EVALUATION OF PICKLING MANGOES FOR PROCESSING QUALITY

By

Zeenath. K. K

(2014-12-134)

THESIS

Submitted in partial fulfillment of the requirement

for the degree of

Master of Science in Horticulture

(PROCESSING TECHNOLOGY)

Faculty of Agriculture

Kerala Agricultural University, Thrissur

Department of Processing Technology

COLLEGE OF HORTICULTURE

VELLANIKKARA, THRISSUR – 680656

KERALA, INDIA

2016

DECLARATION

I hereby declare that the thesis entitled **"Evaluation of pickling mangoes for processing quality"** is a bonafide record of research work done by me during the course of research and the thesis has not been previously formed the basis for the award to me any degree, diploma, fellowship or other similar title, of any other University or Society.

Vellanikkara

Date: 31-01-2017

Zeenath. K. K

(2014-12-134)

CERTIFICATE

Certified that thesis entitled **"Evaluation of pickling mangoes for processing quality"** is a bonafide record of research work done independently by **Mrs. Zeenath. K.K (2014-12-134)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, associate ship or fellowship to her.

Dr. M. L.Jyothi
Major Advisor
Professor (Horticulture)
Regional Agricultural Research Station,
Pattambi.

Vellanikkara

Date: 31-01-2017

CERTIFICATE

We, the undersigned members of the advisory committee of **Mrs. Zeenath. K. K (2014-12-134)**, a candidate for the degree of **Master of Science in Horticulture**, with major field in **Processing Technology,** agree that the thesis entitled **"Evaluation of pickling mangoes for processing quality"** may be submitted by **Mrs. Zeenath. K. K (2014-12-134)**, in partial fulfillment of the requirement for the degree.

31/01/2017

Dr. M. L. Jyothi
Professor (Horticulture)
Regional Agricultural Research Station,
Pattambi

31/1/17

Dr. Sheela. K. B
Professor and Head
Department of Processing Technology
College of Horticulture
Vellanikkara, Thrissur - 680656

31/1/17

Smt. Meagle Joseph
Associate Professor
Department of Processing Technology
College of Horticulture
Vellanikkara, Thrissur - 680656

31/1/17

Dr. Jayaprakash Naik
Associate Director of Research
Regional Agricultural Research Station
Pilicode

31/1/17

External examiner
(C.S. NATARAJAN)

4

ACKNOWLEDGEMENT

And so comes the time to look back on the path traversed during the endeavor and to remember the faces and spirits behind the action with a sense of gratitude. Nothing of significance can be accomplished without the acts of assistance, words of encouragement and gestures of helpfulness from the other members of the society.

First and foremost I bow my head before the ***Almighty God*** *for enlightening and making me confident and optimistic throughout my life and enabled me to successfully complete the thesis work in time.*

It is with immense pleasure I avail this opportunity to express my deep sense of whole hearted gratitude and indebtedness to my major advisor ***Dr. M. L. Jyothi*** *Professor (Horticulture) ,Regional Agricultural Research Station, Pattambi, for her expert advice, inspiring guidance, valuable suggestions, constructive criticisms, constant encouragement, affectionate advice and above all, the extreme patience, understanding and wholehearted co-operation rendered throughout the course of my study. I really consider it is my fortune in having her guidance for the thesis work. My sincere and heartfelt gratitude ever remains with her.*

I consider it as my privilege to express my deep-felt gratitude to ***Dr. Sheela. K. B.,*** *Professor and Head, Department of Processing Technology, College of Horticulture, Vellanikkara for her constant support, valuable suggestions, cooperation throughout the research programme and critical scrutiny of the manuscript. I sincerely thank* ***Smt. Meagle Joseph,*** *Associate Professor, Department of Processing Technology, College of Horticulture, Vellanikkara for her invaluable help, unbounded support, suggestions and constant encouragement throught the periode of the work. I take this opportunity to thank* ***Dr. Jayaprakash Naik,*** *Associate Director of Research, Regional Agricultural Research Station , Pilicode and member of advisory committee for the critical comments , motivation and encouragement . I thank for all the help and cooperation. I express my gratitude to* ***Dr. S. Krishnan,*** *Professor and Head, Dept. of Agricultural Statistics, College of Horticulture, for his valuable assistance, immense help and guidance during the statistical analysis of the*

data. I express my deep sense of gratitude and sincere thanks to ***Dr. Saji Gomez*** *Assistant Professor, Department of Processing Technology for the valuable suggestions and support*

I duly acknowledge the encouragement, moral support, precious suggestions and timely persuasions by my dear seniors, ***Divya S. L, Teena simenthy, Naresh*** *, not only in my research work but also throughout my PG programme. I express my sincere thanks to my classmates* ***Aiswarya.T, Charan. S. M ,Greeshma. K, G and Supritha. A*** *for their affection and kind help offered during my thesis work. I have infinite pleasure to express whole hearted thanks to my loving juniors* ***Karishma*** *and* ***Rose Mary*** *for their love, innumerable help and support.I wish to express my sincere thanks to****Sruthy chechi, Jooby chechi, Jiyana, Lathika chechi, Shiji chechi, Naseema tha, Prasanna chichi, Rini Mam, Sundari chichi, Stella chechi.*** *My thanks to all M.Sc. classmates for their moral support and encouragement.*

I am in dearth of words to express my love towards ***my beloved family*** *Husband* ***Arifkhan,*** *Father* ***HamZa,*** *Mother* ***Nafeesa*** *and Father in law* ***Kutyali,*** *Mother in law, Nafeesa, my brothers* ***Musthafa*** *and* ***Sabeeh and my son Faheem Ali*** *for their boundless affection, moral support, eternal love, deep concern, prayers and personal sacrifices which sustains peace in my life.*

I owe special thanks to Library, College of horticulture. Dr. Francis and all other staff members of Library, who guided me in several ways, which immensely helped for collection of literature for writing my thesis.

I express my deep sense of gratitude to Kerala Agricultural University for financial and technical support for persuasion of my study and research work.

It would be impossible to list out all those who have helped me in one way or another in the successful completion of this work. I once again express my heartful thanks to all those who helped me in completing this venture in time.

Zeenath. K.K.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

1. INTRODUCTION

Mango is popularly known as "The king of fruits", for its wide adaptability, high nutritive value, richness in variety, delicious taste, excellent flavour, attractive appearance and popularity among users (Negi, 2000). Among the major fruit crops cultivated in the world, it ranks fifth in total production. Mango is the second most important tropical fruit with 27 million tonnes being produced annually worldwide (Bally *et al.* 2009). It originated from the foothills of the Himalayas of India and Burma. In India, about 1,500 varieties of mango are grown including 1,000 commercial varieties. Each of the main varieties of mango has a unique taste and flavour.

The main challenges of mango production are poor farm management, improper harvesting and post harvest handling, lack of refrigerated transportation and storage facility. Value-added products offer higher returns, open new markets, create brand recognition and add variety to farm operation (Bachmann, 2001). Mango fruits are utilised at every stage of its growth. A number of products are made from raw and ripe fruits like pickle, chutney, amchoor, pulp, leather, juice, nectar, squash, *etc.* (Negi, 2000). Mango is used for culinary purposes also. Physical properties of mango fruits play an important role in their selection as a raw material for fresh consumption and processing.Yellow/ orange colour gives an attraction to fresh fruit consumers thus determining the type of processed product the pulp can be used for like juices, jam, nectar, dried mango chips and slices (Germain *et al*., 2008).

In Kerala, the area under cultivation of mango is 77,158 ha and production is 457067 tonnes (FIB, 2016). Palakkad, Kozhikode and Malappuram districts hold 1st, 2nd and 3rd positions with 12%, 11% and 10% areas respectively.

Commercial mango cultivation is restricted to Palakkad district. Western Ghats is considered as secondary centre of origin of mango which is partially responsible for the richness in germplasm of the species in Kerala (Radha and Nair, 2000). A number of local varieties and land races were available in homesteads and

avenues and other isolated areas. Vellari manga, Chenka Varikka, Chandrakaran, Karpooram manga, Moovandan, Kotookonam Varikka, Karakka manga, Koonan, Chappikudiyan, Kalkandamanga, Kilichundan *etc* are some of the traditional mango varieties of Kerala. Pickles are made from some of these land races in small scale. An important attribute of these types is their keeping quality. Tender mango pickles, commonly known as *Kadumanga* is popular in Kerala and pickling varieties have great demand for its preparation. However efforts to conserve the trees are limited and these land races are fast approaching extinction. Attempts are made at RARS, Pattambi and RARS, Pilicode under Kerala Agricultural University to conserve pickling mango varieties. Evaluation of these collections for product development is yet to be done. Hence the project entitled "Evaluation of pickling mangoes for processing quality" was formulated with the following objectives

1. To evaluate the quality attributes of 21 pickling mango accessions maintained at RARS, Pattambi and RARS, Pilicode.
2. To study the suitability of the accessions for product development.

2. REVIEW OF LITERATURE

Mango, the 'King of fruit' is greatly savoured for its delicious taste, exotic flavour and succulence. Mango originated in Indo-Malayan region stretching from India to the Philippines and Papua New Guinea. It belongs to family Anacardiaceae and is composed of 69 species of genus *Mangifera*, which are distributed throughout the world (Kostermans and Bompard, 1993). Wide variation is reported by different workers in mango. It includes variation in tree, leaf, bearing, inflorescence, quantitative and qualitative characters of fruits and also its processing qualities.

Mango is a nutritionally important fruit and a rich source of vitamin A, B and C and minerals. (Sadhu and Bose, 1976). During ripening, fruits undergo a series of physiological, biochemical and structural changes which make them attractive to the consumer (Jiang *et al.,* 1999). Most of the mango industries are mainly based on traditional mango cultivars which have been grown for hundreds of years (Bally, 2011).

2.1 Fruit characters

2.1.1 Quantitative characters

Gangwar and Tripathi (1973) reported that in a collection of 40 varieties of mango coefficient of variation was noted high for fruit volume, fruit weight and reducing sugar. Pulp content is an important quality aspect to processors. Varieties having 70% and above pulp yield are perfect for processing economically (Okoth *et al.*, 2013). Bulky fruits had good flavour and high percentage of pulp. (Kalra *et al.*, 1982)

Srivastava *et al.* (1987) evaluated fifteen varieties of mango in Madhya Pradesh. Average weight per fruit varied from 121.8 to 385.7 g. Average peel content varied from 14.3 to 28.8 per cent, pulp content from 49.4 to 70.7 per cent, stone content from 13.3 to 29.9 per cent and crude fibre from 0.56 to 1.6 per cent. Average fruit weight of sucking varieties varied from 10.4 to 220.4 g (Rabbani and Singh, 1988).

Jyothi (2000) based on the studies in pickling mango varieties of Thrissur and Palakkad districts of Kerala reported variation in fruit characters. Length, thickness and breadth of ripe fruits recorded comparatively lesser variation. But in case of weight and volume of fruits there was high variation. Stone weight of mango fruit ranged from 3.8 to 40.8 g with an average of 20.11 g. Maximum variation was noted for stone volume and stone weight followed by stone breadth and stone thickness. In ripe fruits, average pulp content, skin content and stone content was 47.49, 24.21 and 26.24 per cent respectively.

The thickness of fruit skin was low in over ripe Indian Lota (1.8 mm) and Neelambori (1.81mm) and it was high in green Sharma Fazli (3.16 mm). Maximum fruit weight was found in variety Madrazi Tota (564.0g) and minimum was found in Neelambori (160.0g). Variation was observed in fruit weight in respect of the stage of ripening. In developing fruits, weight increased initially after ripening and then slightly decreased (Mannan *et al.*, 2003). Anila and Radha (2003) reported that length of ripe fruit of mango ranged from 8.5 to 10.9 cm and breadth from 5.6 to 6.8 cm. Maximum length and breadth was reported in Ratna and minimum length in Muvandan and breadth in H-151. Weight of ripe fruits of mango ranged from 155.66 to 398.01 g and volume from 155.0 to 395.0 ml. Maximum weight was in Ratna and minimum in H-151. They also reported that stone content of ripe fruits of mango varied from 12 to 20 per cent, pulp content from 58 to 75 per cent and peel content from 13 to 22 per cent in the varieties studied (Alphonso, Prior, Neelum and Muvandan, hybrids - Ratna and H-151). Maximum stone content was in Muvandan, pulp content in Ratna and peel content in Alphonso. Minimum stone content was in Ratna and pulp content in Muvandan.

When fruit undergo ripening, synthesis and accumulation of S-carotene occurs parallel to chlorophyll degradation, and as a result yellow/red colour is expressed (Azzolini *et al.*, 2005).

According to Pradeepkumar *et al.* (2006), in mango, fruit length and stone weight had significant correlation with pulp weight. Shafique *et al.* (2006)

reported that the weight of all mangoes increased gradually with maturity. The rate of increase was different for different varieties. Significant difference was observed among the cultivars at three maturity stages. In the immature stage, the lowest weight of 16.1g was found in Ranipasand and the highest weight of 123.2 g was found in Fazli. At mature and ripe stages, the maximum and minimum weights were also found in Fazli and Ranipasand varieties respectively. In the immature stage, skin content of Fazli and Surjapuri was 20.3 g but in Ranipasand and Mohanbhog it was 22.70 and 22.40 g respectively. In the ripe stage, skin content of Fazli was only 12.2 percent, whereas Khirsapat, Ranipasand, Mohanbhog, Kishanbhog and Langra had higher skin content than that of Fazli. Although skin is the non edible portion of mango, mangoes of some varieties contained skin significantly different from others. A gradual increase in weight of stone was also noticed with the increase of maturity. The stone content of some varieties differed from others. In ripe stage, Gopalbhog and Fazli had 13.1 % and 11.2 % stone respectively. Pulp is the edible portion of mangoes and is given much importance during evaluation. Composition of mango pulp varied between varieties, stage of maturity and location of cultivation. It was determined at the three maturity stages. Pulp content ranged from 66.4 to 73.5 %, 67.4 to 75.3 % and 68.7 to 76.6 % for immature, mature and ripe mangoes respectively.

Physiological loss in weight was observed when fruit ripens. This was due to biochemical activities like respiration, transpiration *etc.* The rate of weight loss is affected by several factors like relative humidity, temperature of storage, thickness of the peel and surface area, volume ratio of the fruit *etc* (Rathore *et al.*, 2007).

Galvex-Lopez *et al.* (2010) reported that fruit length, thickness, breadth, weight, leaf length and leaf breadth were used to index mango morphology. Colour of skin and flesh is a relevant quality aspect, which makes the first impression of the fruit on sight to the consumer. It influences the degree to which it is purchased for either fresh consumption or for processing purposes (Durrani, 2011). Barhate *et al.* (2011) reported that fruit characters such as fruit length,

diameter, fruit weight and fruit volume differed in different varieties. Fruit length varied from 6.3 cm to 12.46 cm. Maximum fruit length was noted in Baneshan and minimum fruit length was recorded in Rumani. Fruit diameter ranged between 5.76 to 12.5cm . Maximum fruit diameter was observed in Mulgoa and minimum was noted in Kalepad. Fruit weight varied from 151.3 g to 707.7g. Maximum fruit weight was recorded in the cultivar 'Mulgoa'. Similarly maximum fruit volume was noted in Mulgoa (705.3ml) and the lowest fruit volume was recorded in Kalepad (149.6ml).

In case of the quantitative traits, higher variability was observed for the characters like fruit weight (14.46%), skin weight (10.06%) and stone/seed depth (8.30%) while other parameters showed moderate variation. Of the qualitative characters studied, a high coefficient of variation was measured for titrable acidity content (8.04%) (Hossain *et al*, 2014). A study was undertaken to evaluate morphological, physical and biochemical characters of ten mango varieties of Karnataka. The results showed that highest fruit length of 14.71 cm, fruit weight of 521.7g, fruit volume of 512.25 ml and pulp weight of 372.83 g were reported in the variety Totapuri. Maximum stone weight of 69.04g was reported in Ratna and highest peel weight of 90.26 g was reported in Mundappa (Kirankumar *et al.*, 2015).

2.1.2 Quality characters

Fruit quality is the result of interaction between environment and the genetic makeup of the mango crop (Krishnapillai and Wijeratnam, 2016). A study on the fruit quality characters of different varieties showed that Amrapali, Alphonso, Mallika, Dashehari, Chousa, Bombay Green, Sehroli, SBM 01-1, SBM 01-9, SBM 01-10, SBM 01-11, SBM 01-12, SBM 01-35 and SBM 01-36 had better skin and pulp colour, high total soluble solids, low acidity and high ascorbic acid contents, reducing and non-reducing sugar content thus, making them suitable for table consumption. Landraces SBM 01-2, SBM 01-3, SBM 01-4, SBM 01-20 and SBM 01-22 having high total acidity were perfect for pickle purpose. Total soluble solids and reducing sugar were positively and significantly

correlated with fruit weight. Similarly, total soluble solids were positively and significantly associated with non-reducing sugar, reducing sugar and total sugars. Non-reducing sugar, reducing sugar and total sugars were also positively and significantly associated among themselves. Total soluble solids, reducing sugar and non-reducing sugar, exerted direct contribution towards the fruit weight in mango. Thus, these quality traits can be modified genetically along with fruit weight in mango (Barholia and Yadav, 2014). Kirankumar *et al.* (2015) reported that highest total soluble solids of 21°brix was in Manibhatta. Maximum titrable acidity of 0.41 per cent was reported in Mundappa, highest reducing sugar content of 4.89 per cent was noted in Kare Ishad.

2.1.2.1 Acidity

Lakshminarayana *et al.*(1970) reported that in case of Alphonso mango maximum acidity of 4.2 to 4.4 per cent was attained within seven weeks and at the time of harvest, acidity declined slowly to 2.7-2.5 per cent. Titrable acidity is an important physiochemical parameter, which protects against the micro organism and improve the product quality. According to Kapur (1974), during development of mango, acidity was reduced. Pandey *et al.* (1974) reported that during maturation, acidity was increased. Elahi and Khan (1983) reported the decrease in titrable acidity during ripening of mangoes. The decrease was from 2.12 per cent to 0.39 per cent in mango variety 'Anwar'after eight days of storage. Medlicott and Thomson (1985) reported that the decrease in acidity was initially due to the high rate of loss of citric acid with only small losses of malic acid. According to Ramakrishna (1988), titrable acidity reduced from 2.26 to 0.28 per cent in developing fruits of mango. In pickling type mango, acidity at tender stage varied from 1.3 to 3.5 per cent and at ripe stage acidity varied from 0.3 to 3.5 per cent. Average acidity of tender mango was 2.09 per cent and average acidity of ripe mango was 1.75 per cent. (Jyothi, 2000). Agbo and Inyang (1995) observed a decrease of titrable acidity from 1.47 per cent to 0.18 per cent in variety Julie.

Maximum titrable acidity was found in Indian Lota (0.032%) and minimum was found in Sharmai Fazli. The highest titrable acidity was observed at green stage and lowest at over ripe stage. Findings of the study indicated that

Madrazi Tota was superior among the selected varieties in relation to fruit weight, juice content, TSS content, Titrable acidity *etc.* (Mannan *et al*, 2003)

Shafique *et al.* (2006) reported that pH of the mangoes ranged from 2.5 to 3.5, 2.7 to 4.2 and 4.2 to 5.4 for immature, mature and ripe mangoes respectively. Acidity of all the mango varieties decreased with maturity. It was due to the breakdown of starch into sugars thereby lowering the percentage of acidity of the fruits. Acidity was determined at all the three stages and reported as citric acid. A gradual decrease in acidity was noticed for all the varieties with the advancement of maturity. The gradual decrease in acid content may be due to conversion of acids into sugars by some physiological and biochemical changes in the fruits. Pradeepkumar *et al.* (2006) reported that average titrable acidity was very high in pickling type mango (1.22%). Rathore *et al.* (2007) also observed a decrease in titrable acidity for the *Dosehari* mango during storage-ripening

Othman and Mbogo (2009) reported that *Dodo* mangoes had higher titrable acidity than *Viringe* mango. During storage ripening, there was a decline in titrable acidity of the *Dodo* mangoes (1.20 per cent to 0.40 per cent) and *Viringe* mangoes (0.75 per cent to 0.25 per cent). Akhtar *et al.* (2010) observed minimum pH lower than 4 and acidity more than 0.60 in all four varieties *viz.*, Chausa, Dusheri, Ratol and Langra fruits harvested even at maturity stage. Total soluble solids (TSS) were directly correlated with the acidity of the fruit. Generally, acidity of the fruit decreased and total soluble solids increase during maturity and ripening stage of the fruit (Padda *et al.* 2011). Pleguezuelo *et al.* (2012) reported high TSS (15.7 to 20° Brix) from the fruits harvested at maturity stage.

2.1.2.2 Polyphenol

Lakshminarayana *et al.* (1970) noticed high phenol content in young fruits. With the development of fruit, phenolic content decreased (Joshi and Shiralkar, 1977). In flesh and peel of mango fruits small amount of polyphenol is present which is responsible for astringency. During maturity and ripening, total content of poly phenols might change (Majumder and Sharma, 1990). Average

polyphenol content in tender mango was 1.75mg/g. It varied from 0.5 to 3.4 mg/g fruit (Jyothi , 2000). Phenols are natural compounds and widely distributed in the plant kingdom. Phenolic compounds provide multiple biological effects like antioxidant activity and protection from pathogens like fungi (Edoga *et al.*, 2005).

2.1.2.3 Crude fibre

Larraauri *et al.* (1996) reported that mango peel is a good source of crude fibre. The crude fibre content showed a slight decrease during the ripening process. Tender mango crude fibre varied from 4.4 to 13.9 per cent with an average of 8.76 per cent (Jyothi , 2000). Gopalan *et al.* (2000) reported that crude fibre values of fruits *viz.* aonla, sapota, fig, and peach were 3.4, 2.6, 2.2 and 1.2 g/100g respectively. Mamiro *et al.* (2007) observed crude fibre content of up to 3.7% in *Dodo* mangoes from Morogoro, Tanzania. In the pickling type mangoes, average crude fibre content was highest (0.58 to 2.92 per cent) followed by table type mangoes (0.4 to 2.4 per cent) (Simi and Rajmohan, 2013).

2.1.2.4 Moisture content

Othman and Mbogo (2009) reported that *Dodo* and *Viringe* mango varieties had high moisture content and it varied from 56.3 per cent to 86.0 per cent. When the moisture content of varieties was compared, *Dodo* mangoes had higher moisture content than Viringe mangoes. The *Dodo* mango of Morogoro had higher moisture content than the *Dodo* mango of Muheza in Tanga. Late season fruits had the highest moisture while early season fruits had the lowest moisture content.

Leghari *et al.* (2013) reported that the moisture content of different varieties significantly differed and it was more than 80% in all varieties. Ueda *et al.* (2000) also reported similar results. They harvested mango fruits at 10, 13, 16 and 19 weeks after flowering and noted moisture content more than 80% in all stages of fruit development. From this study maximum moisture content of 88.6 per cent was observed from the fruits harvested 10 weeks after flowering.

2.1.2.5 Juice content

According to Awasthi and Pandey (1979), large sized sucking varieties had high quantity of juice, which varied from 34.2 to 53.7 per cent. Juice content of sucking varieties of mango varied from 2.9 % to 66.5% with an average juice content of 58.49 % indicating that high quantity of juice was yielded by pickle varieties (Rabbani and Singh, 1988). Jyothi (2000) reported that juice content of ripe pickling type mango varied from 40.0 to 72.7 per cent.

Maximum content of juice was found in Sharmai Fazli (65.89%) and minimum was found in Amrapali(61.49%). Juice content was increased with the maturity but decreased after ripening. The highest juice content was found at ripe stage (71.17%) followed by over ripe stage(63.44%) and it was minimum at green stage(51.12%)(Mannan *et al*, 2003).

2.1.2.6 Sugar content

Lakshminarayana (1973) reported that reducing and total sugars increased slightly at later stages after fruit set, even though they were nearly constant until 14 weeks in the mango variety 'Alphonso' during development and maturation. Biochemical characters of ripe mango such as reducing sugar varied from 2.23 to 2.97 per cent, TSS from 10 to 24°brix and acidity from 0.2 to 0.46 per cent. Maximum reducing sugar and TSS were noted in Ratna and higher acidity was recorded in Alphonso and Neelam fruit (Anila and Radha, 2003). Shafique *et al.* (2006) reported that a gradual decrease in reducing and non-reducing sugars were found till maturity. When the fruits started to ripen on the tree (after about 96 days from fruit set), a decrease in reducing sugar was noted. The soluble sugars of the fruit pulp are mainly glucose, fructose and sucrose. The rate of starch accumulation was sudden at the beginning of fruit growth and slowed later but it continued to increase up to maturity. Sugar-acid ratio is also considered as a measure of quality of fruit. It is generally recognized that quality fruits have higher sugar-acid ratio whereas fruits of less quality have lower sugar-acid ratio. Gopalbhog, Khirsapat and Langra had sugar-acid ratio of 150.0, 162.50 and

131.25 respectively. On the other hand, Ashina and Mohonbhog have sugar-acid ratio of 96.25 and 114.67 respectively. Othman and Mbogo (2009) reported that total and reducing sugars of the mangoes increased from the immature to mature and mature to ripened fruits. These sugars also increased within the seasons from early to late seasons and with days of storage-ripening making the most sugary fruits. They also reported that the reducing sugar content in the mangoes varied from 9.6 per cent to 24.2 per cent. Both *Dodo* and *Viringe* mango varieties showed high percentage of reducing sugars. The reducing sugar content of the mangoes increased within the season and with days of storage ripening. Thus fully ripened late season mangoes had the highest reducing sugar content. *Viringe* mango had slightly higher reducing sugars than *Dodo* mangoes. Leghari *et al.* (2013) observed that the highest reducing sugars (2.78%) were observed in variety Sindhuri as compared to rest of the varieties.

Simi and Rajmohan. (2013) reported that pickling varieties with high content of total sugars were Karpoora Varikka, Velutha Muvandan, Neenda Karpooram, Nedungolan, Perakka manga, Vellari Type-2, Ambalathara Local and Inamanga. Similarly high content (more than 4.3%) of reducing sugars was reported in the varieties, Neenda Karpooram, Mylapore manga, Karpooram manga, Kolambi, Perakka manga, Ambalathara Local and Pulichi

2.1.2.7 TSS

According to Satyavati *et al.* (1972), TSS of ripe mango fruits of local varieties of Kerala varied between 10 and 24°brix. Ramakrishna (1988) reported that in developing fruits of mango, total soluble solids increased from 4.1 to 20.0°brix. TSS of ripe pickling type mango ranged from 5° to 22° brix (Jyothi, 2000). The total soluble solids content was maximum in Indian Lota (18.02%) and it was minimum in Neelambori (17.07%) (Mannan *et al*, 2003)

Shafique *et al.* (2006) reported that TSS content is considered as a measure of quality for most of the fruits. Generally taste, particularly sweetness of fruits, depend on TSS content. Pradeepkumar *et al.* (2006) reported that 31

mango genotypes of north Kerala had TSS ranging from 12.7 and 25.2° brix. Mamiro *et al.,* (2007) reported a high total soluble solids content of 18.9% for the *Dodo* mango of Morogoro during ripening at room temperature. The total soluble solids content of mangoes increased with storage-ripening at room temperature. The highest total soluble solids content was exhibited by late season fruits. TSS is generally represented by sugars, acids and minerals. Othman and Mbogo (2009) reported that the total soluble solids content in the mangoes was within 14.5 per cent and 30 per cent. *Dodo* and *Viringe* varieties showed high percentage of total soluble solids especially during ripening. *Viringe* mangoes had higher total sugars than *Dodo* mangoes.

Simi and Rajmohan (2013) reported that TSS of pickling type mango varied greatly, which ranged from 8.77 to 25.71° brix. Due to the degradation of cell walls and hydrolysis of starch to sucrose in the ripening stage, TSS content increased three times (5.0 to 15.0) after 12 days of storage (Hossain *et al.,* 2014). Krishnapillai and Wijeratnam (2016) claimed that highest TSS value of 24.6 ° brix was noted in mango variety Kodima.

2.2 Processing qualities

2.2.1 Pickle

Generally, pickle is prepared in two flavours: sweet and sour. Fruits and vegetables are the raw material of pickles like mango, lemon, karonda, aonla, bitter gourd, radish, garlic, cauliflower and many more. Mango pickle is much popular than other pickles. The practice of making mango pickle is diverse all over India. In North India, people prefer mustard oil for preservation, whereas in South India, sesame oil is preferred.

Due to the presence of active principle allyl isothiocynate and enzyme myristase in mustard, mustard powder gave a very good pickle as compared to other flavours (Sastry and Krishnamurthy, 1974). Green mangoes (raw and un ripe) are preserved with salt of 15-20% and later converted in to pickles. Pickles prepared are classified as salt pickles or oil pickles. Generally oil used is either

gingelly or mustard oil. Best quality pickles were produced when high acid mango was used (Sastry *et. al.*, 1975).

According to Narayana (1976), Good manufacturing Practices (GMP) is most important in the preparation of pickles. Maximum storage life was reported in pickle varieties like Puliyan and Chandrakaran (AICFIP, 1979). Ismail *et al.* (1986) reported that in mango, quality of pickle was influenced by proper stage of maturity of the fruit. Best stage for pickle making in unripe green mango fruits was just after the endocarp starts hardening (80% maturity). At this stage there was not much reduction in acid and soluble solids content. Maximum starch content was observed, which may be helpful in retention of texture. According to Majumdar and Sharma (1990), young and unripe fruits are used for preparing pickles because of their acidic taste. Green mangoes are processed in to traditional products like pickle, chutney, green mango powder *etc* and ripe mangoes are processed in to nectar, juice and beverages like RTS *etc* (Nanjundaswamy, 1991). According to Radha (1997) fruits of Chandrakaran were juicy and more suitable for tender mango pickling. Unripe mature fruits were used for pickling and the fruit used for the preparation of pickle was thoroughly cleaned, washed in water and air dried (Gupta *et al.*, 1998).

Pickling quality of fruits was evaluated based on the appearance, colour, aroma, taste, texture and overall acceptability of pickled fruit. Between the components of pickling quality, significant positive correlation was noted. Quality characters and size of the fruit were found to influence the pickling quality (Jyothi, 2000).

Shinde *et al.* (2004) reported that pickle has a very vital role in Indian dishes. Pickle gives us food flavourings adding desired flavoring through combined action of salt, fruit acid and condiments. Some mango cultivars like Konkanruchi in Maharastra are specifically grown for pickling purposes.

The method of preservation generally used in mango is preservation with salt: salt improves the taste, flavour and controls fermentation. Salt content of 15% or above restrict microbial spoilage (Nigam *et. al.*, 2007).

2.3.2 Storage attributes of pickle

Kalra *et al.* (1982) reported that there was decreased moisture percentage in mango pickle with the increase in length of storage period. Immediate decline in moisture was noted due to salt treatment, which could have caused osmosis.

2.2.3.3 Sensory attributes of pickle

According to Gupta *et al.* (1998), taste, flavour, and texture of oil less pickle enhanced in the storage period up to 9 months. Overall flavour is explained as a result of perception by the taste buds in the mouth and the aromatic compounds detected by the olfactory organ in the nose (Rathore *et al.*, 2007).

Organoleptic evaluation of pickling mangoes of southern Kerala revealed that varieties like Karpooram manga, Perakka manga, Nedungolan, Neenda Karpooram, Vellari Type-2, Velutha Muvandan , Muthalamookan, Inamanga, Kotookonam Varikka and Ambalathara Local ranked top in overall acceptability (Simi and Rajmohan, 2013).

2.2.3.4 Microbial attributes of pickle

Mango pickles in India were studied for their safety and shelf quality. Fruits with high phenol and crude fibre content showed fungal contamination in the later stages only (Jyothi, 2000). Yunchalad *et al.* (2003) reported that the specific flavour for pickled mango was obtained due to partial fermentation. The activities of microorganisms which bring changes in the pickles depend mainly on the composition of raw materials used for pickle production. Due to their low pH pickles are decayed by yeasts, moulds and aciduric bacteria like *Acetobacter* and lactic acid bacteria.

2.2.3.5 RTS beverage

RTS beverage is one of the most popular beverages that can be prepared by mixing mango pulp, sugar, citric acid and water. Specification for RTS is 15° brix, 0.3% acidity and 10% pulp content. It can be preserved by bottling (Awasthi and Pandey, 1979). Nakadi *et al.* (2001) reported that RTS beverage

prepared with pomegranate and mango juice 60:40 blend was more superior to other combinations because of good colour, appearance, flavour, taste and overall acceptability.

Deka and Sethi (2001) noticed that RTS spiced beverages can be prepared from blended fruit juices of mango-pineapple, lime-aonla, grape – mango and grape- pineapple by the addition of various spices. From this study, they found that mango-pineapple (85:15) blend with cardamom spice drops was best. According to Chitra and Manimegalai (2002), banana RTS beverage could be stored safely up to 300 days under refrigeration with minimum changes in its quality.

2.2.3.7 Sensory attributes of RTS beverage

Effects of sugar and acid levels on mango flavour perception were analyzed. Acid concentration affected ratings for sweet, sour, peachy, pine/terpentine, astringent, and biting. Sugar enhanced the perception of all flavour attributes except for sour taste, while increasing water increased intensities of all flavour notes. It was evident from the study that sugars and acids enhanced human perception of specific flavour notes in mango, including aromatics (Malundo *et al*, 2001). Hayat *et al.* (2005) reported that flavour / taste of Alphonso decreased with storage period when stored at relative humidity of 70-75 % and temperature of 32-36ºC. The values for odour also decreased during storage at room temperature.

Durrani *et al.* (2011) reported that colour of food is the main criterion for judging the eatable quality of food and same criterion is applied for the colour of mango pulp. The values for colour of all prepared samples decreased during storage at ambient temperature. During storage at room temperature, the values for flavour decreased for mango pulp.

3. MATERIALS AND METHODS

The present investigation entitled "Evaluation of pickling mangoes for processing quality" was conducted in the Department of Processing Technology College of Horticulture, Vellanikkara, Thrissur during 2014-2016. Facilities available at Regional Agricultural Research Station, Pattambi and Regional Agricultural Research Station, Pilicode were also utilised. Objective of this study was to evaluate processing quality of pickling mangoes of Kerala.

The whole programme was divided in to two major experiments

3.1 Experiment I

Evaluation of the accessions for quality

3.2 Experiment II

Evaluation of accessions for product development

In the experiment No. I "Evaluation of the germplasm for quality" evaluation of twenty one accessions including variety *Chandrakaran* from the germplasm maintained at RARS, Pattambi and RARS, Pilicode was done (Appendix -I). Fruits were collected at three stages

1. Tender mango stage (Approximately 45 days after fruit set).

2. Mature stage

3. Ripe stage

In the experiment No. II "Evaluation of accessions for product development", fruits of selected accessions were used for making the following products:

1. Tender mango pickle

2. Cut mango pickle

3. RTS beverage

3.2.1 Tender mango pickle

Tender mangoes were harvested just before the endocarp starts hardening (approximately 45 days after fruit set). These mangoes were preserved (one week) with salt (10%) and later converted in to pickles by adding 5% chilli powder and 5% mustard powder under proper sanitary condition. Pickles were stored in an air tight glass bottle (Jyothi, 2000)

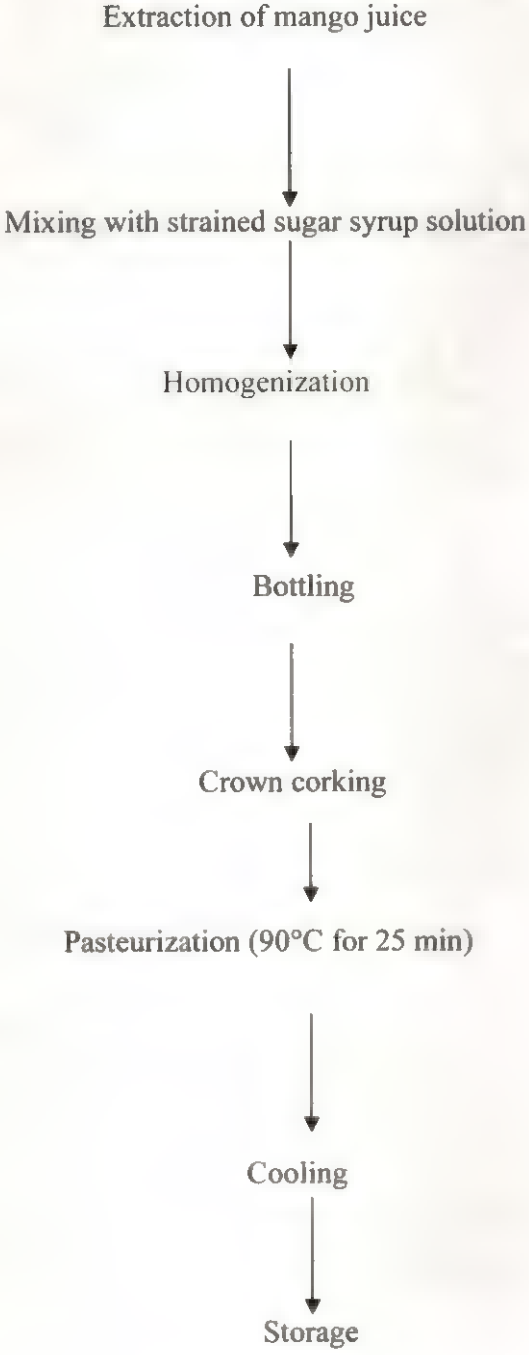
3.2.2 Cut mango pickle

Green mangoes were cut into equal pieces and kept in brine(10% salt) for one week. After one week one spoon of gingelly oil was heated and 5% chilli powder was added. It was mixed with cut mango in brine and was stored in air tight glass bottles

3.2.3 RTS beverage

RTS beverage was prepared by standard procedure conforming to FSSAI specifications. RTS beverages had TSS 15° brix, juice 15% and acidity 0.3%. RTS beverage prepared was stored for three months under refrigerated conditions and observations recorded at monthly intervals.

Preparation of mango RTS beverage



Main items of observations made in experiment I are:

3.1.1 Biometric characters

3.1.1.1 Tender and mature mango

3.1.1.1.1 Length (cm)

Measured by using vernier caliper

3.1.1.1.2 Thickness (cm)

Same as mentioned in 3.1.1.1.1

3.1.1.1.3 Width (cm)

Same as mentioned in 3.1.1.1.1

3.1.1.1.4 Weight (g)

The weight of the samples was recorded by a weighing balance.

3.1.1.1.5 Volume (ml)

Volume of fruit was estimated by water displacement method

3.1.1.1.6 Skin thickness (mm)

Skin thickness was measured using screw gauge

3.1.1.1.7 Flesh thickness (cm)

Same as mentioned in 3.1.1.1.1

3.1.1.1.8 Stone weight (g)(mature mango)

Same as mentioned in 3.1.1.1.4

3.1.1.1.9 Stone volume (ml) (mature mango)

Volume of stone was estimated by water displacement method

3.1.1.1.10 Stone thickness (cm) (mature mango)

Same as mentioned in 3.1.1.1.1

3.1.1.2. Ripe mango

3.1.1.2.1 Length (cm)

Same as mentioned in 3.1.1.1.1

3.1.1.2.2 Thickness (cm)

Same as mentioned in 3.1.1.1.1

3.1.1.2.3 Width (cm)

Same as mentioned in 3.1.1.1.1

3.1.1.2.4 Weight (g)

Same as mentioned in 3.1.1.1.4

3.1.1.2.5 Volume (ml)

Same as mentioned in 3.1.1.1.5

3.1.1.2.6 Skin thickness (mm)

Same as mentioned in 3.1.1.1.1

3.1.1.2.7 Skin content (%)

$$\text{Skin content} = \frac{\text{Weight of the skin (g)}}{\text{Weight of the fruit (g)}} \times 100$$

3.1.1.2.8 Stone content (%)

$$\text{Stone content} = \frac{\text{Weight of the stone (g)}}{\text{Weight of the fruit (g)}} \times 100$$

3.1.1.2.9 Pulp content(%)

$$\text{Pulp content} = \frac{\text{Weight of the pulp (g)}}{\text{Weight of the fruit (g)}} \times 100$$

3.1.1.2.10 Stone volume (ml)

Same as mentioned in 3.1.1.1.9

3.1.1.2.11 Pulp colour

Pulp colour was evaluated by using Royal Horticultural Society Colour chart.

3.1.2 Biochemical characters

3.2.2.1 Tender and mature fruits:

3.1.2.1.1 Titrable acidity

Acidity of the fruit was estimated by titrating a known weight of the sample with standard sodium hydroxide solution (0.1 N NaoH) using a few drops of

phenolphthalein as indicator. End point of the titration was indicated by pink colour of the solution. The acidity was expressed as per cent citric acid (Ranganna, 1997)

3.1.2.1.2 Polyphenol

Polyphenols were estimated by Folin-ciocalteaus method of AOAC (Sadasivan and Manickam, 1992). 0.5 to1.0g of homogenized sample was taken for analysis.The sample was extracted with 10 ml of 80% ethanol and centrifuged. The supernatant liquid was collected and alcohol was evaporated to dryness. The residue was dissolved in a known volume of distilled water.The aliquot was treated with measured in a spectrophotometer at 650 nm. A standard curve was plotted by taking concentration on x- axis and absorbance on y- axis using catechol as standard

3.1.2.1.3 Crude fibre

Crude fibre was evaluated by acid digestion method (Ranganna, 1997). Two grames of dried sample was extracted with ether. The residue was boiled with 200 ml of 0.255N sulphuric acid. The residue was then filtered through muslin cloth and washed with boiling water until washings were no longer acidic. The residue was again boiled with 200 ml of 0.313N NaOH solution and filtered. Again the residue was washed with 1.25% boiling sulphuric acid, water and alcohol. The residue was then dried at 110°C to constant weight. To find out crude fibre, the resultant residue was ignited in muffle furnace.

3.1.2.1.4 Moisture content

Moisture content of the fruit was estimated by drying a known weight of the sample at 50-60°C to a constant weight and expressed as per cent (Ranganna, 1997)

$$\text{Moisture percentage} = \frac{\text{Fresh weight (g) - Dry weight(g)} \times 100}{\text{Fresh weight (g)}}$$

3.1.2.2 Ripe fruits

3.1.2.2.1 Titrable acidity

Same as mentioned in 3.1.2.1.1

3.1.2.2.2 Polyphenol

Same as mentioned in 3.1.2.1.2

3.1.2.2.3 Crude fibre

Same as mentioned in 3.1.2.1.3

3.1.2.2.4 Juice content

Selected ripe fruit was weighed and the pulp was filtered through muslin cloth. Volume of the filtrate was measured by measuring cylinder and juice content was expressed as per cent

$$\text{Juice content} = \frac{\text{Volume of filtrate (ml)}}{\text{Weight of fruit (g)}} \times 100$$

3.1.2.2.5 Reducing sugar content

A known weight of the fruit sample was ground in a mortar and pestle and transferred to a 250 ml volumetric flask. About 100ml of distilled water was added and clarified with 2ml of 45% neutral lead acetate, 2 ml of 22% potassium oxalate solution. Volume was made up to 250 ml using distilled water. The aliquot of the filtered solution was titrated against a mixture of Fehlings solution A and B using methylene blue as indicater.End point was indicated by brick red colour of the solution and reducing sugar was expressed as percentage (Ranganna, 1997)

3.1.2.2.6 TSS

TSS was directly estimated using digital refractometer (0-32°brix) and expressed as °brix

Main items of observations made in experiment 2 are:

3.2.1 Organoleptic evaluation of pickle

Sensory evaluation of pickles was carried out using nine point hedonic scale at monthly intervals for three months. A panel of 10 judges was selected. Each sample was evaluated for appearance, colour, flavour, texture/consistency, odour, taste, after taste and overall acceptability using nine point hedonic scale (Appendix-II)

3.2.2 Microbial evaluation of pickle

Microbial population of the pickles was assessed at monthly intervals for three months.The quantitative assay of the population was carried out by serial dilution pour plate technique (Johnson and Curl, 1972). For the enumeration of the bacterial, fungal and yeast population, Nutrient Agar medium, Rose Bengal agar medium and Sabourd Dextrose agar medium were used respectively.

A sample of 1g was suspended in 100 ml of sterile distilled water taken in a conical flask and using an orbit shaker shaken thoroughly for 20 minutes. Using a micropipette 1ml of the supernatant was accurately pipetted from this into a test tube containing 9 ml of sterile distilled water to get a dilution of10^{-2}. To get 10^{-5} dilution this procedure was repeated. For the enumeration of bacterial, fungal and yeast count of the sample, one ml each of 10^{-2}, 10^{-1} and10^{-2} dilution was used respectively. The count of bacteria was recorded after two days whereas fungal and yeast count was recorded four days after inoculation. The number of microorganisms per gramme of sample was calculated by the formula

Number of colony forming units (CFU) per gramme of the sample

$$= \frac{\text{Mean number of CFU}}{\text{Quantity of the sample weight}} \times 100$$

3.2.3 Organoleptic evaluation of RTS beverage

Same as mentioned in 3.2.1

3.3 Statistical analysis

The observations were recorded and tabulated. The data were analysed statistically as Completely Randomized Design (CRD). Scores for sensory evaluation were analyzed by Kendall's coefficient of concordance.

Plate 1. Instruments used for chemical analysis

Spectrophotometer

Hand refractometer

Muffle furnace

Plate.2 - Tree accessions from RARS, Pilicode

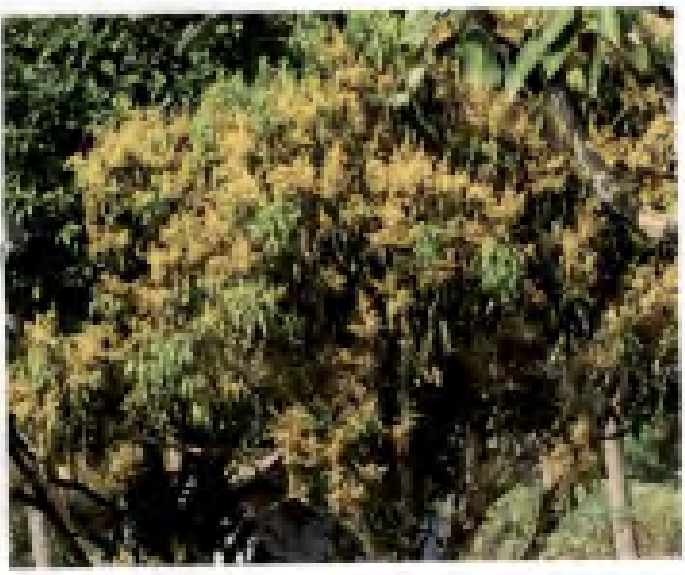
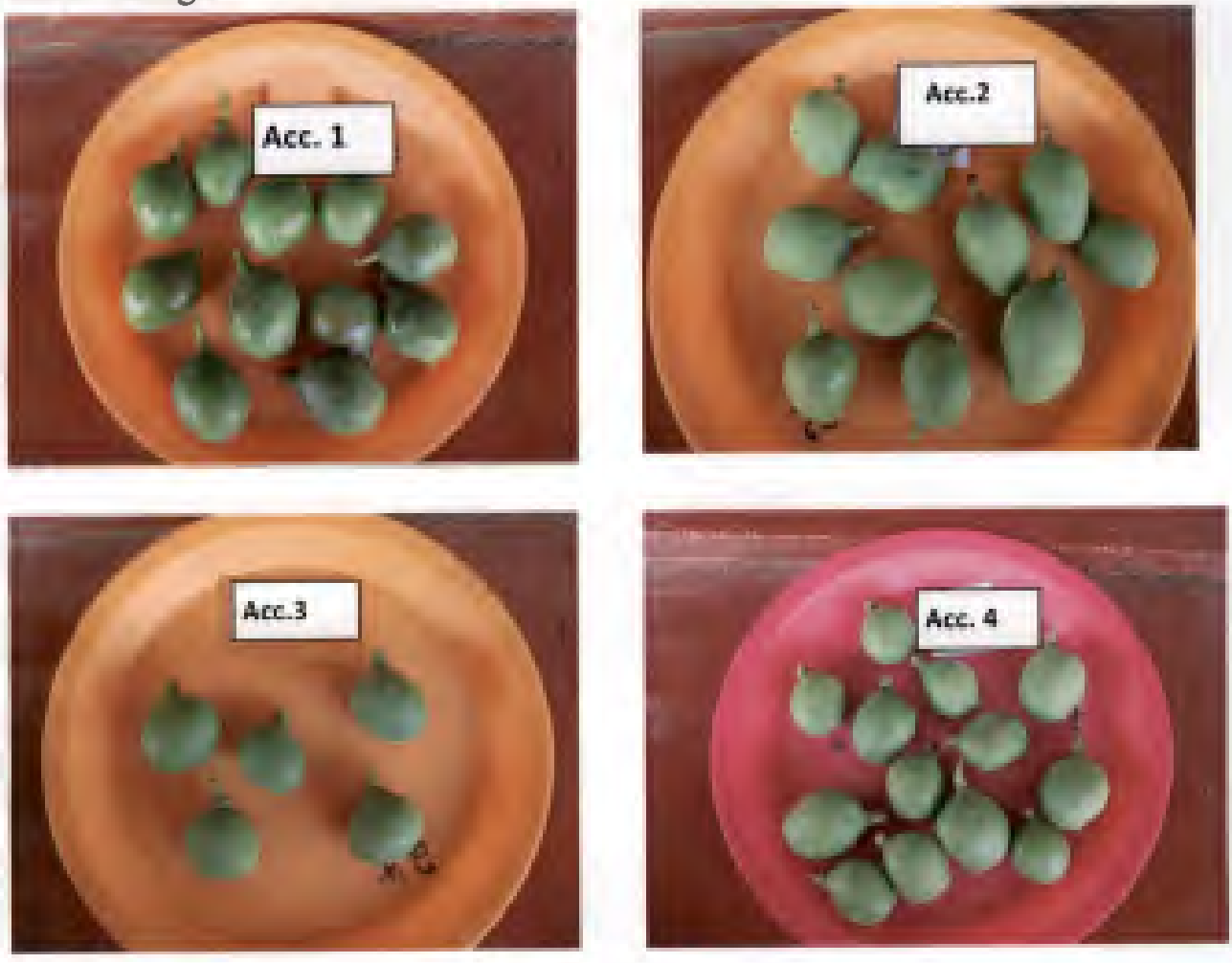


Plate.3 – Tree accessions from RARS, Pattambi

Plate. 4 Fruits of pickling mango accessions from RARS, Pattambi

Tender mango



Mature mango

Plate.5 Fruits of pickling mango accessions from RARS Pilicode

Ripe mango

4. RESULTS

The results obtained in the present investigation entitled "Evaluation of pickling mangoes for processing quality" are presented below.

The whole programme was divided into two major experiments. The study was conducted with samples collected from 21 trees

4.1 Experiment 1

Evaluation of the germplasm for quality

Main items of observations made in experiment 1 are

4.1.1 Biometric characters of tender mango

Results of biometric characters of tender mango are presented in table 1a

4.1.1.1 Length

There was a significant difference in length of tender fruits. It varied from 3.0 to 4.77 cm. Maximum length was noted in Acc.10 followed by Acc. 19 and minimum length was noticed in Acc.15. Mean fruit length was 3.92 cm.

4.1.1.2 Thickness

Maximum thickness was recorded in Acc. 19 and 21 followed by Acc. 4 and minimum was in Acc. 15. Mean fruit thickness was 2.85 cm.

4.1.1.3 Width

Significant variation was noted in width of tender fruits which ranged from minimum of 2.23 cm in Acc. 15 to a maximum of 4.37 cm in Acc. 21.

4.1.1.4 Weight

Maximum and minimum weight of 52.33 g and 6.65 g was noted in Acc. 4 and Acc. 15 respectively. Mean fruit weight was 22.28 g.

4.1.1.5 Volume

The mean fruit volume of tender fruit was 21.06 ml. Maximum volume was observed in Acc.4 followed by Acc.19 and minimum volume was noted in Acc.15. Volume of tender fruits ranged from 7.0 ml to 51.66 ml.

4.1.1.6 Skin thickness

Skin thickness varied from 1.18mm in (Acc. 13) to 2.66 mm in (Acc.12) and mean skin thickness was 1.95mm.

4.1.1.7 Flesh thickness

Flesh thickness of tender fruits varied from 0.5 cm (Acc.1) to 1.76 cm (Acc. 21). Mean flesh thickness of tender fruits was 0.87 cm.

Table 1a. Biometric characters of tender fruits

Accessions	Length (cm)	Thickness (cm)	Width (cm)	Weight (g)	Volume (ml)	Skin thickness (mm)	Flesh thickness (cm)
1	3.33	2.23	2.57	11.97	10.00	1.58	0.50
2	3.46	2.47	2.57	13.20	12.67	1.77	0.53
3	4.13	2.67	3.27	21.10	20.00	1.40	1.08
4	4.50	3.47	4.27	52.30	51.67	1.75	1.10
5	3.10	2.73	2.60	12.70	10.33	1.60	0.87
6	3.63	2.60	3.27	17.77	15.00	2.47	0.77
7	4.17	3.27	3.77	30.63	28.33	2.62	0.85
8	4.27	3.37	3.73	20.07	20.33	1.77	1.35
9	3.67	2.20	2.67	14.58	13.33	2.63	0.55
10	4.77	3.10	3.40	28.58	26.67	2.60	0.90
11	4.20	3.20	3.60	21.80	21.67	2.53	0.88
12	4.47	2.53	3.03	19.44	18.33	2.67	0.65
13	4.07	3.00	3.53	24.93	23.30	1.18	0.88
14	3.40	2.57	3.33	16.63	13.33	1.67	0.75
15	3.00	1.87	2.23	6.65	7.00	1.82	0.65
16	4.07	3.33	3.97	43.20	41.67	1.42	0.93
17	3.57	2.37	2.53	13.47	13.33	1.32	0.83
18	3.83	2.57	3.37	21.33	20.00	2.37	0.77
19	4.73	4.00	4.33	49.70	48.33	1.85	0.93
20	3.50	2.40	2.63	13.40	12.33	1.72	0.68
21	4.63	4.00	4.37	14.43	14.67	2.25	1.77
CD	0.48	0.40	0.41	4.26	4.58	0.26	0.25
Mean	3.92	2.85	3.30	22.28	21.06	1.95	0.87

4.1.2 Biometric characters of mature fruits

The results of biometric characters of mature fruits are presented in table 1b.

4.1.2.1 Length

Maximum length of mature fruit was noted in Acc.6 (8.33 cm) followed by Acc. 21(8.10 cm). Minimum length was noted in Acc. 7 and 3(5.23cm). Mean fruit length was 6.54 cm.

4.1.2.2 Thickness

Average fruit thickness of mature fruit was 4.73 cm. Fruit thickness varied from a minimum of 3.97 cm (Acc. 10) to a maximum of 6.20 cm (Acc. 21).

4.1.2.3 Width

Mature fruit width ranged from 4.1cm (Acc.5) to 7.9 cm (Acc. 21). Mean fruit width was 5.49 cm

4.1.2.4 Weight

Average fruit weight was 101.78 g. It ranged from 49.83 g (Acc. 3) to 197.48 g (Acc. 21).

4.1.2.5 Volume

Maximum volume of fruits was noted in Acc.6 (200 ml) and minimum volume in Acc. 3 (46.66 ml). Mean fruit volume was 100.60 ml.

4.1.2.6 Skin thickness

Skin thickness ranged from 1.10 mm (Acc.12) to 2.73 mm (Acc.10). Average skin thickness recorded was 1.72 mm.

4.1.2.7 Flesh thickness

Minimum and maximum flesh thickness was 0.73cm and 1.87 cm in Acc. 5 and Acc. 1 respectively. Mean flesh thickness was1.29 cm.

4.1.2.8 Stone weight

Maximum stone weight was noted in Acc. 6 (37.83g) and minimum in Acc. Acc. 5 followed by Acc. 11. Average stone weight was 24.37 g.

4.1.2.9 Stone volume

Average stone volume of mature fruit was 23.21 ml. Stone volume ranged from 13.33 ml (Acc. 11) to 37.0 ml (Acc. 6).

4.1.1.2.10 Stone thickness

Stone thickness of fruits varied from 1.67 cm (Acc. 10) to 2.3 cm (Acc. 21). Mean stone thickness was 1.96 cm.

Table 1b.Biometric characters of mature fruits

Accessi-ons	Length (cm)	Thickness (cm)	Width (cm)	Weight (g)	Volume (ml)	Skin thickness (mm)	Flesh thickness (cm)	Stone weight (g)	Stone volume (ml)	Stone thickness (cm)
1	7.37	5.53	6.63	189.53	190.00	1.80	1.87	25.10	23.33	1.73
2	6.47	5.23	5.27	78.27	80.00	1.37	1.38	18.33	18.33	1.90
3	5.23	4.73	5.60	49.83	46.67	1.81	0.85	19.27	16.67	2.00
4	6.90	4.67	5.67	109.90	106.67	2.53	0.97	22.33	20.67	2.03
5	5.50	4.00	4.10	54.80	51.67	1.20	0.73	16.30	15.00	1.87
6	8.30	5.83	7.43	191.03	200.00	1.55	1.63	37.83	37.00	2.17
7	5.23	4.30	4.30	62.37	60.00	1.61	1.10	19.10	18.33	1.90
8	6.27	4.43	4.53	78.53	76.67	1.87	1.23	23.33	21.67	1.93
9	6.77	4.17	4.70	84.97	80.00	1.82	1.22	30.63	30.00	2.13
10	6.63	3.97	4.93	77.43	73.33	2.73	1.02	20.77	20.00	1.67
11	5.90	4.63	5.20	86.04	80.00	1.63	1.40	16.67	13.33	2.07
12	7.17	4.83	5.40	112.53	110.00	1.10	1.52	28.30	26.67	2.00
13	6.33	4.63	5.77	91.83	91.67	1.65	1.17	29.06	28.33	2.17
14	5.60	4.53	5.77	87.43	90.00	1.67	0.98	25.65	25.33	2.10
15	6.17	4.03	4.73	60.53	66.67	1.50	1.07	20.20	18.33	1.77
16	5.80	5.20	5.53	95.80	93.33	1.82	1.78	32.70	31.67	2.07
17	6.43	4.10	4.70	80.90	80.00	1.33	0.95	27.03	26.70	1.90
18	7.90	5.73	7.10	192.03	183.33	1.70	1.72	26.87	25.67	1.97
19	7.43	4.60	5.33	101.27	98.33	1.22	1.57	22.27	21.67	1.77
20	5.90	4.00	4.80	55.07	57.67	1.83	1.25	17.20	17.00	1.80
21	8.10	6.20	7.90	197.47	196.67	2.53	1.83	32.93	31.67	2.30
CD	0.59	0.41	0.38	6.94	10.65	0.22	0.23	5.16	8.56	0.33
Mean	6.54	4.73	5.49	101.78	100.60	1.72	1.29	24.37	23.21	1.96

4.1.3 Biometric characters of ripe fruits

Results of biometric characters of ripe fruits are presented in table 1c

4.1.3.1 Length

Length of ripe fruits varied from 5.0 cm to 8.3 cm. Maximum fruit length was noted in Acc.6 (8.3 cm) followed by Acc. 18 (8.1 cm). Minimum length was observed in Acc. 3 (5.0 cm). Mean fruit length was 6.44 cm.

4.1.3.2 Thickness

Thickness of ripe fruits varied from 4.13 cm (Acc.17) to 6.53 cm (Acc.18). Average fruit thickness was 4.95 cm.

4.1.3.3 Width

Width of mature fruit showed a mean value of 5.60 cm. Fruit width ranged from 4.27 cm (Acc.17) to 8.2 cm (Acc.18).

4.1.3.4 Weight

Weight of ripe fruits ranged from 58.76g (Acc.7) to 252.2g (Acc.18). Mean fruit weight was 112.76 g.

4.1.3.5 Volume

Average volume was 111.43 ml. Volume of ripe fruits varied from 58.33 ml (Acc. 7) to 250 ml (Acc. 18).

4.1.3.6 Skin thickness

Skin thickness of ripe fruits varied from 0.86 mm (Acc.14) to 2.13 mm (Acc.21). Mean skin thickness was 1.55 mm.

4.1.3.7 Skin content

Skin content of ripe fruits varied from 14.93 per cent (Acc. 12 and 9) to 30.27 per cent (Acc. 8).Average skin content was19.96 per cent.

4.1.3.8 Stone content

Stone content of ripe fruits ranged from 14.47 per cent (Acc. 12) to 33.93 per cent (Acc.16). Average stone content was 25.36 per cent.

4.1.3.9 Pulp content

Average pulp content of ripe fruit was 54.01 per cent. Pulp content of fruit ranged from 36.86 per cent (Acc. 8) to 66.76 per cent (Acc. 12).

4.1.3.10 Stone volume

Stone volume of ripe fruits ranged from 13.33 ml to 53.33 ml. Highest stone volume recorded was in Acc. 18 and lowest stone volume was in Acc. 2. Mean stone volume was 23.88 ml

4.1.3.11 Pulp colour

Pulp colour varied from Light greenish yellow (4C) (Acc. 5) to Strong reddish orange (34C) (Acc.17) (Table 1d)

Table 1c. Biometric characters of ripe fruits

Accessions	Length (cm)	Thickness (cm)	Width (cm)	Weight (g)	Volume (ml)	Skin thickness (mm)	Skin content (%)	Stone content (%)	Pulp content (%)	Stone volume (ml)
1	7.53	5.67	6.83	177.03	175.00	1.07	16.20	17.00	65.83	25.00
2	6.13	6.13	5.00	89.27	88.33	1.55	15.63	18.13	65.47	13.33
3	5.00	4.70	5.43	81.73	80.00	1.67	23.27	31.63	41.10	23.33
4	7.60	5.33	6.07	130.70	130.00	1.75	18.37	23.53	57.13	26.67
5	5.60	4.53	4.63	70.93	68.33	1.03	29.00	28.47	42.43	18.33
6	8.30	6.17	7.33	252.00	250.00	1.62	15.65	22.53	63.40	50.00
7	5.30	4.23	4.50	58.77	58.33	1.13	16.87	30.20	54.47	15.00
8	5.83	4.17	4.50	69.32	68.33	1.77	30.27	29.63	36.87	18.33
9	6.00	4.53	4.97	81.30	80.00	1.58	14.93	25.53	59.40	13.33
10	6.47	4.17	4.43	76.60	73.33	1.47	25.17	27.57	47.13	20.00
11	6.53	5.27	5.80	99.30	98.33	1.73	15.78	17.07	64.90	23.33
12	7.30	5.00	5.47	126.97	126.67	1.86	14.93	14.47	66.77	16.67
13	5.87	4.87	5.30	93.97	93.33	1.55	19.57	26.53	53.20	23.33
14	5.23	4.50	6.20	80.13	80.00	0.86	17.70	27.90	53.50	21.67
15	6.03	4.53	5.10	82.53	81.67	1.20	19.43	31.63	48.10	25.00
16	5.80	4.67	5.53	85.97	85.00	1.75	27.37	33.93	40.60	28.33
17	6.10	4.13	4.27	67.50	65.00	1.86	19.07	32.70	47.10	20.00
18	8.10	6.53	8.20	252.27	250.00	1.70	18.13	21.87	59.67	53.33
19	7.03	4.97	5.77	139.58	138.33	1.45	18.00	22.53	57.07	28.33
20	5.97	4.27	5.10	68.73	68.33	1.90	23.60	33.33	44.60	13.33
21	7.53	5.63	7.07	183.33	181.67	2.13	20.30	16.37	65.53	25.00
CD	0.57	0.45	0.51	14.10	14.72	5.98	3.31	3.81	7.93	8.56
Mean	6.44	4.95	5.60	112.76	111.43	1.55	19.96	25.36	54.01	23.88

Table 1d. Pulp colour of ripe fruits

Accessions	Pulp colour	Accessions	Pulp colour
1	Strong orangish yellow (24 B)	12	Light orangish yellow (24C)
2	Light orangish yellow (19A)	13	Light orangish yellow (22C)
3	Light orangish yellow (22D)	14	Brilliant orangish yellow (21B)
4	Brilliant orangish yellow (21B)	15	Light orangish yellow (18B)
5	Light greenish yellow (4C)	16	Strong orangish yellow (22A)
6	Strong orange (24A)	17	Strong reddish orange (34C)
7	Light yellow (18B)	18	Strong orange (30D)
8	Light yellow (17 D)	19	Strong orangish yellow (24B)
9	Light orangish yellow (22B)	20	Light orangish yellow (19A)
10	Pale yellow (19C)	21	Strong orange (26B)
11	Pale yellow (20C)		

4.1.2 Biochemical characters of tender fruits:

Results of biochemical analysis of tender fruits are presented in the table 2a

4.1.2.1 Titrable acidity

Titrable acidity ranged from1.91 per cent (Acc. 6) to 5.01 per cent (Acc.12). Mean fruit acidity of tender fruit was 3.08%.

4.1.2.2 Polyphenol

Polyphenol content of tender fruits on fresh weight basis varied from 0.78 mgg^{-1} (Acc. 8) to 3.8 mgg^{-1} (Acc. 10). Mean polyphenol content of tender fruit was 2.26 mg g^{-1}.

4.1.2.3 Crude fibre

Crude fibre content of tender fruits on dry weight basis ranged from 0.40 per cent (Acc. 14) to 1.58 per cent (Acc. 5). Average crude fibre content was 0.84 per cent

4.1.2.4 Moisture content

Maximum moisture content was recorded in Acc. 4 and the minimum in Acc. 9. Mean value was 71.61 per cent.

Table 2a. Biochemical characters of tender fruits

Accessions	Titrable acidity (%)	Polyphenol (mg g^{-1})	Crude fibre (%)	Moisture content (%)
1	2.99	2.69	1.08	72.50
2	2.64	2.73	1.27	69.90
3	2.75	2.25	0.50	75.92
4	2.44	2.14	0.70	80.82
5	2.54	2.62	1.58	69.63
6	1.91	2.89	0.48	74.19
7	4.28	2.03	0.63	72.80
8	3.10	0.78	0.58	79.03
9	4.14	2.13	1.17	75.32
10	4.14	3.80	1.23	73.39
11	4.42	2.78	0.73	74.24
12	5.01	1.51	0.79	75.09
13	2.44	1.50	0.70	70.14
14	2.96	2.79	0.40	71.68
15	2.16	3.26	0.78	73.29
16	2.64	1.82	0.76	70.79
17	2.64	1.75	0.94	79.21
18	2.33	2.52	0.58	74.93
19	2.44	0.95	0.74	75.63
20	4.42	2.33	1.45	69.01
21	2.36	2.27	0.47	66.25
CD	0.33	0.37	0.09	3.52
Mean	3.08	2.26	0.84	71.61

4.1.3 Biochemical characters of mature fruits

Results of biochemical analysis of mature fruits are presented in table 2b.

4.1.3.1 Titrable acidity

Acidity of mature fruits was highest in Acc. 11 (6.71%) and lowest in Acc. 19 (2.75%). Mean fruit acidity was 4.36 per cent.

4.1.3.2. Polyphenol

Polyphenol content of mature fruits varied from 0.39 mg g^{-1} (Acc. 3) to 2.45 mg g^{-1} (Acc. 7). Mean polyphenol content of mature fruit was 1.41 mgg^{-1}.

4.1.3.4 Crude fibre

Crude fibre content of mature fruits ranged from 0.61 per cent (Acc. 21) to 3.63 per cent (Acc. 8). Mean crude fibre content was 1.69 per cent.

4.1.3.5 Moisture content

Moisture content of mature fruits varied from 70.31 per cent (Acc. 21) to 83.35 per cent (Acc. 6). Mean moisture content of mature fruit was 76.51 per cent

Table 2b. Biochemical characters of mature fruits

Accessions	Titrable acidity (%)	Polyphenol (mg g^{-1})	Crude fibre (%)	Moisture content (%)
1	3.20	1.25	1.51	81.28
2	4.05	0.59	1.82	73.38
3	3.41	0.39	1.01	73.75
4	2.77	0.63	2.50	83.03
5	4.70	2.05	2.81	77.03
6	4.26	2.22	0.90	83.35
7	5.95	2.45	1.83	78.08
8	4.80	0.73	3.63	75.70
9	4.56	1.95	1.81	72.17
10	6.61	1.77	1.51	76.35
11	6.71	1.27	0.83	76.33
12	5.70	0.60	2.51	75.10
13	2.96	0.46	1.43	75.76
14	4.35	2.15	1.51	75.88
15	3.72	1.58	0.82	77.94
16	3.20	1.76	0.75	74.09
17	3.93	0.77	3.20	73.13
18	4.24	2.20	1.28	82.49
19	2.75	0.78	1.24	77.94
20	4.90	1.95	1.95	73.67
21	4.80	1.97	0.61	70.31
CD	0.44	0.13	0.17	3.24
Mean	4.36	1.41	1.69	76.51

4.1.4 Biochemical characters of ripe fruits

Results are presented in the table 2c.

4.1.4.1 Titrable acidity

Acidity was lowest in Acc.17 (0.28 per cent) and highest in Acc. 11(1.4 per cent). Mean value was 0.81 per cent.

4.1.4.2 Polyphenol

Polyphenol content of ripe fruits varied from 0.39 mg g^{-1} (Acc. 4) to 1.4 mg g^{-1}(Acc. 18). Mean polyphenol content was 0.70 mg g^{-1}.

4.1.4.3 Crude fibre

Crude fibre content was maximum in Acc. 8 (3.71 %) and minimum in Acc. 21 (0.70 %). Mean crude fibre content was1.90 per cent.

4.1.4.4 Juice content

Juice content of ripe fruits varied from 20.52 per cent (Acc.16) to 61.63 per cent (Acc. 6). Mean juice content was 37.58 per cent.

4.1.4.5 Sugar content

Reducing sugar content of ripe fruits varied from 1.53 per cent (Acc. 14) to 3.51 per cent (Acc. 6). Mean reducing sugar content was 2.19 per cent.

4.1.4.6 TSS

TSS of ripe fruit ranged from 12.5 °brix (Acc. 14) to 22.2 °brix (Acc. 21). Mean TSS was 16.12 °brix.

Table 2c. Biochemical characters of ripe fruits

Accessions	Titrable acidity (%)	Polyphenol (mg g^{-1})	Crude fibre (%)	Juice content (%)	Reducing sugar (%)	TSS (°Brix)
1	1.26	0.58	1.82	24.72	2.01	15.00
2	0.64	0.42	2.15	44.13	2.07	14.07
3	0.77	0.64	1.03	23.63	2.36	17.00
4	1.04	0.39	2.72	25.60	2.01	17.90
5	0.94	0.97	3.13	26.02	2.03	18.00
6	0.31	0.50	1.32	61.63	3.51	15.00
7	0.84	1.27	2.01	34.71	2.11	14.10
8	0.77	0.49	3.71	34.21	2.19	15.20
9	1.02	0.48	2.00	50.21	2.08	15.10
10	0.66	0.86	1.82	37.63	2.52	20.90
11	1.40	0.59	1.03	40.33	2.11	15.72
12	1.15	0.58	2.83	32.60	2.38	18.60
13	0.66	0.46	1.50	49.50	2.01	15.60
14	0.42	0.65	1.60	25.40	1.53	12.5
15	1.22	0.48	1.01	21.40	1.54	13.70
16	0.52	1.35	0.81	20.52	1.69	17.20
17	0.28	0.68	3.42	40.22	1.71	17.9
18	0.52	1.40	1.43	56.03	2.90	13.24
19	0.83	0.63	1.57	52.72	2.04	15.40
20	1.15	0.63	2.33	27.73	1.97	14.10
21	0.61	0.71	0.70	60.33	3.21	22.20
CD	0.40	0.16	0.17	0.18	0.18	0.39
Mean	0.81	0.70	1.9	37.58	2.19	16.12

4.1.5 Changes in fruit characters during maturation and ripening

Changes in fruit characters from tender to mature stage and from mature to ripe stage were worked out. The results are presented below:

4.1.5.1 Tender to mature stage

4.1.5.1.1 Quantitative characters:

Increase in length from tender to mature stage were lowest in Acc.7 (1.26 fold) and highest in Acc. 6 (2.29 fold). It was higher in accessions 1, 15 and 18 and

lower in Acc. 3, 10 and 11. Increase in fruit thickness was highest in Acc.1 (2.8 times) and lowest in Acc.7 (1.15 times). It was higher in Acc.6, 18 and 15 and lower in Acc.10 and 8. Similarly increase in width from tender to mature stage was highest in Acc.1 (2.58 times). Acc.7 had the lowest rate of increase in width (1.14 times). Increase in width was higher in Acc.6, 15 and 18 and lower in Acc. 8, 19, 4. Increase in weight and volume was similar, highest increase recorded from Acc. 1 and lowest in Acc.19 (Table 3a)

4.1.5.1.2 Quality characters

Increase in acidity varied from 1.07 fold in Acc. 1 to 2.23 fold in Acc.6. In accessions 21, 5 and 18 increase was higher and lower in accessions 9, 20 and 19. Polyphenol content decreased from tender to mature stage. Increase in crude fibre ranged from 0.99 in Acc.16 to 6.26 in Acc.8 (Table 3a)

Table 3a Rate of change in quantitative and quality characters from tender to mature stage

Accessions	Length	Thickness	Width	Weight	Volume	Acidity	Polyphenol	Crude fibre.
1	2.21	2.48	2.58	15.84	19.00	1.07	0.46	1.39
2	1.87	2.12	2.05	5.93	6.32	1.53	0.21	1.43
3	1.27	1.77	1.71	2.36	2.33	1.24	0.17	2.01
4	1.53	1.35	1.33	2.10	2.06	1.14	0.30	3.57
5	1.77	1.46	1.58	4.31	5.00	1.85	0.78	1.78
6	2.29	2.24	2.28	10.75	13.33	2.23	0.77	1.88
7	1.26	1.32	1.14	2.04	2.12	1.39	1.21	2.89
8	1.47	1.32	1.21	3.91	3.77	1.55	0.93	6.26
9	1.85	1.89	1.76	5.83	6.00	1.10	0.91	1.55
10	1.39	1.28	1.45	2.71	2.75	1.60	0.47	1.23
11	1.40	1.45	1.44	3.95	3.69	1.52	0.46	1.13
12	1.60	1.91	1.78	5.79	6.00	1.14	0.40	3.20
13	1.56	1.54	1.63	3.68	3.93	1.21	0.31	2.04
14	1.65	1.77	1.73	5.26	6.75	1.47	0.77	3.74
15	2.06	2.16	2.12	9.10	9.52	1.73	0.48	1.05
16	1.43	1.56	1.39	2.22	2.24	1.21	0.97	0.99
17	1.80	1.73	1.86	6.01	6.00	1.49	0.44	3.40
18	2.06	2.23	2.11	9.00	9.17	1.82	0.87	2.21
19	1.57	1.15	1.23	2.04	2.03	1.13	0.82	1.67
20	1.69	1.64	1.82	4.11	4.68	1.11	0.84	1.34
21	1.75	1.55	1.81	13.68	13.41	2.03	0.87	1.29

4.1.5.2 Mature to ripe stage

Results are presented in table 3b.There was not much variation in fruit length, width and thickness from mature to ripe stage. However, changes were recorded in weight and volume of fruit. The lowest difference was recorded in Acc. 17 and highest in Acc. 3. Acidity and polyphenol content decreased from mature to ripe stage. Crude fibre content increased which was maximum in Acc. 8 (6.39 times).

Table 3b. Rate of change in quantitative and quality characters from mature to ripe stage

Accessions	Length	Thickness	Width	Weight	Volume	Acidity	Polyphenol	Crude fibre
1	1.02	1.02	1.03	0.93	0.92	0.42	0.46	1.68
2	0.95	1.17	0.95	1.14	1.10	0.24	0.72	1.69
3	0.96	0.99	0.97	1.64	1.71	0.28	1.65	2.06
4	1.10	1.14	1.07	1.19	1.22	0.43	0.61	3.88
5	1.02	1.13	1.13	1.29	1.32	0.37	0.47	1.98
6	1.00	1.06	0.99	1.32	1.25	0.16	0.23	2.75
7	1.01	0.98	1.05	0.94	0.97	0.20	0.52	3.19
8	0.93	0.94	0.99	0.88	0.89	0.25	0.67	6.39
9	0.89	1.09	1.06	0.96	1.00	0.25	0.24	1.71
10	0.97	1.05	0.90	0.99	1.00	0.16	0.49	1.48
11	1.11	1.14	1.12	1.15	1.23	0.32	0.46	1.41
12	1.02	1.03	1.01	1.13	1.15	0.23	0.97	3.60
13	0.93	1.05	0.92	1.02	1.02	0.27	1.00	2.15
14	0.93	0.99	1.08	0.92	0.89	0.14	0.30	3.96
15	0.98	1.12	1.08	1.36	1.22	0.57	0.30	1.29
16	1.00	0.90	1.00	0.90	0.91	0.20	0.77	1.07

Accessions	Length	Thickness	Width	Weight	Volume	Acidity	Polyphenol	Crude fibre
17	0.95	1.01	0.91	0.83	0.81	0.11	0.88	3.63
18	1.03	1.14	1.15	1.31	1.36	0.22	0.64	2.47
19	0.95	1.08	1.08	1.38	1.41	0.34	0.81	2.11
20	1.01	1.07	1.06	1.25	1.18	0.26	0.32	1.60
21	0.93	0.91	0.89	0.93	0.92	0.26	0.36	1.48

4.1.6 Grouping of accessions based on quantitative and quality characters

Grouping of accessions was attempted based on D^2 analysis. Grouping was done based on quantitative and quality characters at tender, mature and ripe mango stage.

4.1.6.1 Tender mango characters

Table 4a. Grouping of accessions based on quantitative characters of tender mango

	Length	Thickness	Width	Weight	Flesh thickness
HIGH	Acc. 4, 10, 12, 19, 21	Acc. 4, 19, 21	Acc. 4, 7, 8, 10, 11, 13,16, 19, 21	Acc. 4, 16, 19	Acc. 8, 21
MEDIUM	Acc. 2, 3, 6, 7, 8, 9 ,11 ,13, 14, 16, 18, 20	Acc.1,2, 3, 5, 6, 7, 8, 10,11,12, 14,16,17,18	Acc. 3, 6, 9, 12, 14,18,	Acc.1, 2, 3, 5, 6, 7, 8, 9,10, 11, 12, 13, 14, 17,18, 20, 21	Acc. 3, 4, 5, 6, 7, 10, 11,12, 13, 14, 15, 16, 17, 18, 19, 20
LOW	Acc.1, 5, 15	Acc.1,9,15	Acc.1, 2, 5, 15, 17, 20	Acc.15	Acc.1, 2, 9

Five accessions were grouped under category high for length, 14 under medium and 3 under low. Based on thickness of fruits, 3 were categorised into high, 14 under medium and 3 under low. Maximum number of accessions were under medium category for weight and flesh thickness (17 and 18 respectively). Grouping based on width of fruits showed that more number of fruit were grouped in high. (Table 4a).

Table 4b. Grouping of accessions based on quality characters of tender mango

	Acidity	**Polyphenol**	**Crude fibre**
High	Acc.7, 9, 10, 11, 12, 20	Acc.10, 15	Acc. 5, 2, 10, 20
Medium	Acc.1, 2, 3 , 4, 5, 8, 13 ,14, 16, 17, 18, 19, 21	Acc.1, 2, 3, 4, 5, 6, 7, 9, 11, 14, 16, 17, 18, 20, 21	Acc.1, 2, 3, 4, 7, 8, 9, 11, 13, 15, 16, 17, 19 ,18
Low	Acc. 6,15	Acc. 8, 12, 13, 19	Acc. 6, 14, 21

Acidity, polyphenol content and crude fibre was medium in more number of accessions. Acidity was high in 6 accessions, phenol high in 2 accessions and crude fibre high in 3 accessions. Acidity was low in 2 accessions, poly phenol low in 4 accessions and crude fibre low in 3 accessions (table 4b).

4.1.6.2 Mature mango

Table 4c.Grouping of accessions based on quantitative and quality characters of mature mango

Group	Length	Width	Weight	Flesh thickness	Acidity	Polyphenol	Crude fibre
High	Acc. 6, 18, 21,	Acc.1, 6, 18, 21,	Acc.1, 6, 18,, 21, 18	Acc.1, 6, 16, 18, 21	Acc.7, 10, 11, 12, 21	Acc. 6, 7, 14, 18	Acc. 5, 8, 17
Medium	Acc.1, 2, 4, 8, 9, 10, 11, 12, 13, 15, 16, 17,19, 20	Acc. 2, 3, 4, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20	Acc. 1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16,17, 20	Acc. 2, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20	Acc. 1, 2, 3, 5, 6, 8, 9, 14, 15, 16, 17, 18, 20	Acc. 1, 5, 8, 9, 10, 11, 16, 15, 17, 19, 20, 21, ,	Acc. 1, 2, 3, 4, 6, 7, 9, 10, 12, 13, 14, 18, 19, 20
Low	Acc. 5, 3, 7, 14	Acc. 5, 7	Acc. 3	Acc. 3, 5	Acc.1, 4, 9, 13	Acc. 2, 3, 4, 12, 13	Acc.11, 15,16, 21

Accessions were categorized into low, medium and high based on quantitative and quality characters of mature mango. Maximum number of accessions were under the medium category for all the quantitative and quality characters. Three accessions were listed in the category high for length, 4 accessions for width, weight, acidity and polyphenol, 5 accessions for flesh thickness and 3 accessions for crude fibre. There was only one accession low in weight, 2 accessions low in width and flesh thickness, 3 accessions low in acidity, 4 accessions low in length, 5 accessions low in polyphenol and crude fibre content (Table 4c)

4.1.6.3 Ripe mango

Grouping of accessions was done based on ripe fruit characters. Four accessions each had high width and weight of fruits and skin content where as 5 accessions were high in length of fruits and pulp content. Maximum number of accessions were grouped under medium for all the quantitative characters. Two accessions were low in skin content, 3 low in length, 4 each low in width and stone content. There was no accessions grouped under low category of weight and pulp content (Table 4d).

Table 4d Grouping of accessions based on quantitative characters of ripe mango

Group	Length	Width	Weight	Skin content	Pulp content	Stone content
High	Acc. 1, 4, 6, 18, 21	Acc. 1, 6, 18, 21	Acc. 1, 6, 18, 21	Acc. 5, 8, 10, 16	Acc. 3, 15, 16, 17, 20	Acc.1, 2, 11, 12, 21
Medium	Acc. 1, 2, 5, 8 9, 10, 12, 13, 15, 16, 17, 20	Acc. 2, 3, 4, 5, 9, 11, 12, 13, 14, 15, 16, 19, 20	Acc. 2, 3, 5, 7, 8, 9, 10, 11, 12,13, 14, 15, 16, 17,19, 20	Acc.1, 2, 3, 4, 6, 7, 11, 13, 14, 15, 17, 18, 19, 20, 21	Acc.1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 18, 19, 21	Acc. 4, 6, 7, 9, 10, 13, 14, 15, 17, 18, 19, 20
Low	Acc. 3,7, 14	Acc.7, 8, 10, 17		Acc. 9, 12		Acc. 3, 5, 8, 16

Grouping of accessions was done based on quality characters of ripe fruits. Maximum number of accessions were under the medium group. Three accessions were high in TSS and polyphenol, 4 accessions high for crude fibre and juice content and 5 accessions for acidity. Only one accession was low in polyphenol, 2

accessions low in TSS, 3 each in acidity and juice content and 5 accessions low in crude fibre content for ripe fruits (Table 4e).

Table 4e. Grouping of accessions based on quality characters of ripe mango

Group	Acidity	Poly phenol	Crude fibre	Juice content	TSS
High	Acc.1, 11, 12, 15, 20	Acc. 6, 7, 18	Acc. 5, 8, 12, 17	Acc. 6, 18, 19, 21	Acc. 10, 12, 21
Medium	Acc. 2, 3, 4, 5, 7, 8, 9, 10, 13, 16, 18, 19, 21	Acc.1, 2, 3, 5, 6, 8, 9, 10, 11,12, 13, 14, 15,17, 19, 20, 21	Acc.1, 2, 4, 6, 7, 9, 10, 13, 14, 18, 19, 20	Acc.1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 17, 20	Acc.1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 13, 16, 17, 19, 20
Low	Acc.1, 6, 14, 17	Acc. 4	Acc. 3, 11, 15, 16, 21	Acc. 3, 15, 16	Acc.14, 18

4.2. Experiment 2

Evaluation of accessions for product development

4.2.1 Organoleptic evaluation of pickle

Sensory evaluation of pickle was carried out using nine point hedonic scale at monthly intervals for three months. A panel of 10 judges evaluated each sample for appearance, colour, flavour, texture/consistency, odour, taste, after taste and overall acceptability. Ranking was done based on Kendall's W test.

4.2.1.1 Tender mango pickle

4.2.1.1.1 One month after storage

Highest rank for appearance one month after storage was recorded from Acc.15 followed by accessions 10, 6, 17, 8 and 3. Lowest rank of 5.3 was recorded from Acc. 21. Similarly Acc.18 and 11 had lower ranks. Maximum rank for colour was recorded from Acc. 15 followed by Acc. 17 and minimum from Acc. 21. Acc. 15 and Acc. 10 had ranks of 16.1 and 16.0 respectively for flavour where as the lowest rank of 5.0 was recorded from Acc. 21 and 16. Highest score for texture was recorded from Acc. 15 and lowest from Acc. 21 and 16. Ranking was highest for Acc. 15 for odour and lowest for Acc. 21 and 16. Acc. 15 had maximum rank for taste followed by Acc. 17 and 10. Taste was inferior in the case of Acc. 21, 16 and 13. Acc. 10 had maximum score for after taste and Acc. 21 and 16 had minimum score. Overall acceptability was the highest for Acc. 15 followed by Acc. 3 and 17. Total rank score was maximum for Acc. 15 followed by Acc. 10 and 17. Lowest rank was for Acc. 21. (Table 5a)

Table 5a. Mean sensory rank scores for tender mango pickle one month after storage

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
1	9.00 (7.0)	8.15 (6.5)	10.35 (6.9)	12.70 (7.6)	8.70 (6.2)	12.55 (7.3)	12.30 (7.0)	11.15 (7.1)	84.90 (55.6)
2	13.90 (7.9)	13.60 (7.8)	15.95 (8.0)	13.50 (7.6)	14.40 (7.7)	14.75 (7.8)	12.05 (7.3)	14.60 (7.8)	112.75 (61.9)
3	14.65 (8.1)	13.35 (7.7)	11.80 (7.3)	12.85 (7.4)	12.90 (7.3)	13.70 (7.6)	14.10 (7.5)	15.20 (7.8)	108.55 (60.70)
4	9.75 (7.2)	8.75 (6.6)	11.55 (7.1)	11.00 (7.1)	10.60 (6.8)	11.60 (7.0)	12.75 (7.2)	12.25 (7.3)	88.25 (56.30)
5	9.10 (7.0)	10.10 (7.0)	9.05 (6.8)	10.55 (6.7)	10.30 (6.7)	8.80 (6.5)	9.75 (6.6)	9.45 (6.7)	77.10 (54.00)
6	15.00 (8.1)	14.30 (8.0)	12.95 (7.6)	13.40 (7.5)	13.00 (7.3)	13.75 (7.5)	13.95 (7.4)	13.05 (7.5)	109.40 (60.90)
7	11.40 (7.4)	11.25 (7.3)	11.65 (7.1)	11.45 (7.0)	10.65 (6.9)	9.25 (6.6)	9.10 (6.5)	8.85 (6.6)	83.60 (55.40)
8	14.50 (8.0)	12.05 (7.4)	11.65 (7.3)	11.10 (7.1)	12.10 (7.2)	11.90 (7.3)	13.40 (7.5)	12.20 (7.3)	98.90 (59.10)
9	10.20 (7.3)	12.95 (7.6)	9.95 (7.0)	10.35 (6.8)	9.95 (6.6)	9.50 (6.8)	9.25 (6.6)	10.15 (6.7)	82.30 (55.40)
10	15.10 (8.0)	13.70 (7.8)	16.00 (8.1)	12.45 (7.1)	14.25 (7.7)	15.00 (7.7)	16.50 (8.1)	14.70 (7.8)	117.70 (62.30)
11	6.85 (6.5)	7.70 (6.5)	6.70 (6.3)	9.45 (6.4)	7.55 (6.1)	9.45 (6.5)	9.45 (6.5)	8.35 (6.4)	65.50 (51.20)
12	11.35 (7.4)	12.75 (7.6)	12.85 (7.5)	13.90 (7.6)	13.90 (7.8)	14.25 (7.6)	12.80 (7.4)	13.25 (7.6)	105.05 (60.50)
13	9.05 (7.0)	8.20 (6.7)	9.00 (6.6)	7.10 (6.1)	9.20 (6.4)	6.95 (6.0)	7.65 (6.2)	7.80 (6.3)	64.90 (51.30)
14	10.35 (7.3)	9.55 (7.0)	11.80 (7.3)	8.70 (6.6)	8.80 (6.6)	8.75 (6.6)	9.00 (6.7)	8.45 (6.6)	75.40 (54.70)
15	15.85 (8.3)	16.70 (8.4)	16.10 (8.1)	15.70 (8.1)	16.05 (7.9)	16.20 (8.0)	15.05 (7.8)	17.25 (8.4)	128.90 (65.00)
16	6.85 (6.5)	7.70 (6.5)	5.00 (5.7)	6.90 (5.7)	7.55 (6.1)	6.70 (5.7)	6.30 (5.5)	6.05 (5.7)	53.05 (47.40)
17	14.90 (8.1)	14.65 (8.1)	14.10 (7.9)	13.15 (7.6)	14.60 (7.8)	15.40 (7.9)	14.15 (7.7)	15.00 (7.9)	115.95 (63.00)
18	5.75 (6.5)	7.50 (6.6)	8.15 (6.6)	8.50 (6.3)	8.15 (6.1)	9.00 (6.2)	10.70 (6.6)	8.20 (6.4)	65.95 (51.30)
19	11.40 (7.4)	11.25 (7.3)	11.65 (7.1)	11.45 (7.0)	10.65 (6.9)	7.35 (6.1)	7.30 (6.0)	8.85 (7.00)	79.90 (54.80)
20	10.75 (7.4)	10.85 (7.2)	9.75 (6.9)	9.90 (6.8)	10.15 (6.8)	9.45 (6.8)	9.15 (6.5)	10.15 (8.00)	80.15 (56.40)
21	5.30 (6.1)	5.95 (6.0)	5.00 (5.7)	6.90 (5.7)	7.55 (6.1)	6.70 (5.7)	6.30 (5.5)	6.05 (4.00)	49.75 (44.80)
Kendall's W test	0.309**	0.243**	0.296**	0.167**	0.192**	0.275**	0.245**	0.286**	

Entries in the table indicate mean scores and mean rank. Mean score given in parenthesis

** Significant at 1% level

4.2.1.1.2 Two months after storage

Maximum rank for appearance two months after storage was for accession 15 and 6. Minimum rank was for Acc.21. Acc.15 had the maximum rank for colour followed by Acc.17. Minimum rank was for Acc. 21. Rank for flavour was maximum for Acc. 15 followed by Acc. 2. Minimum was for Acc. 21. Acc. 15 had the highest rank for texture and the lowest was for Acc. 21. Similarly Acc.15 had maximum rank for odour, taste, after taste and overall acceptability which had the also the highest total score. Minimum values for odour, taste, after taste and overall acceptability were recorded from Acc. 21. Acc. 17 ranked second in total score followed by Acc. 2 (Table 5b).

Table 5b. Mean sensory rank scores for tender mango pickle two months after storage

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
1	9.90 (7.2)	7.85 (6.7)	9.90 (7.0)	13.55 (7.8)	8.60 (6.4)	12.55 (7.4)	11.95 (7.1)	11.35 (7.2)	85.65 (56.80)
2	13.80 (8.0)	13.85 (7.9)	15.85 (8.1)	13.80 (7.7)	14.60 (7.8)	15.25 (7.9)	12.90 (7.5)	14.60 (7.9)	114.65 (62.80)
3	14.70 (8.2)	14.05 (7.9)	11.95 (7.4)	13.10 (7.6)	12.95 (7.4)	13.90 (7.7)	14.05 (7.6)	14.95 (7.9)	109.65 (61.70)
4	9.70 (7.3)	8.50 (6.8)	11.50 (7.3)	11.10 (7.3)	10.50 (7.0)	11.25 (7.1)	12.70 (7.3)	12.40 (7.4)	87.65 (57.50)
5	8.85 (7.1)	10.30 (7.1)	9.20 (6.9)	10.55 (6.9)	10.40 (6.9)	8.75 (6.6)	9.50 (6.7)	10.00 (6.9)	77.55 (55.10)
6	15.80 (8.3)	14.75 (8.1)	13.65 (7.8)	13.65 (7.6)	13.30 (7.4)	14.45 (7.7)	13.75 (7.5)	13.60 (7.7)	112.95 (62.10)
7	11.35 (7.5)	11.05 (7.4)	11.75 (7.2)	11.10 (7.1)	11.00 (7.0)	9.30 (6.7)	9.10 (6.6)	8.80 (6.7)	83.45 (56.20)

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
8	14.55 (8.1)	12.25 (7.6)	11.80 (7.4)	11.15 (7.2)	12.20 (7.3)	12.20 (7.4)	13.45 (7.6)	12.10 (7.4)	99.70 (60.00)
9	10.30 (7.4)	13.05 (7.7)	9.85 (7.1)	10.30 (6.9)	9.75 (6.7)	9.70 (6.9)	8.85 (6.6)	9.95 (6.8)	81.75 (56.10)
10	14.45 (7.9)	12.90 (7.7)	15.00 (8.0)	12.00 (7.0)	13.45 (7.6)	14.00 (7.6)	15.65 (8.00)	13.65 (7.7)	111.10 (61.50)
11	6.60 (6.5)	8.15 (6.6)	7.50 (6.5)	9.30 (6.5)	7.65 (6.3)	9.50 (6.7)	9.15 (6.6)	8.45 (6.6)	66.30 (52.30)
12	11.95 (7.6)	13.20 (7.7)	12.80 (7.6)	13.90 (7.7)	14.50 (7.9)	14.45 (7.7)	13.20 (7.5)	13.25 (7.7)	107.25 (61.40)
13	8.35 (7.0)	7.70 (6.7)	8.90 (6.7)	7.05 (6.3)	9.45 (6.5)	6.60 (6.1)	7.60 (6.3)	7.40 (6.5)	63.05 (52.10)
14	9.50 (7.3)	9.05 (7.0)	11.60 (7.4)	8.40 (6.7)	8.75 (6.7)	8.65 (6.7)	9.10 (6.8)	8.95 (6.8)	74.00 (55.40)
15	16.30 (8.4)	17.05 (8.5)	16.10 (8.2)	16.10 (8.2)	16.20 (8.0)	16.35 (8.1)	15.50 (7.9)	17.20 (8.5)	130.80 (65.80)
16	6.90 (6.6)	7.50 (6.5)	4.95 (5.9)	7.30 (5.9)	7.35 (6.2)	7.10 (5.9)	6.15 (5.7)	6.00 (5.9)	53.25 (48.60)
17	14.85 (8.2)	15.10 (8.2)	14.30 (8.0)	13.25 (7.7)	14.80 (7.9)	15.45 (8.0)	14.90 (7.9)	15.00 (8.0)	117.65 (63.90)
18	5.75 (6.6)	7.45 (6.7)	8.05 (6.7)	8.45 (6.5)	7.70 (6.2)	9.05 (6.3)	11.25 (6.8)	8.60 (6.6)	66.30 (52.40)
19	11.75 (7.6)	11.50 (7.5)	12.35 (7.3)	11.50 (7.2)	10.80 (7.0)	7.00 (6.2)	7.20 (6.2)	9.45 (6.8)	81.55 (55.80)
20	10.55 (7.5)	10.65 (7.3)	9.60 (7.0)	9.65 (6.9)	10.55 (6.9)	9.70 (6.9)	9.35 (6.7)	10.05 (7.0)	80.10 (56.2)
21	5.10 (6.0)	5.10 (5.8)	4.40 (5.6)	5.80 (5.6)	6.50 (6.0)	5.80 (5.7)	5.70 (5.4)	5.25 (5.6)	43.65 (45.70)
Kendall's W test	0.337**	0.289**	0.297**	0.197**	0.217**	0.302**	0.265**	0.285**	

Entries in the table indicate mean scores and mean rank.

Mean score given in parenthesis

** Significant at 1% level

4.2.1.1.3 Three months after storage

Three months after storage, highest rank for appearance was recorded from Acc. 15 followed by Acc. 6 and lowest rank was for Acc. 21. For the colour of pickle, highest rank was for Acc. 15 followed by Acc. 17 and 6. Lowest rank was for Acc. 21. Acc. 2 recorded the highest rank for flavour followed by Acc. 15 and lowest for Acc. 21. Highest rank for odour and taste was for Acc. 15 followed by Acc. 17 and 2 and lowest for Acc. 21. After taste was the best for Acc. 15 followed by Acc. 17 and 3. The lowest rank was for Acc. 21. Overall acceptability was maximum for Acc. 15 followed by Acc. 17, 3 and 2. Lowest rank for acceptability was for Acc. 21. Total rank was highest for Acc. 15 followed by Acc. 17. Lowest was for Acc. 21. (Table 5c)

Table 5c. Mean sensory rank scores for tender mango pickle three months after storage

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
1	10.00 (7.4)	7.50 (6.7)	10.20 (7.2)	13.95 (7.9)	8.10 (6.6)	13.10 (7.6)	11.60 (7.2)	11.25 (7.3)	85.70 (57.90)
2	15.05 (8.2)	14.05 (8.0)	16.70 (8.3)	14.05 (7.8)	14.90 (7.9)	15.75 (8.1)	13.70 (7.7)	14.60 (8.0)	118.80 (64.00)
3	14.40 (8.2)	13.55 (7.9)	12.45 (7.6)	13.20 (7.7)	12.80 (7.5)	14.05 (7.8)	14.10 (7.7)	14.80 (8.0)	109.35 (62.40)
4	9.30 (7.3)	8.15 (6.8)	11.45 (7.4)	11.25 (7.4)	10.40 (7.1)	11.30 (7.2)	12.40 (7.4)	12.20 (7.5)	86.45 (58.10)
5	8.90 (7.2)	10.35 (7.2)	8.90 (7.0)	10.60 (7.1)	10.60 (7.1)	8.40 (6.7)	9.35 (6.8)	10.10 (7.1)	77.20 (56.20)
6	16.15 (8.4)	14.55 (8.1)	14.20 (8.0)	14.00 (7.7)	13.40 (7.6)	14.75 (7.8)	13.45 (7.6)	13.50 (7.8)	114.00 (63.00)

Plate.6 Tender mango pickle

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
7	11.35 (7.6)	11.85 (7.6)	12.70 (7.6)	11.05 (7.2)	10.90 (7.1)	9.25 (6.9)	9.25 (6.8)	9.40 (6.9)	85.75 (57.700
8	14.15 (8.1)	12.80 (7.8)	11.55 (7.5)	11.15 (7.3)	12.70 (7.4)	12.35 (7.5)	13.60 (7.7)	12.40 (7.6)	100.70 (60.90)
9	10.20 (7.5)	12.90 (7.8)	9.90 (7.2)	10.30 (7.0)	9.65 (6.8)	9.75 (7.0)	8.55 (6.7)	10.35 (7.0)	81.60 (57.00)
10	12.85 (7.7)	11.50 (7.5)	12.95 (7.7)	10.55 (6.8)	12.10 (7.4)	12.55 (7.4)	13.90 (7.7)	11.75 (7.4)	98.15 (59.600
11	7.30 (6.7)	8.25 (6.7)	7.10 (6.7)	8.85 (6.6)	7.60 (6.4)	9.15 (6.8)	9.10 (6.7)	8.20 (6.7)	65.55 (53.30)
12	12.20 (7.7)	13.80 (7.9)	13.00 (7.7)	14.15 (7.8)	14.80 (8.0)	14.25 (7.8)	13.70 (7.7)	13.45 (7.8)	109.35 (62.40)
13	8.15 (7.1)	7.50 (6.8)	8.55 (6.9)	6.95 (6.5)	9.05 (6.7)	7.35 (6.4)	7.60 (6.5)	7.80 (6.7)	62.95 (53.60)
14	9.55 (7.4)	8.75 (7.1)	11.75 (7.5)	9.10 (6.9)	9.40 (6.9)	9.15 (6.9)	9.30 (6.9)	9.25 (7.0)	76.25 (56.60)
15	16.55 (8.5)	17.90 (8.7)	16.55 (8.3)	16.50 (8.4)	16.55 (8.2)	16.45 (8.3)	16.10 (8.1)	17.60 (8.6)	134.20 (67.10)
16	7.20 (6.7)	9.40 (7.0)	4.55 (6.1)	7.00 (6.1)	7.35 (6.4)	7.00 (6.1)	6.05 (5.8)	5.85 (6.1)	54.40 (50.30)
17	15.45 (8.3)	14.70 (8.2)	15.20 (8.2)	13.40 (7.8)	15.25 (8.1)	15.90 (8.2)	15.65 (8.1)	15.30 (8.2)	120.85 (65.10)
18	6.10 (6.7)	7.20 (6.8)	8.05 (6.8)	8.30 (6.6)	7.95 (6.4)	8.75 (6.5)	11.20 (7.0)	9.10 (6.8)	66.65 (53.60)
19	11.35 (7.6)	11.00 (7.5)	12.05 (7.4)	11.45 (7.3)	10.95 (7.1)	6.70 (6.3)	7.85 (6.4)	9.45 (7.00)	80.80 (56.60)
20	10.10 (7.5)	10.55 (7.4)	9.35 (7.1)	9.90 (7.1)	10.75 (7.0)	9.65 (7.0)	9.30 (6.8)	9.75 (8.00)	79.35 (57.90)
21	4.70 (6.0)	4.75 (5.8)	3.85 (5.5)	5.30 (5.7)	5.80 (6.1)	5.40 (5.6)	5.25 (5.3)	4.90 (5.5)	39.95 (45.50)
Kendall's W test	0.343**	0.302**	0.347**	0.224**	0.241**	0.314**	0.272**	0.284**	

Entries in the table indicate mean scores and mean rank.

Mean score given in parenthesis

** Significant at 1% level

4.2.1.2 Cut mango pickle

4.2.1.2.1 One month after storage

Highest rank for appearance of cut mango pickle one month after storage was for Acc. 21 followed by Acc. 10 and lowest rank was for Acc. 14. Rank for colour was highest for Acc. 4 followed by Acc. 8 and minimum for Acc. 16. Highest rank for flavour was recorded from Acc. 9 followed by Acc. 7 and lowest for Acc. 20. Maximum rank for texture was for Acc. 10 followed by Acc. 21 and lowest for Acc. 19. Acc. 9 followed by Acc. 8 had highest rank for odour and lowest for Acc. 20. Rank for taste was maximum for Acc. 8 followed by Acc. 7and lowest for Acc. 16. Maximum rank for after taste was recorded from Acc. 8 followed by Acc.7 and 21 and minimum for Acc.16. Similarly overall acceptability was highest for Acc. 21 followed by Acc. 8 and minimum for Acc.16. Considering the total of all characters, rank was highest for Acc. 8, followed by Acc. 21. Lowest was for Acc. 20. (Table 5d)

Table 5d. Mean sensory rank scores for cut mango pickle one month after storage.

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
1	10.95 (6.7)	11.85 (6.8)	12.50 (7.0)	11.25 (6.8)	11.90 (6.9)	12.10 (7.0)	14.55 (7.2)	12.10 (6.8)	97.20 (55.20)
2	12.40 (7.0)	12.30 (6.8)	9.40 (6.5)	13.00 (7.1)	9.95 (6.4)	12.10 (6.9)	10.90 (6.6)	10.60 (6.7)	90.65 (54.00)
3	8.20 (6.3)	9.65 (6.4)	8.50 (6.3)	11.10 (6.5)	8.35 (6.1)	9.70 (6.5)	9.75 (6.3)	9.35 (6.3)	74.60 (50.70)
4	15.30 (7.5)	15.65 (7.6)	11.50 (6.9)	15.10 (7.5)	12.90 (7.1)	12.40 (7.0)	14.40 (7.2)	13.30 (7.2)	110.55 (58.00)
5	10.05 (6.7)	12.00 (6.9)	13.05 (7.1)	10.55 (6.6)	11.95 (6.8)	13.45 (7.2)	15.10 (7.2)	13.10 (6.9)	99.25 (55.40)
6	11.65 (6.8)	13.75 (7.1)	12.40 (7.0)	10.85 (6.7)	12.65 (7.0)	12.40 (6.8)	9.90 (6.4)	13.05 (7.0)	96.65 (54.80)
7	10.85	9.60	14.70	12.25	13.05	14.05	12.55	12.55	99.60

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
	(6.8)	(6.5)	(7.4)	(6.9)	(7.3)	(7.1)	(6.8)	(6.9)	(55.70)
8	13.75	15.20	12.60	12.95	15.30	14.95	15.05	15.10	114.90
	(7.3)	(7.4)	(7.1)	(7.1)	(7.5)	(7.5)	(7.3)	(7.5)	(58.70)
9	14.65	12.85	14.90	13.40	15.40	13.65	11.50	13.75	110.10
	(7.4)	(7.0)	(7.6)	(7.3)	(7.6)	(7.3)	(6.8)	(7.3)	(58.30)
10	16.35	10.65	9.00	15.35	7.90	8.35	7.90	10.55	86.05
	(7.7)	(6.6)	(6.3)	(7.7)	(6.1)	(6.2)	(6.0)	(6.6)	(53.20)
11	12.30	11.15	12.90	12.45	12.50	12.35	13.50	12.25	99.40
	(6.9)	(6.7)	(6.9)	(7.0)	(7.0)	(7.0)	(7.1)	(6.9)	(55.50)
12	6.60	12.20	10.75	8.20	9.15	9.75	10.50	9.20	76.35
	(5.8)	(6.7)	(6.3)	(5.9)	(6.3)	(6.3)	(6.3)	(6.2)	(49.80)
13	10.30	10.40	8.75	9.20	10.70	9.25	10.70	9.50	78.80
	(6.4)	(6.4)	(5.9)	(6.3)	(6.2)	(6.2)	(6.4)	(6.3)	(50.10)
14	5.60	7.30	9.10	6.75	9.75	8.70	11.10	8.70	67.00
	(5.5)	(5.9)	(6.0)	(5.8)	(6.4)	(6.4)	(6.6)	(6.1)	(48.70)
15	10.30	12.10	13.45	11.15	12.55	12.70	11.70	11.30	95.25
	(6.5)	(6.8)	(6.9)	(6.7)	(6.8)	(6.9)	(6.6)	(6.7)	(53.90)
16	5.95	5.90	6.60	6.75	7.50	6.30	5.20	5.45	49.65
	(5.6)	(5.5)	(5.6)	(5.5)	(5.9)	(5.9)	(5.3)	(5.4)	(44.70)
17	15.30	12.80	11.20	13.45	11.80	10.85	8.80	11.80	96.00
	(7.5)	(7.0)	(6.8)	(7.3)	(6.9)	(6.9)	(6.1)	(6.8)	(55.30)
18	8.65	10.05	10.00	7.85	9.30	9.15	9.40	9.60	74.00
	(5.7)	(6.5)	(6.3)	(5.9)	(6.4)	(6.4)	(6.1)	(6.3)	(49.60)
19	6.00	9.50	10.20	6.30	8.05	7.80	5.45	7.55	60.85
	(5.4)	(6.2)	(6.0)	(5.4)	(5.9)	(5.9)	(5.4)	(5.7)	(45.90)
20	8.55	6.95	6.00	7.85	6.55	7.25	7.75	6.45	57.35
	(6.1)	(5.7)	(5.5)	(6.0)	(5.7)	(5.7)	(5.7)	(5.7)	(46.10)
21	17.30	9.15	13.50	15.25	13.80	13.75	15.65	15.75	114.15
	(7.8)	(6.3)	(7.3)	(7.7)	(7.3)	(7.3)	(7.5)	(7.6)	(58.80)
Kendall's W test	0.356**	0.179**	0.172**	0.230**	0.181**	0.177**	0.260**	0.203**	

Entries in the table indicate mean scores and mean rank.

Mean score given in parenthesis

** Significant at 1% level

4.2.1.2.2 Two months after storage

Highest rank for appearance of cut mango pickle was for Acc. 21 followed by Acc. 10. Lowest rank was for Acc.16. Highest rank for colour was for Acc. 4 followed by Acc. 8 and lowest for Acc.16. Acc. 9 ranked 1 for flavour followed by Acc.7. Lowest rank was for Acc. 20. Acc. 4 ranked 1 in texture followed by Acc. 10. Acc. 14 was ranked the lowest. Acc. 8 had the highest rank for odour and taste. Acc. 20 recorded the lowest rank for odour and Acc. 16 for taste. Acc. 21 was ranked highest in after taste and Acc. 19, the lowest. Overall acceptability was highest for Acc. 21 followed by Acc. 8 and lowest was for Acc. 16. Based on total scores, Acc. 8 ranked highest followed by Acc. 21 and Acc.16 ranked lowest (Table 5e).

Table 5e. Mean sensory rank score for cut mango pickle two months after storage

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
1	10.80 (6.7)	12.25 (6.8)	12.15 (6.9)	10.65 (6.6)	11.00 (6.7)	11.65 (6.8)	13.75 (7.0)	11.80 (6.7)	94.05 (54.20)
2	11.70 (7.0)	11.80 (6.8)	9.45 (6.4)	13.00 (7.0)	10.60 (6.5)	11.55 (6.7)	11.90 (6.7)	10.55 (6.6)	90.55 (53.70)
3	9.30 (6.3)	9.70 (6.4)	8.50 (6.1)	11.85 (6.6)	9.40 (6.2)	9.30 (6.3)	9.35 (6.1)	10.75 (6.5)	78.15 (50.50)
4	15.20 (7.5)	16.50 (7.6)	12.10 (7.0)	15.20 (7.4)	12.05 (6.9)	13.60 (7.1)	13.75 (7.0)	13.40 (7.1)	111.80 (57.60)
5	9.80 (6.7)	10.95 (6.9)	13.65 (7.2)	10.80 (6.6)	13.30 (7.2)	12.90 (7.0)	14.05 (6.9)	12.65 (6.7)	98.10 (55.20)
6	12.30 (6.8)	13.45 (7.1)	12.00 (6.9)	10.65 (6.6)	12.55 (6.9)	11.50 (6.6)	8.55 (6.1)	12.85 (6.9)	93.85 (53.90)
7	11.30 (6.8)	10.75 (6.5)	14.40 (7.3)	11.90 (6.7)	13.20 (7.2)	13.85 (7.0)	12.60 (6.7)	11.70 (6.7)	99.70 (54.90)
8	13.00 (7.3)	16.05 (7.4)	12.60 (7.0)	12.95 (7.0)	15.20 (7.5)	15.00 (7.4)	14.30 (7.1)	14.50 (7.3)	113.60 (58.00)
9	14.35	12.60	15.05	13.20	13.85	13.70	11.30	13.65	107.70

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
	(7.4)	(7.0)	(7.6)	(7.2)	(7.3)	(7.3)	(6.7)	(7.2)	(57.70)
10	16.25	9.70	9.00	15.05	8.35	8.25	8.85	10.70	86.15
	(7.7)	(6.6)	(6.2)	(7.5)	(6.1)	(6.0)	(6.1)	(6.6)	(52.80)
11	12.35	10.65	12.65	12.05	14.00	12.50	14.05	11.30	99.55
	(6.9)	(6.7)	(6.8)	(6.8)	(7.2)	(6.9)	(7.2)	(6.7)	(55.20)
12	6.65	11.75	11.60	7.90	10.00	10.50	10.95	8.45	77.80
	(5.8)	(6.7)	(6.4)	(5.8)	(6.5)	(6.5)	(6.2)	(6.0)	(49.90)
13	9.60	10.10	8.85	10.15	10.00	10.30	11.05	9.35	79.40
	(6.4)	(6.4)	(5.8)	(6.4)	(6.0)	(6.4)	(6.4)	(6.1)	(49.90)
14	6.70	7.00	8.90	6.55	9.45	8.85	10.25	9.00	66.70
	(5.5)	(5.9)	(5.9)	(5.7)	(6.2)	(6.2)	(6.3)	(6.0)	(47.70)
15	10.45	11.85	12.85	10.90	12.05	13.05	11.20	10.60	92.95
	(6.5)	(6.8)	(6.8)	(6.6)	(6.6)	(7.0)	(6.4)	(6.5)	(53.20)
16	5.50	6.45	6.55	7.20	8.25	6.35	6.05	6.15	52.50
	(5.6)	(5.5)	(5.5)	(5.6)	(6.0)	(5.4)	(5.5)	(5.6)	(44.70)
17	15.20	12.65	10.95	13.65	12.75	9.85	9.95	12.70	97.70
	(7.5)	(7.0)	(6.7)	(7.3)	(6.9)	(6.3)	(6.3)	(6.9)	(54.90)
18	9.20	9.55	10.35	8.30	8.65	9.00	9.40	11.40	75.85
	(5.7)	(6.5)	(6.4)	(6.0)	(6.2)	(6.1)	(6.0)	(6.6)	(49.50)
19	6.10	9.45	10.20	6.90	7.40	7.35	5.80	6.90	60.10
	(5.4)	(6.2)	(5.9)	(5.5)	(5.7)	(5.6)	(5.4)	(5.5)	(45.20)
20	8.30	7.80	6.10	7.70	5.80	8.30	8.10	6.65	58.75
	(6.1)	(5.7)	(5.3)	(5.9)	(5.5)	(5.9)	(5.7)	(5.7)	(45.80)
21	16.95	10.00	13.10	14.45	13.15	13.65	15.80	15.95	113.05
	(7.8)	(6.3)	(7.2)	(7.5)	(7.1)	(7.1)	(7.5)	(7.6)	(58.10)
Kendall's W test	0.322**	0.181**	0.165**	0.204**	0.177**	0.168**	0.211**	0.185**	

Entries in the table indicate mean scores and mean rank.

Mean score given in parenthesis

** Significant at 1% level

4.2.1.2.3 Three months after storage

Three months after storage the highest rank for appearance was for Acc. 21 followed by Acc. 10 and 17. Acc. 16 had the lowest rank. Rank for colour was highest and lowest for Acc. 4 and Acc.16 respectively. Acc. 9 had highest rank for flavour followed by Acc. 5 and lowest was for Acc. 20. Texture was the best for Acc. 4 and 10. Acc. 8 had the highest rank for odour and taste. Lowest rank for odour was for Acc. 20 and for taste it was Acc.16. Acc. 5 had the highest rank for after taste followed by Acc. 8 and lowest was for Acc. 16. Acc. 21 had the highest overall acceptability and total rank three months after storage followed by Acc. 4. Lowest acceptability was for Acc. 16, which recorded the lowest total rank also (Table 5f)

Table 5f. Mean sensory rank score for cut mango pickle three months after storage

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
1	9.85 (6.5)	10.60 (6.5)	11.75 (7.0)	10.00 (6.4)	10.15 (6.3)	11.25 (6.6)	13.05 (6.7)	11.45 (6.5)	88.10 (52.50)
2	11.55 (6.4)	12.25 (6.8)	9.65 (6.5)	13.25 (7.1)	8.90 (6.0)	11.00 (6.5)	11.80 (6.5)	9.95 (6.4)	88.35 (52.20)
3	9.40 (6.2)	9.15 (6.2)	8.40 (6.3)	11.20 (6.4)	9.00 (6.0)	8.55 (6.1)	10.65 (6.2)	10.55 (6.2)	76.90 (49.60)
4	14.60 (7.2)	15.35 (7.5)	11.50 (6.9)	15.05 (7.3)	11.65 (6.6)	13.60 (7.0)	13.70 (6.8)	14.15 (7.2)	109.60 (56.50)
5	10.85 (6.3)	12.30 (6.8)	14.80 (7.1)	10.30 (6.4)	14.00 (7.2)	12.70 (6.8)	14.65 (7.0)	11.00 (6.3)	100.60 (53.90)
6	12.40 (7.0)	13.35 (6.9)	11.60 (7.0)	11.40 (6.7)	12.25 (6.7)	11.20 (6.4)	8.65 (5.9)	13.50 (7.0)	94.35 (53.60)
7	11.35 (6.6)	11.90 (6.8)	13.85 (7.4)	12.85 (6.8)	12.55 (6.9)	14.80 (7.1)	11.45 (6.3)	11.65 (6.6)	100.40 (54.50)

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
8	13.15 (7.1)	14.40 (7.2)	12.05 (7.1)	12.40 (6.8)	15.75 (7.4)	15.30 (7.2)	14.35 (6.8)	13.85 (7.1)	111.25 (56.70)
9	13.60 (7.1)	13.55 (7.0)	14.90 (7.6)	13.55 (7.1)	13.35 (7.1)	12.35 (7.0)	10.60 (6.4)	13.85 (7.1)	105.75 (56.40)
10	15.60 (6.3)	9.65 (6.3)	9.55 (6.3)	15.05 (7.4)	8.60 (6.0)	8.10 (5.8)	9.15 (6.0)	10.30 (6.3)	86.00 (50.40)
11	12.10 (6.6)	10.10 (6.5)	12.35 (6.9)	11.90 (6.7)	13.80 (7.0)	12.55 (6.8)	13.95 (7.1)	11.50 (6.6)	98.25 (54.20)
12	7.60 (5.8)	10.95 (6.4)	11.45 (6.3)	7.60 (5.7)	11.40 (6.6)	9.60 (6.2)	11.65 (5.8)	8.35 (5.8)	78.60 (49.10)
13	10.00 (6.2)	10.60 (6.5)	8.45 (5.9)	11.45 (6.6)	10.35 (6.1)	10.50 (6.3)	10.60 (6.2)	10.00 (6.2)	81.95 (49.90)
14	6.45 (6.2)	7.75 (5.9)	10.00 (6.0)	6.75 (5.6)	10.95 (6.4)	10.30 (6.4)	11.55 (6.2)	9.65 (6.2)	73.40 (49.10)
15	10.85 (6.3)	11.40 (6.6)	12.95 (6.9)	10.60 (6.4)	12.70 (6.7)	13.65 (7.1)	11.45 (6.3)	9.90 (6.3)	93.50 (52.50)
16	5.90 (5.4)	7.35 (5.8)	6.55 (5.6)	7.35 (5.7)	8.40 (5.9)	6.55 (5.5)	6.15 (5.4)	6.10 (5.4)	54.35 (44.60)
17	15.10 (7.0)	12.35 (6.7)	10.70 (6.8)	13.20 (7.1)	12.45 (6.7)	9.70 (6.2)	9.45 (7.0)	13.65 (7.0)	96.60 (53.60)
18	8.95 (6.4)	9.90 (6.4)	11.15 (6.3)	8.00 (5.9)	7.75 (5.9)	9.20 (6.0)	8.80 (6.4)	10.95 (6.4)	74.70 (49.10)
19	6.75 (5.4)	8.90 (6.0)	10.45 6.0	6.95 5.4	7.50 5.6	7.40 5.5	6.95 5.4	7.25 5.4	62.15 (44.80)
20	8.30 (5.8)	8.30 (6.0)	6.10 (5.5)	7.80 (5.8)	5.95 (5.4)	9.00 (5.9)	7.80 (5.8)	7.55 (5.8)	60.80 (45.70)
21	16.65 (7.0)	10.90 (6.4)	12.80 (7.3)	14.35 (7.3)	13.55 (7.0)	13.70 (7.0)	14.60 (7.0)	15.85 (7.0)	112.40 (56.20)
Kendall's W test	0.272**	0.132**	0.156**	0.203**	0.185**	0.169**	0.178**	0.175**	

Entries in the table indicate mean scores and mean rank.

Mean score given in parenthesis

** Significant at 1% level

Plate.7 Cut mango pickle

4.2.2 Organoleptic evaluation of RTS beverage

4.2.2.1. One month after storage.

Mean sensory rank score of appearance and colour of RTS beverage one month after storage was highest for Acc.18 followed by Acc. 8. Lowest score was for Acc. 10 for appearance colour and consistency. Acc. 17 recorded the highest values of mean sensory rank score for flavour, odour, taste, after taste, overall acceptability and total score. Similarly Acc16 had the lowest score for flavour, odour, taste, after taste, overall acceptability and total score. (Table 6 a)

Table 6 a. Mean sensory rank score for RTS beverage one month after storage

Accessions	Appearance	Colour	Flavour	Consistency	Odour	Taste	After taste	Overall acceptability	Total score
1	16.00 (7.8)	16.05 (7.8)	12.70 (7.0)	13.75 (7.2)	13.20 (7.0)	13.30 (7.1)	14.65 (7.2)	12.70 (7.1)	112.40 (58.20)
2	7.85 (6.3)	8.95 (6.4)	12.40 (6.9)	10.35 (6.6)	10.65 (6.5)	11.35 (6.8)	13.00 (6.8)	11.25 (6.7)	85.80 (53.00)
3	11.00 (7.0)	11.45 (6.7)	12.35 (6.9)	13.45 (7.0)	10.85 (6.5)	11.05 (6.7)	11.50 (6.5)	12.20 (6.9)	93.85 (54.20)
4	11.80 (7.1)	12.35 (7.1)	14.05 (7.3)	11.05 (6.6)	10.90 (6.6)	13.80 (7.2)	14.55 (7.0)	14.65 (7.4)	103.15 (56.30)
5	16.45 (8.0)	7.15 (5.9)	8.95 (6.1)	12.75 (6.8)	13.45 (7.3)	12.85 (7.1)	13.55 (7.0)	12.75 (7.1)	97.90 (55.30)
6	16.25 (8.0)	16.30 (8.0)	10.95 (6.6)	13.65 (7.1)	9.35 (6.3)	10.95 (6.5)	14.15 (7.0)	12.15 (7.1)	103.75 (56.60)
7	6.75 (6.1)	8.50 (6.3)	13.35 (7.1)	13.50 (7.1)	13.55 (7.2)	12.20 (7.0)	14.45 (7.3)	12.85 (7.1)	95.15 (55.20)
8	16.55 (7.9)	16.60 (7.9)	14.55 (7.3)	14.15 (7.1)	15.20 (7.4)	15.00 (7.5)	11.65 (6.5)	14.10 (7.3)	117.8 (58.90)
9	3.25 (4.8)	2.95 (4.7)	7.85 (5.7)	4.20 (5.1)	8.15 (5.9)	7.35 (5.7)	5.40 (5.1)	4.75 (5.4)	43.90 (42.40)
10	2.75 (4.5)	2.40 (4.5)	6.20 (5.3)	4.05 (5.1)	6.75 (5.6)	7.20 (5.6)	5.15 (5.1)	3.90 (5.2)	38.40 (31.6)
11	11.85 (7.1)	11.40 (7.0)	15.05 (7.4)	11.15 (6.6)	15.00 (7.3)	13.20 (7.2)	13.35 (6.9)	13.20 (7.1)	104.20 (56.60)
12	11.60 (6.8)	11.35 (6.7)	12.00 (6.5)	12.65 (6.9)	12.40 (6.8)	12.95 (7.1)	11.80 (6.6)	10.30 (6.3)	95.05 (53.70)

Accessions	Appearance	Colour	Flavour	Consistency	Odour	Taste	After taste	Overall acceptability	Total score
13	14.40 (7.6)	14.10 (7.5)	12.15 (6.8)	11.70 (6.8)	14.35 (7.2)	12.55 (7.1)	12.20 (6.8)	13.05 (7.1)	104.50 (56.90)
14	4.30 (5.3)	5.60 (5.6)	5.70 (5.3)	4.60 (5.2)	5.35 (5.2)	3.90 (4.8)	6.05 (5.2)	5.05 (5.5)	40.55 (42.10)
15	6.75 (6.1)	7.20 (6.0)	8.25 (6.0)	8.80 (6.3)	10.35 (6.4)	9.80 (6.4)	7.95 (5.8)	10.05 (6.5)	69.15 (49.50)
16	7.75 (6.0)	10.40 (6.6)	2.50 (4.3)	6.50 (5.9)	2.20 (4.1)	1.75 (3.5)	1.80 (3.9)	2.30 (4.6)	35.20 (38.90)
17	14.85 (7.7)	12.80 (7.2)	18.25 (8.1)	16.30 (7.7)	16.75 (7.9)	18.75 (8.1)	16.15 (7.7)	18.50 (8.3)	132.60 (62.70)
18	18.05 (8.2)	17.95 (8.3)	9.60 (6.0)	13.50 (7.0)	7.25 (5.6)	9.40 (6.1)	9.25 (5.9)	13.30 (7.0)	98.30 (54.10)
19	12.85 (7.3)	13.35 (7.2)	10.90 (6.6)	11.85 (6.8)	11.70 (6.8)	13.40 (7.2)	10.90 (6.4)	11.85 (6.9)	96.80 (55.20)
20	8.75 (6.5)	8.50 (6.3)	9.75 (6.3)	10.45 (6.5)	9.10 (6.2)	7.85 (6.0)	9.10 (6.0)	8.45 (6.2)	71.95 (50.00)
21	11.20 (7.0)	15.65 (7.8)	13.50 (7.1)	12.60 (6.9)	14.50 (7.2)	12.40 (6.9)	14.40 (7.1)	13.65 (7.2)	107.90 (57.20)
Kendall's W test	0.604**	0.537**	0.359**	0.345**	0.374**	0.409**	0.417**	0.450**	

Entries in the table indicate mean scores and mean rank.

Mean score given in parenthesis

** Significant at 1% level

4.2.2.2. Two months after storage.

Acc. 18 had the highest rank for appearance and colour of RTS beverage, two months after storage. Acc17 had the highest rank for the rest of the sensory characters for which it was evaluated. Acc. 16 recorded the lowest rank for flavour, odour, taste, after taste, overall acceptability and total score. Acc. 10 ranked last for appearance and colour and accession 9 for consistency (Table 6b).

Table 6b. Mean sensory rank score for RTS beverage two months after storage

Accessions	Appearance	Colour	Flavour	Consistency	Odour	Taste	After taste	Overall acceptability	Total score
1	15.95 (7.1)	15.70 (7.4)	12.60 (6.4)	13.90 (6.7)	12.40 (6.2)	13.25 (6.7)	15.20 (6.1)	12.25 (6.9)	111.25 (53.50)
2	7.80 (5.9)	8.85 (6.0)	12.30 (6.5)	10.35 (6.2)	10.45 (6.1)	11.55 (6.4)	12.85 (6.4)	11.30 (6.8)	85.45 (50.30)
3	11.75 (6.5)	11.05 (6.2)	12.30 (6.6)	12.25 (6.5)	11.00 (6.0)	10.95 (6.2)	11.40 (6.0)	11.80 (6.4)	92.50 (50.40)
4	12.45 (5.8)	11.80 (6.1)	13.85 (6.0)	10.50 (5.9)	10.70 (6.0)	13.95 (6.3)	14.35 (6.2)	14.85 (6.6)	102.45 (48.90)
5	16.30 (4.9)	6.65 (4.6)	8.85 (5.6)	12.15 (5.9)	13.80 (5.6)	12.55 (5.5)	13.90 (5.4)	11.45 (5.7)	95.65 (43.20)
6	16.15 (7.3)	16.90 (7.2)	11.05 (6.2)	14.05 (6.2)	9.35 (6.1)	10.60 (6.2)	13.80 (6.2)	11.95 (7.2)	103.85 (52.60)
7	7.20 (6.6)	8.15 (5.7)	13.60 (6.2)	13.10 (6.2)	14.00 (6.3)	12.40 (6.0)	14.60 (5.5)	12.95 (6.2)	96.00 (48.70)
8	16.00 (6.6)	16.15 (6.5)	14.85 (6.1)	14.35 (6.0)	15.00 (6.1)	14.65 (6.3)	11.75 (5.9)	14.55 (6.3)	117.3 (49.80)
9	3.15 (4.3)	3.40 (4.2)	8.00 (5.2)	4.40 (4.6)	8.15 (5.4)	6.75 (5.1)	5.20 (4.6)	4.75 (4.9)	43.80 (38.30)
10	2.60 (3.8)	2.25 (3.9)	6.35 (4.4)	4.75 (4.2)	6.80 (4.7)	7.60 (4.8)	5.60 (4.2)	3.90 (4.6)	39.85 (34.60)
11	11.35 (5.1)	11.60 (5.0)	15.50 (5.6)	11.50 (5.1)	14.45 (6.0)	13.30 (5.2)	13.65 (5.2)	13.45 (5.4)	104.80 (42.60)
12	11.40 (6.5)	11.55 (6.3)	11.90 (5.9)	13.15 (6.5)	12.75 (6.1)	13.25 (6.5)	11.65 (5.9)	10.15 (6.3)	95.80 (50.00)
13	13.75 (6.8)	14.35 (6.8)	12.05 (6.2)	11.25 (6.0)	14.50 (6.4)	12.95 (6.4)	12.30 (6.0)	13.55 (6.3)	104.70 (50.90)
14	4.25 (4.8)	5.55 (4.7)	5.55 (4.5)	5.00 (4.9)	5.45 (4.5)	4.05 (4.2)	6.00 (4.6)	5.25 (4.6)	41.10 (36.80)
15	6.90 (5.4)	8.15 (5.4)	8.40 (5.3)	9.05 (5.5)	10.45 (5.7)	9.80 (5.7)	8.35 (5.1)	9.80 (6.0)	70.90 (44.10)
16	7.60 (6.2)	10.60 (6.0)	3.00 (4.5)	7.15 (5.6)	2.10 (5.0)	1.85 (4.5)	1.95 (4.1)	2.50 (4.9)	36.75 (40.80)
17	14.95 (6.1)	12.75 (5.8)	18.35 (6.6)	16.30 (6.4)	16.85 (6.5)	18.70 (6.6)	15.40 (6.3)	18.30 (6.8)	131.60 (51.10)
18	18.40 (7.6)	18.50 (8.4)	8.45 (5.5)	13.00 (6.4)	7.45 (5.2)	9.75 (5.0)	9.50 (5.0)	13.05 (5.6)	98.10 (48.70)
19	12.90	12.90	10.90	11.85	12.00	13.15	10.55	12.35	(96.60)

Accessions	Appearance	Colour	Flavour	Consistency	Odour	Taste	After taste	Overall acceptability	Total score
	(6.1)	(5.8)	(5.6)	(5.6)	(5.6)	(6.0)	(5.2)	(5.7)	(45.60)
20	8.75 (5.4)	8.75 (5.3)	9.70 (5.3)	9.55 (5.7)	9.20 (5.3)	7.80 (5.3)	8.15 (5.2)	8.95 (5.4)	70.85 (42.90)
21	11.40 (6.4)	15.40 (6.4)	13.45 (6.5)	13.40 (6.3)	14.15 (6.2)	12.15 (6.1)	14.85 (6.2)	13.90 (6.3)	108.70 (50.40)
Kendall's W test	0.595**	0.538**	0.362**	0.313**	0.366**	0.398**	0.414**	0.444**	

Entries in the table indicate mean scores and mean rank.

Mean score given in parenthesis

** Significant at 1% level

4.2.2.3. Three months after storage.

Acc18 recorded the highest rank for appearance and colour of the RTS beverage 3 months after storage and accession 17 for rest of the characters. Lowest rank for appearance and colour was for Acc.10 and Acc.16 for flavour, odour, taste, after taste, overall acceptability and total score (Table 6c).

Table 6c Mean sensory rank score for RTS beverage three months after storage

Accessions	Appearance	Colour	Flavour	Consistency	Odour	Taste	After taste	Overall acceptability	Total score
1	16.10 (5.9)	15.40 (6.3)	11.75 (5.7)	13.25 (6.0)	11.05 (5.5)	13.40 (6.0)	14.85 (5.4)	12.15 (6.2)	107.95 (47.00)
2	7.60 (5.3)	9.20 (5.1)	12.45 (6.2)	9.75 (5.9)	11.10 (5.8)	11.65 (6.1)	13.20 (6.1)	11.25 (6.5)	86.20 (47.00)
3	11.75 (5.8)	11.00 (5.4)	11.60 (5.1)	12.50 (6.2)	10.40 (5.8)	10.55 (5.9)	10.45 (5.7)	11.85 (5.8)	90.10 (45.70)
4	12.55 (5.1)	11.75 (5.4)	13.90 (5.0)	10.55 (4.8)	10.55 (4.6)	14.15 (5.0)	14.35 (5.2)	14.35 (5.7)	102.20 (40.80)
5	15.85	5.90	9.10	11.65	13.05	12.70	13.75	11.55	93.55

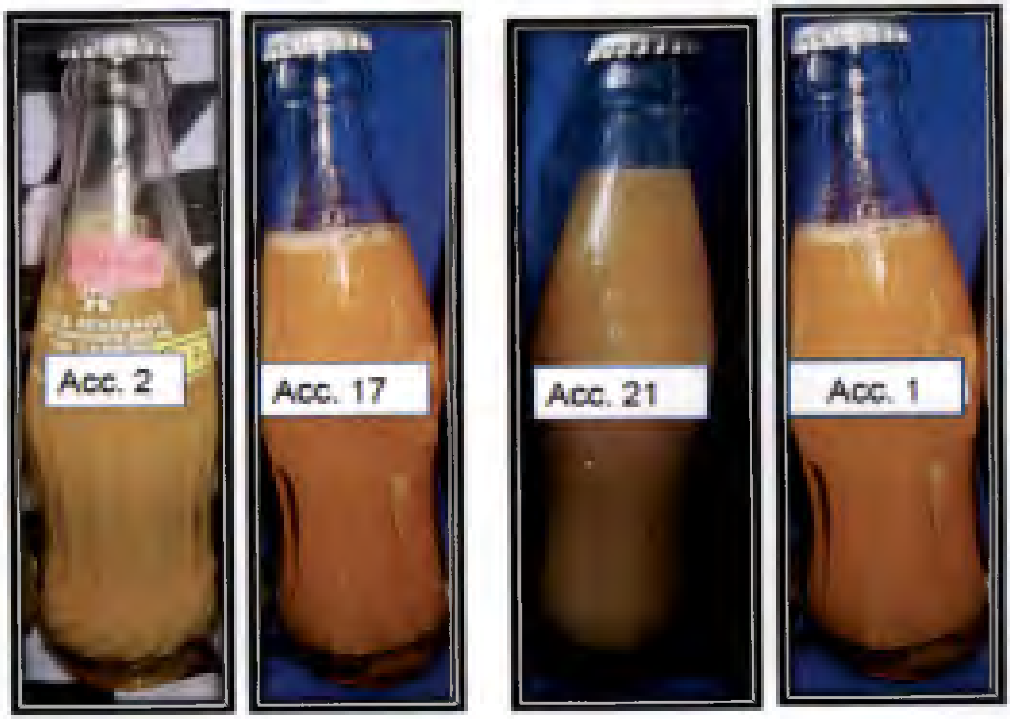
Accessions	Appearance	Colour	Flavour	Consistency	Odour	Taste	After taste	Overall acceptability	Total score
	(3.9)	(3.6)	(4.5)	(4.9)	(4.6)	(4.4)	(4.4)	(4.7)	(35.00)
6	15.85 (6.4)	17.55 (6.5)	10.35 (5.2)	13.10 (6.2)	8.90 (5.2)	10.80 (5.9)	13.15 (4.5)	12.25 (6.1)	101.20 (46.00)
7	7.55 (5.5)	8.10 (5.1)	13.35 (5.6)	12.20 (5.7)	14.50 (5.8)	12.05 (5.5)	15.15 (5.0)	12.95 (5.7)	95.85 (43.90)
8	15.60 (5.6)	15.65 (5.5)	14.50 (5.1)	14.45 (5.0)	14.40 (5.1)	14.80 (5.3)	11.40 (4.9)	14.20 (5.3)	115.00 (41.80)
9	3.10 (3.5)	3.55 (3.2)	8.50 (4.9)	4.60 (4.3)	8.30 (5.0)	6.90 (4.7)	5.55 (4.3)	4.75 (4.6)	45.25 (34.50)
10	2.40 (3.1)	2.45 (3.3)	6.95 (3.9)	4.45 (4.0)	7.35 (4.4)	7.25 (4.6)	5.35 (4.0)	3.70 (4.3)	39.90 (31.60)
11	11.30 (4.1)	11.75 (4.0)	14.75 (4.6)	11.15 (4.1)	14.65 (5.0)	13.15 (4.2)	13.80 (4.2)	13.90 (4.4)	104.45 (34.60)
12	11.25 (5.3)	11.50 (5.0)	11.35 (4.7)	14.00 (5.1)	12.05 (4.9)	12.70 (5.1)	11.80 (4.9)	9.60 (4.9)	94.25 (39.90)
13	14.20 (5.8)	14.40 (4.8)	11.70 (5.2)	12.00 (5.1)	15.15 (5.4)	13.50 (5.4)	12.00 (5.0)	13.95 (5.4)	106.90 (42.10)
14	4.60 (3.6)	5.70 (3.7)	6.15 (3.5)	5.70 (3.9)	5.90 (3.5)	4.15 (3.4)	5.85 (3.7)	5.05 (3.7)	43.10 (29.00)
15	7.05 (4.7)	7.90 (5.1)	8.85 (5.0)	9.80 (5.2)	10.45 (5.4)	10.00 (5.4)	8.55 (4.8)	11.00 (5.9)	73.60 (41.50)
16	7.80 (5.2)	10.60 (5.0)	3.65 (3.6)	7.45 (4.8)	2.00 (4.3)	1.85 (3.5)	2.30 (3.4)	2.70 (3.9)	38.35 (33.70)
17	14.30 (6.3)	13.05 (6.4)	17.50 (5.6)	16.35 (6.4)	17.40 (5.5)	18.60 (5.6)	15.50 (5.3)	18.25 (5.8)	130.95 (46.90)
18	18.80 (6.8)	18.80 (6.5)	9.00 (5.5)	12.35 (6.3)	7.50 (5.1)	10.10 (4.6)	9.55 (4.8)	12.25 (5.4)	98.35 (45.00)
19	13.05 (5.1)	12.40 (5.4)	11.20 (5.1)	12.40 (5.2)	12.10 (5.2)	12.85 (5.6)	10.60 (5.0)	12.65 (5.4)	97.25 (45.00)
20	8.80 (4.7)	8.90 (5.0)	10.40 (4.9)	10.30 (5.3)	9.45 (4.9)	7.95 (5.0)	8.60 (4.9)	8.30 (5.1)	72.70 (39.80)
21	11.50 (5.6)	15.45 (6.2)	14.00 (6.1)	13.00 (5.9)	14.75 (5.9)	11.90 (5.7)	15.25 (5.9)	14.35 (5.9)	110.20 (47.20)
Kendall's W test	0.580**	0.543**	0.291**	0.284**	0.367**	0.395**	0.403**	0.452**	

Entries in the table indicate mean scores and mean rank.

Mean score given in parenthesis ** Significant at 1% level

Plate.8 RTS beverages

Best accessions for RTS beverages



4.2.3 Microbial evaluation of pickle

Tender and mature mango pickles were observed for microbial load. Microbial population in the pickles prepared from all the 21 accessions was analysed at monthly intervals for three months.

4.2.3.1. Tender mango pickle

Results are presented in table 7a

Microbial load was negligible one month after storage. Bacterial and fungal population were noticed in traces in some of the samples each but there was no yeast population. The result was similar in second and third month after storage also. However small colonies of fungal and bacterial population was noticed in some of the accessions like Acc.5, Acc.9, Acc 10, Acc.13, Acc. 20, Acc. 21. No yeast population was recorded in any of the accessions in all the three stages.

4.2.3.2 Cut mango pickles

Results are presented in table 7b

Microbial population in cut mango pickle was relatively lower during the first and second month compared to third month. Three months after storage, it was observed that bacterial count was very high. In accessions 1, 10, 15 and 21 it was too numerable to count (TNTC).Yeast count was also very high. In accessions 1, 2, 6, 10, 15, 21 it was too numerable to count (TNTC). Relatively lower level of population were noticed in Acc. 19, Acc. 17, Acc. 11, Acc. 12, Acc. 4, Acc. 5 and Acc. 8

4.2.4. Nested assortment of accessions based on sensory characters

Balance between the acceptability of mangoes based on total score and overall acceptability score were assessed using a slider filter chart having three layered filters. Individual three layered charts for total score (average of scores for appearance, color, flavor, odour, taste, texture/consistency an after taste) and overall acceptability were sliders. Inner most layer was allotted for score more than 7, intermediate layers for scores between 4 and 7 and the outer most layer for score less

Table 7a. Effect of storage on microbial population of tender mango pickle

	Bacteria (cfu/g) (10^3)			Fungi (cfu/g) (10^1)			Yeast (cfu/g) (10^3)		
	1MAS	2MAS	3MAS	1MAS	2MAS	3MAS	1MAS	2MAS	3MAS
Acc. 1	ND	ND	1	ND	ND	ND	ND	ND	ND
Acc. 2	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acc. 3	ND	ND	1	ND	ND	ND	ND	ND	ND
Acc. 4	ND	1	2	ND	ND	ND	ND	ND	ND
Acc. 5	1	2	3	ND	ND	1	ND	ND	ND
Acc. 6	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acc. 7	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acc. 8	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acc. 9	ND	ND	1	1	2.2	3	ND	ND	ND
Acc. 10	ND	ND	1	3.2	8.1	14.3	ND	ND	ND
Acc. 11	ND	ND	ND	ND	ND	1	ND	ND	ND
Acc. 12	ND	ND	1	ND	ND	ND	ND	ND	ND
Acc. 13	1	2	3	ND	ND	ND	ND	ND	ND
Acc. 14	ND	ND	1	ND	ND	ND	ND	ND	ND
Acc. 15	ND	ND	1	ND	ND	ND	ND	ND	ND
Acc. 16	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acc. 17	ND	ND	1	ND	ND	ND	ND	ND	ND
Acc. 18	ND	ND	1	ND	ND	ND	ND	ND	ND
Acc. 19	ND	ND	1	1	2	3	ND	ND	ND
Acc. 20	ND	1	2	ND	ND	1.5	ND	ND	ND
Acc. 21	10	22.1	38.2	6.2	15.4	22.4	ND	ND	ND

MAS – Month After Storage

ND –Not Detected

Table 7b. Effect of storage on microbial population of cut mango pickle

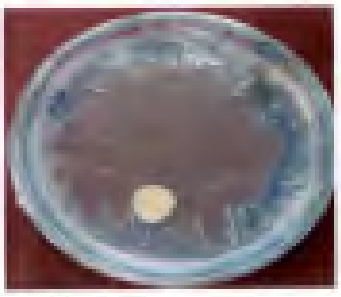
	Bacteria (cfu/g) (10^3)			Fungi (cfu/g) (10^1)			Yeast (cfu/g) (10^3)		
	1MAS	**2MAS**	**3MAS**	**1MAS**	**2MAS**	**3MAS**	**1MAS**	**2MAS**	**3MAS**
Acc. 1	53.4	96.2	TNTC	ND	ND	ND	65.8	121	TNTC
Acc. 2	21.3	54	75.4	ND	ND	ND	54.3	115.5	TNTC
Acc. 3	28.2	59.9	103.2	ND	1	2	31.1	64.2	141.5
Acc. 4	ND	1	2	ND	ND	ND	ND	1	2
Acc. 5	1	2	3.2	ND	1	2	ND	ND	1
Acc. 6	10	17.2	24	ND	ND	ND	45	92	TNTC
Acc. 7	17	42	93.2	25	48	95.5	34	65.4	119.1
Acc. 8	8	18	33.3	ND	ND	2	ND	ND	ND
Acc. 9	ND	ND	ND	17	36	74	ND	ND	ND
Acc. 10	57.1	115.4	TNTC	ND	ND	ND	63.2	120	TNTC
Acc. 11	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acc. 12	ND	ND	ND	ND	ND	1	ND	ND	ND
Acc. 13	4	10	22	ND	4	6	10	20	32
Acc. 14	14	45.3	62.4	5	7	21.1	20	45	82
Acc. 15	39	84	TNTC	ND	1	2	44	93.6	TNTC
Acc. 16	ND	ND	ND	ND	ND	ND	14	25.8	51.1
Acc. 17	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acc. 18	6	19.3	29	ND	ND	ND	24	55.2	98.3
Acc. 19	ND	ND	1	2	5	8.2	ND	ND	ND
Acc. 20	12	31.2	88.3	5	11.8	24.5	18	30.4	92.1
Acc. 21	36	75.6	TNTC	ND	ND	ND	48	104.2	TNTC

MAS – Month After Storage ND –Not Detected TNTC –Too Numerable To Count

Plate.12 Bacterial population on tender mango pickle

Initial

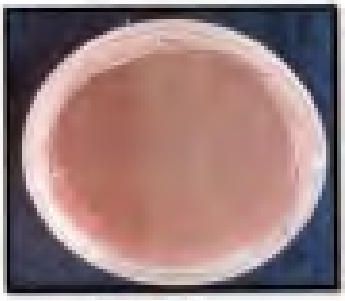
1MAS



2MAS

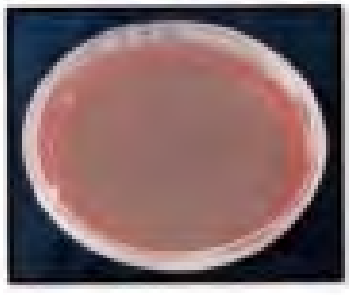
3MAS

Plate.13 Fungal population on tender mango pickle



Initial

1MAS



2MAS

3MAS

Plate. 14 Yeast population on tender mango pickle

Initial

1MAS

2MAS

3MAS

Plate.15 Bacterial population on cut mango pickle

Initial

1MAS

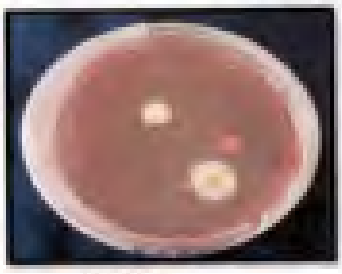
2MAS

3MAS

Plate.16 Fungal population on cut mango pickle

Initial

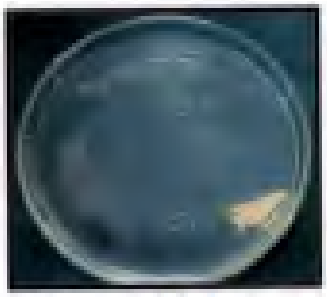
1MAS



2MAS

3MAS

Plate.17 Yeast population on cut mango pickle



Initial

1MAS

2MAS

3MAS

than 4. The accessions were captured at the different overlapping layers, the most promising accessions falling through the innermost layers of both charts.

4.2.4.1 Tender mango pickle (Fig 1 to 3)

4.2.4.1.1 One month after storage

Most acceptable for overall acceptability and total score: Acc. 1, 8, 12 and 20

Most acceptable for overall acceptability and moderately acceptable for total score: Acc.2, 3, 4, 6, 10, 15 and 17.

Most acceptable for total score and moderately acceptable for overall acceptability: Acc. 7, 9, 13, 16 and 19.

Moderately acceptable for total score and overall acceptability: Acc. 5, 11, 14 and 18

Moderately acceptable for total score and least acceptable for overall acceptability: Acc.21.

4.2.4.1.2 Two months after storage

Most acceptable for overall acceptability and total score: Acc. 1, 2, 3, 4, 6, 8, 10, 12, 15 and 17.

Moderately acceptable for total score and overall acceptability: Acc. 5, 11, 13, 14, 16, 18, 19 and 21.

Most acceptable for total score and moderately acceptable for overall acceptability: Acc. 7, 9 and 20.

4.2.4.1.3 Three months after storage

Most acceptable for overall acceptability and total score: Acc.1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 17 and 20.

Moderately acceptable for total score and overall acceptability: Acc.11, 13, 16, 18 and 21.

Most acceptable for total score and moderately acceptable for overall acceptability: Acc.7, 9, 14 and 19.

4.2.4.2. Cut mango pickle (Fig 4 to 6)

4.2.4.2.1. One month after storage

Most acceptable for overall acceptability and total score: Acc. 4, 8, 9 and 21

Moderately acceptable for total score and overall acceptability: Acc.1, 2, 3, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 and 20

4.2.4.2.2. Two months after storage

Most acceptable for overall acceptability and total score: Acc. 4, 8, 9 and 21

Moderately acceptable for total score and overall acceptability: Acc.1, 2, 3, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 and 20

4.2.4.2.3. Three months after storage

Most acceptable for overall acceptability and total score: Acc. 4, 8 and 9

Moderately acceptable for total score and overall acceptability: Acc.1, 2, 3, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 and 20

Most acceptable for total score and moderately acceptable for overall acceptability: Acc.21.

4.2.4.3 RTS beverage (Fig 7 to 9)

4.2.4.3.1 One month after storage

Most acceptable for overall acceptability and total score: Acc. 1, 4, 5, 6, 7, 8, 11, 13, 17, 21

Moderately acceptable for total score and overall acceptability: Acc. 9, 10, 14 and 16

Most acceptable for overall acceptability and moderately acceptable for total score: Acc. 2, 3, 12, 15, 18, 19 and 20

4.2.4.3.2 Two months after storage

Moderately acceptable for total score and overall acceptability: Acc.1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 17, 18, 19, 20 and 21

Moderately acceptable for total score and most acceptable for overall acceptability: Acc. 6

4.2.4.3.3 Three months after storage

Moderately acceptable for total score and overall acceptability: Acc.1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 15, 17, 18, 19, 20 and 21.

Moderately acceptable for total score and least acceptable for overall acceptability: Acc. 16

Moderately acceptable for overall acceptability and least acceptable for total score: Acc. 10

Least acceptable for total score and overall acceptability: Acc.14

Fig: 1 Nested assortment of accessions based on sensory characters of tender mango pickle 1 month after storage

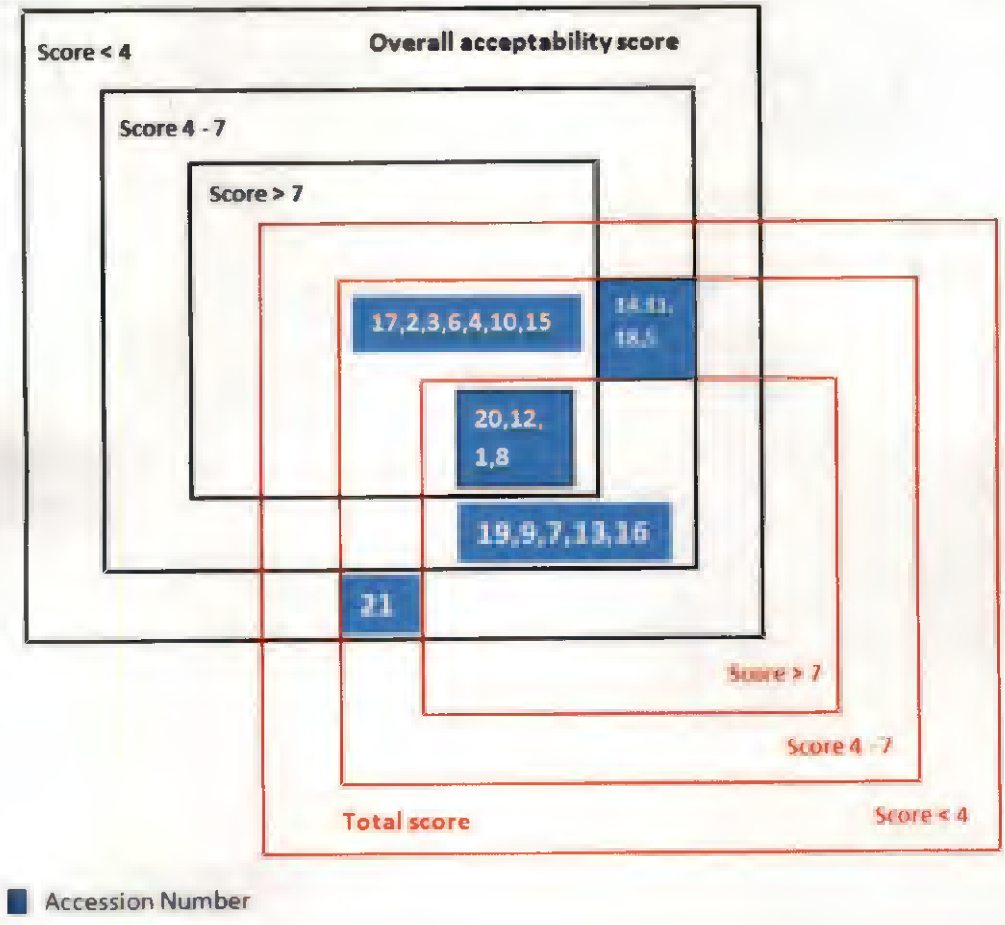


Fig: 2 Nested assortment of accessions based on sensory characters of tender mango pickle 2 months after storage

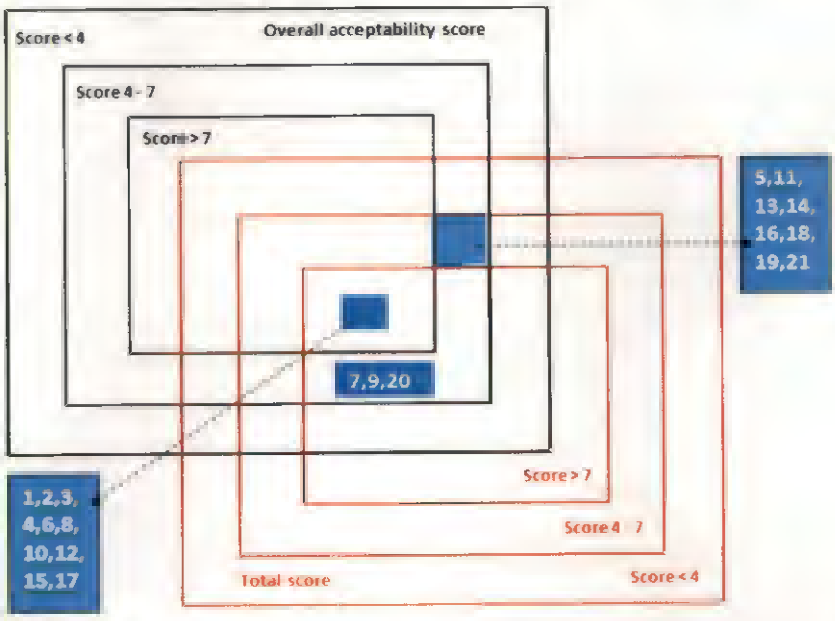


Fig: 3 Nested assortment of accessions based on sensory characters of tender mango pickle 3 months after storage

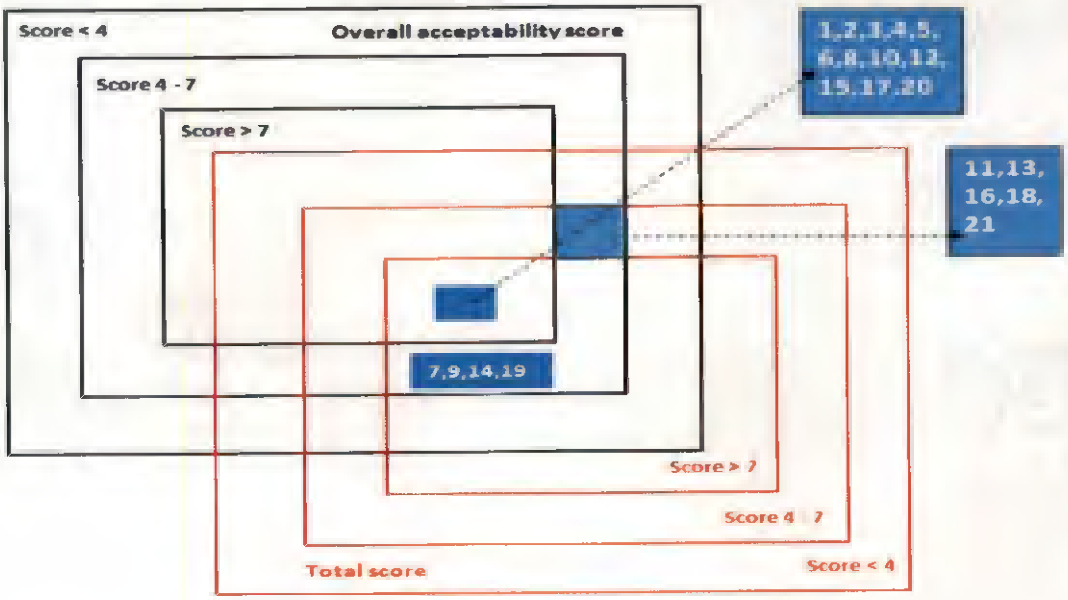


Fig: 4 Nested assortment of accessions based on sensory characters of cut mango pickle 1 month after storage

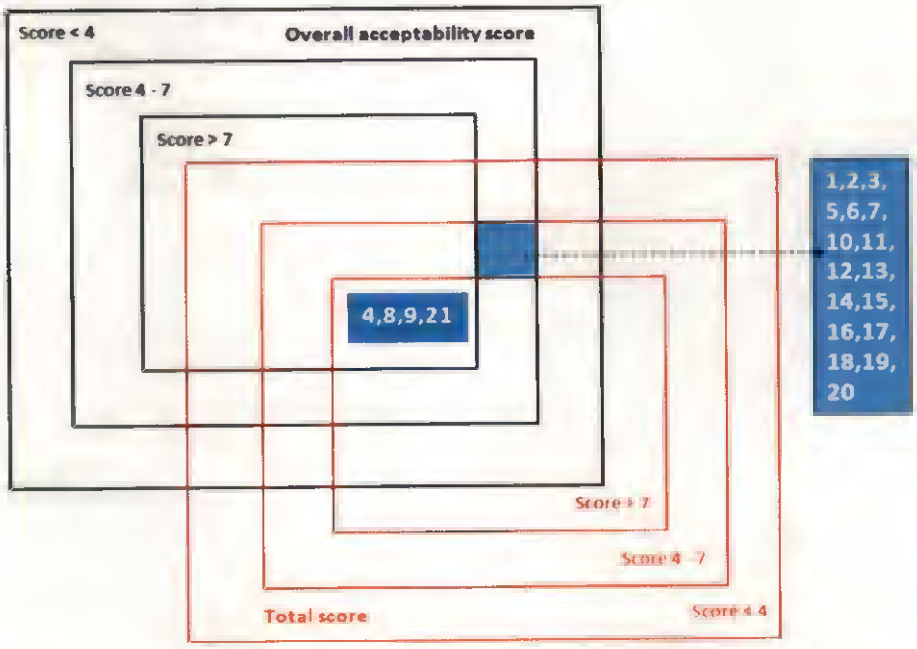


Fig: 5 Nested assortment of accessions based on sensory characters of cut mango pickle 2 months after storage

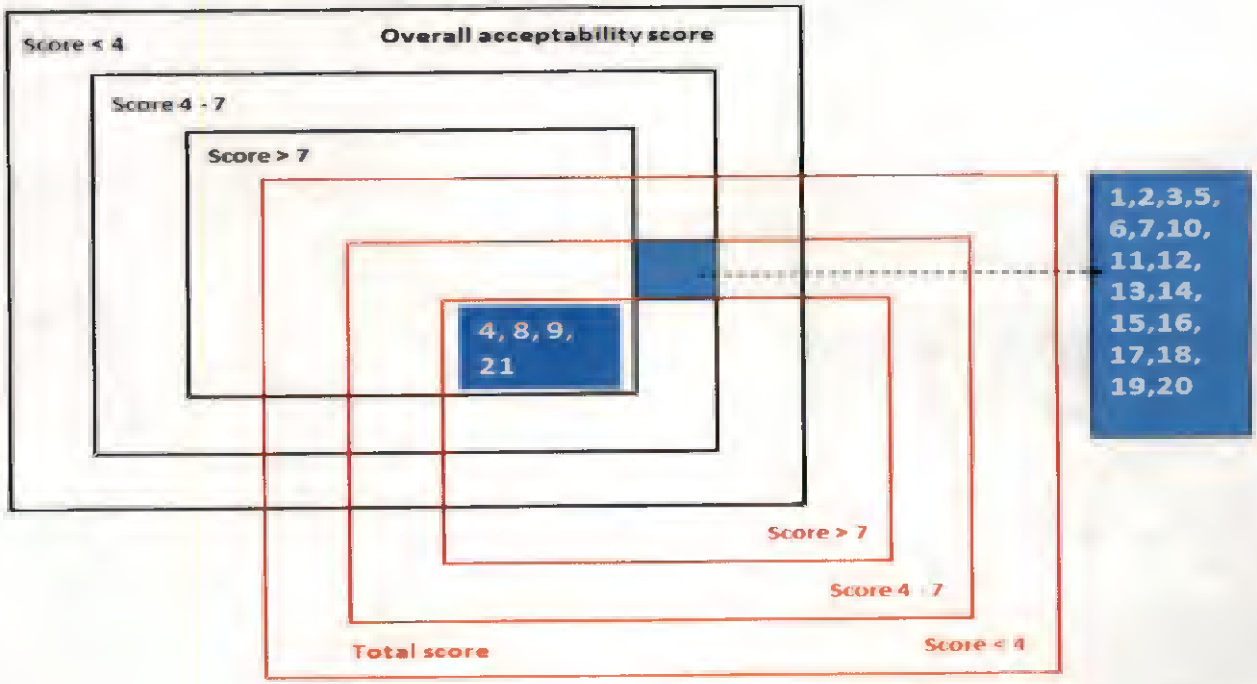


Fig: 6 Nested assortment of accessions based on sensory characters of cut mango pickle 3 months after storage

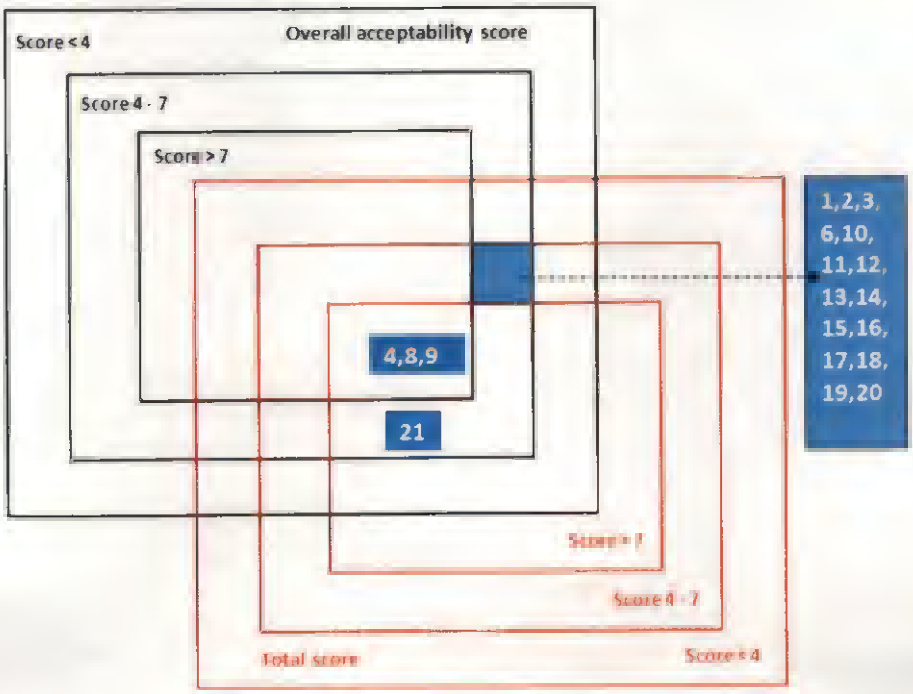


Fig: 7 Nested assortment of accessions based on sensory characters of RTS beverage 1 month after storage

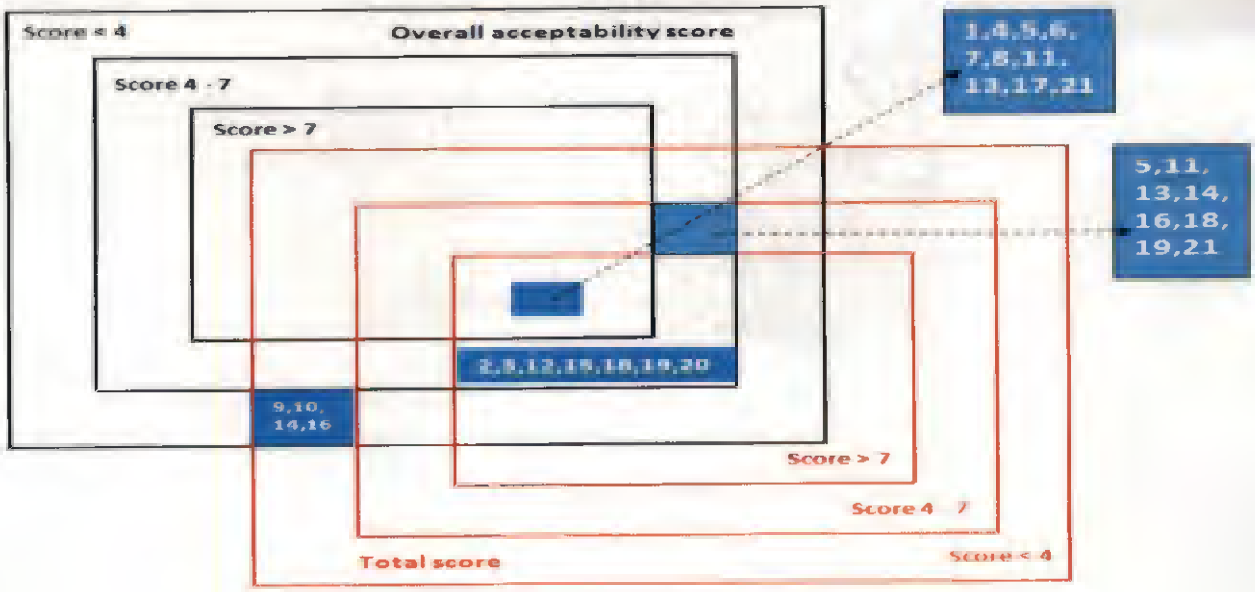


Fig: 8 Nested assortment of accessions based on sensory characters of RTS beverage 2 months after storage

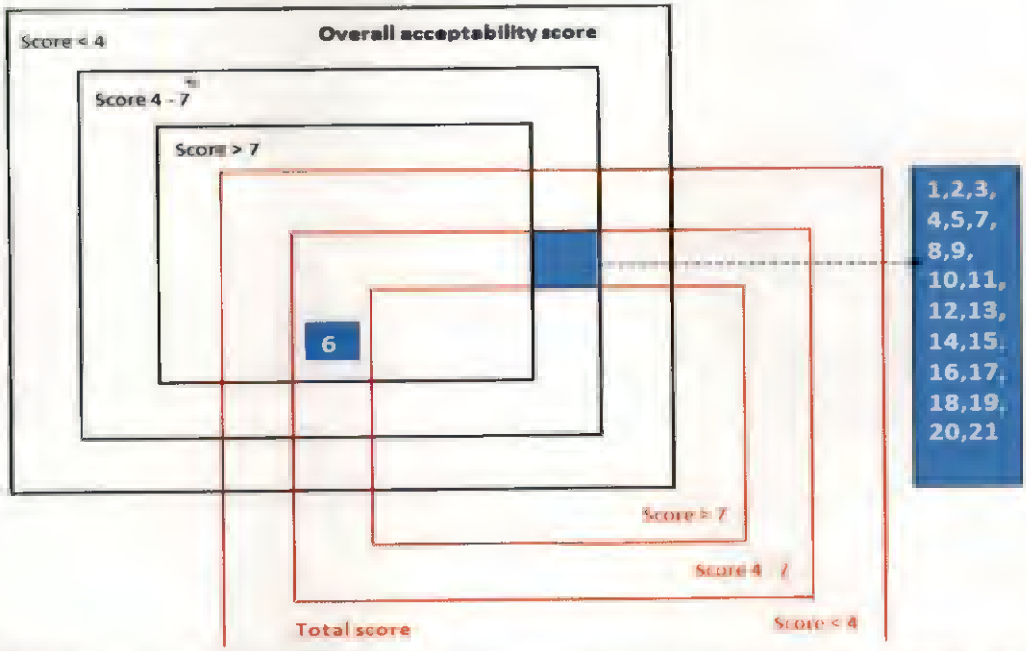
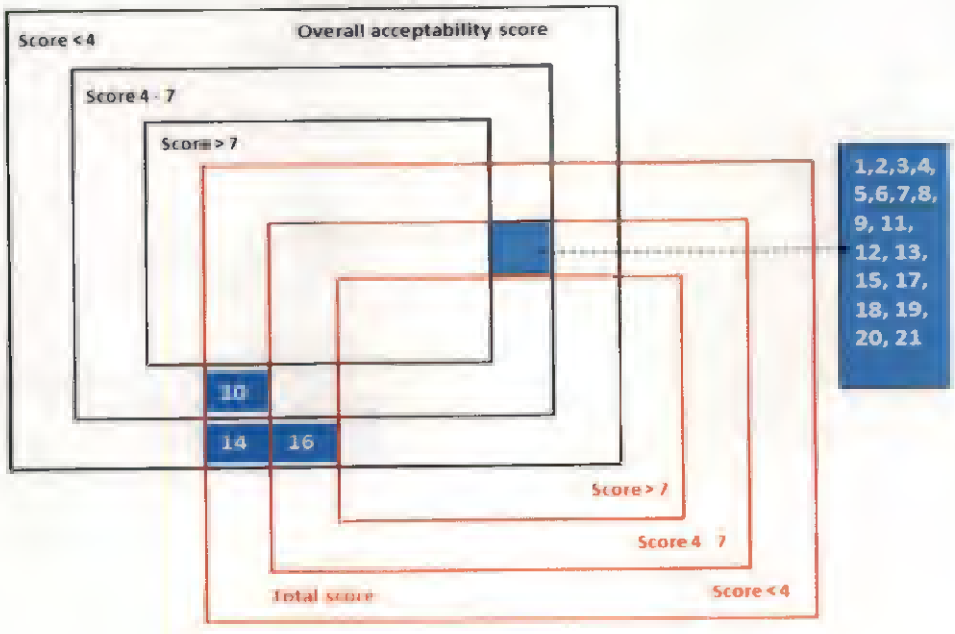


Fig: 9 Nested assortment of accessions based on sensory characters of RTS beverage 3 months after storage



5. DISCUSSION

Mango (*Mangifera indica* Linn.), popularly known as the "King of fruits", is considered to be one of the premium fruits in the world market because of its excellent flavour, taste, attractive fragrance, beautiful colour, delicious taste and health giving properties. It is a very common tropical fruit, mainly consumed in fresh form. In India, mango is cultivated in an area of 2,312 million ha and the production is around 15.03 million tonnes, contributing 40.48% of the total world production. Raw fruits of local varieties of mango are used for preparing various traditional products like raw slices in brine, amchoor, pickle, murabba, chutney *etc.* In Kerala many of the mango accessions available are juicy types which have limited use as a dessert variety but highly suitable for pickling. The present study entitled "Evaluation of pickling mangoes for processing quality" was done with an objective to evaluate the processing quality of pickling mangoes maintained at RARS, Pattambi and RARS, Pilicode for their popularization. Research programme was conducted under two experiments, the results of which are discussed below. In the experiment 1 quantitative and qualitative characters of fruits were analysed and in the second experiment, processing quality was assessed.

5.1 Quantitative characters of pickling mango

5.1.1 Fruit characters

Significant variation was noticed between accessions in quantitative and quality characters at tender, mature and ripe stage.

Length of tender fruits varied from 3.00 cm to 4.77cm, thickness from 1.87 cm to 4.00 cm, width from 2.23 cm to 4.37 cm, weight from 6.65 g to 52.33 g, volume from 7.00 ml to 51.67 ml, skin thickness from 1.18 mm to 2.67 mm and flesh thickness from 0.5 cm to 1.77 cm.

Length of mature fruit varied from 5.23 cm to 8.33cm, thickness from 3.97 cm to 6.20 cm, width from 4.10 cm to 7.90 cm, weight from 49.83 g to 197.47g,

volume from 46.67 ml to 200.00 ml, skin thickness from 1.10 mm to 2.73 mm, flesh thickness from 0.73 to 1.87 cm, stone weight from16.30 g to 37.83 g, stone volume from 13.33 ml to 37.00 ml and stone thickness from 1.67 cm to 2.30 cm .

Length of ripe fruit varied from 5.0 cm to 8.3 cm, thickness from 4.13 cm to 6.53 cm, width from 4.27 cm to 8.20 cm, weight from 58.77 g to 252.30 g, volume from 58.33 ml to 250.01 ml, skin thickness from 0.86 mm to 2.13mm, skin content from 14.93 per cent to 30.27 per cent, stone content from14.47 per cent to 33.93 per cent, pulp content from 36.87 per cent to 66.77 per cent, stone volume from 13.33 ml to 53.33ml, flesh thickness from 0.73 cm to 1.87 cm, stone weight from16.30 g to 37.83 g, stone volume from 13.33 ml to 37.00 ml and stone thickness from1.67 cm to 2.30 cm.

Srivastava *et al.* (1987) evaluated fifteen varieties of mango in Madhya Pradesh. Average weight per fruit varied from 121.8 to 385.7 g. Average peel content varied from 14.3 to 28.8 per cent, pulp content from 49.4 to 70.7 per cent and stone content from 13.3 to 29.9 per cent. Rabbani and Singh (1988) reported that average fruit weight of sucking varieties varied from 10.4 to 220.4 g . Jyothi (2000) based on the study conducted on pickling mangoes reported variation in size characters of tender and ripe fruits. Variation was more for weight and volume compared to length, breadth and thickness of fruits. In ripe fruits average pulp content, skin content and stone content was 47.49, 24.21 and 24.21 per cent respectively. Compared to dessert varieties pulp content was less in pickling types.

Anila and Radha (2003) studied the physico chemical characters of mango varieties of Kerala and reported that length of ripe fruit of mango ranged from 8.5 to 10.9 cm and breadth from 5.6 to 6.8 cm. Maximum length and breadth was reported in Ratna and minimum length in Muvandan and breadth in H-151. Weight of ripe fruits of mango ranged from 155.66 g to 398.01g and volume from 155ml to 395 ml. Maximum weight was noted for variety Ratna and minimum for H-151. Fruit

size of pickling types was smaller compared to the physical characters of dessert types, as reported by various authors.

Barhate *et al.* (2011) reported that fruit characters such as length, diameter, weight and volume differed in different varieties. Fruit length varied from 6.3 cm to 12.46 cm. Maximum fruit length was noted in Baneshan and minimum fruit length was recorded in Rumani. Fruit diameter ranged between 5.76 and 12.5cm. Maximum fruit diameter was observed in Mulgoa and minimum was noted in Kalepad. Fruit weight varied from 151.3 g to 707.7g. Maximum fruit weight was recorded in the cultivar 'Mulgoa'. Similarly maximum fruit volume was noted in Mulgoa (705.3ml) and the lowest fruit volume was recorded in Kalepad (149.6ml).

In the present study, increase in growth characters from tender to mature mango were higher for fruit weight and volume compared to increase in length, breadth and thickness. Increase was more in Accessions 15, 18, 1 and 6.

Fig: 10 shows the variation in fruit length at different stages of fruit growth such as tender, mature and ripe stages. Rate of increase in fruit length was higher from tender to mature stage and from mature to ripe stage it is less.

Fig: 11, 12 and 13 shows the variation in fruit thickness, fruit width and fruit weight between the different stages like tender, mature and ripe. The result was similar to the results expressed in Fig.10

Fig: 14 shows the variation in flesh thickness between the different stages.

In Fig: 15 pulp content, stone content and skin content of ripe mangoes are presented. Pulp content was higher than stone and skin content. Pulp contributed to half of the fruit weight in most of the accessions. Germain *et al.,* (2008) found out that indigenous mango varieties had the least pulp 58% (w/w), compared to four improved varieties grown in Nigeria, while Keitt variety had the highest pulp content of 62% (w/w).

Okoth *et al*, (2013) reported that the highest amount of pulp was obtained from Apple variety (75%) whereas the lowest was the Ngowe varieties (70%). The stone per cent

Fig. 10 Changes in fruit length with maturity

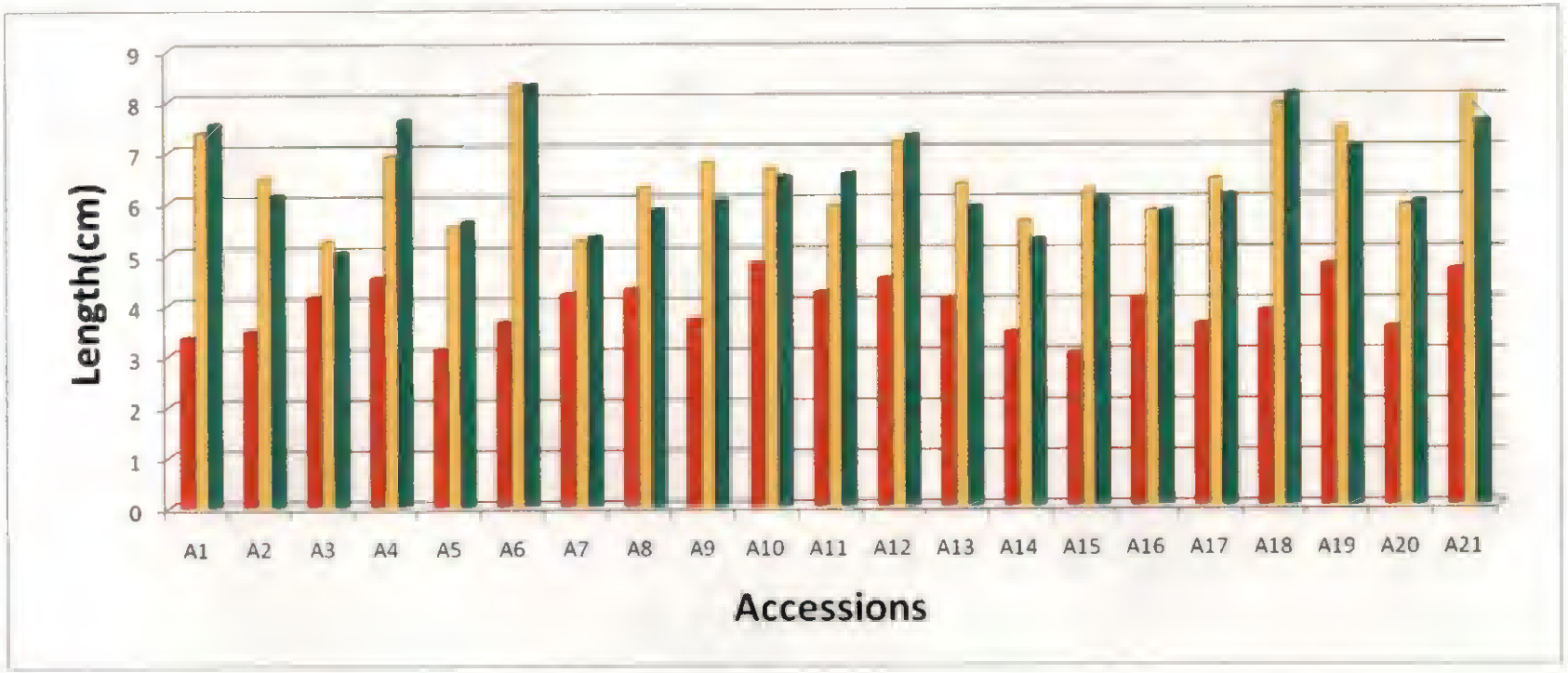


Fig. 11 Changes in fruit thickness with maturity

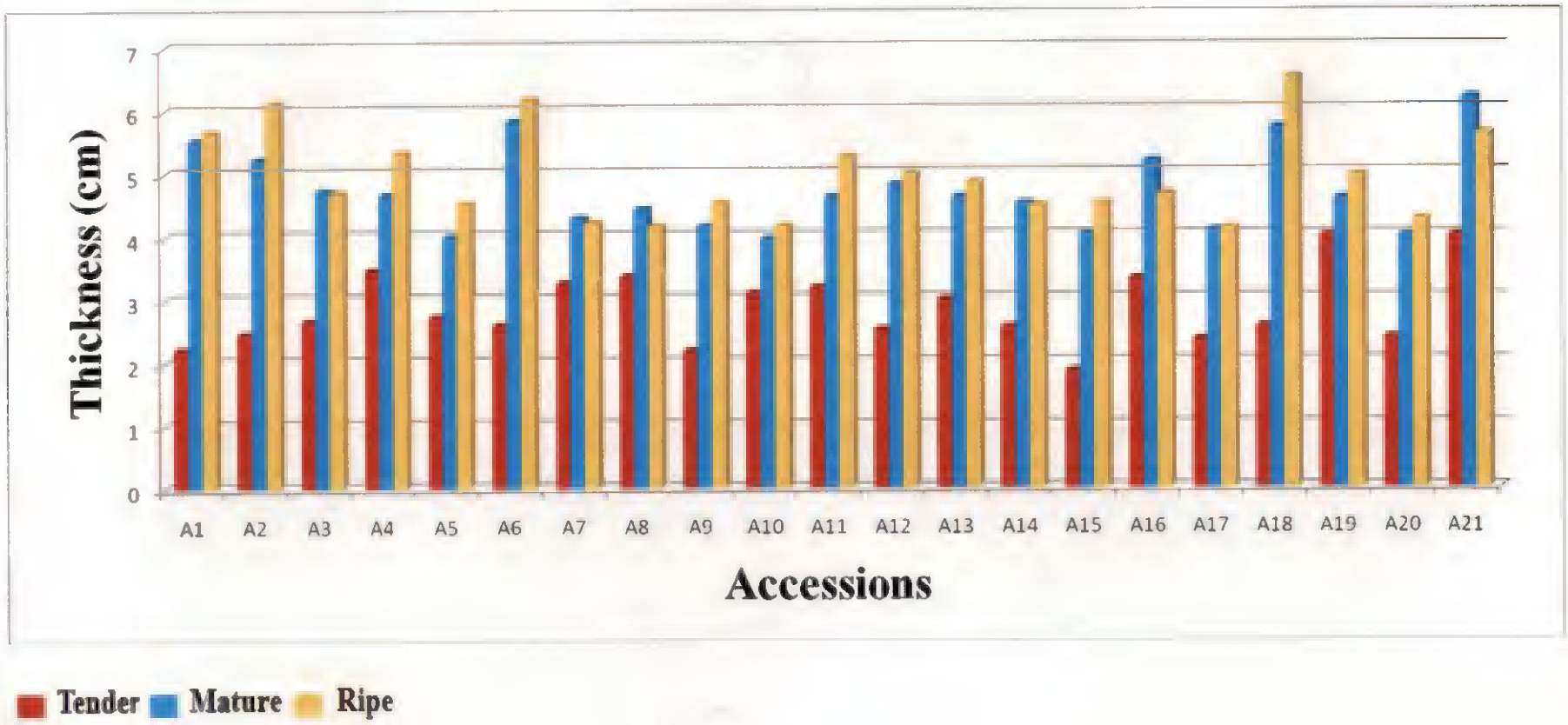


Fig. 12 Changes in fruit width with maturity

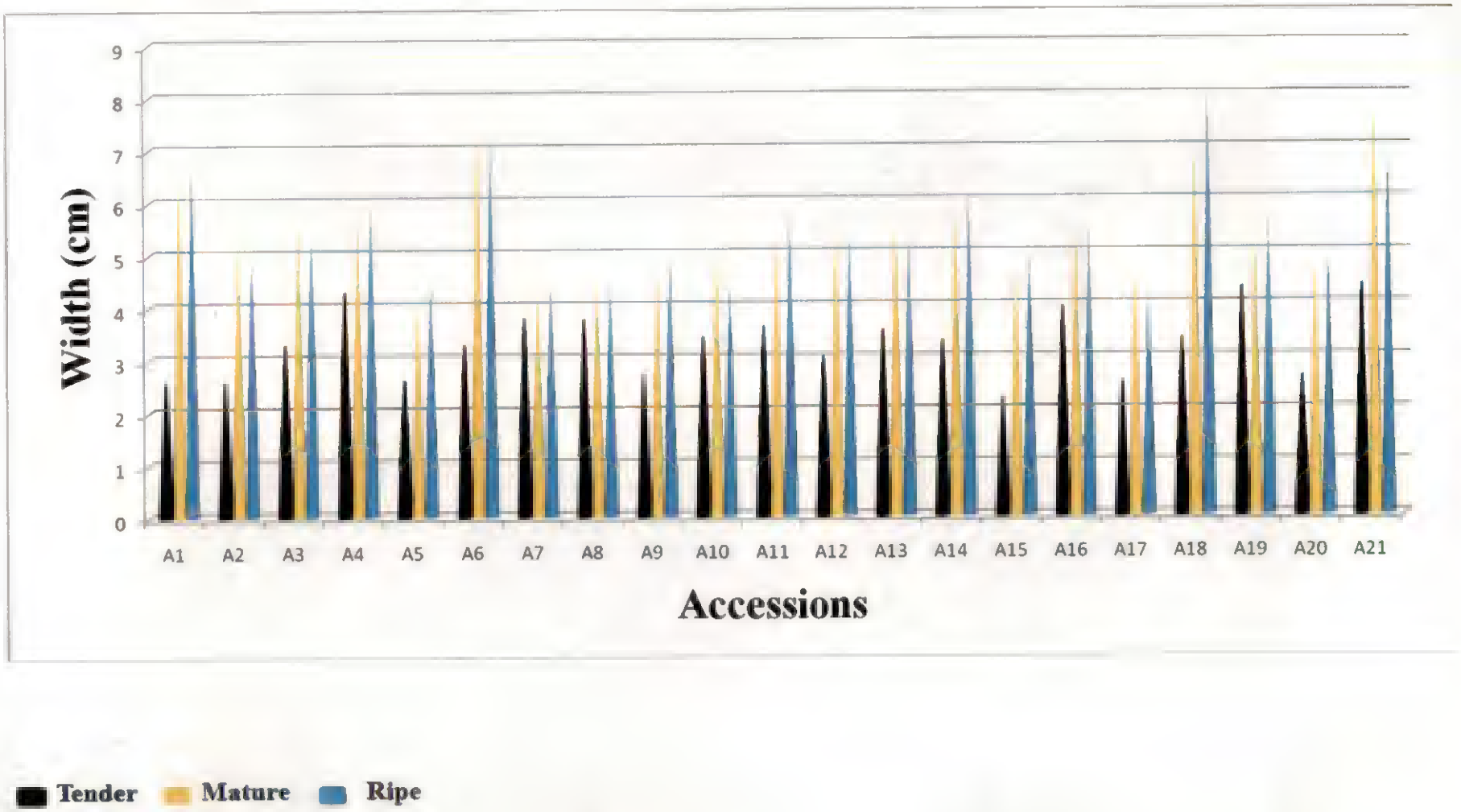


Fig. 13 Changes in fruit weight with maturity

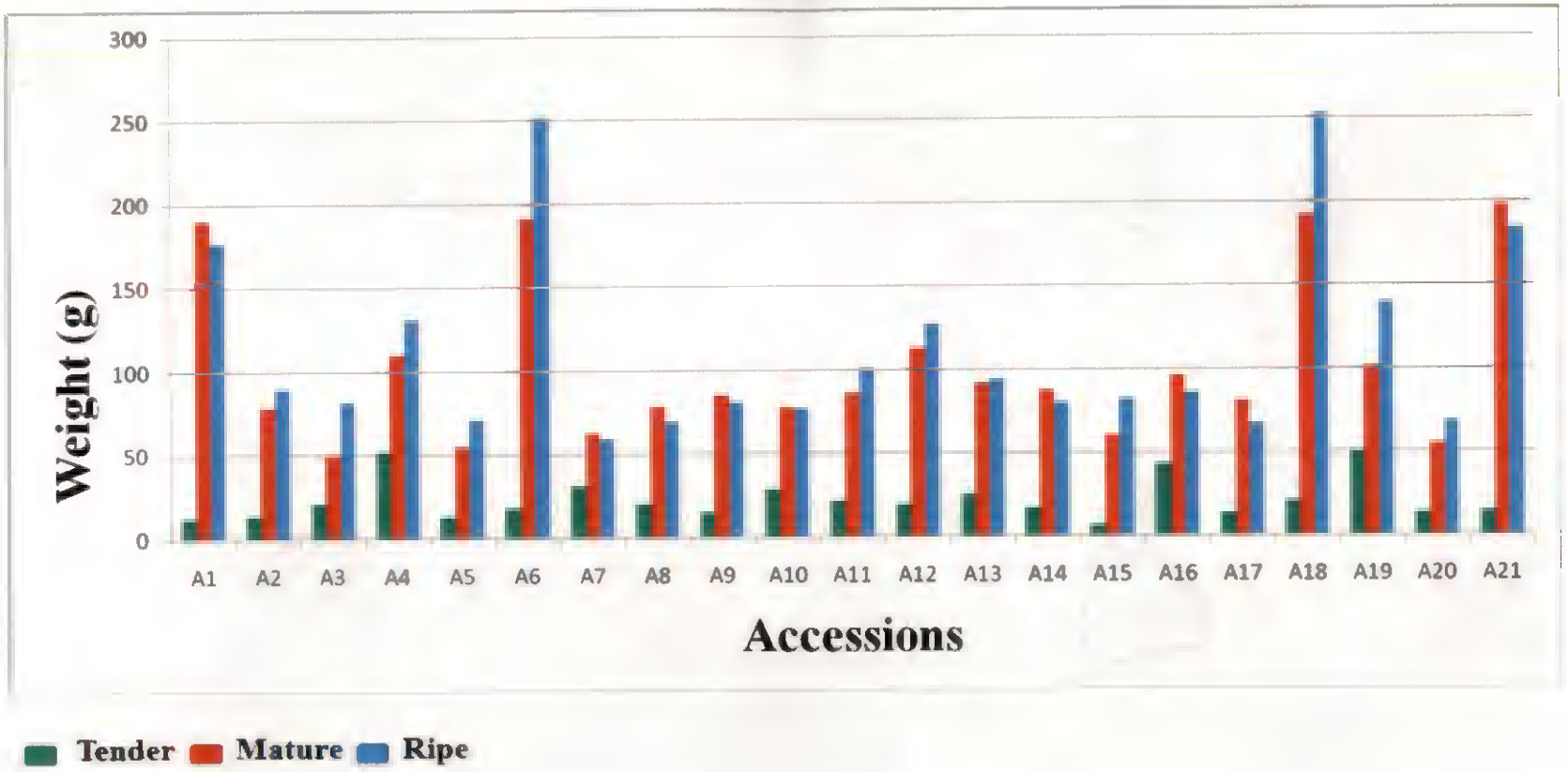


Fig. 14 Changes in flesh thickness with maturity

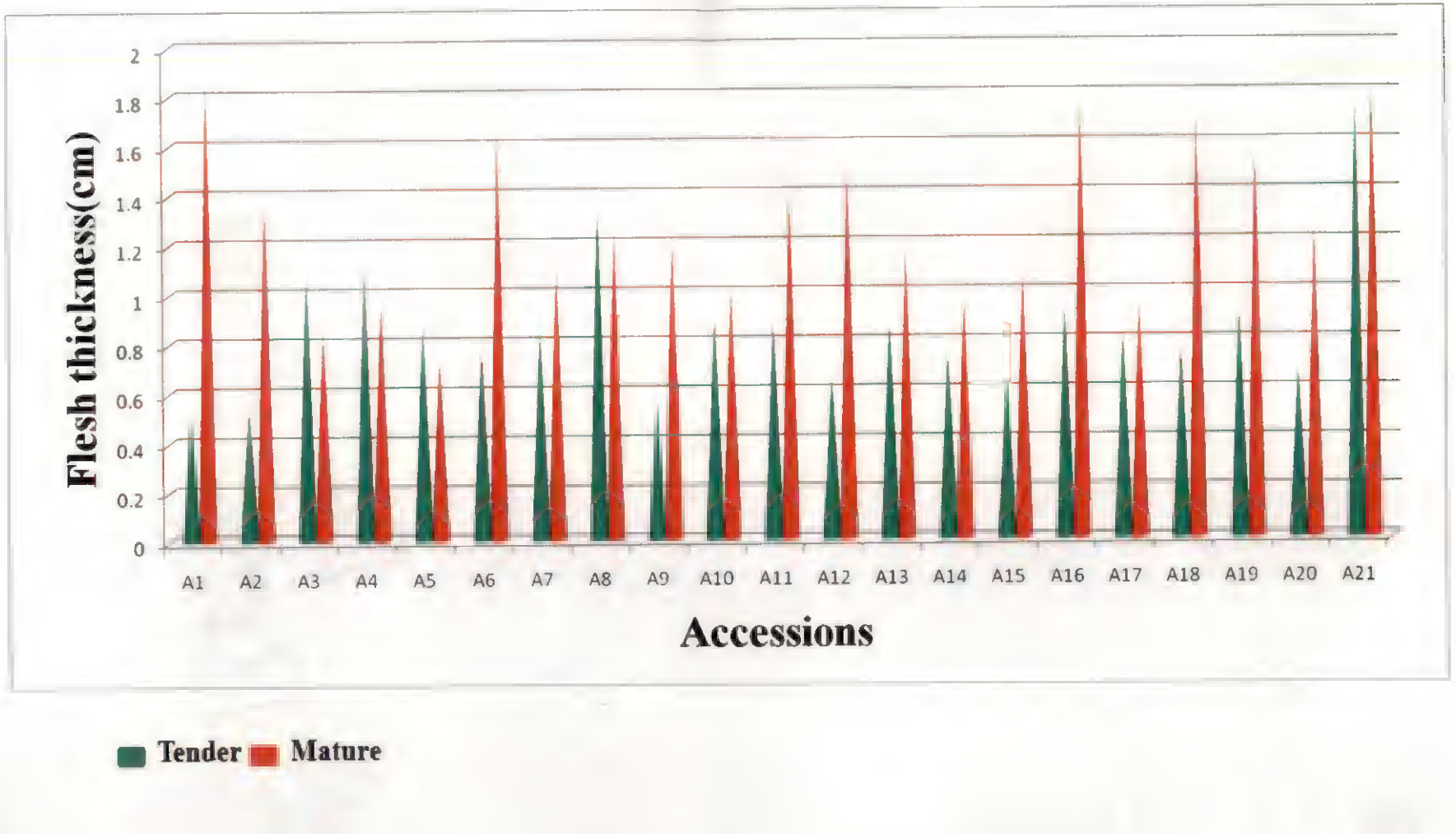
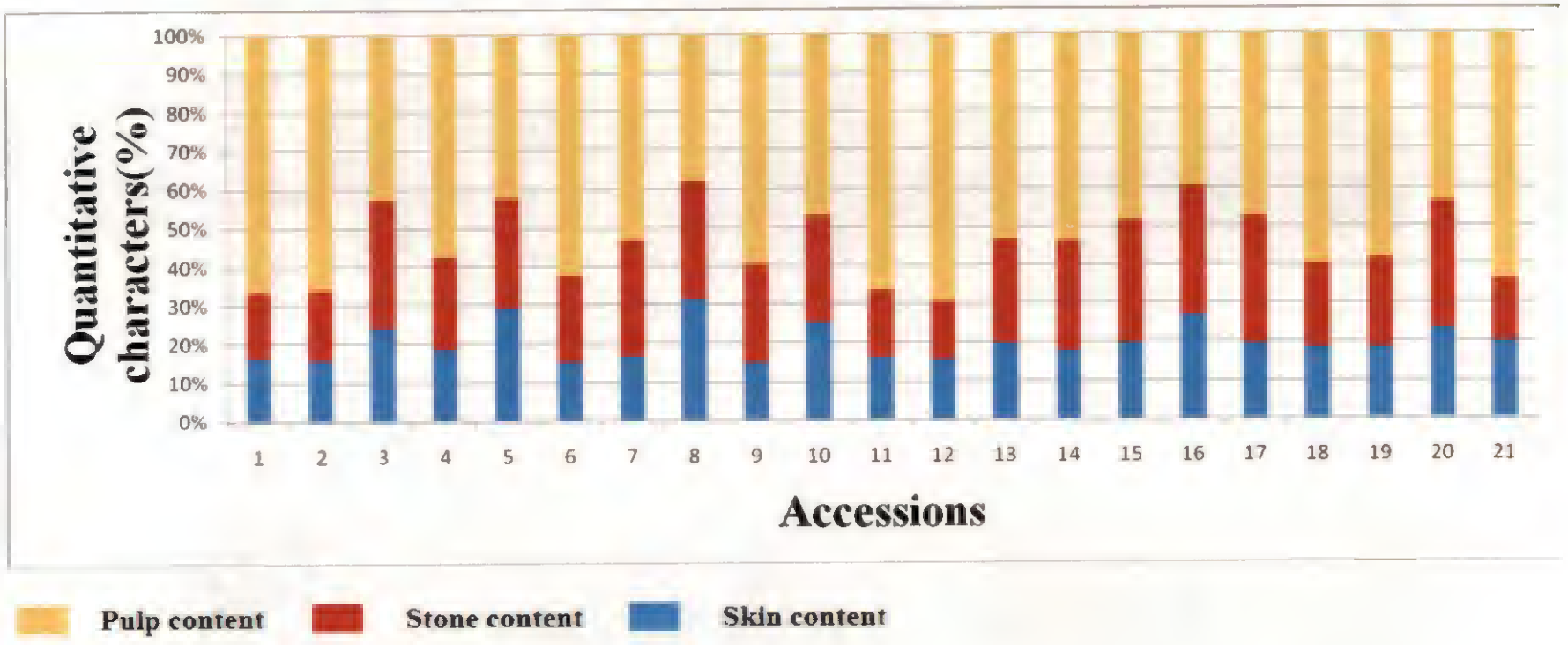


Fig. 15 Quantitative characters of ripe mango



by weight ranged from 9.20 to12.70%. Peel content ranged from 13.50% to 17.30% in Apple variety and Ngowe variety respectively. Pulp content is an important quality aspect to both fresh mango fruit consumers and processors. Mango varieties with 70% and above pulp yield are best for processing economically. The three mango varieties from Kitui and Machakos ecological zones qualified for both fresh and processing utilization.

In the present study pulp colour of ripe fruit was found to be different between the accessions. It varied from light greenish yellow to strong reddish orange.

Quantitative characters of fruits increased from tender to mature stage, but from mature to ripe stage there was no significant change.

5.2 Quality characters of pickling mango

Titrable acidity, polyphenol content and crude fibre was found to vary significantly between accessions in all the three stages. In tender mangoes, titrable acidity varied from 1.91 to 5.01 per cent, poly phenol content from 0.78 to 3.8 mg/g and crude fibre on dry weight basis from 0.40 to1.58 per cent.

During mature stage, titrable acidity varied from 2.74 to 6.71 per cent, poly phenol content from 0.39 to 2.45 mg/g and crude fibre on dry weight basis from 0.61 to 3.63 per cent.

In the ripe stage titrable acidity varied from 0.28 to 1.4 per cent, poly phenol content from 0.39 to 1.4 mg/g and crude fibre content from 0.7 to 3.71 per cent. Juice content varied from 20.52 to 61.63 per cent. TSS of ripe fruits varied from 12.5 to 22.2°brix.

Fig: 16 shows the titrable acidity of fruits in different stages of fruit development. Titrable acidity increased from tender to mature stage then decreased with ripening. Increase in acidity from tender to mature stage was higher in Acc.6, 21, 5 and 18 and lower in Acc.1, 9 19 and 20. The decrease in titrable acidity during ripening was also documented by Elahi and Khan (1973). According to Kapur, (1974)

Fig. 16 Change in titrable acidity with maturity

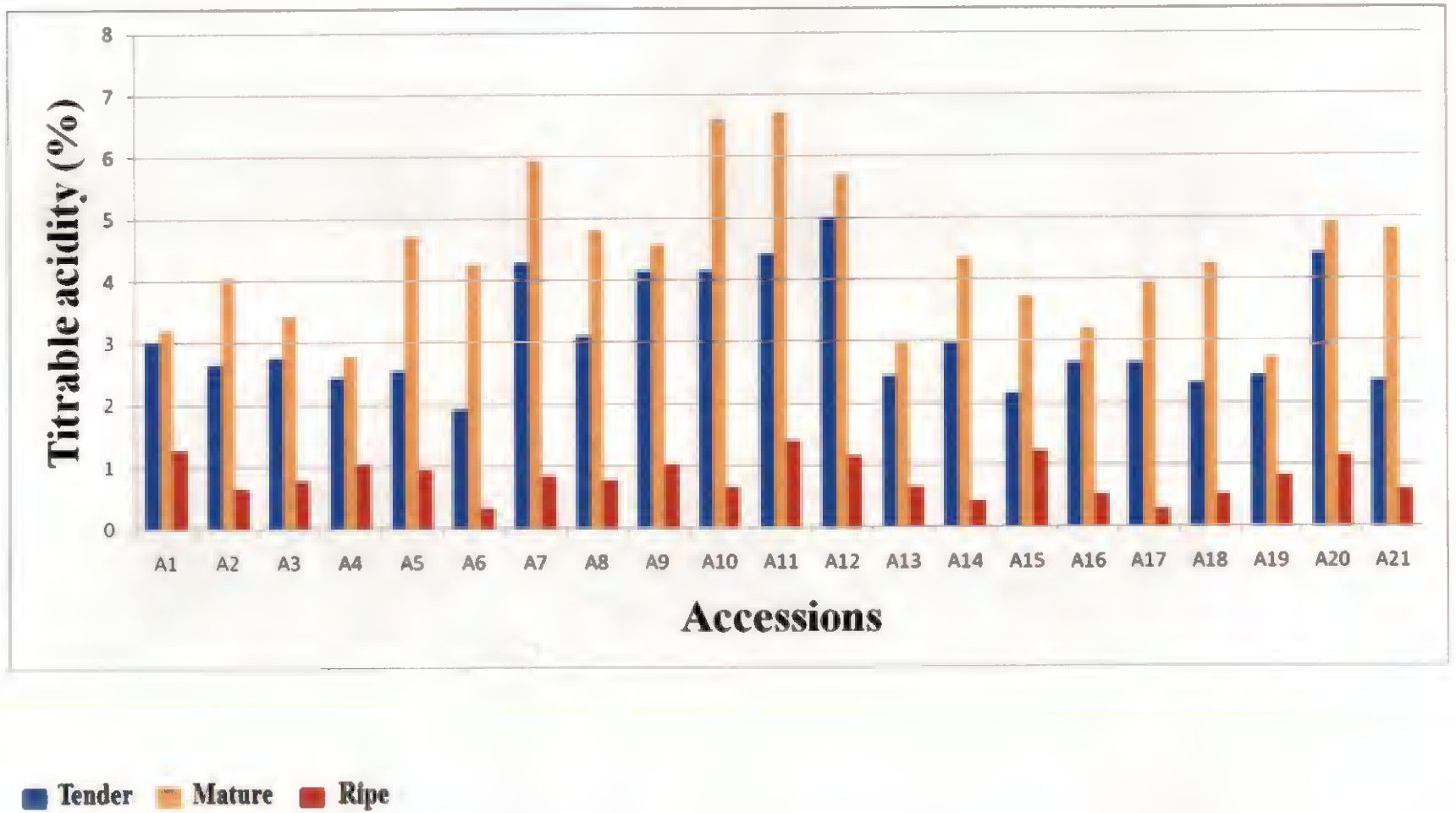


Fig. 17 Change in polyphenol with maturity

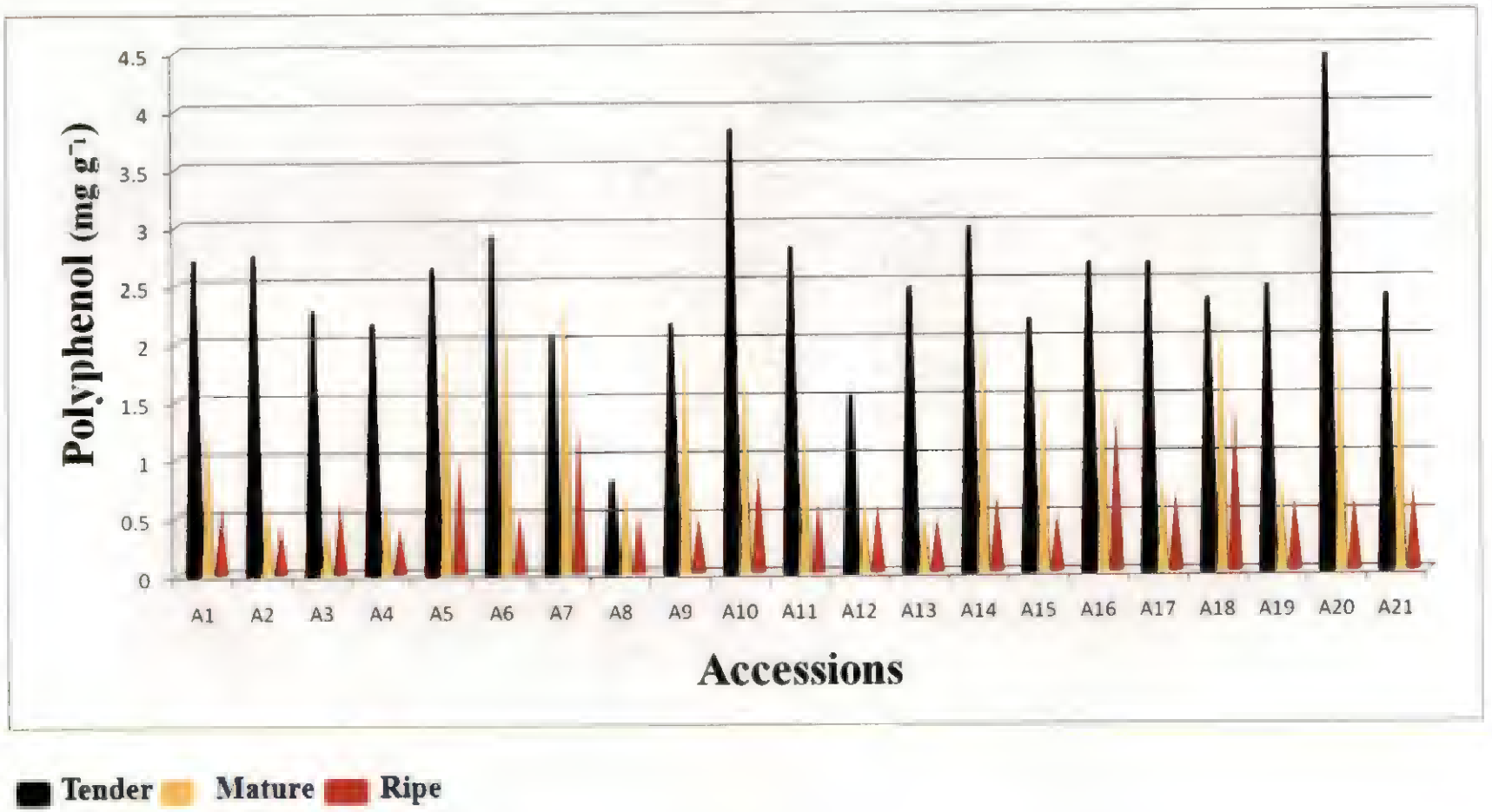


Fig. 18 Change in crude fibre with maturity

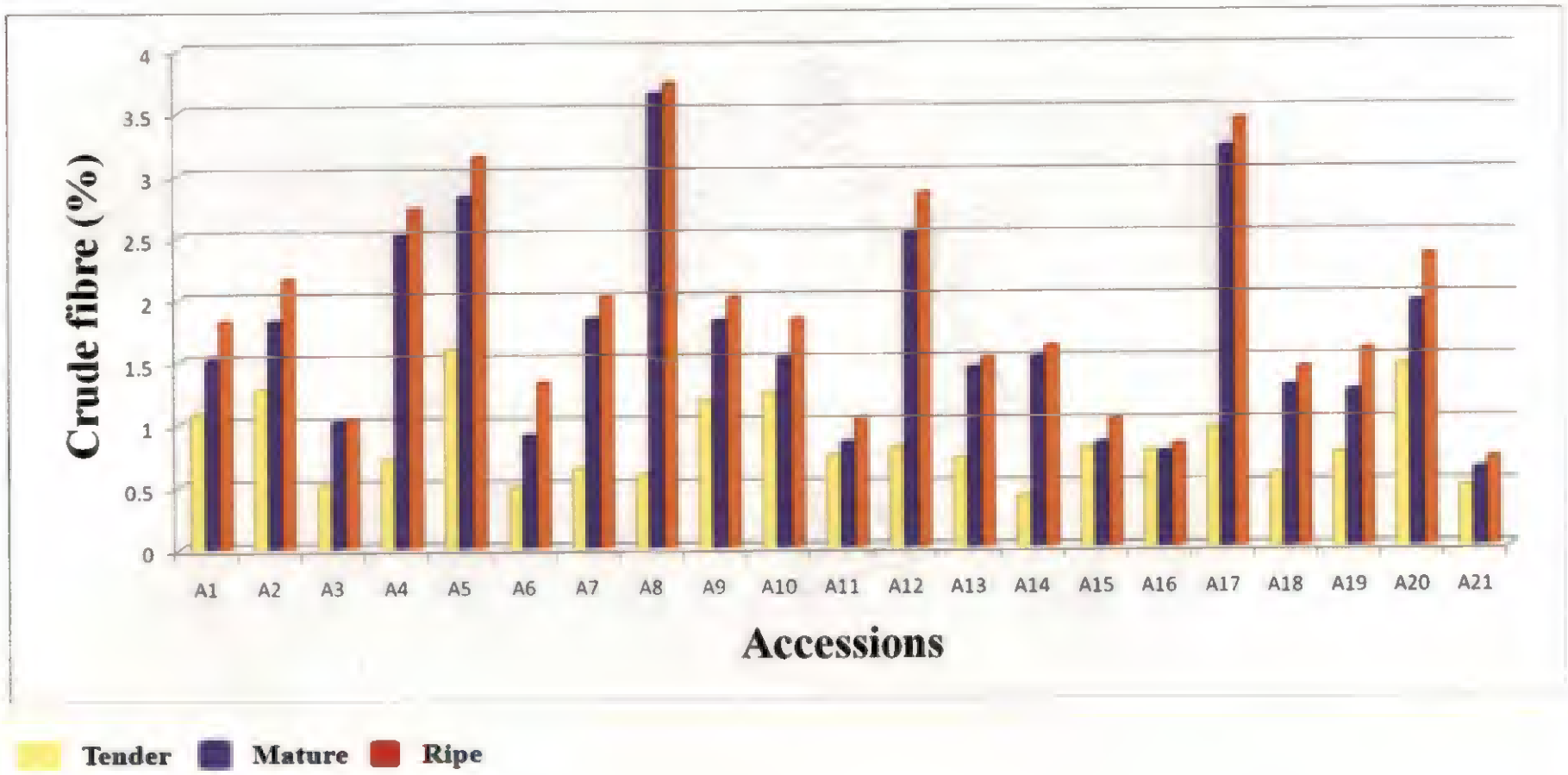


Fig. 19 Juice content of ripe fruits

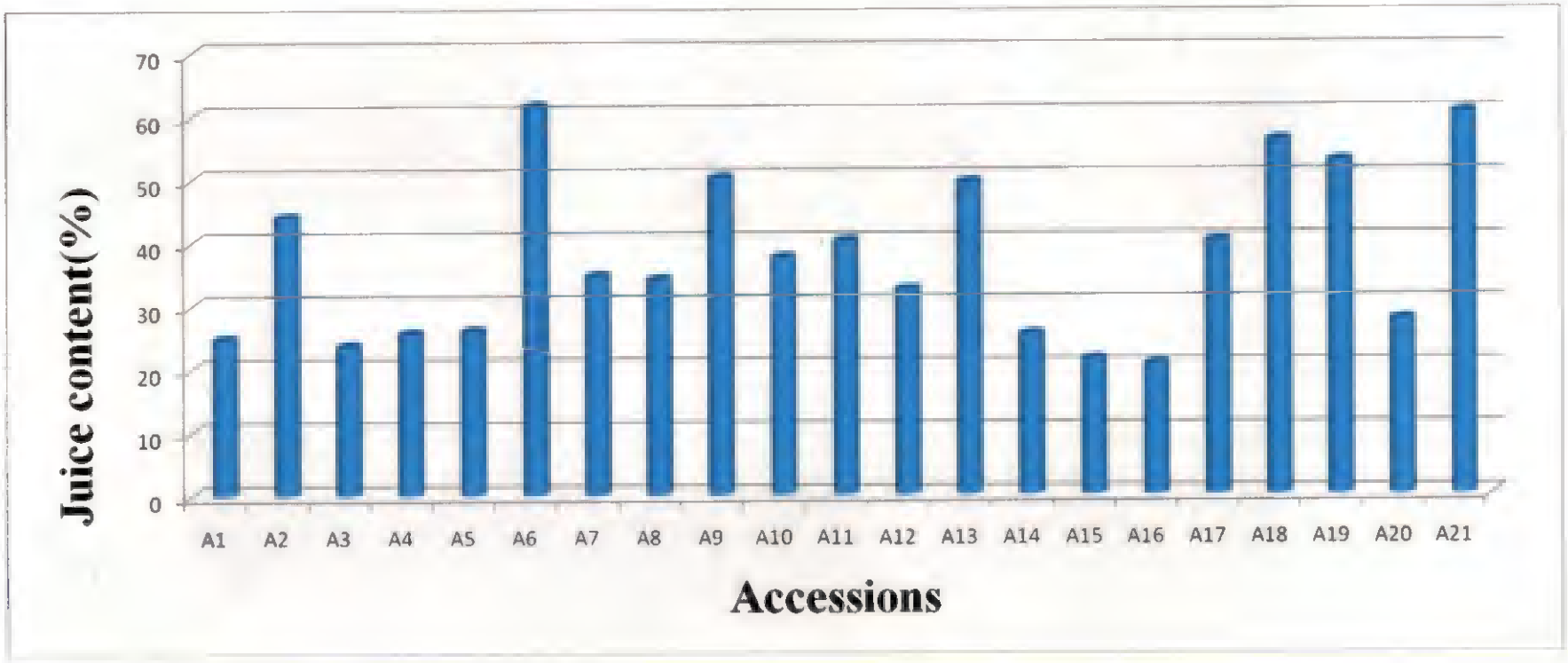
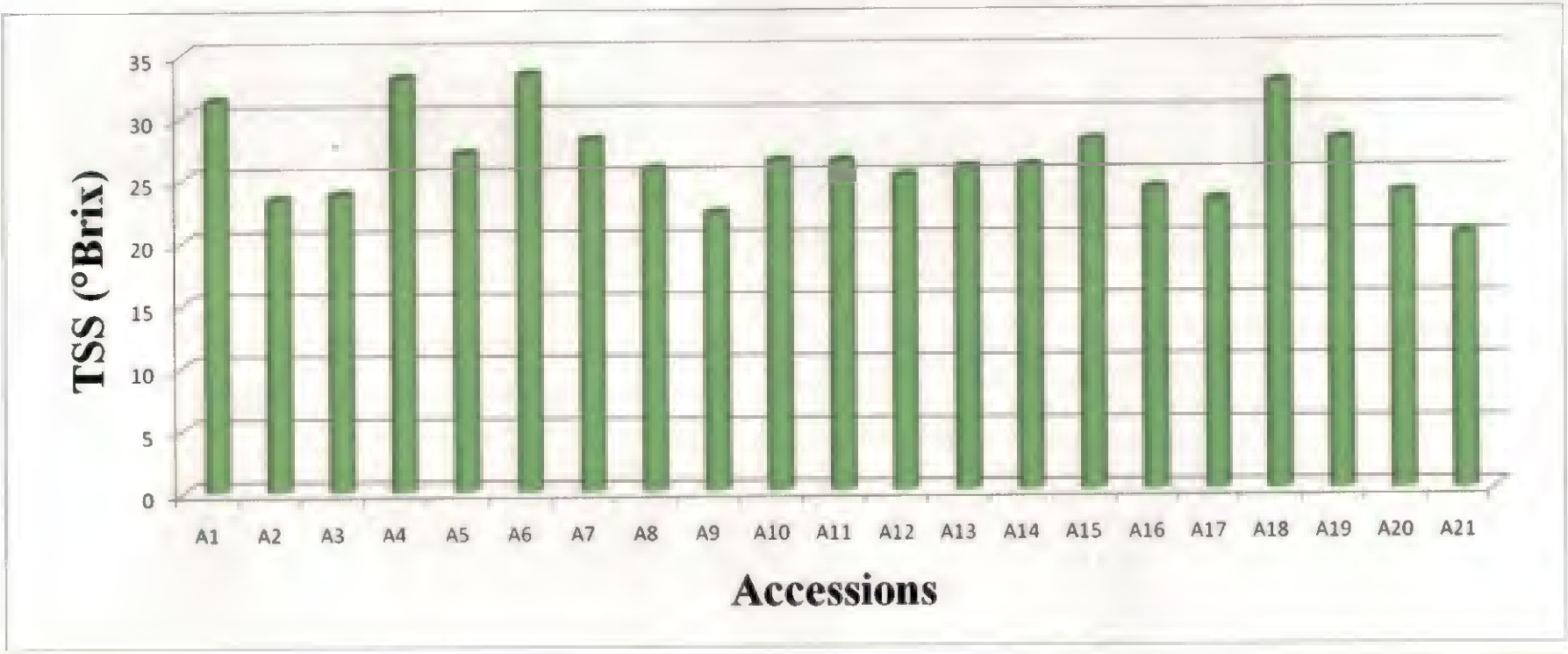


Fig. 20 TSS of ripe fruits



during development of mango acidity reduced and Pandey *et. al.* (1974) reported that during maturation acidity increased. Elahi and Khan (1983) reported that there was a decrease in titrable acidity during ripening of mangoes. The decrease was from 2.12 per cent to 0.39 per cent in 'Anwar' mango variety after eight days of storage. Agbo and Inyang (1995) observed a decrease in titrable acidity from 1.47 per cent to 0.18 per cent in Julie mangoes. Results obtained in the present study are similar to the reports cited. Chaudhari *et al.,(*1997) recorded 0.14 to 0.59% titrable acidity in mango cultivars. In the case of developing fruits acidity increased at early growth phase, attained a peak and then decreased gradually until harvest. Jyothi (2000) reported that acidity of tender mango showed high variation, acidity of young fruits was high and it decreased in ripe fruits. Acidity varied from 1.1 per cent to 3.5 per cent in tender stage and from 0.3 per cent to 3.5 per cent in ripe stage.

Shafique *et al*, (2006) reported that the acidity of all the mangoes decreased with maturity. It was due to the breakdown of starch into sugars thereby lowering down the percentage of acidity of the fruits. Gradual decrease in acid content may be due to conversion of acids into sugars by some physiological and biochemical changes in the fruits. Generally, acidity of the fruit decreases during maturity and ripening stage of the fruit (Padda *et . al.* 2011)

Rate of change in polyphenol content was different from that observed in acidity (Fig: 17). Polyphenol content was higher at tender stage; with the development of fruit from mature to ripe stage polyphenol content decreased. Lakshminarayana *et. al.* (1970) noticed high phenol content in young fruits which were astringent. With the development of fruits, phenolic content decreased (Joshi and Shiralkar, 1977). During maturity and ripening total content of poly phenols might change (Majumder and Sharma, 1990). Average polyphenol content in tender mango was 1.75mg/g. It varied from 0.5 to 3.4 mg/g fruit (Jyothi , 2000)

Fig: 18 shows the changes in crude fibre content which increased from tender to mature stage. From mature to ripe stage there was only a slight increase in crude fibre

content. In pickling type mangoes average crude fibre content was highest ranging from 0.58 to 2.92 per cent followed by table type mangoes which varied from 0.4 to 2.4 per cent. Average titrable acidity and crude fibre were high in pickling types. (Simi and Rajmohan, 2013).

In the present study, acidity and crude fibre increased from tender to mature stage but polyphenol content decreased. Acidity and polyphenol content decreased from mature to ripe stage but crude fibre content increased.

Mollah and Siddique (1973) recorded 78.11% to 87.12% moisture content in 12 mango varieties and Samad (1975) found 78.96% to 87.55% moisture content in 10 mango varieties. Uddin *et al.*, (2006) reported that moisture content varied from 74.58% to 86.36%. Othman and Mbogo (2009) reported that *Dodo* and *Viringe* mangoes had high moisture content that ranged from 56.3 to 86.1%.

Fig.19 represents the variations in juice content among accessions. Highest juice content was noted in Acc.6 (61.63%) and lowest in Acc. 15 (21.40%).

Highest reducing sugar was noted in Acc.6 (3.51%) and lowest in Acc.14 (1.53%). Mamiro *et. al.* (2007) recorded a lower per cent of reducing sugars of 3.59% for the *Dodo* mango of Morogoro. *Viringe* mango had slightly higher reducing sugars than *Dodo* mangoes.

Bhuyan and Guha, (1995) found 16.22 to 24.14% TSS in mango germplasm under the climatic conditions of Rajshahi. Highest TSS was noted in Acc. 21(22.2° brix) and lowest in Acc.18 (13.24° brix) (Fig.20). Similar results were reported by Jyothi (2000). TSS of pickling varieties varied from 5° brix to 22° brix. Anila and Radha (2003) from their study of mango varieties of Kerala reported that TSS varied from 10 ° brix to 24° brix; acidity from 0.21 to 0.46 percent and reducing sugar from 2.23 to 2.97 per cent. Mamiro *et a l* . (2007) also recorded a high percent total soluble solid content of 18.9% for the *Dodo* mango of Morogoro during room temperature

ripening. Othman and Mbogo, (2009) reported total soluble solids content in the mangoes was within 14.5% and 30.0%. Both *Dodo* and *Viringe* varieties showed high percentage of total soluble solids especially during ripening. *Viringe* mangoes had higher total sugars than *Dodo* mangoes.

5.3 Grouping of accessions based on quantitative and quality characters

Grouping of accessions was attempted based on D^2 analysis. Grouping was done for tender, mature and ripe mangoes. Maximum numbers of accessions were in the medium category with respect to all the quantitative and quality characters studied.

5.4 Organoleptic evaluation

Sensory evaluation was done based on nine point hedonic scale by a panel of ten members and the average score was worked out. Evaluation was done for three months at monthly intervals for all the three products.

One month after storage, maximum score for tender mango pickle was awarded to Acc. 15, Acc.17, Acc. 10, Acc. 2 and Acc. 6 with a total score of 65.0, 63.0, 62.3, 61.9, 60.9 respectively. Accessions 15, Acc.17, Acc. 2, Acc. 6 and Acc. 3 had higher total scores during second and third months of evaluation. Three months after storage total score of the accessions 2, 6, 10, 15 and 17 were 64.0, 63.0, 59.6, 67.0 and 65.0 respectively. There was increase in total score along with the storage time. Scores for the contributing characters *viz:* appearance, colour, flavour, odour, texture, taste, after taste, overall acceptability etc were also high for these accessions. It could be concluded from the study that Acc. 15, Acc.17, Acc. 2, Acc. 6 and Acc. 3 are most suitable for tender mango pickling. Acc. 21, 16, 13, 11 and 18 had lower scores for tender mango pickling.

Maximum storage life was reported in pickle varieties like Puliyan and Chandrakaran (AICFIP, 1979). Ismail *et al.* (1986) reported that in mango, quality of pickle was influenced by proper stage of maturity of the fruit. According to

Plate.9 Accessions most suitable for tender mango pickling

Acc. 3

Acc.17

Acc. 2

Acc.6

Acc.15

Plate.10 Accessions most suitable for cut mango pickling

Acc. 7

Acc. 4

Acc. 8

Acc. 9

Plate.11 Accessions most suitable for RTS beverages

Acc. 17 Acc. 2

Acc. 1 Acc. 6

Radha (1997) the fruits of Chandrakaran were juicy and more suitable for tender mango pickling. In the present study also variety Chandrakaran (Acc.17) was found highly suitable for tender mango pickling. According to Gupta *et al.* (1998), taste, flavour, and texture of oil less pickle enhanced, in the storage period up to 9 months. Best stage for pickle making in unripe green mango fruits is just after the endocarp starts hardening (80% maturity). This stage is called 'Avakkai, where there was not much reduction in acid content and soluble solids. At this stage maximum starch content was observed, which may be helpful in retention of texture. Pickling quality of fruits was evaluated based on the appearance, colour, aroma, taste, texture and overall acceptability of pickled fruit. Between the components of pickling quality significant positive correlation was noted. From a study conducted on characterisation of pickling mangoes of Thrissur and Palakkad districts of Kerala, 75 good types for pickling mango were identified for tender mango pickling (Jyothi, 2000). Quality characters and size of the fruit were found to influence the pickling characters. Overall flavour is explained as a result of perception by the taste buds in the mouth and the aromatic compounds detected by the olfactory organ in the nose (Rathore *et al.,* 2007). Organoleptic evaluation showed that pickling mangoes like Karpooram manga, Perakka manga, Nedungolan, Neenda Karpooram, Vellari Type-2, Velutha Muvandan, Muthalamookan, Inamanga, Kotookonam Varikka and Ambalathara Local ranked top in overall acceptability (Simi and Rajmohan, 2013). Fig:21 shows mean sensory scores for tender mango pickle three month after storage, Acc.15 had highest sensory score for appearance, colour, texture, overall acceptability and Acc. 17 had highest score for taste, odour and after taste.

Cut mango pickles prepared from these accessions were subjected to organoleptic evaluation for three months. Acc.21, Acc.8, Acc.9, Acc.4 and Acc.7 had total score of 58.8, 58.7, 58.3. 58.00 and 55.7 respectively one month after storage. Two months after storage, Acc. 21, Acc.8, Acc. 9, Acc.4 and Acc.11 had higher

total score (58.1, 58.00, 57.7, 57.6 and 55.2 respectively). Three months after storage Acc. 8, Acc.4, Acc.9, Acc. 21 and Acc. 7 had higher total score of 56.7, 56.5, 56.4, 56.2 and 54.5 respectively. Study revealed that Acc.8, Acc. 4, Acc. 9, Acc. 21 and Acc.7 were highly suitable for cut mango pickling and Acc.14, 16, 18, 19 and 20 were least suitable.

Fig:22 shows mean sensory scores for cut mango pickle three months after storage, Acc.4 had highest sensory score for appearance, colour and overall acceptability . Acc. 7 had the highest score for taste. Acc. 1 had highest sensory score for flavour, Acc.8 having highest score for odour. Acc. 21 highest sensory score for after taste.

Compared to tender mango pickle, there was a gradual reduction in the total score of cut mango pickle along with the storage time. Similar results were reported by Sheth *et. al.(* 2004). The scores for the sensory attributes decreased for all the pickles upon storage for six months, a reduction of 15%, 14.2%, 9.9% ,13.3%, and 13.8% was observed in the mean scores of color ,appearance, texture ,taste and overall acceptability respectively.

In case of RTS beverage one month after storage, Acc. 17, Acc. 8, Acc.1 ,Acc. 21 and Acc.13 had higher total scores of 62.7, 58.9, 58.2, 57.2 and 56.9 respectively. Two months after storage, Acc. 1, Acc. 6, Acc. 17, Acc. 13 and Acc. 21 had highest total scores of 53.5, 52.6, 51.1, 50.9 and 50.4 respectively. Three months after storage Acc. 21, Acc.1, Acc. 2 , Acc. 17 and Acc. 6 had higher total scores of 47.2, 47.0, 47.0, 46.9 and 46.0 respectively. Results showed that Acc. 21, Acc. 1, Acc. 2, Acc. 17 and Acc. 6 are more suitable for RTS beverage. Sensory score for RTS beverage was found to be drastically reduced along with the storage time. However reports by Chitra and Manimegalai (2002) suggested that banana RTS beverage could be stored safely up to 300 days under refrigeration temperature with minimum changes in its quality. The values for

colour of all prepared samples decreased during storage at ambient temperature. During storage at room temperature the values for flavour decreased for mango pulp. Hayat *et al.* (2005) reported that flavour or taste of Alphonso decreased with storage period when stored at relative humidity of 70-75 % and temperature of 32-36°C. The values for odour also decreased during storage at room temperature. Durrani *et al*, (2011) reported that colour of food was the main criterian for judging the eatable quality of food and the same criterian was applied for the colour of mango pulp .

Fig:23 shows mean sensory scores for RTS beverage three months after storage; Acc.6 having highest sensory score for appearance and colour. Colour of pulp of the above accessions was strong orange. Acc. 2 had highest score for flavour, taste, odour, aftertaste and overall acceptability. Acc.17 had highest sensory score for consistency. Acc.9 10, 14, 15, 16 and 20 were least suitable for RTS beverage preparation.

5.5 Microbial evaluation

Tender and mature mango pickles:

Microbial population of both tender and cut mango pickles of twenty one accessions was evaluated at monthly intervals for three months after storage. There was a gradual increase in the microbial count along with storage. Highest population of microbes was recorded in cut mango pickles compared to tender mango pickle. Cut mango pickle in the present study was preserved with natural preservatives alone which may account for the high population of microbes observed three months after storage. Yeast population was found to be absent and population of bacteria and fungi was found to be negligible in tender mango pickles. This may be due to low moisture content in tender mango.

Mango pickles in India were studied for their safety and shelf quality. Several factors such as processing technique, the environment in which it is processed, *etc.*

Fig.13 Mean sensory scores for tender mango pickle-Three Month After Storage (3MAS)

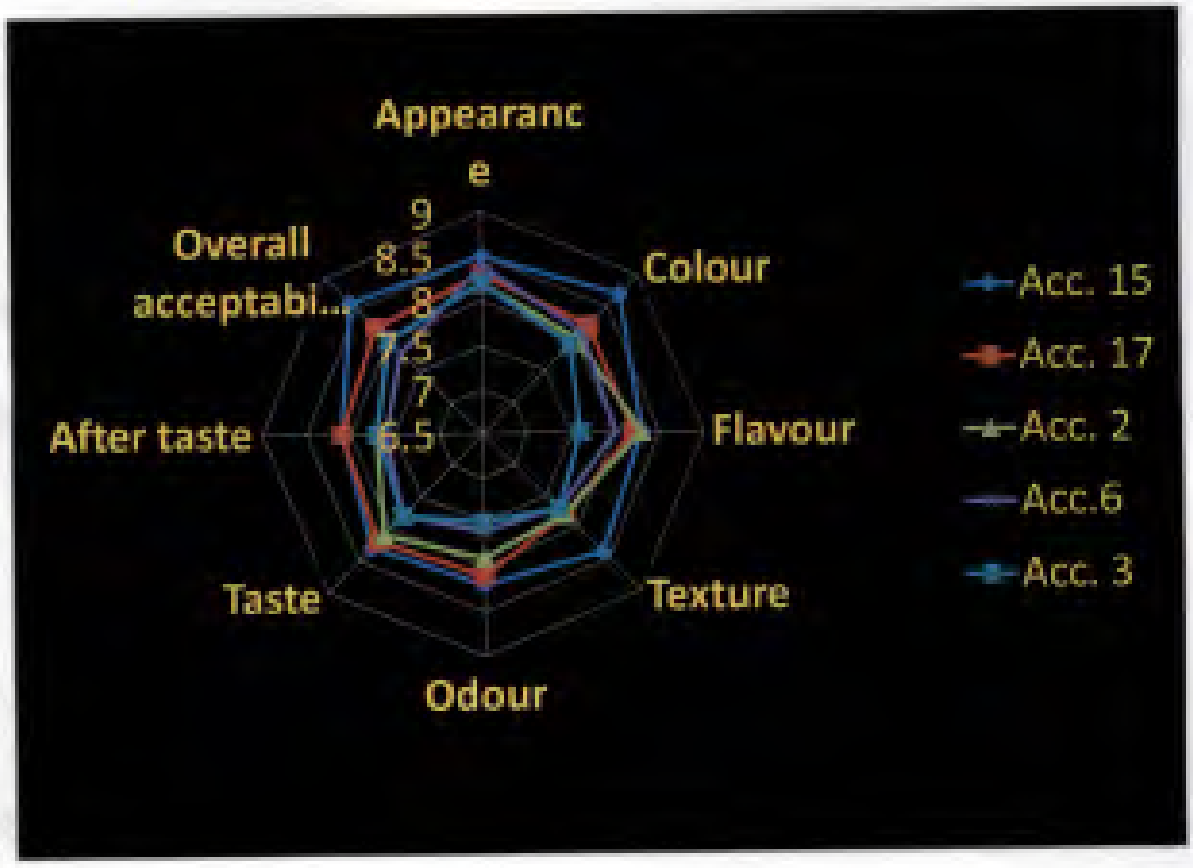


Fig.14 Mean sensory scores for cut mango pickle- Three Month After Storage - 3MAS

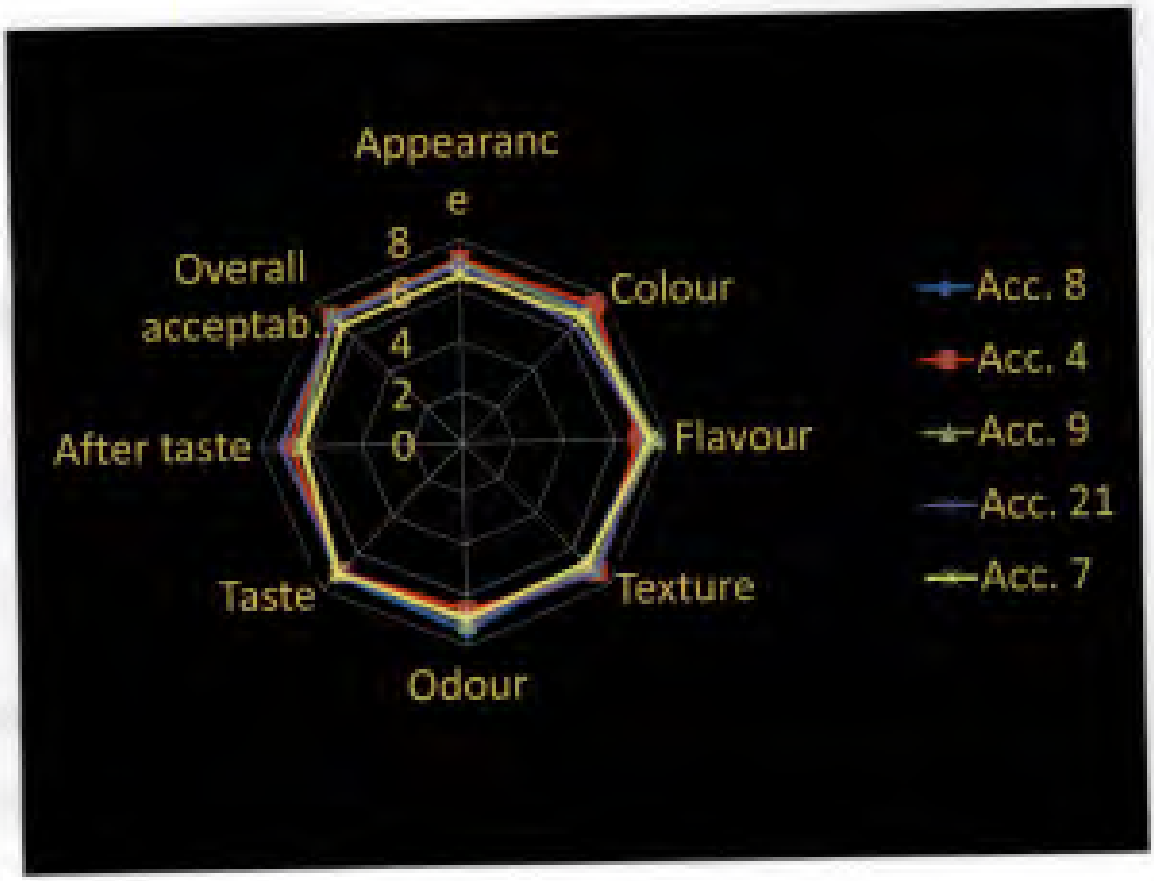
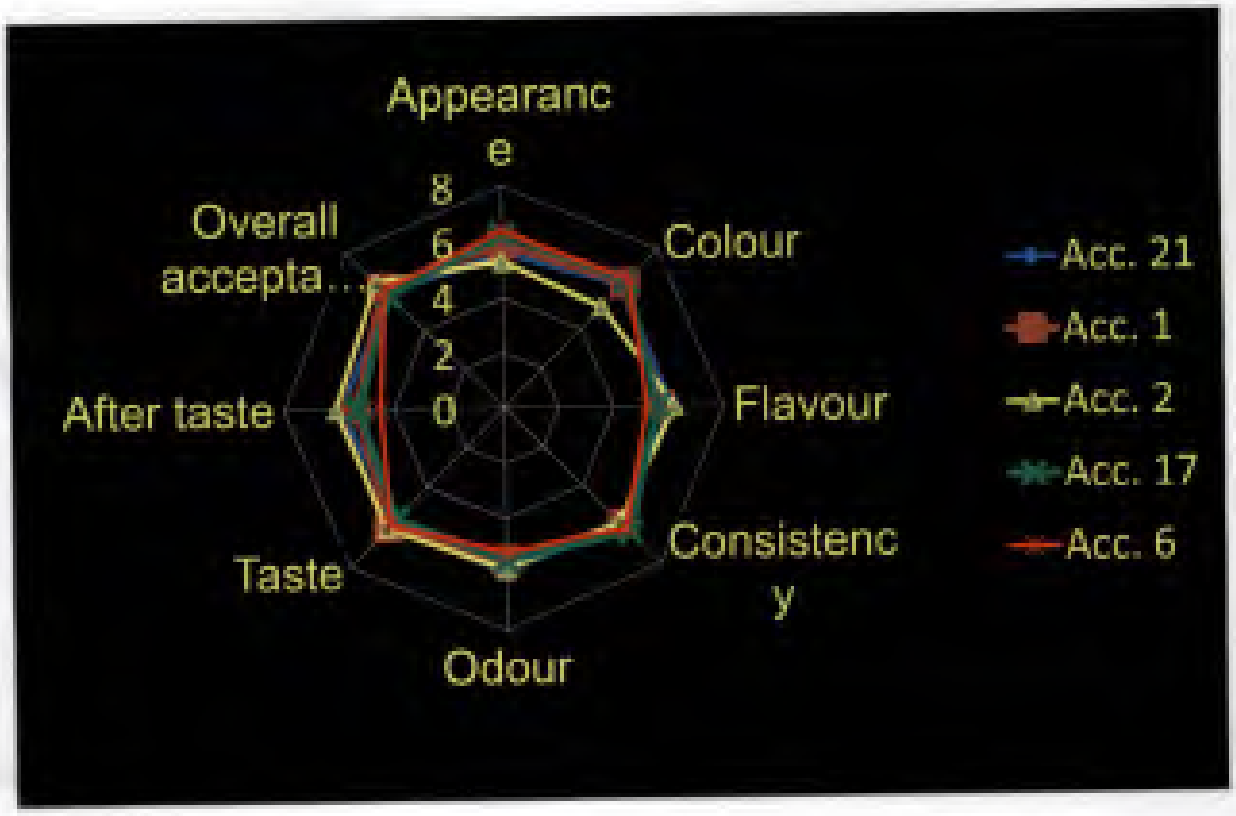


Fig.15 Mean sensory scores for RTS beverages - Three Month After Storage - 3MAS



will have an effect on microbial quality of processed foods (Bryan, 1974). Kalra *et al.* (1983) reported that there was decreased moisture percentage in mango pickle with the increase in length of storage period. Immediate decline in moisture was noted due to salt treatment, which could have caused osmosis. When pickles are kept for curing, due to growth of wild yeast a white scum is formed on the surface (cut mango pickle). This scum may be a thick wrinkled layer or thin film which retards the formation of lactic acid. This action promotes the growth of putrefactive bacteria which causes the pickles to become soft and slippery. Bacteria and mould can soften the pickle by the production of pectolytic enzymes. Degradation of pectin which is seen on the cell wall of product leads to softening of texture. Fruits with high phenol and crude fibre content show fungal contamination in the later stages only (Jyothi, 2000). Due to lack of chemical preservatives, fungal growth was found to be common (Sheth *et al.*, 2005).

Mango varieties used for tender mango pickling generally has a long shelf life. Pickles are prepared without any artificial preservatives and the high keeping quality can be attributed to the quality characters of mango.

Balance between the acceptability of mangoes based on total score and overall acceptability score were assessed. Total scores and overall acceptability scores assessed in 1^{st}, 2^{nd} 3^{rd} months were mostly balanced in all the three products tested.

From the study it could be concluded that accessions 15 and 17 (*Chandrakaran*) were the best for tender mango pickling followed by Accessions 2, 3, 6 and 10. Acc. 4, 8, 9, 17 and 21 were the highly suited for cut mango pickling. Accessions 21, 17, 1, 2 and 6 were good for RTS beverage preparation. Accession 21 was good for cut mango pickle and RTS beverage. Acc. 2, 6 and 17 were good for tender mango pickling and RTS beverage preparation. Acc. 16 was least suitable for all the three products.

6. SUMMARY

The study on "Evaluation of pickling mangoes for processing quality" was conducted in the Department of Processing Technology, College of Horticulture, Vellanikkara, Thrissur during 2014-2016 with the objective of assessing processing quality of pickling mango collections maintained at RARS, Pattambi and RARS, Pilicode.

Results of the first experiment showed that there was significant difference between the accessions in both quantitative and quality characters at all three stages *viz.* tender, mature and ripe.

Length of tender fruits varied from 3.00 cm to 4.77 cm, thickness from 1.87 cm to 4.00 cm, width from 2.23 cm to 4.37 cm, weight from 6.65 g to 52.33 g, volume from 7.00 ml to 51.67 ml, skin thickness from 1.18 mm to 2.67 mm and flesh thickness from 0.5 cm to 1.77 cm. Highest length of tender mango was noted in Acc. 10, weight and volume was highest in Acc. 21. Acc. 4 had highest skin thickness and flesh thickness.

Length of mature fruit varied from 5.23 cm to 8.33cm, thickness from 3.97 cm to 6.2 cm, width from 4.10 cm to 7.9 cm, weight from 49.83 g to 197.47 g, from 46.67 ml to 200 ml, skin thickness from 1.10 mm to 2.73 mm, flesh thickness from 0.73 cm to 1.87 cm, stone weight from 16.30 g to 37.83 g, stone volume from 13.33 ml to 37.00 ml and stone thickness from1.67 cm to 2.30 cm. Average length of mature fruit was 6.54 cm, thickness - 4.73 cm, width - 5.49 cm, weight - 101.78 g, volume - 100.6 ml, skin thickness - 1.72 mm, flesh thickness - 1.29 cm, stone weight - 24.37 g, stone volume - 23.21 ml and stone thickness - 1.96 cm. In mature mango, highest length was noted in Acc. 6. Thickness, width and weight were highest in Acc. 21. Volume was highest in Acc.6. Acc. 10 had highest skin

thickness, flesh thickness was highest in Acc. 1. Stone weight and stone volume was found to be highest in Acc. 6, stone thickness was highest in Acc. 21.

Length of ripe fruit varied from 5.0 cm – 8.3 cm, thickness from 4.13 cm to 6.53 cm, width from 4.27 cm to 8.20 cm, weight from 58.77 g to 252.30 g, volume from 58.33 ml to 250.01 ml, skin thickness from 0.86 mm to 2.13 mm, skin content from 14.93 per cent to 30.27 per cent, stone content from 14.47 per cent to 33.93 per cent, pulp content from 36.87 per cent to 66.77 per cent, stone volume from 13.33 ml to 53.33 ml, flesh thickness from 0.73 cm to 1.87 cm, stone weight from 16.30 g to 37.83 g, stone volume from 13.33 ml to 37.00 ml and stone thickness from 1.67 cm to 2.30 cm. Average length of ripe fruit was 6.44 cm, thickness - 4.95 cm, width - 5.59 cm, weight - 112.76 g, volume - 111.43 ml, skin thickness - 1.55 mm, skin content - 19.96 per cent, stone content - 25.36 per cent, pulp content - 54.01 per cent and stone volume - 23.88 ml. In ripe stage, length was highest in Acc. 6, thickness, width, weight and volume was found to be highest in Acc. 18, Acc. 21 had highest skin thickness, skin content was highest in Acc. 8, highest stone content, pulp content and stone volume was noted in Acc. 16, Acc. 12 and Acc. 18 respectively

Biochemical parameters such as titrable acidity increased from tender to mature stage and decreased on ripening. Polyphenol content was higher at tender stage, which decreased during maturation and ripening. Acidity of mangoes ranged from 1.91 to 5.01 per cent at tender stage, 2.74 to 6.71 per cent at mature stage and from 0.28 to 1.4 per cent at ripe stage. Polyphenol content varied from 0.78 to 3.8 mg g^{-1}in tender stage, 0.38 to 2.45 mg g^{-1} in mature stage and 0.39 to 1.40 mg g^{-1} in ripe stage. Crude fibre content varied from 0.4 to 1.58 per cent in tender mango stage, 0.61 to 3.63 per cent in mature stage and 0.7 to 3.7 per cent in ripe stage. TSS of ripe fruits varied from 12.5 to 22.2 ° brix and juice content from 20.52 to 61.63 per cent. Grouping was done based on D^2 analysis and majority of the accessions were medium in all the quantitative and qualitative characters.

Quantitative characters of fruits increased from tender to mature stage, acidity and crude fibre increased from tender to mature stage but polyphenol content decreased from tender to mature stage. Acidity and polyphenol content decreased from mature to ripe stage but crude fibre content increased.

Organoleptic evaluation of the products was conducted based on hedonic scale. Total score for tender mango pickle increased with the increasing storage time and that of RTS beverage decreased. Accessions 15 and 17 (*Chandrakaran*) were the best for tender mango pickling followed by Accessions 2, 3, 6 and 10. Acc. 4, 8, 9, 17 and 21 were highly suited for cut mango pickling. Accessions 21, 17, 1, 2 and 6 were good for RTS beverage preparation. Accession 21 was good for cut mango pickle and RTS beverage. Acc. 2, 6 and 17 were good for tender mango pickling and RTS beverage preparation. Acc. 16 was not suitable for all the three products.

Microbial count of pickles was enumerated at monthly intervals for three months. Highest population of microbes was recorded in cut mango pickle compared to tender mango. Population of microbes was found to increase by third month. In tender mango pickle yeast population was absent.

Balance between the acceptability of mangoes based on total score and overall acceptability score was assessed. Total scores and overall acceptability scores assessed in 1^{st}, 2^{nd}and3^{rd} months were mostly balanced in all the three products tested.

REFERENCES

Abourayya, M. S., Kassim, N. E., El-Sheikh, M. H., and Rakha. A. M. 2011. Fruit physical and chemical characteristics at maturity stage of Tommy Atkins, Keitt and Kent mango cultivars grown under Nubariya conditions. *J. American Sci.* **7**(3): 228-233.

Agbo, A. U. and Inyang, U. E. 1995. Effect of hot ash treatment of mango fruits on the physicochemical changes during ripening. *Trop Sci.* **35**(3): 259–262.

AICFIP. 1979. Collection of pickle varieties of mango. Mango workers meeting, Panaji, Goa. 2nd-5th May. AICFIP, *Lucknow Tech.* Doc. **13**:216-218.

Akhtar, S. M., Riaz, A., Ahmad., and Nisar, A. 2010. Physicochemical, microbiological and sensory stability of chemically preserved mango pulp. *Pak. J. Bot.* **42**(2): 853-862.

Anila. R and Radha. T. 2003. Physico-chemical analysis of mango varieties under Kerala conditions. *J. Tropical Agric.* **41**: 20-22.

Awasthi, R. K. and Pandey, I. C. 1979. Screening of sucking mango (*Mangifera indica* L.) varieties for juice production. *Indian Food Pack.* **33**(4): 40-49.

Azzolini, M., Jacomino, A. P., Bron, I. U., Kluge, R. A., and Schiavinato, M. A. 2005. Ripening of "Pedro Sato" guava: a study on its climacteric and non-climacteric nature. *Brazilian J. plant physiology*. 17: 87- 95.

Bachmann, J. 2001. Adding value to farm produce: An overview. Appropriate Technology

Bally, I. S. H. 2011. Electronic Document Delivery - Advances in research and development of mango industry. Rev Bras Frutic. 33 http://www.scielo.br. Accessed on 09/08/2014.

Barhate, S. G., Balasubramanyan S., and Bhalerao, R. R. 2011. Genetic diversity in mango (*Mangifera indica* L.) genotypes and molecular characterization, *Asian J. Bio Sci.* **6**(2) : 241-245.

Barholia, A. K. and Yadav, S. 2014. Fruit quality characters and their relation with weight per fruit in mango over years. *Orient. J. Chem.* **30**(3): 1421-1427.

Bhuyan, M. A. J. and Guha, D. 1995. Performance of some exotic mango germplasms under Bangladesh conditions. *Bangladesh Hort.* 23(1&2): 17-22.

Chaudhari, S. M., Patil, B.T., and Desai, U. T. 1997. Performance of south-Indian mango varieties under semi-arid region of Maharashtra. *J. Maharashtra Agric. Univ.* **22**(1): 72-74.

Chitra, P. and Manimegalai, G. 2002. Sustainability of banana for processing in to RTS beverage. Global Conference on Banana and plantain, 28-31 October, 2002, Banglore, India. *Abstract*: 20

Deka, C. B and Sethi,V. 2001. Preparation of mixed fruit juice spiced RTS beverage. *Indian Fd. Packer*. **55**: 58-61.

Durrani, Y., Zeb, A ., Ayub, M., Ullah, W., and Muhammad, A. 2011. Sensory evaluation of mango (Chausa) pulp preserved with addition of selected chemical preservatives and antioxidant during storage. *Sarhad J. Agric.* **27**(3): 471-475.

Edoga, H. O., Okwu, D. E., and Mbaebie, B. O. 2005. Phytochemical constituents of some Nigerian medicinal plants. *Afr. J. Biotechnol.* **4**(7): 685-688.

Elahi, M and Khan, N. 1983. Physico chemical changes in some Pakistani Mango varieties during storage ripening. *J. Agr. Food Chem.* **21**(2): 229.

FIB. 2016. *Farm Guide.* Farm Information Bureau, Government of Kerala, Trivandrum, India, 451p.

Galvez-Lopez, D., Salvador-Figueroa, M., Adriano-Anaya, M., and Mayek-Perez, N. 2010. Morphological characterization of native mangoes from Chiapas, Mexico. *Sub trop Plant Sci.* **62**: 18-26.

Gangwar, B. M. and Tripathi, R. S. 1973. A study on physico chemical changes during growth, maturity and ripening in mango. *Punjab Hort. J.* **13**(4): 230-236.

González-Aguilar, G. A., Buta, J. G. and Wang, C.Y. 2001. Methyl jasmonate reduces chilling injury symptoms and enhances color development of 'Kent' mangoes. *J. Sci Food Agric.* **81**: 1244–1249.

Germain, K., Benoit, B. K., and Israel, L. M. 2008. Biochemical and Physicochemical properties of four mango varieties and some quality characteristics of their Jam. *J. Food Processing and preservation.* **32**:644-655.

Gopalan, C., Ramasastry, B.V., and Balasubramanian, S. C. 2000. Proximate principles: Common foods. In: Narasinga Rao, B. S., Pant, K. C., and Deosthale. Y. G. (ed.), *Nutritive value of Indian foods (Revised and updated edition).* National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India, pp. 53-55.

Gupta, P. N., Mathurarai., Rana, R. S., and Lal, B. 1993. Genetic diversity of mango in Uttar Pradesh. *Abstracts of Golden jubilee Symposium, Horticulture Society of India, Bangalore.* 24th to 28th May p. 2

Hayat, I., Masud, T., and Rathore, H. A. 2005. Effect of coating and wrapping materials on the shelf life of apple (*Malus domestica cv. Borkh). Int'l. J. Food Safety*. **5**: 24-34.

Hossain, M. A., Rana, M. M., Kimura, Y., and Roslan, H. A. 2014. Changes in biochemical characteristics and activities of ripening associated enzymes in mango fruit during the storage at different temperatures. *Bio. Med. Research International*

Ismail, S., Rameshwar, A., and Narayana Rao, M. 1986. Maturity standards for fruits of pickle mangoes. *J. Food Sci.Tech.* **23**(2): 105-106.

Jiang, Y., Joyce, D. C., and Macnish, A. J., 1999. Responses of banana fruit to treatment with 1-methylcyclopropene. *Plant Growth Regulation.* 28, 77–82.

Johnson, L. F and Curl, E. A. 1972. Methods for research on the ecology of soil born plant pathogens. Burgees publishing company, New York, p. 247.

Joshy, D. R. and Shiralkar, N. D. 1977. Polyphenolases of a local variety of mango. *J. Food Sci. Tech.* 14(2):72-79.

Jyothi, M. L. 2000. Variability and character association analysis of pickling type mango. Ph D. (Ag.) Thesis, Dept. of Hort., Kerala Agric. Univ.

Kalra, S. K., Tandon, D. K., Singh, H., and Chadha, K. L. 1982. Assessment of some mango cultivars for nectar production. *Prog. Hort.* **14**(4): 220-224.

Kapur, K. L. 1974. Studies on biochemical changes in mango during growth and ripening. *Indian Food Pack.* **28**(6): 10-16.

Kirankumar, R., Guruprasad, T. R., Nachegowda,V., and Kalpana, P. R. 2015. Evaluation of mango (*Mangifera indica* L.) varieties for physico-chemical parameters under coastal zone of Karnataka. *Environment Ecology.* **33**(2A): 837-839.

Kostermans, A. J. G. H. and Bompard, J. M. 1993. The mangoes, botany, nomenclature, horticulture, cultivation and utilisation, Academic Press, Landon

Krishnapillai, N. and Wijeratnam, R. S. W. 2016. Morphometric analysis of mango varieties. *American J. crop sci.* **10**(6):784-792.

Lakshminarayana, S. 1973. Respiration and ripening patterns in the life cycle of the mango fruit. *J. Hort Sci.* **48**: 227-33.

Lakshminarayana, S., Subhadra, N. V., and Subramanyam, H. 1970. Some aspects of developmental physiology of the mango fruit. *J. hort. Sci.* **45**:133-142.

Larrauri, J. A., Ruperez, P., Barroto, B., and Sauracalivta. F.1996. Mango peels as new tropical fiber, preparation and characterization. *Lebensmittel–Wissenchaft and Technologie.* **29**(9): 729-733.

Leghari, M. S., Sheikh, S. A., Memon, N., Soomro, A. H., and Khooharo, A. A. 2013. Quality attributes of immature fruit of different mango varieties. *J. Basic Applied Sci.* **9**: 52-56.

Malundo, T. M. M., Shewfelt, R. L., Ware, G.O., and Baldwin, E. A. 2001. Sugars and acids influence flavour properties of mango (*Mangifera indica*). *J. Amer. Soc. Hort. Sci.* **126**(1): 115–121.

Majumder, P. K and Sharma, D. K. 1990. Mango. Fruits: *Tropical and subtropical.* Ed. Bose, T. K., Mitra, S. K, Nayaprakash, Calcutta. pp. 1-30.

Mamiro, P., Fweja, L., Chove, B., Kinabo, J., George, V., and Mtebe, K. 2007. Physical and chemical characteristics of off vine ripened mango (*Mangifera indica* L.)fruit (Dodo). *Afri. J. Biotech.* **6**(21): 2477-2483.

Mannan, M. A., Khan,. S. A. K. U., Islam, M., Sirajul- Islam., and Siddiqua, A. 2003. A study on the physicochemical characteristics of some mango varieties in Khulna region. *Pakistan J. Bio. Sci.* 6(24): 2034-2039.

Mollah, S. and Siddique, M. A. 1973. Studies on some mango varieties of Bangladesh. *Bangladesh Hort.* **1**(2):16-24.

Nakadi, S. K., Kotecha, P. M and Kadam, S. S. 2001. Studies on ready- to-serve (RTS) beverage based on pomegranate and mango. *Bev. Fd. Wld.* **28**:36.

Nanjundaswamy, A. M. 1991. Mango processing present status and future outlook. *Acta Hort.* 527: 525-545.

Narayana, B. S. 1976. Some technological aspects of the preparation of popular varieties of green mango pickles. *Indian Food Packer.* **30**(5): 40-44.

Negi, S. S. 2000. Mango production in India. *Acta Hort.* pp. 69-78.

Nigam, S. Bhatt, D. K. and Jha, A. 2007. Different product of mango: the king of fruits. *Processed Food Industry.* 10 (9): 32-40.

Okoth, E. M., Sila, D. N., Onyango, C. A., Owino, W. O., Musembi, S. M., And Mathooko F. M. 2013. Evaluation of physical and sensory quality attributes of three mango varieties at three stages of ripeness, grown in lower eastern province of Kenya - part 1. *J. Animal Plant Sciences* [e-journal] 17(3). available: http://www.m.elewa.org/JAPS.info/content/vol17/issue3/full/3/index.html. ISSN 2071-7024[29 April 2013].

Othman, O. C and Mbogo, G. P. 2009. Physico-chemical characteristics of storage-ripened mango (*Mangifera indica* L.) fruit varieties of Eastern Tanzania. *Tanz J. Sci.* **35**: 57-66.

Padda, M. S., Amarante, C. V. T., Garciac, R. M., Slaughter, D. C., and Mitchama, E. J. 2011. Methods to analyze physico-chemical changes during mango ripening: A multivariate approach. *Post harvest Biol Tech.* **62**: 267-74.

Pandey, R. M., Rao, M. M., and Singh, R. N. 1974. Biochemical changes in the development of mango fruit cv. Dashehri. *Prog. Hort.* **5**(4):47-50.

Pleguezuelo, C. R. R, Zuazo, V. H. D, Fernandez, J. L. M., and Tarifa, D. F. 2012. Physico-chemical quality parameters of mango (*Mangifera indica* L.) fruits grown in a Mediterranean subtropical climate (SE Spain). *J. Agri. Sci. Tech.* **14**: 365-74.

Pradeepkumar, T., Philip, J., and Johnkutty. I. 2006. Variability in physico-chemical characteristics of mango genotypes in northern Kerala. *J. Tropical Agriculture.* **44** (1-2): 57-60.

Rabbani, A. and Singh, I. S. 1988. Evaluation of local sucking mango varieties for beverage industry. *Acta Hort.* **231**:715-720.

Radha, T. 1997. *Mavukrishikeralathil.* Kerala Agricultural University, Thrissur

Radha, T. and Nair, S. R. 2000. Status of mango cultivation in Kerala. *Acta Hort.* pp: 117-121.

Ramakrishna, B. M. 1988. *Studies on physico chemical changes of developing fruits in certain cultivars of mango* (*Mangifera indica*) M.sc. thesis, University of Agriculture Sciences, Bangalore.

Ranganna, S. 1997. Hand book of analysis and quality control for fruits and vegetable products (2nd Ed.). Tata Mc Graw Hill Publishing Company Ltd, New Delhi. pp.12-16.

Shafique, M. Z., Ibrahim, M., Helali, M. O. H., and Biswas, S. K. 2006. Studies on the physiological and biochemical composition of different mango cultivars at various maturity levels. *Bangladesh J. Sci. Ind. Res.* **41**(1-2), 101-108.

Rathore, H. A., Masud, S., and Soomro, H. A. 2007. Effect of storage on physico-chemical composition and sensory properties of mango (*Man*gifera *indica* L.) variety, Dosehari. *Pakistan J. Nutrition*. **6**: 143-148.

Sadasivam, S. and Manickam, A. 1996. *Biochemical Methods (2nd Ed.)*. New Age International Publishers, 256p.

Sadhu, M. K. and Bose, T. K. 1976. Studies on mango cultivars part I: Morphological and physicochemical studies of some promising mango cultivars of the district Mursidabad, West Bengal. *Indian Food Packer,* **30**(5): 24-32.

Samad, M. A. 1975. A study on the physical and bio-chemical characteristics of some common mango varieties of Bangladesh. M. Sc. (Ag.) Thesis, Dept. of Hort., Bangladesh Agric. Univ., Mymensingh. pp. 22-33.

Satyavati, V. K., Bhat, A. V., Varkey G, A. and Mookherjee, K. K. 1972. Studies on suitability of different varieties of Kerala for processing. *Indian Food Pack*. **26**(4): 8-12.

Shinde, A. K., Wagha, R. G., Joshi, G. D., Waghmare, G. M., and Kshirsagar, P. J. 2004. Pickle purpose mango variety- hybrid-4 (Konkan ruche). *Indian Food Packer*, 58(3): 54-58.

Simi, S and Rajmohan, K. 2013. Evaluation of traditional mango (*Mangifera indica* L.) varieties of southern Kerala. *J. Hortl. Sci.* 8(2):228-233.

Srivastava, R. P., Asali, K. P., Patel, M. P., Tiwari, B. L and Bhadauria, U. P. S. 1987. Evaluation of mango varieties in Madhya Pradesh. *Indian J. Hort.* **44**(3&4): 197-201.

Uddin, M. Z., Rahim, M. A., Alam, J. C., Barman., and Wadud, M. A., 2006. A study on bio-chemical characteristics of different mango germplasms grown in the climatic condition of Mymensingh. *Int. J. Sustain. Crop Prod.* **1**(2): 16-19.

Ueda, M. Sasaki, K. Inaba K, Shimabayashi Y. 2000. Changes in physical and chemical properties during maturation of mango fruit (*Mangifera indica* L. Irwin) cultured in a plastic green house. *Food Sci Technol Res.* **6**(4): 299-305.

Yunchalad, M., Thaveesook, K., Hiraga, C., Surojanamathakul, V., and Stonsaovapark, S. 2003. Fermented green mango-chemical changes and microbial growth. Proceedings of 41st Kasetsart university annual conference on 3-7 February. *AgroIndustry,* 348-356.

APPENDIX- I

Accessions	Tree number
1.	PTB-16
2.	PTB-48
3.	PTB-56
4.	PTB-24
5	16 PPM 25/1
6	PPM1/1
7	NOT NUMBERED
8	41PPM3
9	594 -PTB
10	652 -PTB
11	355 -PTB
12	PTB- 65
13	23- PTB
14	587- PTB
15	585- PTB
16	PPM-31
17	Chandrakaran
18	PPM -153
19	PPM-108
20	593- PTB
21	13-PPM

APPENDIX II

Score card for organoleptic evaluation

Name of the judge:

Date:

Characteristics	Scores									
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
Appearance										
Colour										
Flavour										
Texture										
Odour										
Taste										
After taste										
Overall acceptability										

9 point Hedonic scale

Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Signature:

EVALUATION OF PICKLING MANGOES FOR PROCESSING QUALITY

By

Zeenath. K. K

(2014-12-134)

ABSTRACT OF THE THESIS

Submitted in partial fulfillment of the requirement

for the degree of

Master of Science in Agriculture

(PROCESSING TECHNOLOGY)

Faculty of Agriculture

Kerala Agricultural University, Thrissur

Department of Processing Technology

COLLEGE OF HORTICULTURE

VELLANIKKARA, THRISSUR – 680656

KERALA, INDIA

2016

ABSTRACT

Mango (*Mangiferaindica* Linn.), popularly known as the "King of fruits", is cherished for its flavour, succulence and delicious taste. In India the fruit is cultivated in an area of 2,312 ha and the production is around 15.03 million tons, contributing 40.48% of the total world production of mango.Raw fruits of local varieties of mango trees are used for preparing various traditional products like raw slices in brine, amchur, pickle, murabba, chutney*etc.*

In Kerala, commercial cultivation of mango is however limited and Palakkad district ranks first in mango cultivation. Due to the proximity to Western Ghats, the state has a wealth of local varieties which are valued for its pickling quality. Tender mango pickle, commonly known as *Kadumanga,*and cut mango pickles are popular in Kerala. Many of these land races are juicy types. However, studies on their suitability for preparation of different products are limited. Attempts are made at RARS, Pattambi and RARS, Pilicode under Kerala Agricultural University to conserve pickling varieties. Evaluation of these collections for product development is yet to be done.

The study on "Evaluation of pickling mangoes for processing quality." was conducted in the Department of Processing Technology, College of Horticulture, Vellanikkara, Thrissur, during 2014-2016 with the objective of assessing processing quality of pickling mango collections maintained at RARS, Pattambi and RARS, Pilicode. The experiment was conducted in CRD with three replications. Twenty one accessions (8 from RARS, Pilicode and 13 from RARS, Pattambi) were selected for the study out of which one was *Chandrakaran*. The programme was divided into two major experiments. Experiment I was "Evaluation of the accessions for quality" and experiment II "Evaluation of accessions for product development". Fruits were collected at tender, mature and ripe mango stage. Quantitative and qualitative attributes of the selected accessions at the three stages were studied in experiment I. In experiment II fruits of these selected accessions were used for making tender mango pickle, cut mango pickle and RTS beverages. Organoleptic evaluation of these products was made at monthly intervals for three months. Microbial load was also observed in pickles at monthly intervals for three months.

Results of the first experiment showed that there was significant difference between the accessions in both quantitative and qualitative characters at all three stages *viz.* tender, mature and ripe.Biochemical parameters such as titrable acidity increased from tender to mature stage and decreased on ripening. Polyphenol content was higher at tender stage, which decreased during maturation and ripening. Acidity of mangoes ranged from 1.91 to 5.01 per

cent at tender stage,2.74 to 6.71 per cent at mature stage and from0.28 to 1.4 per cent at ripe stage. Polyphenol content varied from 0.78 to 3.8 mg g^{-1}in tender stage, 0.38 to 2.45 mg g^{-1} in mature stage and 0.39 to 1.40 mg g^{-1} in ripe stage. Crude fibre content varied from 0.4 to 1.58 per cent in tender mango stage,0.61 to 3.63 per cent in mature stage and 0.7 to 3.7 per cent in ripe stage. TSS of ripe fruits varied from 12.5 to 22.2 ° brix and juice content from 20.52 to 61.63 per cent.

Organoleptic evaluation of the products was conducted based on hedonic scale. Total score for tender mango pickle increased with the increasing storage time and that of RTS beverage decreased. Accessions 15 and 17 (*Chandrakaran*) were the best for tender mango pickling followed by Accessions 2, 3, 6, 8, 10 and 12. Acc. 4, 8, 9 and 21 were the best for cut mango pickling. Accessions 21, 17, 1, 2, 6, 7, 8, 11, and 13 were good for RTS beverage preparation. Microbial population was negligible in tender mango pickle compared to cut mango pickle. Accession 8 was suitable for all the three products. Accessions 6, 8 15 and 17 were good for both tender mango and cut mango pickle preparation. Accessions 8 and 21 were good for cut mango pickle and RTS beverage. Accessions 16 and 21 were least acceptable for tender mango pickling; 16, 19 and 20 for cut mango pickling and 9, 10, 14, 16 for RTS beverages.