

**STANDARDIZATION OF BLENDED GULKAND BASED ON SAPOTA
[*Manilkara achras* (Mill.) Fosberg] FRUITS**

A

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THE AWARD OF THE DEGREE

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A decorative graphic consisting of several green leaves arranged in a symmetrical, wave-like pattern. The leaves are stylized with visible veins and are positioned behind the text 'OF' and 'MASTER OF SCIENCE (HORTICULTURE)'.

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IN

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ABSTRACT

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**“STANDARDIZATION OF BLENDED GULKAND BASED ON
SAPOTA [*Manilkara achras* (Mill.) Fosberg] FRUITS”**

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ABSTRACT

Sapota [*Manilkara achras* (Mill.) Fosberg] belongs to the family of sapotaceae and native of Mexico. It is intensively and extensively cultivated in the states of Maharashtra, Karnataka Gujarat, Andhra Pradesh and Tamil Nadu. In Gujarat, highest area is occupies in South Gujarat where it is marketed as a fresh fruit. Due to heavy production and increase in area under this crop creates a glut in the market making timely disposal of fruit very difficult. Whereas, the infrastructural facilities for distance market, export, storage and processing are very poor. Therefore, there is a post harvest loss become enormous. Therefore, it is essential to utilize the sapota fruits into suitable value added products. Similarly, in cultivation of rose flower also it faced the problem of surplus disposal in peak season. Its only small quantity is utilized in preparation of *gulkand*. However, it imparts very poor, dull and faded colour after long storage and has very limited nutritional value. This problem can be overcome by blending of sapota and medicinal herbs. Sapota is rich in

polyphenols and tannin which can be utilized in *gulkand* to impart attractive and lustrous natural colour and also provide nutrients mainly antioxidant. In these circumstances, present investigation on "Standardization of blended *gulkand* based on sapota [*Manilkara achras* (Mill.) Fosberg] fruits" was carried out during 2008-09 by blending sapota (100:150:200), rose (pink and red), medicinal herbs (0 and 5 g), citric acid (0.5 and 10 g/kg) and Brix (78 %) at the Department of Post Harvest Technology, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. Among various treatments, the best and most acceptable *gulkand* based on sapota can be prepared by blending sapota (100 g), pink rose (650 g), red rose (250 g) and medicinal herbs (50 g) by adjusting to 78 °Brix and packing in wide mouth glass jars. The product was found most stable with excellent score for taste, flavour, colour, appearance, texture and overall acceptance during the storage of 9 months. There was also an increasing trend in TSS, total sugars, reducing sugars and acidity. whereas, decreasing in non-reducing sugars and pH throughout storage period. This herbal and medicated food product is very aromatic, appetizing, delicious and nutritious. In this method, from total cost production of Rs. 31, the net return (profit) is Rs. 29/kg of sapota based *gulkand*. Therefore, this medicated sapota based *gulkand* technology could be promoted as functional food for good health and exploited for agro food processing industry in both rural and urban areas to generate employment and income so as the produce can be utilized in an effective manner.

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C E R T I F I C A T E

This is to certify that the thesis entitled **STANDARDIZATION OF BLENDED GULKAND BASED ON SAPOTA [*Manilkara achras* (Mill.) Fosberg] FRUITS** submitted by Ms. **PATEL NIKETAKUMARI BHIKHUBHAI** in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **POST HARVEST TECHNOLOGY** of the Navsari Agricultural University is a record of bona fide research work carried out by her under my guidance and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Place : Navsari.


(S.N. Vaghani)

Date : April 20, 2009

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D E C L A R A T I O N

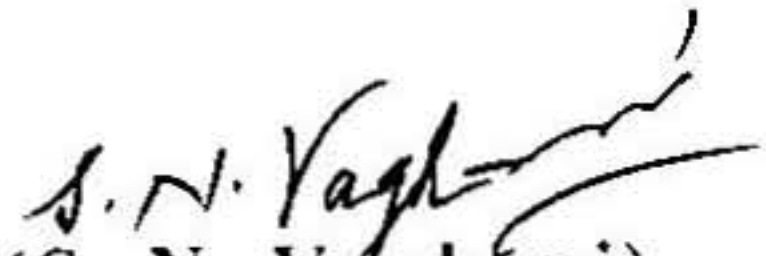
This is to declare that the whole of the research work submitted in this thesis for the partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (HORTICULTURE) in POST HARVEST TECHNOLOGY** is the result of investigation done by the undersigned under the direct guidance and supervision of **Dr. S. N. Vaghani**, Associated Professor, Department of Process Technology, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari and that no part of the work has been submitted for any other degree so far.

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ABBREVIATION AND SYMBOLS

Sr. No.	Abbreviation	Meaning
1.	%	Per cent
2.	°C	Degree Celsius
3.	CD	Critical difference
4.	CV	Co-efficient of variance
5.	S.Em.	Standard Error of mean
6.	Syn.	Synonymous
7.	g	Gram
8.	Kg	Kilogram
9.	Km	Kilometer
10.	@	At the rate
11.	viz.,	Namely
12.	<i>et al.</i>	<i>et alii</i> (and others)
13.	cv.	Cultivar(s)
14.	/	Per
15.	PET Bt.	Polythene terephthalate bottle
16.	Gl. Bt.	Glass Bottle
17.	<i>i.e.</i>	That is
18.	etc.	<i>et cetera</i> (other similar things)
19.	MT	Metric Tonnes
20.	ha.	Hectare
21.	RT	Room Temperature
22.	LT	Low Temperature
23.	CFTRI	Central Food Technology Research Institute.

INTRODUCTION

I. INTRODUCTION

Sapota is one of the most delicious fruit grown largely in tropical regions of the world. It has various synonyms like [*Manilkara zapota* (L.) van Royen], [*Manilkara achras* (Mill.) Fosberg], *Achras zapota* L., *Achras sapota* L. and also commonly known as chiku, baramasi, naseberry, dilly, zapota, sapodilla and chicle. It belongs to the family sapotaceae and native of Mexico and Central America. It is now widespread throughout the tropical regions of the world and commercially grown in India, the Philippines, Sri Lanka, Malaysia, Mexico, Venezuela, Guatemala and some other Central American Countries. In India, it is mainly cultivated for its fruit, while in South-East Mexico, Guatemala and other countries it is commercially grown for the production of chicle which is a gum like substance obtained from milky latex through tapping of bark of tree and is mainly used for preparation of chewing gum.

Sapota is essentially a fruit of warm and humid climate but more suited in coastal regions having the optimum temperature ranges from 12 °C to 36 °C and 70 % relative humidity. Tree is a small to medium sized, evergreen, fairly slow growing and long lived. Areas with an annual rainfall of 125-250 cm are highly suitable. However, it is a hardy tree can also be grown in dry areas and wide ranges of soils. In India, the main seasons are February-April and October-December though flowering may continue around the year. The berry is a large,

round, oval or conical in shape and 4-7 cm in diameter. It has a potato like appearance with rough buff-coloured skin. Fruits are ready to be picked when the scurffy coating on the skin can be easily removed. The flesh is turning yellow, brown or orange-red colour. Fruit consists mainly of three components like edible pulp 72 per cent, peel and core 25 per cent and seeds 3 per cent. Fruit is climacteric harvested matured and ripened at ambient temperature. Fruit is very sweet in taste and smooth or grainy in texture.

In India sapota was first introduced in Maharashtra in 1898 in a village named Gholwad (Cheema *et al.*, 1954). Thereafter, it was spreaded to the other states and commercially cultivated in Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Tamil Nadu and West Bengal. However, it enjoys the status of major fruit crop in South Gujarat, Coastal Maharashtra and Karnataka where it is extensively and intensively grown. India is considered to be the largest producer (1238.1 MT) of sapota in the world. (NHB, 2008) and ranks fifth both production and consumption next to mango, banana, citrus and grapes in the country.

Sapota is the choicest fruit of South Gujarat occupying nearly 95 per cent of the total area under sapota in Gujarat because of well suited medium black soil, warm and moist climate of this coastal area. Thus, its cultivation is restricted in a few districts and major concentration is in Valsad, Navsari and Surat. In Gujarat it is grown in 26.5 thousand ha with an annual

production of 258.9 MT (NHB, 2008), whereas in South Gujarat its area is 14 thousand ha with 1.4 Lakh MT per annum (Anon., 2005-06b).

At present the area under this crop is increasing owing to its sweet and delicious fruit, high productivity, ease of cultivation, continuous fruiting and freedom from major pest and diseases. In Gujarat, this crop is considered as a bank crop to the orchardist as it provides continuous money for their day to day expenditure. Such a favourable conditions are likely to create glut in the market during main season making disposal of produce at times difficult. However, the fruit is highly perishable with a short shelf life and highly susceptible to bruise and compression. Such fruits are very difficult to be handled and transported after ripening. Further, the fruit is susceptible to chilling injury causing its storage and export very difficult. At present, we have no any viable industrial product processing. Thus, in absence of timely disposal of surplus produce, the orchardists are exploited by middlemen and they get very meagre price for their produce and consequently causing post harvest losses about 25-30 per cent.

To overcome these constraints, development of appropriate value added products based on sapota is thought to be convenient and economic alternative for the utilization of surplus produce into stable product to minimize the post harvest losses during peak season. At present, the sapota fruits are mainly used for desert purpose whereas, its negligible quantity is utilized in

halwa, shrikand, milkshakes, ice-cream, drying and mixed fruit jam. However, intensive research work based on sapota processing has been carried out at Navsari Agricultural University, Navsari on sun drying (Vaghani and Chundawat, 1986), osmo-drying, osmo-vac dehydration (Vaghani and Chundawat, 1997), jam (Mulla and Vaghani, 2007), jelly (Desai and Vaghani, 2007), chutney (Meena and Vaghani, 2008), Medicinal jam (Patel and Vaghani, 2008), chyawanprash (Patel and Vaghani, 2008), Herbal beverage (Chaudhari and Vaghani, 2008), Low calorie beverage (Patel and Vaghani, 2009).

In recent year, the increasing consumer awareness has emphasized the need for healthy, nutritious and safe food without chemicals, preservatives and artificial colour and flavours. Looking to the present trend, production of functional food seems to be very appropriate and important for the benefit of human health. Functional foods are foods that may provide a health benefit beyond energy and essential nutrients. Among the various preservation techniques, preserve is found to be the most stable during prolong storage. Therefore, it was thought to produce a functional food based on sapota in the form of preserve by blending of rose petals, herbs and spices. Such product do not contain any synthetic and cancer causing colours and free from harmful chemicals, preservatives and artificial aroma.

This medicated *gulkand* would be more health beneficial than the traditional *gulkand*. Sapota is a rich source of tannins and polyphenoles which induce browning may be useful

to impart dark red colour to *gulkand*. Moreover, fruit is an excellent source of digestible sugar which provides quick energy and also contains antioxidants which work as a protective food.

Herbs and spices which are valued for medicinal and therapeutic properties since the time of immemorial and are frequently recommended for their synergistic effects in both Ayurvedic and Unani system of medicine. Cardamom remove gas in stomach and helps in digestion. Funnel is used as a stimulant and give tone to the stomach. Liquorice remove acidity, cough and use as a tonic. *Chanothi Leaves* (Crab's eye) is used to cure mouth ulcer. *Brahmi* (Indian pennywort) is excellent blood purifier and improve mental function. Asparagus is controlling dysentery and used for disease of the blood, eye and throat. Long pepper roots are used as a tonic and cure low blood pressure.

Gulkand is also known as rose petal preserve, rose petal jam, rose petal jelly or rose petal marmalade. The *gulkand* is abundantly employed in acidity, burning urination, leucorrhoea, constipation, toxemia, piles and sore throat. There is immense scope to generate new source of employment and income for both rural and urban masses with concomitant reduction of fruit and flower losses. This novel approach seems to be the best solution for sapota processing. However, little attempt is made in past to utilize the sapota fruit in production of medicated *gulkand* product. Unfortunately less attention is being paid on blending of sapota with rose flower for processing and the relevant

information is also very scanty. In these circumstances the present investigation was planned with the following objectives:

1. To explore the possibility of *gulkand* based on sapota to avoid post harvest losses and to get a value added processed product.
2. To assess the effect of different blending, chemicals on the storage life and quality of *gulkand*.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The sapota is the highly delicious and nutritive fruit of tropical and sub-tropical region of the world. India is the largest producer of sapota in the world. Now it occupies a significant position among the various states like Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Tamil Nadu and West Bengal. However, South Gujarat, Coastal Maharashtra and Karnataka are the major areas where it is extensively and intensively cultivated. At present the area under this crop is increasing owing to sweet and delicious fruit, high productivity, ease of cultivation, continuous fruiting and freedom from major pest and disease. In Gujarat, this crop is considered as a bank crop to the orchardist as it provides continuous money for their day to day expenditure. It is well known that sapota tree bears fruits heavily in peak season but fruits are highly perishable with a short shelf life. On the other hand, due to non-ideal post harvest practices, transport producers, lack of proper storage facilities, outdated handling practices lead to 25-30% losses of valuable fruits. Under these circumstances, processing of sapota into value added products with sufficient shelf life is most important. At present negligible quantity of the fruits is used in *halwa*, *shrikhand*, milk shake, ice-cream and drying and mixed fruit jam. However, intensive research work based on Sapota processing has been carried out at Navsari Agricultural University, Navsari on drying, osmo-drying, osmo-vac dehydration, jam, jelly, chutney, herbal jam, *chaywanpras*, herbal beverage and low calorie beverage.

Therefore, the present investigation is being undertaken to standardize a technique of sapota based gulkand preparation with different medicinal herb and spices blend.

2.1 Sapota products

In actual processing, sapota fruit is used in mixed fruit jam preparation (Vaghani and Chundawat, 1993). In South Gujarat, sun drying of sapota fruit is very common practice at home and cottage level. The marketing of this fruit is limited to local level. Looking to the importance a number of attempts have been made by many research workers for drying and dehydration (sun, solar, tray, vaccum, osmo and freeze drying) of sapota fruits (Thepa, 1980; Amba Dan, 1985; Anonymous, 1986; Vaghani and Chundawat, 1986; 1991; Nanjundaswamy, 1991; Singaravelu and Arumugam, 1993; Chundawat, 1998; Jain and Jain, 1998; Desai *et al.*, 2001; Gunjayal *et al.*, 2003 and Lakkond *et al.*, 2004). The next important sapota product is canning of slices, which is being adopted by industry on small scale. Its feasibility was also tested and found poor at CFTRI, Mysore (Anonymous, 1985). Moreover, several attempts have been made to develop various processed products of sapota fruits like bar (Nanjundaswamy, 1991), chutney (Nanjundaswamy, 1991), frozen pulp (Nanjundaswamy, 1991), frozen segments (Krishna Prakash *et al.*, 1996), jam (Chundawat and Sharma, 1978; Anon, 1985 and Koli *et al.*, 2004), juice (Gautam and Chundawat, 1997; Alves *et al.*, 2001 and Lakkond *et al.*, 2003), leather (Man *et al.*, 1992), milk-shake (Jadhav *et al.*, 2004), nectar (Alves *et al.*, 2001), powder (Gunjyal *et al.*, 1999),



RTS (Ahmed, 1996), squash (Anon., 1985), steeped slices (Vaghani, 1999) and wine (Gautam and Chundawat, 1998). The excellent product was obtained in form of jam (Mulla and Vaghani, 2007). Jelly (Desai and Vaghani, 2007) by incorporation of sapota fruits with papaya at different ratio, medicinal jam (Patel and Vaghani, 2008), chyavanprash (Patel and Vaghani), RTS beverage (Chaudhary and Vaghani), Low calorie beverage (Patel and Vaghani) by incorporation of Sapota fruits with different fruits and spices ratio.

The principal products tested were poor in colour, flavour, taste and storability (Lakhsminarayana, 1980; Chadha, 1992 and Vaghani and chundawat, 1993). Nanjundaswamy (1991) also reported that sapota fruit is not fit for processing as it has poor flavour due to heat labile delicate flavour, unagreeable pulp colour, intensive labour involvement in peeling, presence of gummy material and development of acrid taste and flavour loss in processed product during storage. Thus, studies conducted in India and abroad, do not promise bright future for industrial processing of sapota fruit (Chundawat, 1998). Under these circumstances a new approach of blending of sapota fruit with other fruits like papaya, star apple, carrot, date, will be helpful to utilize sapota fruit in processed product.

2.1.1 Preserve

A matured fruit/vegetable/flower or its pieces impregnated with heavy sugar syrup till it becomes tender and transparent is known as preserve.

Very few information is available pertaining to the qualitative changes in Preserve during storage. It is believed that medicinal value improves in Preserve with aging.

Patel and Vaghani (2008) studied the effect of sapota blend with fruit blend I (450 g) with spices and herbs (45 g) blend II, sugar (450 g/kg), honey (50 g/kg), citric acid (3 g) and packed in glass bottles. The product was found most stable with excellent score for taste, flavour, colour, appearance, texture and overall acceptability during the storage of six months. There was also an increasing trend in TSS, total sugars, reducing sugars and acidity whereas, decreasing trend in non-reducing sugars and pH throughout storage period of six months.

Kaushik *et al.* (2002) conducted an experiment on biochemical changes of bael preserve during storage. They observe that bael preserve containing 0.6 % citric acid, sugar adjusted to 70 per cent and product stored at ambient temperature in glass jar was found to be most acceptable. The product has recorded acceptable organoleptic score with increased level of total soluble solids and acidity during storage period of six months.

2.1.2 Jam

Fruit preserves are popularly consumed in many households irrespective of income pattern in India and the consumption is likely to increase in future (Sawaya *et al.*, 1993). Among preserves, fruit jam possesses delicacy and is considered to be a fancy item. However, it is rarely produced in fruit factories

due to inadequate technical know-how. But, the global demand for such product is rising as the affluent consumer in domestic and advanced countries demands products with better nutrition.

Goyal *et al.* (2008) studied the experiment on new vistas of value addition to utilize amla and ber fruits. They revealed that products like jam, preserve and squash from amla and ber were found to maintain acceptable quality with sensory attributes like colour, appearance, texture, flavour, taste during storage.

Mulla and Vaghani (2007) studied the effect of sapota blend with papaya in jam quality during storage. They observed that amongst various treatments, blend containing sapota:papaya (30:70) blend with citric acid (6g/kg), sugar (1kg/1kg pulp) and packed in glass bottles was found to be most stable and acceptable. The product recorded excellent score for taste, colour, appearance, flavour and overall acceptability with increased level of total soluble solids, reducing sugar, total sugar and acidity; and decreased level of non-reducing sugar and pH during storage.

Mishra and Chopra (2006) conducted an experiment on processing and storage studies on bael (*Aegle marmelos* Correa) fruit products. They revealed that bael fruit could be successfully utilized in mixed fruit jam. Acidity and TSS were increased slightly after three and four months of ambient storage. Jam was found to maintain acceptable quality up to five and six months of storage.

Prasad and Mali (2006) reported on physico-chemical characteristics of ber jam during storage. They observed that acidity, TSS, total sugars and reducing sugars increased, whereas non-reducing sugars decreased with an increased period of storage. The colour, taste and flavour of the jam remained optimum at low temperature. For long-term storage of ber jam, low temperature storage was found better.

Prasad and Mali (2005) took an experiment on physico-chemical changes in bael jam during storage. They revealed that the reducing sugars, total sugars and acidity were increased, whereas non-reducing sugars declined in all the samples.

Standardization of recipe for papaya nectar and its storage was studied by Saravanan *et al.* (2004a). A preparation of papaya nectar using 23 per cent pulp contains 15 °Brix TSS and 0.3 per cent acidity and filled in glass bottles. The product was stored at room temperature ($20 \pm 5^{\circ}\text{C}$) for 90 days. The product had higher acceptability due to better taste and flavour during storage, recording TSS 15.00 to 15.40°Brix, total sugar 12.52 to 12.81%, reducing sugar 3.94 to 9.56%, colour (8.20-8.00), appearance (8.00-7.80), aroma (7.70-7.50), taste (7.90-7.70) and overall acceptability (7.90-7.70) during storage.

Manivasagan *et al.* (2004) carried out an experiment on qualitative changes in jam of karonda (*Carissa carandus* L.) during storage. They observed an increase in acidity during storage time. Moreover, jam prepared from pink type of karonda was more acceptable than jam prepared from green type of karonda.

Sudhagar *et al.* (2003) studied on preparation of value added products from pear. The pear jam was analyzed for chemical and sensory qualities. Sensory quality of the jam was found superior.

Kannan and Thirumaran (2001) studied the storage life of jamun products like syrup and jam. Jamun syrup was prepared by using 30 per cent of juice contain 65°Brix TSS. This syrup was packed in 200 ml sterilized glass bottles and stored at ambient temperature (27-36.1°C) for 6 months. The product was acceptable even after 6 months of storage at ambient conditions, recording TSS 70.0 to 72.5°Brix and reducing sugar 39.4 to 46.6%. Whereas, jamun jam was prepared by using 65 per cent of juice contain 69°Brix TSS. This jam was packed in 200 ml sterilized broad-mouth glass bottles and stored at ambient temperature (27-36.1°C) for 6 months. The product was acceptable even after 6 months of storage at ambient conditions, recording TSS 69.0 to 71.5°Brix and reducing sugar 30.1 to 36.5%.

Sogi and Singh (2001) reported various kinnow products. Storage studies of kinnow jam revealed that jam made from unpeeled and lye peeled segments showed an increasing trend in TSS, total sugars, reducing sugars and acidity at the end of 90 days storage. The sensory data showed that jam made from lye peeled segment did not develop bitterness.

Yousif and Humeid (2000) conducted an experiment on preparation and evaluation of date jam and revealed that jam

prepared from date with a sugar (0.50:1) obtained the highest scores and was ranked the first.

Sagar and khurdiya (1998) took an experiment on product preparation from ripe mango cv. Dashehari. They reported that mango jam had highest score for colour, texture and flavour when prepared with mango slices and sugar in equal quantity.

Niramon *et al.* (1996) experimented on development of jam from orange and aloe-vera with ratio of 50 : 50 (orange : aloe-vera gel). The product was found acceptable on the basis of physico chemical and sensory evaluation.

Mehta (1995) conducted an experiment on evaluation of different cultivars of aonla (*Emblica officinalis* Gaertn.) fruits for processing. The results showed an increasing trend in acidity on storage period of 135 days.

Singh and Kumar (1995) studied on processing of aonla (*Emblica officinalis* Gaertn.) fruits. The aonla jam containing 45 per cent aonla pulp, 68 per cent total soluble solids and 0.5 per cent acidity was found for ideal organoleptically.

Aina and Adesina (1991) carried out an experiment on quality attributes of jam were prepared from low-usage tropical fruits. High-solids jams prepared from star-apple (*Chryophyllum albidium*) and African plum (*Spondias mombin*). Jams showed storage stability at ambient conditions and sensory evaluation indicated preference to star-apple jams as compared to the plum jams.

Bhatnagar (1991) reported on utilization of watermelon rind for jam making. Jam with low acid and pectin content was highly acceptable in organoleptic assessment. However, mixed jam had high acid and pectin content with better consistency, flavour and colour. Keeping quality of jam was reasonably good under ambient storage conditions for a period of six months.

Uddin and Hoque (1991) took an experiment on development of shelf-stable papaya products. Jam was prepared from ripe and green papaya alone and in combination with mango pulp and pineapple juice. According to sensory evaluation, the jam prepared from green papaya was of excellent quality. The jam prepared from papaya was shelf-stable at the ambient temperature up to twelve months.

Tripathi *et al.* (1988) took an experiment on comparative compositional changes in amla jam. They observed that an increasing trend in TSS, acidity, reducing sugars and total sugars during storage of amla jam.

Sawaya *et al.* (1983) reported on processing of three major Saudi Arabian date cultivars into jam. Physico-chemical tests indicated that all the jams confirmed to the desired product standards. Sensory evaluation tests showed that acceptable jam could be prepared from the 'Khudari', 'Sullaj' and 'Sifri' date cultivars.

2.1.3 Jelly

Fruit preserves are popularly consumed in many households irrespective of income pattern in India and the consumption is likely to increase in future (Sawaya *et al.*, 1993).

Among preserves, fruit jelly possesses delicacy and is considered to be a fancy item. However, it is rarely produced in fruit factories due to inadequate technical know-how about exact/proper gel forming conditions. But, the global demand for such product is rising as the affluent consumer in domestic and advanced countries demands products with better nutrition.

Kumbhojkar *et al.* (2006) studied on preparation of prophylactic jelly from kokum. The best consistency and sensory attributes were attained without addition of any synthetic colour with proportion of 20 per cent sugar, 0.25 per cent pectin and 0.125 per cent citric acid.

Neelima and baby (2006) carried out an experiment on development of whey based fruit jelly. They standardized the ratio of whey to pulp (10:3) in the product development of apple and guava. The data revealed that the overall acceptability was good on evaluation of 15 days and one-month storage period.

Masoodi *et al.* (2005) conducted an experiment on guava jelly and reported a slight increase in total sugars content during storage.

Jadhav *et al.* (2004) studied on preparation and storage of karonda products. The raw karonda jelly showed an increasing trend in the total soluble solids during storage period. The higher organoleptic score was recorded by raw karonda jelly as compared to raw and ripe karonda products.

Singh *et al.* (2004) noted on storage stability of barhal (*Artocarpus lakoocha* Roxb.) products. They observed slight increase in TSS and acidity after two months storage in barhal jelly. Jelly was acceptable up to four months at ambient temperature.

Chopra *et al.* (2003) worked on preparation of jelly from wood apple (*Limmonia acidissima*) fruit. They found the pectin extract slice-water mix in a ratio of 1:3 produced jelly with the best quality. It possessed 68 per cent TSS and 1.24 per cent acidity as citric acid. Jelly thus prepared was found acceptable up to five months of storage at room temperature.

Saikia *et al.* (2002) conducted an experiment to prepare a jelly from carambola fruit (*Averrhoa carambola*) and to evaluate its quality changes during storage. An increasing trend was observed in reducing sugars and total sugars. The jelly was ranked very well in organoleptic evaluation.

Kalarani (2000) carried out an experiment on chemical evaluation of custard apple jelly. And recorded an increasing trend in acidity and reducing sugar content during 90 days of storage at room temperature.

Yousif and Alghamdi (1999) worked on suitability of some date cultivars for jelly making. The results showed that the 50/50 date juice/sugar ratio gave the best jelly. The storage at room temperature up to 32 weeks made marked changes in the

sugar composition. They reported that 32 weeks stored date jelly was still acceptable.

Barwal and Kalia (1998) took an experiment on comparative study of jellies prepared from apple, pomace and concentrate. Results showed that jelly prepared from fruit extract obtained highest scores for colour, flavour, taste and overall acceptability and the texture of pomace jelly was significantly better in comparison to fruit and concentrate jellies.

Aggarwal *et al.* (1997) took an experiment on standardization of jelly preparation from grape: guava blends. They revealed that grape: guava blend in the ratio of 40:60 scored the highest for colour, flavour, consistency and overall acceptability by sensory evaluation.

Uddin and Khanom (1992) reported on comparative studies on single and mixed fruit jelly preparation. From the results of the taste panel, it was concluded that the excellent jellies could be prepared from guava alone and mixture of guava and pineapple juices in the ratios of 25:75, 50:50 and 33:67.

Uddin and Hoque (1991) took an experiment on development of shelf-stable papaya products. Jam was prepared from ripe and green papaya alone and in combination with mango pulp and pineapple juice. According to sensory evaluation, the jam prepared from green papaya was of excellent quality. The jam prepared from papaya was shelf-stable at the ambient temperature up to twelve months.

Yousif *et al.* (1990) conducted an experiment on processing, evaluation and storability of date jelly. They observed significant decrease in pH and a slight increase in total sugars of date jelly after four and six months of storage. Results of the organoleptic and chemical evaluation revealed the possibility of processing and storing date jelly up to six months without affecting their good quality attributes.

Jarut (1989) reported on fresh jelly prepared from passion fruit. The most acceptable ratio of agar and pectin was 1:2 and use of 1.2 per cent of this mixture in jelly gave the most acceptable quality.

Yousif *et al.* (1987) worked on the possibility of processing jelly from Saudi dates. The pH and °Brix values for the prepared date jellies were conformity with Saudi standards for jellies (SASO, 1980). The results showed that the prepared date jellies possessed high quality attributes and were well accepted by panel members.

Joshi *et al.* (1985) worked on utilization of curd whey for the preparation of fruit jelly. The product was evaluated for the taste, colour, transparency and consistency by serving to judging panel. Guava jelly showed good consistency when 1.5 parts of water/whey was used.

Shah and Bhatia (1983) carried out an experiment on processing of culled apples and observed an increasing trend in

acidity and reducing sugar during storage of jelly prepared from culled apples.

2.2 Rose

2.2.1 Rose general

Rose belongs to the family Rosaceae and genus Rosa, an ancient word adopted from Greek Word Rodon (Red) and was so called because of its excellent fragrance. Roses are being cultivated from ancient times in France, Cyprus, Greece, India, Iran, Italy, Morocco and Bulgaria for the production of perfume. In India, several species are found growing wild mostly in Himalayan ranges. The cultivation of roses was perhaps taken up during the Mughal period. Babar introduced Persian or Damask rose in 1526. The Edoward Rose (*R. bourbaniana*) was introduced in 1840 during the British rule. These two roses viz., Damask and Edoward are highly scented and are being extensively cultivated in our country. Their cultivation is concentrated at Aligarh, Kannauj, Ballia and Jaunpur in U.P., at Haldi Ghati and Pushkar in Rajasthan, near Chandigarh in Punjab and in Tamil Nadu. These two varieties are grown mainly for rose Attar and other products, gulkand, gulabjal, etc. (Dashora *et al.*, 2006).

2.2.2 Rose content

Rose flowers contain sugar, essential oil, resin, tannic acids, gallic acids, quercetin, tartaric acid. The flowers are astringent, appetizer, refrigerant, cardiac tonic, laxative and carminative (Bhatt *et al.*, 2000).

2.2.3 Rose products

Rose flower is important from commercial point of view. Many industries are based on rose manufacturing Gulkand, Rose water, Rose oil and Sharbat (Rose syrup), etc. (Dashora *et al.*, 2006).

Bhatt *et al.* (2000) took an experiment on flowers employed as gulkand in medicine. They revealed that the gulkand prepared from rose is abundantly employed in leucorrhoea, toxemia, constipation, piles, sore throat, fever and burning urination.

Singh *et al.* (1993) carried out an experiment on evaluation of rose syrup prepared from different cultivars and varying ingredients and observed that Sweet Sultan and Miss All are best suitable for syrup. Rose syrup containing 10 % rose extract, 1.2 % acidity and 65 % TSS was acceptable during five months of storage.

2.3 Medicinal herbs and spices

2.3.1 General

Spices are common ingredients used for primary purpose of adding flavour to food. Some of the spices also inhibit the growth of micro-organisms (Gupta *et al.*, 2009).

Herbs and spices are safe and are used in control of many disease. In today's world, consumer's demand foods that are natural and have a reasonable keeping quality with assured quality.

They prefer preservation of foods with natural preservatives instead of artificial preservatives as they former can inhibit microbial growth, inactive them in foods. This natural, antimicrobial herbs and spices are also cheap, effective at low doses, stable on storage, reduce the loss of food and are less severely damage by heat processing or freezing. Since in practice many of these compounds are use in combination, they may exert a synergistic effect with other bio-preservatives (Sen and Sanyal 2008).

2.3.2 Medicated and spices products

Patel and Vaghani (2008) studied the effect of sapota blend by using fruit blend I (500 g), spices blend II (20 g), sugar (500 g/kg) and containing citric acid (5 g) and packed in glass bottles. The herbal jam was found most stable with excellent score for taste, flavour, colour, appearance, texture and overall acceptability during the storage of six months. There was also an increasing trend in TSS, total sugars, reducing sugars and acidity whereas, decreasing trend in non-reducing sugars and pH throughout storage period.

Patel *et al.* (2006) prepared prophylactic jam by addition of 50 per cent aloe-vera pulp and 50 per cent pineapple pulp and recorded protein content 2.31 per cent, crude fiber 0.09 per cent, minerals 0.24 per cent, carbohydrates 70.36 per cent, folic acid 20 μg and vitamin C 45 mg/100 g.

Singh *et al.* (2005) studied on processing of aonla (*Emblica officinalis* Gaertn.) fruits. The data on organoleptic evaluation revealed that herbal jam containing 50 per cent aonla pulp + 5 per cent asparagus + 2 per cent ashwagandha extract with 68 per cent TSS and 1.2 per cent acidity was found to be the best.

Deka and Sethi (2001) prepared RTS spiced beverages from blended fruit juices of lime-aonla, mango-pineapple, grape-mango and grape-pineapple with addition of various spice extracts and commercial spice drops. The spiced lemon-aonla (95:5) RTS beverage with salt [common salt (0.5%) + black salt (0.5%)], aqueous spice extracts of curry leaf (0.5%), cumin (0.5%), cardamom (0.25%), black pepper (0.25%), Ginger (2%) and mint (0.4%) was found best among all the beverages likewise mango-pineapple (85:15) with cardamom spice drop (0.006%) was found best among the RTS beverages prepared from commercial spice drops.

Gowda *et al.* (1995) used different additives and spices such as salt, sugar, citric acid, ginger extract, cardamom, cinnamon, garlic and pepper extract individually and also in different combination or adjustment of total soluble solids (TSS) of the juice to different levels (12-20° Brix) were studied in the preparation of RTS from watermelon fruits. The consistency, flavour and overall acceptability of the juice were significantly improved by adjustment of TSS 15° Brix acidity 0.3% along with 0.3% ginger extract.

2.4 Fruits blending

Sharma *et al.* (2009) prepared blended jam from seabuckthorn and apple (65:35) and recorded the highest organoleptic score (8.34) with shelf life of 90 days during storage.

Basu *et al.* (2008) conducted an experiment on preparation of mixed jam using ber, loquat and papaya. They revealed that among the mixed jam loquat, ber and papaya in 0.4: 0.4: 0.2 ratio resulted in most optimum jam for their overall acceptability.

Desai and Vaghani (2007) observed that among various treatments, the best and most acceptable mixed fruit sapota jelly was prepared with 30:70 (sapota: papaya) blending containing citric acid (@ 6 g/kg), pectin (@ 25 g/kg) and packed in glass bottles recorded a most stable product with excellent score for taste, flavour, colour, appearance and overall acceptability for 10 months of storage.

Deka *et al.* (2005) prepared mango pineapple spiced beverage from 'Dasheri' mango and 'Kew' pineapple. 15 % blended juice (85:15) were used for preparation of RTS beverage having 10° Brix, 0.2% acidity and 0.006% cardamom spiced drops. The RTS beverages were stored in bottles for six months. A decreasing trend was found in total soluble solids, reducing sugars, total sugars and NEB.

Ahmad *et al.* (2004) noted on development of fruit bar prepared from tomato and papaya. They reported that fruit bar



prepared from mixed pulp of papaya and tomato in the ratio of 70:30 showed an increasing trend in TSS and acidity and decreasing trend in pH after three months storage. The results of sensory evaluation showed that product was better in terms of colour, aroma, taste and texture.

Alexander and Badrie (2004) carried out an experiment on incorporating of papaya in low sodium carambola hot sauces. The results of sensory evaluation showed that incorporation of papaya in the 20 or 50 per cent ratio gave the better quality product.

Matsuura *et al.* (2004) reported on sensory acceptance of mixed nectar of papaya, passion fruit and acerola. The result of sensory evaluation showed that the nectar produced with 37.5 per cent papaya pulp, 7.5 per cent passion fruit juice, and 0.5 per cent acerola pulp, added with 15 per cent sucrose were found to be most acceptable. The sensory acceptance of nectars was positively affected by increase in the concentrations of papaya pulp.

Venilla (2004) conducted an experiment on the storage behaviour of guava- papaya fruit bar. The guava- papaya (50:50) fruit bar found to be best in sensory characteristics. The product showed an increasing trend in reducing sugar and acidity whereas, decreasing trend in pH during six months of storage.

Jadhav *et al.* (2002) studied on preparation of sapota milk shake. This study was conducted to determine the acceptability of sapota milk shake with different concentrations

(10, 20 and 30 per cent) of sapota pulp. Results showed that the scores for colour and appearance decreased with increasing level of sapota pulp. Increasing the level of sapota pulp resulted in increased viscosity, which was not preferred by the judges.

Imungi and Choge (1996) took an experiment on acceptability of mixed fruit nectar. The most acceptable nectar blends in order of their decreasing ranking were passion fruit + papaya (10+ 90), mango + papaya (10+ 90) and pear + papaya (10+ 90). Such blends should be affordable and would have higher nutritional value than popular soda beverages.

Aruna *et al.* (1992) prepared carrot based RTS beverage and found doable pasteurization at 80° C for 5 minutes to be most effective, the product was found to have a shelf life of more than 6 months in glass bottles. The TSS, total sugar and pH decreased and acidity increased during storage.

The blending of fruits could be an economic requisite to utilize profitably some fruit varieties for processing, which may not otherwise favourable characteristics including cost, for product preparation. Secondly, the objective could be to supplement appearance, nutrition and flavour. Thirdly, one could simply think of new product development through blending (Karla *et al.*, 1991).

Ahmed (1991) noted on watermelon products. Shelf life and consumer acceptability of ready-to-serve (RTS) prepared by blending watermelon juice with sapota pulp at 10 per cent level was studied. The product was analyzed organoleptically at an

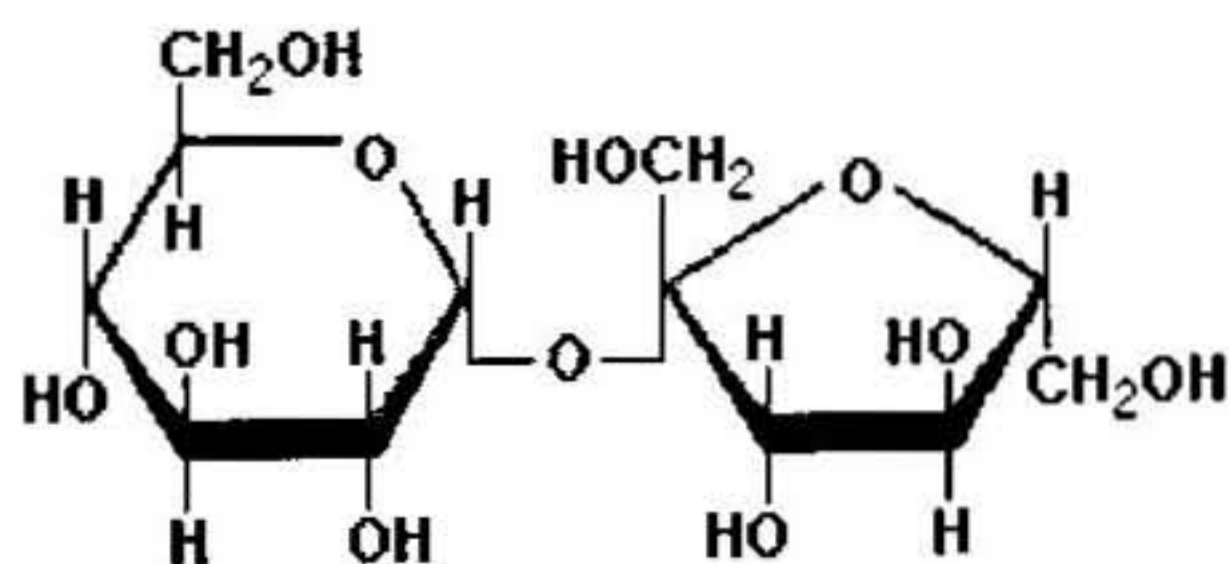
interval of three months and was found highly acceptable up to nine months.

Karla *et al.* (1991) took an experiment on evaluation of mango-papaya blended beverage. The study indicated that 25-33 per cent papaya could be incorporated in mango without affecting the quality and acceptability of the mango-papaya beverage after twelve months storage.

Uddin and Hoque (1991) carried out an experiment on development of shelf-stable papaya products. According to sensory evaluation, the papaya squash prepared from ripe papaya alone and in combination with pineapple and mango pulps were of excellent quality.

Tomar *et al.* (1988) conducted an experiment on the preparation of diabetic jelly. The results of organoleptic evaluation showed that the treatments in which the raw papaya extract and guava extract (each 50 per cent) + sorbitol (30 per cent) + citric acid (0.3 per cent) were used, adjudged the best.

2.5 Sugar



Generally, cane sugar (sucrose) of good quality is used in the preparation of jams. The proportion in which it is added

depends not only on the quantity of fruit, but also on its acidity and degree of ripeness. Sweet fruits require less sugar than tart fruits do. Generally, quantity added should be adequate to give the maximum strength to the pectin-sugar-acid gel. To ensure a minimum of 68.5 per cent in the jam, 24.9 kg of sugar is required for every 20.4 kg of fruit taken. The finished jam should contain 30 to 50 per cent invert sugar (Lal *et al.*, 1998).

Gaur *et al.* (2005) studied the manufacture of ber and loquat. They prepared the ber jam with different pulp:sugar ratio (1:0.7, 1:0.8 and 1:0.9). The expended results revealed that pulp:sugar ratio of 1:0.8 was found most acceptable in regards to colour (6.2), odour (7.8), taste (5.8) and overall acceptability (5.8) than the pulp:sugar ratio for 1:0.7 was found less acceptability in respect to 5.8, 5.0, 4.8 and 5.0 respectively. Whereas, the jam prepared by loquat with different pulp:sugar ratio (1:0.7, 1:0.8 and 1:0.9). Among these, pulp:sugar ratio of 1:0.9 was found to be most acceptable in regards to colour (7.71), odour (6.5) taste (7.6) and overall acceptability (7.50) compared to pulp:sugar ratio of 1:0.7 was recorded less acceptability with 4.00, 4.60, 4.57 and 4.25, respectively.

Koli *et al.* (2004) carried out an experiment on the preparation of sapota jam with various level of sugar (0.750 and 1.000 kg) and the product was stored at ambient temperature ($30 \pm 1^{\circ}\text{C}$) for 90 days. Among these, 1.000 kg of sugar per 1 kg pulp had better acceptability, recording TSS 69.06 to 70.14°Brix, acidity 0.51 to 0.61%, reducing sugar 36.23 to 40.35%, total sugar

64.30 to 66.21%, colour and appearance (8.10-7.07), texture (7.80-7.27), flavour (8.00-7.20), taste (8.00-7.00) and acceptability (8.00-7.13). When 0.750 kg of sugar per 1 kg pulp was used had less acceptability, recording 69.59 to 70.48°Brix, 0.53 to 0.62%, 40.98 to 47.11%, 61.42 to 63.25%, 7.90-7.07, 8.00-7.17, 7.80-7.10, 7.80-6.93 and 7.80-7.10, respectively.

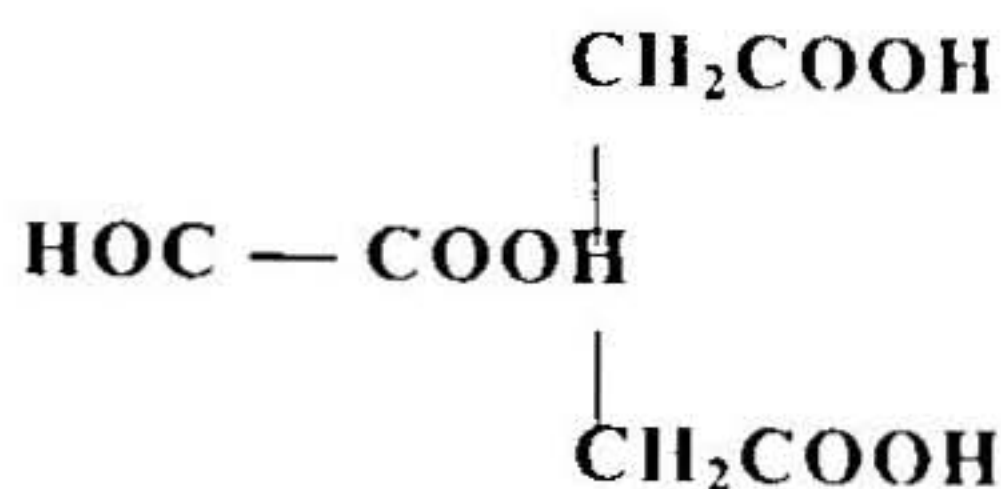
Saravanan *et al.* (2004b) studied the storage behaviour of papaya jam with respect to sugar level (1, 0.75 and 0.60 kg). The product was stored at room temperature ($25 \pm 5^{\circ}\text{C}$) for 90 days. The result revealed that 1 kg of sugar per kg pulp had excellent organoleptic qualities for colour (8.40-8.24), appearance (8.20-8.00), aroma (7.80-7.60), texture (8.00-7.80), taste (8.42-8.22) and overall acceptability (8.42-8.22) and recording TSS 70.00 to 73.00°Brix, total sugar 67.15 to 67.46%, reducing sugar 10.31 to 30.02% and non-reducing sugar 56.83 to 37.44% during storage period compared to 0.60 kg of sugar per 1 kg pulp had minimum organoleptic qualities for 8.00-7.80, 7.80-7.60, 7.50-7.30, 7.70-7.80, 7.70-7.40 and 7.80-7.60, respectively and recording 56.50 to 58.70°Brix, 54.81 to 54.91%, 8.41 to 25.22% and 46.40 to 29.69%, respectively.

2.6 Citric acid

2.6.1 General:

Citric acid is a most tricarboxylic acid formed in the cells of plants and animals in a sequence of reactions known as the Krebs's cycle; it acts as a catalyst of tissue oxidation obtained by

fermentation of molasses and used in foods as an antioxidant and acidulant.



It is most commonly used in food and pharmaceutical industry. It is widely used in preparation of beverages, jams, jellies, marmalades and confectionary (Lal *et al.*, 1967; Lawrence, 1974 and Chundawat and Sharma, 1978). In USSR, it is also widely used in fruit concentrate, kissel powder, stewed fruits, some sauces, pickling and mixed salad.

2.6.2 Function and mechanism of action:

Many beneficial effects of citric acid have been reported during the preservation of many fruit products. It has been reported to impart flavour and balances sugar: acid ratio (Swisher and swisher, 1967); known to improve the colour and retard browning (Somoyogi and Luh, 1975) and known for its preservative properties in minimizing spoilage (Swisher and swisher, 1967) by functioning as an antioxidant in food spoilage (Potter, 1978, 1980; Lawrence, 1974 and Ockerman, 1978). Citric acid is a necessary constituent of fruit jellies. It is used to obtain proper gelation and to bring out the fruit flavour. Good pectin gels are obtained only within the narrow pH limit. The acids are added after the cooking to minimize sucrose inversion which hinders

crystallization and increases the sweetness (Swisher and Swisher, 1967); also minimize the hydrolysis of the pectin. Citric acid acts as a preservative (Lal *et al.*, 1967) resulting in the improvement of palatability and appearance of the product (Lawrence, 1974) and gives excellent taste. Citric acid reacts with the metal ion and binds it, thereby prevents metal catalysis of oxidative reaction (Swisher and Swisher, 1967 and Potter, 1978, 1980) and helps in better preservation of the product.

2.6.3 Application:

The fibrils of the pectin become tough in the presence of acid, and this becomes able to hold sugar in solution in the inter fibrillar spaces. On the other hand, if a large amount of acid is present, the fibrils lose their elasticity with the result that the product becomes syrupy. Citric acid has a preservative action helps in extending shelf life of the product; it also imparts characteristic taste and flavour. It also helps in controlling the sugar inversion process in various products like amla jam (Tripathi *et al.*, 1988), date jelly (Yousif and Alghamdi, 1999), custard apple jelly (Kalarani, 2000), jamun jam (Kannan and Thirumaran, 2001), kinnow jam (Sogi and Singh, 2001), carambola jelly (Saikia *et al.*, 2002), in sapota jam (Koli *et al.*, 2004) and pear jelly (Sudhagar *et al.*, 2005).

2.7 Glass bottle

2.7.1 General

Glass has been defined (ASTM C 162) as an amorphous, inorganic product of fusion that has been cooled to a rigid

condition without crystallizing. It was formed naturally from common elements in the earth's crust long before the world was inhabited. The first glass vessels were probably sculpted from solid blocks about 3000 B.C. In about 1000 B.C. the techniques of pouring molten glass or winding glass threads over a sand mold were developed. However, real revolution in glassmaking came around 200 B.C. By 200 A.D. glassware was fairly used in Roman households. During the following 100 years, glassmaking techniques spread over Europe. Glass remained expensive until improved techniques in the 18th and 19th centuries brought down the price to a relatively affordable price. However, mechanization of glass container manufacture was introduced on large scale in 1892 (Hanlon, 1984), and several developments occurred over the next few decades. The first fully automated machine for bottle making was designed and built in 1903 by Michael J. Owens.

2.7.2 Function and mechanism of action

The aim of packaging foods is to protect them against spoilage and to preserve the quality. It is known that glass is an excellent packaging material which is totally inert, impermeable to moisture and gases, thus making it an ideal material for packing food products (Narayanan, 2000).

2.7.3 Application

Glass packaging is better suited than PET for preserving the flavour and freshness of the content because it has higher chemical durability and less its porous (Sanker, 2000). The better

quality product packed in glass material was found in several products *viz.*, phalsa juice (Khurdiya and Anand, 1981), phalsa syrup (Waskar and Khurdiya, 1987), galgal juice concentrates (Sharma *et al.*, 2001), orange juice (Barlinet *et al.*, 2003) and pear jelly (Sudhagar *et al.*, 2005).

MATERIALS & METHODS

III. MATERIALS AND METHODS

The present investigation on “Standardization of blended *gulkand* based on sapota [*Manilkara achras* (Mill.) Fosberg] fruits” was carried out at the Department of Process Technology, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during 2008-2009 with the following objectives:

1. To explore the possibility of *gulkand* based on sapota to avoid post harvest losses and to get a value added process product.
2. To assess the effect of different blending, chemicals on the storage life and quality of *gulkand*.

3.1 Experimental location

Navsari campus of the Navsari Agricultural University, where this investigation was carried out at which is situated on the coast of Arabian Sea at 20° – 57' N latitude and 72° – 57' E longitude with an altitude of about 13 meters above the mean sea level. The campus is about 12 km away from the great historical place Dandi, on the Arabian seashore.

3.2 Experimental material

The fresh, uniformly matured sapota with uniform sized, cented rose flowers (red and pink) and medicinal herbs like cardamom, funnel, liquorice, *chanothi leaves* (Crab's eye), *brahmi* (Indian pennywort), asparagus, long pepper's roots formed the experimental material. They were procured from local

wholesale market. Over matured or under matured sapota and blemished rose petals were discarded. Selected materials were loaded in special type of plastic crates and brought to the laboratory by smooth drive and carefully unloaded.

3.3 Ripening of sapota fruits

The sapota fruits were arranged on wooden platform of the laboratory and covered with gunny bags for ripening. After sapota ripened, bags were removed. Firm ripened sapota were selected for the experiment.

3.5 Experimental details

The experiment on "Standardization of blended *gulkand* based on sapota fruits" was laid out in CRD (Completely Randomized Design) with three repetitions and ten treatments as detailed below.

Treatment details:

- T₁ Sapota + Pink rose (100: 900), 78 °Brix
- T₂ Sapota + Pink rose (150 : 850), 78 °Brix
- T₃ Sapota + Pink rose (200: 800), 78 °Brix
- T₄ Sapota + Red rose (100: 900), 78 °Brix
- T₅ Sapota + Pink rose + Red rose (100: 650 : 250), 78 °Brix

- T₆ Sapota + Pink rose + Red rose + Medicinal herbs* (100: 650 : 250 : 50), 78 °Brix
- T₇ Sapota + Pink rose + Medicinal herbs* (100: 850: 50), 78 °Brix
- T₈ Sapota + Pink rose + Citric acid (100: 900: 5), 78 °Brix
- T₉ Sapota + Pink rose + Citric acid (100: 900: 10), 78 °Brix
- T₁₀ Sapota + Pink rose (100 : 900), 70 °Brix

*** Medicinal herbs:**

Cardamom	: 20 g
Funnel	: 20 g
Liquorice	: 20 g
Chanothi leaves	: 20 g
Brahmi	: 5 g
Asparagus	: 5 g
Long pepper	: 5 g

3.5 Selection of sapota fruits

The well ripened healthy sapota fruits with firm and sound texture having good flavour were selected. Damaged, infected and over ripe fruits were discarded. Then fruits were thoroughly washed with clean tap water to remove any surface dust and dirt.

3.4 Selection of rose flowers

Fresh rose petals were selected and the blemished and off coloured were discarded if any. Also removed all dirt, pollen and other debris from petals.

3.6 Preparation of *gulkand*

Fresh rose flower petals were used for the preparation of *gulkand*. Whereas, sapota fruits were peeled with stainless steel knife and cut into small pieces by removing the central white fibrous portion and seeds. The slices were homigenised in the high speed blender and thoroughly mixed with desired quantity of petals. The calculated quantities of petals smeared with sapota pulp and sugar as per treatment were arranged in alternate layers in a wide mouth glass jar. The mouth of *gulkand* jar was tied with muslin cloth and placed in sun light for impregnation of sugar into petals. The TSS of mixture was raised by 5°Brix every day, till the desirable Brix (70 and 78 %) achieved as per treatment. On completion of product, medicinal herbs, citric acid were mixed well and TSS was adjusted as per treatments.

3.7 Filling and closing of jars

The wide mouthed glass jars were filled with prepared *gulkand* leaving 2-3 cm head space. The jars were then covered air tightly with lids. The jars were wiped out with wet cloth followed by wiping with clean and dry cloth. They were then labeled appropriately with details of treatment, date, repetition,

serial number and stored under ambient condition for periodical observations.

3.8 Storage of product

The bottled *gulkand* was stored at an ambient temperature (22 to 35°C). These were then subsequently used for periodical evaluation at three months interval for a period of nine months.

3.9 Methodology of observation

The methodology adopted in recording observations of products prepared is detailed below. The first observation was recorded immediately after product preparation followed by subsequent observations at an interval of three months until nine months of storage.

3.10.1 Total soluble solid (° Brix)

The total soluble solids (TSS) in sample were measured with hand refractometer (Erma, Japan). The product was placed on prism and the reading were recorded and corrected at 20°C and presented as °Brix of TSS.

3.10.2 Reducing sugar (%)

The titrimetric method of Lane and Eynon described by Ranganna (1979) was adopted for estimation of reducing sugars. The method is based on principle that invert sugar or reducing sugars reduces the copper in the Fehling's solution to red insoluble cuprous oxide. Sugar in a sample was estimated by

determining the volume of unknown sugar solution required to completely reduce a measured volume of Fehling's solution. Before using the mixture (1:1) of Fehling's solution A and B was standardized against standard glucose for obtaining glucose equivalent and to arrive at a conversion factor.

Reagents used:

1. Fehling's solution A
2. Fehling's solution B
3. Lead acetate (45 %)
4. Methyl blue (1 %)

Procedure:

Known quantity of the sample was taken in a 250 ml volumetric flask and 2 ml of 45 per cent basic lead acetate solution was added for clarification. After 10 minutes, the solution was delead by adding potassium oxalate crystal in excess and the volume made up with distilled water. It was then filtered through Whatman No. 1 filter paper. The filtrate was taken in a burette and titrated against boiling Fehling's mixture (5ml of Fehling's A solution and 5 ml of Fehling's B solution) till the blue coloured faded. Then 1 ml of methyl blue indicator (1 %) was added and the titration was continued till the contents attained a brick red colour. At this stage the titre value was noted. Percentage reducing sugar was calculated adopting the following formula,

$$\text{Reducing sugar (\%)} = \frac{\text{Glucose eq. (0.05)} \times \text{Total volume made up}}{\text{Titre} \times \text{Weight of sample}} \times 100$$

3.10.3 Total sugar (%)

The total sugar of the filtrate were estimated by standardized Fehling's solution A and B using methyl blue indicator as per the procedure described below.

Procedure:

Known quantity of the filtrate was taken to which 5 ml of dilute hydrochloric acid (1:1) was added and the sample was left for inversion for 24 hours at room temperature. Then the solution was neutralized with 40 per cent sodium hydroxide using phenolphthalein as an indicator and the final volume was made up to 100 ml. The solution was filtrated then titrated against boiling Fehling's solution as described earlier. The percentage of total sugar was expressed as invert sugar according to following formula,

$$\text{Total Sugar (\%)} = \frac{\text{Glucose eq. of Fehling's solutions (0.05)} \times \text{Total volume made up} \times \text{Volume made up after inversion}}{\text{Titre} \times \text{Weight of sample taken} \times \text{Aliquot taken for Invesrsion}} \times 100$$

3.10.4 Non-reducing sugar (%)

It was obtained by substracting reducing sugar from total sugar.

$$\text{Non reducing sugar (\%)} = \text{Total sugar (\%)} - \text{Reducing sugar (\%)}$$

3.10.5 Acidity (%)

The method described by Ranganna (1979) was adopted for estimation of the acidity of *gulkand*. Known quantity of the sample was transferred to 100 ml volumetric flask and volume was made up with distilled water. The solution was well mixed and filtered through Whatman No. 1 filter paper and the titre was used for titration. 5 ml of the filtrate was taken in 100 ml conical flask and titrated against standard sodium hydroxide using phenolphthalein as an indicator. The titrable acidity was expressed in terms of percentage citric acid equivalent adopting following formula,

$$\text{acidity (\%)} = \frac{\text{Titre} \times \text{Normality of alkali} \times \text{Volume made up} \times \text{Eq. wt. of citric acid (0.64)}}{\text{Volume of sample taken for estimation} \times \text{Weight of sample} \times 1000} \times 100$$

3.10.6 pH

The glass electrode of pH meter was placed in *gulkand* bottle and the pH of the pulp was recorded.

3.10.7 Sensory evaluation

The sensory evaluation was organoleptically evaluated at the time of preparation and after every three months interval during nine months of storage. A panel of five judges did the sensory evaluation of the product in terms of colour, appearance, texture, taste, flavour and overall acceptability. Scoring was done

by allotting maximum of 10 marks for each character and for any score less than 5 the product was not acceptable.

3.10.8 Statistical analysis of data

The statistical analysis of data for the different characters studied during the investigation was carried out as per the procedure described by Panse and Sukhatme (1967). The method of analysis of variance for CRD was used. The treatment differences were tested by 'F' test of significance of the basis of null hypothesis. The appropriate standard errors (S.Em. \pm) were calculated in each case and the critical differences (C.D.) at 5 per cent level of probability were worked out to compare two treatment means wherever the treatment effects were significant.

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

The results of experiment entitled "Standardization of blended *gulkand* based on sapota [*Manilkara achras* (Mill.) Fosberg] fruits" conducted at the Post Harvest Technology Laboratory, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during 2008-2009 are presented in this chapter. The data collected during experimentation on various treatments during the storage period of nine months were subjected to statistical analysis using Completely Randomized Design. The results alongwith statistical inference are presented in this chapter.

4.1 Total Soluble Solids (%)

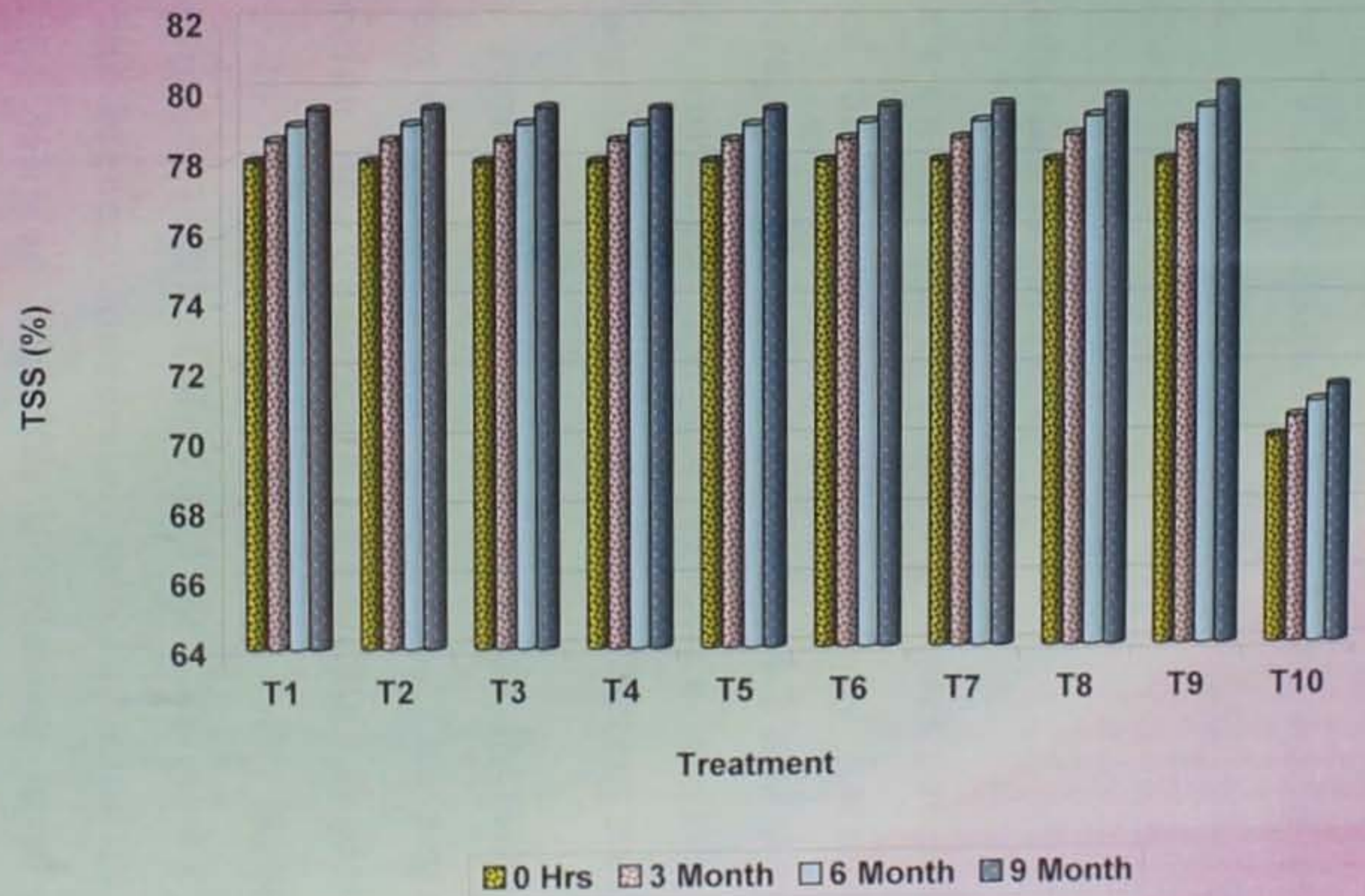
Data regarding changes in TSS content of blended *gulkand* based on sapota influenced by various treatments during the storage are presented in Table 4.1 and depicted in Fig. 4.1. The present data clearly revealed that the TSS content of *gulkand* was found significant during storage period.

In general, TSS content in *gulkand* increased significantly throughout the period of storage. However, pattern of this increase varied according to treatments. The increase has been from 77.20 per cent to 78.81 per cent. The highest increase in TSS per cent was recorded in treatment having optimum level of Brix (78 % TSS) and containing citric acid (10 g) as in T₉ (78.00 to 80.15 %) followed by treatment having lower level of citric acid (5 g) as in T₈ (78.00 to 79.83 %). Whereas, with

Table-4.1 Effect of various treatments on TSS (%) of blended *gulkand* based on sapota during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T ₁	78	78.59	79.03	79.48	78.77
T ₂	78	78.60	79.06	79.52	78.79
T ₃	78	78.61	79.07	79.54	78.80
T ₄	78	78.60	79.05	79.51	78.79
T ₅	78	78.60	79.04	79.49	78.78
T ₆	78	78.63	79.10	79.58	78.82
T ₇	78	78.64	79.12	79.62	78.84
T ₈	78	78.73	79.27	79.83	78.95
T ₉	78	78.86	79.52	80.15	79.13
T ₁₀	70	70.58	71.02	71.47	70.76
Mean	77.2	77.84	78.32	78.81	
S.E.m ±	0.087	0.097	0.138	0.161	
C.D. at 5 %	0.26	0.29	0.41	0.47	
C.V. %	0.19	0.22	0.30	0.35	

Fig -1 : Effect of various treatments on TSS (%) of blended *gulkand* based on sapota during storage



decrease in level of Brix (70 % TSS) showed low increase as in T₁₀ (70.00 to 71.47 %) being minimum during the storage period of 9 months. The experiment revealed has an interesting result with treatment containing medicinal herbs which had exhibited moderate increase in TSS per cent as in T₇ (78.00 to 79.62 %) and in T₆ (78.00 to 79.58 %). Similarly, with increased level of sapota (200 g) there was also little increase in TSS like T₃ (78.00 to 79.54 %).

4.2 Reducing sugars (%)

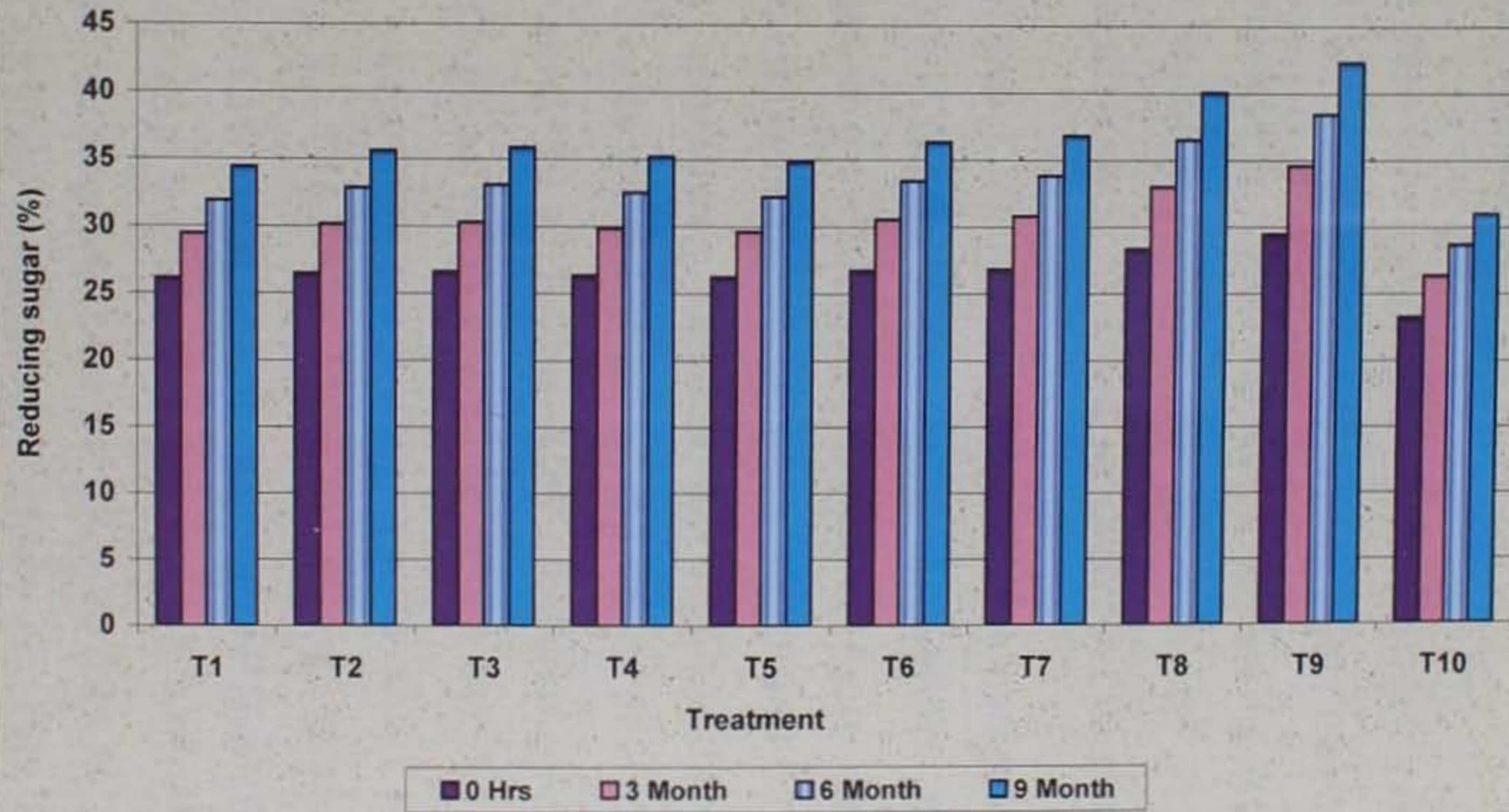
Data on changes in reducing sugars per cent of blended *gulkand* based on sapota as influenced by various treatments during the storage are furnished in Table 4.2 and depicted in Fig. 4.2. The data revealed that the reducing sugars per cent of *gulkand* was significantly influenced by different treatments.

In general, there was significant increase in reducing sugars per cent of *gulkand* during storage. The pattern of which varied according to treatments. Reducing sugars percentage varied from 26.45 to 36.25 per cent. In treatment which containing optimum level of Brix (78 % TSS) and citric acid (10 g) exhibited the highest conversion into reducing sugars as in T₉ (29.48 to 42.31 %) and with the decreasing level of sugar (70 °Brix) there was increase in conversion into digestive sugars were declined being lower in T₁₀ (23.26 to 31.04 %). The experiment has showed an interesting result with treatment containing medicinal herbs which had exhibited moderate increase in

Table-4.2 Effect of various treatments on reducing sugar (%) of blended *gulkand* based on sapota during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T ₁	26.11	29.43	31.91	34.40	30.46
T ₂	26.50	30.14	32.87	35.62	31.28
T ₃	26.63	30.33	33.11	35.90	31.49
T ₄	26.37	29.91	32.56	35.23	31.01
T ₅	26.25	29.63	32.25	34.83	30.74
T ₆	26.75	30.58	33.45	36.34	31.78
T ₇	26.84	30.83	33.83	36.83	32.08
T ₈	28.36	33.03	36.53	40.05	34.49
T ₉	29.48	34.61	38.45	42.31	36.21
T ₁₀	23.26	26.37	28.70	31.04	27.34
Mean	26.45	30.48	33.36	36.25	
S.E.m ±	0.177	0.198	0.229	0.306	
C.D. at 5 %	0.52	0.58	0.68	0.90	
C.V. %	1.15	1.12	1.19	1.46	

Fig- 2 : Effect of various treatments on reducing sugar (%) of blended gulkand based on sapota during storage



reducing sugars per cent as in T₇ (26.84 to 36.83 %) and T₆ (26.75 to 36.34 %). Accordingly, with increased level of sapota (200 g) there was also little increase in TSS like T₃ (26.63 to 35.90 %).

4.3 Total sugars (%)

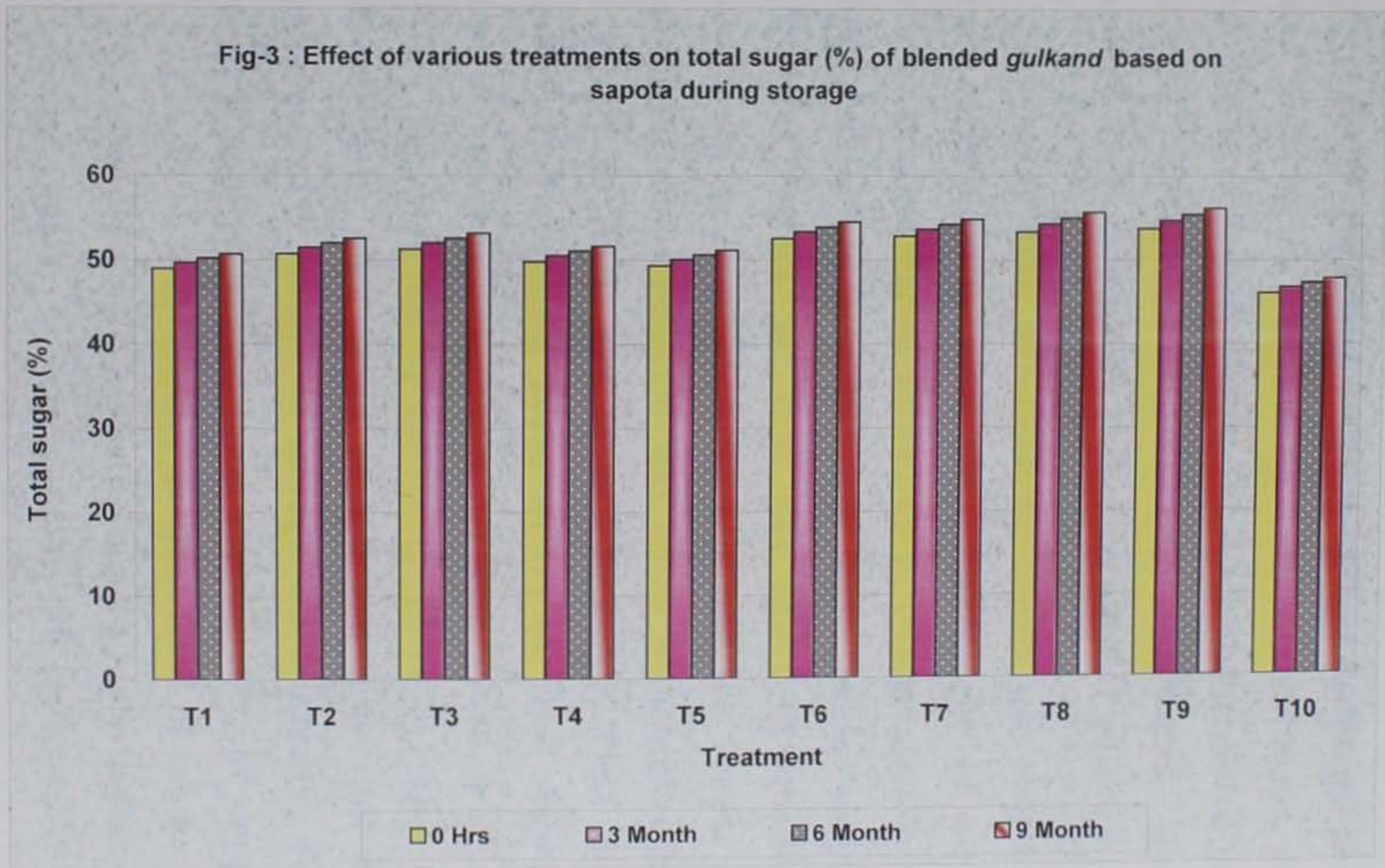
The data on changes in total sugars per cent of blended *gulkand* based on sapota affected by various treatments during storage are furnished in Table 4.3 and graphically depicted in Fig. 4.3. The data manifested that the per cent of total sugars of *gulkand* was significantly affected by different treatments.

In general, there was a significant increase in the level of per cent total sugars of *gulkand* throughout the period of storage, the pattern of which varied according to treatments. The per cent of total sugars varied between 50.87 and 52.84. Amongst the treatments containing 78 °Brix, the highest increase in total sugars per cent was recorded in T₉ (53.76 to 56.16 %) at higher level of citric acid (10 g) followed by treatment with lower level of citric acid (5 g) as in T₈ (53.35 to 55.70 %). This increase in TSS per cent was controlled with lower level of sugar (70 °Brix) being lowest in T₁₀ (46.08 to 47.86 %) during storage passage of 9 months. The experiment has showed an interesting result with treatment containing medicinal herbs which had exhibited little increase in total sugars per cent as in T₇ (52.84 to 54.87 %) and T₆ (52.56 to 54.52 %) respectively. However, rate of increase in total sugars was minimized with treatment containing lower level of sapota (100 g) having 78 °Brix as in T₁ (48.96 to 50.70).

Table-4.3 Effect of various treatments on total sugar (%) of blended *gulkand* based on sapota during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T₁	48.96	49.68	50.22	50.70	49.89
T₂	50.73	51.48	52.04	52.60	51.71
T₃	51.32	52.07	52.63	53.21	52.30
T₄	49.81	50.55	51.10	51.66	50.78
T₅	49.34	50.08	50.63	51.17	50.30
T₆	52.56	53.34	53.92	54.52	53.58
T₇	52.84	53.65	54.25	54.87	53.90
T₈	53.35	54.29	54.99	55.70	54.58
T₉	53.76	54.72	55.44	56.16	55.02
T₁₀	46.08	46.79	47.33	47.86	47.01
Mean	50.87	51.66	52.35	52.84	
S.E.m ±	0.186	0.228	0.305	0.372	
C.D. at 5 %	0.55	0.67	0.90	1.10	
C.V. %	0.63	0.77	1.01	1.22	

Fig-3 : Effect of various treatments on total sugar (%) of blended *gulkand* based on sapota during storage



4.4 Non-reducing sugars (%)

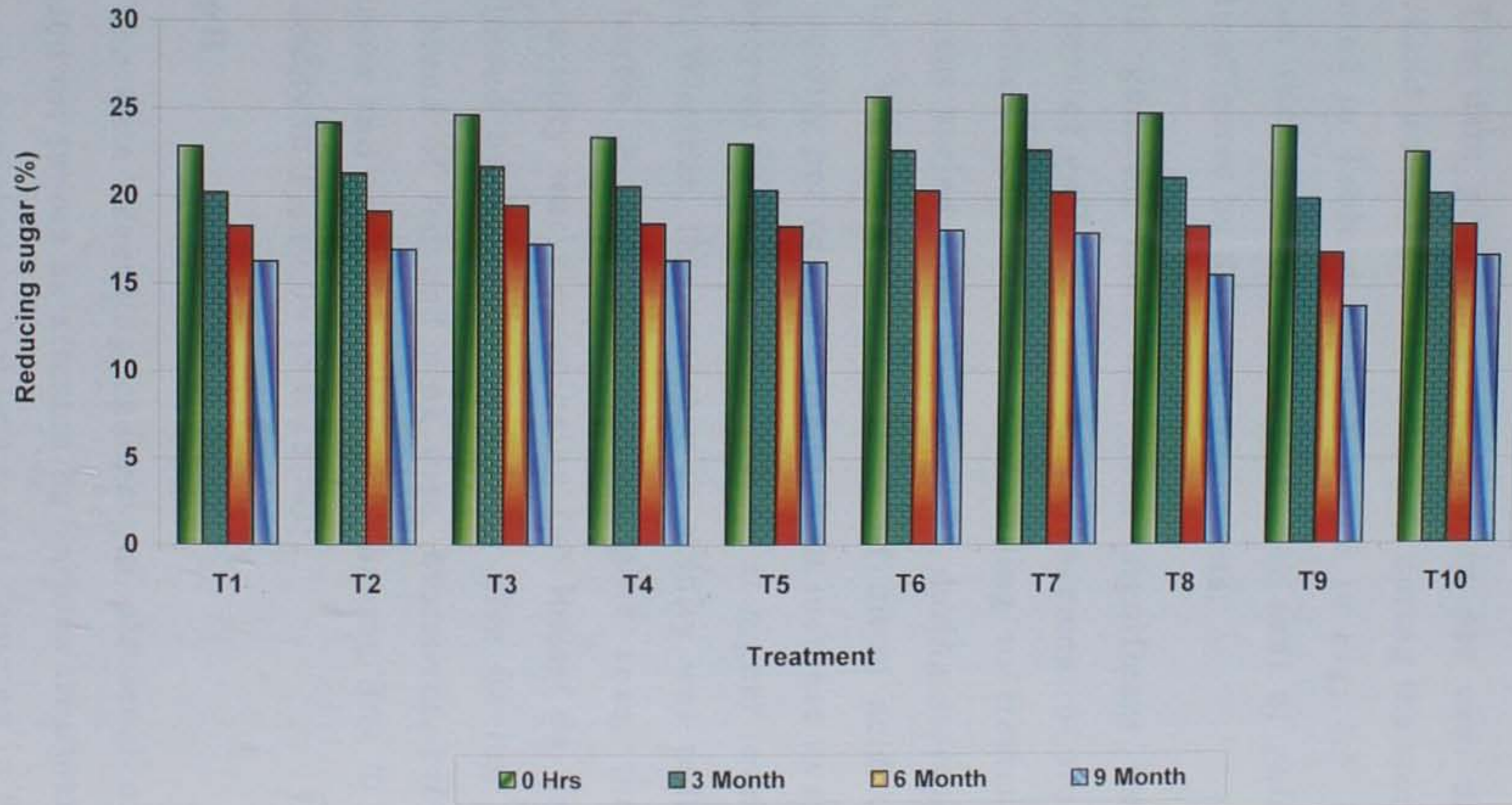
Data regarding changes in non-reducing per cent of blended *gulkand* as affected by various treatments during the storage are have been shown in Table 4.4 and depicted in Fig. 4.4. The data revealed that different treatments significantly influenced the non-reducing sugars per cent of *gulkand*.

In general, non-reducing sugars per cent of *gulkand* declined significantly with the advancement of storage, but pattern of decline varied according to treatments. This decrease has been from 24.22 % to 16.59 per cent. The decreasing trend in non-reducing sugars per cent was lower in treatment those contained higher level of citric acid and the lowest decline in non-reducing sugar per cent was noted with higher level citric acid (10 g) as in T₉ (24.28 to 13.85 %). When the *gulkand* prepared with medicinal herbs with pink rose showed highest decline in non-reducing sugars per cent found in T₇ (26.00 to 18.04 %) followed by T₆ (25.81 to 18.18 %) also containing medicinal herbs with blend of red and pink rose during the advancement of 9 months of storage. An interesting finding was observed that the treatments with higher levels of sapota (200 g) as in T₃ (24.69 to 17.31%) and medium level of sapota (150 g) as in T₂ (24.23 to 16.98%) showed comparatively higher decline in non-reducing sugars per cent as compared to their lower level of sapota (100 g) as in T₁ (22.85 to 16.30%).

Table-4.4 Effect of various treatments on non reducing sugar (%) of blended *gulkand* based on sapota during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T ₁	22.85	20.25	18.31	16.30	19.42
T ₂	24.23	21.34	19.17	16.98	20.43
T ₃	24.69	21.74	19.52	17.31	20.81
T ₄	23.44	20.64	18.54	16.43	19.76
T ₅	23.09	20.45	18.38	16.34	19.56
T ₆	25.81	22.76	20.47	18.18	21.80
T ₇	26.00	22.82	20.42	18.04	21.82
T ₈	24.99	21.26	18.46	15.65	20.09
T ₉	24.28	20.11	16.99	13.85	18.80
T ₁₀	22.82	20.42	18.63	16.82	19.67
Mean	24.22	21.17	18.88	16.59	
S.E.m \pm	0.087	0.086	0.110	0.110	
C.D. at 5 %	0.26	0.26	0.33	0.32	
C.V. %	0.62	0.71	1.01	1.15	

Fig-4: Effect of various treatments on non reducing sugar (%) of blended *gulkand* based on sapota during storage



4.5 Acidity (%)

The data pertaining changes in per cent acidity of blended *gulkand* under various treatments during the storage have been presented in Table 4.5 and depicted in Fig. 4.5. It can be inferred from the data that the acidity per cent of *gulkand* was significantly affected by different treatments.

In general, there has been significant increase in acidity per cent of *gulkand* with the advancement of storage. The pattern of which however varied according to treatments. The acidity per cent varied from 0.21 to 0.35 during storage passage of 9 months. With increase in level of citric acid there was increase in acidity per cent and the highest increase in acidity per cent was observed in T₉ (1.06 to 1.27 %) at higher level of citric acid (10 g). Whereas, this increase in acidity was reduced with medicinal herbs in combination with pink rose, the rate of increase in acidity was slower being the lowest in T₇ (0.06 to 0.17%) followed by T₆ (0.06 to 0.16%) also having medicinal herbs with blend of red and pink rose. Moreover, product with blend of sapota and pink rose (100:900) having Brix 70 % recorded slight higher acidity in T₁₀ (0.09 to 0.25 %).

4.6 pH

The data regarding changes in pH level of blended *gulkand* based on sapota as affected by various treatments during the storage are furnished in Table 4.6 and depicted in figure 4.6.

Table-4.5 Effect of various treatments on acidity (%) of blended *gulkand* based on sapota during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T ₁	0.06	0.13	0.17	0.20	0.14
T ₂	0.06	0.14	0.18	0.21	0.14
T ₃	0.06	0.14	0.20	0.22	0.15
T ₄	0.06	0.12	0.15	0.18	0.12
T ₅	0.06	0.12	0.16	0.19	0.13
T ₆	0.06	0.11	0.16	0.16	0.12
T ₇	0.06	0.11	0.17	0.17	0.12
T ₈	0.56	0.62	0.64	0.66	0.62
T ₉	1.06	1.21	1.25	1.27	1.19
T ₁₀	0.09	0.17	0.22	0.25	0.18
Mean	0.21	0.28	0.33	0.35	
S.E.m ±	0.006	0.010	0.011	0.011	
C.D. at 5 %	0.02	0.03	0.03	0.03	
C.V. %	4.53	5.93	5.67	5.48	

Fig-5: Effect of various treatments on acidity (%) of blended *gulkand* based on sapota during storage

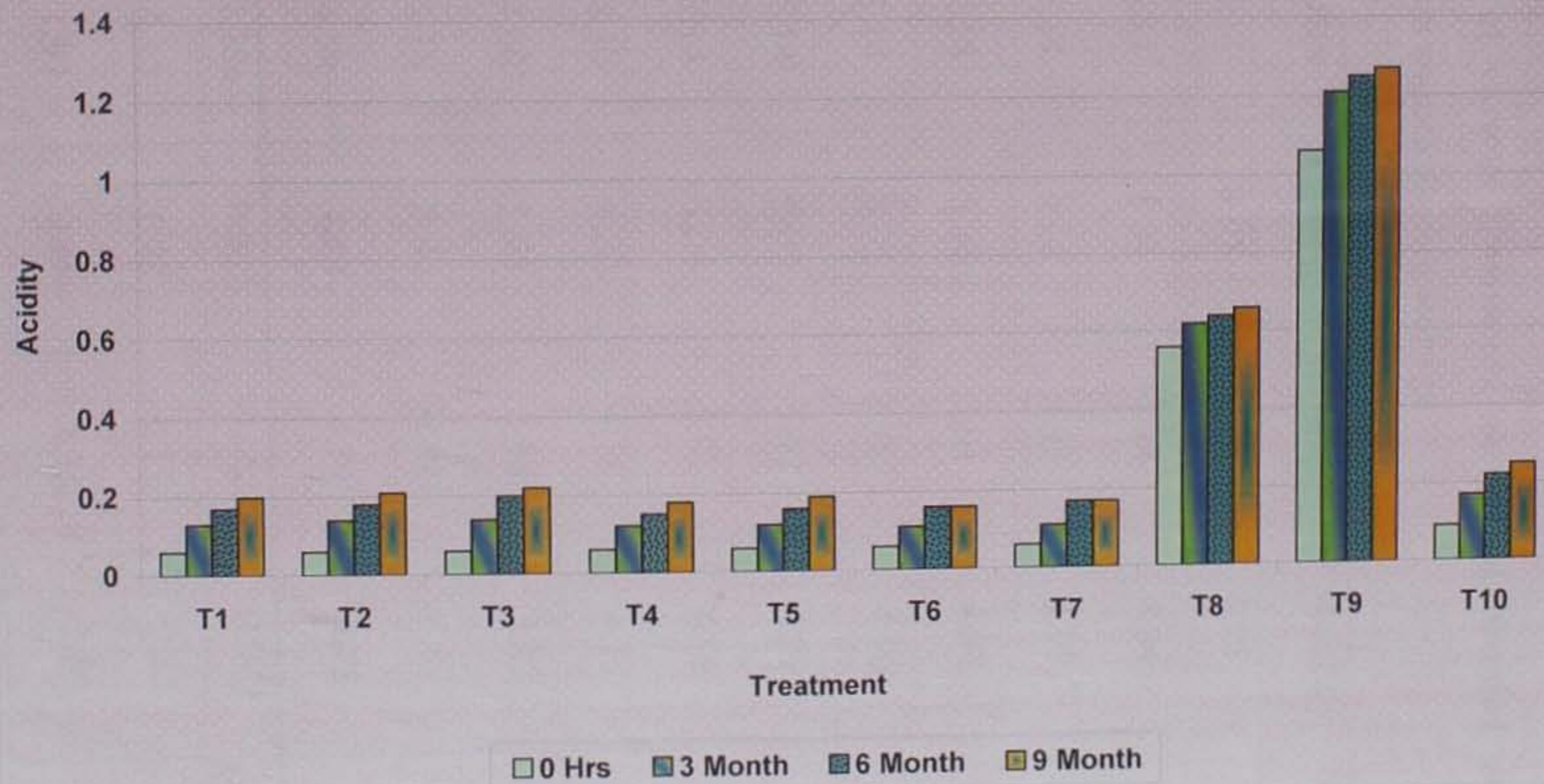
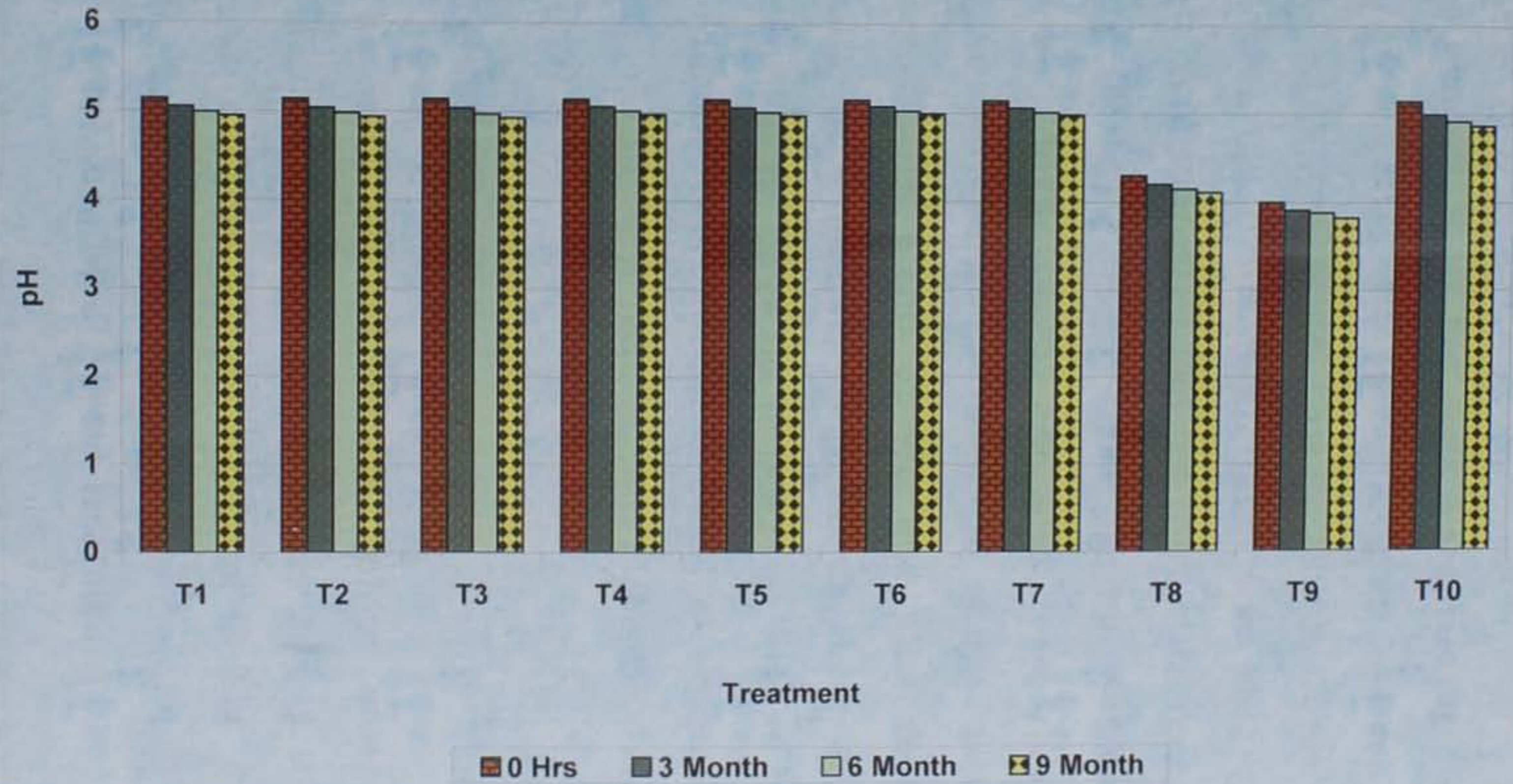


Table-4.6 Effect of various treatments on pH of blended *gulkand* based on sapota during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T ₁	5.14	5.05	4.99	4.95	5.03
T ₂	5.14	5.04	4.98	4.94	5.02
T ₃	5.14	5.04	4.97	4.93	5.02
T ₄	5.14	5.06	5.01	4.97	5.04
T ₅	5.14	5.05	5.00	4.96	5.03
T ₆	5.14	5.07	5.02	4.99	5.05
T ₇	5.14	5.06	5.01	4.98	5.04
T ₈	4.30	4.20	4.15	4.11	4.19
T ₉	4.00	3.91	3.88	3.82	3.90
T ₁₀	5.15	5.00	4.92	4.87	4.98
Mean	4.94	4.84	4.79	4.75	
S.E.m \pm	0.056	0.056	0.065	0.079	
C.D. at 5 %	0.17	0.17	0.19	0.23	
C.V. %	1.97	2.00	2.36	2.89	

Fig-6 : Effect of various treatments on pH of blended *gulkand* based on sapota during storage



The data indicated that the pH of *gulkand* was significantly influenced by different treatments.

In general, there has been a significant decrease in pH level of *gulkand* during storage. However, pattern of declined varied according to treatments. This decline has been from 4.94 to 4.75. The decreasing trend in pH level was observed when the level of citric acid increased and the lowest decrease in pH level was observed in T₆ (5.14 to 4.99) having medicinal herbs in combination with blend of red and pink rose which was found statistically at par with T₇ (5.14 to 4.98) also containing medicinal herbs with blend of red and pink rose during the storage passage of 9 months. Whereas, highest decrease in pH level was recorded in T₉ (4.00 to 3.82) at higher level of citric acid (10 g). Moreover, product with blend of sapota and pink rose (100:900) having Brix70 % recorded little higher decrease in pH in T₁₀ (5.15 to 4.87 %).

4.7 Colour (10 points)

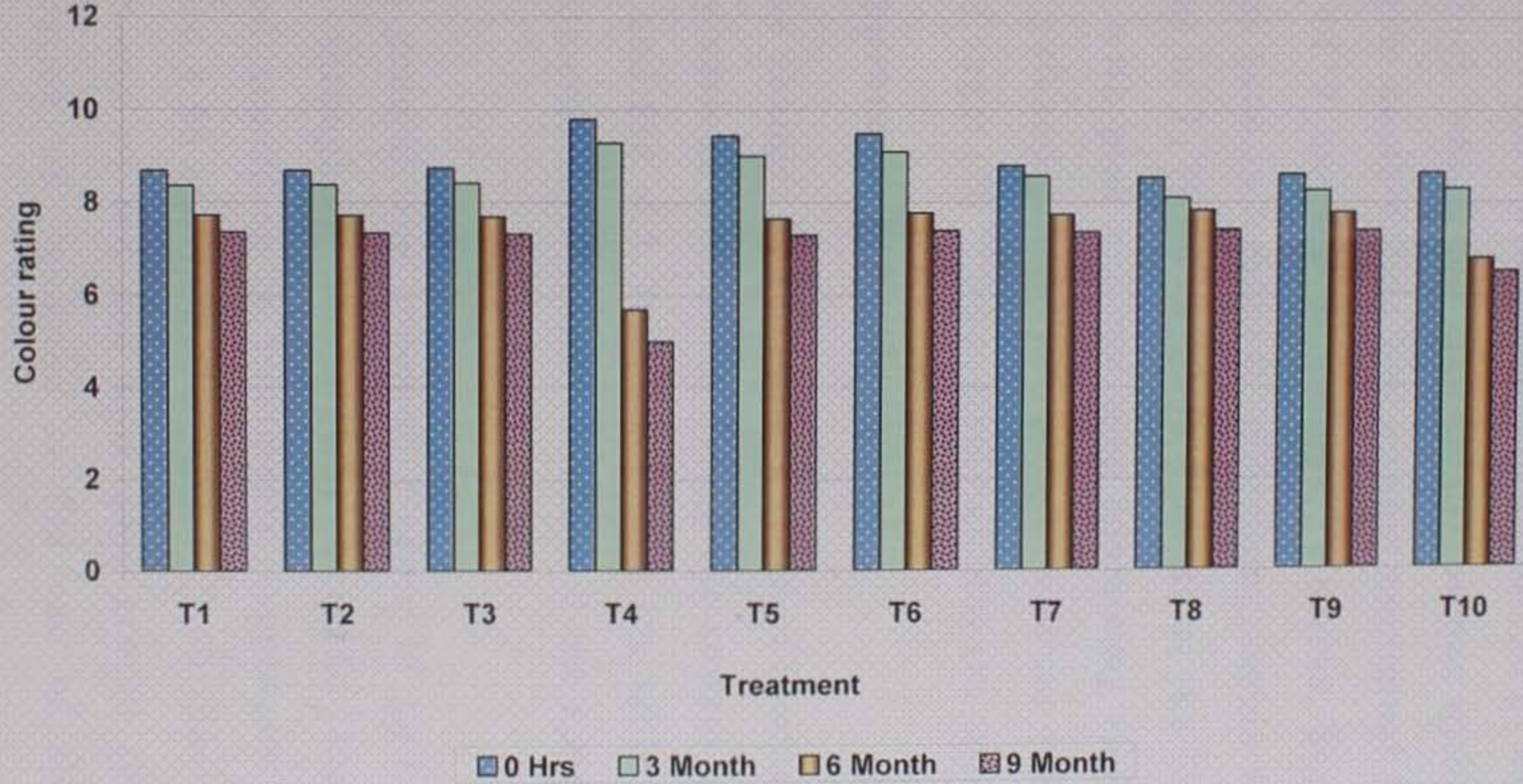
The data on changes in colour score of blended *gulkand* as affected by various treatments during the storage are been presented in Table 4.7 and depicted in Fig. 4.7. It is seen from the table and fig. that the score of colour in *gulkand* was significantly influenced by different treatments.

In general, there has been significant decrease in colour acceptance of *gulkand* during storage, however pattern of decline varied according to treatments. The colour rating has been

Table-4.7 Effect of various treatments on colour rating (10 points) of blended *gulkand* during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T ₁	8.69	8.37	7.73	7.36	8.03
T ₂	8.70	8.39	7.72	7.35	8.04
T ₃	8.75	8.42	7.69	7.32	8.04
T ₄	9.80	9.29	5.69	5.00	7.44
T ₅	9.45	9.01	7.66	7.30	8.35
T ₆	9.50	9.11	7.78	7.39	8.44
T ₇	8.80	8.58	7.74	7.36	8.12
T ₈	8.55	8.12	7.84	7.42	7.98
T ₉	8.63	8.28	7.80	7.40	8.02
T ₁₀	8.66	8.31	6.78	6.50	7.56
Mean	8.95	8.58	7.44	7.04	
S.E.m ±	0.066	0.075	0.087	0.111	
C.D. at 5 %	0.19	0.22	0.26	0.33	
C.V. %	1.27	1.51	2.02	2.72	

Fig-7: Effect of various treatments on colour rating (10 points) of blended *gulkand* during storage



ranged from 8.95 to 7.04. The highest score for colour acceptance was obtained in treatment combined with sapota, pink and red rose (100 : 650 : 250) with medicinal herbs (50 g) as in T₆ (9.50 to 7.39) which was found statistically at par with T₅ (9.45 to 7.30) with same combination but without medicinal herbs during the passage of 9 months of storage. Whereas, the most dark coloration was seen in treatment containing sapota with red rose (100:900 g) as in T₄ (9.80 to 5.00). Therefore, the lower level of sapota blend with pink and red rose containing medicinal herbs improve the gulkand colour acceptance whereas pink rose with lower level of sugar (70^{0Brix}) adversely affects the colour rating.

4.8 Appearance (10 points)

The changes in appearance score of blended *gulkand* as influenced by various treatments during the storage are presented in Table 4.8 and Fig. 4.8. It is clear from the table and fig. that different treatments significantly influenced the appearance score of *gulkand*.

In general, the appearance score of *gulkand* declined significantly throughout the storage periods, the pattern of decline varied according to treatments. Appearance acceptance varied between 8.96 and 7.05. T₆ (9.51 to 7.40) having medicinal herbs with blend of red and pink rose scored the highest in appearance rating of *gulkand* at the end of storage period followed by treatment with same blend but without medicinal herbs as in T₅ (9.48 to 7.31) and the difference between them

Table-4.8 Effect of various treatments on appearance rating (10 points) of blended *gulkand* during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T ₁	8.70	8.36	7.75	7.37	8.04
T ₂	8.72	8.40	7.72	7.36	8.05
T ₃	8.74	8.44	7.69	7.34	8.05
T ₄	9.83	9.30	5.71	5.03	7.46
T ₅	9.48	9.03	7.65	7.31	8.36
T ₆	9.51	9.12	7.79	7.40	8.45
T ₇	8.81	8.59	7.75	7.37	8.13
T ₈	8.56	8.13	7.85	7.43	7.99
T ₉	8.64	8.29	7.81	7.41	8.03
T ₁₀	8.69	8.32	6.76	6.52	7.57
Mean	8.96	8.59	7.44	7.05	
S.E.m ±	0.130	0.125	0.129	0.137	
C.D. at 5 %	0.38	0.37	0.38	0.41	
C.V. %	2.51	2.52	3.00	3.38	

Fig-8: Effect of various treatments on appearance rating (10 points) of blended *gulkand* during storage



found to be significant. The product containing sapota with higher level of red rose (100 : 900) exhibited sharp decline in appearance score with the advancement of storage period and the lowest score for appearance was recorded in T₄ (9.83 to 5.03). Therefore, the optimum level of sapota blend with pink and red rose containing medicinal herbs improved the gulkand appearance acceptance whereas pink rose with lower level of sugar (70^{0Brix}) as in T₁₀ (8.69 to 6.52) adversely affected the appearance rating.

4.9 Texture (10 points)

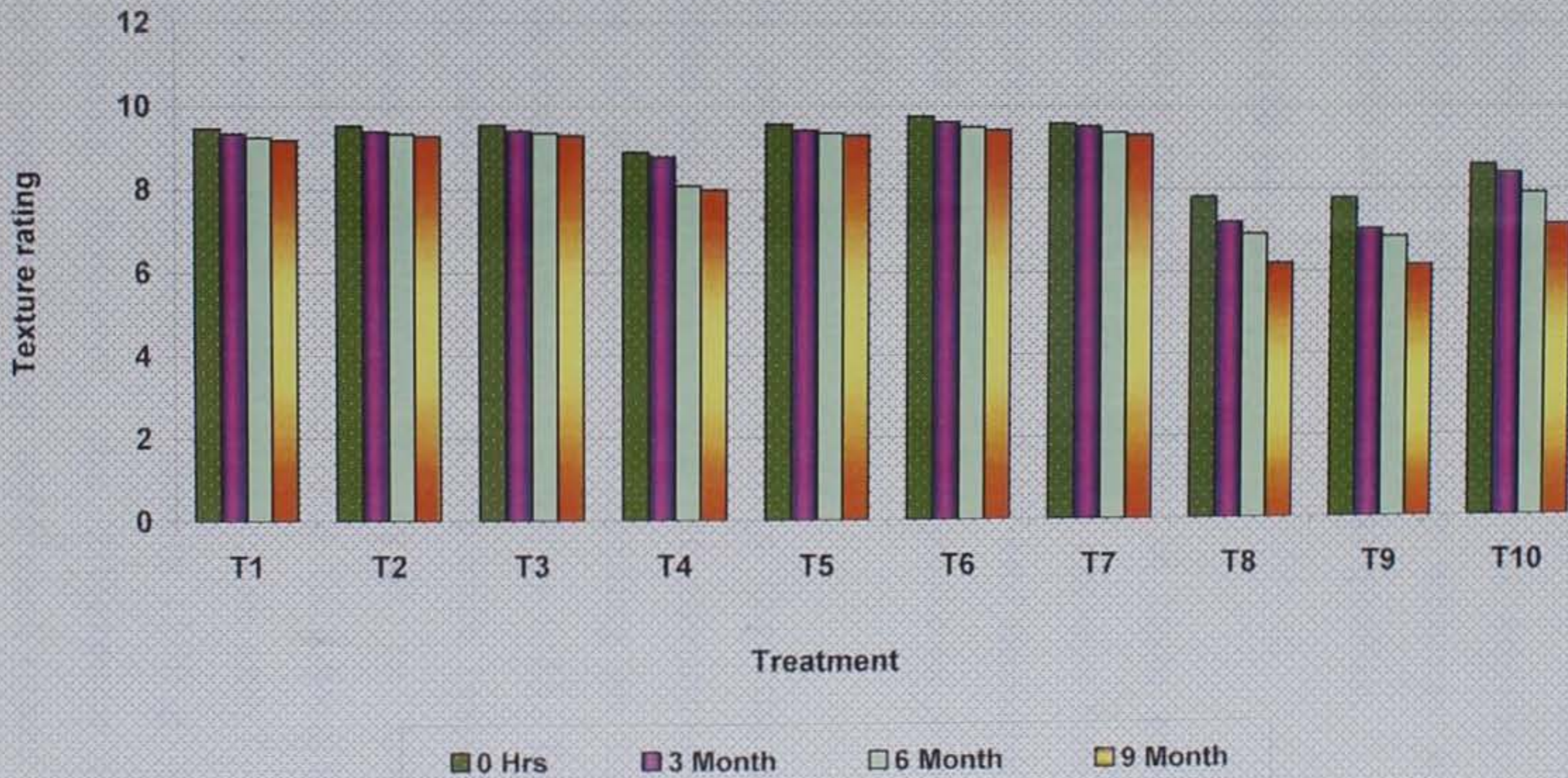
The data pertaining to changes in textural score of blended *gulkand* as influenced under treatments during the storage are furnished in Table 4.9 and depicted in Fig. 4.9. It is clear from the data that the textural score of *gulkand* was significantly influenced by different treatments.

In general, there has been a significant decline in textural score throughout storage period and pattern of decline varied according to treatments. Acceptance rating of texture varied from 9.05 to 8.32. In the present experiment, the textural acceptance score was highly influenced by the addition of medicinal herbs in the product and the highest score was observed in the treatment containing medicinal herbs with blend of pink and red rose as in T₆ (9.76 to 9.43) which was found at par with T₇ (9.58 to 9.31) which also contained same combination but without red rose. Whereas, lowest and more decreasing textural score was recorded in T₉ (7.78 to 6.14) at higher level of citric

Table-4.9 Effect of various treatments on texture rating (10 points) of blended *gulkand* during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T ₁	9.46	9.34	9.25	9.18	9.30
T ₂	9.53	9.39	9.34	9.28	9.38
T ₃	9.55	9.41	9.35	9.30	9.40
T ₄	8.91	8.79	8.10	8.00	8.45
T ₅	9.58	9.43	9.36	9.31	9.42
T ₆	9.76	9.62	9.50	9.43	9.57
T ₇	9.58	9.51	9.36	9.31	9.44
T ₈	7.80	7.19	6.91	6.19	7.02
T ₉	7.78	7.02	6.83	6.14	6.94
T ₁₀	8.58	8.39	7.89	7.13	7.99
Mean	9.05	8.80	8.58	8.32	
S.E.m \pm	0.097	0.110	0.113	0.125	
C.D. at 5 %	0.29	0.32	0.33	0.37	
C.V. %	1.86	2.16	2.28	2.59	

Fig-9: Effect of various treatments on texture rating (10 points) of blended *gulkand* during storage



acid (10 g) followed by lower level of citric acid (5 g) during the passage of 9 months of storage like T₈ (7.80 to 6.19). Accordingly decrease in textural score was found slightly higher in T₁₀ (8.58 to 7.13) with lower Brix (70 %). Thus the addition of medicinal herbs were found as a textural improver whereas, higher level of citric acid adversely affected the textural quality.

4.10 Taste (10 points)

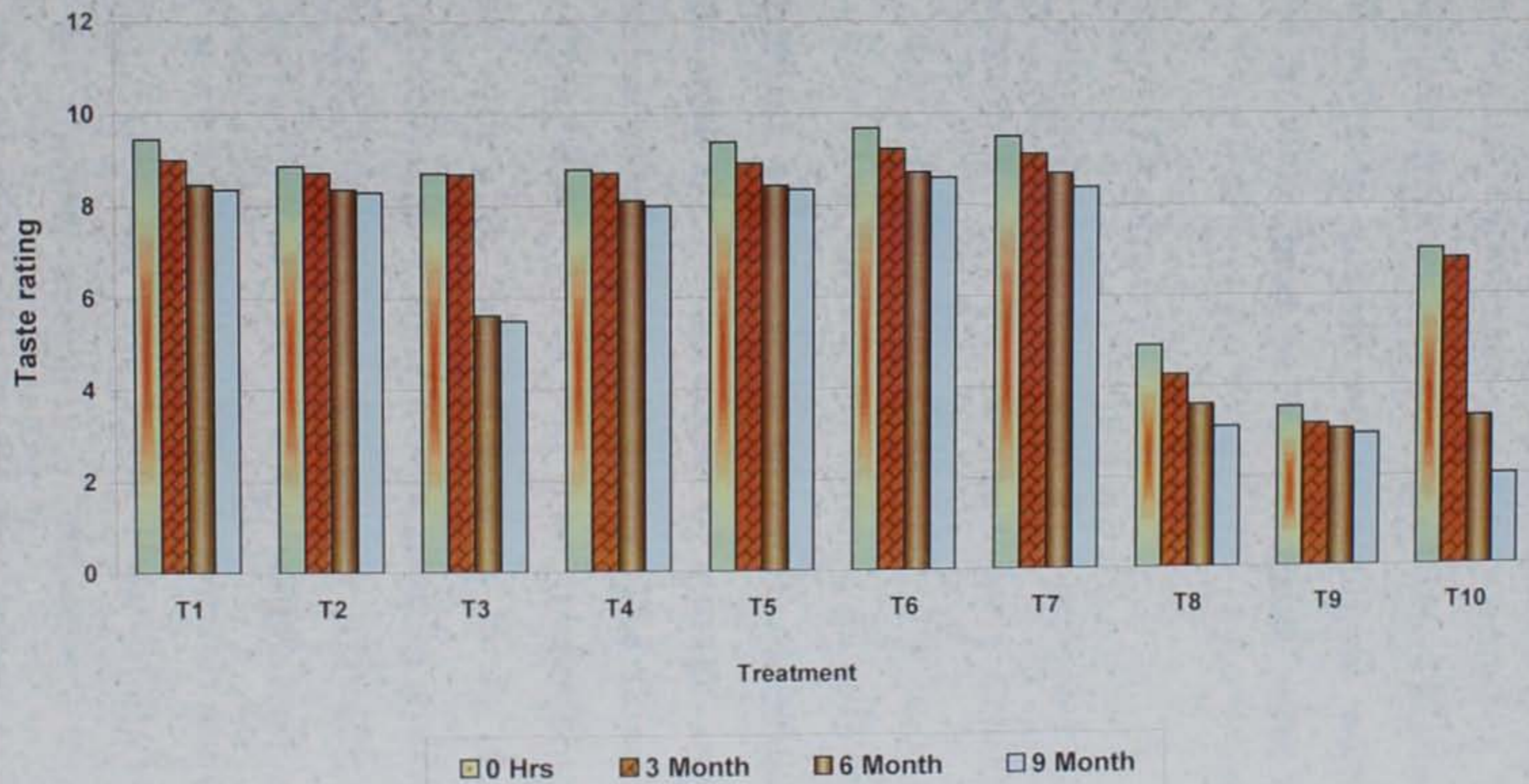
The data regarding changes in taste score of blended *gulkand* based on sapota as affected by various treatments during the storage are presented in Table 4.10 and depicted in Fig. 4.10. The data revealed that taste score of *gulkand* was significantly influenced by different treatments.

It is apparent from the data that the taste score of *gulkand* decreased significantly with the advancement of storage but the pattern of decline varied according to treatments. The taste acceptance score varied from 7.98 to 6.35. Treatments with medicinal herbs exhibited higher acceptance taste score and the highest rating was recorded in T₆ (9.68 to 8.60) containing medicinal herbs with pink and red rose followed by T₇ (9.49 to 8.38) with same content but without red rose and T₁ (9.45 to 8.36) which contained optimum level of sapota (100 g) during storage period of 9 months. However, the difference between these treatments were found to be at par with each other. However this acceptability declined with addition of citric acid in *gulkand* and with higher level of citric acid (10 g) recorded the lowest taste

Table-4.10 Effect of various treatments on taste rating (10 points) of blended *gulkand* during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T ₁	9.45	9.00	8.46	8.36	8.81
T ₂	8.87	8.72	8.36	8.30	8.56
T ₃	8.71	8.68	5.62	5.50	7.12
T ₄	8.79	8.71	8.12	8.00	8.40
T ₅	9.39	8.92	8.44	8.35	8.77
T ₆	9.68	9.23	8.72	8.60	9.05
T ₇	9.49	9.11	8.69	8.38	8.91
T ₈	4.90	4.25	3.59	3.10	3.96
T ₉	3.52	3.15	3.03	2.92	3.15
T ₁₀	7.01	6.80	3.30	2.01	4.78
Mean	7.98	7.65	6.63	6.35	
S.E.m ±	0.099	0.105	0.130	0.129	
C.D. at 5 %	0.29	0.31	0.38	0.38	
C.V. %	2.34	2.55	3.63	3.72	

Fig-10 : Effect of various treatments on taste rating (10 points) of blended *gulkand* during storage



score being minimum in T₉ (3.52 to 2.92) followed by lower level of citric acid(5 g) in T₈ (4.90 to 3.10). Similarly, comparatively moderate lower organoleptic taste score was noted in T₁₀ (7.01 to 2.01) which was prepared with lower Brix 70 %. This investigation showed that more taste acceptance is obtained with medicinal herbs while the product become unacceptable with addition of citric acid.

4.11 Flavour (10 points)

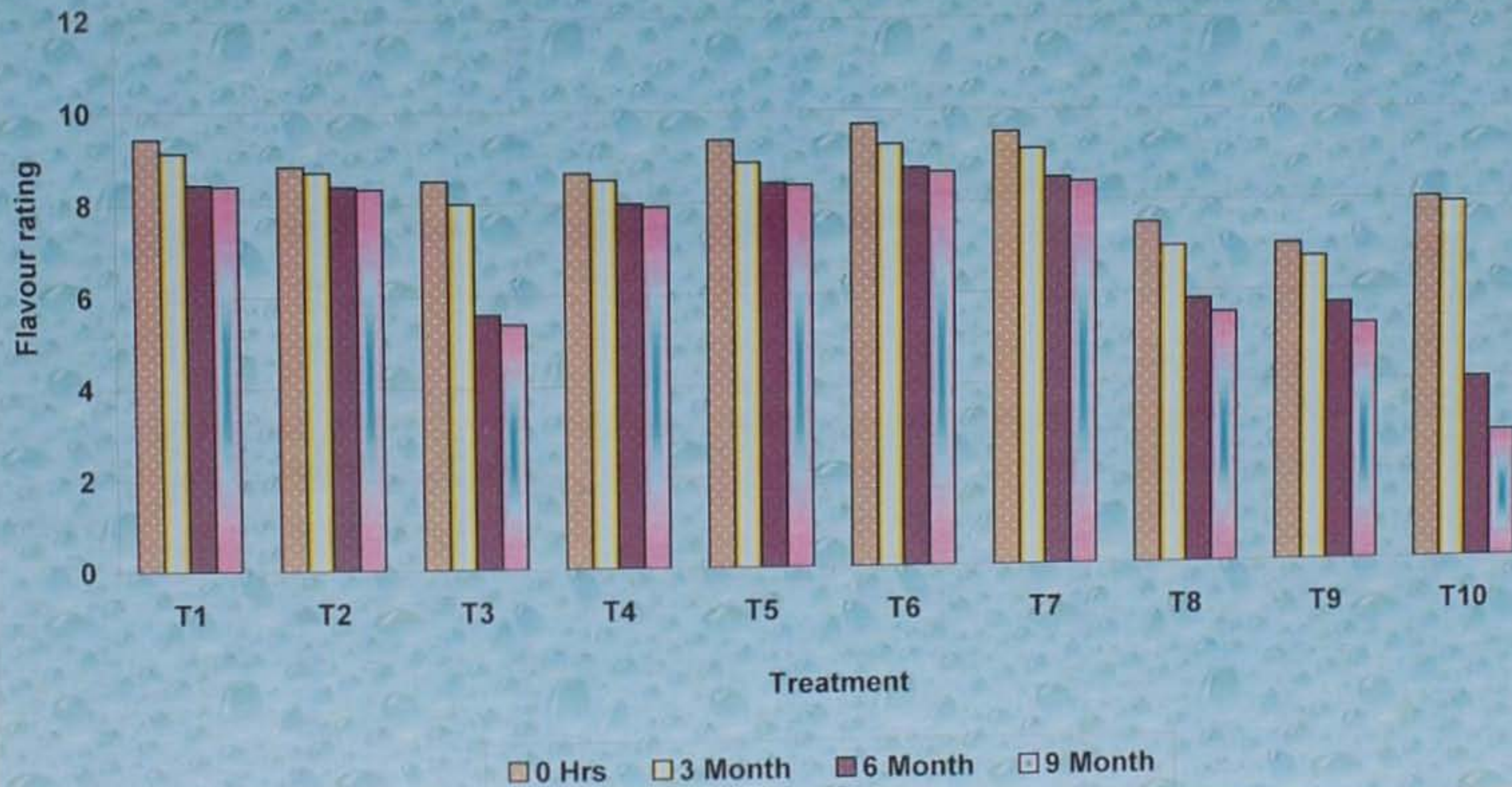
The changes in flavour score of *gulkand* as influenced by various treatments during the storage clearly depicted in Table 4.11 and Fig. 4.11. It is clear from the Table that different treatments influenced the flavour acceptance of *gulkand*.

In general, there was significantly decrease in flavour score of *gulkand* with the advancement of storage, but the pattern of decline varied according to treatments. The flavour score has been ranged from 8.65 to 6.90. The treatment containing medicinal herbs with pink and red rose as in T₆ (9.70 to 8.65) imparted more acceptability for flavour wise in *gulkand* and this product recorded the highest score for flavour which was statistically at par with T₇ (9.51 to 8.42) with blend of medicinal herbs and pink rose and T₁ with optimum level of sapota (100 g) . Whereas, T₁₀ (8.01 to 2.80) with lower level of Brix(70 % TSS) scored lowest for flavour acceptance. However, treatment with citric acid had also showed adverse flavour rating as in T₉ and T₈ (7.01 to 5.23 and 7.51 to 5.51 respectively), with advancement of storage period of 9 months. This investigation had showed the

Table-4.11 Effect of various treatments on flavour rating (10 points) of blended *gulkand* during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T ₁	9.44	9.13	8.45	8.41	8.85
T ₂	8.84	8.71	8.39	8.34	8.57
T ₃	8.51	8.01	5.59	5.38	6.87
T ₄	8.66	8.52	8.00	7.93	8.27
T ₅	9.37	8.89	8.43	8.39	8.77
T ₆	9.70	9.26	8.74	8.65	9.08
T ₇	9.51	9.14	8.51	8.42	8.89
T ₈	7.51	6.98	5.81	5.51	6.45
T ₉	7.01	6.72	5.69	5.23	6.16
T ₁₀	8.01	7.89	3.99	2.80	5.67
Mean	8.65	8.32	7.16	6.90	
S.E.m \pm	0.107	0.105	0.149	0.159	
C.D. at 5 %	0.32	0.31	0.44	0.47	
C.V. %	2.14	2.18	3.60	3.98	

Fig-11 : Effect of various treatments on flavour rating (10 points) of blended *gulkand* during storage



more flavour acceptance could be obtained with medicinal herbs while the product become unacceptable with lower level of Brix and addition of citric acid.

4.12 Overall acceptability (10 points)

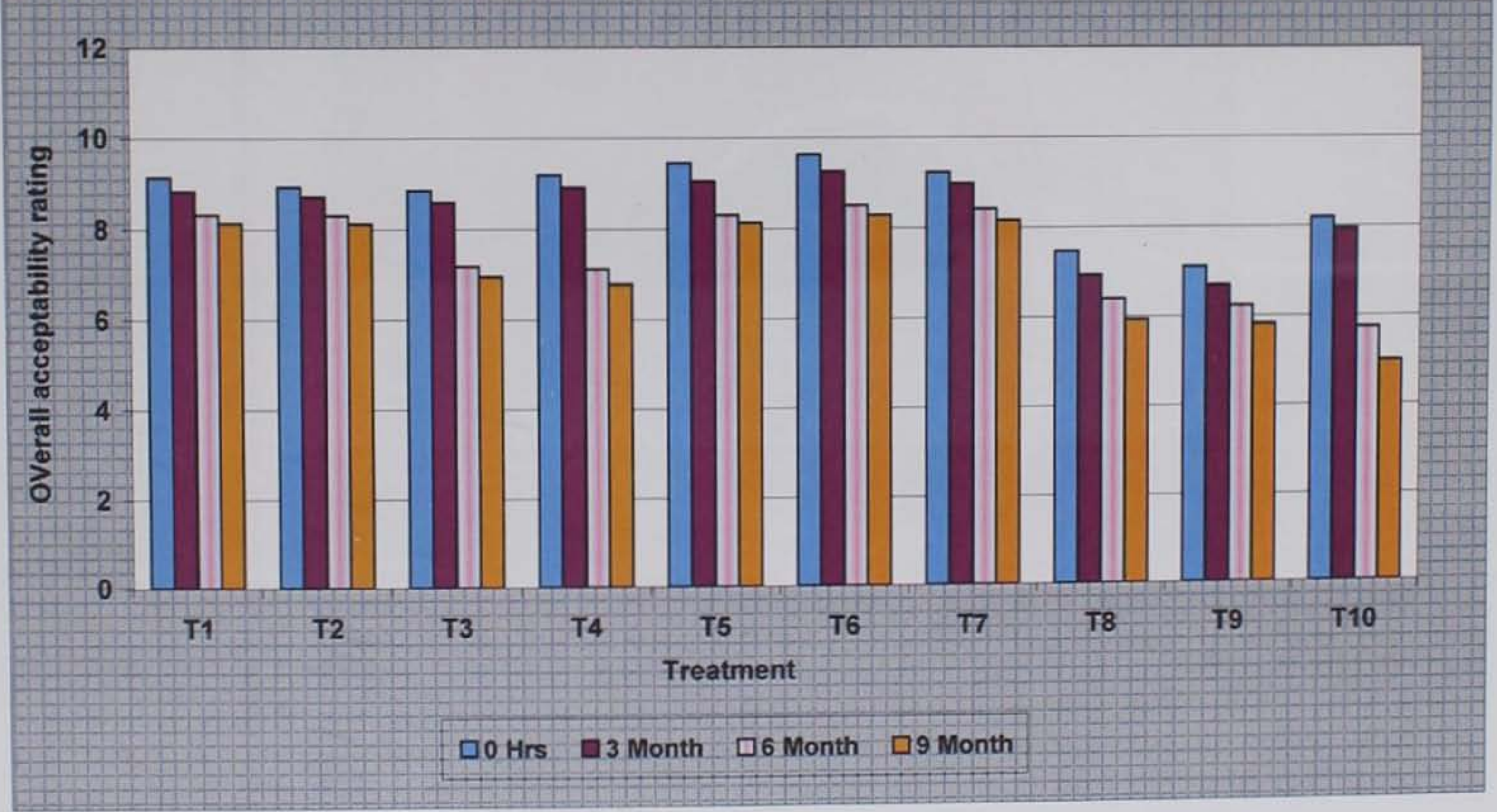
The changes in overall acceptability score of blended *gulkand* based on sapota as influenced by various treatments during the storage clearly depicted in Table 4.12 and depicted in Fig. 4.12. It is clear from the table and fig. that different treatments significantly influenced the overall acceptability score of *gulkand*.

In general, the overall acceptability score of *gulkand* declined significantly with the advancement of storage. The pattern of declined varied according to treatments. Overall acceptability score ranged from 8.71 to 7.13. The highest overall acceptability score was recorded in T₆ (9.63 to 8.29) containing medicinal herbs with blend of pink and red rose. Whereas, the lowest and more decreasing overall acceptability score was recorded in T₉ (7.11 to 5.82) at higher level of citric acid (10 g) followed by lower level of citric acid (5 g) during the 9 months storage period like T₈ (7.46 to 5.93). Accordingly, decrease in overall acceptability score was found moderately higher in T₁₀ (8.19 to 4.99) with lower Brix (70 % TSS). This investigation indicated that showed the more overall acceptability obtained with addition of medicinal herbs while the product becomes unacceptable with addition of citric acid.

Table-4.12 Effect of various treatments on overall acceptability rating (10 points) of blended *gulkand* during storage

Treatments	0 Hrs	3 Month	6 Month	9 Month	Mean
T ₁	9.14	8.84	8.32	8.13	8.60
T ₂	8.93	8.72	8.30	8.12	8.52
T ₃	8.85	8.59	7.18	6.96	7.89
T ₄	9.19	8.92	7.12	6.79	8.00
T ₅	9.45	9.05	8.30	8.13	8.73
T ₆	9.63	9.26	8.50	8.29	8.91
T ₇	9.23	8.98	8.41	8.16	8.69
T ₈	7.46	6.93	6.40	5.93	6.68
T ₉	7.11	6.69	6.23	5.82	6.46
T ₁₀	8.19	7.94	5.74	4.99	6.71
Mean	8.71	8.39	7.45	7.13	
S.E.m \pm	0.050	0.080	0.080	0.063	
C.D. at 5 %	0.15	0.24	0.24	0.19	
C.V. %	1.03	1.68	1.73	1.43	

Fig-12 : Effect of various treatments on overall acceptability rating (10 points) of blended gulkand during storage



DISCUSSION

V. DISCUSSION

The sapota [*Manilkara acharas* (Mill.) Fosberg] is a major fruit crop of South Gujarat. Presently it is being marketed only as a fresh fruit and therefore at the present pace of growth it is likely to face the problem of marketing in times to come. Under these circumstances, processing of sapota fruits into suitable value added product has been found very essential. Therefore, the present experiment on "Standardization of blended *gulkand* based on sapota [*Manilkara achras* (Mill) Fosberg] fruits" was carried out to assess various treatment and levels of sapota, rose blending, medicated herbs and levels of citric acid during the ambient temperature storage condition of 9 months. The effect of various treatments on storage quality of product was investigated and the results obtained are being discussed in this chapter.

5.1 Total Soluble Solids (%)

In general, the TSS content in sapota based *gulkand* increased significantly during storage because of continuous partial degradation of polysaccharides. This increase in TSS content in product was more pronounced and the highest with increase level of citric acid (10 g) in treatment (T₉) containing optimum level of Brix (78 % TSS) and sapota (100 g). At this level of citric acid which helped in hydrolysis of insoluble polysaccharide into soluble sugars and further raised by optimum level of Brix (78 % TSS). This reaction is more pronounced under

higher storage temperature resulting in an increase in TSS. This situation can be reversed with decrease level of Brix (70 % TSS) and without addition of citric acid (T₁₀). This decrease in TSS could be explained by the fact, the treatment containing lower level of Brix (70 %) and without citric acid lead to lesser and slower hydrolysis of complex carbohydrates which was reflected by low TSS in *gulkand*. In the present experiment, our value for TSS content in product conform to the finding of by Tripathi *et al.* (1988) in amla jam, Kannan and Thirumaran (2001) in jamun jam, Sogi and Singh (2001) in kinnow jam, Jadhav *et al.* (2004) in karonda products, Koli *et al.* (2004) in sapota jam, Sarvanan *et al.* (2004) in papaya jam, Singh *et al.* (2004) in Harbal jelly, Prasad and Mali (2005) in bael jam, Prasad and Mali (2006) in ber jam, Mishra and Chopra (2006) in bael jam, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Desai and Vaghani (2007) in Mixed fruit jelly based on Sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyanprash* based on sapota.

5.2 Reducing sugars (%)

In general, the reducing sugars in sapota based *gulkand* increased during successive stages of storage period. The increase in reducing sugar might mainly be assigned to conversion of part of non-reducing sugars into invert sugar during prolongial storage under ambient condition. However, the pattern of increase varied according to treatment. The highest conversion into reducing

sugars was exhibited in T₉ with higher level of citric acid (10 g) and combined with optimum level of Brix (78 % TSS) and sapota (100 g). Its combination with acid might have helped more inversion of non-reducing sugars into invert sugar through the break down process of citric acid at their higher level. Moreover, under higher temperature of ambient storage condition polyphenol content of sapota is more reactive at higher acid level of citric acid and leading to slow and continuous hydrolysis in to simple sugars like glucose and fructose. This can be minimized by decreasing level of Brix (70 %) and same level of sapota (100 g) as in T₁₀ showed lowest increase in reducing sugar. In this treatment without addition of citric acid and low quantity of sugar are responsible for slow inversion leading to reducing sugars through slower break down process in *gulkand*. The changing pattern of reducing sugars run parallel to the observation of Shah and Bhatia (1983) in apple jelly, Tripathi *et al.* (1988) in amla jam, Yousif and Alghamdi (1999) in date jelly, Kalarani (2000) in custard apple jelly, Kannan and Thirumaran (2001) in jamun jam, Sogi and Singh (2001) in kinnow jam, Koli *et al.* (2004) in sapota jam and Sudhagar *et al.* (2005) in pear jelly, Waskar and Khurdiya (1987) in phalsa syrup, Sethi (1993) in litchi squash, Prasad and Mali (2000) in pomegranate squash, Prasad and Mali (2005) in bael jam and Prasad and Mali (2006) in ber jam, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Patel

and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyawanprash* based on sapota.

5.3 Total sugars (%)

In general, the total sugars in sapota based *gulkand* recorded gradual increase on prolonged storage period, which might have been due to a degradation of hemicelluloses and other saccharides into simple sugars. Highest increase in total sugars was recorded in treatments contained higher level of citric acid (10 g) and combined with optimum level of Brix 78% TSS and sapota (100 g) like (T₉) as this treatment showed higher increase in TSS which coincided with increased level of total sugars. This increase is caused by solubilization of blended pulp constituents and hydrolysis of pectin, starch and cellulose into soluble solids. Under the influence of hydrolytic reaction of acid at its higher level and higher temperature of storage conditions leading to raise the level of total sugars. Moreover, sapota pulp is also more reactive under the influence of high storage temperature condition thereby also more conversion into invert sugar. This raise in total sugars was controlled with lower level of Brix (70 %) which has not contained citric acid which is mainly due to low Brix in the treatment and helped by absence of citric acid causing negligible process of hydrolysis into simple sugars. Such changes in increase in total sugars in products is in conformity with the results obtained by Tripathi *et al.* (1988)

in amla jam, Yousif *et al.* (1990) in date jelly, Sogi and Singh (2001) in kinnow jam, Saikia *et al.* (2002) in carambola jelly, Koli *et al.* (2004) in sapota jam, Sarvanan *et al.* (2004) in papaya jam, Masoodi *et al.* (2005) in guava jelly, Prasad and Mali (2005) in bael jam, Prasad and Mali (2006) in ber jam, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyawanprash* based on sapota.

5.4 Non-reducing sugars (%)

In general, the non-reducing sugars per cent in blended *gulkand* based on sapota decreased throughout the storage period. Decrease in non-reducing sugars percentage was in proportion to the increase in reducing sugars. This decrease may be due to increase in reducing sugars at the expense of non-reducing sugars. This might also be due to enzymatic and chemical reaction among organic constituent of the fruits and flowers under the influence of ambient storage temperature. However, the pattern of decline varied according to treatment. This decline in non-reducing sugar was lowest in treatment those contained the highest level of citric acid (10 g), optimum level of Brix (78 % TSS) and sapota (100 g) like (T₉). This may be due to higher hydrolytic effect of citric acid on total solubles and saccharides causing more conversion into reducing sugars which ultimately decrease the level of non-reducing sugars. Such the highest inversion and

in amla jam, Yousif *et al.* (1990) in date jelly, Sogi and Singh (2001) in kinnow jam, Saikia *et al.* (2002) in carambola jelly, Koli *et al.* (2004) in sapota jam, Sarvanan *et al.* (2004) in papaya jam, Masoodi *et al.* (2005) in guava jelly, Prasad and Mali (2005) in bael jam, Prasad and Mali (2006) in ber jam, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyawanprash* based on sapota.

5.4 Non-reducing sugars (%)

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lowest non-reducing sugars can be stabilized more pronouncely when the product without citric acid but with medicinal herbs (50 g) and blend of sapota: pink rose: red rose (100:650:250) in T₇. This could be attributable to the fact that medicinal herbs are well known for their preservation property without degradation of carbohydrates and sugar, leading to maintained the level of non-reducing sugars through slow and less inversion. These findings are more or less similar to those of Shah and Bhatia (1983) in apple jelly, Tripathi *et al.* (1988) in amla jam, Yousif and Alghamdi (1999) in date jelly, Kalarani (2000) in custard apple jelly, Kannan and Thirumaran (2001) in jamun jam, Sogi and Singh (2001) in kinnow jam, Saikia *et al.* (2002) in carambola jelly, Koli *et al.* (2004) in sapota jam, Sudhagar *et al.* (2005) in pear jelly, Prasad and Mali (2005) in bael jam, Prasad and Mali (2006) in ber jam, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyawanprash* based on sapota.

5.5 Acidity (%)

In general, there was a significant increase in acidity of blended *gulkand* based on sapota at the end of 9 months of storage. But, its pattern of increase varied according to treatments. This increase in acidity could possibly be due to initiation fermentation of product through enzymatic reaction and

de-esterification of pectin molecules. The highest increase in acidity per cent was observed in T₉ at higher level of citric acid (10 g) combined with optimum level of Brix 78 % TSS and sapota (100 g) a corresponding fall in pH because this sample already received the highest level of citric acid, thus it is mainly considered as a treatment effect. Whereas, the lowest increase in acidity per cent was recorded in the treatment which contained medicinal herbs (50 g), optimum level of Brix (78 % TSS) and sapota (100 g) in combination with pink and red rose (T₇) with corresponding decline in pH. This treatment contained medicated herbs which helped in prevention of acid production through fermentation caused by the activity of microorganisms and also without citric acid. Therefore, there was negligible changes in acidity. These variable observations are go in conformity with the findings of Sethi (1993) in litchi squash, Prasad and Mali (2000) in pomegranate squash, Sharma *et al.* (2001) in galgal juice concentrates, Prasad and Mali (2005) in bael jam and Prasad and Mali (2006) in ber jam, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyawanprash* based on sapota.

5.6 pH (%)

In general, there has been a significant decrease in pH of sapota based *gulkand* within storage as a result of increase in

the acidity of product due to the phenomenon of production of acid through initiation of process of fermentation during impregnation of sugar into rose petals. However, its pattern of decline varied according to treatments. The lowest decline in pH was recorded in treatment containing medicinal herbs (50 g), blend of pink and red rose (650 : 250), optimum level of sapota (100 g) and adjusted to 78 °Brix (T₆) with a correspondence decrease in acidity percentage, which may be attributed to the antimicrobial activity of added medicinal herbs in product which check the process of fermentation and the highest decrease in pH was recorded in treatment with higher level of citric acid (10 g), optimum level of sapota (100 g) and adjusted to 78 °Brix (T₉). Which can be seen with corresponding increase in acidity percentage, which may be due to treatment received highest amount of citric acid (10 g) resulting in decrease in pH. This observations on pH value are in accordance with the finding of Sethi (1993) in litchi squash, Prasad and Mali (2000) in pomegranate squash, Sharma *et al.* (2001) in galgal juice concentrates, Prasad and Mali (2005) in bael jam and Prasad and Mali (2006) in ber jam, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyawanprash* based on sapota.

5.7 Colour (10 points)

The colour of the product directly affect the marketability of processed product in the trade. If colour is attractive and eye appealing, it will be move very fast in the national and international market. In global market, colour is the first consideration. In the present experiment, there has been a significant decline in colour acceptance score for sapota based blended *gulkand* during the storage. However, its pattern of decline varied according to treatment. The highest score for colour acceptance was obtained in treatment containing the blend of sapota, pink and red rose (100 : 650 : 250) containing medicinal herbs (50 g) and raised product Brix (78 %) in T₆. Sapota is a rich source of polyphenols which develops browning through enzymatic reaction which may be useful to impart desirable colour to this product. Beside this, the natural red colour also rendered through tannin content of sapota as well as from medicinal herbs and carmelization process of sugar (78 %) in *gulkand*. Moreover, blending of red and pink rose release more desirable colour pigments compared to pink rose alone. Such a synergistic effect of ideal blending helped in retention of acceptable colour. Whereas, the most undesirable blood-red dark coloration was observed in treatment containing sapota with red rose (100 : 900 g) in T₄. This treatment mainly consist of red rose petals which are rich in tannin and red pigments are highly sensitive to oxygen and enzyme lead to oxidation and enzymatic browning causing discolouration of product during processing

under direct sun rays and prolong storage at ambient condition. These variable observations are also similar to finding of Ahmed (1996) in watermelon squash and RTS, Kanan and Thirumaran (2001) in jamun jam, Sogi and Singh (2001) in kinnow jam, Koli *et al.* (2004) in sapota jam, Saravanan *et al.* (2004) in papaya jam, Anon. (2005), Chauhan and Chatterjee (2005) in papaya sauce, Masoodi *et al.* (2005) in guava jelly, Prasad and Mali (2005) in bael jam and Prasad and Mali (2006) in ber jam, Sudhagar *et al.* (2005) in pear jelly, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in chyawanprash based on sapota.

5.8 Appearance (10 points)

Appearance is an overall out look of a product. In general, there was a significant decline in the appearance sapota based *gulkand* during storage. But, its pattern of decline varied according to treatment. The highest score for appearance acceptance was obtain in treatment consisting with of sapota, pink and red rose (100 : 650 : 250) containing medicinal herbs (50 g) and Brix raised to 78 % (T₆). Sapota is a rich source of polyphynols which develops browning through enzymatic reaction may be used for better appearance in *gulkand*. Beside this, appearance is also improved through tannin which is present in sapota and medicinal herbs. carmelization process of sugar (78 %)

and blending of red and pink rose are also helpful in increasing appearance acceptance in *gulkand* compared to pink rose alone. Such a synergistic effect of ideal blending helped in retention of acceptable appearance. However, the product containing sapota with red rose (100 : 900) exhibited sharp decline in appearance score with the advancement of storage period and the lowest score for appearance (T₄). This treatment is mainly consist of red rose petals are rich in tannin and red pigments are highly sensitive to oxygen and enzyme leading to enzymatic browning causing discolouration of product during processing under direct sun rays and prolong storage at ambient condition. These observations are in agreement with the findings of Ahmed (1996) in watermelon squash and RTS, Kanan and Thirumaran (2001) in jamun jam, Sogi and Singh (2001) in kinnow jam, Koli *et al.* (2004) in sapota jam, Saravanan *et al.* (2004) in papaya jam, Anon. (2005), Chauhan and Chatterjee (2005) in papaya sauce, Masoodi *et al.* (2005) in guava jelly, Prasad and Mali (2005) in bael jam and Prasad and Mali (2006) in ber jam, Sudhagar *et al.* (2005) in pear jelly, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyawanprash* based on sapota.

5.9 Texture (10 points)

The texture of blended *gulkand* based on sapota has been declined significantly during storage. This pattern of decline

varied according to treatments. The highest textural score was observed in the treatment containing medicinal herbs with blend of pink rose and red rose (T₆). This might obviously be attributed to antioxidant and antimicrobial property of medicinal herbs at their optimum level reduced oxidation and fermentation responsible for softening of product thereby retained acceptable texture during storage period of nine months. Moreover, this product also contained reasonable amount of fruit fibers which is found very helpful in setting of product to thick consistency. Whereas, the lowest and more decreasing textural score was observed when the product was prepared with higher level of citric acid (10 g) as in T₉ which tended to hydrolyze sapota pulp and rose petals making product consistency very soft. Such identical textural scores were observed by Koli *et al.* (2004) in sapota jam, Saravanan *et al.* (2004) in papaya jam, Anon. (2005), Chauhan and Chatterjee (2005) in papaya sauce, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyanprash* based on sapota.

5.10 Taste (10 points)

The consumer's acceptance of food product depends on many factors of which taste is the major parameter. In general, the taste score of the *gulkand* declined significantly as the storage period increased. But, this pattern of decline varied according to

treatments. The most acceptable taste rating was showed in product containing medicinal herbs with blend of pink and red rose (T₆). It is established fact that the spices are mainly used in various food product to develop typical spicy taste. It also helps in preservation of product without imparting any odd taste. Whereas, use of red flowers in small quantity (250 g) with pink rose is helpful in development of pleasant taste with medicinal herbs. The combination of these contents also reduced alcoholic fermentation which is responsible for unpleasant taste. The higher level of citric acid (10 g) recorded lower taste score (T₉). Generally, consumers do not preferred acidic *gulkand*. Moreover, high acidity also reacts with various constitutes especially with polyphenoles which develops odd taste. Again these reactions liberate more aromas from product and finally flavour is emitted from the product within short time. These findings are in line with those results of Sogi and Singh (2001) in kinnow jam, Koli *et al.* (2004) in sapota jam, Saravanan *et al.* (2004) in papaya jam, Prasad and Mali (2005) in bael jam, Sudhagar *et al.* (2005) in pear jelly, Mishra and Chopara (2006) in bael jam, Prasad and Mali (2006) in ber jam, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyawanprash* based on sapota.

5.11 Flavour (10 points)

Flavour is the major quality parameter of foodstuff. There was significant decline in flavour score of *gulkand* based on sapota with the advancement of storage. However, this pattern of decline varied according to treatments. This decrease in flavour score might be due to highly volatile nature of flavour at high storage temperature. The most acceptable flavour rating was showed in product containing medicinal herbs with blend of pink and red rose (T₆). It is established fact that the spices are mainly used in various food product to develops typical spicy flavour. It also helps in preservation of product without odd flavour. The small quantity (250 g) of red flowers blended with pink rose and medicinal herbs also reduced alcoholic fermentation responsible for unpleasant flavour. Treatment with lower level of Brix (70 %) scored lowest for flavour acceptance (T₁₀) which may be due to decreasing level of sugar (70 °Brix) in the product resulting in acidic flavour in *gulkand*. Moreover, high acidity also reacts with various constitutes especially with polyphenoles which develops odd flavour. Again these reactions liberate more aromas from product and finally flavour is emitted from the product within short time. Similar type of variable results are also in accordance with the findings of Sogi and Singh (2001) in kinnow jam, Koli *et al.* (2004) in sapota jam, Saravanan *et al.* (2004) in papaya jam, Prasad and Mali (2005) in bael jam, Sudhagar *et al.* (2005) in pear jelly, Mishra and Chopara

(2006) in bael jam, Prasad and Mali (2006) in ber jam, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyawanprash* based on sapota.

5.12 Overall acceptability (10 points)

Techniques of sensory evaluation have played a key role in building up modern food processing industries based on the development of a wide range processed food products and promotion of international trade. From the consumer's point of view, it is one of the primary characteristics on which the value and sale of the product are decided. Hence, this aspect becomes all the more important to the economical success of a product. In general, overall acceptability score of blended *gulkand* based on sapota was declined significantly throughout the storage period. This pattern of decline varied according to treatments. The decline in overall acceptability of the product might be due to the probable degradation of colour, appearance, taste, flavour and texture. The highest score for overall acceptability of *gulkand* was exhibited in treatment which contained blend of sapota, pink and red rose (100 : 650 : 250) with fortification of medicinal herbs (T₆). This result may probably due to its contents in ideal and balanced form which preserve the product for appreciable period of storage under ambient condition without any degradation. Organoleptic panel judged this product by allotting

highest rating for all sensory parameters. The lowest and more decreasing score for overall acceptability of *gulkand* was recorded in treatment with higher level of citric acid (10 g) followed by lower level of citric acid (5 g) which might be due to its hydrolytic effect on polyphenols, polysaccharides and sugar which ultimately adversely affect almost all the organoleptic parameters resulting in lowest score for overall acceptability. These variable observations are in conformity with the findings of Ahmed (1996) in watermelon squash and RTS, Kanan and Thirumaran (2001) in jamun jam, Sogi and Singh (2001) in kinnow jam, Koli *et al.* (2004) in sapota jam, Manivasagan *et al.* (2004) in karonda jam, Saravanan *et al.* (2004) in papaya jam, Chauhan and Chatterjee (2005) in papaya sauce, Deka *et al.* (2005) in mango-pineapple spiced beverage, Masoodi *et al.* (2005) in guava jelly, Prasad and Mali (2005) in bael jam, Singh and Sharma (2005) in bael/bael blended jam, Singh *et al.* (2005) in aonla jam, Sudhagar *et al.* (2005) in pear jelly, Mishra and Chopara (2006) in bael jam, Prasad and Mali (2006) in ber jam, Desai and Vaghani (2007) in Mixed fruit jelly based on sapota, Mulla and Vaghani (2007) in Mixed fruit jam based on sapota, Patel and Vaghani (2008) in medicinal jam based on sapota, Patel and Vaghani (2008) in *chyawanprash* based on sapota.

SUMMARY & CONCLUSION

VI SUMMARY AND CONCLUSION

The present investigation on “Standardization of *gulkand* based on sapota [*Manilkara achras* (Mill.) Fosberg] fruits” was carried out at the Department of Post Harvest Technology, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during 2008-09 with the following objectives:

1. To explore the possibility of *gulkand* based on sapota to avoid post harvest losses and to get a value added process product and
2. To assess the effect of different blending, chemicals on the storage life and quality of *gulkand*.

The results obtained in terms of chemical and qualitative changes in products obtained by using different blending of sapota, rose flowers, medicinal herbs and chemicals during storage of 9 months has being summarized below.

- (1) In general, TSS content in *gulkand* based on sapota increased significantly throughout the period of storage. The increase has been from 77.20 per cent to 78.81 per cent. Highest increase in TSS per cent was recorded in treatment having optimum level of Brix (78 % TSS) and containing higher level of citric acid (10 g) whereas with decrease level of Brix (70 % TSS) showed low increase being minimum.
- (2) There has been significant increase in reducing sugars per cent of *gulkand* during storage period under the influence of treatments. Reducing sugars percentage varied from 26.45 to

36.25 per cent. In treatment which containing optimum level of Brix (78 % TSS) and citric acid (10 g) exhibited highest conversion into reducing sugars at ambient storage. Whereas, with the decreasing level of sugar (70 °Brix) conversion into digestive sugars were declined being lower kept under ambient storage conditions.

- (3) There has been a significant increase in the level of per cent total sugars of *gulkand* throughout the period of storage and the per cent of total sugars varied between 50.87 and 52.84. The highest increase in total sugars per cent was recorded at higher level of citric acid (10 g). Moreover, this increase in TSS per cent was controlled with lower level of sugar (70 °Brix) being lowest at ambient storage conditions during storage passage of 9 months.
- (4) In general, non-reducing sugars per cent of *gulkand* declined significantly with the advancement of storage, but pattern of decline varied according to treatments. This decrease has been from 24.22 per cent to 16.59 per cent. The lowest decline in non-reducing sugar per cent was noted with higher level of citric acid (10 g). The *gulkand* prepared with medicinal herbs with pink rose showed the highest decrease in non-reducing sugars per cent.
- (5) In general, there has been significant increase in acidity per cent of *gulkand* with the advancement of storage. The pattern of which however varied according to treatments. The acidity per cent varied from 0.21 to 0.35 during storage passage of 9

months. With increase in level of citric acid there was increase in acidity per cent and the highest increase in acidity per cent was observed at higher level of citric acid (10 g). This increase in acidity was reduced with medicinal herbs in combination with pink rose, the rate of increase in acidity was slower being lowest.

- (6) There has been a significant decrease in pH level of *gulkand* during storage. However, pattern of decline varied according to treatments. This decline has been from 4.94 to 4.75. The decreasing trend in pH was observed with the increasing level of citric acid and the highest decrease in pH was observed in higher level (10 g) of citric acid, whereas lowest decline was observed in treatment containing medicinal herbs and without addition of citric acid.
- (7) In general, there has been significant decrease in colour acceptance of *gulkand* during storage, however pattern of decline varied according to treatments. The colour rating has been ranged from 8.95 to 7.04. The highest score for colour acceptance was obtained in treatment combined with sapota, pink and red rose (100 : 650 : 250) with medicinal herbs (50 g). Whereas, the most dark coloration was seen in treatment containing sapota with red rose (100 : 900 g). Therefore, the optimum level of sapota blend with pink and red rose containing medicinal herbs improved the *gulkand* colour

acceptance whereas level of pink rose with lower level of sugar (70 °Brix) adversely affected the colour rating.

- (8) In general, the appearance score of *gulkand* declined significantly throughout the storage periods, the pattern of decline varied according to treatments. Appearance acceptance has been varied between 8.96 and 7.05. At ambient storage conditions, The product containing sapota with higher level of red rose (100 : 900) exhibited sharp decline in appearance score with the advancement of storage period. Whereas, treatment having medicinal herbs with blend of red and pink rose scored the highest in appearance rating of *gulkand* at the end of storage period. Therefore, the optimum level of sapota blend with pink and red rose containing medicinal herbs improve the *gulkand* appearance acceptance whereas pink rose with lower level of sugar(70 °Brix) adversely affected the appearance rating.
- (9) In general, there has been a significant decline in textural score throughout storage, pattern of decline varied according to treatments. Acceptance rating of texture varied from 9.05 to 8.32. The textural acceptance score was highly influenced by the addition of medicinal herbs in the product and the highest score was observed in the treatment containing medicinal herbs with blend of pink rose and red rose. Whereas, the lowest and more decreasing textural score was recorded at higher level of citric acid (10 g) followed by lower level of citric acid (5 g) during the passage of 9 months

of storage. Thus the addition of medicinal herbs were found as a textural improver whereas, higher level of citric acid adversely affect the textural quality.

- (10) It is apparent from the data that the taste score of *gulkand* decreased significantly with the advancement of storage but the pattern of decline varied according to treatments. The taste acceptance score varied from 7.98 to 6.35. Under ambient storage condition, product with medicinal herbs exhibited higher acceptance taste wise and the highest rating was recorded which containing medicinal herbs with pink and red rose. However this acceptability declined with addition of citric acid in *gulkand* and with higher level of citric acid (10 g) recorded lower taste score being minimum followed by lower level of citric acid (5 g). Thus, the quality of product was more acceptable with medicinal herbs while the product become unacceptable with addition of citric acid.
- (11) In general, there has significantly decrease in flavour score of *gulkand* with the advancement of storage, but the pattern of decline varied according to treatments. The flavour score has been ranged from 8.65 to 6.90. The treatment containing medicinal herbs with pink and red rose impart more acceptability flavour wise in *gulkand* and this product has recorded the highest score for flavour. Whereas, product with lower level of Brix (70 %) scored the lowest for flavour acceptance. Moreover, the more flavour acceptance was more

with medicinal herbs while the product become unacceptable with addition of citric acid.

- (12) In general, the overall acceptability score of *gulkand* declined significantly with the advancement of storage. The pattern of decline varied according to treatments. Overall acceptability score ranged from 8.71 to 7.13. The highest overall acceptability score was recorded in the treatment containing medicinal herbs with blend of pink and red rose. Whereas, the lowest and more decreasing overall acceptability score was recorded at higher level of citric acid (10 g) followed by lower level of citric acid (5 g) during the 9 months storage period at ambient temperature. Thus, the more overall acceptability was obtained with addition of medicinal herbs while the product become unacceptable with addition of citric acid.

In light of the results obtained in the present investigation, it can be concluded that sapota based blended *gulkand* containing sapota (100 g) combined with pink and red rose (650 : 250 g), medicinal herbs (50 g) and adjusted to 78⁰Brix, packed in glass jars was found to be the most stable and acceptable product in the terms of flavour, taste, colour, appearance, texture and overall acceptability when stored under ambient temperature (25-30⁰ C) for the storage period of 9 months.

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* Original not seen

APPENDIX

Appendix-I : Effect of various treatments on physico- chemical parameters of *gulband* based on sapota

Treatments	TSS (%)	Reducing sugar (%)	Total sugar (%)	Non-reducing sugar (%)	Acidity (%)	pH
T₁	78.77	30.46	49.89	19.42	0.14	5.03
T₂	78.79	31.28	51.71	20.43	0.14	5.02
T₃	78.80	31.49	52.30	20.81	0.15	5.02
T₄	78.79	31.01	50.78	19.76	0.12	5.04
T₅	78.78	30.74	50.30	19.56	0.13	5.03
T₆	78.82	31.78	53.58	21.80	0.12	5.05
T₇	78.84	32.08	53.90	21.82	0.12	5.04
T₈	78.95	34.49	54.58	20.09	0.62	4.19
T₉	79.13	36.21	55.02	18.80	1.19	3.90
T₁₀	70.76	27.34	47.01	19.67	0.18	4.98

Appendix-II : Effect of various treatments on sensory evaluation of gulkand based on sapota

Treatment	Parameter						
	Taste	Flavour	Colour	Appearance	Texture	Total	overall organoleptic score %
T ₁	8.81	8.85	8.03	8.04	9.30	43.03	86.06
T ₂	8.56	8.57	8.04	8.05	9.38	42.60	85.20
T ₃	7.12	6.87	8.04	8.05	9.40	39.48	78.96
T ₄	8.40	8.27	7.44	7.46	8.45	40.02	80.04
T ₅	8.77	8.77	8.35	8.36	9.42	43.67	87.34
T ₆	9.05	9.08	8.44	8.45	9.57	44.59	89.18
T ₇	8.91	8.89	8.12	8.13	9.44	43.49	86.98
T ₈	3.96	6.45	7.98	7.99	7.02	33.40	66.80
T ₉	3.15	6.16	8.02	8.03	6.94	32.30	64.60
T ₁₀	4.78	5.67	7.56	7.57	7.99	33.57	67.14

Appendix-III : Computation of costing of *gulkand* based on sapota fruits (per 1 kg)

Material	Quantity (gm)	Price / kg (Rs.)	Total (Rs.)
Sapota fruits	60	4.00	0.25
(Sapota pulp)	(40)	-	
Rose petals (pink)	250	20.00	5.00
Rose petals (red)	100	20.00	2.00
Sugar	780	12.50	9.75
Medicinal herbs	20	250.00	5.00
Processing Charge	-	2.00	2.00
Packaging	-	7.00/piece	7.00
Total cost / 1 kg	-	-	31.00
Wholesale price	-	-	60.00
Net profit	-	-	29.00

CERTIFICATE

This is to certify that I have no objection to supply one copy of any part of this thesis at a time to any scientist through reprographic process for rendering reference services in a library or documentation centre.

Place : Navsari.

Date : April 20, 2009


(Patel N. B.)