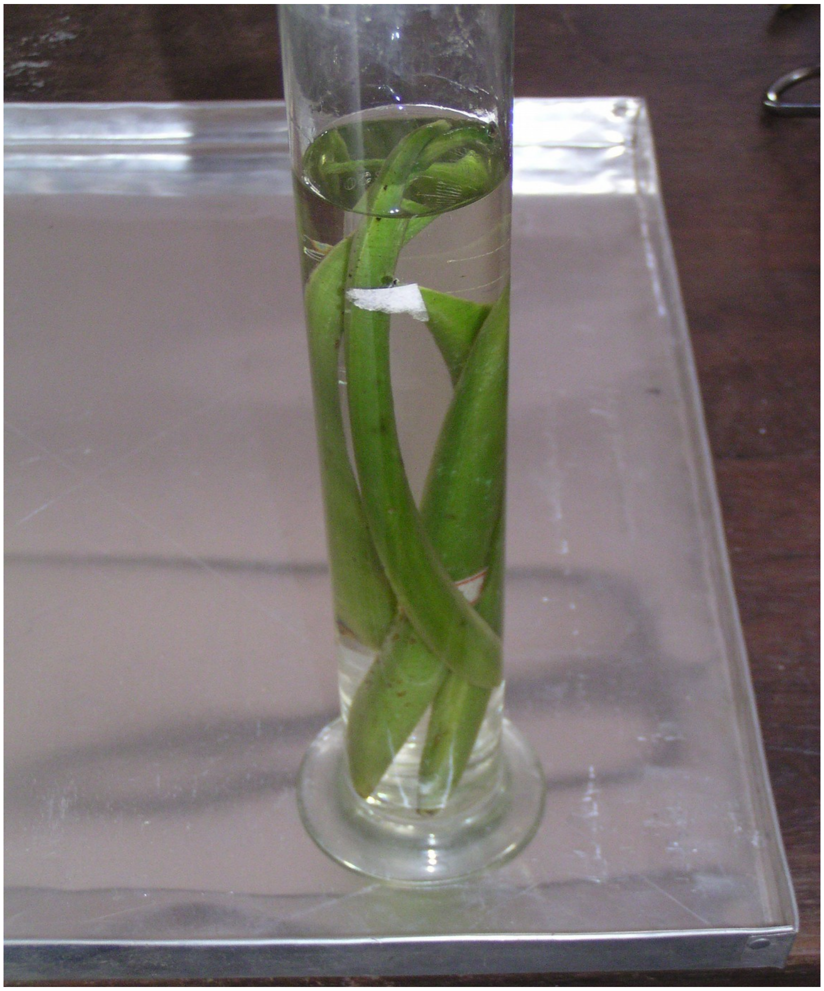

Plate No. 9 Killing Using Alcohol

3.3.2.3 Sweating

In this step the temperature of the beans was raised by two different methods.

3.3.2.3.1 Alternate Sweating and Sun Drying

This method was adopted for the first (A1, B1, C1) and second (A2, B2, C2) sets of samples. The beans after killing were made to sweat by wrapping in black woolen blanket lined with white cloth and stored in air-tight wooden box for 24hr.This was then followed by exposing them to sun light for about 1-1.5hr during day time in a raised platform erected at about 75 to 100cm above the ground (Plate No.10 &11). This process of alternate exposure to sun and wrapping in woolen blanket and storing in wooden box was repeated for 10 days. The beans were weighed before sun drying at an interval of 24h. (Purseglove *et.al.*1998).

Plate No.10 Sun Drying

Plate No.11 Sweating in Wooden Box

3.3.2.3.2 Mechanical Drying

This process involved sweating and drying of method III and method IV samples, on perforated trays, at different temperature. High temperature mechanical drying was done for the samples A3, B3, C3 here the drying temperature was increased from temperature 50-70^{o}C with step of 10^{o}C. While for the low temperature mechanically dried samples A4, B4, C4, drying was done at the temperature 50,55 and 60 ^{o}C. This has been given in Appendix-II. Drying was done for one-hour duration, at 12 hours interval. The whole process took 6 days to reduce the MC to required level.

3.3.2.4 Slow Drying

All the four sets of beans were allowed to dry slowly by spreading them on perforated trays fitted on to a wooden rack at ambient temperature. The relative humidity of the room was kept above 80% by hanging moistened cloths and keeping water in trays below the racks. The beans were checked regularly to prevent any mould growth and turned upside down for uniform drying. They were weighed and the dimensions were measured at every 12h interval. The duration of slow drying was 8 days for all the samples.

3.3.2.5 Conditioning

The beans were bundled and tied at both the ends using black threads. They were then properly packed in bee wax paper and stored in air-tight containers to allow full development of flavour and aroma. The duration of conditioning was 30 days. The observations were taken at every one-week interval.

3.4 Quality Evaluation:

The quality of cured vanilla beans was analyzed based on the vanillin content and moisture content. This was tested at the quality evaluation laboratory, Spices Board, Cochin. The vanillin content was tested by AOAC method 990.25,2000 and the moisture content by the ASTA method 2.0,1997. The result has been given in Appendix-XV.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

This chapter enunciates the results of the survey and the experiments conducted to standardize the vanilla curing techniques. The various constraints in vanilla cultivation and curing and the different physical parameters, which in turn affect the quality of cured beans, have been discussed in detail.

4.1 Farm -and-Home Visit

Results of the survey on constraints of vanilla cultivation and processing are described under the following headings.

4.1.1 Constraints in Vanilla Cultivation

Vanilla planifolia is the major variety grown in all the four districts under study. All the farmers in the sample survey are educated and own their farms. Table-4.1 shows the classification of the farmers according to the land holding. Ten percentage of the total farmers were in the small-scale category (< 1 acre); 62.5% were in the medium-scale group and (1-3 acre); and 27.5% in large-scale group (≥ 3 acres). The table also shows an increase in area under vanilla cultivation with the increase in total agricultural area (Figure-4.1 and Table-4.1).

Table 4.1. Area under vanilla cultivation

Area under vanilla(acres)	Number of Far	Total area	Percentage of total area under

	mers	**(acres)**	**vanilla cultivation**
<1	4	4	23
1-2	19	6	31
2-3	6	9	32
3-4	2	11.5	34
≥4	9	16	37

Fig. 4.1: Percentage of total area under vanilla cultivation

There was no significant variation in the cropping practices from one district to another. Planting is done in August or September. Flowering commences in the third year after planting and is noticed from December to March. Since the natural pollination is not possible, artificial pollination is practiced for vanilla. This is the major constraint faced by the farmers. Artificial pollination is done on the same day of flower opening, usually from 6 am to 12 noon.

Majority of the farmers are using bio-fertilizer (92.5%)for vanilla cultivation, whereas a few are using chemical fertilizer (5%). The remaining farmers are not using either bio-fertilizer or chemical fertilizer. Most of the farmers are practicing irrigation for their cultivation, however they are facing acute water shortage in the dry spell. The details of the irrigation systems are given in Table-4.2.

Table 4.2. Adoption of Cultivation Techniques

Characteristics	Percentage of adoption
Irrigation:	
➢ Sprinkler Irrigation	75
➢ Mist Irrigation	25
Fertilizers:	
➢ Bio- Fertilizers	92.5
➢ Chemical	5.0
➢ No Fertilizers	2.5

In Calicut, Kannur, and Wayanad districts, harvesting is done during the month of December while in Idukki, harvesting begins in January. During the interview session with the farmers, it was observed that most of them derive less income than that is expected due to spread of fungal infection and water shortage. Lack of marketing facility and theft are the other major constraints. Some of the farmers are using electric fencing to protect cultivation.

4.1.2 Constraints in Post Harvest Technology of vanilla

The common method of curing the vanilla beans that is being adopted by farmers is the Bourbon method. Careful processing of beans by this method takes nearly 4 months depending upon the climatic conditions. Curing is done within 1 to 2 days after harvesting. Labour requirement for curing process varied from 5 to 10 persons. All the farmers do curing without the help of external processing agencies. However most of them follow the expertise from the Spices Board. Figure: 4.2 shows that the 72.5 per cent of the farmers are practicing curing and the remaining is selling the raw beans.

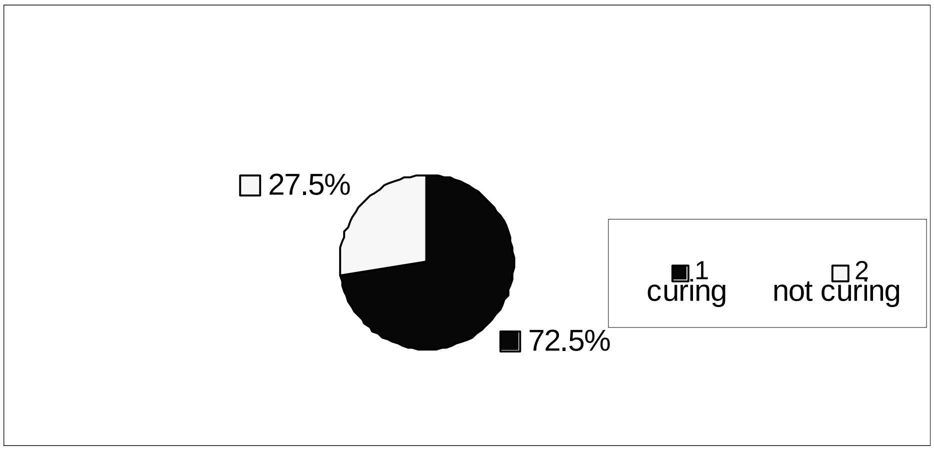

Fig.4.2 Curing practices

It is also observed that the farmers with very small land holding (<1 acre) prefer a group venture rather than processing the beans individually (Table-4.3). However about 50 percentage of the very small land holding farmers sell the beans as raw. The analysis also showed a positive trend in individual processing with the increase in land area. The farmers who possess l above 3 acres of vanilla cultivation are doing the processing individually. This is due to their financial stability. Most of the small and medium scale farmers are also doing the curing process in groups. But as the cultivated area increases, from small to medium, the group processing trend decreased from 58 to 50 per cent. However the large-scale farmers (≥3 acres) are neither interested in joint venture nor prefer to sell the beans as raw.

Table 4. 3. Interaction between land holding and curing

Area (acres)	Individual(%)	Group(%)	No processing(%)
<1(very small)	0	50	50
1-2(small)	5	58	37
2-3(Medium)	33	50	17
3-4(large)	100	0	0
≥4(very large)	100	0	0

Adoption of curing technique is detailed in table-4.4. It shows that the majority of the farmers are practicing the curing technique by sun drying (92.5%). Only 7.5 per cent adopted mechanical drying, that too only during the monsoon season. It is also observed that the majority of farmers prefer a group effort (67.5%) rather than doing individually (32.5%)

Table 4.4. Adoption of Curing Techniques

Characteristics	***Percentage of adoption***
Curing	72.5
Type of processing:	
➢ Group	67.5
➢ Individual	32.5
Method of drying:	
➢ Sun Drying	92.5
➢ Mechanical Drying	7.5

The general conditions adopted in curing are given in the table-4.5. The duration of killing process varies from 2.5 to 3.5 min. This variation is due to the increase in thickness of the vanilla beans. As the thickness increases the killing time has to be increased from 2.5 to 3.5 min., so as to allow the penetration of heat to the interior of the beans. The sweating process is practiced for 8 to 10 days depending on the climate. The time taken and the process parameters are detailed in the Table-4.5.

The table shows that the entire curing process is too lengthy and laborious, which takes almost 3.5 to 4.5 months. The farmers face difficulty in the storage of processed vanilla due to high relative humidity. The high temperature and relative humidity of the storage room is congenial for the growth of different microorganisms, which was another constraint faced by the farmer in vanilla processing. Some of the farmers are using ethyl alcohol treatment to prevent the microbial/ insect contamination**.**

Table 4.5. Conditions of Curing

Stage of Curing	Time	Temperature (ºC)	Relative Humidity (%)
Killing	2.5 – 3.5 min	65	-
Sweating	8 – 10 days	45 - 65	65
Slow drying	20 – 28 days	28	90 – 92
Conditioning	3 months	28-30	55 - 65

At present, there is no market for the processed vanilla in the state. Most of the farmers, sell their produce through different agencies to Bangalore and this was another major constraint faced by the vanilla grower. The study revealed that the initial cost of infrastructure required for processing is less and the net profit gain after processing is comparatively exorbitant. The lack of consistency of profits is another finding of this study.

4.2 Standardization of vanilla curing

Curing was under taken in vanilla beans using four different methods. This facilitated the enzymatic process that transforms glucovanillin into vanilla and development of flavour and aroma. Subsequently the physical properties of the beans were changed which cause a reduction in the initial weight of the beans. The result obtained is discussed under the following headings.

4.2.1 Measurement of physical properties

Vanilla beans procured from the local market were used for the experiments. The test samples were prepared according to the sorting procedure discussed in chapter 3. The dimension of the fresh beans and the initial weight of each sample were measured by standard methods. And results are tabulated in table 4.6.

Table. 4.6 Physical properties of fresh beans

Sample	Avg.Length(cm)	Avg.Width(cm)	Avg.Thickness(cm)	Moisture(wb,%)	Colour
A	21.5	1.27	.90	81.65	Green
B	17.2	1.08	.85	83.43	Green
C	12	1.14	.68	83.06	Green

4.2.2 Calculation of Perforated Area

The perforated area of the drier tray was calculated as per the equation described under 3.2.1. The perforation area is 81.65%. The perforated area of the wooden rack was calculated using the same formula and found out as 46%

4.2.3 Initial moisture content

The moisture content of the beans was estimated by the oven dry method and the results obtained are in table 4.7

Table.4.7 Moisture content of fresh beans

Sample	Initial weight (gm)	Final weight (gm)	Moisture content (wb,%)	Moisture content (db, %)
A	11.99	2.20	81.65	444.95

B	10.14	1.68	83.43	503.50
C	10.51	1.78	83.06	490.32

4.2.4 Variations in Physical Properties

4.2.4.1 Sweating and Drying

The variations in the physical properties of the beans viz. moisture content, length, breadth and thickness for different treatments, during sweating and drying, are discussed under the following heads.

4.2.4.1.1 Moisture Content

The variations in moisture content of the beans during sweating and drying, for the four treatments are depicted in Appendix III and fig.4.3, 4.4 and 4.5.

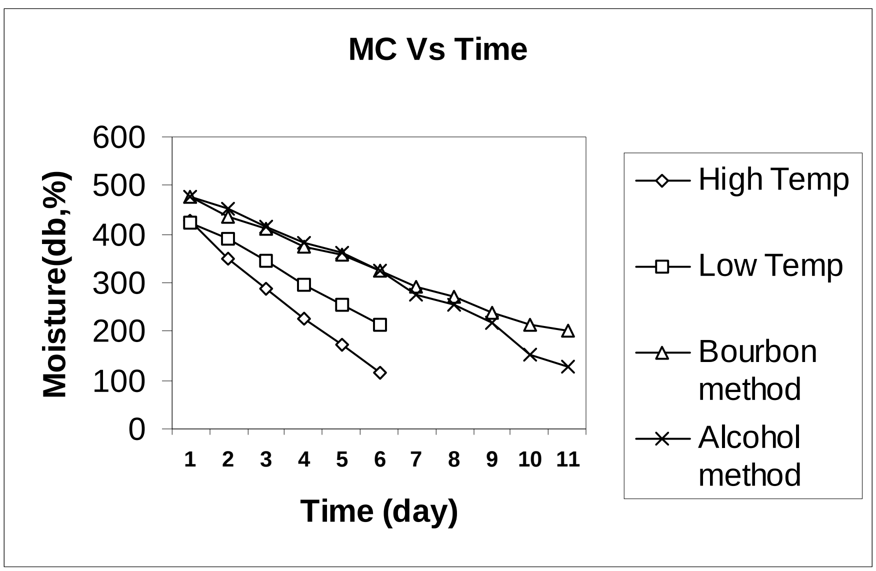

Fig.4.3. MC Vs Time during sweating, for sample A

The moisture content of the A grade beans after high temperature method reduced from 478.38 % to a lower value to 102.55%. However, by low temperature method the initial MC was reduced to 208.07%and by alcohol method MC was found to be 125.72%. The reduction in MC after sweating was minimum in Bourbon method (200.2%).

The linear relationship between moisture content and drying time for the different methods are as follows:

For Bourbon method:

$y = -27.918x + 498.59$ ($R^2 = 0.9943$) -------------(4.1)

For Alcohol method:

$y = -35.443x + 525.4$ ($R^2 = 0.9914$) -------------(4.2)

For High Temperature method:

$y = -61.885x + 479.31$ ($R^2 = 0.9953$) --------------(4.3)

For Low Temperature method:

$y = -42.83x + 471.73$ ($R^2 = 0.9978$) ---------------(4.4)

where, y = moisture content(db) of the beans in %

x = time for sweating in days

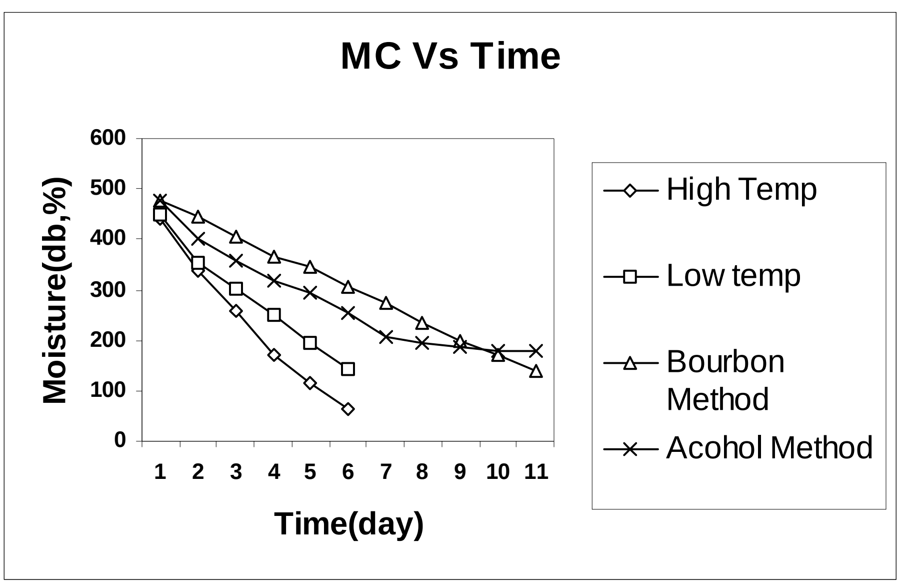

Fig. 4.4. MC Vs Time during sweating, for sample B

The variation in MC for grade B is shown in figure 4.4.The variation in MC was maximum for high temperature method and the MC after sweating was found to be 87.05%. The variation was minimum for bourbon method with a final MC of 203.01%. For the low temperature method the MC reduced to 178.16% while the final MC of the alcohol method was 151.84%

The linear relationship between moisture content and drying time for the different methods are as follows:

For Bourbon method:

$y = -33.972x + 509.68 \quad (R^2 = 0.9985)$ ---------------(4.5)

For Alcohol method:

$y = -29.372x + 454.33 \quad (R^2 = 0.9138)$ ---------------(4.6)

For High Temperature method:

$y = -75.75x + 497.41 \quad (R^2 = 0.9852)$ ---------------(4.7)

Low Temperature method:

$y = -59.037x + 488.95 \quad (R^2 = 0.9856)$ ---------------(4.8)

where, y = moisture content (db) of the beans in %

x = time for sweating in days

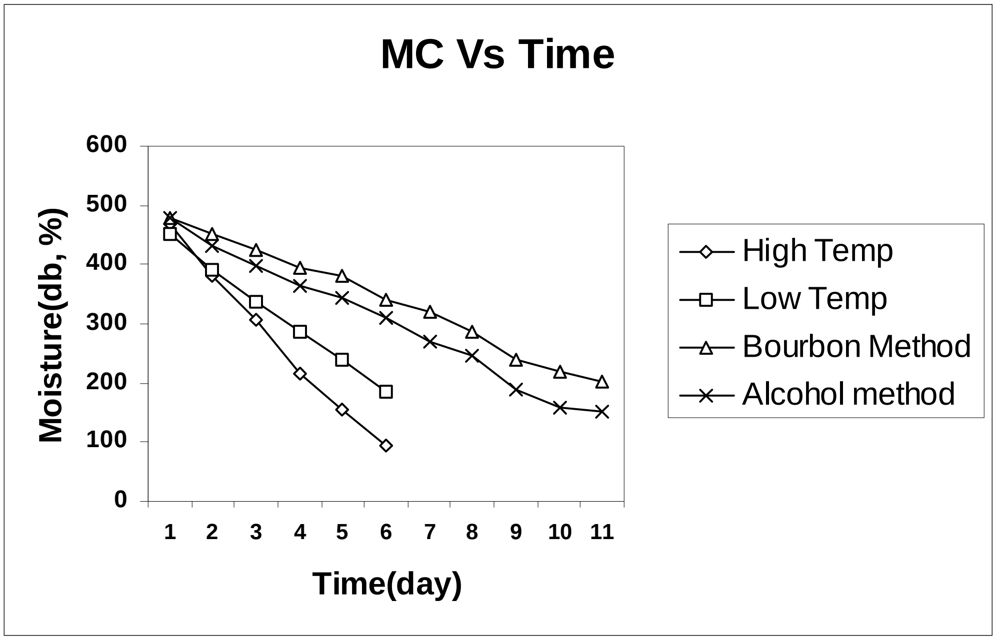

Fig. 4.5. MC Vs Time during sweating, for sample C

The variation in MC for grade C beans is shown in fig.4.5.Grade C beans, after sweating, the percentage reduction in MC was observed as 78.5%, 68.25%, 58.6% and 57.56% for High temperature method, alcohol method, Low temperature method and bourbon method respectively.

The linear relationship between moisture content and drying time for the different methods are as follows:

For Bourbon method:

y = - 28.533x + 51.11 (R^2 = 0.9936) ---------------(4.9)

For Alcohol method:

y = - 33.329x + 503.23 (R^2 = 0.9927) ---------------(4.10)

For High Temperature method:

y = - 75.423x + 534.89 (R^2 = 0.9943) ---------------(4.11)

For Low Temperature method:

$$y = -52.324x + 497.95 \quad (R^2 = 0.9983) \quad \text{---------------(4.12)}$$

where, y = moisture content (db) of the beans in %

x = time for sweating in days

4.2.4.1.2 Length

The variations in the length of the beans, during curing process, for the four treatments are shown in Appendix IV, VIII & XII and fig.4.6, 4.7 and 4.8.

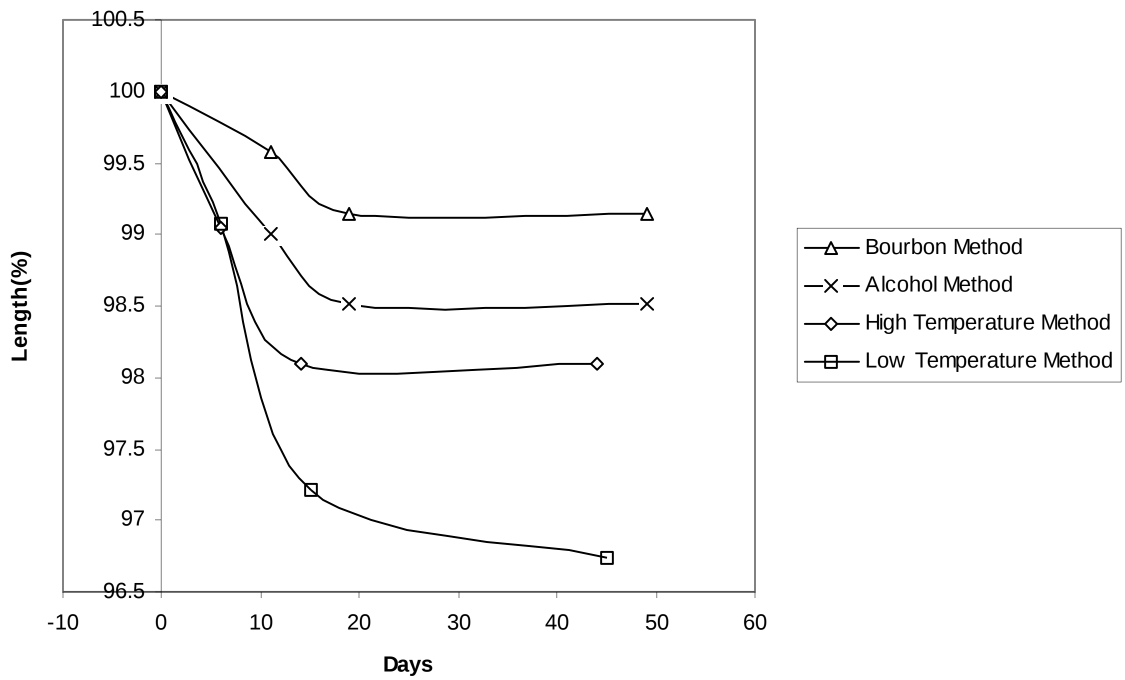

Fig. 4.6. Length Vs Time during curing, for sample A

The variation in length for grade A beans, during sweating and drying, is shown in fig.4.6.The reduction in length was maximum for beans cured by Alcohol method (1%), followed by High Temperature method(0.95 %). The minimum variation is seen for beans cured by Bourbon method (0.43%), preceded by Low Temperature method (0.93%).

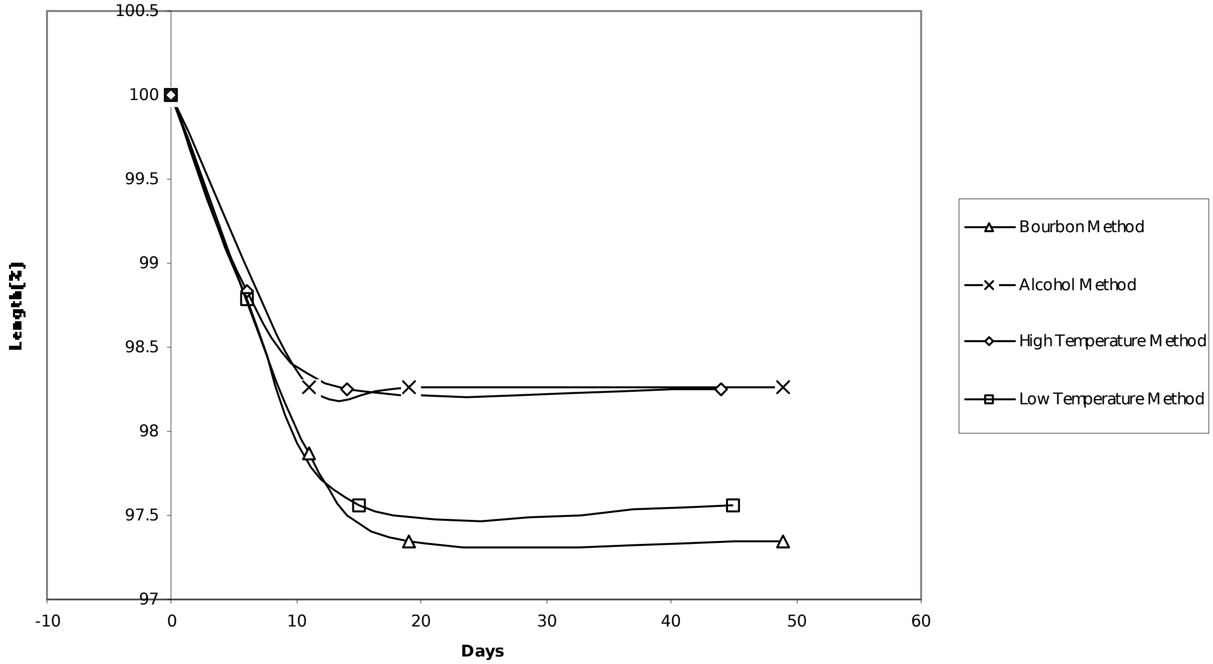

Fig. 4.7. Length Vs Time during curing, for sample B

The variation in length for B grade beans, during sweating and drying, is shown in fig.4.7. The reductions in length were observed to be 2.13%, 1.75%, 1.74% and 1.22% for Bourbon method, High Temperature method, Alcohol method and Low Temperature method respectively.

The variation in length for grade C beans, during sweating and drying, is shown in fig.4.8. The maximum reduction in length was seen for High Temperature method (2.24%) followed by, Low Temperature method (1.75%), Alcohol method (1.72%) and Bourbon method (1.57%).

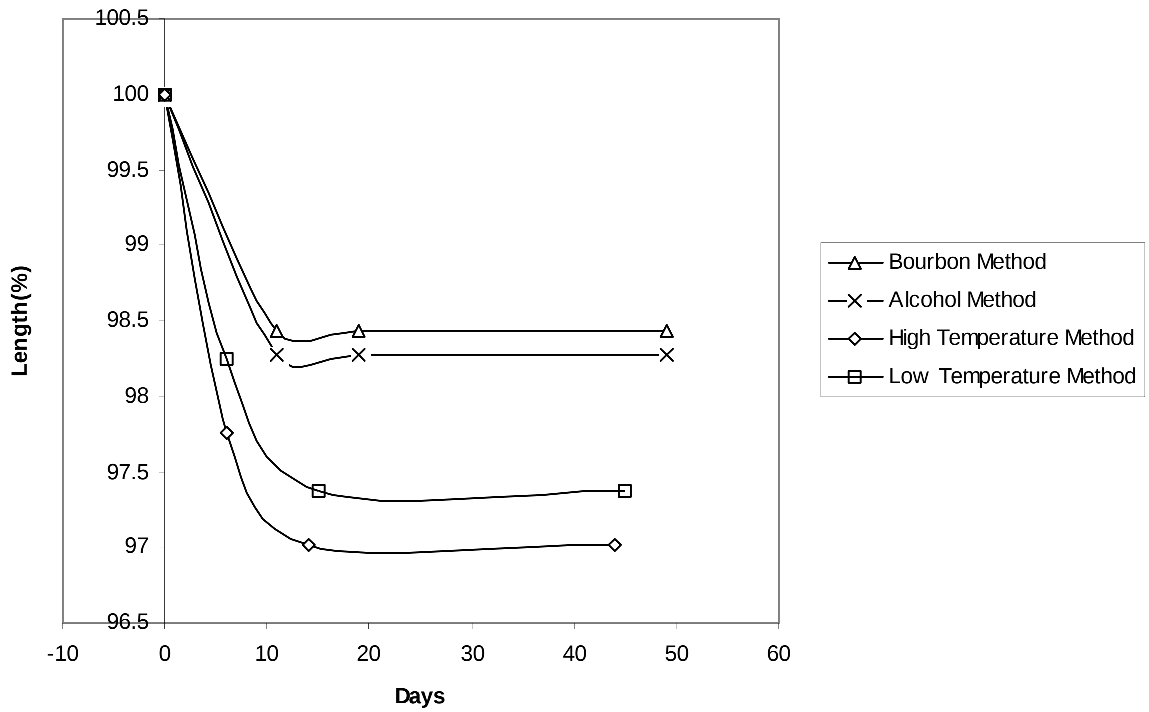

Fig. 4.8. Length Vs Time during curing , for sample C

4.2.4.1.3 Breadth

The variations in the breadth of the beans during curing, are highlighted in Appendix V, IX, XIII and fig 4.9, 4.10 & 4.11.It was observed that the variation in breadth was higher when compared to length.

Fig.4.9 shows the variation in breadth for grade A beans, during sweating and drying. It is revealed that the variation in breadth during sweating is the maximum (36.87%) for low temperature method. There, the breadth reduced from 1.41cm to 0.89cm. For the high temperature method, the reduction was 27.9%. The minimum variation was observed for Bourbon method, the variation being 8.8%. For alcohol method, the breadth of the beans reduced from 1.15cm to 0.79cm.(31.3%).

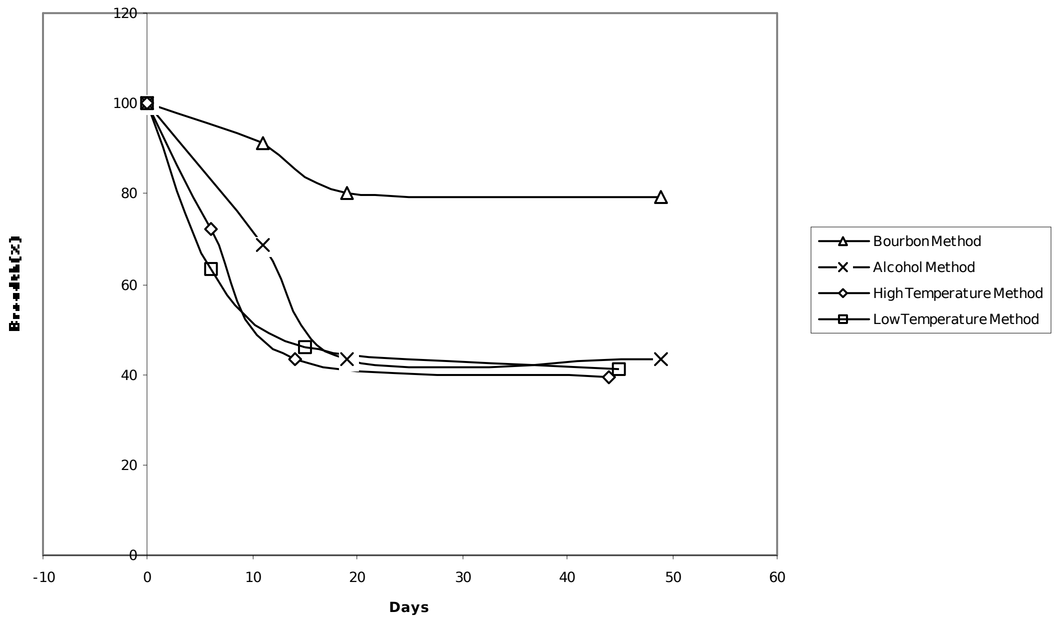

Fig. 4.9. Breadth Vs Time during curing, for sample A

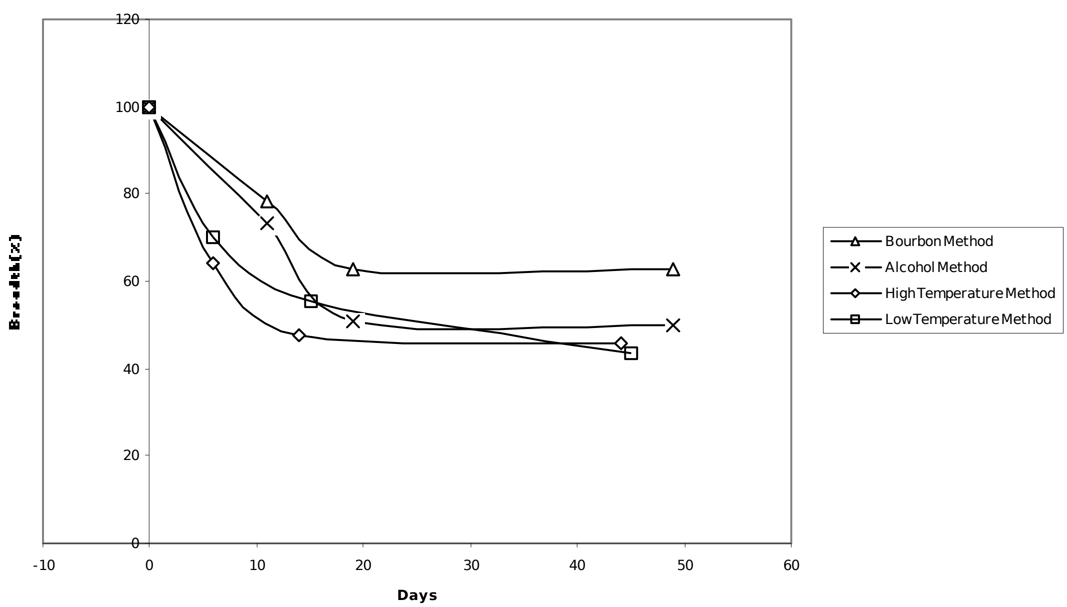

Fig. 4.10. Breadth Vs Time during curing , for sample B

Fig.4.10 shows the variation in breadth for grade B beans, during sweating and drying. After high temperature mechanical drying the breadth reduced from 1.09cm to 0.7cm causing a variation of (35.78%). After low temperature method the breadth showed a maximum variation of 29.9%. The minimum variation in breadth was observed in the case of Bourbon method (21.70%) preceded by Alcohol method (26.85%).

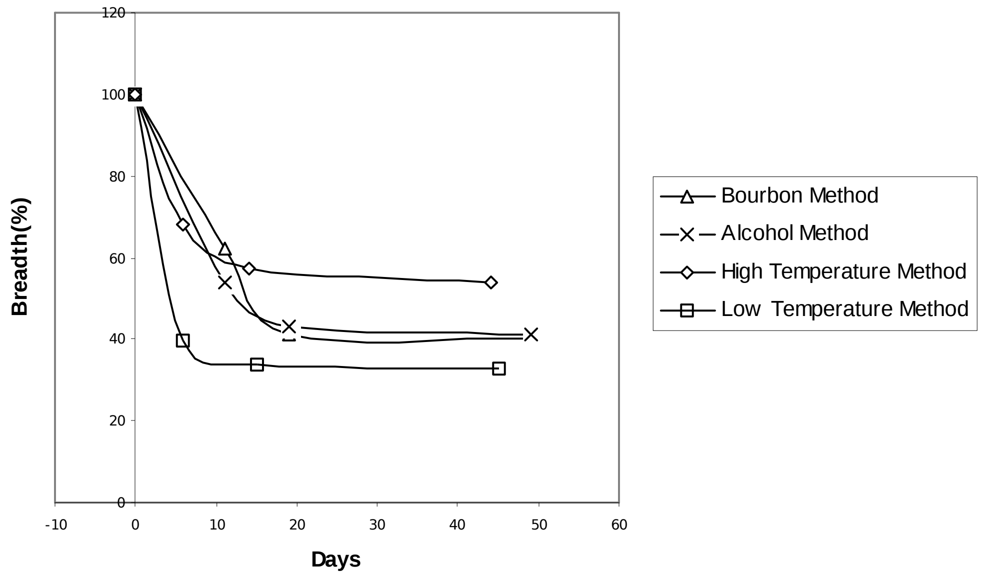

Fig. 4.11. Breadth Vs Time during curing, for sample C

The variations in the breadth of the C grade beans, during sweating and drying, are given by fig.4.11and were found to be 37.61%, 45.87%, 31.86% and 60.20% for Bourbon method, Alcohol method, high temperature method & low temperature method respectively.

4.2.4.1.4 Thickness

There was a considerable reduction in the thickness of the beans after curing, and the variations are depicted in Appendix VI, X, XIV and figures 4.12,4.13 and 4.14.

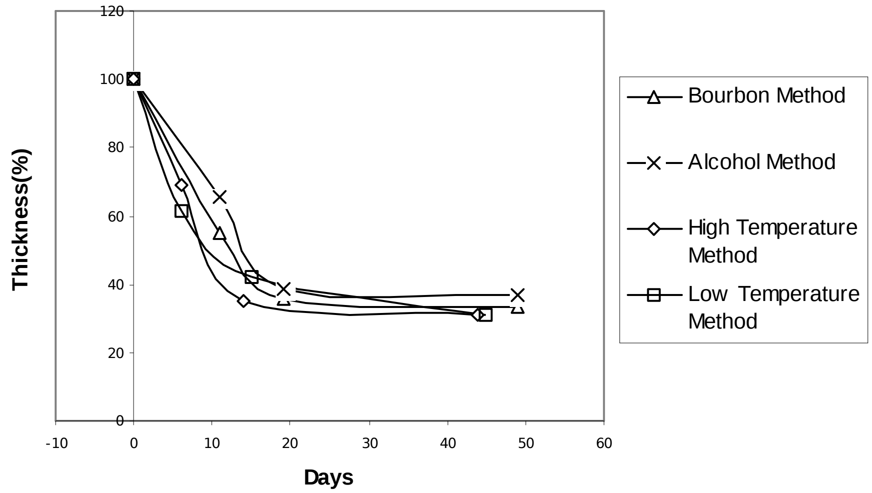

Fig. 4.12. Thickness Vs Time during curing, for sample A

Fig.4.12 shows the variation in thickness for grade A beans, during sweating and drying. The thickness of the beans treated by alcohol method reduced from 0.86 to 0.59cm(31.39%)while that treated by low temperature method reduced from 0.93to 0.57cm(38.7%). The percentage reduction in thickness was the maximum in the case of Bourbon method (45.16%) and was the minimum in the case of high temperature method (24.18%).

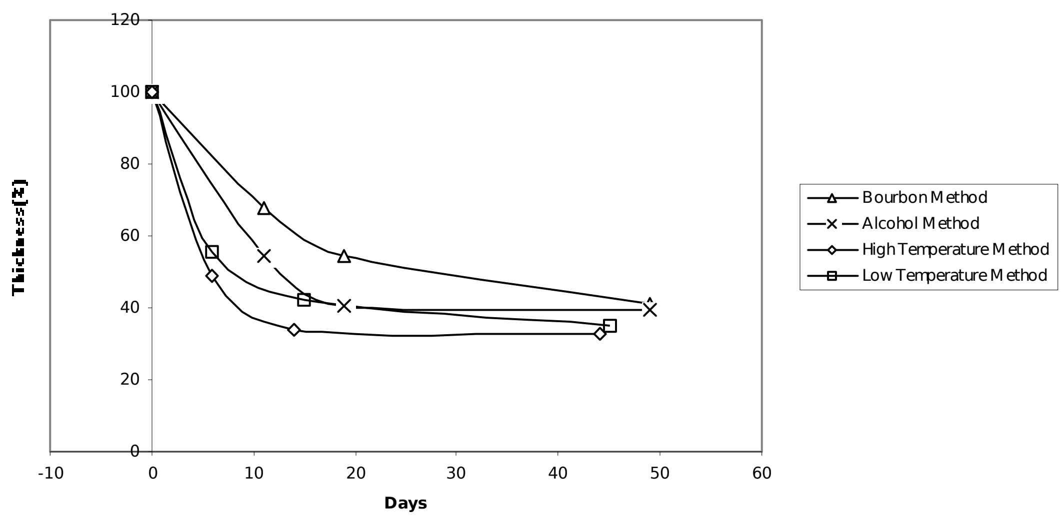

Fig. 4.13. Thickness Vs Time during curing, for sample B

Fig.4.13 shows the variation in thickness for the B grade beans, during sweating and drying. In the case of Bourbon method, the thickness reduced from 0.95 to 0.71cm(25.26%). while it reduced from 0.75cm to 0.47cm(37.33%), in the case of alcohol method .For the high temperature method, the variation in thickness was 47.06%. The thickness reduced from 0.85cm to 0.49cm in the case of beans dried by low temperature method, the variation being 42.35%.

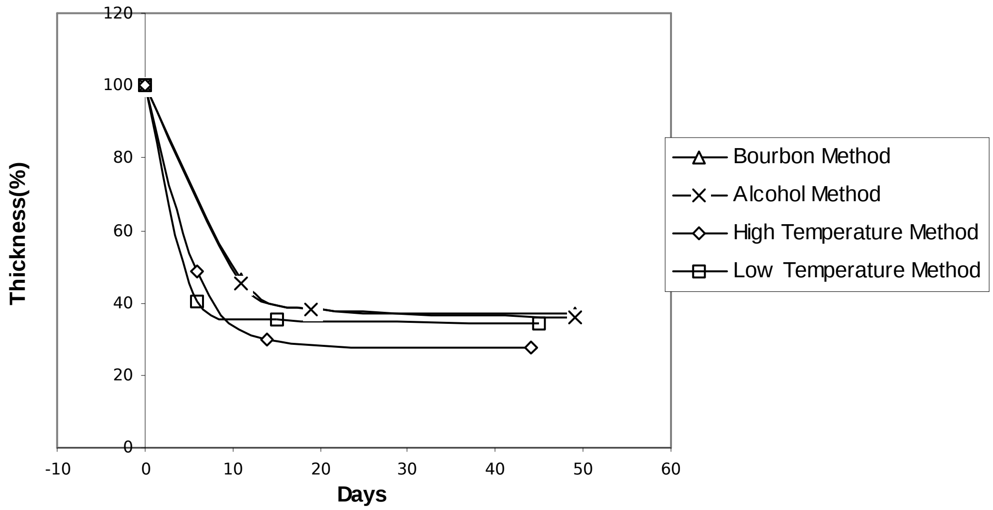

Fig. 4.14. Thickness Vs Time during curing, for sample C

The variations in thickness for grade C beans, during sweating and drying, are shown in fig.4.14.The results show that maximum variation in thickness was for low temperature method (56.16%) and minimum variation was for bourbon method (33.33%). For high temperature method and alcohol method the variations were observed as 45.07% and 40.90% respectively.

The beans after sweating and drying done by the different methods are shown in Plate No. 12- 14

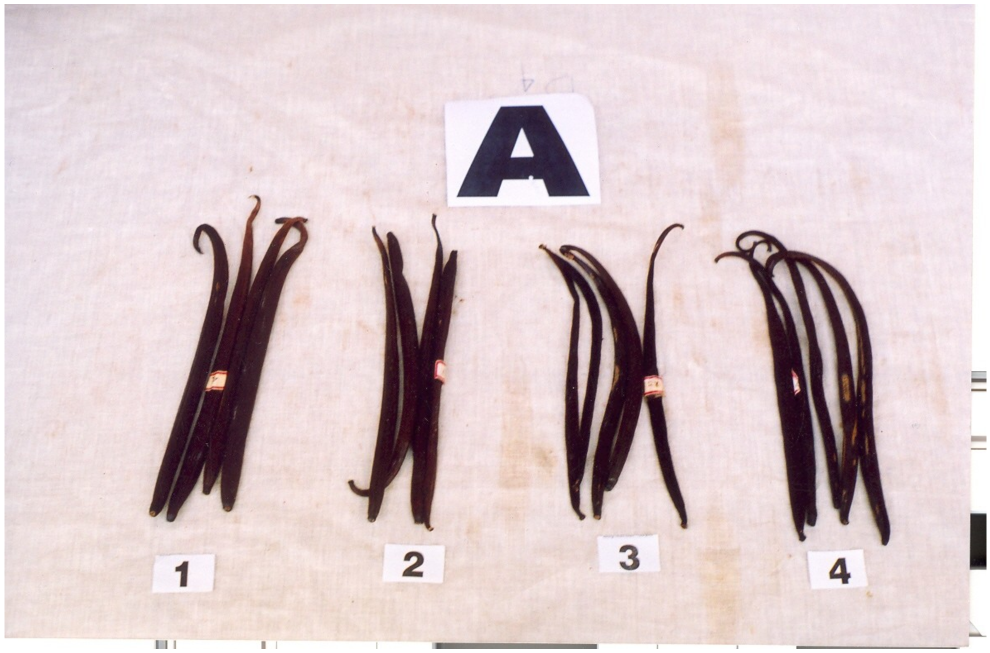

Plate No.12 Sample A Beans after Sweating and Drying

Plate No.13 Sample B Beans after Sweating and Drying

Plate No.14 Sample C Beans after Sweating and Drying

4.2.4.2 Slow Drying

The variations in the physical properties of beans observed during slow drying are given below. (Plate No.15)

Plate No.15 Slow Drying of Beans on Wooden Shelf

4.2.4.2.1 Moisture Content

The variations in the MC of beans during slow drying for different treatments are described in the Appendix VII and fig 4.15,4.16,4.17.

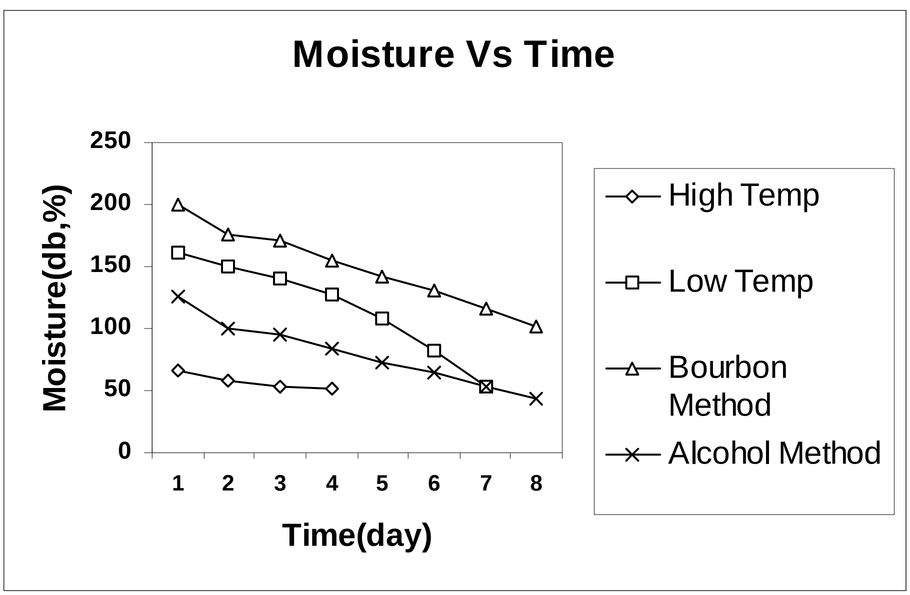

Fig. 4.15. MC Vs Time during slow drying, for sample A

The variation in MC for sample A beans, after slow drying, is shown in fig.4.15. In Bourbon method , the MC was 102.16%, but in high temperature method the MC was reduced to 50.81% and for low temperature method, the MC was found to be 116.96% , which was the maximum . The MC was minimum in the case of beans cured by alcohol method (43.98%).

The linear relationship between moisture content and drying time for the different methods are as follows:

For Bourbon method:

$$y = -13.289x + 208.68 \quad (R^2 = 0.9896) \quad \text{---------------}(4.13)$$

For Alcohol method:

$$y = -10.861x + 128.45 \quad (R^2 = 0.9744) \quad \text{---------------}(4.14)$$

For High Temperature method:

$$y = -5.0789x + 69.694 \quad (R^2 = 0.9423) \quad \text{---------------}(4.15)$$

For Low Temperature method:

$$y = -17.715x + 188.5 \quad (R^2 = 0.9535) \quad \text{---------------}(4.16)$$

where, y = moisture content (db) of the beans in %

x = time for slow drying in days

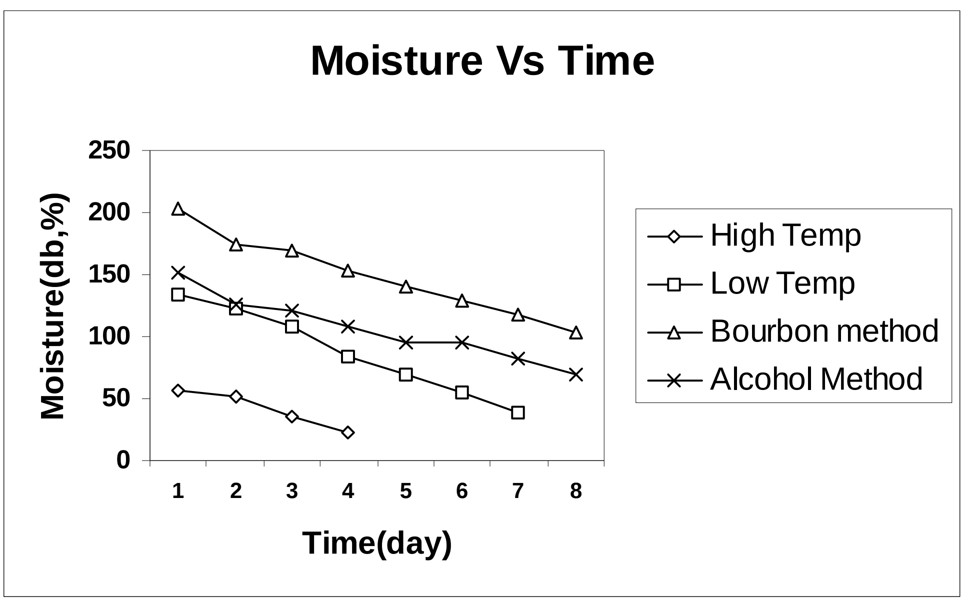

Fig. 4.16. MC Vs Time during slow drying, for sample B

From the figure 4.16, it is seen that the maximum variation in the MC was for beans treated by high temperature method (22.66%) while MC was reduced to 116.96%, for low temperature method. In the case of alcohol method, the MC was found to have reduced to 69.3%. For Bourbon method, MC was found to be 103.46%.

The linear relationship between moisture content and drying time for the different methods are as follows:

For Bourbon method:

$y = - 13.268x + 208.65 \quad (R^2 = 0.9824)$ ---------------(4.17)

For Alcohol method:

$y = - 10.578x + 153.76 \quad (R^2 = 0.963)$ ---------------(4.18)

For High Temperature method:

$y = - 11.371x + 69.806 \quad (R^2 = 0.9629)$ ---------------(4.19)

For Low Temperature method:

$y= - 16.349x + 152.41 \quad (R^2 = 0.9941)$ ---------------(4.120)

where, y = moisture content (db) of the beans in %

x = time for slow drying in days

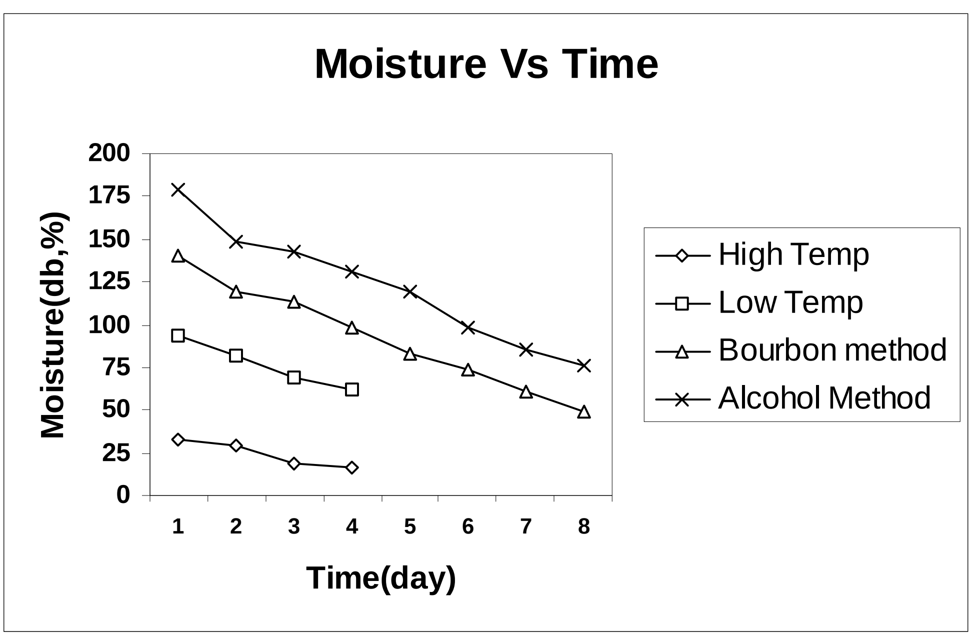

Fig. 4.17. MC Vs Time during slow drying, for sample C

The figure 4.17 shows the variation in MC for grade C beans. After high temperature method, MC was reduced to 16.06%, which is the maximum reduction, in the case of sample C beans. The minimum reduction in MC was seen in alcohol method (57.83%). After slow drying, the variation in MC for Bourbon method was 65.14%.

The linear relationship between moisture content and drying time for the different methods are as follows:

For Bourbon method:

$y = - 12.723x + 149.58 \quad (R^2 = 0.9926)$ ---------------(4.21)

For Alcohol method:

$y = - 14.123x + 185.85 \quad (R^2 = 0.9772)$ ---------------(4.22)

For High Temperature method:

$y = - 6.0312x + 38.984 \quad (R^2 = 0.9352)$ ---------------(4.23)

For Low Temperature method:

$y= - 10.663x + 103.41 \quad (R^2 = 0.9863)$ ---------------(4.24)

where, y = moisture content (db) of the beans in %

x = time for slow drying in days

4.2.4.2.2 Length

Appendix VIII and fig.4.6, 4.7 & 4.8 show the variation in length during slow drying for the different treatments.

Fig.4.6 shows the variation in length for sample A beans. The maximum reduction was given by low temperature method (0.483%)) while the minimum reduction was 0.43%, after Bourbon method. The variations were similar for high temperature method (0.476%) and low temperature method (0.50%)

The variation in length for grade B beans, during slow drying, is shown in fig.4.7.The length reduced by 0.54% in Bourbon method. No variation in the length was seen for alcohol method while for high temperature method the length reduced by 0.59%. For low temperature method, the variation was found to be 0.62%.

The variations in length for grade C beans, during slow drying, are shown in fig.4.8. No variation in length was observed, for Bourbon and alcohol methods but slight variation in length (0.76%) was observed in the case of high temperature method and low temperature method (0.89%).

4.2.4.2.3 Breadth

A slight decrease in breadth is seen after slow drying, for the four methods and this is shown in Appendix IX and fig.4.9, 4.10,4.11

For grade A beans, the variation in breadth is shown in fig.4.9. Maximum variation in breadth was observed in high temperature method (37.70%) and minimum was 12.28%; seen in the case of Bourbon method. After low temperature, the breadth reduced by26.96%. The variation after alcohol method was found to be 36.70%.

The variation in breadth for sample B beans is given by fig.4.10. By Alcohol method showed maximum variation of 30.3%, while minimum variation was observed for beans treated by Bourbon method (20%). After high temperature method, the breadth was reduced by25.7%. For low temperature method the variation was observed to be 20.7%.

The variation in breadth for sample C beans is shown in fig.4.11. The beans treated by Bourbon method showed maximum reduction of 33.82 % while it was 20.33% for alcohol method and 15.5% for high temperature method. The least reduction was 15%, which was in the case of low temperature method.

4.2.4.2.4 Thickness

Appendix X and figures 4.12, 4.13, 4.14, depict the changes in thickness for various samples during slow drying, subjected to the different treatments

The figure 4.12 depicts variation in thickness for grade A beans, during slow drying. The maximum reduction in thickness after slow drying was observed as 32.75% for low temperature method .The thickness was reduced by 40.67% in the case of both alcohol method and by 49.27for high temperature method .For Bourbon method, the thickness reduced from 0.51cm to 0.33 cm (35.29%).

The variation in thickness for sample B beans, during slow drying, is shown in fig.4.13. The maximum variation in thickness was observed to be 38.02%, in the case of Bourbon method. After alcohol method the thickness was reduced by 25.53%. The variation in thickness for high temperature method was 31.11 % and for low temperature method was 24.48 %.

Fig.4.14 shows the variation in thickness for grade C beans, during slow drying. The reduction in thickness was the maximum in high temperature method (38.46 %) while it was 17.64% and 15.38 % for Bourbon method and alcohol method respectively. After low temperature method the thickness was reduced to 0.28cm(12.5%).

4.2.4.3 Conditioning

After slow drying, the beans were bundled and wrapped in bee-wax paper and kept for conditioning (Plate No.16 & 17).The variation in physical properties of beans was less during the conditioning stage compared to the other three stages and these are discussed below.

Plate No.16 Beans after Slow Drying Followed by Bundling

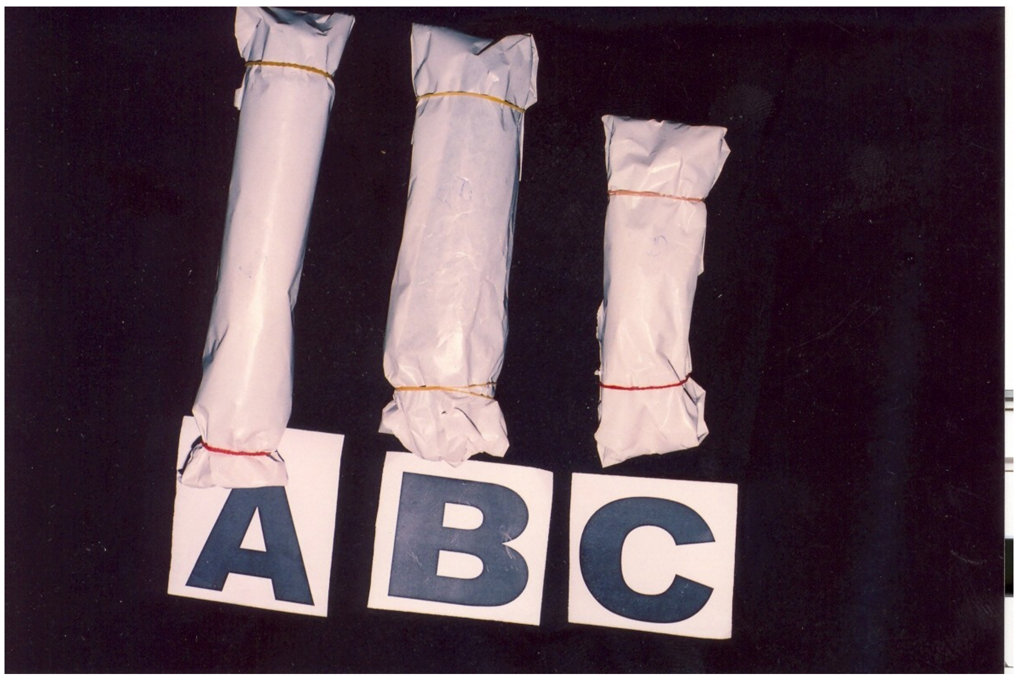

Plate No.17 Beans Wrapped in Bee-Wax Paper for Conditioning

4.2.4.3.1 Moisture content

The variation in the MC of beans during the conditioning stage is depicted in Appendix XI and figures 4.18, 4.19 & 4.20.

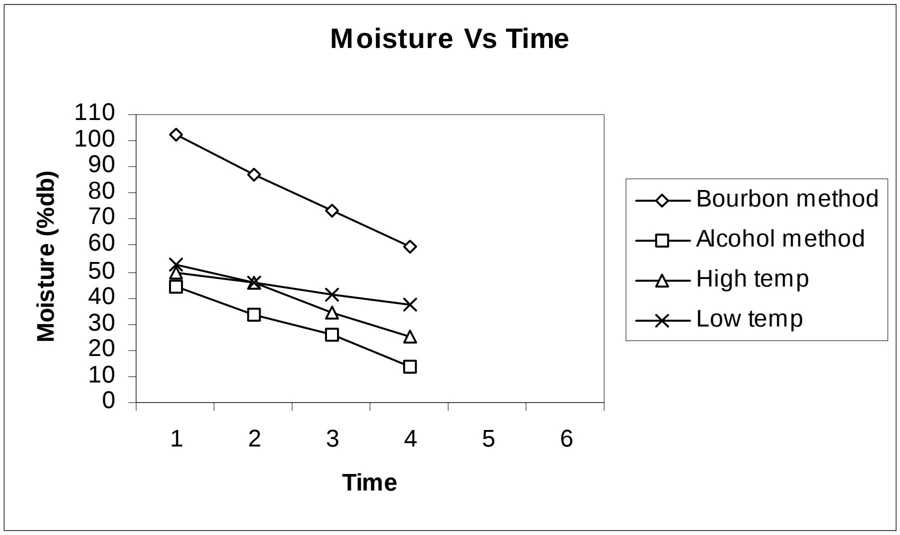

Fig. 4.18 MC Vs Time during conditioning, for sample A

Fig 4.15 shows the variation in MC for sample A beans. It was maximum for the Bourbon method (42.51%) and minimum for the low temperature method (15.31%). For the alcohol method, the MC reduced from 43.98% to 13.77% while for the high temperature method, MC reduced from 49.86% to 25.01%; the variation being 24.85%.

The linear relationship between moisture content and drying time for the different methods are as follows:

For Bourbon method:

$$y = - 14.138x + 115.95 \quad (R^2 = 0.9996) \text{ ---------------(4.25)}$$

For Alcohol method:

$$y = - 9.849x + 54.055 \quad (R^2 = 0.9929) \text{ ---------------(4.26)}$$

For High Temperature method:

$$y = - 8.6424x + 60.337 \quad (R^2 = 0.9674) \text{ ---------------(4.27)}$$

For Low Temperature method:

$$y = -5.6054x + 56.859 \quad (R^2 = 0.9824) \text{ ---------------(4.28)}$$

where, y = moisture content (db) of the beans in %

x = time for conditioning in days

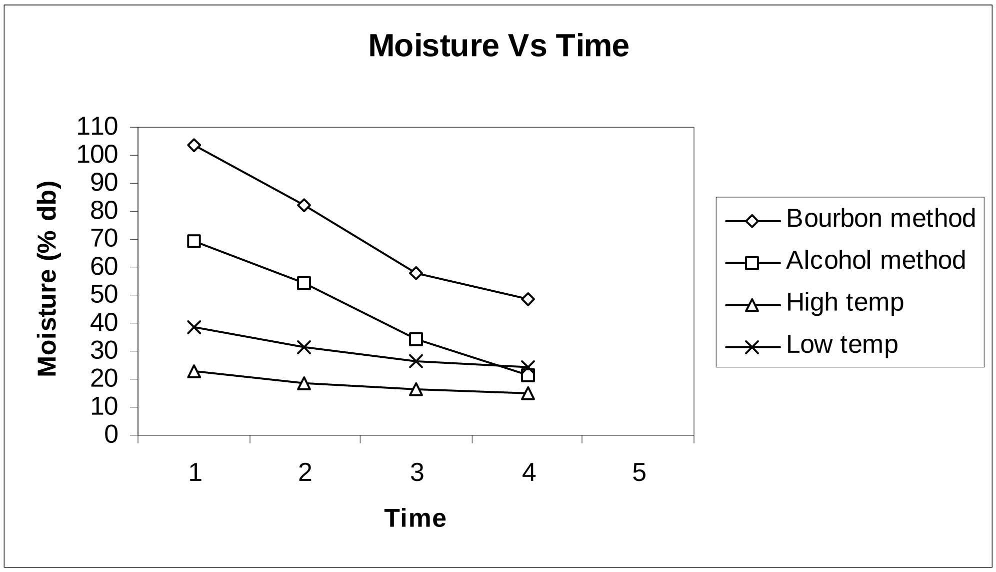

Fig. 4.19. MC Vs Time during conditioning, for sample B

The variation in MC for the grade B beans is shown in fig.4.19. Under high temperature method, the MC variation was minimum (7.67%)the MC of the beans under low temperature method reduced from 38.32%to 24.29% while in case of alcohol method it was from 43.98% to 13.77%. The variation was maximum for the beans under Bourbon method (55.17%).

The linear relationship between moisture content and drying time for the different methods are as follows:

For Bourbon method:

$$y = -18.932x + 120.29 \quad (R^2 = 0.9743) \text{ ---------------(4.29)}$$

For Alcohol method:

$$y = -16.404x + 85.726 \quad (R^2 = 0.9947) \text{ ---------------(4.30)}$$

For High Temperature method:

$$y = -2.4702x + 24.362 \quad (R^2 = 0.9397) \text{ ---------------(4.31)}$$

For Low Temperature method:

$$y = -4.7119x + 41.849 \quad (R^2 = 0.9476) \text{ ---------------(4.32)}$$

where, y = moisture content (db) of the beans in %

x = time for conditioning in days

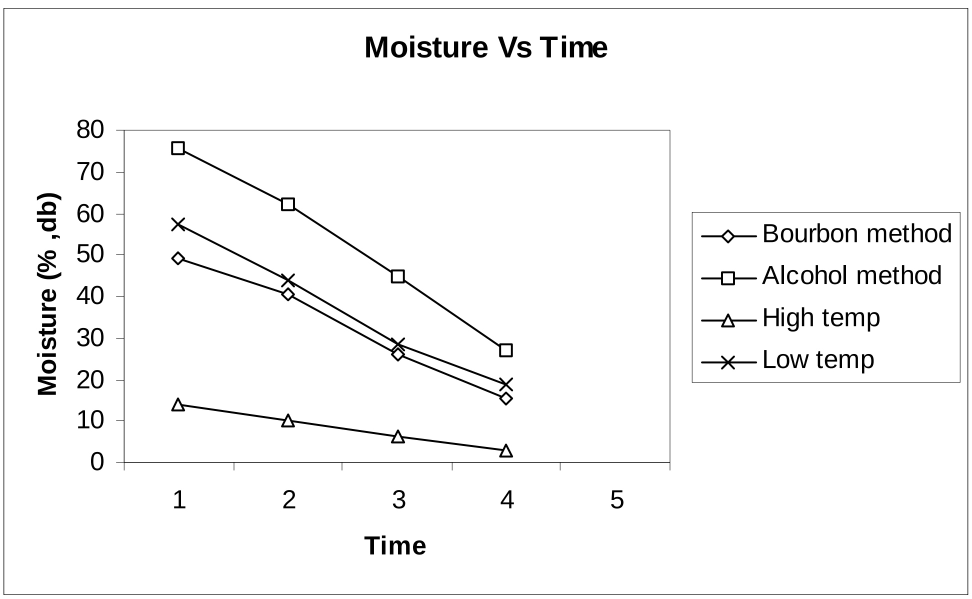

Fig. 4.20 MC vs. Time for sample C, conditioning

The variations in the MC for grade C beans are shown in fig.4.20. during conditioning stage were observed as 33.48%, 48.92%11.04%and 38.62% for Bourbon method alcohol method, high temperature method and low temperature method respectively.

The linear relationship between moisture content and drying time for the different methods are as follows:

For Bourbon method:

$$y = -11.495x + 61.415 \quad (R^2 = 0.9913) \quad \text{---------------}(4.33)$$

For Alcohol method:

$$y = -16.376x + 93.322 \quad (R^2 = 0.9958) \quad \text{---------------}(4.34)$$

For High Temperature method:

$$y = -3.672x + 17.58 \quad (R^2 = 0.9966) \quad \text{---------------}(4.35)$$

For Low Temperature method:

$$y = -13.118x + 69.872 \quad (R^2 = 0.9932) \quad \text{---------------}(4.36)$$

where, y = moisture content (db) of the beans in %

x = time for conditioning in days

4.2.4.3.2 Length

During conditioning stage the variation in length of the beans was observed to be nil (given in Appendix XII). A straight-line variation was obtained in each case, as shown in figure 4.6,4.7 and 4.8.

4.2.4.3.3 Breadth

The variation in breadth of the beans during the curing stage was insignificant and is highlighted in Appendix XIII and figure 4.9, 4.10, 4.11.

Fig.4.9 shows the variation in breadth for grade A beans, during conditioning. Under alcohol method, the breadth remained same. For the beans treated by Bourbon method, the breadth was 1cm for the first 10 days and then reduced to 0.99cm(1%) and no further variation was observed .The variation in breadth on conditioning was 3.77% and 3.33% for the beans cured by high temperature and low temperature methods respectively.

The variation in breadth for grade B beans ,during conditioning, is shown in fig.4.10.There was no variation in breadth, , for the beans cured by Bourbon method and low temperature method. For the beans cured by high temperature method and alcohol method, the variations in breadth were 3.84% and 1.81% respectively.

Fig.4.11 depicts the variation in breadth for grade C beans. The variation in breadth was found to be maximum for the beans cured by high temperature method (1.61%). The variation was 1%, 1.61% and 3.03% for the beans under Bourbon method, alcohol method and low temperature method respectively.

4.2.4.3.4 Thickness

The variations in thickness of the beans on conditioning are depicted in Appendix X1V and figures 4.12, 4.13 & 4.14.

The variation in thickness for grade A beans is depicted in fig.4.24. On conditioning thickness was the same for Bourbon method and high temperature method (6.06%). The maximum variation was seen in the case of beans cured by low temperature method (6.45%). The variation in thickness for alcohol method was 5.71%.

Fig.4.13 gives the variation in thickness for grade B beans, during conditioning. For the low temperature method, the thickness remained same but for the beans cured by Bourbon method, alcohol method and high temperature, there was a reduction by 2.27%, 2.85%and 3.22% respectively.

The variation in thickness , during conditioning, for grade C beans is shown in fig.4.14 . Maximum variation in thickness was observed for the beans under alcohol method (6.06%). But for all other beans cured by Bourbon method, high temperature method and low temperature method, the thickness was found to b have reduced by 3.57%, 4.34%and 3.57% respectively.

4.2.5 Effect of Different Treatments on Curing

The observed features and general out look of the vanilla beans as affected by different curing methods are shown in the tables 4.8, 4.9, 4.10 & 4.11. From the tables it is revealed that the beans cured by alcohol method and low temperature method have high vanillin content.

Table 4.8. Observed Features of Hot Water Killed- Sun dried Beans.

Stage	Characteristics				
	Colour	MC	Aroma	Wt (% of original wt)	Vanillin Content (% by wt)
Killing	Pale green	478.37	Nil	Nil	1.90
Sweating	Light Brown	181.22	Present	48.63	
Slow drying	Brown	84.86	Present	39.16	
Conditioning	Chocolate Brown	41.14	Present	21.40	

Table 4.9. Observed Features of Alcohol Killed Sun dried Beans.

Stage	Characteristics

	Colour	MC	Aroma	Wt (% of original wt)	Vanillin Content (% by wt)
Killing	Green	478.42	Nil	Nil	2.14
Sweating	Light Brown	152.34	Present	43.63	
Slow drying	Brown	62.98	Present	28.18	
Conditioning	Chocolate Brown	20.57	Present	9.21	

Table 4.10. Observed Features of Hot Water Killed- High Temperature Mechanically Dried Beans

Stage	Characteristics				
	Colour	MC	Aroma	Wt (% of original wt)	Vanillin Content (% by wt)
Killing	Pale green	478.37	Nil	Nil	2.05
Sweating	Light Brown	82.6	Present	35.12	
Slow drying	Brown	29.84	Present	22.98	
Conditioning	Chocolate Brown	14.37	Present	13.29	

Table 4.11. Observed Features of Hot Water Killed, Low Temperature Mechanically Dried Beans

Stage	Characteristics

	Colour	MC	Aroma	Wt (% of original wt)	Vanillin Content (% by wt)
Killing	Pale green	478.38	Nil	Nil	2.17
Sweating	Light Brown	175.56	Present	50.54	
Slow drying	Brown	87.59	Present	26.32	
Conditioning	Chocolate Brown	26.77	Present	14.44	

SUMMARY & CONCLUSION

SUMMARY AND CONCLUSION

Vanilla beans are one of the most expensive spices traded in the global market. The fresh vanilla beans do not have any flavour or aroma because vanillin and other chemical substances responsible for it are not present in the free form at the time of harvesting. During the process of curing, free vanillin is developed in the beans as a result of a series of enzymatic actions on several glycosides.

The traditional curing method (Bourbon method) is time consuming and laborious. This puts off the farmers from curing beans. With this in view, an attempt was made in KCAET, Tavanur to standardize the curing techniques.

An extensive survey was conducted among vanilla growers in different districts viz. Calicut, Wayanad, Idukki and Kannur and the various constraints in the vanilla cultivation and processing were identified. The constraints in vanilla cultivation are spread of diseases, high water requirement and theft, while the constraints in curing were high labour requirement, time consumption, improper storage and fungal infection.

Following this, beans were procured and graded based on length into three sets A (>20 cm), B (15-20 cm), and C (<15 cm). Each set was then divided into four samples and subjected to four different curing techniques-

Method I: Hot water killing followed by sun drying.
Method II: Killing using alcohol followed by sun drying.
Method III: Hot water killing followed by high temperature mechanical drying.
Method IV: Hot water killing followed by low temperature

mechanical drying.

Each method consists of four stages viz; killing, sweating, slow drying and conditioning. The moisture kinetics and the physical parameters like length, breadth, and thickness were monitored during each stage.

At the time of sweating and drying, maximum reduction in moisture content (87.83%) was seen in beans cured by high temperature method , followed by low temperature method (70.63%) and Bourbon method (70.63%). The reduction in moisture content was the minimum for alcohol method (67.44%).

The percentage reductions in moisture content, during slow drying stage, were observed as 65%, 50%, 48.97%and 43.79% for alcohol method, high temperature method, Bourbon method and low temperature method respectively.

On conditioning, the moisture content reduced to 68.69% for alcohol method, followed by 49.84%, 41.61% and 29.06%for high temperature method, Bourbon method and low temperature method respectively.

No significant variations were observed in the length and breadth of the beans, in each stage of curing. The thickness reduced significantly during each stage and the final thickness was observed as 69%, 67.77%, 65.55%, and 63.33%, of the initial thickness, for the high temperature method, low temperature method, Bourbon method and alcohol method respectively.

After curing, the vanillin content and moisture content of the beans were tested at the Quality Evaluation Laboratory, Spices Board, Cochin. The vanillin content was found to be 2.17%, 2.14%, 2.05%, and 1.90% for low temperature method, alcohol method, high temperature method and Bourbon method respectively. The maximum moisture content was determined to be 39% in the case of beans cured by Bourbon method, followed by alcohol method (27%), low temperature method(24%) and high temperature method (15%).

SUGGESTIONS

- Curing may be done devoid of killing stage and the quality changes may be observed.
- Sun drying may be done under shade nets to prevent over burning of beans.
- Solar drying can be tried as an alternate to sun drying, to control the drying conditions and prevent contamination of beans.
- Convective drying may be performed under various low temperature ranges.
- Slow drying may be tried with low temperature and low relative humidity conditions.
- Conditioning could be carried out under different conditions of temperature and relative humidity.

ABSTRACT

An extensive survey was conducted among vanilla growers in four different districts in Kerala, to identify the various constraints in vanilla cultivation and processing. The high time consumption and labour requirement of the traditional curing technique put off the farmers from doing the curing process. In this study, an attempt was made to standardize the curing technique. For this purpose, the beans were cured by four different methods. The first method adopted was the traditional Bourbon method, which took two months and the final moisture content was 39% and the reduction in thickness was 34.45%. The second method consisted of killing by alcohol followed by sun drying and final moisture content was found to be 27%and the reduction in thickness was 68.69%. The third method consisted of killing using hot water followed by high temperature mechanical drying and the final moisture content (15%) and reduction in thickness (31%) was observed. Method four consisted of killing using hot water followed by low temperature mechanical drying. For this method the final moisture content was 24% and reduction in thickness was 32.23%. The vanillin content of the beans on completion of curing was tested at the Quality Evaluation Laboratory, Spices Board, Cochin. The maximum vanillin content (2.17%) was found in the beans cured by low temperature method followed by alcohol method (2.14%), high temperature method (2.05%) and Bourbon method (1.90%).

REFERENCE

REFERENCES

Abdulla, K.M.1997. Drying of vanilla pods using green-house effect solar dryer. *Drying Technology*, 15(**2**): 685-698

Anilkumar, A.S.2004.Vanilla Cultivation-A Profile Agri-based Enterprise.Kerala Calling 26- 29.(www.kerala.gov.in/keralacalfeb04/p26-30.pdf)

Anon.1998. *Vanilla. The prince of spices*. Spice Board India. Cochin.pp:55-69

Anon.2001.*Vanilla*. Indian Institute of Spices Research.Calicut. pp:3 (www.iisr.org /atic/vanilla.pdf)

Anon.2003. http://www.thehindubusinessline.com

Anon.2004.Indian Agricultural Resources. Vanilla. Horticulture Paper. pp 5-6. (www.indiaagronet.com/horticulture/content/vanilla.htm)

*Ansaldi, G. M., Marseille, G.G. and Aubagne, J. L. P. 1990. Process for obtaining natural vanilla flavour by treatment of green vanilla beans and the flavour obtained. *US Patent No. 4*. 1956.192.

Arana, F. E. 1943.Action of β-Glucosidase in the curing of vanilla. *Food Res*. **8**:343-351.

*Arana, F.E. 1944. *Vanilla curing and its chemistry*. USDA Fed. Expt. Station. Mayaguez. Puerto Rico; Bulletin No. 42 (October) Washington DC: USDA.

*Balls, A. K. and Arana, F. E. 1941a. Curing of vanilla. *Ind. Eng. Chem*. **33**: 1073-1075.

*Balls, A. K. and Arana, F. E. 1941b. Determination and significance of phenols in vanilla extract. *Assoc. off. Agr. Chem. J*. **24**: 570-512.

*Bouriquet, G. 1954. *Le vanillier et la Vanille dans le Monde*. Paris:Editions Paul Lechavalier.

*Cernuda, C. F. and Loustalot, A. J. 1948. Vanilla curing. USDA Fed. Expt Station.Mayaguez. Puerto Rico; Report for 1947 (Oct. 1948) Washington DC: USDA.

*Childers, N. F., Cibes, H. R. and Hernandez-Medina, E. 1959. *Vanilla-The orchid of commerce*. In: C. L. Withner (Ed.).A Scientific Survey, Robert E. Krieger Publishing company, Malabar, Florida : 477-508.

*Correll, D. S. 1953. Vanilla its botany, history, cultivation and economic import. *Econ. Bot*. **7**:291-358.

*Dignum, M. J. W., Kerler, J. and Verpoorte, R. 2001a. Vanilla production: Technological, Chemical, and Biosynthetic aspects. Food Res. Inter. **17**: 199-219.

*Dignum, M. J. W., Kerler, J. and Verpoorte, R. 2001b. β-Glucosidase and Peroxydase stability in crude enzyme extracts from grean beans of *vanilla planifolia* Andrews. Phytochem. Anal. **12**: 174-179.

Felter,H.W. and Lloyd,J.U.1998.Tincture of vanilla. Kings American Dispensatory. (www.ibiblio.org/herbmed/electric/king/vanilla-tinc.html)

Havkin ,D., French ,J.C., Graft ,N.M., Pak ,F.E., Frenkel, C.and Joel, D.M. 2004. *Interrelation of Curing and Botany in Vanilla Bean*. International Horticultural Congress:The Future for Medicinal and Aromatic Plants.**12:** 93-96. (www.baktoflavours.com./pdf/vanilla%20dafna %20 ishs.pdf)

*Havkin-Frenkel, D., French, J.C., Pak, F.E. and Frenkel, C. 2003. Botany and Curing of vanilla. *J. Arom. Med. Plants*. In press.

*Jones, M. A. and Vincente, G. C. 1949a. Criteria for testing vanilla in relation to killing and curing methods, *J. Agric*. *Res*., **78**, 425-34.

*Jones, M. A. and Vincente, G. C. 1949c.Quality of cured vanilla in relation to some natural factors, *J. Agric*. *Res*., **78**, 425-50.

*Leong, G., Archavlis, A. and Derbesy, M. 1989a. Research on the glucoside fraction of the vanilla bean. *J. Essent. Oil Res*. **1**: 33-41.

*Leong, G., Uzio, R. and Derbesy, M. 1989b. Synthesis, identification and determination of glucosides present in green vanilla beans *vanilla fragrans* Andrews. *Flavour frag. J*. **4**: 163-167.

Madhusoodanan, K.J. ,Radhakrishnan, V.V. and Sudarsan, M.R.2003. Botany of Vanilla, *Spice India* (**16**): 14-15.

*Memory, G. 1968. Food flavourings. Composition, manufacture and use, West port, Conn: Avi Publishing Co.

Pruthi, J.S. 2000.*Minor Spices and Condiments*. Directorate of Information and Publications of Agriculture, New Delhi : 610-615.

Pruthi, J.S.1998. *Spices and Spice Products*, Allied Publishers Limited, New Delhi.175

Purseglove,J.W; Brown,E.G., Green.C.L. and Robbins, S.R.J.1988. *Spices* (**2**), Longman Scientific and Technical Publishing Co. ,New York:648-657

*Ranadive, A. S., Szkutnica, K., Guerreram, J. G. and Frenkel, C. 1983. Vanillin biosynthesis in vanilla bean. IX International Congress of Essential Oils. Singapore. Proceedings of the Congress, Book **147**.

Sahay,K.M and Singh,K.K . 1994.Unit Operations of Agricultural Processing,Vikas Publishing House Pvt.Ltd.,New Delhi,p:67.

Senguptha, R.2003. *Vanilla: The Spice of Life for Indian Farmers*. http://www.kisanwatch.org/eng/features

Shedding kans., Fungicide application-Thomas .2003. *Spice India* (**16**): 14-25.

Subbiah,A.,Ramesh,A.,Selvarajan,M. and Chezhiyan,N.2002.Vanilla Cultivation as a sustainable Intercrop under Coconut Plantations. *Spice India* (**15**): 2.

*Swamy, B. G. L. 1947. On the life history of vanilla planifolia. Botanical Gazette **108**: 449-456.

*Theodose, R. 1973. Traditional methods of vanilla preparation and their improvement. *Trop. Sci*. **15**: 47-57.

Thomas,J.,Suseela,R. and Vijayan,A.K.2003.Vanilla-Diseases and Their Management. *Spice India* (**16**): 20-25.

Thomas, J.2003.Shedding of Immature Beans in Vanilla. *Spice India* (**16**). 30-31.

Varadarasan,S.,Gopakumar,B. and Chandrasekar,S.S. 2003. Pests and their Management in Vanilla. *Spice India* (**16**): 30-32.

www.swsbm.com ,2004, Harvesting and curing of vanilla .

www.gnujake.med.yale.edu/herbmed,2004, The fruit of *Vanilla planifolia.*

*Original not seen

STANDARDISATION OF VANILLA CURING TECHNIQUES

BY

Manjusha Mathew
Roshni Raju
Shailesh Kumar Singh

ABSTRACT OF THE PROJECT REPORT

Submitted in partial fulfilment of the Requirement for the degree

Bachelor of Technology
In
Agricultural Engineering

Faculty of Agricultural Engineering
Kerala Agricultural University

Department of
Post Harvest Technology & Agricultural Processing
KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
TAVANUR- 679 573 , MALAPPURAM
KERALA , INDIA
2005

Appendix I

Schedule for Collecting Data from Farmers

Kerala Agricultural University

Kelappaji College of Agricultural Engineering and Technology

Tavanur-679573

Survey of Vanilla Crop for Processing

Location: **Date:**

1. Name :
2. District :
3. Taluk :
4. Total Area Under Cultivation: Marginal 1 2 3 4 5 Large
5. Area under Vanilla cultivation: Marginal 1 2 3 4 5 Large
6. Variety of Vanilla Cultivated:
   (i)
   (ii)
   (iii)
7. Numbers of year since taking up Vanilla cultivation :
8. Source of Cultivating Materials :
9. Method of pollination adopted :
10. Method of Irrigation :

11. Any scientific method used for cultivation :

12. Time/Stage which harvesting is done :

13. Are the beans sold raw :

14. The reason for not curing beans :

15. Time required for curing process :

16. Numbers of days after harvest with in which curing must be done :

17 Method of killing :
    a. Time:
    b. Temperature:
    c. Humidity:

18 Method of bundling used :
    a.
    b.

19 Type of Thread used :

20 Type of Blanket used for sweating :

21 Time for Sweating :

22 Temperature for sweating :

23 Humidity at sweating :

24 Method of drying :
    a.
    b.

25 Temperature for drying :

26 Drying time :

27 Humidity :

28 Method of conditioning or ageing :

29 Temperature for ageing :

30 Time for ageing :

31 Stage at which the curing process is completed :

32 Humidity of cure bean :

33 Colour of cure bean :

34 Method adopted for the prolong storage :
   a. Temperature :
   b. Humidity :

35. Approximate cost of curing process :
36. Approximate time for curing process :

37. Are doing curing by self or taking help from any organization/Institution :

38. Numbers of labour required for curing :

39. Any Machine for curing :

40. Any Aid from Government/spice board :

41. Have you received any Experts opinion :

42. If time of curing is reduced are you interested to adopting it :

43. Any suggestion for reducing time :

44. Agencies sought after for sale of beans :

45. Usual difficulties encountered during Vanilla cultivation :

46. Organic manures/fertilizer used for vanilla cultivation :

47. Are you aware of the immense profit you could make through the sale of cured vanilla beans :

48. Relative Advantage :

I. Initial cost : Cheap 1 2 3 4 5 Expensive

II. Net Profitability : Meagre 1 2 3 4 5 Exorbitant

III. The consistency of profits : Irregular 1 2 3 4 5 Regular

IV. Saving of time : Time consuming 1 2 3 4 5 Time saving

V. Multiple use potential : Single benenfit 1 2 3 4 5 Multiple benefits

49. Personal experience in Vanilla cultivation :

50. Any suggestion for vanilla cultivation to other farmers:

Note: **Relative Advantage**

I. **Initial Cost**: Cash or capital investment required for adoption of an innovation by farmers.

II. **Net Profitability**: Quantum of benefit expected due to adoption of an innovation.

III. **Consistency of profits**: Regularity of net return from an innovation over a period of time

IV. **Saving of time**: Efficiency of an innovation in terms of saving of time and best utilization of opportunities.

V. **Multiple use potential**: Adoption of an innovation result in multiple benefits

APPENDIX – II

Table II-i. Temperature Adopted for Mechanical Drying

Methods	High temperature		Low temperature	
Duration (H)	Temp (ºC)	Duration of drying (H)	Temp (ºC)	Duration of drying (H)
0	50	1	45	1
12	50	1	45	1
24	60	1	50	1
36	60	1	50	1
48	60	1	55	1
60	60	1	55	1
72	70	1	55	1
84	70	1	60	1
96	70	1	60	1
108	70	1	60	1
120	70	1	60	1
132	70	1	60	1

Appendix III

Table III- i. Variation in Moisture Content during Sweating

Days	Bourbon method(MC,%)			Alcohol method (MC,%)			High temp method (MC, %)			Low temp method(M		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C
1	478.39	478.39	478.33	478.43	478.34	478.48	478.38	478.37	478.38	478.38	478.38	47
2	435.65	452.53	444.32	453.29	431.02	401.91	397.25	444.34	419.65	411.76	428.14	42
3	409.00	424.63	404.92	416.50	398.16	359.38	333.8	363.59	321.61	379.91	372.49	34
4	375.99	394.01	366.43	380.35	363.72	318.97	275.96	281.77	239.42	335.59	321.49	28
5	359.35	379.59	345.84	359.92	343.74	294.30	214.35	203.71	158.84	288	275.71	23
6	326.52	340.19	304.48	323.77	309.04	256.02	155.37	138.42	99.72	244.43	224.47	17
7	291.05	321.88	276.01	277.24	268.03	207.53	102.55	87.05	58.2	208.07	178.16	14
8	270.13	286.16	234.29	255.23	244.90	195.19						
9	236.85	239.00	198.30	218.14	189.96	187.11						
10	214.75	219.68	170.90	151.49	157.10	180.73						
11	200.20	203.01	140.47	125.72	151.84	179.46						

Table III- ii. Duration and % Reduction in Moisture Content during Sweating

	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
Days	10	10	10	10	10	10	6	6	6	6	6	6
%decrease in mc	58.15	57.56	70.63	73.72	68.26	62.49	78.56	81.08	87.83	56.50	62.75	70.63
Avg% decrease in mc	62.11			68.16			82.49			63.29		

Appendix IV

Table IV- i. Variation in Length during Sweating

Days	Bourbon (l, cm)			Alcohol (l, cm)			High temp (l, cm)			Low temp (l, cm)		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
1	23.5	18.8	12.7	20.2	17.2	11.6	21	17.1	13.4	21.5	16.4	11.4
2	23.5	18.8	12.7	20.2	17.2	11.6	21	17.1	13.3	21.5	16.4	11.3
3	23.48	18.7	12.7	20.2	17.2	11.6	21	17.0	13.3	21.5	16.3	11.3
4	23.42	18.7	12.7	20.2	17.1	11.5	20.9	17.0	13.2	21.4	16.2	11.2
5	23.42	18.7	12.6	20.2	17.1	11.5	20.9	16.9	13.1	21.4	16.2	11.1
6	23.41	18.6	12.6	20.2	17	11.5	20.8	16.9	13.0	21.3	16.2	11.1
7	23.41	18.6	12.6	20	17	11.5						
8	23.4	18.5	12.6	20	16.9	11.5						
9	23.4	18.5	12.6	20	16.9	11.4						
10	23.4	18.5	12.5	20	16.9	11.4						
11	23.4	18.4	12.5	20	16.9	11.4						

Table IV-ii. Duration and % Reduction in Length during Sweating

Days	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
	10	10	10	10	10	10	6	6	6	6	6	6
%Decrease in length	0.42	0.54	0	0.5	0	0	0.48	0.59	0.76	0.95	0.62	0.89
Avg% decrease in length	0.32			0.167			0.6			0.82		

Appendix V

Table V-i. Variation in Breadth during Sweating

Days	Bourbon (b, cm)			Alcohol (b, cm)			High temp (b, cm)			Low temp (b, cm)		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
1	1.25	1.15	1.09	1.15	1.08	1.09	1.29	1.09	1.13	1.41	1.17	0.98
2	1.2	1.14	0.99	1.13	1.03	1	1.17	0.98	0.98	1.3	1.05	0.79
3	1.17	1.12	0.95	1.09	0.98	0.98	1.14	091	0.91	0.98	0.96	0.68
4	1.17	1.11	0.89	1.01	0.91	0.94	1.09	0.81	0.88	0.93	0.90	0.61
5	1.17	1.08	0.84	0.96	0.89	0.89	1.0	0.77	0.81	0.91	0.86	0.55
6	1.16	1.02	0.81	0.92	0.85	0.8	0.93	0.70	0.77	0.89	0.82	0.39
7	1.16	1.01	0.79	0.9	0.84	0.77						
8	1.15	0.98	0.74	0.87	0.83	0.71						
9	1.15	0.96	0.7	0.82	0.82	0.69						
10	1.14	0.92	0.69	0.8	0.8	0.64						
11	1.14	0.9	0.68	0.79	0.79	0.59						

Table V-ii. Duration and % Reduction in Breadth during Sweating

	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
Days	10	10	10	10	10	10	6	6	6	6	6	6
%Decrease in breadth	8.84	21.7	37.6	31.3	26.85	45.87	27.90	35.7	31.85	36.9	29.9	60
Avg %decrease in breadth	22.71			34.67			31.81			42.26		

Appendix VI

Table Vi-i. Variation in Thickness during Sweating and Drying

Days	Bourbon (t, cm)			Alcohol (t, cm)			High temp (t, cm)			Low temp (t, cm)		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4

1	0.93	1.05	0.73	0.9	0.86	0.86	1.0	0.92	0.8	0.93	0.88	0.79
2	0.9	0.96	0.65	0.86	0.79	0.81	0.91	0.88	0.69	0.81	0.8	0.65
3	0.74	0.92	0.63	0.8	0.72	0.73	0.83	0.76	0.6	0.72	0.69	0.55
4	0.65	0.9	0.6	0.76	0.69	0.68	0.80	0.64	0.57	0.64	0.59	0.38
5	0.62	0.86	0.51	0.72	0.63	0.62	0.76	0.51	0.49	0.59	0.54	0.34
6	0.61	0.82	0.48	0.69	0.6	0.58	0.69	0.45	0.39	0.57	0.49	0.32
7	0.6	0.8	0.46	0.67	0.59	0.55						
8	0.58	0.78	0.41	0.64	0.56	0.5						
9	0.55	0.75	0.38	0.62	0.52	0.48						
10	0.52	0.73	0.36	0.6	0.49	0.42						
11	0.51	0.71	0.34	0.59	0.47	0.39						

Table VI-ii. Duration and % Reduction in Thickness during Sweating

Days	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
	10	10	10	10	10	10	6	6	6	6	6	6
%Decrease in thickness	45.16	32.38	53.42	34.44	45.34	54.65	31.0	51.1	51.3	33.3	44.3	59.5
Avg %decrease in thickness	43.62			44.81			44.44			45.71		

Appendix VII

Table VII-i. Variation in Moisture Content during Slow Drying

Days	Bourbon method (%,MC)			Alcohol method II (MC,%)			High temp method (MC,%)			Low tempMethod(		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	
1	200.20	203.01	140.47	125.72	151.84	179.46	102.55	87.05	58.2	208.07	178.16	1
2	175.19	174.02	119.34	99.62	126.60	147.98	65.99	55.71	32.61	161.57	169.45	1
3	170.92	169.67	113.97	95.22	121.08	142.45	61.81	53.92	32.04	154.04	133.71	9
4	154.73	154.01	97.85	83.28	107.41	130.54	58.22	50.85	28.81	150.44	126.71	8
5	141.45	141.09	83.53	72.27	95.85	119.48	55	41.14	21.77	146.84	122.26	8
6	129.90	128.77	73.86	64.10	94.53	97.79	52.96	36.29	18.15	140.90	114.78	7
7	116.44	117.61	60.61	52.47	82.70	85.03	51.77	27.77	16.44	130.77	107.38	6
8	102.16	103.46	48.97	43.98	69.30	75.67	50.81	22.66	16.06	127.67	96.09	6
9										116.96	83.54	6

Table VII-ii. Duration and % Reduction in Moisture Content during Slow Drying.

Days	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
	6	6	6	6	6	6	5	5	5	10	10	10
%Decrease in MC	78.64	78..4	65.14	90.80	85.51	84.18	56.5	73.9	72.4	38.6	46.1	53.0
Avg% decrease in MC	74.05			86.83			65.61			45.89		

Appendix VIII

Table VIII-i. Variation in Length during Slow Drying

Days	Bourbon (l, cm)			Alcohol (l, cm)			High temp (l, cm)			Low temp (l, cm)		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
1	23.4	18.4	12.5	20	16.9	11.4	20.7	16.9	13.1	21	16.1	11.2
2	23.5	18.4	12.5	20	16.9	11.4	20.7	16.9	13.1	21	16.1	11.2
3	23.5	18.4	12.5	20	16.9	11.4	20.7	16.9	13.1	21	16.1	11.2
4	23.48	18.4	12.5	20	16.9	11.4	20.6	16.9	13.1	21	16.1	11.2
5	23.42	18.3	12.5	19.9	16.9	11.4	20.6	16.9	13.1	21	16.1	11.2
6	23.42	18.3	12.5	19.9	16.9	11.4	20.6	16.8	13.1	20.9	16.1	11.2
7	23.41	18.3	12.5	19.9	16.9	11.4	20.6	16.8	13.1	20.9	16.1	11.1
8	23.3	18.3	12.5	19.9	16.9	11.4	20.6	16.8	13	20.9	16	11.1
9										20.9	16	11.1

Table VIII-ii. Duration and % Reduction in Length during slow drying

Days	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
	6	6	6	6	6	6	5	5	5	10	10	10
%Decrease in length	0.42	0.53	1.57	0.99	1.74	1.7	0.95	1.16	2.98	0.93	1.21	2.63
Avg %decrease in length	0.84			1.48			1.69			1.59		

Appendix IX

Table IX-i. Variation in Breadth during Slow Drying

Days	Bourbon (b, cm)			Alcohol (b, cm)			High temp (b, cm)			Low temp (b, cm)		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
1	1.14	0.9	0.68	0.79	0.79	0.59	0.9	0.7	0.77	0.89	0.82	0.39
2	1.13	0.88	0.65	0.72	0.75	0.58	0.88	0.69	0.76	0.8	0.8	0.38
3	1.1	0.86	0.62	0.69	0.72	0.57	0.81	0.67	0.76	0.78	0.78	0.38
4	1.08	0.85	0.6	0.64	0.7	0.55	0.76	0.64	0.74	0.75	0.77	0.37
5	1.05	0.81	0.59	0.6	0.65	0.52	0.71	0.6	0.73	0.73	0.76	0.36
6	1.03	0.79	0.58	0.58	0.61	0.49	0.62	0.59	0.69	0.7	0.74	0.36
7	1.02	0.76	0.5	0.54	0.58	0.48	0.56	0.57	0.65	0.69	0.71	0.35
8	1	0.72	0.45	0.5	0.55	0.47	0.53	0.52	0.62	0.65	0.68	0.34
9										0.60	0.65	0.33

Table IX-ii. Duration and % Reduction in Breadth during slow drying

Days	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
	6	6	6	6	6	6	5	5	5	10	10	10
%Decrease in breadth	11.5	18.18	30.76	30.55	26.67	18.96	39.77	24.63	18.42	25	35	13.15
Avg% decrease in breadth	20.14			25.39			27.60			16.13		

Appendix X

Table X-i. Variation in Thickness during Slow Drying

Days	Bourbon (t, cm)			Alcohol (t, cm)			High temp (t, cm)			Low temp (t, cm)		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
1	0.51	0.71	0.34	0.59	0.47	0.39	0.69	0.45	0.39	0.58	0.49	0.32
2	0.48	0.68	0.33	0.55	0.46	0.38	0.64	0.41	0.38	0.58	0.48	0.32
3	0.46	0.62	0.32	0.5	0.45	0.38	0.6	0.39	0.37	0.56	0.46	0.32
4	0.41	0.6	0.32	0.48	0.43	0.37	0.58	0.37	0.34	0.51	0.44	0.32
5	0.39	0.58	0.31	0.44	0.4	0.36	0.5	0.35	0.3	0.49	0.43	0.31
6	0.37	0.52	0.3	0.4	0.39	0.36	0.46	0.33	0.27	0.47	0.41	0.3
7	0.35	0.46	0.29	0.38	0.37	0.35	0.4	0.32	0.25	0.43	0.4	0.29
8	0.33	0.44	0.28	0.35	0.35	0.33	0.35	0.31	0.24	0.4	0.39	0.29
9										0.39	0.37	0.28

Table X-ii. Duration and % Reduction in Thickness during Slow Drying

Days	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
	6	6	6	6	6	6	5	5	5	10	10	10
%Decrease in thickness	31.25	27.27	15.15	36.36	23.90	13.15	48.43	24.39	39.47	46.55	35.41	12.5
Avg % decrease in thickness	24.55			24.47			37.43			31.48		

Appendix XI

Table XI-i. Variations in Moisture Content during Conditioning

Days	Bourbon (MC, %)			Alcohol (MC,%)			High temp (MC,%)			Low temp (MC,%)		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
1	102.16	103.46	48.97	43.98	69.30	75.67	49.86	22.66	14.16	52.67	38.32	57.29
10	87.22	81.97	40.38	33.92	54.05	62.06	45.97	18.40	9.97	45.73	31.34	43.84
20	73.39	58.14	25.87	26.06	34.33	45.04	34.08	16.70	6.35	41.63	26.33	28.52
30	59.65	48.29	15.49	13.77	21.19	26.75	25.01	14.99	3.12	37.36	24.29	18.67

Table XI-ii. Duration and % Reduction in Moisture Content during conditioning.

Days	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
	30	30	30	30	30	30	30	30	30	30	30	30
%Decrease in mc	41.61	53.32	68.37	68.69	69.42	64.64	49.84	33.85	77.96	29.07	35.83	67.41
Avg% decrease in mc	54.43			67.58			53.88			44.10		

Appendix XII

Table XII-i. Variation in Length during Conditioning

Days	Bourbon (l,cm)			Alcohol (l,cm)			High temp(l,cm)			Low temp (l,cm)		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4

1	23.3	18.3	12.5	19.9	16.9	11.4	20.6	16.8	13	20.8	16	11.1
10	23.3	18.3	12.5	19.9	16.9	11.4	20.6	16.8	13	20.8	16	11.1
20	23.3	18.3	12.5	19.9	16.9	11.4	20.6	16.8	13	20.8	16	11.1
30	23.3	18.3	12.5	19.9	16.9	11.4	20.6	16.8	13	20.8	16	11.1

Table XII-ii. Duration and % Reduction in Length during Conditioning

Days	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
	30	30	30	30	30	30	30	30	30	30	30	30
%Decrease in length	0	0	0	0	0	0	0	0	0	0	0	0
Avg% decrease in length	0			0			0			0		

Appendix XIII

Table XIII-i. Variation in Breadth during Conditioning

Days	Bourbon (b, cm)			Alcohol (b, cm)			High temp (b, cm)			Low temp (b, cm)		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
1	1	0.72	0.45	0.50	0.55	0.47	0.53	0.52	0.62	0.60	0.65	0.33
10	1	0.72	0.45	0.50	0.55	0.46	0.52	0.52	0.62	0.59	0.65	0.33
20	0.99	0.72	0.44	0.50	0.54	0.46	0.51	0.51	0.61	0.58	0.65	0.33
30	0.99	0.72	0.44	0.50	0.54	0.45	0.51	0.5	0.61	0.58	0.65	0.32

Table XIII-ii. Duration and % Reduction in Breadth during Conditioning

Days	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
	30	30	30	30	30	30	30	30	30	30	30	30
%Decrease in breadth	1	0	2.22	0	1.81	4.22	3.77	3.84	1.61	3.33	0	3.13
Avg% decrease in breadth	1.07			2.02			9.22			2.15		

Appendix XIV

Table XIV-i. Variation in Thickness during Conditioning

Days	Bourbon (t, cm)			Alcohol (t, cm)			High temp (t, cm)			Low temp (t, cm)		
	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
1	0.33	0.44	0.28	0.35	0.35	0.33	0.33	0.31	0.23	0.31	0.31	0.28
10	0.32	0.44	0.28	0.34	0.35	0.32	0.32	0.31	0.23	0.3	0.31	0.28
20	0.32	0.43	0.27	0.34	0.34	0.32	0.32	0.31	0.23	0.3	0.31	0.28
30	0.31	0.43	0.27	0.33	0.34	0.31	0.31	0.3	0.22	0.29	0.31	0.27

Table XIV-ii. Duration and % Reduction in Thickness during Conditioning

Days	A1	B1	C1	A2	B2	C2	A3	B3	C3	A4	B4	C4
	30	30	30	30	30	30	30	30	30	30	30	30
%Decrease in thickness	6.06	2.27	3.57	5.70	2.85	6.06	6.06	3.22	0	6.45	0	3.75
Avg% decrease in thickness	3.96			4.87			3.09			3.40		

Appendix I

Schedule for Collecting Data from Farmers

Kerala Agricultural University

Kelappaji College of Agricultural Engineering and Technology

Tavanur-679573

Survey of Vanilla Crop for Processing

Location: **Date:**

1. Name :

2. District :

17. Taluk :

18. Total Area Under Cultivation: Marginal 1 2 3 4 5 Large

19. Area under Vanilla cultivation: Marginal 1 2 3 4 5 Large

20. Variety of Vanilla Cultivated:
    (i)
    (ii)
    (iii)

21. Numbers of year since taking up Vanilla cultivation :

22. Source of Cultivating Materials :

23. Method of pollination adopted :

24. Method of Irrigation :

25. Any scientific method used for cultivation :

26. Time/Stage which harvesting is done :

27. Are the beans sold raw :

28. The reason for not curing beans :

29. Time required for curing process :

30. Numbers of days after harvest with in which curing must be done :

17 Method of killing :
a. Time:
b. Temperature:
c. Humidity:

18 Method of bundling used :
a.
b.

35 Type of Thread used :

36 Type of Blanket used for sweating :

37 Time for Sweating :

38 Temperature for sweating :

39 Humidity at sweating :

40 Method of drying :
a.
b.

41 Temperature for drying :

42 Drying time :

43 Humidity :

44 Method of conditioning or ageing :

45 Temperature for ageing :

46 Time for ageing :

47 Stage at which the curing process is completed :

48 Humidity of cure bean :

49 Colour of cure bean :

50 Method adopted for the prolong storage :

a. Temperature :
b. Humidity :

35. Approximate cost of curing process :
36. Approximate time for curing process :

37. Are doing curing by self or taking help from any organization/Institution :

38. Numbers of labour required for curing :

39. Any Machine for curing :

40. Any Aid from Government/spice board :

41. Have you received any Experts opinion :

42. If time of curing is reduced are you interested to adopting it :

43. Any suggestion for reducing time :

44. Agencies sought after for sale of beans :

45. Usual difficulties encountered during Vanilla cultivation :

46. Organic manures/fertilizer used for vanilla cultivation :

47. Are you aware of the immense profit you could make through the sale of cured vanilla beans :

48. Relative Advantage :

I. Initial cost : Cheap 1 2 3 4 5 Expensive

II. Net Profitability : Meagre 1 2 3 4 5 Exorbitant

III. The consistency of profits : Irregular 1 2 3 4 5 Regular

IV. Saving of time : Time consuming 1 2 3 4 5 Time saving

V. Multiple use potential : Single benenfit 1 2 3 4 5 Multiple benefits

49. Personal experience in Vanilla cultivation :

50. Any suggestion for vanilla cultivation to other farmers:

Note: **Relative Advantage**

VI. **Initial Cost**: Cash or capital investment required for adoption of an innovation by farmers.

VII. **Net Profitability**: Quantum of benefit expected due to adoption of an innovation.

VIII. **Consistency of profits**: Regularity of net return from an innovation over a period of time

IX. **Saving of time**: Efficiency of an innovation in terms of saving of time and best utilization of opportunities.

X. **Multiple use potential**: Adoption of an innovation result in multiple benefits