STUDIES ON PREPARATION OF SYRUP FROM BAEL FRUIT

By

Miss. Bangale Usha Pandurang
(Reg. No. 014/293)

A Thesis submitted to the

**MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI - 413 722, DIST. AHMEDNAGAR,
MAHARASHTRA, INDIA**

In partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE

in

FOOD TECHNOLOGY

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY
POST GRADUATE INSTITUTE
**MAHATMA PHULE KRISHI VIDYAPEETH,
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APPROVED BY

Dr. S.S. Thorat
(Chairman and Research Guide)

Dr. P.M. Kotecha
(Committee Member)

Dr. C.A. Nimbalkar
(Committee Member)

Prof. R.S. Gaikwad
(Committee Member)

Dr. J.K. Dhemre
(Committee Member)

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2016

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part there of has not been submitted by me or other person to any other University or Institute for a Degree or Diploma

Place : MPKV, Rahuri

Date : / /2016 (U.P. Bangale)

Dr. S.S. Thorat
Head,
Department of Food Science and Technology,
Mahatma Phule Krishi Vidyapeeth,
Rahuri - 413 722, Dist. Ahmednagar,
Maharashtra State (INDIA).

CERTIFICATE

This is to certify that the thesis entitled, **"STUDIES ON PREPARATION OF SYRUP FROM BAEL FRUIT"** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri in partial fulfilment of the requirements for the award of the degree of **MASTER OF SCIENCE** in **FOOD TECHNOLOGY** embodies the results of a piece of *bonafide* research work carried out by **MISS. USHA PANDURANG BANGALE** under my guidance and supervision and that no part of the thesis has been submitted to any other University for Degree or Diploma.

The assistance and help rendered during the course of this investigation have been duly acknowledged.

Place: MPKV, Rahuri. (S.S. Thorat)

Date : / /2016 Research Guide

Dr. B. R. Ulmek
Associate Dean,
Post Graduate Institute,
Mahatma Phule Krishi Vidyapeeth,
Rahuri - 413 722, Dist. Ahmednagar,
Maharashtra State (INDIA)

CERTIFICATE

This is to certify that the thesis entitled, **"STUDIES ON PREPARATION OF SYRUP FROM BAEL FRUIT"** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri in partial fulfilment of the requirements for the award of the degree of **MASTER OF SCIENCE** in **FOOD TECHNOLOGY** embodies the results of a piece of *bonafide* research work carried out by **MISS. USHA PANDURANG BANGALE** under the guidance and supervision of **Dr. S.S. THORAT**, Head, Department of Food Science and Technology, M.P.K.V., Rahuri and that no part of the thesis has been submitted to any other University for Degree or Diploma.

Place : MPKV, Rahuri (B. R. Ulmek)

Date : / /2016

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Place: MPKV, Rahuri.

Date: / / 2016 **(U.P. Bangale)**

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LIST OF ABBREVIATIONS

°C	:	Degree Celsius
C.D.	:	Critical Difference
cm	:	Centi metre (s)
et al.	:	et alli
FCRD	:	Factorial Completely Randomised Design
Fig.	:	Figure
hr	:	hour (s)
i.e.	:	that is
kg	:	kilogram (s)
min	:	minute
N	:	Normality
No	:	Number
NS	:	Non-significant
pp	:	page (s)
ppm	:	Parts Per Million
AT	:	Ambient Temperature
RT	:	Refrigerator temperature
S.E.	:	Standard Error
T	:	Temperature
TSS	:	Total soluble solids
SP	:	Storage period
Wt	:	Weight

ABSTRACT

STUDIES ON PREPARATION OF SYRUP FROM BAEL FRUIT

BY

Miss. Usha Pandurang Bangale

A candidate for the degree
of
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Research Guide	: Dr. S.S. Thorat
Discipline	: Food Science and Technology

The present investigation was carried out for preparation of syrup from bael fruit and to study changes in chemical composition and organoleptic properties of bael syrup during storage.

The recovery of pulp was 68 per cent. The fresh bael syrup pulp contained 23.30 °Brix TSS, 0.44 per cent titrable acidity, 3.96 per cent reducing sugars, 8.22 per cent total sugars, 5 pH

Preliminary experiments were conducted to find out the optimum levels of bael pulp and citric acid for preparation of quality syrup. Best treatment was selected from different level of treatments i.e. 25 per cent pulp, 60 per cent sugar, 0.5 per cent citric acid and 600 ppm sodium benzoate and was packed in pet bottles and stored at ambient (30±2°C) and refrigerated temperature (5±2°C) for 90 days to study their storage feasibility.

Abstract contd..... **Miss. Usha P. Bangale**

The fresh syrup had TSS 60.23 ^{0}Brix, titrable acidity 1.21 per cent, total sugars 54.38 per cent, reducing sugars 16.29 per cent, non reducing sugars 38.18 per cent, pH 2.73. The chemical analysis of syrup was carried out regularly at an interval of 30 days. The mean score of T_4 good quality fresh bael syrup for color and appearance was 8.0, flavor 8.5, taste 8.75 and 8.25 overall acceptability on 9 point hedonic scale.

The storage studies indicated that there was a gradual decrease in pH content with advancement of storage period. While TSS, titrable acidity, total sugars and reducing sugars, non reducing sugars increased continuously. The sensory quality of bael syrup decreased at slowly rate during storage. However, bael syrup was found to be acceptable even after 90 days of storage at ambient and refrigerated temperature. But, the bael samples stored at refrigerator temperature were found better as compared to samples stored at ambient temperature.

1. INTRODUCTION

Fruits and vegetables are important constituents of the diet and provide significant qualities of nutrients, especially vitamins, sugars, minerals and fibers. Daily consumption of fruits and vegetables reduce the risk of cancer, heart disease, premature ageing, stress and fatigue primarily due to the integrated action of oxygen radical scavengers such as β-carotene and ascorbic acid plus calcium and dietary fibers. The perishable nature of the fruits and vegetables they require immediate processing to avoid post harvest losses (20-25 %).

Bael (*Aegle marmelos* (L.) Serr.) is an indigenous fruit of India belongs to family Rutaceae and it is commonly known as Bengal quince, Indian quince and Golden apple. Bael fruit is subtropical, deciduous tree and fruit is globule with grey or yellowish hard woody shell.

The bael fruit is known in India from prehistoric times. The fruit is native to Northern India but widely found throughout the Indian Peninsula (Rahman and Pravin, 2014). It is also grown in Sri Lanka, Pakistan, Bangladesh, Burma, Thailand and most of the Southeastern Asia countries (Rakesh *et al.*, 2005).

Ripe bael fruit through very important from the therapeutic and nutritional point of view, it is not consumed freely in the fresh form because of eating difficult. Standardized the techniques for the extraction of pulp from ripe bael fruits (Roy, 1979).

The extracted pulp was adjusted to different levels of total soluble solids by addition of sugar, keeping the acidity

unaltered. The ideal requirement of the total soluble solids in the pulp was determined by organoleptic evaluation. The bael fruit pulp having ideal total soluble solids and acidity.

Bael is originated in India normally the seedlings of bael being require 6 to 7 years to better forming and Vegetative propagated trees bear fruits in five years. The full production is reached in 15 year. The fruit is harvested when yellowish green after 8 days of harvest it looses its green tint. Bael tree may yield as many 800 fruits in a season but an average crop yield is 150-200 or in the cultivar, upto 400 fruits. Hundred grams of edible portion of bael contains 54.96-61.5 g water 1.8 – 0.62 g protein, 0.2-0.3 g fat, 28.11 – 31.8 g carbohydrates, 1.04 – 1.79 ash, 55 mg carotene, 0.13 mg thiamin, 1.19 mg riboflavin, 1.1 mg nacin, 8-60 mg ascorbic acid and 2.11 mg tartaric acid(Gopalan *et al.*,1967). Bael fruit is truly popular for its ability to combat constipation. The unripe bael fruits are used for pharmaceutical use. The fruit is aromatic, cooling and laxative. It is useful in preventing or curing scurvy and it also strengthens the stomach and promotes its action. Bael is considered to be one of the richest source of riboflavin and provides lots of minerals and vitamins. The pulp also contains a balsam like substance and 2 furocoumarins-psosalen and marmelosin ($C_{13}H_{12}O_3$) highest in the pulp of large, cultivated forms.

They cultivars of bael to locality where they are most easily available. It is mainly cultivated in Banarsi, Kagzi Etawah, Narendra Bael-1, Narendra Bael-2, Narendra Bael-5 and Narendra Bael-9. Some scientists have tried to identify and compare different varieties of bael fruits. Jauhari *et al.* (1969) surveyed the central

and eastern Uttar Pradesh, Western Bihar and selected seven varieties for physico-chemical studies. They found the “Kaghzi Etawah” as the best variety having 1893 g weight per fruit and 1583 g pulp per fruit with 36 % TSS, 0.33 % acidity and 21.7 mg ascorbic acid per 100 g edible pulp.

Bael fruit is one of the most nutritious fruits. No other fruit has a high content of riboflavin (1.19 mg/100 g edible portion) has found in this fruit. Marmelosin is probably the most apeutically active principle of bael fruit. All parts of this fruit viz., root, bark, leaves, flowers or fruits are used for curing or the other human disease. The roots are sweet, astringent and febrifuge. They are useful in curing dyspepsia, entery, diarrhea, vomiting, stomachalgia, intermittent fever, weakness, uropathy and gastric irritability in infants, bark decoction is administered in malaria fever. The leaves useful in treating ophtalmia, inflammations, catarrhness, diabetes and asthamatic complaints. The flowers allay and vomiting. The unripe bael fruits are used for curing diarrhea and stomachalgia. The ripe bael fruits are aromatic, cooling, laxative good tonic for heart and brain cure dyspepsia.

Bael is considered a medicine able to cure different diseases, including cholera and diarrhea. The unripe fruit, when 3 to 4 months old, has claimed anti diarrhoeal properties. Curiously, the ripe fruit is used as medicine for curing constipation. The most significant claimed pharmacological effects of the plant are anti helminthic, hypoglycaemic cardiac stimulant, anti diarrhoeal and antiviral. The Green Energy Mission in Nepal (GEM/Nepal) uses Bael fruit and leaves to manufacture various herbal remedies for diarrhea, intermittent fever, fish poison, anti helminthic,

hypoglycaemic, antibacterial, snake bite, cardiac stimulant and antiviral problems in the twenty first century. Bangladesh has listed the Bael tree as priority medicinal plant.

The low cost of production of bael fruits will reduce the cost of processed product resulting in increased demands. The development of small scale industries will help to increase fruit products. The increased processing outlet will help to increasing plantation and better use of marginal land. It will generate enough opportunities of self employment by starting small scale processing unit or cottage industry that will be remunerative to the growers. Thus the preparation of bael pulp with sample technology and its utilization in the form of pulp and syrup have a great scope. Syrup can be prepared from bael pulp and sugar. The recommended concentration of tamarind pulp in syrup is 20-24 per cent, which makes beverages after dilution with distinct flavor and desirable acidity. Syrup containing 56.7 per cent total solids, 43.8 per cent reducing sugars, 56.54 per cent total sugars, and a total acidity of 1.11 per cent as tartaric acid yielded refreshing drink after appropriate dilution (Salunke and Desai,1984). Guava syrup was prepared by using 1.5 kg of sugar,500 ml of water,17.5 g of citric acid and 2g KMS per kg of guava pulp. The syrup was diluted to make RTS guava beverage (Amba Dan, 1973). A pomegranate syrup of about 60^0 Brix with an added acidity of 1.5 per cent as citric acid had a bright purplish-red color and a delightful taste and flavor. It was preserved by pasturization by addition of sodium benzoate (Trapaidze and Abuladze,1989). The syrup was prepared from phalsa fruit juice in which the clear juice was mixed with an equal

amount of sugar and preserved with sodium benzoate (Amba Dan,1973).

It is therefore, proposed to process bael fruit for syrup making with the following specific objectives

1. To standardize the process for preparation of bael syrup.
2. To study the changes in chemical composition of bael syrup during storage.
3. Sensory evaluation and qualities of bael syrup during storage.

2. REVIEW OF LITERATURE

Bael (*Aegle marmelos* Corr.) is a rare species but, equally valued plant for its edible fruits and immense medicinal properties.

The pulp of bael is used as making different products such as wine, candy, slab, jam, toffee, squash, syrup etc. Excellent flavor, nutritive value and medicinal characteristics of fruit indicate its good potentiality for processing into value added products. However, very little work has been carried out on the processing and storage aspects of bael.

The low cost productions of these fruits will reduce the cost of processed products resulting in increasing demands. The available information on the physio-chemical characteristics and processing of syrup with particular references to standardize the process of making syrup is reviewed in this chapter.

2.1 Physical characteristics of bael fruits

Physical characteristics of bael fruits plays a very important role in development of a processing technology and on quality of final products.

The shape of bael is spheroid oblong length was observed 9.23 cm and average weight of bael fruit 435 g, color of bael fruit green to yellow (Garg et al., 1973).

2.2 Chemical composition of bael pulp

The fruits are rich in carbohydrates protein and riboflavin. Jauhari *et al.* (1969) reported that, the bael fruit TSS and acidity ranged from 28 to 36% and 0.256 to 0.368 respectively. According to Jahuri and Singh(1971), bael fruit contains 28 to 36% TSS, 19-21% carbohydrates, 11-17% sugars,1% protein, 0.2%

fat,7-21 mg/100gm vitamin C. Its food value is 88 calories/100 gm. In addition, it is rich in vitamin A (186 IU/100gm pulp), volatile oils and marmelosines.

2.3 Extraction of pulp

The fresh disease free healthy bael ripe fruits were selected for extraction of pulp. The bael fruits were graded and washed in running water and the fruits were then broken into two halves. The pulp along with seed was extracted with the help of knife the plate were removed taking care that no pulp was left in the peel. The pulp was then added with equal amount of water and heated up to 80^0 C for one minute to get homogenous mixture of pulp and water. The pulp and water was also get thoroughly mixed with the help of domestic mixer with two passes. The mixture obtained was then passed from steel sieve of 20 meshes and with two layered muslin cloth. The seed and fibre were removed by filtration method and clean bael pulp was obtained (Roy *et al.*, 1979).

2.4 Bael fruit

In India and abroad different scientists has been working on various bael fruit varieties and processing of bael fruit. Some literature has been reviewed below in brief. However, very little work has been reported in the literature.

Swingle (1943) specimens have been maintained in citrus collection in Florida and in Agriculture Research Stations. The Dr. Daid Fairchild grown the fruits at his home garden at Kampong and tested the pulp with the jaggery.

Singh *et al.* (1961) at the Horticultural Research Institute Sharanpur, India surveyed Bael fruit trees in Uttar

Pradesh. Screened about hundred seedlings, selected as most promising for commercial planting. Mitzapuri, Dargoji, Ojha, Rampuri, Azamati, Khamaria. One esteemed large cultivar with thin rind and few seeds is known as 'Kagzhi'. Rated the best was mitzpari with very thin rind. +Breakable with slight pressure of thumb pulp of the fine texture, free from gum of excellent flavor and containing few seeds.

Teaotia *et al.* (1963) studied five varieties of bael fruit for the physical characteristics and chemical composition. Kagzhi Gonda, Bast No.1, Gonda No.2 and Gonda No.3 among these varieties. Kagzhi Gonda seems to be best of all. The fruit are large in size, possesses thinnest rind and highest percentage of pulp which is yellow in color, soft in texture and good in taste and excellent in flavor.

Jauhari *et al.* (1969) made survey of bael varieties and samples collected were studied physico-chemically to access their characters. Seven distinct varieties have been described in this series. The criterion for the best variety was large size of fruit and has maximum sugar and TSS content. Its color, shape, flavor and taste were also excellent.

Mishra (2001) studied the quality of bael fruit pulp powder. Influence of clones and drying methods. Bael fruit powder is prepared by some pharmaceutical companies but information regarding suitability of a clone with a suitable method of drying was lacking. Therefore a comparison between sun and cabinet drying using various clones of bael for preparation of pulp powder was conducted.

Shrivastav *et al.* (2003) studied the dehydration of unripe bael and ripe bael fruit. The unripe bael pieces were dried at 60^0C till it was completely dried. Unripe edible pulp of bael was air dried at 60^0C. It took 4 hours to reduce moisture content from about 755 to around 10 % (w.b.) the dried pieces were ground in domestic mixer to provide bael powder. The shrinkage ratio was observed to be 2.83 to 2.85 however the dehydration ratio was found to be vary between 2.11 to 2.17.

2.5 Medicinal

Shailajan *et al.* (2011) studied that, marmelosin is one of the coumarin in bael with its potential pharmacological activities such as hypoglycemic, anti-inflammatory, anticancer, antidiabetic, and antioxidants.

Prashanth *et al.* (2012) found that, the highest per cent activity was found in freeze-dried pulp (32.50%), rind (28.33%) and seed (10.13%). The bael plant part extracts shown to be potential antibacterial and antiplatelet aggregation activities.

Singh and Kochhar (2013) reported that, the supplementation of bael (Aegle marmelos L.) leaf, pulp and seed powder along with nutrition counseling significantly improved the food and nutrient intake of the diabetic patients.

Singh *et al.* (2014) reported that, the bael had nutritional and medicinal properties, make this fruit one of the most valuable and a good source of nutrients and qualities to cure diarrhoea, dysentery and other stomach ailments. This fruit have unlimited potential in its processed form.

2.6 Syrup

Syrup can be prepared from tarmarind pulp and sugar. The recommended concentration of tamarind pulp in syrup is 20-24 per cent, which makes a beverages after dilution with distinct flavor and desirable acidity. Syrup containing 56.7 per cent total solids,43.8 per cent reducing sugars, 56.54 per cent total sugars, and a total acidity of 1.11 per cent as tartaric acid yielded refreshing drink after appropriate dilution (Salunke and Desai, 1984). Guava syrup was prepared by using 1.5 kg of sugar,500 ml of water,17.5 g of citric acid and 2g KMS per kg of guava pulp. The syrup was diluted to make RTS guava beverage (Amba Dan, 1973).A pomegranate syrup of about 60^0 Brix with an added acidity of 1.5 per cent as citric acid had a bright purplish-red color and a delightful taste and flavor. It was preserved by pastrurization by addition of sodium benzoate (Trapaidze and Abuladze,1989).The syrup was prepared from phalsa fruit juice in which the clear juice was mixed with an equal amount of sugar and preserved with sodium benzoate (Amba Dan,1973).

2.7 Chemical characteristics observations

2.7.1 Total Soluble Solids (^{0}Brix)

Mehta and Bajaj (1983) observed that, there was increasing trend in total soluble solids in case of citrus juices after the period of eight months storage.

Khurdiya and Roy (1985) reported gradual increase in total soluble solids (TSS) content in jamun juice during storage period.

Jain *et al.* (1986) reported that, in the storage of different fruit squashes like phalsa and litchi under different storage conditions had no appreciable change in TSS.

Kalra *et al.* (1987) noted the loss of vitamin C during a year of storage whereas; T.S.S. and tritable acidity were increased in guava beverage of cv. Allahabad Safeda.

Vaidya *et al.* (1998) reported that, the total soluble solids slightly increased during the storage of guava : pomegranate (30:70) and guava : ber (40:60) mixed juice beverages.

Deka *et al.* (2001) in juice blends found an increasing trend in total soluble solids during storage at ambient and low temperature in lime - aonla and mango-pineapple spiced RTS beverages.

Kannan and Thirumaran (2002) reported that, the total soluble solids of the jamun products showed a gradual increase during the storage period.

Kaushik *et al.* (2002) studied that, total soluble solids increased during storage of preserve at room temperature.

Kotecha and Kadam (2003) observed that, the TSS content was increased slightly throughout the storage period from 66.0 to 67.1^{0}Brix and from 66.0 to 66.7^{0}Brix in the syrup stored at ambient and low temperature, respectively.

Deka *et al.* (2005) reported that, the increase in TSS was low, both at low temperature and cool chamber as compared to ambient temperature.

Prasad and Mali (2006) observed, increase in TSS of bael squash with storage period both at ambient and at low temperature.

Sujana (2006) carried out an experiment at Department of Horticulture, Dr. PDKV, Akola and found that, the total soluble solids of custard apple pulp increased throughout the storage period.

Srinivas *et al.* (2007) conducted an experiment on standardization of recipes for production of squash in pomegranate (*Punica granatum* L.) cv. Ganesh and Mridula and observed an increasing trend of total soluble solids during storage period of 90 days.

Reddy and Chikkasubbanna (2008) carried out an experiment to study the storage behaviour of lime blended aonla squash and noticed an increasing trend in total soluble solids.

Das (2009) observed an increase in total soluble solids content of jamun processed products during storage.

Reddy and Chikkasubbunna (2009) conducted an experiment on storage behaviour of aonla syrup with 25 and 30 per cent pulp, 65^{o} and 70^{o} Brix total soluble solids and registered an increasing trend in total soluble solids.

Tandon *et al.* (2010) observed slight increase in total soluble solids content of mango pulp in all the samples during storage upto 6 months when cultivar Rumani was blended either with cultivar Mallika or Dashehari pulp in the ratio of 9:1, 8:2 and 7:3.

Bhardwaj *et al.* (2011) carried out an experiment on Effect of fruit juice blending ratio on kinnow juice preservation at ambient storage condition reported that there is increased in total soluble solids during storage.

Chavan *et al.* (2011) carried out an experiment on changes in chemical composition of pomegranate RTS of cv. Kesar as influenced by different per cent of syrup concentration and storage periods and noticed an increasing trend of total soluble solids levels of RTS during storage period of 3 months.

Gaikwad (2011) conducted an experiment to study chemical changes and sensory qualities of guava beverage under different storage condition at Dr. PDKV, Akola and found that the total soluble solids of guava beverage increased throughout the storage period.

Jadhao (2012) conducted experiment on storability study in lime blended aonla beverages at Dr. PDKV, Akola and found that the total soluble solids of aonla beverages increased throughout the storage period.

Bhandalkar (2013) conducted an experiment to study the chemical changes and sensory qualities of lime blended bael syrup under different storage condition at Dr. PDKV, Akola and found that the total soluble solids of lime blended bael syrup increase throughout the storage period.

Mishra *et al.* (2013) carried out an experiment in Post Harvest Laboratory of Department of Horticulture, N. D. University of Agriculture and Technology, Kumarganj, Faijabad, (UP) during 2004-05 to assess the effect of packaging containers

on storage stability of bael candy stored in glass jar and polythene pouches at ambient temperature and observed that the total soluble solid of bael candy increased during storage in both type of containers.

Dalal *et al.* (2014) conducted an experiment to evaluate the chemical changes and to find out suitable recipe for lime blended aonla syrup under different storage condition and reported that, less changes in TSS at 90 and 120 days of storage under ambient and refrigerated condition, respectively were observed in aonla syrup prepared by using 25% pulp blended with 10% lime juice stored in cold storage condition.

Garg *et al.* (2014) reported that, there was increase in total soluble solid in bael wine during 12 months of storage period.

Tiwari and Bhagwan (2014) reported that, there is increase in total soluble solids content of squash prepared from blend of bael pulp and aloe vera gel continuously up to five months under ambient conditions.

Papade *et al.* (2015) reported that, there was increased in total soluble solids of acid lime squash during storage.

2.7.2 Titrable acidity

Singh and Mathur (1953) reported that, there was decrease in titrable acidity in cashew apple juice kept under cold storage till the process completed.

Chakraborty *et al.* (1973) was noted an increase in acidity of watermelon RTS beverages during storage.

Palaniswamy and Muthukrishanan (1974) observed the decreasing trend of acidity from 3.06 to 2.31 per cent in lemon juice during storage period.

Mehta and Rathore (1976) reported an increase of total acidity from 2.0 to 3.0 per cent in aonla juice stored for ten weeks at room temperature.

Shreshtha and Bhatia (1982) studied the physico-chemical characteristics and storage behaviour of apple juice and noticed that, the acidity in juice was decreased during storage and it was more at 37^0C at room temperature storage.

Mehta and Bajaj (1983) observed that, the acidity of citrus juices was decreased during storage at room temperature and loss of acidity was ranged from 13.83 to 51.70 per cent.

Jain *et al.* (1984) carried out an experiment at Government Fruit Preservation and Canning Institute, Lucknow and study revealed that, the acidity of orange, lemon and bael squash was decreased during storage at room and ambient temperature.

Khurdiya and Roy (1985) observed decrease in acidity in jamun juice during storage period of 12 months.

Jain *et al.* (1986) reported that, the acidity decreased after a period of 6 months in all the squashes (phalsa and litchi), the minimum fall in acidity was recorded in the samples kept in refrigerator as compared to control.

Bawa and Saini (1987) observed the gradual decrease in the titrable acidity from 0.31 to 0.28 per cent in preserved

carrot juice when stored at room temperature (22-35^{0}C) and at low temperature.

Tripathi *et al.* (1988) reported that, aonla juice exhibited an increase in acidity from 2.28 to 3.14 per cent on storage at room temperature.

Beerh *et al.* (1989) was noted an increase in acidity from 0.28 to 0.34 per cent of mango RTS beverage.

Attri *et al.* (1998) observed that, the titrable acidity of pear juice was found to be increased by blending with apricot pulp and plum pulp, whereas it was reduced with the apple juice and apple juice concentrate during blending and after six months storage.

Kumar and Manimegalai (2001) reported that, there was a gradual increase in the acidity of the mixed fruit juices and RTS samples when stored in different conditions.

Kannan and Thirumaran (2002) carried out the experiment on jamun processing at Home Science College and Research Institute, TNAU, Madurai and observed the decrease in acidity of jamun products.

Kaushik *et al.* (2002) studied that, acidity decreased during storage of preserve at room temperature.

Srinivas *et al.* (2007) noticed that, acidity of squash prepared from pomegranate cv. Ganesh and Mridula showed slight decreased trend in acidity.

Verma and Gehlot (2007) observed the increase in total sugar of bael nectar during storage period.

Reddy and Chhikkasubbanna (2008) noted the, decreasing trend in acidity of lime blended aonla squash with 25 per cent juice in the ratio of 1:3, 1:1 and 3:1 during storage period.

Verma *et al.* (2008) observed decrease in acidity in bael beverage during two months storage period.

Das (2009) noticed that, acidity of squash and syrup of jamun had increasing trend from the beginning of storage, which ranged from 1.20 to 1.39 per cent and 1.20 to 1.37 per cent, respectively.

Reddy and Chhikkasubbanna (2009) was noticed decreasing trend in acidity of aonla syrup during storage period.

Bhardwaj *et al.* (2011) carried out an experiment on Effect of fruit juice blending ratio on kinnow juice preservation at ambient storage condition reported that there is decreased in acidity during storage.

Chavan *et al.* (2011) reported that, there was a gradual decrease in the acidity of pomegranate RTS during storage period of 3 months.

Gaikwad (2011) conducted an experiment to study chemical changes and sensory qualities of guava beverage under different storage condition at Dr. PDKV, Akola and observed that, the acidity of guava beverage decreased throughout the storage period.

Jadhao (2012) carried out an experiment on storability study in lime blended aonla beverages at Dr. PDKV, Akola and

observed that, the acidity of aonla beverages showed a gradual decreased during the storage period.

Bhandalkar (2013) conducted an experiment to study the chemical changes and sensory qualities of lime blended bael syrup under different storage condition at Dr. PDKV, Akola and found that the titrable acidity of lime blended bael syrup decrease throughout the storage period.

Mishra *et al.* (2013) carried out an experiment in Post Harvest Laboratory of Department of Horticulture, N. D. University of Agriculture and Technology, Kumarganj, Faijabad, (UP) during 2004-05 to assess the effect of packaging containers on storage stability of bael candy stored in glass jar and polythene pouches at ambient temperature and observed that the titrable acidity of bael candy increased during storage in both type of containers.

Dalal *et al.* (2014) conducted an experiment to evaluate the chemical changes and to find out suitable recipe for lime blended aonla syrup under different storage condition and reported that, less changes in acidity at 90 and 120 days of storage under ambient and refrigerated condition, respectively were observed in aonla syrup prepared by using 25% pulp blended with 10% lime juice stored in cold storage condition.

Garg *et al.* (2014) reported that, there was decrease in acidity in bael wine during 12 months of storage period.

Tiwari and Bhagwan (2014) reported that, there is increase in acidity of squash prepared from blend of bael pulp

and aloe vera gel continuously up to five months under ambient conditions.

Tiwari and Deen (2014) conducted an experiment on bael syrup prepared by blending with 25 per cent aloe-vera , 50 per cent sugar, 1.25 per cent acidity and observed that T.S.S. , acidity, reducing sugars, total sugars content and browning increased during storage whereas vitamin C , non reducings sugars content and organoleptic score were decreased continuously with the storage period. The squash prepared from blend of bael pulp and aloe-vera gel could be stored upto five month under ambient conditions with acceptable quality.

Papade *et al.* (2015) reported that, there was decreased in acidity of acid lime squash during storage.

2.7.3 pH

Mehta and Rathore (1976) noticed that, throughout the storage period of aonla juice, the pH retained constant and did not change with time, treatments and storage temperature.

Mehta and Bajaj (1983) reported that, there was a slight increase in pH value of citrus juices during storage.

Tripathi *et al.* (1988) observed that, the pH of aonla products was slightly higher than the fresh fruits and did not change during storage period.

Beerh *et al.* (1989) reported that, the mango RTS beverage prepared from Fazil variety showed, the decline in pH during storage period (12 months).

Prasad and Mali (2000) studied the changes in physico-chemical characteristics of pomegranate squash during

storage and observed that, when squashes were stored both at room temperature (25-40^{0}C) and at low temperature, there was a corresponding fall in pH. The increase was more at room temperature as compared to low temperature.

Kumar and Manimegalai (2001) conducted an experiment on storage stability of mixed fruit juice RTS beverages in different storage conditions and reported that, there was a slight reduction in pH of the RTS samples in room temperature and at low temperature.

Kannan and Thirumaran (2002) noticed that, the chemical reactions taking place between acid and pigments could be responsible for change in pH.

Ejilearassane and Khurdiya (2005) reported higher pH of the carrot pulp kept in cool store as compared to cool chamber and room temperature.

Choudhary *et al.* (2006) noted that, the pH value in guava ready-to-serve beverage had the decreasing trend with an increasing period of storage upto 150 days under room temperature.

Reddy and Chhikkasubbanna (2009) observed that, the pH of aonla syrup indicated increasing trend during three months of storage period.

Gaikwad (2011) conducted an experiment to study chemical changes and sensory qualities of guava beverage under different storage condition at Dr. PDKV, Akola and observed that, the pH of guava beverage decreased throughout the storage period.

Jadhao (2012) carried out an experiment on storability study in lime blended aonla beverages at Dr. PDKV Akola and noticed an increasing trend in pH during storage period.

Bhandalkar (2013) conducted an experiment to study the chemical changes and sensory qualities of lime blended bael syrup under different storage condition at Dr. PDKV, Akola and found that the pH of lime blended bael syrup increase throughout the storage period.

2.7.4 Total sugars

Tripathi *et al.* (1988) reported that, the total sugars content of the fresh aonla fruit was ranged from 3.75 to 15.57 per cent.

Mehta and Bajaj (1983) reported that, there was gradual increase in total sugars content of juice of all the three varieties of citrus. The gain in sugar per cent varied between 5.89 to 12.11 in Kinnow juice, 14.40 to 30.14 per cent in Blood Red juice and 50.77 to 68.84 per cent in Villa France juice.

Palaniswamy and Muthukrishnan (1974) noticed an increase in total sugars content ranged from 0.47 to 1.18 per cent in lemon juice.

Bawa and Saini (1987) studied the effect of method of preservation on the storage quality of carrot juice and observed that, the increase in reducing sugar content of juice stored at room temperature was higher (2.81 to 4.60) as compared to refrigerated storage (2.81 to 3.00).

Waskar and Khurdiya (1987) observed that, there was slight increase in total sugars of phalsa beverages during the storage period of 180 days.

Patil (2001) revealed that, there was continuous increase in total sugars content of jamun juice during storage. It increased from 9.70 to 11.12 per cent. The rate of increase was higher in juice samples stored at room temperature.

Sogi and Singh (2001) found that, the total sugars of kinnow squash increased with the advancement of storage.

Jain *et al.* (2006) reported that, there was slight increase in total sugars of aonla squash ranged from 45.54 to 46.75 per cent.

Prasad and Mali (2006a) observed that, increase in total sugars of bael squash with storage period both at ambient and at low temperature.

Srinivas *et al.* (2007) reported that, there was a gradual increase in the total sugars of squash prepared from pomegranate cv. Ganesh and Mridula.

Verma and Gehlot (2007) found that, total sugar was increased in bael nectar during storage period.

Verma *et al.* (2008) observed increase in total sugar in bael beverage during two months storage period.

Bhardwaj *et al.* (2011) carried out an experiment on Effect of fruit juice blending ratio on kinnow juice preservation at ambient storage condition reported that there is increased in total sugars of blending juice during storage.

Gaikwad (2011) conducted an experiment to study chemical changes and sensory qualities of guava beverage under different storage condition at Dr. PDKV, Akola and observed that, the total sugar of guava beverage increased throughout the storage period.

Jadhao (2012) found that, the total sugars of aonla beverages increased with the advancement of storage.

Bhandalkar (2013) conducted an experiment to study the chemical changes and sensory qualities of lime blended bael syrup under different storage condition at Dr. PDKV, Akola and found that the total sugar of lime blended bael syrup increase throughout the storage period.

Dalal *et al.* (2014) conducted an experiment to evaluate the chemical changes and to find out suitable recipe for lime blended aonla syrup under different storage condition and reported that, less changes in total sugars at 90 and 120 days of storage under ambient and refrigerated condition, respectively were observed in aonla syrup prepared by using 25% pulp blended with 10% lime juice stored in cold storage condition.

Tiwari and Bhagwan (2014) reported that, there is increase in total sugar of squash prepared from blend of bael pulp and aloe vera gel continuously up to five months under ambient conditions.

2.7.5 Reducing sugars

Palaniswamy and Muthukrishanan (1974) reported that, the reducing sugars increased from 0.40 to 1.32 per cent in lemon juice with the advancement of storage.

Shrestha and Bhatia (1982) noted decreasing trend in reducing sugars during storage of apple juice and temperature had significant effect in the changes of reducing sugars. The decrease was more at 37^0C than at room temperature.

Mehta and Bajaj (1983) studied the effects of storage and methods of preservation on the physico-chemical characteristics of citrus juice and observed that, there was a gradual increase in reducing sugars of stored citrus juice.

Jain *et al.* (1984) reported that, lemon, orange and bael squashes showed continues increase in reducing sugars. The rise in reducing sugars might be assigned to the conversion of non-reducing sugars owing to the process of hydrolysis.

Bhatia *et al.* (1986) noted that there was a gradual increase in reducing sugars of jackfruit squash during storage in all the methods of preservation. The increase was more in case of the higher temperature storage.

Bawa and Saini (1987) studied the physico-chemical and organoleptic characteristics of bottled carrot juice and observed that, the reducing sugars content was increased when juice stored at room temperature which was higher (2.81 to 4.60%) as compared to refrigerated storage (2.81 to 3.00%).

Waskar and Khurdiya (1987) undertaken the experiment on processing and storage behaviour of phalsa beverages and observed that, reducing sugars was increased in phalsa beverages irrespective of storage conditions. The rate of increase was more at room temperature, followed by cool chamber and cool store.

Srivastava (1988) carried out an experiment on comparative study of RTS drinks prepared from Dasheri and Banganpalli cultivars of mango and observed that, reducing sugars were increased during storage of pulp as well as RTS drinks.

Beerh *et al.* (1989) observed that, reducing sugars of mango RTS was increased significantly due to acid hydrolysis of sucrose at room temperature during 6 months of storage.

Ranote *et al.* (1992) observed that, the reducing sugars content of kinnow RTS was increased from 4.37 to 5.85 per cent when stored for 24 weeks at room temperature (12-38^{0}C).

Attri *et al.* (1998) noted that, the reducing sugars were found to be increased in the blending ratio with the apple juice where as it was decreased with apricot and plum juice during storage.

Prasad and Mali (2000) observed that, the reducing sugars were increased during storage of pomegranate squash at room as well as low temperature.

Patil (2001) conducted an experiment on preservation of jamun juice at Mahatma Phule Krishi Vidyapeeth, Rahuri and reported that, there was significant increase in reducing sugars in jamun juice throughout the storage. This may be due to gradual inversion of non-reducing sugars to reducing sugars by the hydrolysis process.

Kannan and Thirumaran (2002) observed an increase in reducing sugars content during storage period of different jamun products.

Deka *et al.* (2005) reported that, during storage of mango-pineapple spiced beverages, there was gradual increase in reducing sugars.

Prasad and Mali (2006a) observed that, increase in reducing sugars of bael squash with storage period both at ambient and at low temperature.

Sujana (2006) found that, reducing sugars of custard apple pulp increased during storage period under Akola conditions.

Verma and Gehlot (2007) found that, the increase in reducing sugar of bael nectar during storage period.

Reddy and Chhikksubbanna (2008) observed that, the reducing sugar was increased during storage of lime blended aonla squash.

Verma *et al.* (2008) observed increase in reducing sugar in bael beverage during two months storage period.

Reddy and Chhikksubbanna (2009) observed considerable rise in reducing sugars of aonla syrup during storage period.

Tandon *et al.* (2010) conducted an experiment on improvement in quality of beverages prepared from Rumani mango blended with Dashehari and Mallika at CISH, Lucknow and study revealed that, there was continuous increase in reducing sugars in all the samples during storage upto 12 months.

Gaikwad (2011) conducted an experiment to study chemical changes and sensory qualities of guava beverage under

different storage condition at Dr. PDKV, Akola and observed that, the reducing sugar of guava beverage increased throughout the storage period.

Jadhao (2012) carried out an experiment on storability study in lime blended aonla beverages at Dr. PDKV Akola and noticed an increasing trend in reducing sugars during storage period.

Bhandalkar (2013) conducted an experiment to study the chemical changes and sensory qualities of lime blended bael syrup under different storage condition at Dr. PDKV, Akola and found that the reducing sugar of lime blended bael syrup increase throughout the storage period.

Dalal *et al.* (2014) conducted an experiment to evaluate the chemical changes and to find out suitable recipe for lime blended aonla syrup under different storage condition and reported that, less changes in reducing sugars at 90 and 120 days of storage under ambient and refrigerated condition, respectively were observed in aonla syrup prepared by using 25% pulp blended with 10% lime juice stored in cold storage condition.

Garg *et al.* (2014) reported that, there was increase in reducing sugar in bael wine during 12 months of storage period.

Tiwari and Bhagwan (2014) reported that, there is increase in reducing sugar of squash prepared from blend of bael pulp and aloe vera gel continuously up to five months under ambient conditions.

2.7.6 Non-reducing sugars

Mehta and Bajaj (1983) reported that, non-reducing sugars content was increased in citrus juice during storage.

Srivastava (1988) observed decrease in non-reducing sugars both in mango pulps as well as RTS drinks prepared from all the samples.

Khartude (2004) found that, there was increase in non reducing sugars of aonla RTS when stored at room temperature, which was higher as compared to refrigerated storage.

Choudhary *et al.* (2006) observed that, there was decrease in non-reducing sugar in ready-to-serve guava beverage during storage.

Sujana (2006) found that, non-reducing sugars of custard apple pulp increased throughout the storage period under Akola conditions.

Reddy and Chhikksubbanna (2008) observed considerable decline in non-reducing sugars during storage in lime blended aonla squash.

Gaikwad (2011) conducted an experiment to study chemical changes and sensory qualities of guava beverage under different storage condition at Dr. PDKV, Akola and observed that, the non-reducing sugar of guava beverage decreased throughout the storage period.

Jadhao (2012) conducted experiment on storability study in lime blended aonla beverages at Dr. PDKV Akola and found that the non-reducing sugars of aonla beverages decreased throughout the storage period.

Bhandalkar (2013) conducted an experiment to study the chemical changes and sensory qualities of lime blended bael syrup under different storage condition at Dr. PDKV, Akola and found that the non-reducing sugar of lime blended bael syrup decrease throughout the storage period.

Dalal *et al.* (2014) conducted an experiment to evaluate the chemical changes and to find out suitable recipe for lime blended aonla syrup under different storage condition and reported that, less changes in non-reducing sugars at 90 and 120 days of storage under ambient and refrigerated condition, respectively were observed in aonla syrup prepared by using 25% pulp blended with 10% lime juice stored in cold storage condition.

Tiwari and Bhagwan (2014) reported that, there is decreased in non-reducing sugars of squash prepared from blend of bael pulp and aloe vera gel continuously up to five months under ambient conditions.

2.8 Sensory qualities (Taste, Color, Flavor and Overall acceptability)

Bhatia *et al.* (1986) noticed that, all the samples of jackfruit squash stored at room temperature and in the refrigerator retained their characteristics aroma throughout the period of storage (one year). The samples stored at 37^0C developed a kind of caramelized off taste.

Jain and Borker (1970) suggested that, ascorbic acid greatly improves the flavor of RTS beverage of guava fruits which can be prepared from high pulp content.

Palaniswamy and Muthukrishnan (1974) reported that, decrease in color has been noticed in lemon juice during seven month of storage.

Karla and Revti (1981) observed a continuous decrease in taste score of stored guava pulp.

Khurdiya and Roy (1985) reported that, the overall organoleptic score in jamun juice was highest with 18^0 Brix and 0.6 per cent acidity which corresponds to Brix / acid ratio of 30 and the addition of 25 per cent juice was the best recipe.

Jain *et al.* (1986) observed that, retention of flavor was better in all the fruit squash stored at low temperature.

Waskar and Khurdiya (1987) carried out an experiment to study the processing and storage of phalsa beverages such as nectar, concentrate, squash and crush. They reported that, these beverages were found to be acceptable upto 180 days and crush to 240 days in cool store followed by 120 days in cool chamber but only upto 60 days at room temperature.

Karla *et al.* (1987) noticed that, there was continuous decrease in taste score of stored guava pulp.

Ranote *et al.* (1995) observed highly decline in color score for ambient storage as compared to cold storage due to catalytic effect of light on deteriorative changes in Kinnow juice.

Attri *et al.* (1998) had reported that, two or more fruit juice pulp may be blended in various proportions for the preparation of nectar, RTS beverages, etc. The blending of juice

may also improve aroma, taste and nutritive value of all the beverages.

Ghorai and Khurdiya (1998) observed that, storage temperature had significant effect on the color of the juice.

Vaidya *et al.* (1998) reported that, refrigeration was found to be most effective in maintaining the taste of mixed fruit juice beverage prepared from ber, pomegranate and guava.

Prasad and Mali (2000) observed that, the color, taste and flavor of the pomegranate squash remained better at low temperature whereas original color of the squash could not be obtained for 3 months of after storage at room temperature and all the samples of squashes were organoleptically acceptable at low temperature for a year.

Deka *et al.* (2001) blended the fruit juice / pulp of lime, aonla, grape, pineapple and mango in different proportion (5 to 95%) for RTS beverages. Among the different recipes tried for RTS beverages, LA-45 (lime 95% + Aonla 5%) recipe was found to be the best on overall sensory score.

Kumar and Manimegalai (2001) noticed color degradation was more rapid in mixed fruit beverage stored at 21^0C than 2^0C.

Murtaza (2002) prepared strawberry RTS beverage with 20 per cent pulp, filled in 250ml bottles and stored at room temperature (25^0C), refrigeration temperature (4-6^0C) and high temperature (40-45^0C). It was found that, strawberry drink can be successfully stored at refrigeration temperature at a

commercial scale, as it had significant stability in color, flavor and taste.

Kotecha and Kadam (2003) noted that, there was gradual decrease in the overall acceptability score of tamarind beverages when stored at room temperature during the storage period of 180 days.

Jain and Khurdiya (2004) reported that, overall sensory quality and vitamin C content, RTS beverage prepared by blending gooseberry and Pusa Navrang grape juice in 20:80 ratio was found to be the best.

Prasad and Mali (2006b) noticed that, the color, taste and flavor of the ber jam retained optimum at low temperature, whereas the original color of the jam disappeared at ambient temperature after 3 months of storage.

Srinivas *et al.* (2007) observed that squash prepared from cv. Ganesh with 25 per cent juice, 50^{o} Brix TSS and 1.5 per cent acidity and in cv. Mridula with 25 per cent juice, 45^{o} Brix TSS and 1.5 per cent acidity was found to be the best recipe with overall acceptability and good organoleptic scores.

Reddy and Chhikkasubbanna (2008) reported that, overall acceptability of lime blended aonla squash was influenced by the interaction effect of pulp and total soluble solids. Squash prepared with 25% pulp (aonla pulp and lime juice in the ratio of 1:3), 40^{0} Brix TSS was found to be the best recipe.

Reddy and Chhikkasubbanna (2009) prepared the aonla syrup having composition of 25 per cent pulp, 70^{0} Brix total soluble solids and 1.3 per cent acidity and found on ideal

recipe for organoleptic qualities like appearance, aroma and flavor, taste and overall acceptability.

Pilania *et al.* (2010) carried out an experiment on standardization of recipe and juice extraction method for preparation of ready-to-serve beverage from custard apple. They observed that recipe with 15 per cent blended juice of custard apple and lime (3:2) , 15 per cent TSS , 0.2% acidity was found best with respect to color (off white), taste, over-all acceptance.

Chavan *et al.* (2011) reported that, overall sensory qualities of the RTS beverage prepared from pomegranate having 15 per cent juice, 10^0 Brix total soluble solids, 0.4 per cent acidity and sodium benzoate 500ppm were found to be best.

Gaikwad (2011) conducted an experiment to study chemical changes and sensory qualities of guava syrup and RTS under different storage condition at Dr. PDKV, Akola and found to be acceptable up to 180 days and 56 days, respectively in sensory qualities except ambient storage.

Jadhao (2012) conducted an experiment on storability study in lime blended aonla beverages at Dr. PDKV Akola and found that the lime blended aonla syrup (10% lime) and RTS stored at deep freeze storage condition was found superior after 180days and 64 days of storage, respectively in sensory qualities.

Bhandalkar (2013) conducted an experiment to study the chemical changes and sensory qualities of lime blended bael syrup under different storage condition at Dr. PDKV, Akola and found to be acceptable up to 120 days and 90 days in refrigerate storage and ambient storage condition respectively.

Mishra *et al.* (2013) carried out an experiment in Post Harvest Laboratory of Department of Horticulture, N. D. University of Agriculture and Technology, Kumarganj, Faijabad, (UP) during 2004-05 to assess the effect of packaging containers on storage stability of bael candy stored in glass jar and polythene pouches at ambient temperature and observed that the organoleptic quality of bael candy was extremely good in polythene pouches up to four months while only one month in glass jar.

Dalal *et al.* (2014) conducted, on the basis of the four data that, the syrup prepared from 25 per cent aonla blended with 10 per cent lime juice and stored in cold storage gives longest storability (120 days) and maximum consumer acceptability. However, at ambient condition it could be stored up to 90 days.

Dalal *et al.* (2016) was carried out an experiment on Responses of recipes and storage conditions on sugar content and sensory qualities of lime blended Aonla syrup . They were reported that, there is decreased in taste , color , flavor score aonla syrup of during storage.

2.9 Storage

Waskar and Khurdiya (1987) observed that, the syrup remained acceptable in all the container (glass PVC and HDPE bottles) upto 120 days in cool chamber and 60 days at room temperature.

Prasad and Mali (2000) studied the physico-chemical changes in pomegranate squash during storage and revealed that

it was acceptable organoleptically for a period of 3-4 months at room temperature and upto one year at low temperature.

Kumar and Manimegalai (2001) reported that, the overall acceptability of mixed beverage prepared from pineapple, pear and pomegranate juice (1:1:1 ratio) stored better in cold condition than at ambient temperature.

During the course of study Kannan and Thirumaran (2002) found that, the jamun RTS beverage remain acceptable upto a storage period of 6 months when this product was stored in colorless glass bottles.

Deka *et al.* (2005) found that, mango pineapple spiced ready-to-serve beverages having 15 per cent blended juices (15:15), 10^0 Brix TSS, 0.2% acidity and 0.006 per cent cardamom spice drops stored in amber colored bottles under low temperature scored increasing TSS, reducing sugars, total sugars and NEB up to 6 months.

Gaikwad (2011) noticed that, the guava syrup and RTS beverages remain acceptable up to storage period of 180 days and 56 days respectively when these product were stored in cold chamber, deep freeze storage and refrigerated storage condition.

Jadhao (2012) noticed that, the lime blended aonla syrup (10% lime) and RTS beverages remain acceptable up to storage period of 180 days and 64 days respectively when these product were stored in deep freeze storage conditions.

Bhandalkar (2013) noticed that, the lime blended bael syrup remain acceptable up to 120 days and 90 days in refrigerated storage and ambient storage condition.

Singh *et al.* (2014) found that, the recipe of bael preserves syrup was found best and it was stored at room (25-37 degrees C) and refrigerated temperatures (8-10 degrees C) up to 8-12 months as well as organoleptic score 4.64 and 4.88 was found best among all treatments of local and NB-5 cultivars respectively.

Tiwari and Bhagwan (2014) reported that, The squash prepared from blend of bael pulp and aloe vera gel could be stored up to five months under ambient conditions with acceptable quality.

3. MATERIAL AND METHODS

The present investigation on “Studies on prepartion of syrup from bael” was conducted at the Department of Food Science and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra during the year 2015-2016.

3.1 Materials

3.1.1 Fruits

The fully riped, healthy and uniform size bael fruits of local cultivar were selected and brought from local market of Rahuri, Dist. Ahmednagar (Plate 1) to the laboratory for further experimentation.

3.1.2 Chemicals

Most of the chemicals used in this investigation were of analytical grade. They were obtained from M/S Qualigens. Mumbai, M/S. Sarabhai. M. Chemicals Baroda and E. Merck, Mumbai.

3.1.3 Packaging materials

Pet bottles of 500 ml size were purchased from local market and used for packaging of syrup.

3.1.4 Ingredients

Citric acid, sugar, sodium benzoate were obtained from local market and used for preparation of bael syrup.

3.2 Methods

3.2.1 Physical characteristics of fresh fruits

3.2.1.1 Weight of fruits

The weight of five bael fruits was taken and average weight was recorded.

3.2.1.2 Length (height)

The length of five fruits determined with the help of Vernier caliper and mean value (cm) was recorded.

3.2.1.3 Pulp content

The total weight of pulp along with seeds and fibre from five bael fruits was taken. The weight of seeds and fibre was deducted and the average weight of pure pulp was recorded.

3.2.1.4 Extraction of bael pulp

Fully ripe bael fruits were manually opened and flesh was removed. The bael pulp was obtained as per the process indicated in Fig 1.

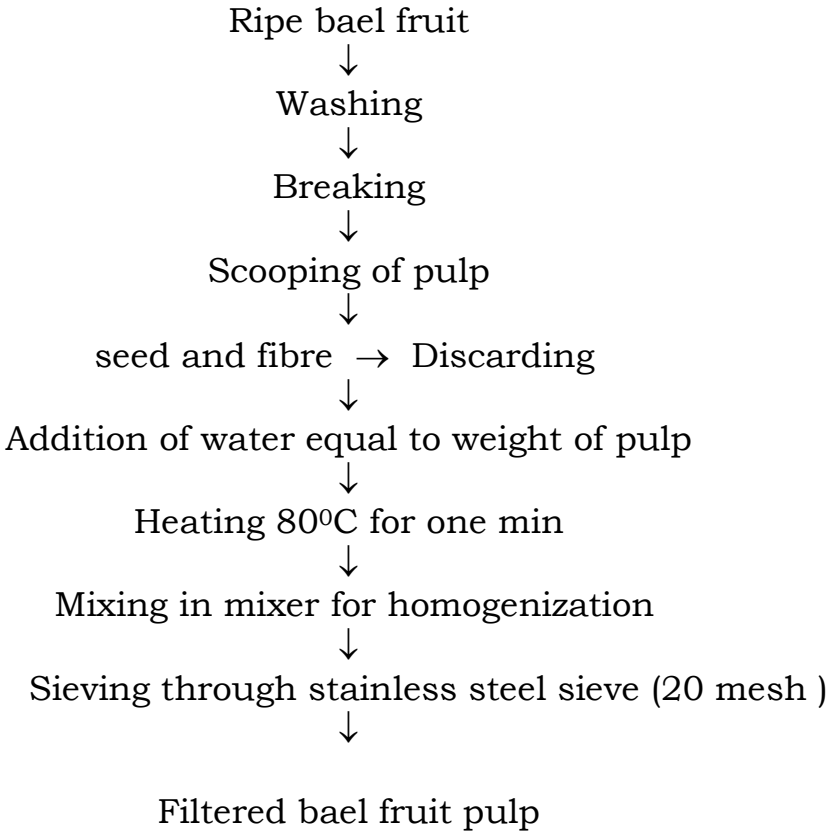

Fig1. Flow diagram for preparation of bael pulp

3.2.1.5 Preparation of bael syrup

The bael syrup was prepared from the bael pulp using the flow chart shown in Fig 2

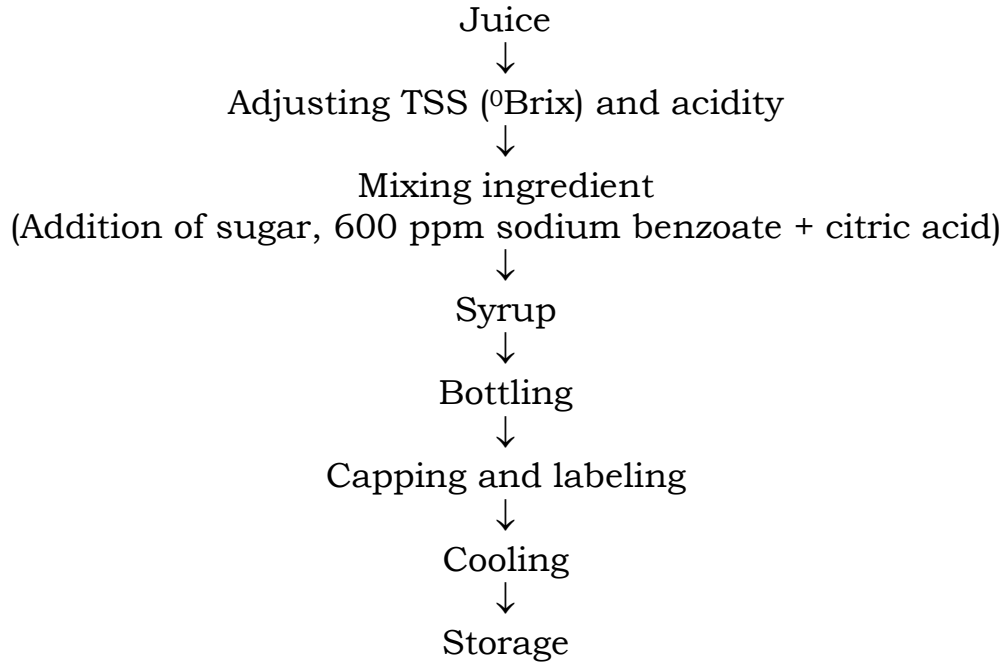

Fig 2. Flow diagram for preparation of bael syrup

3.3 Treatment details

Based on review of literature and preliminary trials, the experimental parameters were identified. The detail work plan, sample variables and experimental are given below.

Treatment	Juice	Acidity(%)	Sugar (%)
T_1	20	0.5	60
T_2	20	1.0	60
T_3	20	1.5	60
T_4	25	0.5	60
T_5	25	1.0	60
T_6	25	1.5	60
T_7	30	0.5	60
T_8	30	1.0	60
T_9	30	1.5	60

The syrup was prepared by using bael pulp, citric acid, sugar, sodium benzoate, as preservatives and different level acidity.

3.4 Physico-chemical analysis of pulp and bael syrup

3.4.1 Total soluble solids (TSS)

The TSS content of pulp and syrup was determined with the help of Erma hand refractometer of 0-32 range in duplicate (A.O.A.C., 1990). The prism of refractometer was washed with distilled water and wiped to dry after each reading.

3.4.2 Tiratable Acidity (%)

The titratable acidity was determined by the procedure as reported by Ranganna (1986).

Reagents

1. Sodium hydroxide (0.1N) prepared by dissolved 4.0 g NaOH in water to make up 1000 ml volume.
2. Phenolphthalein indicator

Procedure

A 10 ml of bael pulp and syrup thoroughly mixed in beaker then distilled water added and poured into 100 ml volumetric flask and volume was made up to 100 ml with distilled water. From this 10 ml was taken in a conical flask and titrated against standard 0.1 N sodium hydroxide solution using phenolphthalein as an indicator, until faint pink color persisted for 15 second. The titratable acidity was calculated and expressed in terms of anhydrous citric acid in per cent.

Formula

$$\% \text{ Titratable acidity} = \frac{0.1N\ (NaOH) \times Titre \times 0.64}{\text{Volume of juice taken}} \times 100$$

3.4.3 pH

The pH of bael syrup was measured by using Perkin-Elmer pH Meter.

3.4.4 Total sugars

Total sugars were determined by volumetric method of Lane and Eynon (1923) as reported by Ranganna (1986) as follows.

The estimation was carried out by pipetting solution of wood apple pulp and leather was taken into 250 ml conical flask. To this, concentrated hydrochloric acid (5 ml) was added and the mixture was kept for 24 hours. It was neutralized with 1N NaOH and the volume was made up to 100 ml. The total sugar content was estimated by titration as described in reducing sugars procedure. The total sugars were determined in the same way as described under reducing sugars and calculated as follows:

$$\text{Total sugars (\%)} = \frac{\text{Factor x volume made up}}{\text{Titre x Wt. of sample taken}} \times 100$$

3.4.5 Reducing sugars

The reducing sugars were estimated by the volumetric method of Lane and Eynon (1923) as reported by Ranganna (1986) as follows.

Reagents

1. Fehlings solution (A): Prepared by dissolving 69.28 g copper sulphate ($CuSO_4$. $5H_2O$) in distilled water and diluted to 1000 ml and filtered through No. 4 whatman filter paper.

2. Fehling's solution (B): Prepared by dissolving 346 g Rochelle salt i.e. potassium sodium titrate ($KNaC_4H_4O_6.4H_2O$) and 100 g NaOH in distilled water and volume was made to 1000 ml.
3. Methylene blue indicator (1% in ethyl alcohol)
4. Neutral lead acetate solution (45 %): It was prepared by dissolving 225 g of neutral lead acetate in distilled water and diluted to 500 ml.
5. Potassium oxalate solution (22 %): It was prepared by dissolving 110 g potassium oxalate in distilled water and diluted to 500 ml.

Preparation of sample

The bael pulp and syrup separately (10 g) the well mixed pulp was taken into 250 ml volumetric flask to which about 100 ml water was added and content was neutralized with 1N sodium hydroxide solution (colorless). Two ml lead acetate was added and kept for 10 min followed by addition of 10 ml potassium oxalate solution. The volume was made to 100 ml with distilled water and then filtered through filter paper. The filtrate was further used for titration against Fehling's A and B solutions.

Procedure

Five ml each Fehlings 'A' and 'B' solution were pipetted in 250 ml conical flask and diluted to about 50 ml with distilled water. The mixture was heated to boiling. During boiling, the clarified sample was added carefully through the burette until the brick red color appeared. Finally 2-3 drops of methylene blue indicator were added and titration was continued until brick red precipitate was formed. The reducing sugars content was calculated and expressed in percentage.

Formula

$$\text{Reducing sugars (\%)} = \frac{\text{Factor} \times \text{Volume made up}}{\text{Titre} \times \text{Volume of sample taken}} \times 100$$

3.4.6 Non-reducing sugars

The percentage of non-reducing sugar was deducing the percentage of reducing sugars from the total sugars.

The fully ripened bael fruits were collected from local market. The bael pulp was extracted manually. The process of bael syrup preparation is shown in Fig 1.

3.5 Packaging and storage of bael syrup

Pet bottles were used as a packaging material. The bael syrup prepared was packed and stored at ambient (27 $\pm$ 5^{0}C) and refrigerated temperature (5 $\pm$ 2^{0}C) for 90 days. The samples were drawn at an interval of 30 days and evaluated for chemical and sensory quality.

3.6 Sensory evaluation of bael syrup

Sensory evaluation of bael syrup was carried out according to method of Amerine *et al.* (1965) on a 9 point hedonic scale (Appendix). The average scores of the seven semi-trained judges for different quality characteristics *viz.* color and appearance, flavor, taste and overall acceptability were recorded.

3.7 Statistical analysis

The data obtained for changes in chemical constituents and various sensory parameters during storage were analyzed for statistical significance according to the procedure given by Panse and Sukhatme (1985). All the experiments were planned and carried out using Factorial Completely Randomized Design (FCRD) using three replications.

4. RESULTS AND DISCUSSION

The present investigation was undertaken develop a technology for extraction of pulp from bael and utilization of this pulp in preparation of syrup. The syrup was stored at room temperature and refrigerated temperature. The syrup was evaluated for its chemical compostion and sensory qualities at 0, 30, 60, 90 days after storage for 3 months.

The observation on physico-chemical characteristics of fresh bael pulp have been recorded. The syrup samples obtained from different treatments were also evaluated for their sensory properties. The result obtained are presented and discussed in this chapter, under following headings.

4.1 Physico-chemical composition of bael and pulp

The data on physico-chemical composition of bael pulp is presented in Table 1.

Table 1. Physico-chemical composition of bael and pulp

Sr. No.	Parameters	Mean value
A.	**Physical constituents**	
1.	Shape of bael	Round to oblong
2.	Color of bael	Green to Yellow
3.	Average length of bael (cm)	9.23
4.	Average weight of bael (g)	435.50
5.	Pulp recovery (%)	68.00
B.	**Chemical constitutes**	
1.	TSS (^{0}Brix)	23.30
2.	Titrable acidity (%)	0.44
3.	Reducing sugars (%)	3.96
4.	Total sugars (%)	8.22
5.	Non reducing sugars (%)	4.26
6.	pH	5.00

The data revealed that bael fruits were yellowish to orange in color with an average weight 435.50 g and recovery of pulp was 68.00 per cent. Among the chemical composition of bael pulp the mean value for TSS was 23.30 ^{0} Brix, acidity 0.44 per cent, reducing sugars 3.96 per cent, total sugars 8.22 per cent, non-reducing sugars 4.26 per cent and pH 5.

The values obtained for various physico-chemical characteristics of bael pulp are within the range reported in literature (Garg et al., 1973).

4.2 Sensory evaluation of fresh bael syrup

The data regarding sensory evaluation of fresh bael syrup is presented in Table 2.

Table 2. Sensory evaluation of fresh bael syrup

Treatment	Color and appearance	Flavor	Taste	Overall acceptability
T_1	7.6	7.6	7.5	7.4
T_2	8.3	8.3	8.5	8.2
T_3	7.0	7.0	7.0	7.0
T_4	8.0	8.5	8.75	8.25
T_5	7.8	8.0	7.0	7.7
T_6	8.0	6.0	5.0	6.0
T_7	5.0	6.0	5.0	5.0
T_8	7.3	7.5	7.7	7.4
T_9	7.0	6.0	5.0	6.0
Mean	7.33	7.21	6.82	6.99
SE $\pm$	0.065	0.066	0.014	0.022
CD 5%	NS	NS	0.044	0.066

Where T_1 20 % pulp and 0.5 % acidity, T_2 20 % pulp and 1 % acidity, T_3 20% pulp and 1.5% acidity,T_4 25% pulp and 0.5% acidity,T_5 25% pulp and 1% acidity,T_6 25% Pulp and1.5% acidity,T_7 30% pulp and 0.5% acidity, T_8 30% pulp and1% acidity,T_9 30% pulp, 1.5% acidity.

Organoleptic evaluation of fresh bael syrup was done and score is presented in Table 2. Based on the score of sensory evalution the treatment 25 per cent pulp. 60 per cent sugar and 0.5 per cent citric acid and 600 ppm sodium benzoate i.e.T_4 was found better with respect to all sensory characteristics (Plate 2,Plate 3). Hence samples of T_4 treatments were selected for further 3 months storage studies. The chemical and sensory evaluation of syrup was done at interval of 30 days during 90 days of storage.

4.3 Chemical composition of fresh bael syrup

The mean values of fresh bael syrup revealed TSS 60.23^0 Brix, acidity 1.21 per cent, total sugars 54.38 per cent, reducing sugars 16.29 per cent, non-reducing sugars 38.18 per cent, pH 2.67. It is represented in Table 3.

Table 3. Chemical composition of fresh bael syrup

Treatment	TSS (^{0}Brix)	Acidity (%)	pH	Total sugars (%)	Non reducing sugars (%)	Reducing sugars (%)
T_1	60.20	1.58	2.60	53.82	38.03	16.02
T_2	60.21	1.60	2.62	53.86	38.09	16.27
T_3	60.22	1.59	2.64	53.90	38.11	16.28
T_4	60.25	1.60	2.65	53.91	38.14	16.29
T_5	60.27	1.61	2.67	54.94	38.16	16.31
T_6	60.30	1.63	2.68	54.64	38.17	16.33
T_7	60.32	1.58	2.70	54.70	38.19	16.35
T_8	60.35	1.59	2.71	54.78	38.21	16.36
T_9	60.37	1.62	2.73	54.86	38.23	16.38
Mean	60.23	1.60	2.67	54.38	38.18	16.29
SE $\pm$	0.011	0.037	0.022	0.058	0.024	0.014
CD 5%	0.032	0.054	0.064	0.173	0.070	0.041

*As indicated in Table 2

4.4 Chemical analysis of bael syrup during storage

The bael syrup prepared by using T_4 tratment was selected to storage and during storage it was analysed for chemical characteristics and data is presented in Table 4.

Table 4. Chemical analysis of bael syrup during the storage

Storage (days)	TSS (^{0}Brix)		Acidity (%)		pH		Total sugars (%)		Reducing sugars (%)		Non reducing sugars (%)	
	RT	AT	RT	AT	RT	AT	RT	AT	RT	AT	RT	AT
0	60.20	60.20	1.58	1.58	2.60	2.60	54.28	54.28	16.25	16.25	38.03	38.03
30	61.01	60.67	1.59	1.61	2.62	2.68	54.29	54.33	16.15	16.27	38.05	38.14
60	61.62	60.75	1.61	1.63	2.63	2.72	54.31	54.45	16.15	16.32	38.13	38.16
90	60.93	60.79	1.62	1.65	2.65	2.76	54.34	54.57	16.13	16.41	38.16	38.21
Mean	60.94	60.60	1.60	1.61	2.63	2.69	54.31	54.41	16.17	16.31	38.09	38.14
SE $\pm$	0.058	0.034	0.051	0.048	0.007	0.004	0.016	0.009	0.016	0.009	0.003	0.005
CD 5%	0.177	0.102	0.125	0.078	0.022	0.013	0.048	0.028	0.047	NS	0.009	0.016

Where AT-Ambient temperature RT-Refrigerated temperature

4.4.1 Total soluble solids (TSS)

The data indicated that the mean TSS increased from 60.20 to 61.62 ^{0}Brix within storage period of 90 days at ambient temperature while, at refrigerator temperature i.e. 60.20 to 60.79 ^{0}Brix (Table 5).

The gradual increase in TSS content in jamun juice during storage period (Khurdiya and Roy (1985), the TSS of slightly increased during the storage of guava:ber (40:60) mixed juice beverages (Vaidya *et al.*, 1998), to conducted an experiment on storage behaviour of anola syrup with 25 and 30% pulp 65 ^{0} and 70^0 Brix TSS and registered an increasing trend in TSS (Reddy and Chikkasubbuunna (2009).

Table 5. Changes in TSS content (⁰Brix) of bael syrup during storage

Storage period (Days)	AT	RT	Mean
0	60.20	60.20	60.20
30	60.90	60.67	60.79
60	61.01	60.75	60.88
90	61.62	60.79	61.20
Mean	60.93	60.60	60.77
	T	SP	T x SP
S.Em. ±	0.034	0.058	0.117
CD at 5 %	0.102	0.177	0.355
CD at 1 %	0.142	0.246	0.492

T : Temperature SP : Storage period

*AT &RT as indicated in Table 4

4.4.2 Titrable Acidity

The data on effect of storage on acidity of bael syrup is presented in Table 6. The data indicated that acidity increased from 1.58 to 1.65 per cent at ambient temperature while from 1.58 to 1.60 per cent at refrigerated temperature within storage period of 90 days. The increase in acidity was faster in samples stored at room temperature.

It is reported that an increase of total acidity from 2.0 to 3.0 pre cent in anola juice stored for ten weeks at room temperature(Mehta and Rathore,1976). An increased acidity of watermelon RTS beverages during storage was observed (Chakraborty *et al.* (1973). Anola juice exhibited an increase in acidity from 2.28 to 3.14 per cent on storage at room temperature (Tripathi *et al.*, 1988). The titrable acidity of pear juice was found to be increased by blending with apricot pulp and plum pulp, whereas it was reduced with the apple juice and apple juice concentrate during blending and after six months storage (Attri *et al.*, 1988). The gradual increase in acidity found to be more ambient

temperature as compared to be room temperature of bael syrup (Parasad and Mali, 2006).

Table 6. Changes in titrable acidity content (%) of bael syrup during storage

Storage period (Days)	AT	RT	Mean
0	1.58	1.58	1.58
30	1.61	1.59	1.60
60	1.63	1.61	1.62
90	1.65	1.62	1.63
Mean	1.61	1.60	1.260
	T	SP	T x SP
S.Em. ±	0.048	0.051	0.086
CD at 5 %	0.078	0.125	0.265
CD at 1 %	0.098	0.170	0.351

T : Temperature SP : Storage period

*AT & RT as indicated in Table 4

4.4.3 pH

The data indicated that the mean pH increased from 2.60 to 2.76 with in storage period of 90 days at ambient temperature while increased pH of syrup stored at refrigerated temperature was from 2.60 to 2.65 (Table 7).

Table 7. Changes in pH content of bael syrup during storage

Storage period (Days)	AT	RT	Mean
0	2.60	2.60	2.60
30	2.68	2.62	2.65
60	2.72	2.63	2.68
90	2.76	2.65	2.70
Mean	2.69	2.62	2.66
	T	SP	T x SP
S.Em. ±	0.004	0.007	0.015
CD at 5 %	0.013	0.022	0.044
CD at 1 %	0.018	0.031	0.061

T : Temperature SP : Storage period

*AT &RT as indicated in Table 4

There was a slight increase in pH value of citrus juices during storage (Tripathi *et al.*, 1988). The increase in p^H of pomegranate squash was more at room temperature as compared to low temperature (Parasad and Mali, 2000). It was noted that, the pH value in guava ready-to-serve beverage had the decreasing trend with an increasing period of storage upto 150 days under room temperature (Choudhary, 2005). It is observed that, the pH of anola syrup increased during three months of storage period (Reddy and Chhikksubbanna, 2009).

4.4.4 Total sugars

The data indicated that the total sugars increased from 54.28 per cent to 54.57 per cent at ambient temperature while from 54.28 to 54.34 per cent at refrigerated temperature within storage period of 90 days (Table 8). The increase was faster in samples that were stored at ambient temperature. Increase in total sugars might be due to loss of moisture during storage.

Table 8. Changes in total sugars content (%) of bael syrup during storage

Storage period (Days)	AT	RT	Mean
0	54.28	54.28	54.28
30	54.33	54.29	54.31
60	54.45	54.31	54.38
90	54.57	54.34	54.45
Mean	54.40	54.30	54.35
	T	SP	T x SP
S.Em. ±	0.009	0.016	0.032
CD at 5 %	0.028	0.048	0.097
CD at 1 %	0.039	0.067	0.134

T : Temperature SP : Storage period

*AT &RT as indicated in Table 4

It was reported that, there was gradual increase in total sugars contents of all the three varieties of citrus. The gain in sugar

per cent varied between 5.89 to 12.11 in kinnow juice, 14.40 to 30.14 per cent in blood red and 50.77 to 68.84 in villa France juice (Mehta and Bajaj (1983). It was noticed an increase in total sugars from 0.42 to 1.18 per cent in lemon juice (Palaniswamy and Muthukrishnan, 1974). The total sugars of kinnow squash increased with the advancement of storage (Sogi and Singh, 2001).

4.4.5 Reducing sugars

The data indicate that the reducing sugar increased from 16.25 to 16.41 per cent at ambient temperature while decreased from 16.25 to 16.13 per cent at refrigerated temperature of 90 days (Table 10). It was noticed, there was a gradual increase in reducing sugars of jackfruit squash during storage. The increase was more in case of the higher temperature storage (Bhatia *et al.*, 1956). It was observed in citrus juice that, there was a gradual increase in reducing sugars owing to the process of hydrolysis (Jain *et al.*, 1989). The reducing sugars was increased in phalsa beverages irrespective of storage condition. The rate of increase was more at room temperature, followed by refrigerated and cool store (Waskar and Khurdiya, 1987).

Table 9. Changes in reducing sugars content (%) of bael syrup during storage

Storage period (Days)	AT	RT	Mean
0	16.25	16.25	16.25
30	16.27	16.15	16.21
60	16.32	16.15	16.24
90	16.41	16.13	16.27
Mean	16.31	16.17	16.24
	T	SP	T x SP
S.Em. ±	0.009	0.016	0.031
CD at 5 %	NS	0.047	0.095
CD at 1 %	NS	0.066	0.0131

T : Temperature SP : Storage period

*AT &RT as indicated in Table 4

4.4.6 Non-reducing sugars

The data indicated that the non-reducing sugars increased from 38.03 to 38.21 per cent at ambient temperature while from 38.03 to 38.16 per cent at refrigerator with in storage period of 90 days (Table 9). It might be due to hydrolysis of non-reducing sugars into reducing sugars during storage. The increase in non-reducing sugars was higher in sample stored at ambient temperature. It was reported that, non-reducing sugars content was increased in citrus juice during storage (Mehta and Bajaj, 1983). It was found that, there was increase in non -reducing sugars of anola RTS when stored at room temperature, which was higher as compared to refrigerated storage (Khartude, 2004). The non-reducing sugars of custard apple pulp increased throughout the storage period under ambient conditions (Sujana, 2006).

Table 10. Changes in non-reducing sugars content (%) of bael syrup during storage

Storage period (Days)	AT	RT	Mean
0	38.03	38.03	38.03
30	38.14	38.05	38.10
60	38.16	38.13	38.14
90	38.21	38.16	38.18
Mean	38.13	38.09	38.11
	T	SP	T x SP
CD at 5 %	0.016	0.009	0.032
CD at 1 %	0.023	0.013	0.045

T : Temperature SP : Storage period

*AT &RT as indicted in Table 4

4.5 Changes in sensory parameters of bael syrup during storage

The standardized syrup containing 60 per cent sugar, 5 per cent acidity, 25 per cent pulp. The syrup was packed in sterilized pet bottles stored at ambient temperature and refrigerated temperature. The syrup was evaluated for sensory attributes by a panel of 10 semi-trained judges using a 9 point Hedonic scale ranging from like extremely to dislike extremely. The mean sensory scores of bael syrup for parameters like color and appearance, flavor, taste and overall acceptability of bael syrup are presented.

4.5.1 Color and appearance

The data on color and appearance score of bael syrup by diluting RTS as influenced by storage are presented in Table 11.

Table 11. Changes in color and appearance (9 point scale) of bael syrup during storage

Storage period (Days)	AT	RT	Mean
0	9.00	9.00	9.00
30	8.50	8.70	8.60
60	7.89	8.20	8.05
90	7.45	7.72	7.59
Mean	8.21	8.41	8.31
	T	SP	T x SP
S.Em. $\pm$	0.032	0.019	0.065
CD at 5 %	0.098	0.057	N.S.
CD at 1 %	0.136	0.079	N.S.

T : Temperature SP : Storage period

*AT &RT as indicated in Table 4

The data indicate that score for color and appearance of samples decrease from 9.00 to 7.45 ambient temperature and refrigerator temperature 9.00 to 7.72 during storage period of 90 days. The color deterioration was more in the bael syrups stored at ambient temperatures and which might be due to degradation of pigments at ambient temperatures.

Similar observation was reported in lemon juice (Palaniswamy and Muthukrishnan, 1974), guava pulp (Karla and Revti, 1981), mixed fruit beverage (Kumar and Manimegalai, 2001).

4.5.2 Flavor

The data on flavor score of bael syrup as influenced by storage are present in Table 12. The data indicate that score for flavor of sample decreased from 9.00 to 7.87 at ambient temperature and 9.00 to 8.08 at refrigerator temperature during storage period of 90 days. The decrease was more in the sample stored at ambient temperature.

Table 12. Changes in flavor (9 point scale) of bael syrup during storage

Storage period (Days)	AT	RT	Mean
0	9.00	9.00	9.00
30	8.75	8.85	8.80
60	8.07	8.50	8.29
90	7.87	8.08	7.97
Mean	8.42	8.61	8.51
	T	SP	T x SP
S.Em. ±	0.033	0.019	0.066
CD at 5 %	0.100	0.057	N.S.
CD at 1 %	0.138	0.080	N.S.

T : Temperature SP: Storage period

*AT &RT as indicated in Table 4

Similar observation were reported in Strawberry RTS beverage (Murtaza *et al.*, 2002), in anola syrup (Reddy and Chhikkasubbanna, 2009), in blended anola beverages (Jadhao Kavita, 2012), in squash (Jain, 1986).

4.5.3 Taste

The data on taste score of bael syrup as influenced by storage is presented in Table 13. The data indicates that score for taste of samples decreased from 8.67 to 8.80 at ambient temperature and 8.67 to 8.01 at refrigerator temperature during storage period of 90 days. The samples stored at refrigerator temperature were liked most by the Judges.

Table 13. Changes in taste score (9 point scale) of bael syrup during storage

Storage period (Days)	AT	RT	Mean
0	8.67	8.67	8.67
30	8.45	8.50	8.48
60	8.20	8.35	8.28
90	8.80	8.01	7.91
Mean	8.28	8.38	8.33
	T	SP	T x SP
S.Em. ±	0.007	0.004	0.014
CD at 5 %	0.022	0.013	0.044
CD at 1 %	0.030	0.018	0.061

T : Temperature SP : Storage period

*AT & RT as indicated in Table 4

Similar observations were reported in decrease in taste score of stored guava pulp (Karla *et al.*, 1987), in ber, guava and pomegranate beverage (Vaidya *et al.*, 1998), in pomegranate squash (Parasad and Mali, 2000), in RTS beverage from custard apple (Pilania *et al.*, 2010).

4.5.5 Overall acceptability

The overall acceptability is a combined effect of color, flavor and taste of the bael syrup by diluting RTS are present in Table 14. As storage period upto 90 days there was decreased in the overall acceptability score. The rate decreased was higher in sample stored at ambient temperature as compared to refrigerator temperature during storage period of 90 days.

Table14. Changes in Overall acceptability (9 point scale) of bael syrup during storage

Storage period (Days)	AT	RT	Mean
0	8.90	8.90	8.90
30	8.88	8.85	8.77
60	8.05	8.65	8.20
90	7.88	8.19	3.04
Mean	8.56	8.46	8.51
	T	SP	T x SP
S.Em. ±	0.006	0.011	0.022
CD at 5 %	0.018	0.033	0.066
CD at 1 %	0.026	0.046	0.092

T : Temperature SP : Storage period

*AT & RT as indicated in Table 4

Similar observations were reported in anola, grape, pineapple and mango RTS beverages (Deka *et al.*, 2001), tamarind beverages (Kotecha and Kadam, 2003), squash of pomegranate (Srinivas *et al.*, 2007).

5. SUMMARY AND CONCLUSIONS

The present investigation was undertaken at the Department of Food Science and Technology, M.P.K.V., Rahuri during the year 2014-16 to optimize the conditions for preparation of good quality syrup from bael.

The flesh from fully ripped bael fruits of local cultivar was removed, then water was added to it and mixing and heating at 80^0C for 1 min, was performed to extract the pulp. The pulp was sieved through the sieve to remove fibre and to get fine pulp. Fine pulp was collected to which ingredients like sugar, citric acid and sodium benzoate were added one by one, then stirred and mixed well and heated for few min to obtain syrup. Then syrup was filled into pet bottles for further storage. The fresh and stored bael syrup samples were evaluated for sensory qualities by semi trained judges. The syrup samples were stored at ambient temperature (30 ± 5°C) and refrigerated temperature (5 ± 2°C) for 90 days. The representative samples were drawn periodically at 30 days interval to evaluate changes in sensory and chemical parameters of the syrup. The results obtained during this investigation are summarized below:

1. The bael fruits used were greyish, spheriod oblong with an average weight 435.9 g/fruit, average length of 9.23 cm and recovery of pulp was about 68 per cent.
2. The fresh fruit pulp of bael contained average values of TSS 23.30 °B, acidity 0.44 per cent, total sugars 8.22. per cent, reducing sugars 3.96 per cent and non-reducing sugars 4.26 per cent.

3. Best treatment, the fresh bael syrup contained average values of TSS 60.23°B, acidity 1.60 per cent, total sugars 54.38 per cent, reducing sugars 16.29 and non-reducing sugar 38.18, pH 2.73 per cent.
4. There was significant increase in TSS, pH, reducing sugars and total sugars during storage of bael syrup. The titrable acidity of bael syrup increased significantly during storage.
5. The bael syrup stored at refrigerated temperature contained significantly lower levels of reducing sugars and total sugars than those stored at ambient temperature. There was gradual decrease in mean score for color and appearance, flavor, taste and overall acceptability of bael syrup during storage. However, better retention of color, taste and flavor was observed in refrigerated storage.
6. Bael syrup prepared with of citric acid and sodium benzoate stored at refrigerated temperature remained in excellent condition even after 3 months of storage
7. Among all treatments, it was found that good quality and acceptable syrup was obtained from treatment T4 i.e. 25 per cent pulp, 0.5 per cent acidity, 600 ppm sodium benzoate, 60 per cent sugars.

Conclusion

It is concluded that the best quality of bael syrup can be prepared by 25 per-cent bael pulp, sugar 60 per-cenT, acidity 0.5 per-cent and sodium benzoate 600 ppm. The samples stored at refrigerated temperature were found better as compared to samples stored at ambient temperature.

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*** Originals not seen**

7. APPENDIX

Performa for organoleptic evaluation of bael syrup

Name of the judge : Date :

Sr. No.	Samples	Sensory score			
		Color and appearance	Flavor	Taste	Overall acceptability
1.	T_1				
2.	T_2				
3.	T_3				
4.	T_4				
5.	T_5				
6.	T_6				
7.	T_7				
8.	T_8				
9.	T_9				

* Score out of 9

Organoleptic score

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

8. VITA

Miss. Bangale Usha Pandurang

A candidate for the degree
of
MASTER OF SCIENCE
in
FOOD SCIENCE AND TECHNOLOGY
2016

Title of thesis	:	Studies on preparation of syrup from bael (*Aegle marmelos* Corr.).
Department	:	Food Science and Technology
Biographical Information:		
*Personal	:	Born at Gunj, Tal. Sindkhedraja, Dist. Buldana, Maharashtra on 15th January, 1992. Daughter of Sau. Kamal and Shri. Pandurang Santosh Bangale.
*Educational	:	Passed S.S.C. Examination from Shri. Shivaji Highschool Sakharkherda, Buldana with First class Distinction in 2008.
	:	Passed H.S.C. Examination from Shri. Shivaji Junior College, Chikhali, Buldana with First class Distinction in 2010.
	:	Received B.Sc. (Agri) degree from College of Agriculture, Akola with first class in 2014.
Achievement	:	Assistant Field Officer (MSSCL Mahabeej Chikhali).
*Address	:	A/P-Shindi Tal. Sindkhedraja Dist. Buldana- 443202
Email	:	usha1482878@gmail.com