“STUDIES ON STANDARDIZATION OF SAPOTA
(Manilkara achras (Mill.) Fosberg) SYRUP”

BY

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July, 2015
CANDIDATE'S DECLARATION

I hereby declare that the thesis or any part thereof has not been previously submitted by me or other person to any other University or Institute for a degree.

Place: Killa-Roha
Date:   /   / 2015

(H.I. DALVI.)
Acknowledgement

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(Ms. Harshala Ishwar Dalvi.)
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**ABSTRACT**

The present research work entitled “Studies on standardization of sapota (*Manilkara achras* (Mill.) Fosberg) syrup” was undertaken in the Department of Post-Harvest Management of Fruit, Vegetable and Flower crops in Post Graduate Institute of Post-Harvest Management, Killa-Roha, during the year 2014-2015.

The experiment on preparation of sapota syrup was laid out with four main treatments and three replications. The experiment was conducted by using factorial completely randomized design (FCRD) and the product was analyzed for physico-chemical composition and sensory qualities at an interval of 30 days till 90 days of storage period at ambient conditions.

The present study revealed that the chemical parameters viz. T.S.S., reducing sugars and total sugars increased with decrease in the acidity and ascorbic acid content during storage of 90 days. The physical parameters viz.
L* value for colour decreased with increasing a* and b* value for colour during the storage period of 90 days.

The syrup recipes i.e. 1 part of juice + 1.5 parts of dry sugar and 1 part juice + 4 parts 75⁰ B sugar syrup were found to be the best recipes for sapota syrup with highest organoleptic score for colour, flavour and overall acceptability. Based on the economics and organoleptic qualities, the recipe i.e. 1 part juice + 4 parts 75⁰ B sugar syrup was the best recipe for the production of sapota syrup.
फल, सब्जी और फूल फसलों की कटाई पश्चात फल प्रबंधन विभाग,
कटाई पश्चात व्यवस्थापन पदव्युत्तर संस्था,
डॉ. बाळासाहेब सावंत कोकण कृषि विद्यापीठ दापोली

| प्रबंधकारीकरणीकरक | :- | “चिकू (मॅवनलकारा अचरस (मिल.) फोसेएर्ग) सिरप का प्रमाणीकरण” |
| प्रबंधकारीकरणीकरक | :- | कृ. हर्षला इश्कर दापळी. |
| प्रबंधकारीकरणीकरक | :- | पी. एच. एम. आर. एम. १३८७ |
| प्रबंधकारीकरणीकरक | :- | २०१४-२०१५ |
| प्रबंधकारीकरणीकरक | :- | एम. एस. सी. (पी. एच. एम.) |
| प्रबंधकारीकरणीकरक | :- | डॉ. श्री. पी.पी. रेठेकर. |
| प्रबंधकारीकरणीकरक | :- | सहयोगी प्राध्यापक |
| प्रबंधकारीकरणीकरक | :- | कटाई पश्चात व्यवस्थापन पदव्युत्तर संस्था |
| प्रबंधकारीकरणीकरक | :- | किल्ला, रोहा |

प्रबंधसार

वर्तमान अभ्यास “चिकू (मॅवनलकारा अचरस (मिल.) फोसेएर्ग) सिरप का प्रमाणीकरण रत्नगढ़ जिले में दापोली स्थित डॉ. बाळासाहेब सावंत कोकण कृषि
विद्यापीठ कि कटाई पक्षात प्रबंधन विभाग मे 2014-2015 ईस काल मे किया गया।

चिकौ मिठीत सिरप बनाने के लिए विभिन्न अनुपत वाले चार उपचारो का उपयोग कीया गया। प्रयोग के लिए भाज्य संपूर्ण याददशिक नमुने (एफसीआरडी) का उपयोग कीया गया। नब्बे दिनो भंडारण कि अवधि मे हर तीस दिनो कि सामान्य स्तरी मे उत्पाकी भौतिक-रासायनिक संरचना और संबंधी गुणो का विश्लेषन किया गया।

वर्तमान अभ्यास से यह पाता चला कि नब्बे दिनो कि भंडारण कि अवधि मे रासायनिक गुण जैसे कुल विद्राब्य शर्करा, शर्करा मे हुई कमी,कुल शर्करा कि मात्रा मे बाधवत हुई और आमल्ता एव आसफे किक की मात्रा कम हुई।भौतिक गुणो मे रंग कि a* एव b* मात्र मे बढ गई लेकी रंग कि L* मात्र मे कमी हुई।

संबंधी गुण जैसे रंग,स्वाद के संबंध मे १ हिस्सा रस + १.५ हिस्सा शर्करा और १ हिस्सा रस + ४ हिस्सा ७५° ब्रिस्क्स चार्स्नी यह पाक कृतीया सर्वाधिक स्वीकार एवं आशाजनक परिणाम दिखाए।अर्थशास्त्र और संबंधी गुनो के के आधारपार बहतरीन पाक कृतीयो मे १ हिस्सा रस + ४ हिस्सा ७५° ब्रिस्क्स इस उपचार पदधतीने सर्वाधिक स्वीकार एवं आशाजनक परिणाम दिखाए।
फळे, भाजीपाला आणि फुळ यिके काढणी पक्षात व्यवस्थापन विभाग
काढणी पक्षात व्यवस्थापन पदंपितर संस्था
डॉ. बाळासाहेब सावंत कोकण कृषि विद्यापीठ, दापाली

| प्रबंध शीर्षक | :- | “चिकू (मॅनिलकारा अचरस (मिल.) फोसेबर्ग ) सिरपाचे प्रमाणीकरण” |
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| नोंदणी क्रमांक | :- | पी. एच. एम. आर. एम. १३८७ |
| शैक्षणिक वर्ष | :- | २०१४-२०१५ |
| अभ्यास क्रम | :- | एम. एस. सी. (का. प. व्य.) |
| संशोधन मार्गदर्शकाचे नाव | :- | डॉ. श्री. पी. पी. रेटेकर. |
|
|
| सहयोगी प्राध्यापक, काढणी पक्षात व्यवस्थापन पदंपितर संस्था, किल्ला, रोहा. |

सदर संशोधन कार्य "चिकू (मॅनिलकारा अचरस (मिल.) फोसेबर्ग ) सिरपाचे प्रमाणीकरण" हे रत्नगिरी जिल्यातील दापाली येथील डॉ. बाळासाहेब सावंत कोकण कृषि विद्यापीठाच्या काढणी पक्षात व्यवस्थापन विभागामध्ये २०१४-२०१५ या कालाभावीत करण्यात आले.

चिकू सिरप बनविण्यासाठी वेगवेगळ्या चार उपचारांचा वापर करण्यात आला. प्रयोगासाठी, घटकात्मक अहेतुक आराखडा (एफसीराडी) वापरण्यात आला. नव्वूद दिवसांच्या साठवण कायमत दर तीस दिवसांच्या अंतराने सामान्य परिस्थितीत उत्पादनाच्या भौतिक-रसायनिक रचना आणि संवेदनात्मक गुणांचे विश्लेषण करण्यात आले.

सदर अभ्यासातून असे निर्दशित करून आले कि नव्वूद दिवसांच्या साठवण कायमत रसायनिक गुणधर्म जसे एकूण विद्रव्य साखर, कमी झालेली साखर आणि एकूण साखरचे
प्रमाण वाढले तर आंबटपना,क जीवनसत्क्रमात प्रमाणात घट झाली. तसेच भौतिक
गुंधर्मातील रंगाचे a* मूल्य आणि b* मुल्याचे प्रमाण वाढले तर L* मुल्याच्या प्रमाणात घट
झाली.
संवेदनात्मक गुणांच्या जसे रंग, स्वाद बाबतीत १ (१ भाग रस + १.५ भाग साखर)
आणि २ (१ भाग रस + ४ भाग ७५° ब्रिक्स साखरेचा पाक) यांना उपचार पदार्थांने
सर्वांत्क विकाहता दर्शवली. अर्थशास्त्र आणि संवेदनात्मक गुणांच्या आधारावर १ भाग
रस + ४ भाग ७५° ब्रिक्स साखरेचा पाक या उपचारपदार्थांने सर्वांत्क विकाहता
दर्शवली.
CHAPTER - I
INTRODUCTION

Sapota [Manilkara achrus (Mill.) Fosberg] also known as sapodilla or chiku, is a popular fruit species belonging to the family sapotaceae. Sapota is a native of Mexico and Central America and is now widely cultivated in the West Indies and other tropical countries. In Asia, it was first introduced to the Philippines by the Spanish and later spread to other Asian countries. Due to its hardy nature and ability to thrive under different soil and climatic conditions, it is becoming a commercial crop in many tropical countries (Bal, 1997).

In India, it was introduced in ‘Gholwad’, Maharashtra state, probably in 1888 (Cheema et al. 1954). Thereafter, it spread to the nearer states and now it occupies a significant position among the fruit crops and India is a leading producer of sapota, where it is commercially grown in the states like Maharashtra, Gujarat, Karnataka, Andhra Pradesh, Tamil Nadu and West Bengal.

It is well known minor fruit crop cultivated in many parts of India. In India, it is cultivated on 1, 60,000 hectares with annual production of 14, 24,000 metric tonnes in the year 2010-11. In Maharashtra, it is cultivated on an area of about 70,000 hectares with the production of 3, 22,000 metric tonnes in the year 2010-11 (Anon., 2011).

Sapota is basically an evergreen tropical fruit tree, thriving up to an altitude of 1000 meters above the mean sea level. It prefers humid coastal climate with an annual rainfall ranging from 1250 to 2500 mm. Temperature below 4-5°C during winter causes chilling injury to the plants.

Sapota fruit when fully ripe is delicious and eaten as dessert fruit. The pulp is sweet and melting. The fruit skin can also be eaten since it is richer
than the pulp in nutritive value. It has a higher sugar content, vitamins A, B, C and also useful minerals, proteins, carbohydrates, thiamine and riboflavin.

The cultivation of Kalipatti chiku is a highly profitable business, especially in the Thane district of the Konkan region. However, yet there is a very small area under chiku in Ratnagiri and Sindhudurg districts, where it can be cultivated on commercial scale.

Sapota fruit is highly perishable and rated very poor for process ability, negligible export and is mainly used for table purpose. The shelf-life of sapota fruits is short at ambient temperature. Being sensitive to low temperature, the sapota fruits cannot be stored for longer period at room temperature and cannot be stored in cold storage.

Sapota fruit is a good source of sugar which ranges between 12 and 14 per cent. A 100 g of edible portion of fruit contains 73.7 g moisture, 21.49 g carbohydrates, 0.7 g protein, 1.1 g fat, 28 mg calcium, 27 mg phosphorus, 2 mg Iron and 6 mg ascorbic acid as reported by Bose and Mitra (1990).

Kalipatti is one of the leading sapota varieties of India, occupying major area under sapota in India. It is famous for its outstanding quality, better yield and ultimate good returns.

It has dark green leaves, spreading branches and produces both oval and round fruits of excellent quality. The fruit has a thin brown scurf skin and the flesh of the fruit is yellowish–brown, delicious, and sweet with pleasant aroma. It contains one or two black shiny seeds. The cultivation of kalipatti chiku is a highly profitable business. Fruit juice are refreshing and retain characteristics taste and aroma even after few month of their preparation into a beverage.

Sapota fruits are used for making various processed products such as jams, jellies (Relekar et al., 2011) osmo-dehydrated slices (Relekar et al.
2013 a) and squash (Reddy, 1959, Relekar et al. 2013 b). Products like sweet chutney, dried sapota pieces, sapota milk shake, nectar, blended sapota drinks, pickle, preserve and candy can also be prepared with good sensory quality (Sawant, 1989). Even a good quality wine can also be prepared from sapota fruit as reported by Gautam and Chundawat (1998).

It has been observed that when there is a bumper production of sapota, the fruit goes waste for want of suitable preservation facilities. Thus, considering the fast increasing area under sapota cultivation, preservation and processing technology needs to be developed in order to prevent huge post-harvest losses and regulate prices during glut period and thereby protecting the interest of the growers. Hence, there is a need to develop a low cost technology for processing sapota fruits into value added products such as sapota syrup. With this view, the present investigation was carried out with the following objectives.

1) To standardize recipe for sapota syrup

2) To study the storage behaviour of sapota syrup
CHAPTER – II

REVIEW OF LITERATURE

The research on “Study on standardization of sapota [Manilkara achras (Mill.) Fosberg] syrup” is reviewed in the current chapter under the following headings. Since very limited work has been reported on processing of sapota syrup, the literature in this regard on other important fruit crops is also reviewed.

2.1 Juice recovery of sapota and other fruits

2.2 Chemical composition of fresh sapota juice

2.3 Preparation of syrup

2.4 Physical parameters of syrup

2.5 Changes in chemical composition of syrup during storage

2.6 Microbial spoilage

2.7 Sensory evaluation of syrup

2.1 Juice recovery of sapota and other fruits

Khurdiya and Roy (1985) studied various methods of jamun juice extraction and found that the juice yield varied according to the method used. Hand crushing and basket pressing reported the minimum juice yield (32%) while steaming (5 min.) and basket pressing yielded 41.8 per cent juice. Different juice recoveries were recorded due to effect of heating, incorporation of water and enzyme treatments, hand crushing, heating, steaming, pulping, grating and basket pressing.

Nawale (1987) reported that the juice content in different cashew apple types was ranged was 44.43 to 77.90 per cent.

Honde (1995) reported that the sapota juice recovery varied between 36 to 42 per cent as whole fruit basis and 51 per cent to pulp basis.
Dalvi (1998) reported the juice recovery in kokum, jamun, sapota and pineapple fruits as 29.84, 40.74, 34.34 and 42.01 per cent, respectively.

Dhutade (2012) reported the sapota juice recovery as 40 per cent.

Shikhare (2014) reported 36.5 percent sapota juice recovery.

2.2 Chemical composition of sapota and other fruits

2.2.1. Total soluble solids (°B)

Khurdiya and Roy (1985) studied the quality of jamun juice extracted by different methods and recorded the T.S.S. of juices in the range of 2.5 to 9.0 per cent. They also studied the effect of temperature on extraction and quality of rose apple juice. By method of grating, juice with a T.S.S. of 10.0° Brix was obtained at 90°C while juice with T.S.S. of 8.0° Brix was obtained by method of pulping when extracted at the temperature of 80° or 90°C.

Joshi et al. (1986) recorded 20.17 per cent T.S.S in ripe karonda fruit.

Singh (1988) studied 25 guava cultivars and reported that the T.S.S content ranged from 8-15 per cent.

Bhajipale (1997) reported that there was a continuous increase in T.S.S. of karonda fruit from 11.8° Brix at mature stage to 19.7° Brix at over ripe stage.

Raut (1999) studied the changes in total soluble solids content of sapota fruits cv. Kalipatti during storage at ambient temperature. He reported that there was an increase in the T.S.S. during ripening of sapota fruits, followed by a decline after reaching peak. The T.S.S. at mature, ripe and at the end of shelf life was 18.02, 23.65 and 20.24° Brix, respectively.

Panesar et al. (2000) observed that T.S.S. of the juice of kinnow fruit recorded was 10° Brix T.S.S.

Hiwale and Singh (2006) reported the increase in T.S.S of anola fruits from 9.7 to 10.5° B during storage.
Pawar et al. (2011) observed 19.0⁰, 23.60⁰ and 22.60⁰ Brix T.S.S in mature, ripe and over ripe stage, respectively in sapota.

Devra et al. (2013) recorded the highest T.S.S of 12⁰ Brix in aonla juice.

### 2.2.2. Titratable acidity (%)

Hulme (1970) observed a decrease (0.23% to 0.10%) in the acidity from mature stage to over ripe stage in sapota fruit.

Khurdiya and Roy (1985) studied the effect of different methods of extraction on the quality of jamun juice and recorded the range of its acidity from 0.40 to 1.49 per cent.

Singh (1988) studied 25 guava cultivars and reported the acidity varying from 0.08 to 1.68 per cent.

Gautam and Chundawat (1998) observed that there was a decrease in the acidity from 1.20 per cent at half ripe stage to 0.96 per cent at over ripe stage in sapota.

Siddig et al. (2006) studied the characteristics of tamarind and reported the total acidity ranges varying from 12.2 to 23.8 per cent.

Hend and Pawar (2013) reported per cent acidity in lemon, pineapple as 5.0 and 0.8, respectively.

### 2.2.3. Sugars (reducing and total sugars)

Khurdiya and Anand (1981) reported that the phalsa juice contained 18.12 and 17.98 per cent reducing and total sugars, respectively.

Singh (1988) studied 25 guava cultivars and reported reducing sugars ranging from 2.2 to 6.1 per cent, with 5.6 to 11.1 per cent total sugars in guava.
Pawar (1988) observed that the total sugar content in karonda fruits was 1.66 per cent at fruit set and 11.22 per cent at ripe stage, while reducing sugars increased from 0.82 per cent at fruit set to 8.81 per cent at ripe stage.

Changes in chemical composition of sapota fruits during ambient temperature storage were studied by Sawant (1989) and observed that the reducing sugar content increased from 8.28 per cent (at harvest) to 10.86 per cent (at ripe stage). It was further observed that the reducing sugars decreased from ripe stage to the end of shelf life.

Pawar et al. (2011) observed an increase in total and reducing sugars in sapota fruit i.e 14, 8.90 per cent (at mature stage), 19.12, 11.08 per cent (at ripe stage) and 18.20, 10.11 per cent (at over ripe stage), respectively.

Nayak and Bhatt (2011) recorded an increase in the reducing sugars from 1.5 to 1.6 per cent and total sugars from 7.4 to 7.6 per cent in aonla fruits on 9th days of storage.

2.2.4. Ascorbic acid (mg/100g)

Salvi (1991) reported that the ascorbic acid content of karonda fruit declined drastically from 45.8mg/100g at mature green stage to 2.3 mg/100g at ripe stage.

Honde (1995) reported the ascorbic acid content of sapota Cv. Kalipatti juice as 5.6 mg/100g.

Bhajipale (1997) reported 10.89 mg/100g ascorbic acid in ripe karonda fruit.

Gosavi (1998) recorded the ascorbic acid content of mature green and ripe kokum and karonda fruits as 13.07 mg/100 g, 9.41 mg/100g, 25.55 mg/100 g and 12.93 mg/100 g, respectively.
Kumar et al. (2005) and Singh et al. (2005) reported that the ascorbic acid decreased from initial value of 309 to 252 mg/100 g in aonala during 9 days of storage.

Kadam et al. (2014) recorded that the ascorbic acid content was 45 mg/100g in grape.

2.3 Preparation of syrup

Nair (1986) standardized the recipe for preparation of kokum syrup by adding cane sugar in ripe kokum rind at 1:1 and 1:2 proportions. The syrup with 1:1 and 1:2 sugar, the extraction had 64.2 to 64.80°Brix and 87.4 to 88.20°Brix T.S.S., respectively.

Marathe (1989) prepared cashew apple syrup by raising the T.S.S. of extracted juice to 60°Brix by adding cane sugar and maintained 2 per cent acidity by adding citric acid with sodium benzoate @ 610mg/kg of final product as preservative.

Joshi (1994) prepared the syrup from raw kokum fruits by raising T.S.S. of juice to 70°Brix and acidity to 2 per cent.

Chavan (1997) standardized the syrup from cashew apple, raw and ripe karonda and kokum and lime fruits by addition of citric acid and preservative with the recipe as 1 kg juice/ pulp, 2 kg sugar, 1.5 per cent acid and preservative @ 610 mg/kg of final product (sodium benzoate for coloured products and KMS for colorless products). During 8 months of storage, a significant difference in T.S.S. and acidity was found.

Shikhare (2014) prepared sapota syrup blended with kokum juice and they observed an increasing trend in total soluble solids, reducing and total sugars and a decreasing trend in acidity during storage.
Korgaonkar *et al.* (2015) prepared the snap melon syrup and they observed an increasing trend in total soluble solids, reducing sugars, total sugars and a decreasing trend of acidity during storage.

### 2.4 Physical parameters of syrup

#### 2.4.1 Colour (a*, b* and L* values)

Khurdiya (1993) observed that the Amrapali mango nectar possessed 1.22, 6.79 and 1.19 times higher values of L, + a and + b than those of Totapuri, respectively.

Maester *et al.* (2004) reported a decreasing trend colour intensity in aril’s in syrup.

Rein and Heinonen (2004) reported the L*, a*, b*, c*, h values of different juices of berries during studies on the stability and enhancement of berry juice colour.

Chaovanalikit *et al.* (2012) reported 20.42 ± 0.18 L* value for colour in mangosteen juice prepared from concentrate under vaccume evaporator + pectinase.

### 2.5 Changes in chemical composition of syrup during storage

#### 2.5.1 Total Soluble Solids (⁰ B)

Khurdiya (1979) studied the changes during storage of phalsa syrup and observed that the T.S.S increased slightly after two months of storage.

Shinde (1993) observed that there was an increasing trend in T.S.S. of syrup prepared from ripe sapota cv. Kalipatti fruits during 150 days of storage.

Kannan and Thirumaran (2004) studied the storage life of Jamun fruit products. They observed that the T.S.S of jamun syrup was increased up to 96.5⁰ Brix during storage.
Kotecha and Kadam (2003) prepared a syrup from tamarind fruit and they observed the gradual increase in T.S.S from 60.83 to 62.06 \(^0\) Brix during the 3 months of storage.

Nath et al. (2005) reported the increasing trend in T.S.S during 3 months of storage of ginger blended kinnow mandarin squash.

Siddig et al. (2006) studied the chemical composition of the syrup prepared from tamarind which had 56.5˚ Brix T.S.S.

Das (2009) prepared beverages from jamun fruits and studied their storage stability. An increase in T.S.S content from 65.00 to 65.58 per cent during the storage period of 0 to 6 months was observed and it might be due to the conversion of polysaccharides into sugar.

Mandal and Nath (2013) studied the changes during storage of aonala squash and they reported that the T.S.S. increased slightly after two months of storage.

### 2.5.2 Titrable acidity (%)

Bhatia et al. (1956) reported that the degree of reduction in acidity is dependent on the concentration of sugar and is a general phenomenon during storage of beverages in the presence of sugars.

Shinde (1993) observed that there was a decrease in the acidity of syrup prepared from ripe sapota cv. Kalipatti fruits during 150 days of storage.

Lakshmi et al. (2005) observed a reduction in the acidity during storage in flavoured tamarind ready to serve beverage.

Siddig et al. (2006) studied the chemical composition of the syrup prepared from tamarind that had 1.11 per cent acidity.

### 2.5.3 Reducing sugars

Shinde (1993) noticed that there was an increasing trend in reducing sugars of syrup prepared from ripe sapota cv. Kalipatti fruits during 150 days of storage.
Kotecha and Kadam (2003) observed in increase in the reducing sugars in tamarind syrup.

Siddig et al. (2006) studied the chemical composition of the syrup prepared from tamarind syrup which had 43.8 per cent reducing sugars.

Thakur et al. (2013) noticed an increase in reducing sugars in pomegranate aril syrup from 36.77 to 41.52 per cent during 3 months of storage period.

2.5.4 Total sugars

Shinde (1993) observed that there was an increasing trend in the total sugars of syrup prepared from ripe sapota cv. Kalipatti fruits during 150 days of storage.

Marimuthu and Thirumaran (2000) prepared the syrup from jamun juice and they observed the gradual increase in the total sugars during 6 months of storage.

Kotecha and Kadam (2003) observed an increase in the total sugars in tamarind syrup during storage.

Siddig et al. (2006) studied the chemical composition of the syrup prepared from tamarind which had 56.5 per cent total sugars.

2.5.5 Ascorbic acid

Roy and Singh (1979) reported the losses of ascorbic acid in fruit beverages during ambient storage.

Basavraja (2005) observed a decrease in the ascorbic acid during storage in rose apple and aonla squash.

Thakur et al. (2013) observed that the ascorbic acid deceased from 8.34 to 4.99 mg /100g during 3 months of storage period in pomegranate arils syrup.

Kurkanoor and Chavan (2013) observed a decrease in the ascorbic content in tamarind syrup during storage.
2.6 Microbial spoilage

Attri et al. (1998) found that the blends of sand pear juice with apple, apricot and plum could be stored at room temperature for six months without any spoilage.

Ejechi et al. (1998) reported that the heating mango juice to $55^0$ C for 15 minutes and supplementing with nutmeg (4% v/v) and ginger (4% v/v) markedly inhibited microbial growth.

Deka (2000) reported a negligible growth of moulds and yeasts in lime-aonla and mango-pineapple spiced – RTS beverages, which got further reduced during storage due to inhibitory effect and antioxidative properties of spices.

Chopra and Singh (2009) observed that standard plate count determined in Malta orange squash was found to be quite safe after a storage period of 90 and 105 days and stored at $25\pm\!20^0$ C.

Reddy and Chikkasubhana (2009) reported that the amla syrup was free from microbial spoilage during storage period of 90 days. There were no defective remarks regarding the fermentation of syrup by the organoleptic evaluation panel.

Lad (2012) reported that the squash prepared from lime Cv. Sai Sarbati was free from microbial spoilage after 90 days of storage.

Kalunkhe et al. (2014) observed that the squash prepared from Konkan lemon stored at ambient conditions for three months, did not show any growth of bacteria as well as fungi.

2.7 Sensory evaluation of syrup

2.7.1 Overall acceptability
Kotecha and Kadam (2003) prepared the R.T.S. beverage, syrup and concentrate from tamarind. All these products have been satisfactorily preserved and stored for over 180 days without affecting their quality.

Prasad and Mali (2003) recorded the decrease in the organoleptic score of ber squash during storage.

Mandal and Nath (2013) reported the decrease in the organoleptic score of aonla squash during storage at room temperature.

Thakur et al. (2013) reported the overall acceptability scores of pomegranate aril syrup which decreased significantly from 8.25 to 6.70 during storage period.
CHAPTER – III
MATERIAL AND METHODS

The present research work entitled “Study on standardization of sapota [Manilkara achras (Mill.) Fosberg] syrup” was undertaken in the Department of Post-Harvest Management of Fruit, Vegetable and Flower crops in Post Graduate Institute of Post-Harvest Management, Killa-Roha, during the year 2014-2015. The material used and methods adopted for standardization of sapota [Manilkara achras (Mill.) Fosberg] syrup during the course of investigation are presented in this chapter.

3.1 Experimental material

The sapota fruits required for conducting the research were procured from Pradip Gardens, Bordi Tal. – Dahanu, Dist- Palaghar. The fresh ripe fruits were selected and brought to laboratory for conducting the research.

The present experiment was laid out with four main treatments and three replications. The experimental details are listed as below.

3.1.1 Experimental details

1. Crop : Sapota [Manilkara achras (Mill.) Fosberg]

2. Cultivar : Kalipatti

3. Design : F.C.R.D.

4. Number of treatment combinations : 4X4=16

5. Replications : 3
I) Details of treatment:

The treatments comprised of 4 syrup recipes as main treatment along with four storage periods as sub treatment.

A. Main treatments:

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Proportion of sapota juice and sugar syrup</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>1 part of juice + 1.5 parts of dry sugar</td>
</tr>
<tr>
<td>T₂</td>
<td>1:4 (75⁰ brix syrup)</td>
</tr>
<tr>
<td>T₃</td>
<td>1:5 (75⁰ brix syrup)</td>
</tr>
<tr>
<td>T₄</td>
<td>1:6 (75⁰ brix syrup)</td>
</tr>
</tbody>
</table>

B. Sub-treatments

<table>
<thead>
<tr>
<th>Sub treatments</th>
<th>Storage period (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S₁</td>
<td>0 day</td>
</tr>
<tr>
<td>S₂</td>
<td>30 days</td>
</tr>
<tr>
<td>S₃</td>
<td>60 days</td>
</tr>
<tr>
<td>S₄</td>
<td>90 days</td>
</tr>
</tbody>
</table>

3.2 Methods

3.2.1 Per cent juice recovery

Uniformly ripened sapota fruits were selected for juice extraction. Extraction of juice from sapota fruits was done manually and recovery of juice was measured on weight basis.

\[
\text{Juice recovery (\%)} = \frac{\text{Weight of juice (g)}}{\text{Weight of fruits (g)}} \times 100
\]
3.2.2 Chemical composition of the sapota [Manilkara achras (Mill.) Fosberg]

The sapota fruits were analysed for different chemical constituents as per the procedures given below.

3.2.2.1 Total soluble solids ($^\circ$ B)

Total soluble solids were determined using Hand refractometer (Atago Japan, 0-32$^\circ$ Brix) and the values were corrected at 20$^\circ$ C with the help of temperature correction chart (A.O.A.C., 1975).

3.2.2.2 Titratable acidity (%)

A known quantity of sample was titrated against 0.1 N NaOH solution using phenolphthalein as an indicator. The sample of known quantity with 20 ml distilled water was transferred to 100 ml volumetric flask, made up the volume and filtered. A known volume of aliquot (10 ml) was titrated against 0.1 N sodium hydroxide (NaOH) solution using phenolphthalein as an indicator (Ranganna, 1997). The results were expressed as per cent anhydrous malic acid.

\[
\text{Titratable acidity} (\%) = \frac{\text{Normality of alkali} \times \text{Titre reading} \times \text{Volume made} \times \text{Equivalent weight of acid}}{\text{Weight of sample taken} \times \text{Volume of sample taken for estimation} \times 1000} \times 100
\]

3.2.2.3 Reducing sugars (%)

The reducing and total sugars were estimated by using Lane and Eynon method (1923) with modifications suggested by Ranganna (1997). A known weight of sample was taken with distilled water using lead acetate (45 %) for precipitation of extraneous material and potassium oxalate (22 %) to de-lead the solution. This lead free extract was used to estimate reducing sugars by titrating against standard Fehling’s mixture (Fehling A and B in equal proportion) using methylene blue as an indicator to a brick red end point.
3.2.2.4 Total sugars (%)

Total sugars were estimated by the same method after acid hydrolysis of an aliquot of delead sample with 50 per cent hydrochloric acid followed by neutralization with 40 per cent sodium hydroxide.

\[
\text{Total sugars} \; \% = \frac{\text{Factor} \times \text{Dilution} \times 100}{\text{Titre reading} \times \text{Weight of sample}}
\]

3.2.2.5 Ascorbic acid (mg/100g)

Determination of ascorbic acid was done by 2, 6-dichlorophenol indophenol dye method of Johnson (1948) as described by Ranganna (1997). A known quantity of sample was with taken 3 per cent metaphosphoric acid (HPO\(_3\)) to make the final volume of 100 ml and then filtered. A known quantity of aliquot was then titrated against 0.025 per cent 2, 6 dichlorophenol - indophenol dye to a pink coloured end point. The ascorbic acid content of the sample was calculated taking into consideration the dye factor and expressed as mg of ascorbic acid per 100 g fruit juice.

\[
\text{Ascorbic acid} \; \text{(mg/100g)} = \frac{\text{Titre reading} \times \text{Dye factor} \times \text{Volume made up}}{\text{Aliquot extract taken for estimation} \times \text{Weight of sample}} \times 100
\]

3.2.3 Preparation and evaluation of sapota [\textit{Manilkara achras} (Mill.) Fosberg] syrup.

The sapota syrup was prepared as per the steps given below.

3.2.3.1 Selection of fruits

Fully ripe, fresh and sound sapota fruits were selected for the preparation of syrup.
3.2.3.2 Preparation of fruits for juice extraction

The fruits were washed with water to remove dirt and dust. The fruit stalks were removed manually. The fruits were then peeled and cut into the pieces after removing the seeds. The sapota pieces were then used for the extraction of juice.

3.2.3.3 Extraction of juice

The sapota juice was extracted manually by squeezing the pulp taken in muslin cloth which was then strained through fourfold muslin cloth.

3.2.3.4 Addition of chemical preservative

The chemical preservative i.e. potassium metabisulphite was added @1000 ppm of fruit juice after extraction of sapota juice.

3.2.3.5 Clarification of sapota juice

The sapota juice was stored at ambient conditions for a period of 1 month for the settling of particles to obtain the clear juice. The clarified sapota juice thus, collected was later on used for the preparation of syrup.

3.2.3.6 Preparation of syrup

i) Preparation of sapota syrup

The sapota syrup was prepared by adding sugar syrup (75° brix), as per the treatments and 1 per cent acidity of the sapota syrup was maintained in each treatment by adding citric acid to the syrup.

3.2.3.7 Filling and storage of the sapota syrup

The product was then filled in presterilized glass bottles. The bottles were then sealed air tight, labelled and stored at a cool and dry place at ambient temperature conditions for further investigation.

3.2.4 Storage behaviour of sapota syrup
The syrup was stored at ambient temperature conditions to study the storage behaviour of the product with respect to the changes in physical, chemical and sensory qualities during storage. The product was evaluated immediately after preparation and at an interval of 30 days up to 90 days of storage.

3.2.4.1 Physical parameters of sapota syrup

3.2.4.1 (a) Colour

The colour of syrup was determined as L*, a* and b* values using a colorimeter (Make Konica Minolta, Japan).

The colour parameters were represented by L* for lightness, a* for redness and b* for yellowness.

3.2.4.2 Changes in chemical composition of the sapota syrup during storage

The changes in chemical constituents such as T.S.S., titratable acidity, reducing and total sugar content of syrup were determined at an interval of 30 days up to 90 days of storage. The procedure followed to determine the chemical constituents is as described under 3.2.2.1-3.2.2.5.

3.2.4.3 Changes in organoleptic qualities of the sapota syrup

The product was evaluated for their organoleptic qualities like colour, flavour and overall acceptability on a hedonic scale (Amerine et al., 1965) as given below
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Organoleptic score</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>9</td>
<td>Like extremely</td>
</tr>
<tr>
<td>2.</td>
<td>8</td>
<td>Like very much</td>
</tr>
<tr>
<td>3.</td>
<td>7</td>
<td>Like moderately</td>
</tr>
<tr>
<td>4.</td>
<td>6</td>
<td>Like slightly</td>
</tr>
<tr>
<td>5.</td>
<td>5</td>
<td>Neither liked nor disliked</td>
</tr>
<tr>
<td>6.</td>
<td>4</td>
<td>Dislike slightly</td>
</tr>
<tr>
<td>7.</td>
<td>3</td>
<td>Dislike moderately</td>
</tr>
<tr>
<td>8.</td>
<td>2</td>
<td>Dislike very much</td>
</tr>
<tr>
<td>9.</td>
<td>1</td>
<td>Dislike extremely</td>
</tr>
</tbody>
</table>

(Source: Amerine et al., 1965)

The overall rating was obtained by averaging the score of evaluation. The syrup with organoleptic score of 5.5 and above was rated as acceptable. The syrup was evaluated organoleptically by diluting it with chilled water in the proportion of 1:4.

### 3.2.5 Microbial analysis

The microbial analysis of the syrup was carried out at 0 days and after 90 days of storage as per the method described by Kiiyukia (2003).

Nutrient Agar media was prepared by weighing required quantity of nutrient agar and diluted with double distilled water to a known volume. The media was then autoclaved at 121\(^0\) C for 20 min. When the temperature of media reached to 40\(^0\) C, it was used for plating.

The plating was carried out with 0.1 ml sample in sterile petriplates under the Laminar Air Flow. The sample of each treatment was taken on a separate petriplate, followed by pouring of approximately 20 ml of media (35-40\(^0\) C) on the sample and mixing was done by tilting plate properly.
Plates were sealed with parafilm and incubated at 37\(^0\) C for 48 hrs. to check bacterial count and kept it for 5-6 days at room temperature for fungal count. Total microbial plate count was measured in colony forming unit/gram.

3.2.6 Statistical analysis

The data collected on physical parameters of sapota fruit such as juice recovery, colour (L*, a* and b* values), microbial count of prepared product and chemical parameters \textit{viz.}, T.S.S., acidity and sugars were represented as mean values. The data collected on the changes in the physico-chemical composition and organoleptic qualities were statistically analysed by the standard procedure given by Panse and Sukhatme (1985) using Factorial Completely Randomized Design and valid conclusions were drawn only on significant differences between treatment mean at 0.05 per cent level of significance.

3.2.7 Economics

The economics of the product was worked out by considering existing rates of various inputs such as cost of raw material, labour, fuel, electricity, packaging, depreciation (repairing charge) and interest on the fixed capital.

The gross returns as per the treatments were worked out by considering prevailing market price. The sale price of the product was calculated by adding 20 per cent profit margins to the cost of product. The net profit was calculated for different treatments of the experiments.
Flow chart I

Preparation of sapota syrup

Selection of ripe sapota fruits

Washing of fruits

Peeling and removal of seed

Cutting them into slices

Extraction of juice by two fold muslin cloth

Straining through double fold muslin cloth

Addition of KMS @ 1000 ppm as perservatives and storing the juice for 1 month for sedimentation

Separation of clear juice

Mixing juice with 75\(^0\) brix sugar syrup as per the treatment and 1.0 \% citric acid in each treatment

Filling the product in pre-sterilized bottles

Capping and Labelling

Storage of the product at cool and dry place
CHAPTER – IV
RESULTS AND DISCUSSION

The research project entitled “Studies on standardization of sapota [Manilkara achras (Mill.) Fosberg] syrup” was undertaken in the Department of Post-Harvest Management of Fruit, Vegetable and Flower Crops, Post Graduate Institute of Post-Harvest Management, Killa-Roha, during the year 2014 – 2015. The results of the experiment under study are presented and discussed in this chapter.

4.1 Per cent juice recovery and chemical composition

4.1.1 Per cent juice recovery of sapota fruit

The data pertaining to the juice recovery of sapota fruit are presented in Table 1 and it could be observed from the data that the average juice recovery of sapota fruit was 36.2 per cent.

Honde (1995) also reported that sapota juice recovery varied between 36 and 42 per cent as whole fruit basis and 51 per cent to the pulp basis.

Dhutade (2012) reported that the sapota juice recovery was 40 per cent.

Shikhare (2014) reported the sapota juice recovery 36.5 per cent.

4.1.2 Chemical composition of fruit juice

The data regarding the chemical composition of fruit juices are presented in Table 1.

4.1.2.1 Total soluble solids (°Brix)

The data regarding the total soluble solids content of sapota juice presented in Table 1 indicate that sapota fruit juice recorded the average T.S.S. of 19.8° Brix. Pawar (1988) and Raut (1999) also reported that the T.S.S of ripe sapota fruit was 23.60° and 23.65° Brix, respectively.

Shikhare (2014) reported 20° Brix T.S.S. of sapota juice.
Table 1. Juice recovery and chemical composition of sapota juice

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Particulars</th>
<th>Mean*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Juice recovery (%)</td>
<td>36.2</td>
</tr>
<tr>
<td>B.</td>
<td>Chemical parameters</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>T.S.S. (°B)</td>
<td>19.8</td>
</tr>
<tr>
<td>2.</td>
<td>Titrable acidity (%)</td>
<td>0.17</td>
</tr>
<tr>
<td>3.</td>
<td>Reducing sugars (%)</td>
<td>10.20</td>
</tr>
<tr>
<td>4.</td>
<td>Total sugars (%)</td>
<td>18.38</td>
</tr>
<tr>
<td>5.</td>
<td>Ascorbic acid (mg/100g)</td>
<td>5.4</td>
</tr>
</tbody>
</table>

* The values are the means of three observations

4.1.2.2 Titratable acidity (%)

The results presented in Table 1 indicate that the average titratable acidity of sapota juice was 0.17 per cent. Similarly 0.13 per cent acidity was also reported by Pawar (1988). Shinde (1993) reported that the average titratable acidity in A, B, C and D grades of sapota cv. Kalipatti was 0.12, 0.11, 0.10 and 0.12 per cent, respectively.

Gautam and Chundawat (1998) observed that there was a decrease in the acidity from 1.20 per cent at half ripe stage to 0.96 per cent at over ripe stage in sapota.

4.1.2.3 Sugars (reducing and total sugars) (%)

The data with respect to reducing and total sugars of sapota juice are presented in Table 1. The per cent reducing and total sugar content of sapota juice was 10.20 and 18.38, respectively. The similar observations were also
noticed by Pawar et al. (2011) who recorded 10.11 and 18.20 reducing sugar and total sugars respectively in sapota fruit.

Shikhare (2014) reported that the reducing and total sugar content was 10.82 and 18.67 per cent, respectively in sapota fruit.

4.1.2.4 Ascorbic acid (mg/100 g)

It is revealed from the data presented in Table 1 that the ascorbic acid content of sapota juice was 5.4 mg/100g. Identical observations were recorded by Honde (1995) who reported the ascorbic acid content of sapota Cv kalipatti juice as 5.6 mg/100g.

4.2 Changes in physico-chemical composition of sapota syrup during storage

4.2.1 Physical parameters of sapota syrup.

4.2.1.1 Colour (L*, a* and b* value)

4.2.1.1 (A) L* value for colour

The data presented in Table 2 and Fig. 1 with respect to the L* value for colour of the sapota syrup revealed that the L* value for colour influenced significantly due to recipe treatments as well as the storage period.

The treatment T2 recorded highest (19.68) mean L* value for colour, followed by treatment T3 (19.28) and T4 (18.49). The lowest (18.28) mean L* value for colour was observed in the treatment T1. Thus, it is evident from the data that the L* value declined with increase in the relative proportion of 75° B sugar syrup in the product.

The colour L* value varied significantly during storage irrespective of the treatments. The highest mean (19.31) colour L* value was recorded at 0 days of storage and the lowest (18.34) mean colour L* value was observed at
Table 2. Changes in L* value for colour of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period (Days)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>Mean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>18.53</td>
<td>18.33</td>
<td>18.17</td>
<td>18.07</td>
<td>18.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>20.33</td>
<td>20.20</td>
<td>20.10</td>
<td>18.08</td>
<td>19.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>19.53</td>
<td>19.33</td>
<td>19.17</td>
<td>19.07</td>
<td>19.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4</td>
<td>18.83</td>
<td>18.67</td>
<td>18.33</td>
<td>18.13</td>
<td>18.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>19.31</td>
<td>19.13</td>
<td>18.94</td>
<td>18.34</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>S.E.m ±</th>
<th>C.D. at 5 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (T)</td>
<td>0.03</td>
<td>0.08</td>
</tr>
<tr>
<td>Storage (S)</td>
<td>0.03</td>
<td>0.08</td>
</tr>
<tr>
<td>Interaction (TXS)</td>
<td>0.06</td>
<td>N.S</td>
</tr>
</tbody>
</table>

**Fig.1.** Changes in L* value for colour of sapota syrup during storage at ambient condition.

- **T1** - (1 part juice + 1.5 parts dry sugar)
- **T2** - 1:4 (75⁰ brix sugar syrup)
- **T3** - 1:5 (75⁰ brix syrup)
- **T4** - 1:6 (75⁰ brix syrup)
90 days of storage. Thus, a decreasing trend was noticed up to 90 days of storage. This might be due to darkening of the sapota syrup during storage period of 90 days at ambient conditions.

The interaction between treatments and the storage period was found statistically non-significant.

Similar results were recorded by Deka (2000) who reported a decreasing trend in hunter L* values and colour differences during storage of lime-aonla and mango-pineapple spiced RTS beverages in different containers under various storage conditions.

4.2.1.1 (B) a* value for colour

The data presented in Table 3 and Fig. 2 exhibit the colour a* value of syrup. It is observed from the data that the colour a* value varied significantly due to the treatments and storage period.

The treatment T₁ recorded highest (0.96) mean a* value for colour. The lowest (0.73) a* value for colour was noticed in the treatment T₂. The treatment T₃ (0.78) which was at par with the treatments T₂ (0.73) and T₄ (0.85). The a* value for the colour indicates the redness of the sapota syrup. Thus, it is clear from the data that the sapota syrup prepared by using dry sugar 1:1.5 ratio was darker than treatment of prepared by use of 75⁰ B sugar syrup. The colour a* value varied significantly during storage irrespective of the treatments. The increasing trend was seen up to 90 days of storage. The highest (1.02) mean a* value for colour was recorded at 90 days of storage and the lowest (0.68) mean a* value for colour was observed at 0 days of storage. The increase in a* value for colour indicates darkening the colour of the product.

The interaction effects related to a* value for colour between recipe treatment and the storage period were found statistically non-significant.
Table 3. Changes in a* value for colour of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period (Days)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td>0.70</td>
<td>0.83</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;</td>
<td>0.57</td>
<td>0.70</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td>0.67</td>
<td>0.70</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;</td>
<td>0.77</td>
<td>0.80</td>
</tr>
<tr>
<td>Mean</td>
<td>0.68</td>
<td>0.76</td>
</tr>
</tbody>
</table>

S.E.m ± C.D. at 5 %

| Treatment (T) | 0.03 | 0.08 |
| Storage (S)   | 0.03 | 0.08 |
| Interaction (TXS) | 0.05 | N.S |

Fig. 2. Changes in a* value for colour of sapota syrup during storage at ambient condition

T<sub>1</sub> - (1 part juice +1.5 parts dry sugar)  
T<sub>2</sub> - 1:4 (75<sup>0</sup> brix sugar syrup)  
T<sub>3</sub> - 1:5 (75<sup>0</sup> brix syrup)  
T<sub>4</sub> - 1:6 (75<sup>0</sup> brix syrup)
The identical observations to this are also reported by Khurdiya (1993) who observed that the Amrapali nectar possessed 6.79 times higher values of a* and then those of Totapuri, respectively.

4.2.1.1 (C) b* value for colour

The data with respect to the colour b* value of syrup are presented in Table 4 and Fig. 3. It was observed that the colour b* value was influenced by the recipe treatments and storage period. The treatment T₁ recorded highest (24.48) mean b* value, followed by the treatments T₄, and T₃ which were significantly b* different from each other and recorded 23.67 and 22.75 mean b* value, respectively where it was lowest (21.67) in the treatment T₂.

The colour b* value varied significantly during storage irrespective of the treatments up to 90 days of storage and there was an increase in b* value for colour after 90 days of storage period. The highest (23.36) mean b* value for colour was recorded at 90 days of storage and the lowest (22.93) mean b* value for colour was observed as 0 days of storage.

The interaction between treatments and storage period for b* value for colour was statistically non-significant.

Deka (2000) reported a decreasing trend in hunter L* and a* values and increasing trend in b* value and colour differences during storage of lime-aonla and mango-pineapple spiced RTS beverages in different containers under various storage conditions.

4.2.2 Chemical parameters of syrup

4.2.2.1 Total soluble solids (°B)

It is evident from the data presented in Table 5 and illustrated in Fig. 4 that there was an increase in the T.S.S. of syrup during storage. It could be observed from the data that the T.S.S. of the syrup varied significantly due to the treatments under study. Among the treatments, the treatment T₄ exhibited
Table 4. Changes in b* value for colour of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period (Days)</th>
<th>b* value for colour</th>
<th>S.E.m ±</th>
<th>C.D. at 5 %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>30</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>T_1</td>
<td>24.27</td>
<td>24.37</td>
<td>24.53</td>
<td>24.73</td>
</tr>
<tr>
<td>T_3</td>
<td>22.53</td>
<td>22.70</td>
<td>22.83</td>
<td>22.93</td>
</tr>
<tr>
<td>T_4</td>
<td>23.40</td>
<td>23.60</td>
<td>23.77</td>
<td>23.90</td>
</tr>
<tr>
<td>Mean</td>
<td>22.93</td>
<td>23.06</td>
<td>23.21</td>
<td>23.36</td>
</tr>
</tbody>
</table>

S.E.m ± C.D. at 5 %

| Treatment (T) | 0.04 | 0.11 |
| Storage (S)   | 0.04 | 0.11 |
| Interaction (TXS) | 0.08 | N.S |

Fig. 3. Changes in b* value for colour of sapota syrup during storage at ambient condition

T_1 - (1 part juice +1.5 parts dry sugar)  
T_2 - 1:4 (75^0 brix sugar syrup)  
T_3 - 1:5 (75^0 brix sugar syrup)  
T_4 - 1:6 (75^0 brix sugar syrup)
significantly highest (69.65\(^{0}\) B) mean T.S.S., followed by the treatments T\(_{1}\) and T\(_{3}\) which were significantly different from each other and recorded the mean T.S.S. of 68.63\(^{0}\) B and 67.94\(^{0}\) B respectively. The treatment T\(_{2}\) 1 part juice 4 parts 75\(^{0}\) brix sugar syrup exhibited significantly minimum (66.75\(^{0}\) B) mean T.S.S. among all treatments. It is clear from the data that the T.S.S. of the sapota syrup increased with increase in the sugar syrup level in the sapota product.

It is evident from the results that initially, the syrup exhibited a minimum (67.99\(^{0}\) B) mean T.S.S. and it was significantly increased to maximum (68.51\(^{0}\) B) after 90 days of storage period.

The interaction between treatments and storage was recorded as statistically non -significant.

An increase in total soluble solids of syrup during storage might be due to hydrolysis of polysaccharide like starch, cellulose and pectin substance into simpler substances. Similar results were recorded by Marimuthu and Thirumaran (2000) who observed an increase in T.S.S. from 70 to 72\(^{0}\) B in jamun syrup during 0 to 3 months of storage and similar observations were observed by Jadhav et al. (2004) in ripe karonda syrup during storage period of 240 days. Das (2009) reported an increase in T.S.S. of jamun syrup from 65.00 to 65.58 per cent during 6 months of storage.

### 4.2.2.2 Titratable acidity (%)

It could be observed from the results presented in Table 6 and Fig. 5 that the titratable acidity of syrup varied significantly with different recipe treatments as well as the storage period. It is noticed from the results that the acidity of the sapota syrup decreased significantly during storage period of 90 days.

It is apparent from the data that among all treatments, the significantly
Table 5. Changes in T.S.S. (°B) of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period (Days)</th>
<th>TSS (°B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td>68.37</td>
<td>68.53</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;</td>
<td>66.50</td>
<td>66.60</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td>67.63</td>
<td>67.80</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;</td>
<td>69.47</td>
<td>69.60</td>
</tr>
<tr>
<td>Mean</td>
<td>67.99</td>
<td>68.13</td>
</tr>
</tbody>
</table>

S.E.m ± C.D. at 5 %

- Treatment (T): 0.04 ± 0.10
- Storage (S): 0.04 ± 0.10
- Interaction (TXS): 0.7 ± N.S

Fig. 4. Changes in T.S.S. (°B) of sapota syrup during storage at ambient condition

T<sub>1</sub> - (1 part juice + 1.5 parts dry sugar)  
T<sub>3</sub> - 1:5 (75° brix sugar syrup)

T<sub>2</sub> - 1:4 (75° brix sugar syrup)  
T<sub>4</sub> - 1:6 (75° brix sugar syrup)
highest (0.976 %) mean titratable acidity was exhibited by T$_4$, followed by T$_2$ (0.964 %) and T$_3$ (0.965 %) at par with each other. In all treatments, significantly lower (0.953 %) mean titratable acidity was noticed in the treatment T$_1$.

The interaction between treatments and storage was recorded as statistically significant.

It was also noticed from the Table 6 that the mean titratable acidity was significantly decreased from initial 0.984 per cent to 0.944 per cent up to 90 days of storage period. The decrease in titratable acidity of the product might be due to utilization of acids for conversion of non-reducing sugars into reducing sugars during storage. Similar observations were reported by Shinde (1993) who observed a decreasing trend in acidity of syrup prepared from ripe sapota cv. Kalipatti fruits during 150 days of storage.

4.2.2.3 Reducing sugars (%)

The data presented in Table 7 and illustrated graphically in Fig. 6 indicate that the syrup recipe as well as storage period exhibited significant changes in the reducing sugar content of the sapota syrup. The mean reducing sugar content was highest (11.04 %) in the treatment T$_4$, followed by the treatments T$_3$ (9.92 %) and T$_2$ (9.63 %), which were significantly different with each other. The lowest (7.84 %) mean reducing sugar content was noticed in the treatment T$_1$ (1 part juice + 1.5 parts dry sugar).

The variation in reducing sugars during storage was found significant at 5 per cent level of significance after three months of storage period. The reducing sugar content of the sapota syrup was increased from 9.17 to 10.15 per cent after 90 days of storage.

The interaction between treatments and storage period was found non-significant at 5 per cent level of significance.
Table 6. Changes in titratable acidity (%) of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period (Days)</th>
<th>Titratable acidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>T₁</td>
<td>0.987</td>
<td>0.953</td>
</tr>
<tr>
<td>T₂</td>
<td>0.977</td>
<td>0.973</td>
</tr>
<tr>
<td>T₃</td>
<td>0.987</td>
<td>0.980</td>
</tr>
<tr>
<td>T₄</td>
<td>0.987</td>
<td>0.980</td>
</tr>
<tr>
<td>Mean</td>
<td>0.984</td>
<td>0.972</td>
</tr>
</tbody>
</table>

S.E.m ± C.D. at 5 %

- Treatment (T): 0.003, 0.008
- Storage (S): 0.003, 0.008
- Interaction (TXS): 0.006, 0.016

Fig. 5. Changes in titratable acidity of sapota syrup during storage at ambient condition

T₁ - (1 part juice +1.5 parts dry sugar)  
T₂ - 1:4 (75⁰ brix sugar syrup)  
T₃ - 1:5 (75⁰ brix sugar syrup)  
T₄ - 1:6 (75⁰ brix sugar syrup)
Table 7. Changes in reducing sugars (%) of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period (Days)</th>
<th>Reducing sugars (%)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>T₁</td>
<td>7.50</td>
<td>7.77</td>
<td>7.98</td>
</tr>
<tr>
<td>T₂</td>
<td>9.20</td>
<td>9.56</td>
<td>9.68</td>
</tr>
<tr>
<td>T₄</td>
<td>10.49</td>
<td>10.79</td>
<td>11.03</td>
</tr>
<tr>
<td>Mean</td>
<td>9.17</td>
<td>9.45</td>
<td>9.66</td>
</tr>
</tbody>
</table>

S.E.m ± C.D. at 5 %

Treatment (T) 0.03 0.09
Storage (S) 0.03 0.09
Interaction (TXS) 0.07 N.S

Fig. 6. Changes in reducing sugars (%) of sapota syrup during storage at ambient condition

T₁ - (1 part juice +1.5 parts dry sugar)  T₃ - 1:5 (75⁰ brix sugar syrup)
T₂ - 1:4 (75⁰ brix sugar syrup)  T₄ - 1:6 (75⁰ brix sugar syrup)
During storage, the reducing sugars were found to increase irrespective of treatments and storage period. This increase might be due to hydrolysis of non-reducing sugars into reducing sugars. Similar results were obtained by Marimuthu and Thirumaran (2000) as well as Kannan and Thirumaran (2004) in jamun syrup while Reddy and Chikkasubbanna (2009) in amla syrup.

4.2.2.4 Total sugars (%)  

It is evident from the data presented in Table 8 and graphically presented in Fig. 7 that the total sugar content of sapota syrup exhibited a variation due to the treatment and increased significantly during storage.

The variation in total sugars due to different treatments was found significant at 5 per cent level of significance. The treatment $T_4$ recorded the highest (55.50 %) mean followed by $T_1$ (55.33 %) $T_3$ (54.62%),$T_2$ (52.18 %). The treatment $T_2$ i.e. 1 part juice + 4 parts 75 $^0$B sugar syrup recorded significantly lowest (52.18 %) mean total sugar content. It is the evident from the data that the total sugar content of syrup increased with rise in the relative proportion of 75$^0$ B sugar syrup in the product.

The total sugar content increased significantly from 52.65 per cent at the time of preparation to 56.53 per cent after 90 days of storage. A linear increase in the total sugar content of the sapota syrup was noticed up to 90 days of storage. The interaction between treatment and storage period was found significant at 5 per cent level of significance.

The total sugars of sapota syrup increased significantly during storage period of 90 days. This could be attributed to the fact that the hydrolysis of polysaccharides during storage resulted into increase in the soluble sugars. It is also reported by Reddy and Chikkasubbanna (2009) in amla syrup. Similar results were observed by Marimuthu and Thirumaran (2000) in jamun syrup.
Table 8. Changes in total sugars (%) of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period (Days)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>T₁</td>
<td>53.69</td>
<td>54.58</td>
</tr>
<tr>
<td>T₂</td>
<td>51.23</td>
<td>51.97</td>
</tr>
<tr>
<td>T₃</td>
<td>52.34</td>
<td>53.69</td>
</tr>
<tr>
<td>T₄</td>
<td>53.34</td>
<td>54.07</td>
</tr>
<tr>
<td>Mean</td>
<td>52.65</td>
<td>53.58</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S.E.m ±</th>
<th>C.D. at 5 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (T)</td>
<td>0.05</td>
</tr>
<tr>
<td>Storage (S)</td>
<td>0.05</td>
</tr>
<tr>
<td>Interaction (TXS)</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Fig. 7. Changes in total sugars (%) of sapota syrup during storage at ambient Condition

T₁ - (1 part juice + 1.5 parts dry sugar)  
T₃ - 1:5 (75⁰ brix sugar syrup)  
T₂ - 1:4 (75⁰ brix sugar syrup)  
T₄ - 1:6 (75⁰ brix sugar syrup)
where the total sugar content was increased from 65.00 to 68.30 per cent during the 3 months of storage.

Kannan and Thirumaran (2004) also reported the increase in total sugar content of jamun syrup from 63.00 to 69.20 per cent in 6 months of storage period.

**4.2.2.5 Ascorbic acid (mg/100 g)**

It is evident from the data presented in Table 9 and graphically presented in Fig. 8 that the ascorbic acid content of sapota syrup exhibited variation due to the treatment and increased significantly during storage.

The treatment T\textsubscript{2} recorded the highest (3.78 mg/100g) ascorbic acid content, followed by the treatment T\textsubscript{3} (2.89 mg/100g). The treatment T\textsubscript{1} recorded significantly lowest (2.23 mg/100g) mean ascorbic acid content, whereas, the treatment T\textsubscript{4} recorded significantly lowest (2.56 mg/100g) mean ascorbic acid content. The ascorbic acid content of the sapota syrup decreased with rise in the proportion of the sugar syrup with 75\textdegree B strength.

The ascorbic acid content decreased significantly from (3.38 mg/100g) at the time of preparation to (2.37 mg/100g) per cent after 90 days of storage. A linear decrease in the ascorbic acid content of the sapota syrup was noticed up to 90 days of storage. The interaction between treatment and storage period was found non-significant.

The decline in ascorbic acid content of sapota syrup during storage could be attributed to its degradation during storage.

Identical observations were also observed by Pawar (1988) in karonda syrup as well as Marathe (1989) in cashewapple syrup.
Table 9. Changes in ascorbic acid (mg/100g) content of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Ascorbic acid (mg/100g)</th>
<th>Storage period (Days)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td>2.77</td>
<td>2.43</td>
<td>2.08</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;</td>
<td>4.26</td>
<td>3.80</td>
<td>3.68</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td>3.35</td>
<td>2.97</td>
<td>2.73</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;</td>
<td>3.12</td>
<td>2.73</td>
<td>2.43</td>
</tr>
<tr>
<td>Mean</td>
<td>3.38</td>
<td>2.93</td>
<td>2.73</td>
</tr>
</tbody>
</table>

S.E.m ± C.D. at 5 %

| Treatment (T) | 0.04 | 0.11 |
| Storage (S)   | 0.04 | 0.11 |
| Interaction (TXS) | 0.08 | N.S |

Fig. 8. Changes in ascorbic acid (mg/100g) content of sapota syrup during storage at ambient condition

T<sub>1</sub> - (1 part juice +1.5 parts dry sugar)   T<sub>3</sub> - 1:5 (75<sub>0</sub> brix sugar syrup)
T<sub>2</sub> - 1:4 (75<sub>0</sub> brix sugar syrup)   T<sub>4</sub> - 1:6 (75<sub>0</sub> brix sugar syrup)
4.3 Microbial analysis of syrup

The results related to the microbial count for bacteria as well as for fungi in sapota syrup were presented in the Table 10 and Fig. 8. It is clear from the data that the microbial count in sapota syrup was not influenced by the recipe treatments and the results were statistically significant. The highest (0.38 cfu/ml) mean microbial count was observed in the treatment T_2. The lowest (0.13 cfu/ml) mean microbial count was observed in the treatment T_4, followed by T_1 and T_3. The microbial count declined with the increase in the proportion 75° B syrup in the product.

A significant increase in mean microbial count of syrup from 0 to 0.51 cfu/ml was observed in 90 days of storage period. However, the microbial count of syrup was negligible irrespective of the treatments during storage period of 90 days. The interaction between treatments and storage period with respect to microbial count was found statistically significant.


4.4 Changes in organoleptic qualities of sapota syrup during storage condition.

It could be revealed from the data that the sapota syrup prepared according to the recipes under study was found to be organoleptically quite acceptable not only at the time of preparation but also throughout the storage period of 90 days.

4.4.1 Colour

The data on the changes in the organoleptic score for colour of sapota syrup influenced by different treatments and storage period are presented in
Table 10. Changes in microbial count (cfu/ml) of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period (Days)</th>
<th>Microbial Count (cfu/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>T₁</td>
<td>0</td>
<td>0.41</td>
</tr>
<tr>
<td>T₂</td>
<td>0</td>
<td>0.75</td>
</tr>
<tr>
<td>T₃</td>
<td>0</td>
<td>0.61</td>
</tr>
<tr>
<td>T₄</td>
<td>0</td>
<td>0.25</td>
</tr>
<tr>
<td>Mean</td>
<td>0.00</td>
<td>0.51</td>
</tr>
</tbody>
</table>

S.E.m ± C.D. at 5 %

- Treatment (T) 0.02 0.05
- Storage (S) 0.01 0.04
- Interaction (TXS) 0.02 0.07

Fig 9. Changes in microbial count of sapota syrup during storage at ambient condition

T₁ - (1 part juice +1.5 parts dry sugar)  
T₂ - 1:4 (75⁰ brix sugar syrup)  
T₃ - 1:5 (75⁰ brix sugar syrup)  
T₄ - 1:6 (75⁰ brix sugar syrup)
Table 11. Changes in the organoleptic score for colour of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period (Days)</th>
<th>Organoleptic score for colour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>T₁</td>
<td></td>
<td>8.00</td>
</tr>
<tr>
<td>T₂</td>
<td></td>
<td>7.83</td>
</tr>
<tr>
<td>T₃</td>
<td></td>
<td>7.67</td>
</tr>
<tr>
<td>T₄</td>
<td></td>
<td>7.17</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>7.67</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>S.E.m ±</th>
<th>C.D. at 5 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (T)</td>
<td>0.10</td>
<td>0.27</td>
</tr>
<tr>
<td>Storage (S)</td>
<td>0.10</td>
<td>0.27</td>
</tr>
<tr>
<td>Interaction (TXS)</td>
<td>0.19</td>
<td>N.S</td>
</tr>
</tbody>
</table>

Fig. 10. Changes in the organoleptic score for colour of sapota syrup during storage at ambient condition

T₁ - (1 part juice + 1.5 parts dry sugar)  
T₂ - 1:4 (75⁰ brix sugar syrup)  
T₃ - 1:5 (75⁰ brix sugar syrup)  
T₄ - 1:6 (75⁰ brix sugar syrup)
Table 11 and graphically illustrated in Fig. 10.

It could be noticed from the data that the changes in the organoleptic score for colour of the syrup, prepared by four different treatments were statistically significant. The treatment $T_1$ recorded highest (7.50) mean sensory score for colour, but it was at par (7.42) with the treatment $T_2$ i.e. 1 part juice + 4 parts 75$^\circ$ brix sugar syrup. The lowest (6.71) mean was noticed in the treatment $T_4$, followed by the treatment $T_3$ (7). Treatments $T_1$ (7.50) and $T_2$ (7.42) were significantly superior to other treatments viz. $T_3$ (7.00) and $T_4$ (6.71).

The variation in the organoleptic score for colour during storage was found statistically significant at 5 per cent level of significance. The significantly higher (7.67) mean organoleptic score for colour was recorded immediately after preparation which was decreased with increase in the storage period (6.63). The interaction effect between storage and treatment was found to be statistically non-significant.

Analogous observations to these finding were reported by Marimuthu and Thirumaran (2000) and Das (2009) in jamun beverages where the jamun products were found to be acceptable up to five months of storage.

4.4.2 Flavour

The changes in the organoleptic score for flavour of sapota syrup are presented in Table 12 and illustrated in the Fig 11.

The significantly maximum (7.42) mean score for flavour was recorded by the treatments $T_1$ and $T_2$. The treatment $T_4$ recorded the lowest (6.58) mean score for flavour of sapota syrup, followed by the treatment $T_3$ (6.92).
Table 12. Changes in the organoleptic score for flavour of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Organoleptic score for flavour</th>
<th>Storage period (Days)</th>
<th>0</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td></td>
<td></td>
<td>7.67</td>
<td>7.5</td>
<td>7.33</td>
<td>7.17</td>
<td>7.42</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;</td>
<td></td>
<td></td>
<td>7.83</td>
<td>7.5</td>
<td>7.17</td>
<td>7.17</td>
<td>7.42</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td></td>
<td></td>
<td>7.17</td>
<td>7.0</td>
<td>6.83</td>
<td>6.67</td>
<td>6.92</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;</td>
<td></td>
<td></td>
<td>6.38</td>
<td>6.67</td>
<td>6.50</td>
<td>6.33</td>
<td>6.58</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td>7.38</td>
<td>7.17</td>
<td>6.96</td>
<td>6.84</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>S.E.m ±</th>
<th>C.D. at 5 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (T)</td>
<td>0.8</td>
<td>0.23</td>
</tr>
<tr>
<td>Storage (S)</td>
<td>0.8</td>
<td>0.23</td>
</tr>
<tr>
<td>Interaction(TXS)</td>
<td>0.16</td>
<td>N.S</td>
</tr>
</tbody>
</table>

Fig. 11. Changes in the organoleptic score for flavour of sapota syrup during storage at ambient condition

T<sub>1</sub> - (1 part juice +1.5 parts dry sugar)  
T<sub>2</sub> - 1:4 (75<sup>0</sup> brix sugar syrup)  
T<sub>3</sub> - 1:5 (75<sup>0</sup> brix sugar syrup)  
T<sub>4</sub> - 1:6 (75<sup>0</sup> brix sugar syrup)
The organoleptic score for flavour of the syrup reduced significantly during storage, which was maximum 7.38 i.e. immediately after preparation, but decreased to score of 6.84 after 90 days of storage.

The interaction between treatment and storage was found to be statistically non-significant. Similar observations were also reported by Marimuthu and Thirumaran (2000) and Das (2009) in jamun syrup and Jadhav et al. (2004) in ripe karonda.

**4.4.3 Overall Acceptability**

It is evident from the data presented in Table 13 and Fig. 12 that the changes in the organoleptic score for overall acceptability of syrup due to treatments were found statistically non-significant.

It is noticed from the data that the treatment T<sub>1</sub> was significantly superior to the rest of treatments with respect to overall acceptability, except the treatment T<sub>2</sub>. The treatment T<sub>1</sub> scored maximum (7.46) mean but it was at par with treatment T<sub>2</sub>. The lowest (6.67) mean organoleptic score for overall acceptability of the sapota syrup was recorded by the treatment T<sub>4</sub>, followed by the treatment T<sub>3</sub>. The addition of higher level of sugar syrup (1:5 or 1:6) in the product affected the overall acceptability of the product. Thus, it is clear from the data that the good quality sapota syrup with respect to overall acceptability could be prepared by using 1 part juice + 1.5 parts dry sugar or by adding 75° B sugar syrup in sapota juice in the proportion of 1:4. In storage, the organoleptic score for overall acceptability of the syrup declined significantly i.e. from 7.52 to the score of 6.77 after 90 days of storage. Moreover, the organoleptic score overall acceptability do not show any variation up to 30 days storage, but declined significantly during lantern period of storage of the product at ambient condition. The interaction effects
Table 13. Changes in the organoleptic score for overall acceptability of sapota syrup during storage at ambient condition

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period (Days)</th>
<th>Organoleptic score for overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td></td>
<td>7.83</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;</td>
<td></td>
<td>7.83</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td></td>
<td>7.42</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;</td>
<td></td>
<td>7.00</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>7.52</td>
</tr>
</tbody>
</table>

S.E.m ± C.D. at 5 %

| Treatment (T) | 0.09 | 0.25 |
| Storage (S)   | 0.09 | 0.25 |
| Interaction (TXS) | 0.17 | N.S  |

Fig. 12. Changes in the organoleptic score for overall acceptability of sapota syrup during storage at ambient condition

T<sub>1</sub> - (1 part juice + 1.5 parts dry sugar)  
T<sub>2</sub> - 1:4 (75<sup>0</sup> brix sugar syrup)  
T<sub>3</sub> - 1:5 (75<sup>0</sup> brix sugar syrup)  
T<sub>4</sub> - 1:6 (75<sup>0</sup> brix sugar syrup)
between treatment and storage were found statistically non-significant.

Analogous observations in conformity to these finding were also reported by Marimuthu and Thirumaran (2000) and Das (2009) in jamun syrup and Jadhav et al., (2004) in ripe karonda syrup.

4.5 Economics

The economics for the preparation of 100 kg of sapota syrup is given in Table 14. From the results, it could be observed that the total expenditure for production of sapota syrup was highest (Rs. 11042.95/-) in the treatment T1 i.e. 1 part of juice + 1.5 Parts of dry sugar and lowest (Rs. 8978.55) in the treatment T4 i.e. 1 part juice 6 parts 75⁰ B sugar syrup.

Higher gross return and net profit of Rs. 13251.54/- and Rs. 2208.59/-, respectively was found in the treatment T1 i.e. 1 part of juice + 1.5 Parts of dry sugar and lowest gross return (Rs. 10774.26/-) and net profit (Rs. 1795.71/-) in the treatment T4 i.e. 1 part juice 6 part 75⁰ B sugar syrup.

The sale price was maximum (Rs. 26.50/-) in T1 and lowest (Rs. 21.54/-) in the treatment T4 i.e. 1:6 (75⁰ Brix sugar syrup). Benefit cost ratio was 1.20 same in all four treatments, as the profit margin was considered as 20 per cent to each treatment.

Comparatively, a cheaper Sapota syrup could be prepared by 75⁰ B syrup as compared to the product prepared by using dry sugar in the ratio of 1:1.5.

According to the sensory qualities for overall acceptability, the treatment recipe T1 1 part of juice + 1.5 part of dry sugars and T2 were best recipes for the sapota syrup among all other recipes. Sale price for the treatment T1 and T2 for 200 ml syrup bottle was Rs. 26.50/- and Rs. 22.14. Among these treatments, the treatments T2 was better than the treatment T1 with respect to cost of production and lower sale price.
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars</th>
<th>T₁</th>
<th>T₂</th>
<th>T₃</th>
<th>T₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cost of Sapota fruits @ Rs. 25/- per kg</td>
<td>2762.43</td>
<td>1381.21</td>
<td>1151.01</td>
<td>986.58</td>
</tr>
<tr>
<td>2.</td>
<td>Labour charge @ Rs. 200/- per skilled and Rs. 120/- per unskilled Labour</td>
<td>640</td>
<td>440</td>
<td>440</td>
<td>440</td>
</tr>
<tr>
<td>3.</td>
<td>Glass bottle @ Rs. 5/- per bottle</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
</tr>
<tr>
<td>4.</td>
<td>Sugar @ Rs. 36/- per kg</td>
<td>2160</td>
<td>2160</td>
<td>2250</td>
<td>2314.28</td>
</tr>
<tr>
<td>5.</td>
<td>Citric acid @ Rs. 25.5/- per 100gm</td>
<td>237.66</td>
<td>246.33</td>
<td>247.77</td>
<td>248.80</td>
</tr>
<tr>
<td>6.</td>
<td>KMS @ Rs. 634/- per kg</td>
<td>25.36</td>
<td>12.68</td>
<td>10.56</td>
<td>9.05</td>
</tr>
<tr>
<td>7.</td>
<td>Plastic caps @ Rs. 50/- per 100 caps</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>8.</td>
<td>Fuel charge @ Rs. 8.33/hour</td>
<td>99.96</td>
<td>33.32</td>
<td>41.65</td>
<td>49.98</td>
</tr>
<tr>
<td></td>
<td>Cost of Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Working capital</td>
<td>8675.41</td>
<td>7023.54</td>
<td>6890.99</td>
<td>6798.69</td>
</tr>
<tr>
<td>2.</td>
<td>Supervision charges @ 10% of the working capital</td>
<td>867.54</td>
<td>702.35</td>
<td>689.09</td>
<td>679.86</td>
</tr>
<tr>
<td>3.</td>
<td>Depreciation charges @ 2% of the fixed capital @ 2% on Rs. 10000/-</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>4.</td>
<td>Interest on fixed capital @ 13% on Rs. 10000/-</td>
<td>1300</td>
<td>1300</td>
<td>1300</td>
<td>1300</td>
</tr>
<tr>
<td>5.</td>
<td>Total cost of production (A)</td>
<td>11042.95</td>
<td>9225.89</td>
<td>9080.08</td>
<td>8978.55</td>
</tr>
<tr>
<td>6.</td>
<td>Gross returns (B)</td>
<td>13251.54</td>
<td>11071.06</td>
<td>10896.09</td>
<td>10774.26</td>
</tr>
<tr>
<td>7.</td>
<td>Net profit (B-A) Rs.</td>
<td>2208.59</td>
<td>1845.17</td>
<td>1816.01</td>
<td>1795.71</td>
</tr>
<tr>
<td>8.</td>
<td>Benefit : cost (B/A)</td>
<td>1.20</td>
<td>1.20</td>
<td>1.20</td>
<td>1.20</td>
</tr>
<tr>
<td>9.</td>
<td>Sale price per 200 ml bottle (Rs.)</td>
<td>26.50</td>
<td>22.14</td>
<td>21.79</td>
<td>21.54</td>
</tr>
</tbody>
</table>
CHAPTER V
SUMMARY AND CONCLUSION

The research project entitled “Studies on standardization of sapota [Manilkara achras (Mill.) Fosberg] syrup” was undertaken in the Department of Post-Harvest Management of Fruit, Vegetable and Flower Crops, Post Graduate Institute of Post-Harvest Management, Killa-Roha, during the year 2014 – 2015.

The pivotal findings of the present investigation are summarised and mentioned as below.

5.1 Per cent juice recovery of sapota.

The average juice recovery of sapota was 36.2 per cent.

5.2 Chemical composition of fruit juices.

The T.S.S of sapota fruit juice was 19.8° brix with 0.17 per cent titratable acidity. The reducing and total sugars of sapota fruit juice were 10.20 and 18.38 per cent, respectively. The ascorbic acid content of the sapota juice was 5.4 mg/100g.

5.3. Changes in the physico-chemical composition of syrup

5.3.1 Physical parameters of syrup

5.3.1.1 L* Value for colour

The treatment T₂ recorded the highest (19.68) mean L* value for colour i.e. 1 part juice 4 parts 75% sugar syrup. The lowest (18.28) mean L* value for colour was observed in the treatment T₁.

The decreasing trend was seen up to 90 days of storage. The highest (19.31) mean colour L* value was recorded at 0 days of storage and the lowest (18.34) at 90 days of storage.
5.3.1.2 a* value for colour:

The treatment $T_1$ recorded the highest (0.96) mean $a^*$ value for colour i.e. 1 part juice 1.5 parts dry sugar. The lowest (0.73) mean $a^*$ value for colour was observed in the treatment $T_2$ i.e. 1 part juice 4 parts 75° brix sugar syrup.

The increasing trend was seen up to 90 days of storage. The highest (1.02) mean $a^*$ value for colour was recorded at 90 days of storage and the lowest (0.68) was observed at 0 days of storage.

5.3.1.3 b* value for colour

The treatment $T_1$ recorded the highest (24.48) mean $b^*$ value for colour i.e. 1 part juice + 1.5 parts dry sugar. The lowest (21.67) mean $b^*$ value for colour was observed in the treatment $T_2$ i.e. 1 part juice 4 parts 75° brix sugar syrup.

The increasing trend was noticed up to 90 days of storage. The highest mean (23.36) $b^*$ value for colour was recorded at 90 days of storage and the lowest (22.93) mean $b^*$ value for colour was observed after 0 days of storage.

5.3.2 Chemical composition of sapota syrup

The changes in the chemical constituents of syrup were observed during the storage period of 90 days as given below.

1. As regards the total soluble solids (T.S.S.), the treatment $T_4$ i.e. 1 part juice + 6 parts 75% brix sugar syrup recorded maximum (69.65° Brix) mean T.S.S. while it was minimum (66.75° Brix) T.S.S in the treatment $T_2$ i.e. 1 part juice + 4 parts 75° brix sugar syrup. A significant increase in the T.S.S. of syrup was noticed throughout the storage period of 90 days.

2. While considering the acidity of sapota syrup, it was decreased significantly with increasing in the storage period. The highest
(0.976%) mean titratable acidity was recorded in the treatment T₄ i.e. 1 part of juice + 6 parts 75⁰ brix sugar syrup and the lowest acidity i.e. 0.953 per cent was recorded in the treatment T₁ i.e. 1 part of juice +1.5 parts of dry sugar.

3. As far as reducing sugar content in sapota syrup is concerned, the treatment T₄ i.e. 1 part juice + 6 parts 75⁰ brix sugar syrup recorded significantly highest (11.04%) reducing sugars and lowest in the treatment T₁ 1 part of juice + 1.5 parts of dry sugar i.e. 7.84 per cent. There was an increase in the reducing sugar content of syrup irrespective of treatments during storage.

4. Total sugar content of syrup exhibited variation due to the treatments and increased significantly during the storage. The maximum (55.50%) total sugar content was recorded in treatment T₄ i.e. 1 part juice + 6 parts 75% brix sugar syrup. The minimum total sugar content was noticed in the treatment T₂ (52.18%) i.e. 1 part juice + 4 parts of dry sugar.

5. The ascorbic acid where of the sapota syrup decreased significantly with increase in the storage period. The highest (3.78 mg/100g) mean ascorbic acid was recorded in the treatment T₂ i.e. 1 part of juice + 4 parts 75% brix sugar syrup and the lowest ascorbic acid i.e. (2.23 mg/100g) was recorded in the treatment T₁ i.e. 1 part of juice + 1.5 parts of dry sugar.

Thus, an increasing trend in T.S.S, reducing sugars and total sugars was observed while a decreasing trend in the titrable acidity and ascorbic acid content and was noticed during storage period of 90 days of at ambient conditions.

5.4 Microbial analysis of sapota syrup
At 0 days of the storage, the microbial count was nil in all the treatments. The increase in mean microbial count from 0 to 0.51 cfu/ml irrespective of the treatments was observed after 90 days of storage of sapota syrup but it was within the permissible limits.

5.5 Changes in organoleptic qualities of syrup

Sapota syrup prepared from sapota fruit juice was organoleptically acceptable after 90 days of storage.

Among different recipes, the treatment $T_1$ i.e 1 part of juice + 1.5 parts of dry sugar and $T_2$ recorded maximum mean score for colour, flavour and overall acceptability of the sapota syrup. The organoleptic score of sapota syrup was decreased throughout the storage period of 90 days. Among all the recipes, the syrup recipe i.e $T_1$ part of juice + 1.5 parts of dry sugar and $T_2$ were found to be superior in organoleptic qualities to rest of the treatments.

5.6 Economics of syrup

As far as the economics of sapota syrup is concerned, among all the treatments, the treatment $T_1$ (1 part of juice + 1.5 parts of dry sugar) recorded the highest sale price i.e. Rs. 26.50/- and lowest in the treatment $T_4$ (Rs. 21.54). Benefit to cost ratio was the same for all the treatments (1.20).

From organoleptic point of view, the treatment $T_1$ and $T_2$ were the best treatment. Among the treatments, the treatment $T_2$ recoated the lower (Rs.22.14 per 200 ml) sale prize with comparatively higher gross returns on the investment then the treatment $T_1$.

CONCLUSION

From the present investigation, it could be concluded that all the recipes of sapota syrup were found to be organoleptically acceptable not only
at the time of preparation but also throughout the storage period of 3 months at ambient conditions.

The sapota syrup prepared from sapota fruit juice was significantly superior with respect to overall acceptability of the product.

The syrups recipe i.e. 1 part of juice + 1.5 parts of dry sugar and 1 part juice + 4 parts 75\(^0\) B sugar syrup were found to be the best recipes for sapota syrup with highest organoleptic score for colour, flavour and overall acceptability. Based on the economics and organoleptic qualities, the recipe i.e. 1 part juice + 4 parts 75\(^0\) B sugar syrup was the best recipe for the production of sapota syrup.
**Literature Cited**


*Original not seen
# APPENDIX I

## Weekly Weather Data Roha Center, Year - 2015

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<th>Period</th>
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<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
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APPENDIX II

ABBREVIATIONS USED

% : per cent
(TxS) : Interaction of treatments and storages
/ : Per
@ : At the rate of
\(^0\)Brix : Degree Brix
\(^0\)C : Degree Celsius
a* : Redness
A.O.A.C. : Association of Official Analytical chemists
Anon. : Anonymous
b* : Yellowness
C.D. : Critical difference
Cv. : Cultivar
et al. : and others
etc. : Etcetera
FCRD : Factorial Completely Randomized Design
Fig. : Figure
g. : Gram (s)
Ha : Hectare
hrs. : Hours
i.e. : that is
kg : Kilogram
L* : Brightness
M.S. : Maharashtra State.
mg : Milligram
min : Minute
ml : Milliliter
mm : Millimeter
MT : Metric tonne
<table>
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<td>nm</td>
<td>Nano meter</td>
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<tr>
<td>NS</td>
<td>Non-significant</td>
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<tr>
<td>ppm</td>
<td>Parts per million</td>
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<tr>
<td>S.E.m</td>
<td>Standard error of mean</td>
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<td>Sig.</td>
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<td>Total soluble solids</td>
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<td>Namely</td>
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## VITAE

**HARSHALA ISHWAR DALVI.**

A candidate for the degree of

**M.Sc. (Post Harvest Management)**

<table>
<thead>
<tr>
<th>Title of thesis</th>
<th>Studies on standardization of sapota (Manilkara achras (Mill.) Fosberg) syrup.</th>
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<td>Post-Harvest Management of Fruit, Vegetables and Flowers Crops.</td>
</tr>
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### Biographical Information

**-Personal data**

Born at Thane on November 27, 1991, Unmarried.


**-Education**

Attended secondary school at P. J. High school Wada, Higher secondary school at S.V.V. Junior College, Wada. Received the Bachelor’s Degree in Agriculture in second class, from college of Shardchandraji Pawar college Of Agriculture Kharwate -Dahiwali, Dist- Ratnagiri, in 2013.
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(Manilkara achras (Mill.) Fosberg) SYRUP”

BY

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