Studies on Preparation of Wood apple Based Mixed Fruit Jam

THESIS

Submitted to the

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

In partial fulfillment of the requirements for the Degree of

MASTER OF SCIENCE

In

AGRICULTURE

Horticulture (Fruit Science)

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2015

CERTIFICATE - I

This is to certify that the thesis entitled "Studies on preparation of Wood apple based mixed fruit jam" submitted in partial fulfillment of the requirement for the degree of ***MASTER OF SCIENCE in Agriculture, Horticulture (Fruit Science)*** *of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by Mr. Nakul Rao Rangare under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.*

All the assistance and help received during the course of the investigation have been acknowledged by him.

Place: Jabalpur

Date: **(Dr. P.K.Jain)**

Chairman of the Advisory Committee

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CERTIFICATE - II

This is to certify that the thesis entitled "Studies on preparation of Wood apple based mixed fruit jam" submitted by Mr. Nakul Rao Rangare to the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfillment of the requirements for the degree of Master of Science in Agriculture, Horticulture (Fruit Science) in the Department of Horticulture has been, after evaluation, approved by the External Examiner and by the Student's Advisory Committee after an oral examination on the same.

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I, Nakul Rao Rangare S/o Nem Das rangare Certify the work embodied in thesis entitled *"Studies on preparation of Wood apple based mixed fruit jam"* is my own first hand bonafide work carried out by me under the guidance of Dr. P.K. Jain at Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur during 2014-15.

The matter embodied in the thesis has not been submitted for the award of any other degree/diploma. Due credit has been made to all the assistance and help.

I, undertake the complete responsibility that any acts of misinterpretation, mistakes and errors of fact are entirely of my own.

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LIST OF SYMBOL AND ABBREVIATIONS

Symbol		Abbreviations
/	:	Per
%	:	Percentage
vol.	:	Volume
ppm	:	Parts per million
ml	:	Millilitre
L	:	Litre
mg	:	Milligram
g	:	Gram
Kg	:	kilogram
@	:	At the rate
etc.	:	et cetera
et.al	:	and other
Fig.	:	Figure
i.e.	:	that is
NL	:	Normal
HPO_3	:	Meta phosphoric acid
TSS	:	Total soluble solids
Temp	:	Temperature
RH	:	Relative humidity
viz.	:	Namely
˚C	:	Celsius
C.D.	:	Critical difference
Max.	:	Maximum
Min.	:	Minimum
DAS	:	Days after storage
DF	:	Degrees of Freedom
Var.	:	Varieties
cv.(s)	:	cultivars

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Place : Jabalpur

Date : **(Nakul Rao Rangare)**

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INTRODUCTION

Fruits are important ingredient in the human dietaries due to their high nutritive value. They make significant nutritional contribution to human well being. They are the cheaper and better source of the protective foods. If they can be supplied in a fresh or preserved form throughout the year for human consumption, the national picture will be improved greatly. The perishable fruits are available as seasonal surpluses during certain part of the year in different regions and are wasted in large quantities due to absence of facilities and unawareness of proper handling, distribution, marketing and storage. Further more massive amount of the fruit produced during a particular season results in glut in the market and become scarce during other season, neither they all are consumed in fresh form nor sold at economically viable prices.

India is the second largest producer of Fruits after China, with a production of 44.04million tons of fruits from an area of 3.72 million hectares. India is a unique comparative edge in the cultivation of variety of horticulture crops. Fruits are also known to be excellent source of energy, minerals, vitamins and bioactive compounds like phonetics and carotenoids and fibers, which play a unique role in meeting the nutritional needs of our population. Fruits are an important part of healthy diet. They play an important role in keeping the body healthy by reducing the risk of some chronic disease like heart disease including heart attack and stroke, obesity, diabetes, kidney stones etc.

Wood apple (*Feronialimonia* L.) belongs to the family Rutaceae is one of the hardy fruit grown in arid and semi-arid region of the country. Wood apple grows in abundance throughout India's drier regions and is cultivated along both peninsula of the country. In India, Wood apple being hardy in nature is grown in neglected and marginal areas of tropical and sub-tropical regions. Undoubtedly, this fruit crop plays an important role in pushing up the income of the farmers, where the cultivation of other fruit crop is arduous and less profitable. Wood apple fruit consists of 64.2% moisture, 7.1% protein, 3.7% fat, 1.9% minerals,

5.0% fiber and 18.1% carbohydrates per 100 grams. They are rich in oxalic acid, malic acid, citric acid and a concentrated tannic acid.

Mango (*Mangifera indica* L.) belons to the family Anacardiaceae. Approximately 50% of all tropical fruits produced worldwide are mangoes. Mango is an important fruit crop in India and popularly called the 'king of fruits'. Mango is the most widely cultivated fruit in India. India is the major Mango growing country, contributing nearly 49.62 per cent of world's area and 42.06 per cent of world's production respectively. Area under Mango crop in Andhra Pradesh is the highest in the country. The fruit is very popular with the masses due to its wide range of adaptability; it has high nutritive value, richness in variety, delicious taste and excellent flavour. It is a rich source of vitamin A and C. Raw fruits are used for preparing various traditional products like raw slices in brine, amchur, pickle, murabba, jam, chutney, panhe (sharabat) etc.

Banana (*Musa* sp.) belonging to the family Musaceae banana and plantains are grown in about 120 countries. Total annual world production is estimated at 86 million tones of fruits. India leads the world in banana production with an annual output of about 14.2 million tones. Other leading producers are Brazil, Eucador, China, Philippines, Indonesia, Costarica, Mexico, Thailand and Colombia. In India banana ranks first in production and third in area among the fruit crops. It accounts for 13% of the total area and 33% of the production of fruits. Production is the highest in Maharashtra (3924.1 thousand tones) followed by Tamil Nadu (3543.8 thousand tones), in India. It is a rich source of carbohydrate and vitamins particularly vitamin B. processed products such as chips, banana puree, jam, jelly, juice, and wine are also manufactured from this fruit.

Apple (*Malus domestica*) belonging to the family Rosaceae, is commercially the most important temperate fruit and is fourth among the most widely produced fruits in the world after banana, orange and grape. The area under apple cultivation in India increased by 24% from 1.95 lakh ha.in 1991-92 to 2.42 lakh ha. in 2001-02 although the production increased by less than 1% (i.e.

from 11 to 12 lakh tones). It is mostly grown in the states of Jammu & Kashmir, Himachal Pradesh, Uttaranchal, Arunachal Pradesh and Nagaland. Apples are mostly consumed fresh but a small part of the production is processed in to juices, jellies, canned slices and other items.

Papaya (*Carica papaya*) belonging to the family Caricaceae is a tropical fruit. The area under papaya cultivation in India increased by 63% from 45.2 thousand ha. in 1991-92 to 73.7 thousand ha., in 2001-02 and the production increased from 8 lakh tones to 26 lakh tones. It is a rich source of vitamin A and C. It has a high nutritive and medicinal value. Papain prepared from dried latex of its immature fruits is used in meat tenderizing, manufacture of chewing gum, cosmetics.

The processing of fruits into various products is one of the best way to reduce the losses due to high acidity and astringent taste in wood apple fruits. Its utilization for the preparation of jam is very limited. Therefore, blending of two or more fruit pulp is a better alternative to utilize its high nutritive value.

Hence, keeping the above point in view the present investigation entitled **"Studies on preparation of wood apple based mixed fruit jam**." was conducted with the following objectives:

1. To evaluate various fruits for making mixed fruit jam.
2. To find out suitable recipe for making wood apple based mixed fruit jam.
3. To calculate the economics of the various treatments.

REVIEW OF LITERATURE

Fruits are nature's gift to the mankind. These are not only delicious and refreshing but also a good source of higher nutritional, medicinal and calorie values. Some fruits possess good nutritional, medicinal contents but still they are not liked much, due to its poor taste.The perishable fruit are available as seasonal surpluses during certain part of the year in different regions and are wasted in large quantities due to absence of facilities and unawareness of proper handling, distribution, marketing and storage. The wood apple fruit are generally utilized to prepare chutney and pickles in rural areas. On the other hand mango is a rich source of vitamin A and C. Raw fruits used for preparing various traditional products like raw slices in brine, amchur, pickle, murabba, jam, chutney, panhe (sharabat) etc. and banana, papaya, apple also have high nutritive value for man kind and suitable to jam making.

Due to acidity and astringent taste in wood apple fruit its utilization for the preparation of jam is very limited. During the last so many years, much experimental work has been done at different time and different part of the country and about to standardize the recipe for preparation of mixed value added products of fruits and vegetables. The literature on standardization / evaluation of various recipes for preparation of mixed fruit jam is scanty. Research work done by other scientist on the line of present investigation has been presented in this chapter.

Sensory parameters:

Dhyani and khali (1993) reported that out of 198 species, only six species of fig Viz. *Ficus glomerata, Ficus hispida, Ficus auriculara*, *Ficus semicordeta, Ficus subincisa*and, *Ficu spalmat,* were found promising for preparation of jam and jelly.

Baramanray *et. al.* (1995) reported that organoleptic quality of freshly prepared jelly to be highly acceptable but quality of jelly reduced with the increased storage period. He also reported that colour, flavour, texture, taste and

acceptability of jelly prepared from cultivar Sardar has higher initial score but decreased significantly at 90 days of storage.

Zhuang-fuzui (1998) observed that fruit of Jaboticaba (*mycriaria cauliflora*) were not only good for fresh consumption but also for processing for jam, jelly, juice and confectionery. The peel of jaboticaba fruit can also be used as a medicine.

Koveshnikova and Merkulova (1999) reported that fruits of different varieties of gooseberry were very promising and can be recommended in the form of jam, jelly, juice and wine.

Pandey and Singh (1999) reported that recipe containing 10% pulp and 11% total soluble solid with 0.25% acidity was found most ideal for preparation of guava RTS beverage prepared from Cv. L-49 was better than Cv. Allahabad safeda, apple colour and sangam.

Mochiznki *et al*. (2000) reported that fragrance of jam made from inter specific hybrids of strawberry was quit specific and different from these made from processing varieties of strawberry. The colour of the jam reflected the flesh colour and texture and test were almost same as the control samples made from processing varities.

Abdullah and Cheng (2001 reported that Response surface methodology using mixture design was used to determine the optimum ratio of pineapple, papaya and car-

ambola in the formulation of reduced calorie tropical mixed fruit jam. Ten formulations covering the entire range of a triangular simplex were subjected to sensory evaluation. Contour plot of sensory attributes showed that formulations containing 3.5±37.7% papaya, 0±15% carambola and 61.5±96.5% pineapple produced optimum acceptance. A predicted optimum formulation containing 71% pineapple, 25% papaya and 4% carambola together with two non-optimal formulations were selected and subjected to sensory evaluation to con®rm the validity of the model. There was a signi®cant di erence (P40.05) between the

predicted optimum and the other two tested formulations. Results obtained matched the predicted value where the optimum formulation received the best sensory scores for most attributes tested. The optimum mixed fruit jam formulation contained 106 kcal/100g which is one-third of the caloric value of a normal jam.

Chopra and Singh (2001) reported that 1:2 ratio of the flesh and water and heating of this mixture to 100°C were found ideal for an easy extraction of wood apple pulp.

Shabrawy *et al*. (2002) found that flavoured processed cheese with mango had the lowest oil index values, where as the cheese with banana showed the highest values. The fat separation increased with increasing percentage of the fruit pulp added to the blend. Flavoured treatment had significantly higher metability values as compared to control of guava or mango, whereas, it decreased with increasing banana ratio. The penetration value was lower in unflavoured cheese (control) then in flavoured treatment.

Seidemann (2002) reported that aromatic pulp of wood apple fruits are eaten and processed in to jam, jelly, chutney and juice.

Manivasagan *et al.* (2004) showed that total soluble solid, ascorbic acids and organoleptic rating of karonda jam decreased consciously during storage (120 days) respectively of jam. Browning and acidity content from pink karonda was more acceptable as compared to jam prepared from green karonda.

Sakate *et al.* (2004) observed that 20% wood apple pulp with 45% sugar produced desirable wood apple burfi with improved sensory quality and low cost production.

Fugel *et al*. (2005) reported that adulteration of foods is a serious economic problem concerning most food commodities, in particular fruit products. Since high-priced fruits command premium prices, producers of fruit-based products such as juices, jams, jellies, puree's, and fruit preparations might be tempted to blend these products with cheaper fruits. In addition to admixtures of

adulterants, the labelled fruit contents may not be met. Both types of adulteration are difficult to detect and lead to a deterioration of product quality.

Singh *et al.* (2005) revealed that during storage of the jam, the total soluble solids and total sugars increased up to three months. Throughout the storage period of six months, the reducing sugars and browning increased, whereas, acidity and non-reducing sugars showed a decreased trend. They also reported that the organoleptic rating decreased from 8.36 to 6.57 irrespective of the recipes during storage.

Parmar (2008) observed that the highest economical treatments are T3 (75% guava + 25% papaya + 62.5 gm. Sugar + 5 gm. citric acid) with B:C ratio of 3.2 followed by T6 (75% guava + 25% papaya + 62.5 gm. Sugar + 6 gm. citric acid) with same B:C ratio of 3.2. It was further noticed that B:C ratio of further leather significantly increased with increase in the sugar content.

Nathan *et al* (2010) reported variation in the physicochemical properties such as juice volume, residue wet weight, pH, protein, reducing sugars, total sugars and sugar identification of two varieties of cashew apple (red and yellow) collected from 5 agro fields of Katchiperumal village, Ariyalur District were investigated.

Rocha *et al.* (2011) reported results of drying of tropical fruit pulps in spouted beds (SBs) are presented, focusing on the effects of fruit pulp composition on the SB fluid dynamics and process performance and the development of new products formulated from mixtures of pulps with varied composition. It was verified that high starch and lipid contents favoured stable fluid dynamics and high powder production efficiency, while high reducing sugar concentrations resulted in bad dynamic regime and very low powder production.

Watanabe *et al*. (2011) observed that strawberry impregnated with sucrose was used for the jam preparation, and its effects on the stability of anthocyanin's and the jam colour were examined. The amount of sucrose in impregnated strawberry depended on the concentration of sucrose solution and the operation time for the impregnation.

Kumari and Sandal (2011) evaluated the local mango fruit (Desiaamb) for preparation of squash, RTS beverage and jam was carried out. The prepared product was evaluated for their chemical characteristics at different storage intervals i.e., 0, 25, 50, 75 and 100 days. The TSS, PH, ascorbic acid., b-carotene and total and non-reducing sugars decreased with the increase in storage period whereas acidity and reducing sugars increased. Further studies revealed that overall acceptability slightly decreased after storage of 100 days.

Shahnawaz and Shiekh (2011) reported that analysis of viscosity of jamun fruit juice, squash and jam at different compositions to ensure the suitability of processing applications this study would be a ready reference and helpful communication particularly to those desires for commercial processing of jamun products with customary feature.

Souad *et al.* (2012) reported that Jam was prepared from watermelon rind with different flavors (vanilla, pineapple, strawberry, lemon and no flavour). Five different samples were prepared at various compositions T_1 (50-50), T_2 (80-20), T_3 (60-40), T_4 (40-60) and T_5 (20-80) of rind and sugar. T_1 (50-50) gave the best jam set. Ten man panel (trained) evaluated the jam for its sensory characteristics and physicochemical analysis.

Basu *et al.* (2013) An attempt was made for manufacturing low calorie mango jam by replacement of sucrose with alternative sweeteners (stevioside and sucralose). Manufacture of mango jam with desired jam-like soft solidcharacteristics was feasible only with 25% stevioside or sucralose substitution. Herschel Bulkley and Hahn model adequately described the steady state and time dependent rheological behavior of f stevioside/sucralose jam, respectively. Consistency index and yield stress values of jam samples decreased with increasing substitution of stevioside or sucralose due to reduction of total soluble solids (TSS). Flow behavior index increased with decreasing TSS values, signifying liquid like behavior of jam.

Gomez *et al.* (2013) reported that changes in the microbiological and physicochemical quality during storage of osmotically dehydrated strawberry jam

stabilized with plant extracts. The use of plant extracts reduces the microbial charge (aerobic mesophylls, lactic acid bacteria, molds, and yeasts) and is most effective when pomegranate and lemon extracts are used, as these do not cause significant changes in the physicochemical characteristics. Furthermore, adding pomegranate and or lemon extract improved the consistency of jams during storage. In general, the additional extracts involved an increase in stability of strawberry jam during storage at room temperature.

Senthilkumar and Venkatesalu (2013) reported that the fruit pulp essential oil of wood apple (Feronialimonia) was studied for its chemical constituents, in vitro antioxidant and antimicrobial activities. Totally, 50 constituents were identified by GC and GC–MS analyses and thymol (52.22%) was identified as the major chemical compound. The antioxidant activity showed that the essential oil had good scavenging potential.

Patil *et al.* (2013) reported that Jam is prepared from fruit pulp by boiling with sufficient quantity of sugar to a moderately thick consistency. There are different types of fruit jams like strawberry jam, mango jam, pineapple jam, apple jam and mixed fruit jam. Hencean attempt was made to find out the possibilities of mixing guava and sapota for making jam and utilizing a major portion of marketable surplus of guava. Guava and Sapota pulp was blended in the ratios of 100:0, 90:10, 80:20, 70:30, and 60:40respectively to prepare blended jams. The treatment of T4, 60% guava pulp and 40% sapota pulp, showed significantly less titrable acidity (1.05%), higher TSS (74.2°Brix) and total sugar (67.28%). Among the blended jams, the highest score for colour (8.64), flavor (8.88), consistency (8.97), taste (8.12) and overall acceptability (8.78) was judged in the treatment 60%guava pulp and 40% sapota pulp. Treatment T4, 60% guava pulp and 40% sapota pulp was more in red color.

Jayabalan and Karthikeyan (2013) The present work was focused on the sensory quality of jam produced by aloe vera. Response surface methodology (RSM) was used to optimize the ingredients like: aloe vera juice (800-1200 ml), sugar (800-1200 g kg-1), pectin (35-60 g kg-1) and citric acid (20-40 ml). Results

showed that the model fit was significant ($p < 0.05$) and there was satisfactory correlation between actual and fitted values.Sensory analysis for color, taste, aroma and texture in the aloe vera jam produced at the optimized ingredients composition were performed.

Satheeskumar and Murugesan (2014) reported that The aim of the present investigation was to evaluate the mineral content of mixed fruit jam processed by electron beam irradiation instead of addition of chemical preservatives. The freshly prepared mixed fruit jam was exposed to electron beam irradiation at doses of 2.5 kg, 5.0 kg, 7.5 kg and 10 kg. The irradiated and control samples were stored at room temperature. The minerals sodium, potassium, phosphorus and calcium in the irradiated and control jams were evaluated at different time intervals. After irradiation and storage, minimal changes were observed in mineral content of mixed fruit jam at this dose levels (2.5 to 10 kg) and it may not be affected the nutritional quality of the product compared to control samples. Therefore, the results suggest that the electron beam irradiation could be useful in preserving the mixed fruit jam without impairing the mineral content of jam after irradiation.

Shakir *et al.* (2014) reported that comparative study was carried out on mixed fruit jam of (apple + pear) pulp, incorporated within the ratios 50:50 (T_1), 60:40 (T2), 40:60 (T_3), 100% apple (T_4) and 100% pear (T_5). All the jam samples were stored in sterilized glass jars and evaluated physic chemically for ascorbic acid, acidity, pH, total soluble solids, reducing sugars and non reducing sugars for an interval of 15 days during 3 months storage period. All the samples were significantly different at ($P < 0.05$) during storage.

Tham and Minh (2014) reported that effect of ripen Mature and Ratio of wood apple's pulp supplemented with Sugar for *feronia limonia* quach wine fermentation.

Sindumathi and Amutha (2014) reported that in recent years emphasis is focused on product diversification, by products utilization and development of value added coconut products to improve the coconut economy.Coconut jam is a

traditional high sugar coconut food product, commonly consumed as dessert, bread spread and rice cake topping. The changing in chemical microbial and organoleptic characteristics of the coconut jam were studied.

Touati *et al.* (2014) reported that storage conditions are important factors for jam quality. The objective of this study was to monitor the physicochemical stability and sensorial profile of apricot jam during storage for 60 days at 5 °C, 25 °C and 37 °C. For that purpose, special attention was paid to total soluble solids (TSS), titratable acidity (TA), colour, free amino acids (FAA), total sugars (TS) and hydroxyl methylfurfural (HMF).

Viana *et al* (2014) obsereved that the physico-chemical and sensory properties of mixed jam elaborated with banana and araça-boi. Four banana extract (BE) and araçá-boi (AB) jams were prepared using the following proportions: F1 (70% BE:30% AB), F2 (60% BE:40% AB), F3 (40% BE:60% AB) and F4 (30% BE:70% AB). The jams were analyzed for physicochemical and sensory properties. The formulation F1 was considered the most accepted for all attributes evaluated and showed high purchase intent (68%), and was therefore appropriate for industrialization and consumption.

Kelebek *et al.* (2015) reported that the phenolic compounds, organic acids, sugars, aroma profiles and antioxidant properties of Sel-42 and Tainung papayas grown in Turkey. High-performance liquid chromatography / electrospray ionisation tandem mass spectrometry (HPLC–ESI–MS/MS) method was used for the phenolic compounds analysis.

Quality / chemical parameters:

Das *et al.* (1954) observed the losses of ascorbic acid and carotene during the preparation and storage of dried mango pulp. They reported the losses of ascorbic acid from 92-98% and carotene from 30-40% during sun drying of mango pulp.

Hamanan *et al.* (1980) found that change in composition of stored pulp but showed no change of pH value of pulp from both the cultivar. (Red fleshed and white fleshed) during 27 week storage period.

Ramana *et al.* (1984) reported deterioration in ascorbic acid content in mango pulp during storage.

Chouhan, (1981) observed a gradual decrease in acidity with increase in the storage period in guava jelly. The decrease in acidity might be due to formation of sulphuric acid during storage.

Tripathi *et al.* (1992) observed that the total soluble solid and acidity were increased during storage in pineapple guava mixed beverages. Similar finding were also reported by attri *et al.* (1998) and Pandey and Singh (1999).

Humeid and yousif (2000) observed that 0.25:1 of sugar and over ripe was found best for preparation of jam and jelly. Pectin (0.1%) was required to produce an acceptable jam texture in case of Salty and Thompson seedless varieties of grapes but zaini variety of grapes did not need this addition. Grapes jelly with a pH of 3.28 and 8 ^{0}Brix of 72% confirmed to the quality of both national and international standards.

Saravanan *et al.* (2004) observed slight decrease in acidity of papaya jam, during storage. Similarly, acidity reduction observed in the guava juice concentrate prepared from vacuum concentration method.

Wicklund *et al.* (2004) reported that jam was prepared from five strawberry cultivars; ‘Senga Sengana’, ‘Korona’, ‘Polka’, ‘Honeoye’ and ‘Inga’. The jam was stored at 4 and 20 1C, in darkness and under fluorescent light (950 lux).Then achieve a good coloured strawberry jam with high antioxidant capacity, the industry should consider to store the products at 41^{0}C and to replace ‘SengaSengana’ with one of the ‘Korona’, ‘Honeoye’ and ‘Polka’ cultivars.

Deka *et al.* (2005) reported that the TSS, acidity, total sugar and reducing sugar were gradually increased in mango-pineapple mixed beverages during storage, while the ascorbic acid content was decreased.

Sesmero *et al*. (2006) reported that analyzed several quality parameters of strawberry jam prepared from transgenic fruits with reduced expression of a pectatelyase gene. The results obtained indicate that inhibition of pectatelyase gene expression can improve several quality traits of strawberry jam, such as texture and content of whole berries.

Chauhan *et. al*. (2008) reported that, the TSS and acidity of guava pulp was increased slightly during storage. Whereas, pH, ascorbic acid content and organoleptic values (appearance, flavour, taste and over all acceptability) were decreased after 60 days of storage. However, the pulp quality was acceptable even after 60 days of storage.

Mazur *et al.* (2014) observed those Effects of ripeness and cultivar on chemical composition of strawberry (*Fragaria ananassa* Duch.) fruits and their suitability for jam production as a stable product at different storage temperatures.

MATERIAL AND METHODS

The present investigation entitled “Studies on preparation of wood apple based mixed fruit Jam” was conducted during the year 2014-15. The details of materials used and techniques employed in the present investigation are described under the following heads:-

3.1 Experimental site

The experimental work of **“Studies on preparation of Wood apple based mixed fruit Jam.”** was conducted at the Post Harvest Technology Laboratory, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (M.P)

3.2 Climatic conditions

Jabalpur is situated at 23.90˚ North latitude and 79.58˚ East longitude at an altitude of 411.78 M above the sea level. Jabalpur has a subtropical climatic with hot and dry summer 46.4˚C and cool winter 3.6˚C during winter with an occasional occurrence of frost.The temperature and humidity of lab during study period were recorded with the help of max. and min. thermometer and dry wet bulb thermometer respectively. The mean relative humidity was recorded 77.36 percent.

3.3 Experimental Material

The Wood apple fruits local cultivars were collected from Almoda village Sehora Near Jabalpur. The fruits were collected in monsoon season (2014) and Mango (Totapuri), Banana, Apple, Papaya fruits were collected from “Fruit Mandi, Jabalpur (M.P.)” and used for experimentation. The unripe, shorted diseased, damaged and off type fruits were discarded. The selected fruits were thoroughly washed with tap water to remove dirt and dust particles adhering to the surface of fruit and were allowed for surface drying. The good quality/shorted fruits were picked up and used for the purpose of experimentation.

Table 3.2.1 Temperature and relative humidity during storage period (September 2014 to January 2015)

DATE	METEROLOGICL WEEKS	TEMPERATURE (°C)		RELATIVE HUMIDITY (%)	
		MAX.	MIN.	MAX.	MIN.
11 Sep.- 17 Sep.	1	30.5	27.1	77	59
18 Sep.- 24 Sep.	2	30.8	29.1	75	66
25 Sep.- 01 Oct.	3	30.9	28.8	71	52
02 Oct. - 0 8 Oct.	4	31.1	26.9	80	51
09 Oct. - 15 Oct.	5	31.1	26.1	80	47
16 Oct. - 22 Oct.	6	31.1	24.4	80	47
23 Oct. - 29 Oct.	7	31.3	23.8	80	47
30 Oct. - 05 Nov.	8	31.1	22.9	80	45
06 Nov.-12 Nov.	9	31.1	22.9	80	47
13 Nov.- 19 Nov.	10	31.1	20.5	80	40
20 Nov.- 26 Nov.	11	31.1	20.1	80	40
27 Nov.- 02 Des.	12	31.1	20	80	40
03 Des.– 09 Des.	13	31.1	18.2	80	40
10 Des - 16 Des.	14	31.1	18.2	80	40
17 Des.- 23 Des.	15	31.1	16.3	80	40
24 Des.- 30 Des.	16	31.1	15.9	80	40
31 Des.- 06 Des.	17	22.4	7.7	77	49
07 Jan.- 13 Jan.	18	22.4	7.7	77	49

3.4 Experimental details:

The experiment entitled “Studies on preparation of Wood apple based mixed fruit Jam.” was carried out during the year 2014-2015. On monsoon season Wood apple, Mango (Totapuri), Banana, Apple and Papaya crops.

3.4.1 Experimental design:

The experiment was laid out in a Completely Randomized Design with 3 replications.

3.4.3 Other details of experiment:

- Crops : Wood apple, Banana, Papaya, Mango, Apple
- Design : CRD (Completely Randomized Design)
- No. of treatments : 12
- Replications : 3
- Date of preparation of jam : 11 September 2014
- Quantity of jam/bottle : 360 g.
- No. of bottles/replication : 3
- No. of bottles treatment : 12
- Total no. of bottles Prepared : 36
- Storage condition of jam : Ambient condition (At Room temperature)

3.4.4 Observations to be recorded

(A). Physico-chemical characteristics of fruits

1.Physical Composition:-

- Fruit weight in g.
- Skull / peel weight in g.
- Pulp weight in g.
- Core weight in g.
- Stone weight in g.
- Seed weight in g.

2.Chemical:-

- Total soluble solids (%)
- Acidity (%)
- Ascorbic acid (mg. /100g.)
- pH
- Total sugar %
- Reducing sugar %
- Non reducing sugar %

3.4.2 Treatment details:

The experiment was comprised of 12 treatment combinations consisting 12 pulp ratios. The details of various treatments and their combinations are presented below:

Treatments	Fruit Pulp [in g.]				Extract Wood apple pectin
	Banana	Apple	Mango	Papaya	
T_1	125	125	125	125	500 ml
T_2	166	166	166	-	500 ml
T_3	166	166	-	166	500 ml
T_4	-	166	166	166	500 ml
T_5	166	-	166	166	500 ml
T_6	250	250	-	-	500 ml
T_7	250	-	250	-	500 ml
T_8	250	-	-	250	500 ml
T_9	-	250	250	-	500 ml
T_{10}	-	250	-	250	500 ml
T_{11}	-		250	250	500ml
T_{12}	-	-	-	-	1000ml

3.4.4 Observations to be recorded

(A). Physico-chemical characteristics of fruits

1.Physical Composition:-

- Fruit weight in g.
- Skull / peel weight in g.
- Pulp weight in g.
- Core weight in g.
- Stone weight in g.
- Seed weight in g.

2.Chemical:-

- Total soluble solids (%)
- Acidity (%)
- Ascorbic acid (mg. /100g.)
- pH
- Total sugar %
- Reducing sugar %
- Non reducing sugar %

(B) PULP:-

- Colour of pulp
- TSS (%)
- Acidity (%)
- Ascorbic acid (mg. /100g.)
- pH of fruit pulp.

(C). Mixed fruit jam (at 0, 30, 60, 90, 120 days of storage)

1. Organoleptic evaluation of mixed fruit jam:-

- Colour
- Flavour
- Taste
- Texture
- Overall acceptability

1. Quality characters:-

- TSS (%)
- Acidity (%)
- pH
- Ascorbic acid (mg./100g.)

(D). Economic of the treatments:

3.5 Methodology followed:

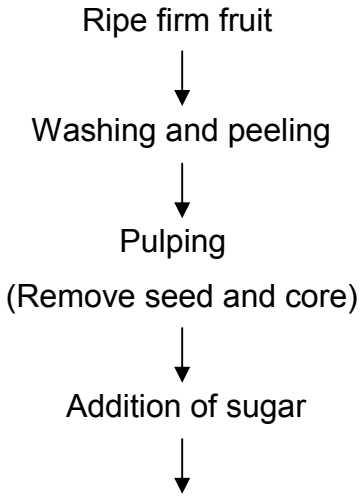
The uniform Wood apple fruits local cultivar were collected from Almoda village, Sehora near Jabalpur and mango (Totapuri), banana, apple, papaya fruits cultivar were collected from “Fruit Mandi, Jabalpur (M.P.)”. Unripe and ripe fruits of wood apple and mature fruit of mango, banana, apple, papaya were collected and used for preparation of jam.The fruits of wood apple, mango, banana, apple and papaya were washed and graded to select fruit to treatment having uniform maturity.

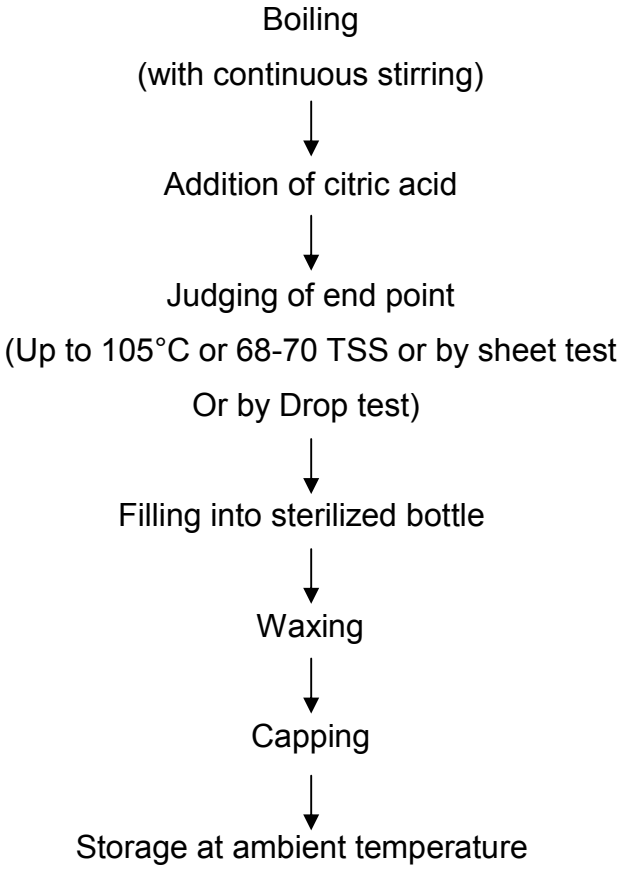
3.6 Extraction of pulp from wood apple mango, Banana, Apple and papaya:

The fruit of wood apple were broken into small pieces with the help of small hammerand scoop out with the help of spoon after that some quantity of water was added and steamed for pulp preparation. The steamed pulp was prepared with the help of mixercum grinder.

In case of mango, Banana, Apple and Papaya were washed and peeled off separately and cut into small pieces. After removal of seeds (stones) some quantity of water added and steamed for pulp preparation. The steamed pulp was prepared with the help of mixer cum grinder.

3.7 Technological flow sheet for preparation of wood apple based mixed fruit jam:





3.8 Determination of end point

(1) Sheet (or) Flake Test:

A small portion of jam is taken out during boiling in a spoon or wooden laddle and cooled slightly. It is then allowed to drop. If the product falls off in the form of a sheet (or) flakes instead of flowing in a continuous stream (or) syrup, it means that the end point has been reached and the product is ready. Otherwise boiling is continued till the sheet test is positive.

(2) Drop Test:

A drop of the concentrated mass is poured into a glass containing water setting down of the drop without disintegration denoted the end point.

3.9 Methodology followed to record the observations:

The following observations were recorded at 0,30,60,90 and 120 days interval:-

3.9.1 Physical character:-

Sensory evaluation of jam:

The Jam of different pulp concentration and recipes was evaluated for various sensory qualities attributes like colour, flavour, taste and overall acceptability at 0, 30, 60, 90 and 120 days of storage by panel of 5 judges by giving marks as per 9 point hedonic scale (Amerine, *et al*., 1965) as given below:

Table for hedonic scale

S. NO.	Characteristics	Organoleptic score
1	Like extremely	9
2	Like very much	8
3	Like moderately	7
4	Like slightly	6
5	Neither like nor dislike	5
6	Dislike	4
7	Dislike moderately	3
8	Dislike very much	2
9	Dislike extremely	1

1. **Appearance:** Marks were given on the basis of liking of colour of jam.
2. **Taste:** The taste of jam was recorded as per liking of sweetness and sourness and marks were given accordingly
3. **Flavou**r: The flavour of jam was categorized as per liking of judges and marks were given accordingly.
4. **Texture:** Marks were given on the basis of softness of the jam.

The overall final rating was obtained by averting the marks “Liked moderately” was considered for acceptability of the products.

3.9.2 Quality Characters of Jam:

Various methods mentioned below were used for chemical analysis of fresh fruit pulp and RTS. The Homogeneous samples were used for estimation of the following parameters:

(1) Total soluble solids (TSS %)

The total soluble solids in RTS were determined with the help of a Hand refractometer (AOAC 1980). The drop sample was placed on the surface of the prism and the hinged part was placed back. The refractometer reading was taken and the average of reading was calculated (%) for each replication.

(2) pH

The pH of extracted pulp and RTS was measured using an elementary pH meter after calibration of the instrument with a standard buffer solution.

(3) Acidity (%):

Alkaline titration method as described in A.O.C.C (1984). 20g jam was taken by spoon in a 100ml flask in which distilled water was added to make a volume up to 100ml and then shaked, 25ml of the diluted jam solution was taken by pipette and transferred into a 250 ml beaker in which 3 drops of Phenolphthalein indicator was added and titrated with N/10 NaOH solution till the pink colour end point was reached. End point readings were recorded and the percentage acidity was calculated by the following formula:

Total Acidity (%) = 0.128 × Titration value

(4) Ascorbic acid (Vitamin C):

The ascorbic acid content was estimated as per Assay method given by Ranganna (1986) as detailed below:

(a) Preparation of 3% Meta phosphoric acid (HPO_3) solution:

For Preparation of the solution of 3% Meta phosphoric acid (HPO_3)**,** 15g sticks or pellets of 3% Meta phosphoric acid was dissolved in 500 ml distilled water.

(b) Preparation of standard ascorbic acid:

100mg of L-ascorbic acid was weighed and the volume was made up to 100ml with 3% Meta phosphoric acid. 1ml of this solution was diluted to 10 ml by adding 3% HPO_3 (1ml = 0.1 mg ascorbic acid).

(c) Preparation of dye solution:

52 mg (0.52g, 52/100) of Sodium salt of 2,6 - dichlorophenol indophenol was dissolved in 150 ml of hot distilled water containing 42mg (42g) Sodium bicarbonate ($NaHCO_3$). After cooling, it was diluted with 200ml distilled water and stored in refrigerator and standardized every day.

(d) Standardization of dye:

In 5 ml of standard Ascorbic acid solution, 5 ml of HPO_3 was added. Micro burette was filled with the dye solution. Standard Ascorbic acid was titrated against dye solution up to a pink colour, which persisted for 15 seconds. 1mg of ascorbic acid was used per ml of dye to determine the dye factor as follows:-

Dye factor = 0.8 / Titration value

(e) Preparation of sample:

10g/ml of sample to be detected was mixed with 100ml of 3% HPO3 and after that it was filtered.

(f) Assay of Ascorbic acid:

An aliquot (10ml) of the sample was taken and titrated against standard dye to a pink colour end point, which persisted for 15 seconds. Ascorbic acid content of the sample was calculated by using the following formula:

$$\text{Ascorbic acid (mg. per 100g.)} = \frac{\text{Titre} \times \text{Dye Factor} \times \text{Volume made up}}{\left(\text{Aliquot of Sample Taken for estimation}\right) \times \left(\text{Weight of Sample Taken for estimation}\right)} \times 100$$

Economics of the treatment

The economics of the treatments was estimated as per the actual cost of production and the market value of the product as estimated as per the method suggested by Yang and Dhondyal (1971).

i. Cost of production

The cost on preparation of mixed fruit jam was calculated by taking into Consideration the cost of all the inputs used and expenditure involved in the extraction of pulp from the fruits. The cost of production has been calculated for

20kg of pulp i.e., 10kg for both the fruit, then the cost for 1kg of fruit pulp was estimated and also the individual quality of pulp of both fruits needed for one replication, with different sugar quantity, labor charges, fuel and other expenses were worked out for the preparation of wood apple, banana, apple, mango, and papaya mixed fruit jam. The cost of product can be calculated by calculating the total product (kg) with the total expenditure.

The selling prices for each treatment was worked out by comparing the cost of treatment with the estimated market value of mixed fruit jam as per quality.

ii. Gross Return (Rs.)

It is calculated by taking the estimated cost of mixed fruit jam as per quality and worked out for gross return.

iii. Benefit Cost Ratio

It is the ratio of gross return (Rs) to the cost of product (Rs/kg). It is expressed in returns per rupee invested.

Benefit Cost Ratio (B:C) = Gross return (Rs) **/** Cost of product (Rs/kg)

3.10 Statistical analysis

Analysis of different variables was carried out to know the degree of variation amongst all the treatments. The data were statistically analyzed. The analysis of variance has been given in appendix and the skeleton of ANOVA for complete randomized design (CRD) is presented in table given below:

Skeleton of Analysis of variance

Source of variation	d.f.	S.S.	M.S.S.	F cal.	F tabulated at 5% level
Treatment	t-1	SSt	MSSt	MSSt/MSSe	
Error	n-t	SSe	MSSe		
Total	n-1				

n = Total number of observations.

t = Number of treatments.

The 'F' test was applied to check the overall significance of various treatments in general and comparison of individual treatment was made with the help of critical difference at 5 % level of significance, which was calculated as given below:-

$$\text{SEm}\pm \text{ for treatment t} = z \sqrt{\frac{\text{MSS}}{\text{No. of replications}}} \times 100$$

S.Ed for treatment = SEm x √2

C.D. for treatment = S.Ed x 't' value at 5% error degree of freedom.

Where,

SEm± = Standard Error of treatment means.

S.Ed = Standard Error of difference between two treatments.

C.D. = Critical difference

RESULTS

The results of the experiment obtained during the course of investigation have been described in this chapter under appropriate headings. The observations recorded during the study are summarized in the form of tables (Table 4.1 to 4.11) and illustrate through figures (4.2 to 4.10) wherever found necessary. Analysis of variance table for the parameters studied has been appended for reference in Appendices.

4.1 Physicochemical characteristics of the wood apple, mango, papaya, apple and banana

The data related to the physico-chemical characteristics of the wood apple, mango, papaya, apple and banana fruits are presented in Table 4.1. It was further noted that the fruit weight in gm, skull/peel weight in gm, stone/ seed weight in gm and average weight of pulp in gm.

The data presented in Table 4.1 further indicates that the chemical composition of the wood apple, mango, papaya, and apple and banana fruits recorded TSS with acidity and ascorbic acid per 100gm of fruit pulp and reducing, non reducing and total sugar.

4.2 Colour and appearance of mixed fruit jam

As the per data presented in Table 4.2, it was confirmed that the colour and appearance of mixed fruit jam of wood apple, banana, apple, mango and papaya fruits were significantly influenced by the different ratio of fruit pulp.

It was observed that the highest score (8.840) for colour and appearance of fresh jam was observed in T_{10} (i.e., 250g apple + 250g papaya + 500ml wood apple pectin) followed by T_8 (250g banana + 250g papaya + 500 ml of wood apple pectin). Whereas minimum score (8.050) was recorded in T_{12} (1000ml wood apple pectin) at 0 day of storage.

Table 4.1 Physico-chemical characteristics of the wood apple, mango, papaya, apple and banana fruits

Physical Composition					
Contents	**Banana**	**Apple**	**Mango**	**Papaya**	**Wood apple**
Av. wt. of fruit (gm)	118	126	341.9	830	185
Skull/peel wt. (gm)	75	23	36.9	77	69
Pulp wt (gm)	45	100	261.48	749	88
Stone/seed wt.(gm)	-	3	43.52	4	25
Chemical characteristics of the fruit pulp					
T.S.S	20	14.25	16.6	13.5	10.5
pH	5.28	4.84	4.20	4.57	4.50
Acidity (%)	0.3	0.12	0.46	0.33	1.07
Ascorbic acid	8.7	4.6	15.85	58.5	5.76
Reducing sugar (%)	13.63	11.0	2.29	6.92	1.23
Non reducing sugar (%)	7.047	1.5	10.51	3.58	0.89
Total sugar (%)	20.67	12.50	12.80	10.50	2.12

Table 4.2: Effect of fruit pulp ratio on colour and appearance of mixed fruit jam during storage

Symbol	Ratio of fruit pulp B+A+M+P (in g)	Wood apple pectin (in ml.)	0 Days During Storage Period	30 Days During Storage Period	60 Days During Storage Period	90 Days During Storage Period	120 Days During Storage Period
			Recipe	Recipe	Recipe	Recipe	Recipe
T_1	125+125+125+125	500	8.773	8.720	8.707	8.670	8.663
T_2	170+170+170+0	500	8.693	8.660	8.640	8.633	8.620
T_3	170+170+0+170	500	8.740	8.727	8.690	8.683	8.643
T_4	0+170+170+170	500	8.790	8.760	8.743	8.730	8.713
T_5	170+0+170+170	500	8.767	8.750	8.713	8.703	8.690
T_6	250+250+0+0	500	8.757	8.737	8.723	8.713	8.697
T_7	250+0+250+0	500	8.727	8.713	8.700	8.687	8.673
T_8	250+0+0+250	500	8.807	8.793	8.787	8.773	8.747
T_9	0+250+250+0	500	8.457	8.440	8.427	8.413	8.400
T_{10}	0+250+0+250	500	8.840	8.833	8.793	8.787	8.773
T_{11}	0+0+250+250	500	8.613	8.590	8.580	8.573	8.553
T_{12}	0	1000	8.050	8.040	8.030	8.017	8.000
Mean							
SEm±							
CD at 5% level							

*B= Banana, A=Apple, M=Mango, P=Papaya

In stored jam, the colour and appearance was gradually decreased at 30, 60, 90, and 120 days of storage respectively in all the treatments under the study.

4.3 Flavor

The present finding revealed that (Table 4.3) there was significant difference among the various treatments for the flavor isconcerned. The data on the effect of storage period on the flavour of mixed fruit jam clearly indicate that the flavour was reduced in all the treatments with the increase in storage period. However, the reduction in flavour was influenced by various pulp concentrations.

The highest score for flavor (8.793) was observed with T_7 (i.e., 250g banana + 250g mango + 500ml wood apple pectin) followed by T_9 while, the lowest value (8.053) was observed in T_{12} (1000ml wood apple pectin). The values of flavor rating were recorded at 30, 60, 90 and 120 days.

4.4 Texture

It was revealed from the present data (table 4.4), the highest texture value (8.837) was recorded witrh T_7 (*i.e.* 250g banana + 250g mango + 500 ml of wood apple pectin) which is followed by (8.737) with T_9 (*i.e.* 250g apple + 250g mango + 500ml wood apple pectin) over rest of the ratio of fruit pulp at 0 day of storage period. The minimum value for texture (7.850) was recorded with T_{12} (*i.e.*1000ml wood apple pectin) at 0 day of storage.

Texture of jam slightly decreased in all the treatment combinations during the storage but jam was acceptable and rated as equal to fresh jam even after 120 days of storage.

4.5 Taste

The data presented in table 4.5 revealed that the taste of mixed fruit jam of wood apple. The taste of mixed fruit jam at 0 day of storage was highly influenced by the ratio of fruit pulp.

Table 4.3: Effect of fruit pulp ratio on flavour of mixed fruit jam during storage

Symbol	Ratio of fruit pulp B+A+M+P (in g)	Wood apple pectin (in ml.)	0 Days During Storage Period	30 Days During Storage Period	60 Days During Storage Period	90 Days During Storage Period	120 Days During Storage Period
			Recipe	Recipe	Recipe	Recipe	Recipe
T_1	**125+125+125+125**	500	8.437	8.433	8.407	8.380	8.373
T_2	**170+170+170+0**	500	8.740	8.723	8.707	8.687	8.673
T_3	**170+170+0+170**	500	8.693	8.677	8.663	8.647	8.647
T_4	**0+170+170+170**	500	8.753	8.740	8.727	8.700	8.680
T_5	**170+0+170+170**	500	8.767	8.753	8.747	8.713	8.697
T_6	**250+250+0+0**	500	8.767	8.743	8.727	8.707	8.693
T_7	**250+0+250+0**	500	8.793	8.747	8.750	8.727	8.713
T_8	**250+0+0+250**	500	8.760	8.783	8.733	8.717	8.690
T_9	**0+250+250+0**	500	8.773	8.767	8.753	8.740	8.693
T_{10}	**0+250+0+250**	500	8.763	8.753	8.740	8.723	8.693
T_{11}	**0+0+250+250**	500	8.727	8.720	8.700	8.683	8.660
T_{12}	**0**	1000	8.053	8.040	8.020	8.003	7.993
Mean			8.669	8.657	8.640	8.619	8.600
SEm±			0.099	0.099	0.099	0.098	0.096
CD at 5% level			0.291	0.290	0.292	0.288	0.282

*B= Banana, A=Apple, M=Mango, P=Papaya

Table 4.4: Effect of fruit pulp ratio on texture of mixed fruit jam during Storage

Symbol	Ratio of fruit pulp B+A+M+P (in g)	Wood apple pectin (in ml.)	0 Days During Storage Period	30 Days During Storage Period	60 Days During Storage Period	90 Days During Storage Period	120 Days During Storage Period
			Recipe	Recipe	Recipe	Recipe	Recipe
T_1	125+125+125+125	500	8.277	8.253	8.227	8.200	8.160
T_2	170+170+170+0	500	8.487	8.467	8.433	8.410	8.397
T_3	170+170+0+170	500	8.167	8.067	7.957	7.930	7.897
T_4	0+170+170+170	500	8.540	8.507	8.470	8.440	8.413
T_5	170+0+170+170	500	8.493	8.473	8.433	8.407	8.393
T_6	250+250+0+0	500	8.320	8.273	8.240	8.210	8.177
T_7	250+0+250+0	500	8.837	8.810	8.783	8.757	8.730
T_8	250+0+0+250	500	8.663	8.640	8.617	8.593	8.573
T_9	0+250+250+0	500	8.737	8.720	8.700	8.673	8.640
T_{10}	0+250+0+250	500	8.617	8.583	8.547	8.520	8.493
T_{11}	0+0+250+250	500	8.550	8.510	8.487	8.460	8.440
T_{12}	0	1000	7.850	7.820	7.757	7.703	7.693
Mean			8.462	8.427	8.388	8.359	8.334
SEm±			0.152	0.157	0.164	0.161	0.161
CD at 5% level			0.447	0.461	0.481	0.473	0.472

*B= Banana, A=Apple, M=Mango, P=Papaya

Table 4.5: Effect of fruit pulp ratio on taste of mixed fruit jam during storage

Symbol	Ratio of fruit pulp B+A+M+P (in g)	Wood apple pectin (in ml.)	0 Days During Storage Period	30 Days During Storage Period	60 Days During Storage Period	90 Days During Storage Period	120 Days During Storage Period
			Recipe	Recipe	Recipe	Recipe	Recipe
T_1	125+125+125+125	500	8.457	8.447	8.427	8.400	8.373
T_2	170+170+170+0	500	8.693	8.677	8.663	8.647	8.642
T_3	170+170+0+170	500	8.740	8.723	8.707	8.687	8.673
T_4	0+170+170+170	500	8.753	8.740	8.727	8.700	8.680
T_5	170+0+170+170	500	8.767	8.753	8.733	8.713	8.697
T_6	250+250+0+0	500	8.757	8.747	8.727	8.707	8.693
T_7	250+0+250+0	500	8.793	8.783	8.750	8.727	8.713
T_8	250+0+0+250	500	8.773	8.767	8.753	8.740	8.693
T_9	0+250+250+0	500	8.760	8.747	8.733	8.717	8.690
T_{10}	0+250+0+250	500	8.727	8.720	8.700	8.683	8.660
T_{11}	0+0+250+250	500	8.763	8.753	8.740	8.723	8.693
T_{12}	0	1000	8.055	8.040	8.020	8.003	7.993
Mean			8.670	8.658	8.640	8.621	8.600
SEm±			0.099	0.100	0.099	0.098	0.096
CD at 5% level			0.291	0.294	0.292	0.288	0.282

*B= Banana, A=Apple, M=Mango, P=Papaya

The highest value for taste (8.793) was observed with T_7 (*i.e.*,250g banana + 250g mango + 500 ml of wood apple pectin) followed by T_8 (8.773) (*i.e.*, 250g banana + 250g papaya + 500ml wood apple) which were significant over rest of the ratio of fruit pulp at 0 day of storage. Similar trend was observed up to 120 days of storage period. The lowest value (8.055) was seen with the treatment T_{12} (1000ml wood apple pectin) at 0 day of storage.

There was less difference in the taste of mixed fruit jam during the different periods of storage, however it slightly decreased in all the treatment at 30, 60, 90 and 120 days of storage.

4.6 Over all acceptability

A critical perusal of the data presented in the table 4.6 revealed that the mean value of overall acceptability of mixed fruit jam decrease with increase in the duration of storage.

The highest mean score for overall acceptability of mix fruit jam was found with T_7 (8.840) (*i.e*. 250g banana + 250g mango + 500 ml wood apple pectin) which is at par with T_9 (8.807) (*i.e*. 250g apple + 250g mango + 500ml wood apple pectin) at 0 day of storage. The minimum score for over all acceptability was obtained with treatment T_{12} (8.053) (1000ml wood apple pectin) at 0 day of storage.

4.7 Total soluble solid (T.S.S)

The data presented in table 4.7 revealed that the various ratio of fruit pulp (T_1 to T_{12}) differed significantly for T.S.S of mixed fruit jam.

It was observed that the maximum T.S.S of mix fruit jam was recorded with T_7 (72.58^0Brix) (*i.e*., 250g banana + 250g mango + 500ml wood apple pectin) which was significantly higher than T_6 (72.09^0Brix) (*i.e.,* 250g banana + 250g apple + 500ml wood apple pectin) at 0 day of storage. Whereas minimum TSS score obtained with the treatment T_{10} (68.87^0Brix) (i.e., 250g apple + 250g papaya + 500ml wood apple pectin). However, similar trend was observed at 30, 60, 90 and 120 days of storage.

Table 4.6: Effect of fruit pulp ratio on over all acceptability of mixed fruit jam during storage

Symbol	Ratio of fruit pulp B+A+M+P (in g)	Wood apple pectin (in ml.)	0 Days During Storage Period	30 Days During Storage Period	60 Days During Storage Period	90 Days During Storage Period	120 Days During Storage Period
			Recipe	Recipe	Recipe	Recipe	Recipe
T_1	125+125+125+125	500	8.613	8.590	8.580	8.573	8.553
T_2	170+170+170+0	500	8.690	8.680	8.673	8.657	8.640
T_3	170+170+0+170	500	8.693	8.660	8.640	8.633	8.620
T_4	0+170+170+170	500	8.727	8.713	8.700	8.687	8.673
T_5	170+0+170+170	500	8.757	8.737	8.723	8.713	8.697
T_6	250+250+0+0	500	8.767	8.750	8.713	8.703	8.690
T_7	250+0+250+0	500	8.840	8.833	8.793	8.787	8.773
T_8	250+0+0+250	500	8.790	8.760	8.743	8.730	8.713
T_9	0+250+250+0	500	8.807	8.793	8.787	8.773	8.747
T_{10}	0+250+0+250	500	8.773	8.720	8.707	8.670	8.663
T_{11}	0+0+250+250	500	8.740	8.727	8.690	8.683	8.643
T_{12}	0	1000	8.053	8.040	8.030	8.017	8.000
Mean			8.688	8.667	8.648	8.636	8.618
SEm±			0.078	0.078	0.074	0.076	0.078
CD at 5% level			0.229	0.229	0.217	0.223	0.229

*B= Banana, A=Apple, M=Mango, P=Papaya

Table 4.7: Effect of fruit pulp ratio on TSS of mixed fruit jam during storage

Symbol	Ratio of fruit pulp B+A+M+P (in g)	Wood apple pectin (in ml.)	0 Days During Storage Period	30 Days During Storage Period	60 Days During Storage Period	90 Days During Storage Period	120 Days During Storage Period
			Recipe	Recipe	Recipe	Recipe	Recipe
T_1	125+125+125+125	500	71.777	72.027	72.053	72.060	72.070
T_2	170+170+170+0	500	71.900	72.107	72.113	72.157	72.160
T_3	170+170+0+170	500	71.160	71.423	71.433	71.433	71.440
T_4	0+170+170+170	500	70.210	70.487	70.510	70.527	70.550
T_5	170+0+170+170	500	71.570	71.847	71.850	71.880	71.890
T_6	250+250+0+0	500	72.087	72.180	72.223	72.267	72.333
T_7	250+0+250+0	500	72.580	72.823	72.860	72.873	72.883
T_8	250+0+0+250	500	70.913	70.943	70.953	70.960	70.967
T_9	0+250+250+0	500	69.900	70.087	70.127	70.163	70.193
T_{10}	0+250+0+250	500	68.943	69.113	69.170	69.220	69.253
T_{11}	0+0+250+250	500	68.960	69.133	69.193	69.233	69.253
T_{12}	0	1000	69.100	69.357	69.363	69.397	69.433
Mean			70.758	70.961	70.987	71.014	71.035
SEm±			0.042	0.041	0.052	0.043	0.040
CD at 5% level			0.124	0.121	0.154	0.125	0.117

*B= Banana, A=Apple, M=Mango, P=Papaya

The T.S.S of mix fruit jam was slightly increased with increase in the duration of storage period in all the treatment combinations.

4.8 pH

It is evident from the data given in table 4.8 that the different ratio of fruit pulp had significant effect on the pH of mixed fruit jam.

The treatment combination T_8 (i.e.,250g + banana + 250g papaya + 500 ml of wood apple pectin) found to have the highest pH value (4.797) which was at par with T_7 (4.740) but significant over rest of the pulp ratio at 0 day of storage. Whereas minimum pH value was observed with T_{12} (3.710) (1000ml wood apple pectin) at 0 day of storage.

This similar trend of pH value for the same ratio of fruit pulp was recorded at 30, 60, 90 and 120 days of storage period.

4.9 Acidity

The data presented in table 4.9 indicated that the acidity of mixed fruit jam was significantly influenced by the various ratio of fruit pulp at 0 day of storage.

The maximum mean value for acidity was observed with T_{12} (0.565) (*i.e.*1000ml wood apple pectin) which was at par with T_9 (0.560), however it was significant over rest of the ratios at 0 day of storage. The same trend was exhibited at 30, 60, 90, and 120 days of storage. The minimum score for acidity was seen in the treatment T_8 (0.549) (*i.e.*250g banana + 250g apple + 500 ml of wood apple pectin).

It was further noticed that the acidity of mix fruit jam was gradually increased with increase in period of storage in all the treatment combinations but jam storage till 120 days was found acceptable and rated as equal to fresh jam.

4.10 Ascorbic acid

The data presented in table 4.10 revealed that the jam prepared by the pulp of ripen fruits of papaya and mango contained the maximum ascorbic acid (61.8mg/100g and 27.7mg/100gm) which was significantly higher than the jam

Table 4.8: Effect of fruit pulp ratio on pH of mixed fruit jam during storage

Symbol	Ratio of fruit pulp B+A+M+P (in g)	Wood apple pectin (in ml.)	0 Days During Storage Period	30 Days During Storage Period	60 Days During Storage Period	90 Days During Storage Period	120 Days During Storage Period
			Recipe	Recipe	Recipe	Recipe	Recipe
T_1	125+125+125+125	500	4.643	4.610	4.577	4.533	4.500
T_2	170+170+170+0	500	4.517	4.483	4.450	4.447	4.427
T_3	170+170+0+170	500	4.677	4.643	4.610	4.600	4.567
T_4	0+170+170+170	500	4.507	4.473	4.440	4.397	4.363
T_5	170+0+170+170	500	4.467	4.433	4.400	4.357	4.323
T_6	250+250+0+0	500	4.510	4.477	4.443	4.403	4.370
T_7	250+0+250+0	500	4.740	4.707	4.673	4.630	4.597
T_8	250+0+0+250	500	4.797	4.763	4.730	4.687	4.653
T_9	0+250+250+0	500	4.440	4.407	4.373	4.330	4.297
T_{10}	0+250+0+250	500	4.573	4.540	4.507	4.467	4.433
T_{11}	0+0+250+250	500	4.620	4.587	4.553	4.510	4.477
T_{12}	0	1000	3.710	3.677	3.643	3.600	3.567
Mean			4.590	4.557	4.523	4.487	4.455
SEm±			0.132	0.135	0.129	0.124	0.119
CD at 5% level			0.388	0.397	0.379	0.365	0.350

*B= Banana, A=Apple, M=Mango, P=Papaya

Table 4.9: Effect of fruit pulp ratio on acidity of mixed fruit jam during storage

Symbol	Ratio of fruit pulp B+A+M+P (in g)	Wood apple pectin (in ml.)	0 Days During Storage Period	30 Days During Storage Period	60 Days During Storage Period	90 Days During Storage Period	120 Days During Storage Period
			Recipe	Recipe	Recipe	Recipe	Recipe
T_1	125+125+125+125	500	0.558	0.559	0.560	0.561	0.563
T_2	170+170+170+0	500	0.554	0.555	0.556	0.558	0.559
T_3	170+170+0+170	500	0.557	0.558	0.559	0.561	0.562
T_4	0+170+170+170	500	0.559	0.560	0.561	0.562	0.565
T_5	170+0+170+170	500	0.557	0.557	0.558	0.560	0.561
T_6	250+250+0+0	500	0.555	0.556	0.558	0.559	0.564
T_7	250+0+250+0	500	0.552	0.553	0.555	0.558	0.560
T_8	250+0+0+250	500	0.549	0.551	0.554	0.556	0.557
T_9	0+250+250+0	500	0.560	0.562	0.563	0.565	0.567
T_{10}	0+250+0+250	500	0.556	0.557	0.558	0.559	0.563
T_{11}	0+0+250+250	500	0.557	0.558	0.559	0.560	0.562
T_{12}	0	1000	0.565	0.567	0.570	0.572	0.573
Mean			0.557	0.558	0.559	0.561	0.563
SEm±			0.001	0.000	0.000	0.001	0.001
CD at 5% level			0.002	0.001	0.001	0.002	0.004

*B= Banana, A=Apple, M=Mango, P=Papaya

Table 4.10: Effect of fruit pulp ratio on ascorbic acid of mixed fruit jam durin storage

Symbol	Ratio of fruit pulp B+A+M+P (in g)	Wood apple pectin (in ml.)	0 Days During Storage Period	30 Days During Storage Period	60 Days During Storage Period	90 Days During Storage Period	120 Days During Storage Period
			Recipe	Recipe	Recipe	Recipe	Recipe
T_1	125+125+125+125	500	59.71	59.70	59.67	59.66	59.65
T_2	170+170+170+0	500	59.68	59.67	59.66	59.65	59.63
T_3	170+170+0+170	500	59.70	59.69	59.68	59.66	59.64
T_4	0+170+170+170	500	59.67	59.67	59.65	59.63	59.62
T_5	170+0+170+170	500	59.69	59.67	59.65	59.63	59.62
T_6	250+250+0+0	500	59.59	59.58	59.56	59.54	59.52
T_7	250+0+250+0	500	59.67	59.66	59.61	59.60	59.59
T_8	250+0+0+250	500	59.70	59.68	59.63	59.60	59.59
T_9	0+250+250+0	500	59.63	59.62	59.60	59.59	59.59
T_{10}	0+250+0+250	500	59.70	59.69	59.66	59.65	59.64
T_{11}	0+0+250+250	500	59.72	59.71	59.69	59.68	59.65
T_{12}	0	1000	59.79	59.79	59.77	59.75	59.69
Mean			59.69	59.68	59.65	59.64	59.62
SEm±			0.004	0.007	0.018	0.012	0.016
CD at 5% level			0.013	0.020	0.054	0.035	0.046

*B= Banana, A=Apple, M=Mango, P=Papaya

prepared in treatment combination T_{12} (59.79 mg/100g) (i.e.1000ml wood apple pectin) followed by T_{11} (59.72mg/100g) (i.e.250g mango + 250g papaya + 500ml wood apple pectin). Whereas, minimum content of ascorbic acid was found with treatment combination T_6 (59.59 mg/ 100g) (i.e.250g banana + 250g of apple + 500ml wood apple pectin).

Ascorbic acid content of mixed fruit jam slightly decreased in all the treatment combinations during the storage but found acceptable and got rated as equal to a fresh jam at the 90 days of storage period.

4.11 Economics of the treatment

The result obtained from the table 4.11 shows that the highest economic return was obtained by the treatment combination T_{11} (1.968:1) (*i.e.*250g mango + 250g papaya + 500 ml of wood apple pectin) followed by T_7 (1.937:1) while minimum was found in T_8 (*i.e.*250g banana + 250g apple + 500 ml of wood apple pectin).

The difference in recipe has not shown much effect on the B:C ratio. The B:C ratio was an economical parameter for the comparison to other parameters like sensory and quality parameters.

Table 4.11 Effect of various treatments on gross return and B:C ratio

Treatment	Cost of fruit pulp (Rs.)	cost of pectin (Rs.)	Cost of sugar (Rs.)	Processing cost (Rs.)	Total cost (Rs.)	Gross return (Rs./Kg)	Net return (Rs.)	B:C ratio
T_1	17.75	5	30	12.45	65.2	120	54.8	1.84
T_2	20.65	5	30	12.45	68.1	120	51.9	1.76
T_3	19.6	5	30	12.45	67.05	120	52.95	1.78
T_4	19.95	5	30	12.45	67.4	120	52.6	1.78
T_5	14.53	5	30	12.45	61.98	120	58.2	1.93
T_6	22	5	30	12.45	69.45	120	50.55	1.72
T_7	13.5	5	30	12.45	60.95	120	59.05	1.96
T_8	27.69	5	30	12.45	75.14	120	44.86	1.59
T_9	22.5	5	30	12.45	69.95	120	50.05	1.71
T_{10}	21	5	30	12.45	68.45	120	51.55	1.75
T_{11}	14.5	5	30	12.45	61.95	120	58.05	1.93
T_{12}	0	10	30	12.45	52.45	100	47.55	1.90

DISCUSSION

The present investigation entitled **"Studies on preparation of wood apple based mixed fruit jam."** was carried out to observe the effect of different pulp ratio combination in prepared mixed fruit jam.

On the basis of finding described in the preceding chapter, the result has been described here critically in the light of literature pertaining to the finding of other workers for different characters, wherever possible.

5.1 Organoleptic evaluation of wood apple based mixed fruit jam

The sensory / organoleptic evaluation of mixed fruit jam were evaluated and the result revealed that the higher rating for texture, flavour, and taste was obtained with treatment combination in T_7 (i.e., 250g banana + 250g mango + 500ml wood apple pectin). Thus, a higher acceptable score was given to it while, lower score was found in T_{12} (1000 ml wood apple pectin).

The high score for sensory character were observed in T_7 and T_9 because of presence of high percentage of pulp of banana + mango + wood apple pectin and apple + mango + wood apple pectin respectively in the combinations of these fruits. These fruits gave a good colour and appearance, flavor, taste and texture to a mixed jam.

It was also observed that as the storage period increases the sensory attribute (colour and appearance, texture, flavour and taste) and over all acceptability of mixed fruit jam decreased considerably. The similar results were reported by Hamanan *et.al.* (2005) and Chauhan *et.al.* (2008).

5.1.1 Colour and appearance

The result of present investigation clearly indicated that the colour rating of mixed fruit jam decreased with increases in storage period. The higher rating (8.840) for colour and appearance was recorded in treatment T_{10} (250gm apple + 250gm papaya + 500ml wood apple pectin) due to higher contribution of papaya

pulp in these combinations. The minimum value for colour was obtained with treatment T_{12} (1000ml wood apple pectin) i.e., (8.05).

It was observed that the colour and appearance slightly decreased from initial day of storage up to 120 days. This might be due to loss of ascorbic acid content due to oxidation reaction during storage. These results corroborated the findings of Hamanan *et. al.* (1980), Baramanray *et. al.* (1995) and Poul *et. al*. (2005).

5.1.2 Flavour

It was cleared from the results that the higher mean score of flavour was found in treatment T_7 (i.e., 250gm banana + 250gm mango + 500ml wood apple pectin) i.e., (8.793) because of higher ratio of mango pulp that showed higher values for flavour whereas minimum rating (8.053 and 8.430) was found in T_{12} and $T_{1.}$

This study proved that the flavour rating were degraded with time. In the present context of results, Hamanan *et. al*. (1980) also supported the finding.

5.1.3 Texture

The highest value (8.830) for texture found in T_7 (250gm banana + 250gm mango + 500 ml of wood apple pectin) while minimum in (7.850) in T_{10} (1000ml wood apple pectin).The result showed that the mango pulp provide hardness, work of shear, stickiness, work of adhesion and proportion of banana pulp in combination to wood apple pectin was better for improving the texture of mixed fruit jam. It might be due to presence of pectin in the banana which has the good binding capacity and in addition to it, the higher quality of sugar gave better texture of jam.

As the period of storage extended, the values decreases. This reason may be attributed to the activity of pectin degrading enzymes. These findings are in collaboration with Chauhan *et. al*. (2008)

5.1.4 Taste

The result for taste indicated that the higher rating (8.793) of mixed fruit jam was obtained from the treatment combination in T_7 (i.e., 250gm banana + 250gm mango + 500 ml of wood apple pectin) while, minimum rating (8.055) was seen in treatment T_{12} (1000ml wood apple pectin).

It was found that the taste of mixed jam was due to interaction effect of banana, mango and sugar. The rating of taste decrease might be due to higher T.S.S value. Similar results were found by Naikare *et.al*. (1998).

The rating for taste of jam degraded but with very little variation. This slight decrease in rating might be due to conversion of polysaccharides into soluble sugars. These findings were in conformity with the results reported by Hamanan *et.al*.(1980), Baramanray *et.al*.(1995) and Chauhan *et.al*. (2008).

5.1.5 Overall acceptability

The overall acceptability of mixed fruit jam was dependent on colour or appearance, texture, flavour, and taste rating of the product. The result obtained showed that the highest score (8.840) for overall acceptability was found in treatment combination T_7 (i.e., 250gm banana + 250gm mango + 500 ml wood apple pectin), because it possessed attractive texture, flavour and taste. While minimum acceptable score (8.053) was recorded in treatment T_{12} (1000ml wood apple pectin).

As the period of storage prolonged, the overall acceptability showed a decreasing trend. The possible reason might be due to decrease in rating of colour flavour, taste and texture of jam. The reason behind the decreasing trend for organoleptic rating of jam might be loss of ascorbic acid content, pectin degradation, oxidation due to presence of residual oxygen in glass container and conversion of polysaccharides into soluble sugars.

These result were supported by the finding of Hamanan *et.al*. (1980), Baramarnaray *et.al*. (1995), Poul *et.al*. (2005) and Chauhan *et.al*. (2008) in guava pulp.

5.2 Qualitative characters of mixed fruit jam-

In this investigation, the chemical parameter like T.S.S., pH, acidity, ascorbic acid content of mixed fruit jam were estimated in different ratio of banana, apple, mango and papaya with wood apple pectin.

And, it was observed that the TSS and acidity values increased with increase in storage period while pH and ascorbic acid content of the jam decreased. The same trend was reported in the finding of Baramanray *et.al*. (1995), Karla and Revanthi (1997), Sarvanan *et.al*. (2004) in papaya jam.

5.2.1 Total Soluble Solids

As per results recorded from the present investigation, it was found that the highest score for TSS (72.58 ^{0}Brix) of jam was recorded in T_7 (i.e., 250gm banana + 250gm mango + 500ml wood apple pectin) which showed significant difference from other treatments and this effect on TSS persisted till 120 days of storage.

As the period of storage increased, the TSS values increased significantly up to 120 days of storage. The increase in TSS of jam during storage might be due to conversion of polysaccharides into soluble sugars. Similar inferences were drawn by the findings of Manivasagan *et.al*. (2004) in karonda jam. Similarly Sarvanan *et.al*. (2004) reported the increase in TSS of papaya during storage. It might be due to solubilization of pulp constituent during hydrolysis of polysaccharides.

5.2.2 pH

The overall pH score of mixed fruit jam was observed to be less than 7.0 i.e., acidic. The pH values, however observed to be high at initial day of storage in all the treatment combination but decreased as the period of storage increased.

The highest pH value (4.797) in jam was recorded in T_8 (i.e., 250gm banana + 250gm papaya + 500 ml of wood apple pectin) and minimum (3.710) pH value was record in T_{12} (1000ml wood apple pectin). It was observed that as

the quantity of sugar is increased the pH values, it can be easily seen that as the proportion of wood apple pectin increased in treatment combination, the value of pH decreased. It was also observed that as the storage period was prolonged, the pH values decreased with a small variation. This may be due to increase in acidity. Panday and Singh (1999) also reported that the higher acidity may account due to lower pH value.

5.2.3 Acidity

In case of acidity, it was found that the higher value (0.565) in treatment T_{12} (1000ml wood apple pectin) while, minimum value (0.549) in T_8 (i.e., 250gm banana + 250gm apple + 500 ml of wood apple pectin). The reason for high acidity in T_{12} was their lower pH value as possessed an inverse relation i.e., increase in value of one factor, decreases the value of other factor automatically.

Here, the increase in acidity might be due to formation of organic acid from ascorbic acid degradation as suggested by Panday and singh (1999).

It was observed that the acidity of jam slightly increases with increase in storage period. Increase in acidity during storage was also reported by Baramanray *et.al.* (1995), in guava nectar and Imran *et.al*. (2000), in guava pulp.

5.2.4 Ascorbic acid

The result clearly indicated that the higher proportion of papaya pulp in comparison to other fruit pulp had a pronounced effect on the ascorbic acid content of mixed fruit jam. The reason for higher ascorbic acid content (59.79 mg/100g) in treatments T_{12} (1000ml wood apple pectin) and minimum value in treatment T_6 (250gm banana + 250gm apple + 500ml wood apple pectin) mean value showed i.e., (59.59 mg/ 100 gm). The wood apple fruit possess more vitamin C (approx. 60mg/100g) in comparison to banana (nearly 10.3mg/100g), apple (nearly 8.4mg/100g) and mango (nearly 27.7mg/100g) which is responsible for high ascorbic acid.

It was also observed that as the period of storage increased, the value of ascorbic acid decreased. The slight reduction in ascorbic acid might be due to

oxidation of residual oxygen in glass bottles. Similar result were reported by Karla and Revanthi (1983), Dhawan and Gupta (1996), Vidhya and Narain (2011).

5.3 Economics of the treatments

The highest economic returns were obtained with the treatments T_7 (1.96) followed by T_{11} and minimum was found with T_8 and T_6. The difference in recipe has not showed much effect on the B:C ratio. The B:C ratio was an economical parameter in comparison to other parameters like sensory and quantitative parameter.

SUMMARY CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH WORK

Summary

The present investigation entitled **"Studies on preparation of Wood apple based mixed fruit jam"** was carried out at the Post Harvest laboratory of the Department of Horticulture, College of Agriculture, JNKVV Jabalpur (M.P) during the year 2014-15.

The investigation was carried out with twelve (12) treatment combinations with three replications in a Completely Randomized Design (CRD). The mixed fruit jam was prepared as per the treatment combinations and stored at room temperature for 120 days.

The organoleptic parameter (colour and appearance, texture, flavour and taste) and over all acceptability of jam was evaluated by a panel of 10 judges on a 9 point Hedonic scale (Amerine *et.al*., 1965). The marks were given in the scale of 1 to 9 ranting from extremely disliked to extremely liked. The chemical parameter like T.S.S estimated by hand refractometer (60 to 80^0 Brix range), pH was estimated by using pH meter whereas, acidity by simple acid alkaline titration method which is described in A.OC.C. (1984) and ascorbic acid was estimated as per Assay method given by Ranganna (1986). The data were analyzed statistically and reported at 5% level of significance (Panse and Sukhatme, 1951). The findings of the experiment are summarized below.

It was found from the data (Table 4.1 to 4.10) that the various ratio of pulp for the preparation of mixed fruit jam showed differences with regard to different sensory and chemical parameters.

It was seen that the ratio of fruit pulp T_7 (250g banana + 250g mango + 500 ml of wood apple pectin) were rated the best for organoleptic parameter which is based on over all acceptability while, T_{12} (1000ml wood apple pectin) scored minimum. The T_{10} (i.e., 250g apple + 250g papaya + 500ml wood apple pectin) scored maximum rating for colour whereas T_7 (i.e., 250g banana + 250g

mango + 500ml wood apple pectin) found the best rating for the flavour, taste and texture.

Amongst chemical or quality parameters, the maximum T.S.S was recorded in T_7 (*i.e*., 250g banana + 250g mango + 500ml wood apple pectin) pulp ratio which was significantly higher than T_6 (*i.e*., 250g banana + 250g apple + 500ml wood apple pectin) While, the minimum score (69.02^0Brix) was obtained in treatment T_{12} (1000ml wood apple pectin).

The highest value of pH was recorded in T_8 (*i.e.,* 250g banana + 250g papaya + 500 ml of wood apple pectin) which was at par with T_7 (4.740) but significant over the rest of treatment combinations at 0 day of storage. The minimum (3.710) pH value was observed in T_{12} (1000ml wood apple pectin) at 0 day of storage and similar trend of result was observed up to 120 days of storage.

The maximum mean score for acidity was observed in T_{12} (1000ml wood apple pectin) which was *at par* with T_9, however, it was significant over rest of the treatments combinations. Same trend was exhibited at 30, 60, 90, and 120 days of storage. The minimum score for acidity was seen with treatment T_8 (0.549).

The ascorbic acid content of mixed fruit jam showed significant difference with different ratio of fruit pulp. The treatment T_{11} showed the highest mean value for ascorbic acid followed by T_8 whereas, the minimum mean value for ascorbic acid found in the treatment T_6.

In case of storage of jam at the room temperature, there was no marked changes observed amongst the various ratio of fruit pulp. But there was a slight decrease in sensory attribute (colour and appearance, texture, flavour and taste) and over all acceptability of jam was noticed under all the treatments under study even though at 120 days of storage jam was noted as equal to a fresh jam and was acceptable.

A study on the comparative cost of 1 Kg pulp with cost of each recipe for the preparation of wood apple based mixed fruit jam of 250g + banana 250g

mango + wood apple pectin showed that the highest B: C ratio (1.937:1) was obtained by the treatment T_7 whereas the highest acceptability was score by T_5 (1.936) while minimum B:C ratio was obtained In T_8 and T_6 treatment combinations.

Conclusion:

The experiment was conducted to standardize the recipe for the preparation of wood apple based mixed fruit jam where the observations like colour and appearance, flavour, taste, texture and overall acceptability, T.S.S, pH acidity and ascorbic acid were used as milestone to standardize the best recipe for making mixed fruit jam. The mixing of 250gm banana, 250gm mango and 500ml of wood apple pectin was found the best with recipe T_7 followed by 250g apple, 250g papaya and 500ml wood apple pectin regarding all the sensory and quality parameters during storage of 120 days. Hence, it is clear that the combination of banana, mango and wood apple pectin is suitable for the preparation of mixed fruit jam having good quality and high nutritive value. The cost for the preparation was also very low. Therefore, this recipe can be recommended for making wood apple based mixed fruit jam.

Suggestions for further work

These studies have been concluded with good findings in the new area of developing low cost technologies for value addition of fruits. However, it is also resulted with its commercial value and better marketability. On the basis of present investigations the following suggestions are made for the further research work.

- The present studies may be repeated for confirmation of the experimental findings.
- The recipe may be modified further and may tried with other fruit pulp ratio.
- The preparation of large scale, banana and mango with wood apple pectin mixed fruit jam may be proposed because it will make the availability of

these fruits even in off season at the same time it contains high nutritive values particularly ascorbic acid.

- Other fruits should also be tried for making mixed fruit jam with various recipes with different ratio of fruit pulp.

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APPENDICES

ANALYSIS OF VARIANCE TABLE FOR DIFFERENT CHARACTER

Appendix 1:

Colour and appearance of mixed fruit jam at 0 day

Source of Variation	D.F.	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.581	0.144	4.275	0.00142
Error	24	0.807	0.034		
Total	35	2.388			

Colour and appearance of mixed fruit jam at 30 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.555	0.141	4.172	0.00167
Error	24	0.813	0.034		
Total	35	2.369			

Colour and appearance of mixed fruit jam at 60 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.493	0.136	4.184	0.00164
Error	24	0.779	0.032		
Total	35	2.272			

Colour and appearance of mixed fruit jam at 90 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.497	0.136	4.031	0.00208
Error	24	0.810	0.034		
Total	35	2.307			

Colour and appearance of mixed fruit jam at 120 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.487	0.135	4.001	0.00219
Error	24	0.811	0.034		
Total	35	2.298			

Appendix 2:

Flavour of mixed fruit jam at 0 day

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.529	0.139	4.728	0.00072
Error	24	0.706	0.029		
Total	35	2.235			

Flavour of mixed fruit jam at 30 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.525	0.139	4.753	0.00069
Error	24	0.700	0.029		
Total	35	2.226			

Flavour of mixed fruit jam at 60 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.552	0.141	4.769	0.00068
Error	24	0.710	0.030		
Total	35	2.262			

Flavour of mixed fruit jam at 90 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.546	0.141	4.885	0.00057
Error	24	0.691	0.029		
Total	35	2.237			

Flavour of mixed fruit jam at 120 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.481	0.135	4.875	0.00058
Error	24	0.663	0.028		
Total	35	2.144			

Appendix 3:

Texture of mixed fruit jam at 0 day

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	2.435	0.221	3.178	0.00863
Error	24	1.672	0.070		
Total	35	4.107			

Texture of mixed fruit jam at 30 days

Source of Variation	DF	Sum of Squares	Mean Square	F-Calculated	Significance
Treatment	11	2.614	0.238	3.208	0.00820
Error	24	1.778	0.074		
Total	35	4.392			

Texture of mixed fruit jam at 60 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	2.952	0.268	3.330	0.00664
Error	24	1.935	0.081		
Total	35	4.887			

Texture of mixed fruit jam at 90 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	3.062	0.278	3.582	0.00433
Error	24	1.866	0.078		
Total	35	4.928			

Texture of mixed fruit jam at 120 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	3.044	0.277	3.566	0.00445
Error	24	1.863	0.078		
Total	35	4.907			

Appendix 4:

Taste of mixed fruit jam at 0 day

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.503	0.137	4.646	0.00081
Error	24	0.706	0.029		
Total	35	2.208			

Taste of mixed fruit jam at 30 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.510	0.137	4.576	0.00090
Error	24	0.720	0.030		
Total	35	2.230			

Texture Taste of mixed fruit jam at 60 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.517	0.138	4.662	0.00079
Error	24	0.710	0.030		
Total	35	2.227			

Taste of mixed fruit jam at 90 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.518	0.138	4.796	0.00065
Error	24	0.691	0.029		
Total	35	2.209			

Taste of mixed fruit jam at 120 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.481	0.135	4.875	0.00058
Error	24	0.663	0.028		
Total	35	2.144			

Appendix 5:

Over all acceptability of mixed fruit jam at 0 day

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.435	0.130	7.147	0.00003
Error	24	0.438	0.018		
Total	35	1.873			

Over all acceptability of mixed fruit jam at 30 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.416	0.129	7.035	0.00003
Error	24	0.439	0.018		
Total	35	1.855			

Over all acceptability of mixed fruit jam 60 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.363	0.124	7.549	0.00002
Error	24	0.394	0.016		
Total	35	1.757			

Over all acceptability of mixed fruit jam 90 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.364	0.124	7.156	0.00003
Error	24	0.416	0.017		
Total	35	1.780			

Over all acceptability of mixed fruit jam 120 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	1.361	0.124	6.792	0.00005
Error	24	0.437	0.018		
Total	35	1.798			

Appendix 6:

T.S.S of mixed fruit jam at 0 day

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	55.773	5.070	950.582	0.00000
Error	24	0.128	0.005		
Total	35	55.901			

T.S.S of mixed fruit jam at 30 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	56.184	5.108	998.154	0.00000
Error	24	0.123	0.005		
Total	35	56.306			

T.S.S of mixed fruit jam at 60 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	55.554	5.050	614.934	0.00000
Error	24	0.197	0.008		
Total	35	55.752			

T.S.S of mixed fruit jam at 90 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	54.993	4.999	915.589	0.00000
Error	24	0.131	0.005		
Total	35	55.124			

T.S.S of mixed fruit jam at 120 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	54.586	4.962	1,033.144	-0.00000
Error	24	0.115	0.005		
Total	35	54.702			

Appendix 7:

pH of mixed fruit jam at 0 day

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	2.529	0.230	4.392	0.00119
Error	24	1.256	0.052		
Total	35	3.786			

pH of mixed fruit jam at 30 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	2.529	0.230	4.191	0.00162
Error	24	1.316	0.055		
Total	35	3.846			

pH of mixed fruit jam at 60 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	2.529	0.230	4.604	0.00086
Error	24	1.198	0.050		
Total	35	3.727			

pH of mixed fruit jam at 90 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	2.569	0.234	5.026	0.00047
Error	24	1.115	0.046		
Total	35	3.684			

pH of mixed fruit jam at 120 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	2.572	0.234	5.472	0.00025
Error	24	1.025	0.043		
Total	35	3.597			

Appendix 8:

Acidity of mixed fruit jam at 0 day

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	0.001	0.000	38.243	0.00000
Error	24	0.000	0.000		
Total	35	0.001			

Acidity of mixed fruit jam at 30 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	0.001	0.000	79.441	0.00000
Error	24	0.000	0.000		
Total	35	0.001			

Acidity of mixed fruit jam at 60 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	0.001	0.000	68.906	0.00000
Error	24	0.000	0.000		
Total	35	0.001			

Acidity of mixed fruit jam at 90 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	0.001	0.000	41.649	0.00000
Error	24	0.000	0.000		
Total	35	0.001			

Acidity of mixed fruit jam at 120 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	0.001	0.000	12.838	0.00000
Error	24	0.000	0.000		
Total	35	0.001			

Appendix 9:

Ascorbic acid content of mixed fruit jam at 0 day

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	0.109	0.010	169.125	0.00000
Error	24	0.001	0.000		
Total	35	0.111			

Ascorbic acid content of mixed fruit jam at 30 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	0.098	0.009	65.584	0.00000
Error	24	0.003	0.000		
Total	35	0.101			

Ascorbic acid content of mixed fruit jam at 60 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	0.056	0.005	5.115	0.00041
Error	24	0.024	0.001		
Total	35	0.081			

Ascorbic acid content of mixed fruit jam at 90 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	0.094	0.009	19.808	0.00000
Error	24	0.010	0.000		
Total	35	0.104			

Ascorbic acid content of mixed fruit jam at 120 days

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Treatment	11	0.051	0.005	6.160	0.00010
Error	24	0.018	0.001		
Total	35	0.069			

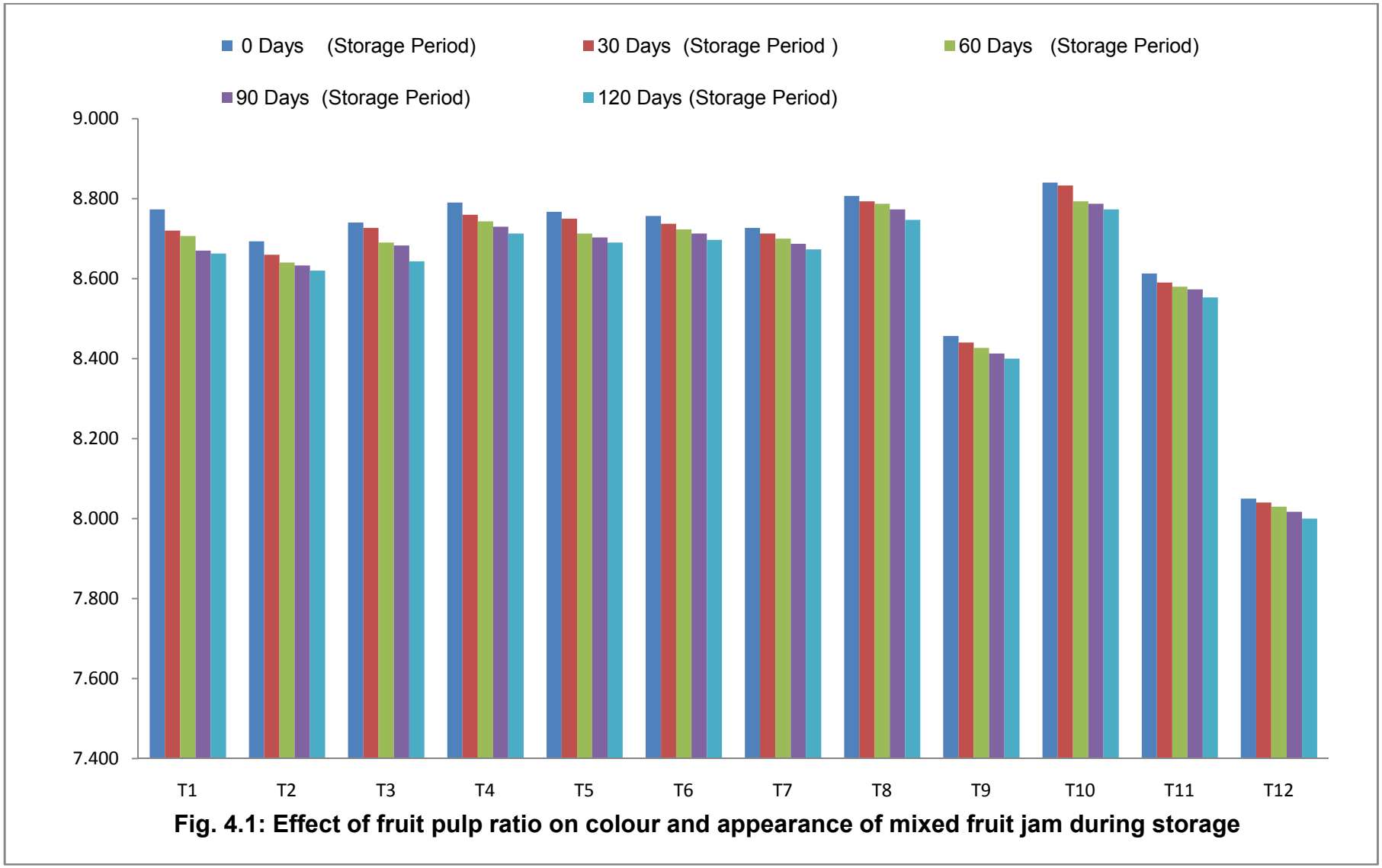

Fig. 4.1: Effect of fruit pulp ratio on colour and appearance of mixed fruit jam during storage

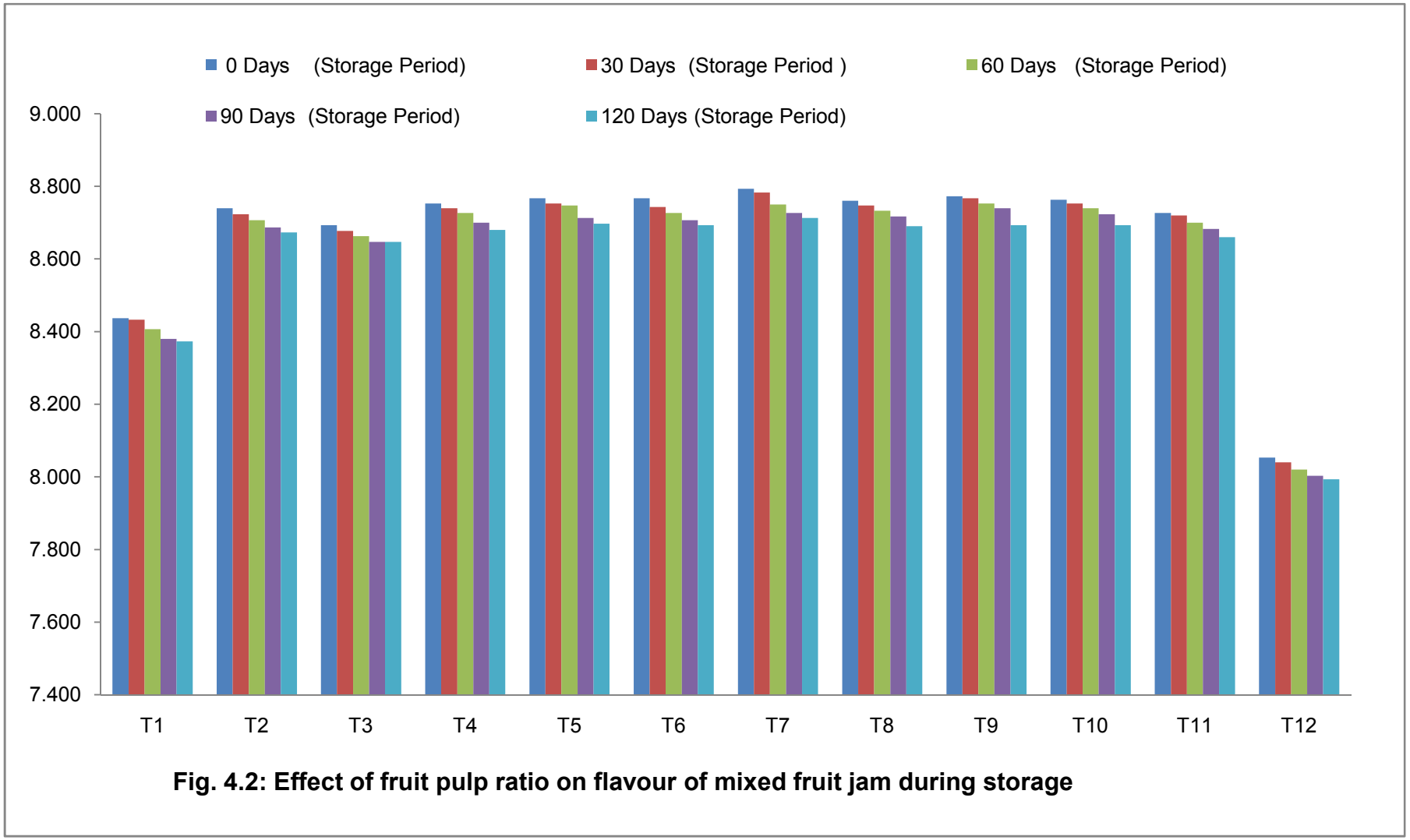

Fig. 4.2: Effect of fruit pulp ratio on flavour of mixed fruit jam during storage

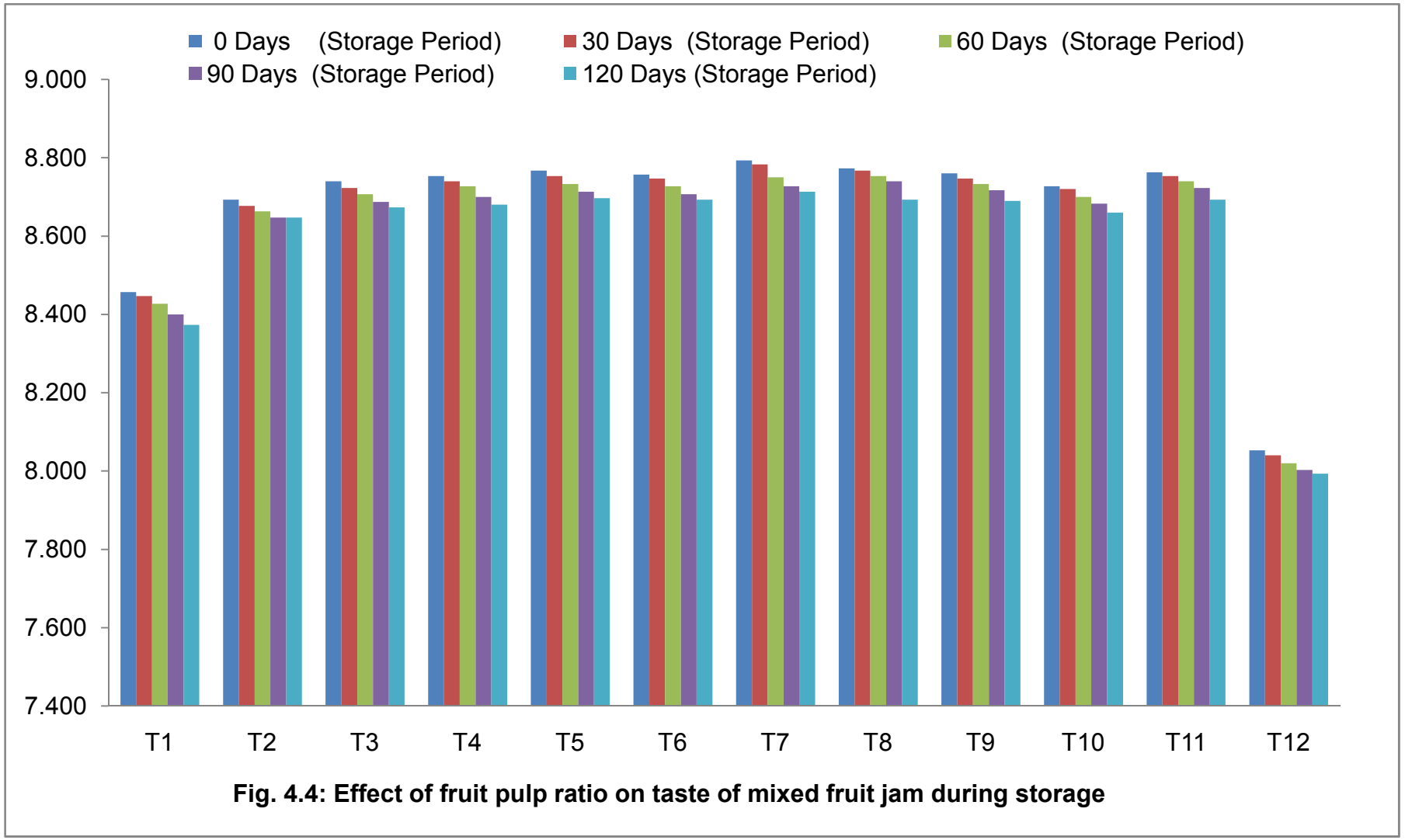

Fig. 4.4: Effect of fruit pulp ratio on taste of mixed fruit jam during storage

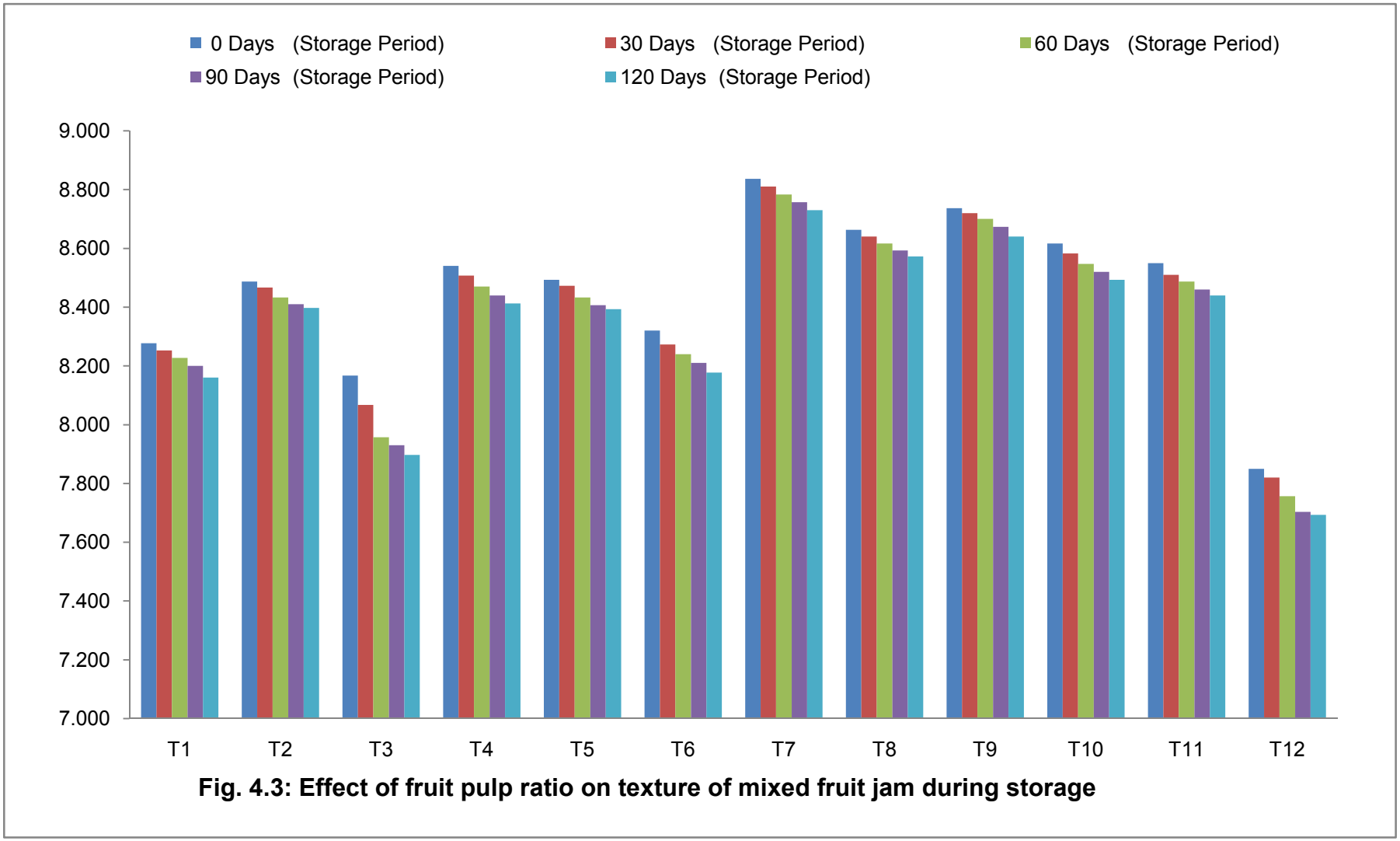

Fig. 4.3: Effect of fruit pulp ratio on texture of mixed fruit jam during storage

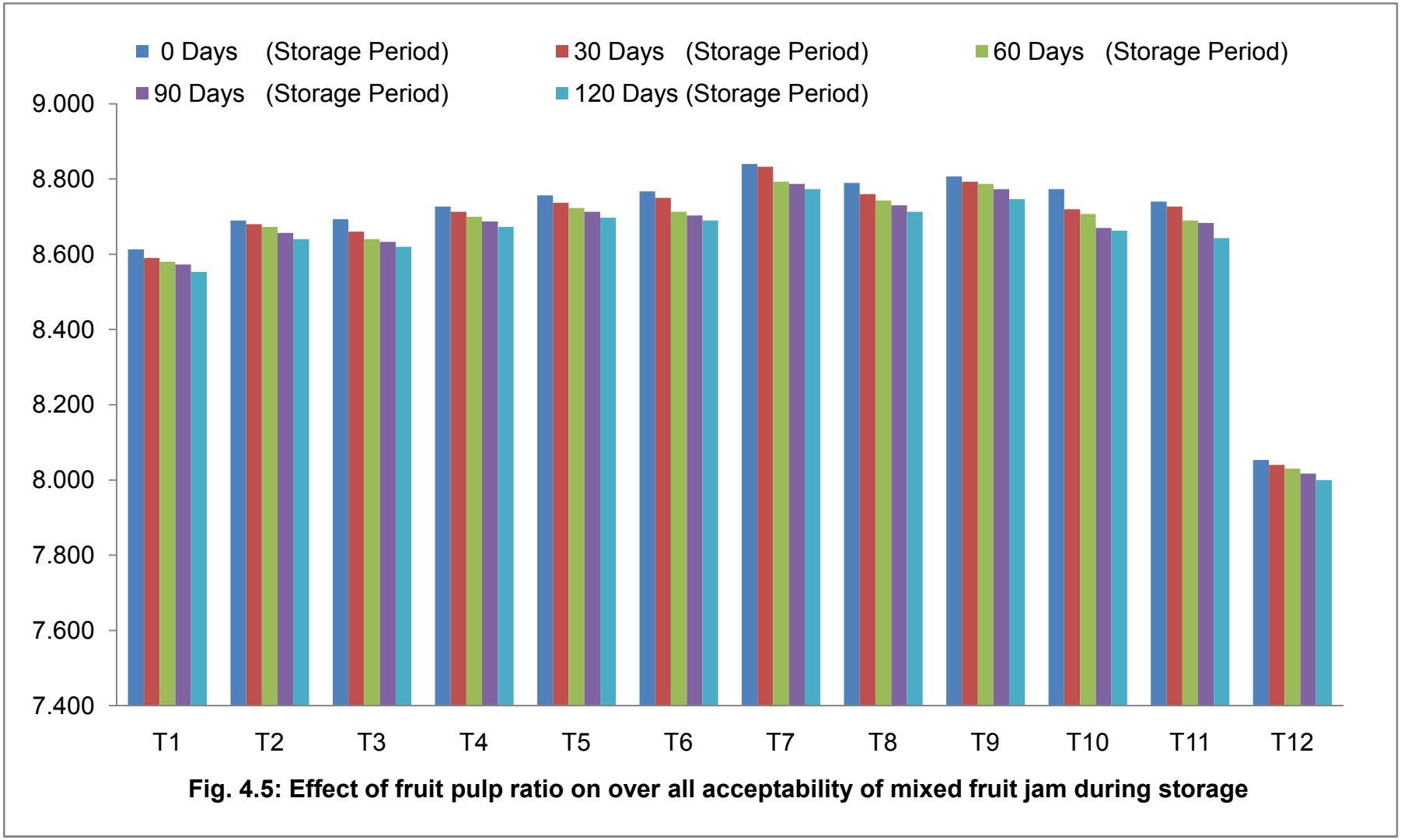

Fig. 4.5: Effect of fruit pulp ratio on over all acceptability of mixed fruit jam during storage

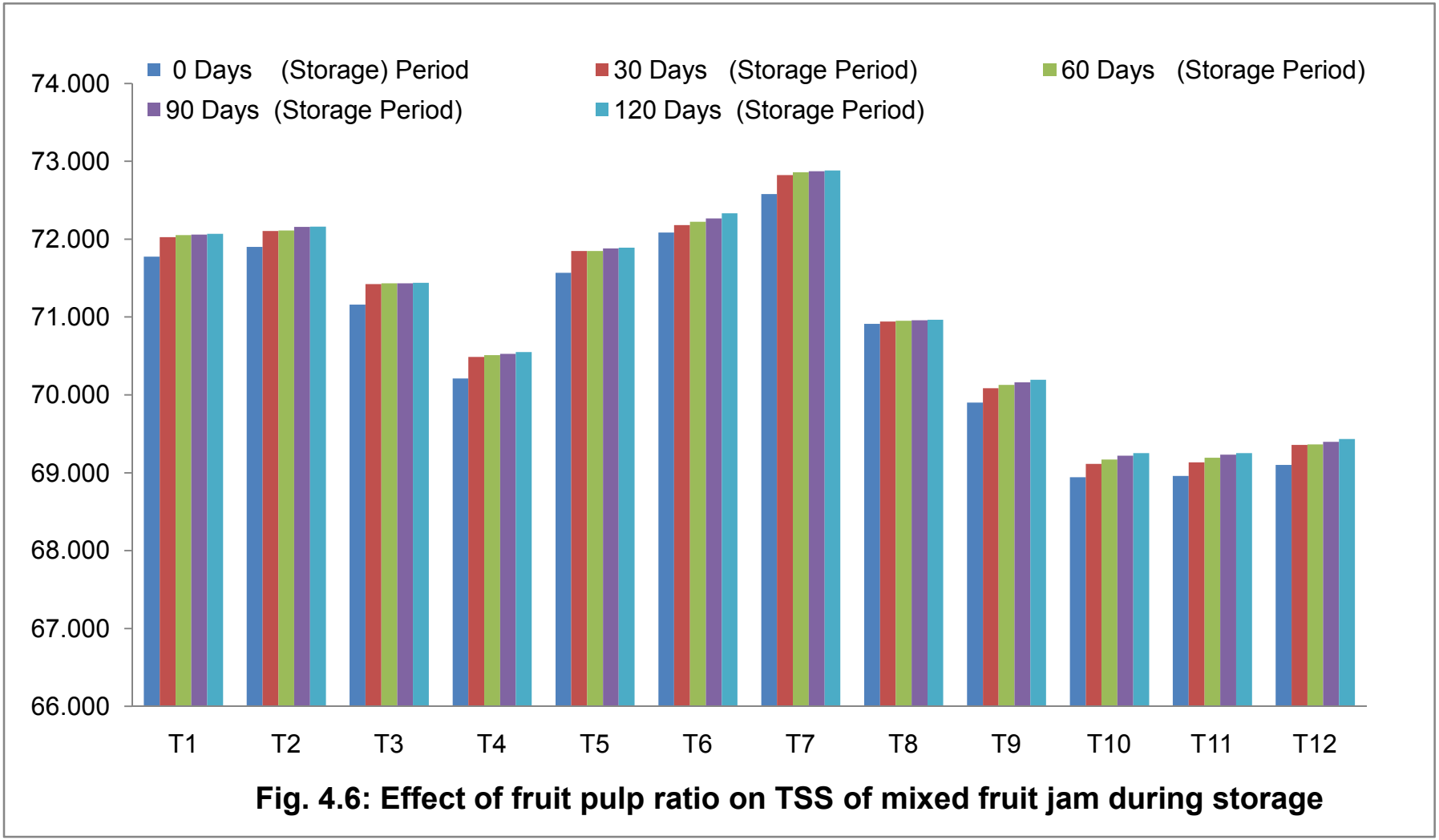

Fig. 4.6: Effect of fruit pulp ratio on TSS of mixed fruit jam during storage

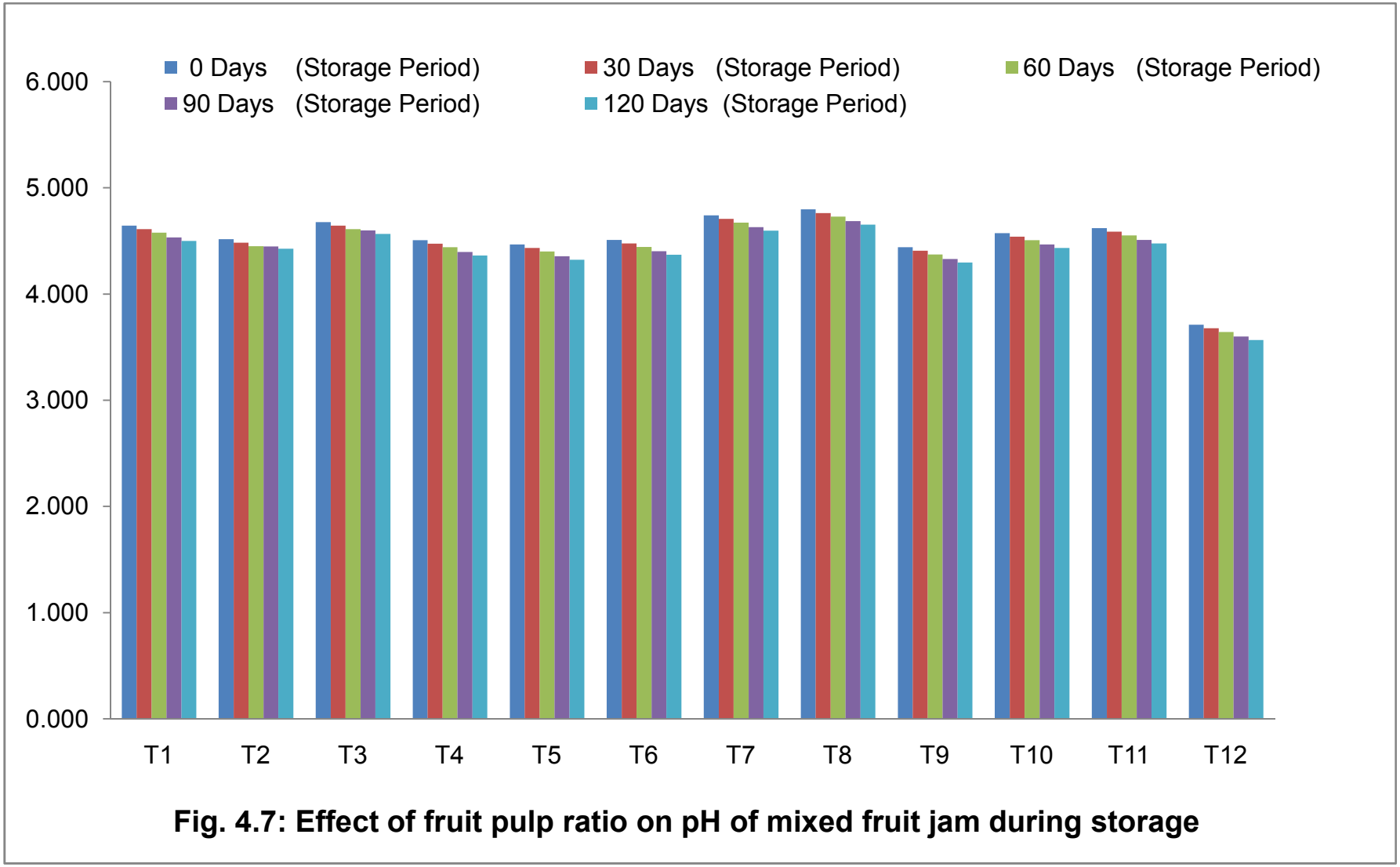

Fig. 4.7: Effect of fruit pulp ratio on pH of mixed fruit jam during storage

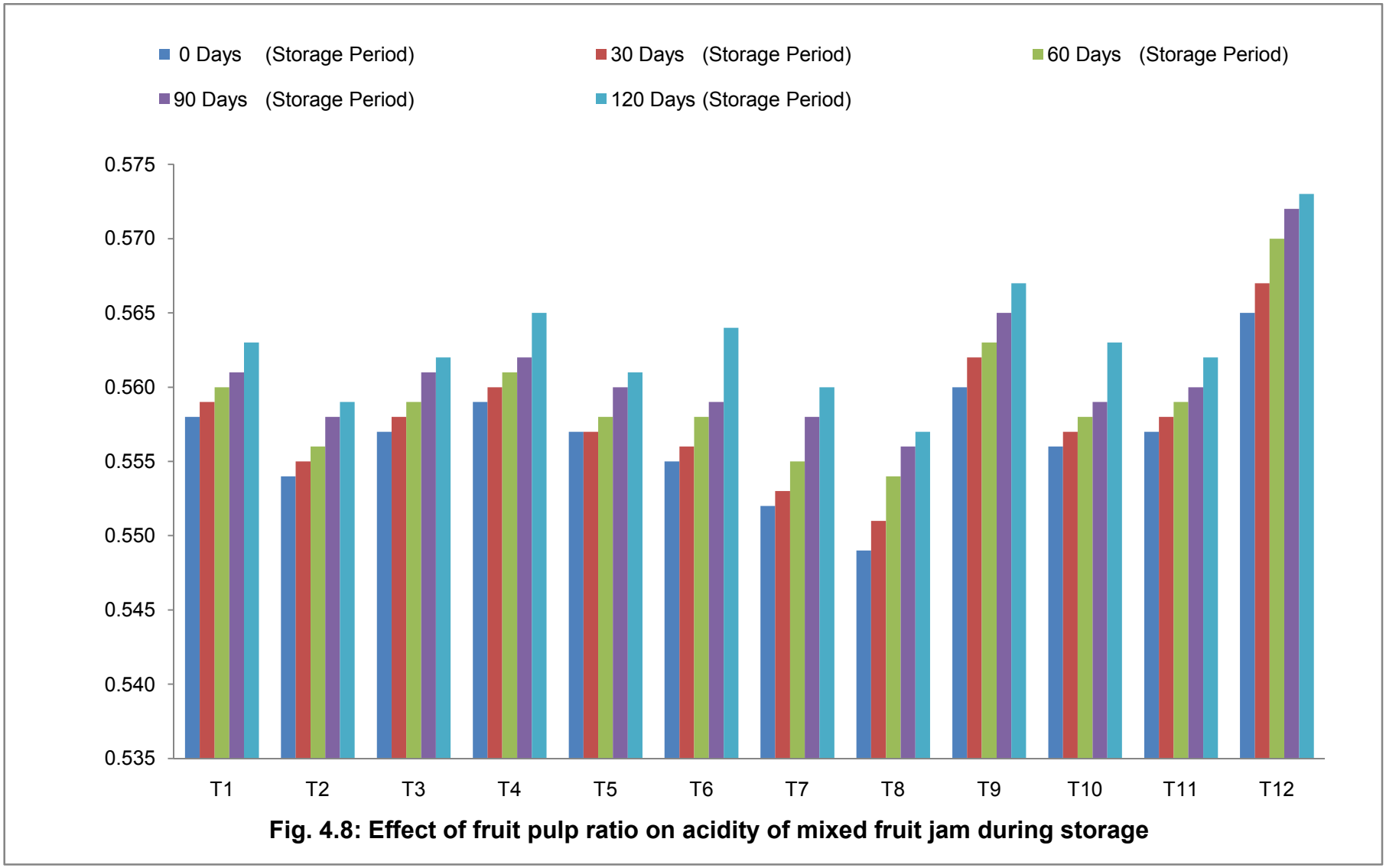

Fig. 4.8: Effect of fruit pulp ratio on acidity of mixed fruit jam during storage

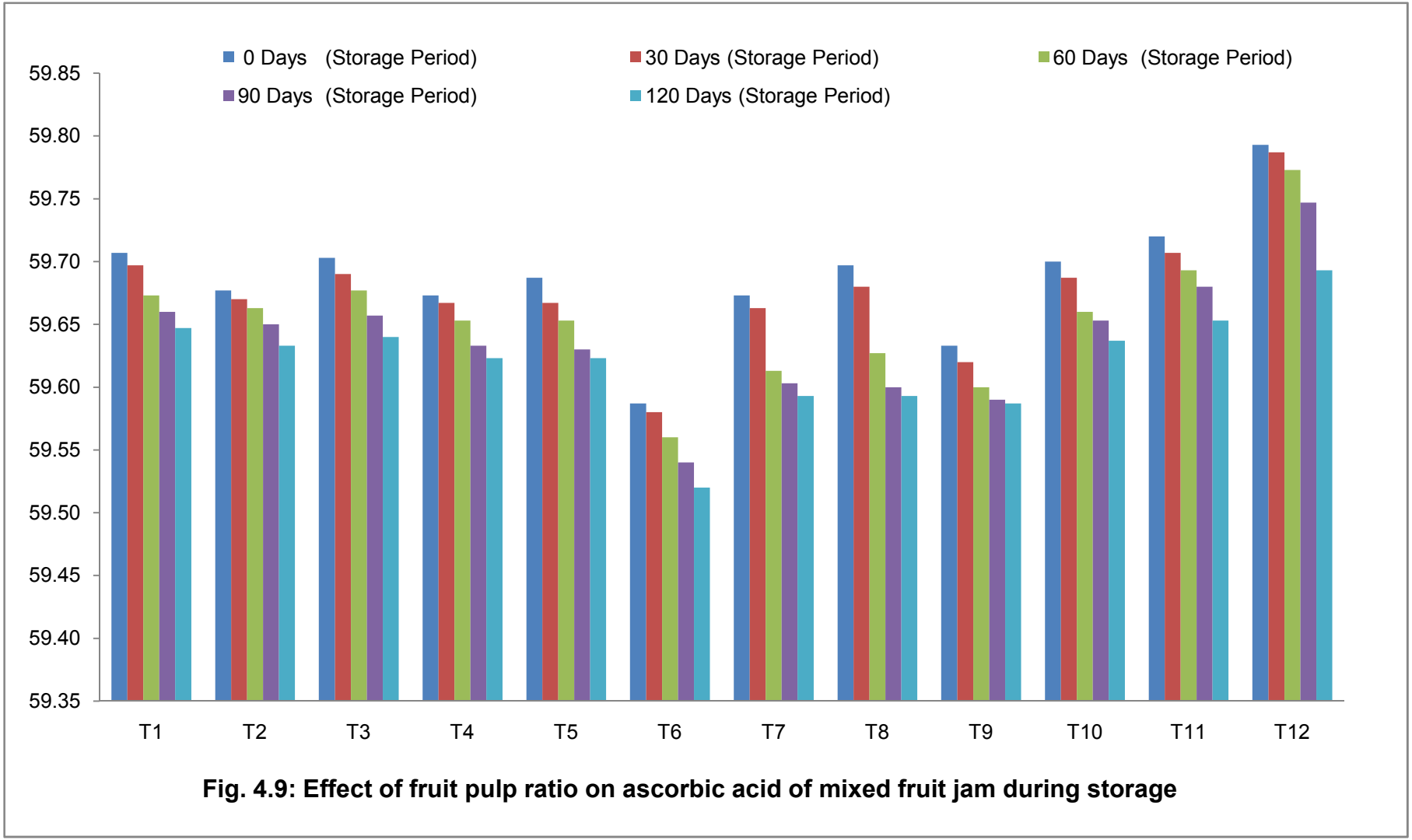

Fig. 4.9: Effect of fruit pulp ratio on ascorbic acid of mixed fruit jam during storage

PREPARED PULP OF PAPAYA AND MANGO FRUITS

PREPARED MIXED FRUIT JAM

PLATE -1

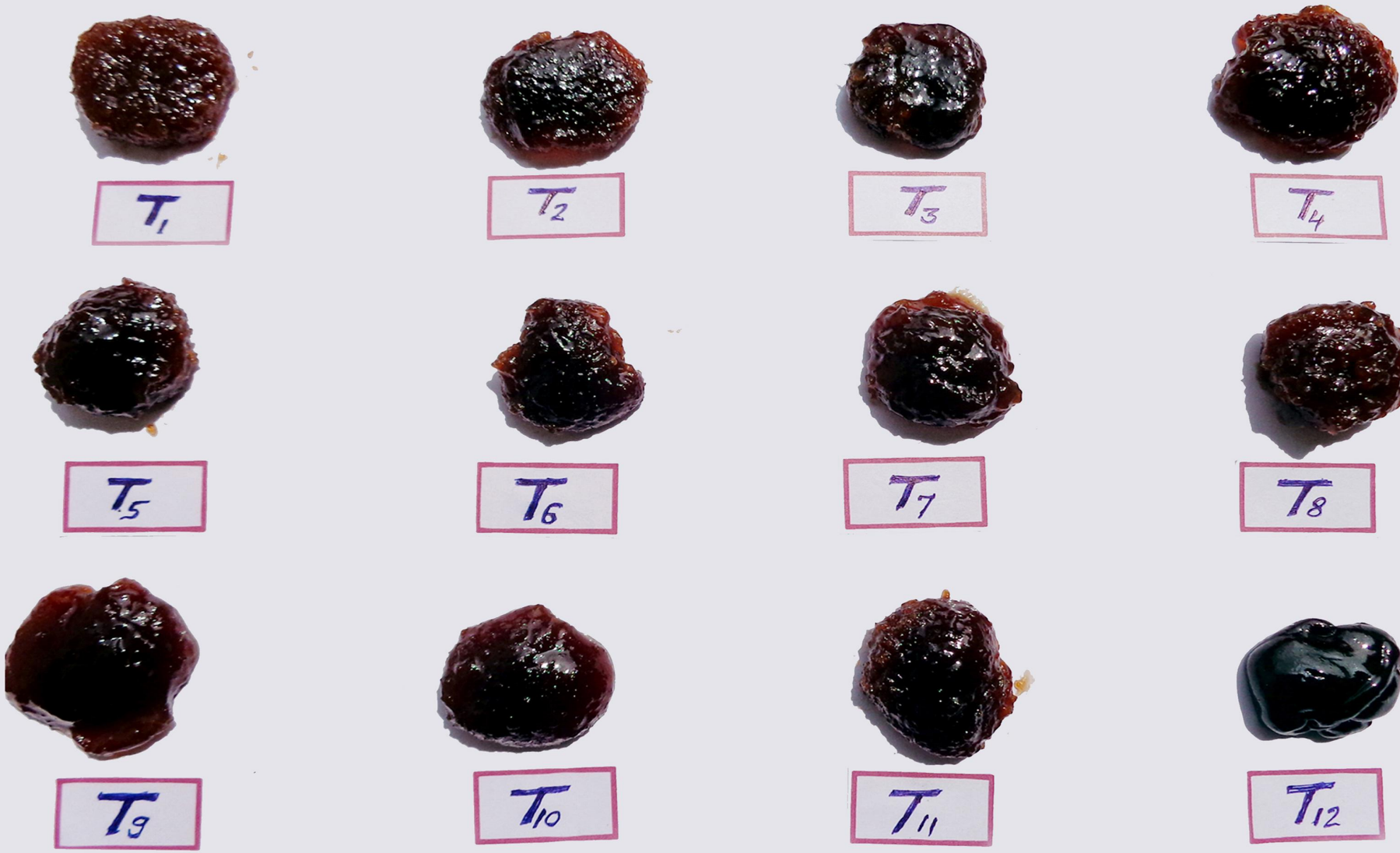

PLATE -2 SAMPLES OF MIXED FRUIT JAM (TREATMENT 1-12)

ABSTRACT

Title of the thesis	:	**"Studies on preparation of Wood apple based mixed fruit jam"**
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Year of award of degree	:	2015
Major subject	:	Horticulture (Fruit Science)
Total number of pages in the thesis	:	55
Number of words in the abstract	:	262

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A comparative study was carried out on mixed fruit jam of (Banana +Apple+ Mango+ Papaya+ Wood apple pectin) pulp, incorporated within the ratios in (g) T_1 (125g Banana+ 125g Apple+ 125g+ Mango+ 125g Papaya+ 500ml wood apple pectin), T_2 (166g Banana+ 166g Apple+ 166g Mango), T_3 (166g Banana+ 166g Apple+ 166g Papaya) , T_4 (166g Apple+ 166g Mango+ 166g papaya) , T_5 (166g Banana+ 166g Mango+ 166g papaya), T_6 (250g Banana+ 250g Apple) T_7 (250g Banana+ 250g Mango) T_8 (250g Banana+ 250g Papaya) T_9 (250g Apple+ 250g Mango) , T_{10} (250g Apple+ 250g Papaya) T_{11} (250g Mango+ 250g Papaya), T_{12} (1000ml Wood apple pectin). All the jam samples were stored in sterilized glass jars and evaluated physicochemically for colour, flavour, texture, taste, overall acceptability and TSS, pH, acidity, and ascorbic acid. All the samples were significantly different at storage. A decrease was observed in colour the higher rating (8.840) with T_{10} and minimum with T_{12} (8.05), Flavour the higher rating with T_7 i.e., (8.793) whereas minimum with T_{12} (8.053), Texture the higher rating with T_7 i.e., (8.830) whereas minimum with T_{10} (7.850), Taste the higher rating with T_7 i.e., (8.793) whereas minimum with T_{12} (8.055), Overall acceptability the higher rating with T_7 i.e., (8.840) whereas minimum with T_{12} (8.053), pH the higher rating with T_8 i.e., (4.797) whereas minimum with T_{12} (3.710), Ascorbic acid the higher rating with T_{12} i.e., (74.52mg/ 100g) whereas minimum with T_6 (68.87mg/ 100g). While increase was noted in TSS the higher rating with T_7 i.e., (74.52 ^{0}brix) whereas minimum with T_6 (68.87 ^{0}brix). Acidity the higher rating with T_{12} i.e., (0.549%) whereas minimum with T_8 (0.564%) during evaluation.

CURRICULUM VITAE

The author of this thesis **Mr. Nakul Rao Rangare** S/o Nem Das Rangare was born on 03rd June, 1989 at Hatta, Dist. Balaghat (M.P.). He passed the High School Examination in the year 2005 with 58.56 per cent marks and Higher Secondary Examination in the year 2007 acquiring 54.00 per cent marks. Then, he joined Allahabad school of agriculture Allahabad Uttar Pradesh in the year 2009 and successfully completed the degree of B.Sc. Agriculture from Sam Higginbottom Institute of Agriculture, Technology and Sciences(Deemed-to-be-University) Allahabad (U.P.) during the year 2013 with 7.88 OGPA out of 10.00 point scale.

After completing graduation, he was selected for M.Sc. (Ag.) Horticulture degree programme in College of Agriculture, Jabalpur in the year 2013 for specialization in Fruit Science. He has successfully completed all the course requirements for master's degree from Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during the year 2015 with 7.11 OGPA out of 10.00 point scale.

For the fulfillment of the master's degree programme, he was allotted a research problem entitled **"Studies on preparation of wood apple based mixed fruit Jam"** This is duly completed by him and presented in the form of this thesis.