

**PROCESSING AND QUALITY
EVALUATION OF SPICED PLUM
NECTAR AS HEALTH DRINK.**

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UNIVERSITY OF AGRICULTURAL SCIENCES AND
TECHNOLOGY OF KASHMIR, SRINAGAR.**

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SUBMITTED TO THE FACULTY OF POST-GRADUATE STUDIES

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UNIVERSITY OF AGRICULTURAL SCIENCES AND TECHNOLOGY
OF KASHMIR**



**BY
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DIVISION OF POST HARVEST TECHNOLOGY

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CERTIFICATE-I

This is to certify that the thesis entitled “**Processing and Quality Evaluation of Spiced Plum Nectar as Health Drink**” submitted in partial fulfilment of the requirements for the Degree of **Master of Science** in Agriculture (Post Harvest Technology), to the faculty of Post-Graduate Studies, Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir is a record of bona fide research carried out by **Imtiyaz Ahmad** (Registration No 2001-A-635-M) under my supervision and guidance and no part of the thesis has been submitted for any other degree or diploma.

It is further certified that such help or assistance received during the course of investigation have been duly acknowledged.

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We, the members of the Advisory Committee of Mr. Imtiyaz Ahmad a candidate for the degree of Master of Science (Post Harvest Technology) have gone through the manuscript of the thesis entitled “**Processing and Quantity Evaluation of Spiced Plum Nectar as Health Drink**” and recommended that it may be submitted by the student in partial fulfilment of the requirement for the degree.

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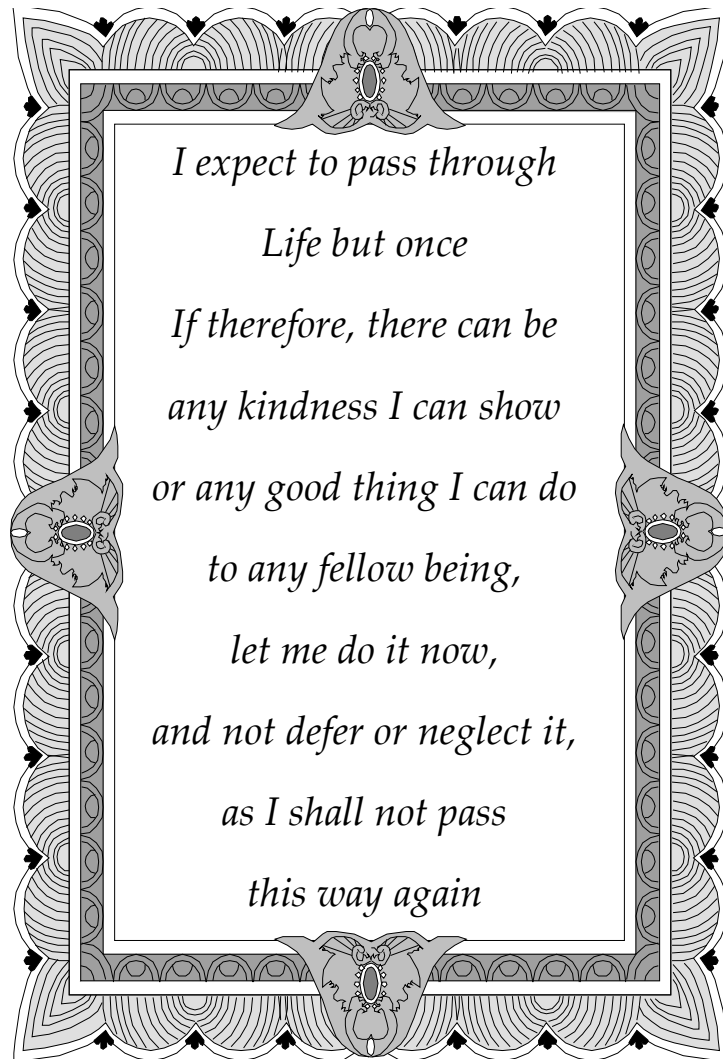
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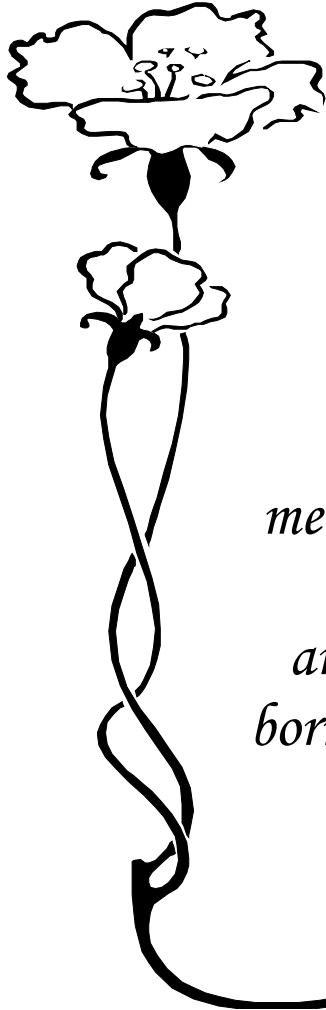
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*I expect to pass through
Life but once
If therefore, there can be
any kindness I can show
or any good thing I can do
to any fellow being,
let me do it now,
and not defer or neglect it,
as I shall not pass
this way again*



DEDICATED TO

*My loving parents,
memories of my late sister*

*and all those who were
born but never died
.....are missing.*

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ACKNOWLEDGEMENT

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ABSTRACT

Investigations were carried out on “Processing and Quality Evaluation of Spiced Plum Nectar as Health Drink”. Two Cultivars of plum viz Santa Rosa and Satsuma were used. The fruits were first analysed for various physical characteristics. Pulping of the fruit was done by using hot break method and the pulp was preserved by pasteurization (90° C for 30 minutes) in pre-sterilizing glass bottles for further analysis. Preserved pulp was then utilized for development of nectar as per F.P.O specification (1955), using (20%) pulp, T.S.S (18%) and acidity (as maleic acid) maintained at (0.4%) and by adding various spices viz. black cumin, cardamom, black pepper, black salt, common salt, ginger extract, mint extract in various proportions. However no spice was added to control which was only chemically preserved

using sodium benzoate at 120ppm, while as other treatments were pasteurized at 90° C for 30 minutes.

Physico-chemical, Microbiological and Sensory evaluation of the product developed was carried at 0, 60, 120 and 180 days interval. Results revealed that there was gradual increase in TSS (%), titrable acidity (%), total sugars (%), reducing sugars (%) and non-enzymatic browning while ascorbic acid (mg/100g.), anthocyanins (mg/100g.) and tannins (%) showed decreasing trend, irrespective of cultivar used.

Sensory evaluation was carried by a panel of 10 semi-trained judges for colour, flavour and overall acceptability on 4.00 scale and the results revealed that nectar prepared from Santa Rosa cultivar with spice concentration (T₁) scored maximum with respect to colour, flavour and overall acceptability.

Microbiological studies revealed pasteurization along with addition of spices was superior than chemical preservation as there was no spoilage/microbial load in treatments where pasteurization along with addition of spices was practised.



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INTRODUCTION

INTRODUCTION

World wide, the food processing industries are considered sunrise industries and have the potential of attracting huge local and foreign investments. The investments will not only accelerate the pace of industrialization, but will also lead to improvements in both rural and urban infrastructure. A well run food processing industry ensures that while on one hand the producer gets remunerative price for his product, the consumer pays less for higher and assured quality.

Although India is one of largest producers of raw materials for food processing industry in the world, the industry itself is extremely under-developed in India. In India less than 2 per cent of fruit and vegetable product is processed, compared with 30 per cent in Thailand, 70 per cent in Brazil, 78 per cent in Philippines and 80 per cent in Malaysia. The value addition in the food sector is still very low at 7 per cent (Saigal, 2001).

India is the second largest producer of fruit, next only to China, even though the area under horticulture crops is only 9.24 per cent of the total area under agriculture. This limited area gives the return of various horticulture commodities to the extent of 149 million tonnes of which share of fruits and vegetables is 137 million tonnes. It has been estimated that 37 per cent of this highly perishable crops are wasted due to lack of post-harvest management, cold chain infrastructure and value addition, which accounts for an annual loss of Rs. 23,000 crore approximately (Nagi, 2002).

The 20th century was marked by unprecedented human achievements in the range of endeavour, art, civics, humanities, medicine, science and technology and

social relation to name a few. Yet, at the beginning of 21st century widespread poverty, chronic hunger, malnutrition, diseases, conflict and environmental degradation are the main challenges before mankind. An important aspect of viable production system is preserving what is produced because food produced has no value unless it does not reach the consumer in acceptable state. It has been estimated that nearly about 20 – 40 per cent of food produced is wasted thus depriving the hungry humanity of their basic need. In order to feed the hungry mouths we need to have good post-harvest management and value addition of the perishable food items, the fruits and vegetables, because it is only through post-harvest management and value addition we can reduce the post harvest losses thus reducing hunger, malnutrition and diseases, as fruits and vegetables act as protective foods.

The horticulture produce faces a glut situation when it arrives at the market and farmers restore to distress sale due to perishability, thus reducing farmers income. Then comes the scarcity and vacuum in the market. If somebody wants to relish apples, mangoes, pear and other fruits, all the year round, it is just not available. Thus horticulture produce calls for value addition and product formulation for the purpose of

- Table and raw consumption
- Liquid beverages (non-alcoholic and alcoholic)
- Health drinks
- Pulp and other semi-liquid foods.
- Recycling of horticulture waste.
- Pharmaceuticals, oleoresins, cosmetics, perfumery and confectionary

Plum (*Prunus saliciana*, Lindl.) is an ancient fruit and its cultivation dates back 2000 years. Among the cultivable species, *Prunus domestica* – the European plum and *Prunus saliciana* – the Japanese plum are commercially grown species which are most popular around the world. The Japanese plum is native to China while as European plum is native to South-Eastern Europe (Westwood, 1988).

In India plum is predominantly grown in Jammu and Kashmir, Himachal Pradesh, hills of U.P and Tamil Nadu (Kishore *et al.*, 1991). Area under plum in Jammu and Kashmir state is 2876 hectares and production during year 2002 was 4060 MT (Anonymous, 2002). The important cultivars of plum grown in Jammu and Kashmir state are Santa Rosa, Formosa, Satsuma, Burbank, Blue Imperatrice, Grand Duke, Titron, Prune – D – Agon and Wickson (Anonymous, 2002).

Nutritionally plum is a good source of carbohydrates, minerals (Ca, Mg and K) and fairly good source of protein with aspartic acid and asparagine as main two amino-acids. It is also a good source of vitamin-C and dietary fibre (1.3 – 2.4 %). The fruit picked at right stage of maturity give excellent taste and flavour on ripening. The Plum tree is a prolific and regular bearer. It is climacteric fruit having a short shelf life (Wills *et al.*, 1982). Plum cannot be stored over longer period at room temperature because of its soft juicy nature. At 40°C plum retains market quality for 3 to 4 days (Tsuji *et al.*, 1984). However the shelf-life of fruit can be enhanced upto 3 – 4 weeks by storing the fruits under cold storage conditions at -0.6°C to 0°C and relative humidity of 90 – 95 per cent (Lutz and Hardenberg, 1968).

Keeping in view the heavy regular bearing habit of plum tree, short crop period, perishable nature of fruit, short shelf-life, seasonal losses, problems of post-harvest

storage and long distance marketing, value addition of this perishable crop is need of the hour. Also due to high acidity and astringency the utilization of plum for preparation of various processed products becomes limited, despite having high nutritional qualities. Therefore using 10-25 per cent pulp for production of RTS beverages and addition of spice extracts are thought to be convenient alternative for its utilization in order to have some value added fruit drinks which are of high quality in respect of both nutritional and sensory aspects. Moreover, there is always demand from consumers all over the world for new food products which should be nutritious and delicately flavoured.

Spiced beverages are gaining importance in market place in the form of fruit drinks, squashes, appetizers, health drinks etc (Lal *et al.*,1999). Spices in foods are primarily used for their consistency of flavour, aroma and stability in storage and have natural antioxidant and antimicrobial properties. They also have carminative, antispasmodic, flatulent and diuretic properties and aid in digestion through stimulation of appetite (Griffin, 1992). The species apart from having appetizing properties also possess medicinal and therapeutic values, which have a profound effect on human health since they affect many functional processes.

In today's world of changing food habits, consumers are becoming more health conscious than before and show good interest in health foods. They are driven more towards the natural products which are health friendly and provide various vitamins and minerals than the synthetic ones like carbonated drinks which do more harm than good. Thus we have to provide them something new which is health friendly and nutritious - Health Drink. One such attempt is developing spiced RTS plum nectar.

With the above facts in view, present investigation was taken at SKUAST-K with following objectives.

1. To standardize recipe for the development of spiced nectar from different cultivars of plum.
2. To study the effect of variety on the quality of spiced nectar.
3. To study the economics of formulated product.
4. To study effect of storage on the quality of product.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

2.1 Biochemical Composition of Plums

The chemical composition of plum varies with cultivars, climate, maturity and cultural practices (Hansen, 1959 and Claypool *et al.*, 1962).

Major constituents of plum are moisture, total solids which include sugars, organic acids. The other minor constituents include proteins, vitamins, fats, dietary fibre, minerals, polyphenols, enzymes etc.

2.1.1 Moisture and Total Soluble Solids:

Moisture is the major constituents of plum and varies from 86 – 88 per cent depending upon cultivar and location (Wills *et al.*, 1983; Westwood, 1988 and Gothwal *et al.*, 1998). The TSS varies from cultivar to cultivar depending upon cultivar, climate, and maturity stage, it ranges from 9.2 – 17.40 per cent (Chopra *et al.*, 1981).

2.1.2 Sugars:

Plums are rich source of sugars. The total sugars content of plum varies from 6.7 – 9.9 per cent (Chopra *et al.*, 1981 and Rozmyslova, 1989). The sucrose is the major sugar (1.0 to 4.2%), other sugars detected include D-glucitol, sorbitol, galactose, mannose, arabinose, rhamnose, raffinose and xylulose (Wills *et al.*, 1983 and Landerhoven *et al.*, 1991).

2.1.3 Organic Acids:

The organic acids in plum range from 1.4 – 2.7 per cent. The major acids being maleic acid 0.14 to 2.5 per cent, citric acid 0.03 – 0.04 per cent, quinic acid 0.12 – 0.41 per cent (Wills *et al.*, 1983 and Landerhoven *et al.*, 1991).

2.1.4 Proteins and Fats:

The protein content of the fruit is low like other fruits. It varies from 0.4 – 0.8 per cent. The chief amino-acids present in plum include asparagine, aspartic acid, glutamic acid, glutamine, serine, threonine, α -alanine, γ - amino-butyric acid, valine, leucine, proline, besides traces of hydroxyl proline. The fat content is about 0.2– 0.3 per cent (Wills *et al.*, 1983 and Landenhoven *et al.*, 1991).

2.1.5 Vitamins, Minerals and Dietary Fibre:

Even though plum has other vitamins, it is the vitamin-C, which is present in a quantity to be of nutritional significance. Various vitamins present in plum include thiamine (0.02 – 0.05 mg/100g.), riboflavin, (0.04 – 0.05 mg/100g.), vitamin-C (4.00 – 11.00 mg/100 g.), niacin, (0.2 – 0.9 mg/100 g.), carotene (0.26 – 0.78 mg/100g.). The various minerals present in plum include Potassium (120-190 mg/100g.), Sodium (3.00 mg/100g.), Calcium (6.0 – 8.0 mg/100 g.), Magnesium (4.0 – 7.0 mg/100g.), Iron (0.1 – 0.4 mg/100g.), Zinc (0.1 mg/100g.). The dietary fibre in plum ranges from 1.3 – 2.4 per cent. (Halme 1978; Wills *et al.*, 1983; Rozmyslova 1989 and Landerhoven *et al.*, 1991).

2.1.6 Pectin.

The pectin content in plum fruit ranges from 0.81 – 0.98 per cent (Raynal *et al.*, 1991).

2.2 Processed Products:

Processing extends the availability of seasonal fruits, retains their nutritive and aesthetic values to improve human health and add variety to diet. One of the prime goal of food processing is to convert perishable goods into stabilized products which

thus enhance its shelf-life. Processing changes fruit into new and more usable forms preserving their taste and flavour (Salunkhe and Desai, 1984).

Plum can be processed into number of products like juices, jams, squashes, RTS beverages, nectar etc.

2.2.1 Juices:

Studies were conducted by Wani and Saini (1990) to standardize the method of juice extraction from plum (*Prunus saliciana* Lindl.) cultivars, Alubukhara, Satsuma and Santa Rosa. Pulp and juice yield by hot break method was higher in all three cultivars of plum compared to cold break extraction. Addition of water increased juice yield but reduced total solids content. Pectinolytic enzyme treatment increased juice yield but reduced total soluble solids, total solids, pectin and relative viscosity of the juice.

Wani *et al.* (1990) studied physico-chemical changes during preparation of plum juice concentrate. Pulp and juice from, three plum cultivars viz Alubukhara, Satsuma and Santa Rosa were concentrated in glass evaporator at 50 – 60 °C under Vacuum of 27 – 30 inches of Hg. They observed that plum pulp could not be concentrated beyond 26 °Brix, while the juice was concentrated to 73 °Brix. An increase in TSS, total solids, reducing sugars, browning and viscosity was observed with negligible decrease in acidity and pectin during concentration.

Joshi *et al.* (1991) reported that addition of pectinolytic enzyme (pectinol) to the pulps of plum, peach and apricot increased juice yield, causing a slight change in TSS, pH and acidity and a drastic increase in apparent viscosity. Addition of pectinol

also improved colour and clarity without affecting flavour. Optimum enzyme concentration for addition was found to be 0.5 per cent.

Wani and Saini (1993) studied enzymatic clarification of plum pulps (var. Alubukhara, Santa Rosa and Satsuma). They reported that juice yield obtained from hot pulps was higher than from cold extracted pulps for all plum varieties and pectinolytic enzyme treatment yielded clear bright juice with thin consistency and no residual pectin. Enzymatically clarified juice from hot extracted pulps gave best results in terms of colour of ready-to-serve drinks. Overall scoring improved further when plum juices were blended uniformly prior to preparation of RTS drinks. Enzymatically clarified juices were suitable for concentration due to elimination of suspended material.

Kang *et al.* (1994) developed procedure for commercial production of a sour plum juice. They reported that 5 per cent puree, 1.2 per cent concentrated juice and 10.5 – 12 per cent sucrose, with 0.1 per cent pectin and 0.2 per cent sodium carboxymethylcellulose was best recipe. The final product was brown red in colour, had a good taste and flavour and contained soluble solids at 10 per cent, total acid at 0.25 per cent and total bacterial count 100 cells/ml.

Siddiq *et al.* (1995) investigated effect of five commercial pectinases (poly galacturonases) on yield and quality of Stanley plum juice. Pectin enzymes were added at concentration of 0.05, 0.10, 0.20, 0.40 and 0.60 per cent (V/V) to macerated plums. After holding (4 hrs. 49°C) the fruit was passed through cheesecloth to obtain juice. Juices were analysed for yield, clarity, colour, degree Brix, titrable acidity, pH, °Brix/acid ratio, sugars, total anthocyanins, total phenolics and enzymatic browning.

The five pectic enzymes improved, to varying degrees, yield, colour and clarity of juice. Effectiveness of pectinase increased as enzyme concentration was increased; however at concentrations greater than 0.20 per cent the enzyme imparted a bitter flavour to the juice. Pectinase at a concentration of 0.20 per cent produced the highest yield of sediment- free plum juice.

Chauhan *et al.* (2001) studied pectinolytic liquefaction of plum, apricot and mango pulps for juice extraction. Optimal conditions were investigated for liquefaction of plum (var. Titrone) apricot (var. Charmagaz) and mango (var. Amarpali) pulps with pectinase enzyme for juice extraction. Pectinase powder with pectinesterase and polygalacturonase activities of 1.15 and 6.68 unit/g. respectively was used. Conditions tested included incubation time (1 – 7 hrs), temperature (30° – 50° C) and enzyme concentration (0.25 – 10 %). Optimum liquefaction of plum and apricot pulps occurred at 45°C in 5 hrs with enzyme concentration of 0.5 per cent, resulting in maximum juice yields of 82 per cent and 78 per cent respectively. Incubation at 45°C for 6 hrs at 0.9 per cent enzyme concentration led to maximum juice yield of 59 per cent from mango pulp. Juices obtained after pulp liquefaction had higher moisture content. TSS, total and reducing sugars and acidity and lower crude fibre, vitamin-C and pH values than pulps. Values for fat, protein, ash and beta-carotene contents remained approximately the same in juices as in pulps.

2.2.2 Nectars /RTS Beverages:

Waskar and Khurdiya (1987) observed the attractive colour of perishable phalsa fruit and its beverages was due to anthocyanins which was liable to quick degradation at high temperatures prevailing during harvesting season and storage of

beverages. The investigation was undertaken to study the processing and storage of phalsa beverages such as nectar, concentrate, squash and crush. It was found that there was a maximum retention of anthocyanins in the phalsa beverages stored in cold store followed by storage in cool chamber and at room temperature. All these beverages were found to be acceptable upto 180 days and crush upto 240 days in cold storage, followed by 120 days in cool chamber but 60 days at room temperature. Storage studies indicated increase in TSS, total and reducing sugars.

Gofur *et al.* (1994) studied formulation and preservation of ripe mango nectar. Mango nectar was made from ripe mango pulp and bottled in 150 ml sterilized glass bottles sealed and stored at (22 – 37°C) for 380 days. Composition, shelf-life and acceptability of the nectars were studied at 10 days interval upto day 30, then at intervals of 20 days upto to day 110 and then at intervals of 45 days upto day 380. With the exception of vitamin-C content, which decreased from onset of storage, no significant changes were noted with regard to colour, acidity, pH, total soluble solids, ash, and fibre in nectar during storage for 360 days, thereafter, deterioration in colour and taste was observed.

Baramanray *et al.* (1995) studied the suitability of guava hybrids for nectar making. Three commercially grown cultivars (Allahabad Safeda, Banarsi Surkha and Lucknow-4) were included for comparison. Fruits were harvested at firm ripe stage and nectar was prepared. Nectar was stored for 90 days at room temperature (25 ± 5°C) to evaluate shelf life. Samples were examined at 30 days intervals. During storage there was a linear increase in browning, total soluble solids, titrable acidity, total and reducing sugars whereas ascorbic acid, pectin and organoleptic quality

decreased with increased duration of storage. High quality nectar was prepared from all the hybrids and rated better than that of commercial cultivars

Wang and Liu (1996) investigated the causes of non-enzymatic browning in peach (cv. Jiubao and Luhua-3) nectar during processing using statistical analysis of path co-efficient of colourless anthocyanins, anthocyanins, OD value and ascorbic acid in relation to agitation time, blanching method, deaeration and sterilization time , in eight treatments. Results showed that the major factor responsible for non-enzymatic browning were anthocyanins, with path coefficient of 0.7073 and colour less anthocyanins with a path coefficient of 0.5310 for cultivar, Jiubao and ascorbic acid with path coefficient of 0.8102 for cultivar Luhua-3.

Gothwal *et al.* (1998) studied preparation and storage of some processed products from plum. Commercially important varieties (Santa Rosa, Meriposa and Early Transparent Gage) of plums grown in hilly regions of Uttar Pradesh, India were assessed with respect to suitability for manufacture of products. They reported ready-to serve (RTS) beverage, squash, nectar and jam products of desirable quality could be prepared from fresh and stored pulp of the plums by pre heating and using 550 ppm SO₂. Physiochemical characteristics of fresh fruits and chemical composition of sulphited pulp and heat processed pulp stored at ambient temperature for upto 9 months were analysed. RTS beverages exhibited good colour, taste, aroma and mouthfeel.

Pandey and Singh (1999) conducted studies on the preparation and preservation of guava RTS beverages using cultivars Allahbad Safeda, Sardar (L-49), Apple Colour and Sangam. The storage studies showed that there was a gradual increase in

TSS acidity, non-enzymatic browning and decrease in vitamin-C and organoleptic rating during 4 months of storage in all the recipes irrespective of cultivar used. The recipe containing 10 per cent and 11 per cent TSS with 0.25 per cent acidity was found to be most acceptable and the RTS beverages prepared from Sardar guava (L-49) was rated highest.

Doodnath and Badriel (2001) reported that watermelon fruits (*Citrus lanatus*), var. Crimson Sweet were processed to RTS pasteurised nectars (85°C for 20 minutes) with varying levels of °Brix (15, 20, 25), Xanthum gum per cent (0.10, 0.20, 0.25), citric acid percentage (0.10, 0.15, 0.20, 0.30) and fortified with 1.0 per cent ascorbic acid with or without addition of potassium sorbate. Sensory evaluation indicated that watermelon nectar which consisted of 20 or 25 °Brix, 0.20 per cent Xanthum gum, 0.15 per cent citric acid or pH 3.75 – 3.87 was most highly ranked by the panellists, than nectar blends of watermelon with mango. On storage for 5 weeks at 20-25°C there were no quality changes in consistency and TSS (°Brix). However there were slight reduction in the pH, fading of colour and loss of ascorbic acid with negligible growth of micro organisms.

Krishnaveni *et al.* (2001) prepared RTS beverages from two varieties of jack fruits with 10 per cent pulp. 18°Brix TSS and 0.25 per cent acidity (citric acid) and packed in coloured (green) and colourless bottles and stored at room temperature to study the storage stability. The storage study showed that there was an increasing trend in acidity and reducing sugar and decreasing trend in pH, total sugars, ascorbic acid and β - carotene content, but TSS did not change during storage. Retention of ascorbic acid and β - carotene contents were much better in the samples stored in green

bottles. The sensory quality attributes were found to be highly acceptable even after storing for 6 months at room temperature.

2.2.3 Spiced Beverages:

Obodovich *et al.* (1988) prepared a non-alcoholic beverage having 50-55 days shelf-life by lowering the content of citric acid (by 50 %) and sugar content (by 2.6 %). The beverage contained spices, based on extracts from nutmeg, baidan, ginger, clove and zhen-shen. Blends were aseptically prepared using invert syrup, electrochemically treated and pH adjusted to 2.5 – 2.7. The beverages had a pleasant taste and aroma.

Pavlyuk-Ryu (1988) developed vitamin fortified non-alcoholic beverages using freeze-dried powder from whole fruits to which extracts from spices and herbs were added. Beverage included vitamin fortified tonic and special-type products designed for expeditions, sportsmen, astronauts and children etc. To prepare the products, sugar and an organic acid were mixed together with extract from spices and herbs and the freeze-dried powder, ethanol extract of essential oil was added during mixing. Tables were presented showing composition of 22 beverages viz, content of vitamins, phenolic substances and minerals.

Joshi *et al.* (1991) conducted studies on preparation and evaluation of spiced plum vermouth (cv. Santa Rosa). In the vermouth with increased levels of alcohol, total soluble solids, pH, aldehyde, esters, phenols and per cent sediment increased, while titrable acidity and vitamin-C declined. Volatile acidities, sugar contents and colour values remained unaffected. The herbs/spices extract addition (black pepper, coriander, cumin, clove, large cardamom, saffron, fenugreek, nutmeg, cinnamon,

poppy seed, ginger, woodfordia, asparagus, withania, adhatoda, rosemary) increased total phenols, aldehydes and ester content of vermouth. Sensory evaluation of the products showed the sweet products to be superior to the dry ones. Vermouth with 15 per cent alcohol and sweet taste was the best product.

Joshi *et al.* (1993) studied the use of enzymatically extracted plum, juice for preparation of beverages . Cultivar used for studies was Santa Rosa. For nectar 20, 25 and 30 per cent juice contents were used and their TSS were raised to 16 °Brix with sugar syrup. For plum appetizer, the TSS of 35 per cent pulp was raised to 45 – 55 °Brix. In one sample of each product spices or flavour extracts were added (mint, ginger, salt, black salt, cumin, cardamom, black pepper, citric acid and sodium benzoate). Plum juice beverages containing 40 per cent juice and at 10 °Brix were found to be most acceptable juice products. For fruits nectars products with 20 per cent juice at 15 °Brix were found to be optimum. Plum appetizer with added spices was most acceptable.

Barwal and Sharma (2001) developed spiced plum appetizer using cultivar Santa Rosa. Two different combinations of fruit pulp and spice recipe were tried at three levels (40, 45 and 50 °Brix) of total soluble solids for standardization of the product. The prepared appetizers were evaluated for sensory attributes by a panel of semi-trained judges. A combination of 30 per cent fruit pulp with standard recipe (0.1 % cardamom, 0.25 % cumin, 0.4 % black pepper, 0.5 % common salt. 1.0 % black salt, 1.5 % ginger extract and 1.0 % mint extract) at 40 °Brix was found to be the best. The developed appetizer was also analysed for various physico-chemical

characteristics. The appetizer had appealing colour, body, flavour, and 30.8 sugar/acid ratio.

Deka and Sethi (2001) prepared RTS beverages from blended fruit juices of lime-aonla, mango-pineapple, grape-mango and grape-pineapple with the addition of various aqueous spice extracts and commercial spice drops. The spiced lime aonla (95:5) RTS beverage with salt (common salt 0.5 % + black salt 0.5 %), aqueous spice extracts of curry leaf (0.5 %), cumin (0.25 %), cardamom (0.25 %), black pepper (0.1 %), juice of ginger (2 %), and mint (0.4 %) was found best among all the beverages. Like wise mango-pineapple (85:15) with cardamom spice drops (0.006 %) was best among the RTS beverages prepared from commercial spice drops. The addition of spices improved the quality of beverages.

2.2.4 Jams:

Kamneva and Lisakova (1973) prepared dietary plum jam with sorbitol and xylitol. For jam preparation the fruits were blanched with water for 5 minutes at 80 – 85 °C held for 10 minutes at a pressure of 3.33 KPa in sorbitol or xylitol containing syrup. For each 110 parts of fruit 100 parts of sorbitol or xylitol were used, with an addition of 0.4 – 0.8 per cent of highly esterified pectin. A mixture of sorbitol or xylitol in the ratio 1: 1 or 1:2 proved to be satisfactory from the point of view of jams flavour and appearance. The plum jam contained 60.4 per cent, dry matter, 0.61 per cent acid, 6.66 per cent total sugars. 3.61 per cent glucose, 1.71 per cent fructose, 0.49 per cent soluble pectin, 26.5 per cent sorbitol. The composition of jam did not change substantially after a year of storage except for a small drop in the total pectin content.

Vorobeva and Onishchuk (1974) studied the effect of sugar concentration on properties of jams. In view of the trend towards reduction in sugar content of jams, tests were carried out in which plum and apple jam was made with 2 parts of puree to 1 part sugar (experimental) as well as with established 1.25 parts puree and 1 part sugar (control). The dry matter was 66 per cent in both cases. In a 3rd variant the dry matter content of experimental jam was reduced to 60 per cent. Both experimental jams had better taste characteristics than control, but after 5 months storage at 20°C their spreadability was poorer.

Ganhar and Karim (1978) studied the effect of cold storage on marketing and processing quality of plum. Fazle-Manani cultivar plums were harvested at three maturity stages, under ripe, medium ripe, over ripe stored for 6 weeks at 32 ± 2 °F, 85 – 90 per cent relative humidity and evaluated for fresh consumption and processing into jam. Tabulated data from analysis and consumer evaluation show that jam from freshly harvested plums was preferred to that prepared after 3 weeks storage. After six weeks storage enzyme degradation of pectin prevented setting. Medium ripe fruit was preferred both for jam and fresh consumption even after storage.

2.2.5 Squashes:

Jain *et al.*(1988) analysed four varieties of litchi viz Desi, Calcuttia, Rose Sented and Late Bedana for different chemical constituents related to quality and discolouration characteristics. The squashes prepared from Calcuttia and Desi variety was superior in comparison to other varieties and maintained its organoleptic quality for longer period. Storage studies indicated a pattern of progressive increase in TSS,

sugars and browning whereas acidity, ascorbic acid and tannin contents showed decreasing trend.

Khuridya (1990) observed that phalsa beverage such as nectar, concentrate, squash and crush packed in glass containers were found to be acceptable upto 240 days of storage kept at 3°C. However the phalsa squash kept in glass bottles and stored at low temperature was superior to other treatments and maintained its natural colour, taste and flavour upto 6 months. Further Sethi (1993) reported that litchi squash was found to be acceptable organoleptically for 4 months at room temperature (25 – 35°C) and upto six months at low temperature (4 – 5 °C).

Prasad and Mali (2000) studied physico-chemical changes in pomegranate squash during storage and revealed that it was acceptable organoleptically for a period of 3 – 4 months at room temperature and upto one year at low temperature. The original colour of the squash was maintained as such upto three months. Thereafter it started fading at room temperature but remained as such for one year at low temperature. The TSS, total sugars and reducing sugars increased with increased period of storage both at room temperature as well as at low temperature.

Barwal *et al.* (2002) investigated the potential use of sorbitol to produce a low calorie seasoned plum squash using plum (cv. Santa Rosa) pulp, spices and herbs at five different proportions of sucrose to sorbitol. With the increase in the proportion of sorbitol sweetness, the sensory score for colour, body and flavour increased. The standard (100 % sucrose sweetened) had highest overall acceptability. The mean value for overall acceptability after a storage period of 30-180 days was similar to that of day zero.

MATERIAL AND METHODS

MATERIAL AND METHODS

The present investigation entitled. “Processing and Quality Evaluation of Spiced Plum Nectar as Health drink” was carried out in the Division of Post Harvest Technology, Sher-e- Kashmir University of Agricultural Science and Technology (K) Shalimar, Srinagar during the year 2002-2003.

3.1 Raw Materials:

In the present study the fresh plum cultivars viz, Santa Rosa and Satsuma were harvested from trees growing in the varietal collection blocks of Pomology Division of SKUAST (K) at Shalimar campus and were carried to Division of Post Harvest Technology in wooden boxes of 5 kg capacity. They were temporarily stored under low temperature (0-4°C).

3.1.2 Spices and Herbs:

The spices viz, cardamom, cumin, black pepper, black salt, common salt were brought from open market and care was taken while buying that the spices were of best quality with minimum impurities. Fresh ginger and mint were also procured from open market.

3.2 Physical Parameters:

Before processing following physical parameters of fruits were evaluated.

3.2.1 Fruit Weight:

The representative sample of 30 fruits in 5 replicates (6 fruits/replicate) were taken from each variety and weighed on top pan electric balance (Metzer Biomedical and electronics Pvt. Ltd.) to calculate average fruit weight in grams.

3.2.2 Fruit Dimensions:

Fruit length and diameters were recorded in millimetres using Vernier calliper for the above mentioned representative samples from both cultivars.

3.3 Product Development:

Nectars were prepared as per following specifications

Pulp (%)	:	20 (%)
TSS (%)	:	18 (%)
Acidity (%)	:	0.4 (%)

3.3.1 Preparation of Pulp:

Fruits taken from cold storage were sorted and rotten fruits were discarded. Only ripe fruits were selected for product development. The sorted and selected fruits were washed with running water to remove adherent dirt and dust particles. The stalks were removed manually. Fruits were first weighed and then pulped using hot break method where in fruits were mashed with 10 per cent water, heated to 85°C for 10 minutes to soften the fruits. Then pulp extraction was carried out using junior pulper fitted with $\frac{1}{32}$ seive. The pulp obtained was weighed to determine pulp yield, hot filled in pre-sterilized glass bottles of 650 ml capacity, crown corked and then sterilized in boiling water for 30 minutes. The preserved pulp was analysed for various physico-chemical parameters viz, total soluble solids (TSS %), acidity (%) as maleic acid, pH, reducing sugars (%), total sugars(%), vitamin-C (mg/100 g.), anthocyanins (mg/100g.), tannins as (%tannic acid).

The stones obtained were collected, washed in running water, dried and weighed to determine pulp stone ratio.

3.3.2 Preparation of Spices and Herbs:

Cardamom, cumin, and black pepper were cleaned manually of any impurities. Then they were dried in oven at 50° C for 24 hours, ground in mixer-grinder. Black salt was broken in small pieces and ground in pestle and mortar. Then these spices plus black salt and common salt were boiled in 100ml water for 5 minutes, strained through triple folded muslin cloth, the extract collected and later on added to nectar. Fresh ginger was washed thoroughly, peeled manually and passed through screw type juice extractor to extract juice. Fresh mint was washed thoroughly crushed in blender, squeezed through muslin cloth to extract the juice which was later on added to the product.

3.3.3 Preparation of Nectar:

The preserved pulp from both varieties was utilized for product development as per specifications, using concentrations of spices as shown in the table -1

Table 1: Spices (grams/litre)

Spices	T ₀ (Control)	T ₁ (Std I)	T ₂ (Std II)	T ₃ (Std III)
Cardamom	No Spice	0.75	1.25	1.75
Black cumin		1.0	1.50	2.0
Black pepper		1.0	1.50	2.0
Black salt		1.5	2.0	2.50
Common salt		2.50	2.50	2.50
Ginger		4.0	7.0	10.0
Mint		6.0	9.0	12.0

The pulp was strained through double folded muslin cloth, hot sugar syrup was added to strained pulp and mixed thoroughly. Then spice extracts as per the table -1 were added to it, followed by addition of mint and ginger extracts, later on citric acid was added to all formulations and sodium benzoate @ 120 ppm to control (T_0) only. The nectar was then hot filled in pre-sterilized turbo glass bottles of 200ml capacity, care was taken that enough head space was left during the filling of bottles. The bottles were crown corked, pasteurized in boiling water for 30 minutes, cooled, labelled and stored at ambient temperature (15-35° C ; relative humidity 60-80%). Unspiced treatments containing sodium benzoate as chemical preservative were not pasteurized. Nectar prepared was stored for six months and evaluated at 60 days interval to monitor the physico-chemical, organoleptic and microbiological changes.

3.4 Analytical Methods:

3.4.1 Total Soluble Solids:

The TSS was determined by using hand refractometer (Atago N1 Japan) (0-32 °Brix) and the values were corrected at 20° C using correction factor.

3.4.2 Titrable Acidity:

Titration acidity (%) was determined by titration and values expressed as maleic acid (Rangana 1986). 10 ml sample from the prepared product was taken and volume made upto 100 ml with distilled water. Then these samples were titrated against standard 0.1 N NaOH using phenolphthalein as indicator till light pink colour (end point) was obtained and the volume used was noted. Then percentage acidity was calculated using following formula.

$$\text{Titration Acidity (\% as maleic acid)} = \frac{\text{titre value} \times \text{normality of Alkali} \times \text{vol. made up} \times 67}{\text{vol. of sample taken} \times \text{aliquot taken} \times 1000} \times 100$$

3.4.3 pH:

pH was determined by using digital pH meter (Tanco, B-1011). The pH meter was first calibrated using buffers of pH 4.0 and pH 7.0 at room temperature. The sample was then taken in the 100 ml beaker, stirred and electrode of pH meter put in it and direct reading from pH meter was taken when the reading stabilized.

3.4.4 Sugars:

Total and reducing sugars were estimated by Lane and Eynon method (Rangana, 1986). 10 ml of sample was diluted with about 50 ml of distilled water and neutralized with sodium hydroxide (1*N*) using phenolphthalin as an indicator. To it 2 ml of 45 per cent lead acetate was added, shaken well and left undisturbed for 10 minutes, de-leaded with 2 ml of 22 per cent potassium oxalate and volume made upto 250 ml with distilled water. It was then filtered and marked as solution (A).

For estimating reducing sugars, solution (A) was used, but for the estimation of total sugars 50 ml of solution (A) was inverted in 200 ml flask by adding 5 grams of citric acid to it and then boiled for 15-20 minutes and cooled, neutralized with 1*N* NaOH till pink coloured appeared using phenolphthalin as an indicator. Volume made upto 250 ml and the solution designated as solution (B).

Five ml of each Fehling's solution (A) and (B) were taken in a titration flask containing 25 ml of distilled water and titrated against solution (A) for estimation of reducing sugars and solution (B) for total sugars, till brick red colour was observed. After this, 2 drops of methylene blue (indicator) were added and titration was continued till brick red precipitate was observed. During the entire period, the flask

was kept on burner to keep the contents hot. Percentage of reducing sugars and total sugars were calculated using following equation.

$$\text{Reducing or total Sugars (\%)} = \frac{0.05 \times \text{vol. made}}{\text{titre value} \times \text{vol. of sample}} \times 100$$

3.4.5 Ascorbic Acid (Vitamin-C):

Vitamin-C was estimated by the method as described by Rangana (1986) using 2,6, Dichlorophenol Indophenol as dye. Dye factor was first calculated by titrating 5 ml standard ascorbic acid plus 5 ml (3%) metaphosphoric acid against 2,6 Dichlorophenol Indophenol till pink colour appeared and vol used noted.

$$\text{Dye factor} = \frac{0.5}{\text{titre value}}$$

The vitamin-C of the sample was estimated by taking 10 ml of sample, volume made upto 100 ml with (3%) metaphosphoric acid and filtered. Then aliquot of 10 ml was taken in a titration flask and titrated against dye 2,6 Dichlorophenol Indophenol till light pink colour appeared (which should persist for 15 seconds). Vitamin-C was calculated using following formula

$$\text{Ascorbic acid (mg/100g.)} = \frac{\text{titre value} \times \text{Dye factor} \times \text{vol made up}}{\text{vol. of filtrate taken} \times \text{vol. of sample taken}} \times 100$$

3.4.6 Anthocyanins:

Anthocyanins were calculated by the method as described by Rangana (1986). 10 ml of sample was taken and diluted to 100 ml with ethanolic HCl (95% Ethanol – 1.5 N HCl) and then kept in refrigerator over night at 4° C. Then it was filtered using Whatman paper no. 1. Filtrate was taken in a cuvet and its O.D (Optical Density) was taken at 535 nm using spectrophotometer against 95 per cent alcohol as blank. Total anthocyanins were calculated using following equations.

$$\text{Total Optical Density (O.D)} = \frac{\text{OD at 535} \times \text{vol. made}}{\text{weight of sample}} \times 100$$

$$\text{Total Anthocyanins (mg/100 g.)} = \frac{\text{Total O.D}}{98.2}$$

3.4.7 Non-Enzymatic Browning (NEB) :

NEB was estimated by the method described by Rangana (1986). 20 ml sample was taken to which 30 ml of 60 per cent alcohol was added, mixed thoroughly, kept over night and filtered using what man paper no. 1. Filtrate was taken in a cuvet and its optical density was taken at 440nm using spectrophotometer against 60 per cent alcohol as blank.

3.4.8 Tannins (Polyphenols):

Calorimetric method was used to estimate tannin content (AOAC, 1984). Varying amounts (0-10 ml) of standard 0.1 per cent tannic acid solution were taken in 100 ml volumetric flasks each containing 75 ml distilled water, 5 ml of Follin-Denis reagent and 10 ml of saturated sodium carbonate solution. Volume was made up to mark with distilled water, mixed well and kept for 30 minutes. Absorbance was measured at 760 nm using spectrophotometer and a standard curve was plotted.

To estimate tannins, 5g sample was taken in 500 ml volumetric flask and distilled water was added to it, mixed thoroughly and volume made with distilled water, filtered. Filtrate (10-20 ml) was taken in 100 ml volumetric flask to which 5 ml of Follin-Denis reagent, 10 ml of saturated sodium carbonate solution was added and volume made up to mark. 1-2 ml of this solution was taken in cuvet and its optical

density was taken at 760 nm as before and percentage tannic acid was calculated using the following formula.

$$\text{Tannins (as \% tannic acid)} = \frac{\text{mg of tannic acid} \times \text{vol made}}{\text{vol. of sample taken for colour dev.} \times \text{wt. of sample} \times 1000} \times 100$$

3.5 Microbial Analysis:

Method used for microbial analysis was serial dilution and pour plate method as outlined by Rangana (1986). Two types media were used, bacterial media and Yeast / mould media. These media (s) were autoclaved along with glass ware and other equipment at 15 psi for 20 minutes. Dilutions were prepared. Media were melted using water bath, cooled to 45° C. One ml of dilution was taken in petriplate and media poured over it and mixed thoroughly by moving clockwise and counter clockwise. Then media was allowed to set and plates inverted. Then whole operation i.e. from taking samples upto setting of media was done under laminar flow to avoid contamination. The inverted plates were then incubated in an incubator at 37° C for 48 hours and colonies counted using magnifier and colony counter.

$$\text{Colony count per ml} = \text{No of colonies per plate} \times \text{Reciprocal of dilution}$$

3.6 Sensory Evaluation: (Organoleptic Quality)

Sensory quality attributes such as colour, flavour and overall acceptability of nectar were evaluated by panel of 10 semi-trained judges. The nectars for organoleptic evaluation were presented to the judges in coded form and they were requested to note their sensory responses on the basis of colour, flavour and overall acceptability on 4-point numerical scale as under:

Excellent	=	4
Good	=	3
Fair	=	2
Poor	=	1

3.7 Statistical Analysis:

The data was statistically analysed by using CPCS1 package programme developed by Dr. H. S. Cheema, Department of Statistics, Punjab Agricultural University, Ludhiana, using Completely Randomised Design (CRD) in Factorial Experiment.

EXPERIMENTAL RESULTS

EXPERIMENTAL RESULTS

The present investigations were carried out to study the effect cultivar, spice concentration and storage on the quality of plum nectar. Each plum cultivars viz Santa Rosa and Satsuma were analysed for various physico-chemical parameters and then pulped using hot break method. Nectar was developed using (20 %) pulp, (18 %) TSS and acidity (as maleic acid) maintained at (0.4 %). Physico-chemical and sensory evaluation of the product was carried out under ambient conditions (15 – 35° C, Relative humidity 60 – 80 %) at 60 days interval during 6 months of storage.

The quality analysis conducted at regular sampling periods comprised of TSS (%), acidity (%), pH, reducing sugars (%), total sugars (%), ascorbic acid (mg/100g.), anthocyanins (mg/100g.), tannins (%) and non-enzymatic browning.

4.1 Physico-Chemical Characteristics of Plum Cultivars:

Table-2 revealed that average fruit weight recorded was highest (36 g.) for Satsuma cultivar and lowest (32.6 g.) in Santa Rosa cultivar. Similar trend was observed with respect average fruit length, average fruit diameter, pulp yield and pulp stone ratio. Average fruit length recorded for Satsuma was 40 mm and for Santa Rosa it was 39 mm. Average fruit diameter for Satsuma was 42 mm and for Santa Rosa it was 37 mm; pulp yield was 83.33 per cent for Satsuma and 81.25 per cent for Santa Rosa; and pulp stone ratio was 23.94 for Satsuma and 21.66 for Santa Rosa.

The two cultivars of plum viz, Santa Rosa and Satsuma also showed variation in TSS, acidity, pH, total sugars, reducing sugars, anthocyanins, tannins and vitamin-C and Santa Rosa cultivar recorded the highest TSS of 11.8 per cent while as it was 9.4 per cent for Satsuma. Similar trend was observed with respect to Total sugar (%),

Table-2: PHYSICO-CHEMICAL CHARACTERISTICS OF PLUM CULTIVARS

Parameters	Cultivars	
	SantaRosa	Satsuma
Average fruit length (mm)	39	40
Average fruit diameter (mm)	37	42
Average fruit weight (g.)	32.6	36
Pulp yield (%)	81.25	83.33
Pulp : Stone Ratio	21.66	23.94
TSS (%)	11.8	9.4
Acidity (% as maleic acid)	1.97	1.64
pH	3.00	3.04
Total Sugars (%)	8.80	6.72
Reducing sugars (%)	6.00	4.80
Anthocyanins (mg/100g.)	84.52	127.29
Vitamin-C (mg/100g.)	5.52	5.20
Tannins (as % tannic acid)	0.18	0.24

reducing Sugars (%), vitamin-C (mg/100g.). Total Sugars recorded were 8.80 per cent for Santa Rosa , 6.72 per cent for Satsuma, reducing sugars was 6.00 per cent for Santa Rosa and 4.80 per cent for Satsuma; vitamin-C recorded was 5.52 (mg/100g.) for Santa Rosa and 5.20 (mg/100 g.) for Satsuma.

pH, tannins and anthocyanins were highest for Satsuma cultivar. pH recorded was 3.04 for Satsuma, 3.00 for Santa Rosa; anthocyanin (mg/100g.) were 127.29 for Satsuma and 84.52 for Santa Rosa and tannins (as % tannic acid) were 0.24 per cent for Satsuma 0.18 per cent for Santa Rosa.

4.2 Physico-Chemical Composition of Plum Nectar During Storage:

4.2.1 Total Soluble Solids:

Plum nectar prepared from Santa Rosa and Satsuma cultivars revealed significant increase in mean TSS during 180 days of storage (Table-3). Mean TSS increased from 18.00 to 18.30 per cent and 18.00 to 18.17 per cent in Santa Rosa and Satsuma nectar respectively. The pooled storage mean of nectar for both the cultivars showed significant increase from 18.00 to 18.23 per cent. Plum Nectar developed from Santa Rosa cultivar observed significantly higher varietal mean value of 18.18 per cent compared to 18.13 per cent for Satsuma cultivar.

Spiced nectar treatments T₂ and T₃ from Santa Rosa cultivar showed highest identical increase of TSS from initial value of 18.00 to 18.60 per cent while as treatment T₂ from Satsuma cultivar revealed highest increase of TSS from 18.00 to 18.60 per cent during 180 days of storage. Treatment T₁ in both cultivars observed lowest increase of TSS from initial values of 18.00 to 18.40 per cent during storage. Nectar developed without spices T₀ (control) showed increase in TSS upto 60 days of

TABLE 3: EFFECT OF STORAGE ON TOTAL SOLUBLE SOLIDS (%) OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma					Treatment Mean
	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days	Mean	
T ₀	18.00	18.20	17.86	*17.60	17.91	18.00	18.20	17.56	*17.20	17.74	17.82
T ₁	18.00	18.20	18.20	18.40	18.20	18.00	18.20	18.30	18.40	18.22	18.21
T ₂	18.00	18.20	18.50	18.60	18.32	18.00	18.20	18.40	18.60	18.30	18.31
T ₃	18.00	18.20	18.40	18.60	18.30	18.00	18.20	18.40	18.50	18.27	18.28
Mean	18.00	18.20	18.24	18.30		18.00	18.20	18.16	18.17		
Varietal Mean					18.18					18.13	
Storage Mean	0 days =18.00		60 days=18.20		120 days =18.21		180 days=18.23				

C.D at 5%

Variety = 0.047
 Treatment = 0.066
 Storage = 0.066
 Variety x Treatment = 0.094
 Variety x Storage = N.S
 Treatment x Storage = 0.133
 Variety x Treatment x Storage = N.S

* Microbial spoilage

storage followed by decrease in TSS during rest of storage period, irrespective of the cultivar used. Table-3 observed increase of TSS in T_0 irrespective of cultivar from 18.00 to 18.20 per cent upto 60 days of storage followed by significant decrease in values to 17.60 and 17.20 per cent in Santa Rosa and Satsuma nectar respectively after 180 days of storage.

Santa Rosa and Satsuma spiced nectar observed higher mean TSS of 18.32 and 18.30 per cent for treatment T_2 while lowest TSS value of 18.20 and 18.22 per cent were recorded for treatment T_1 . However the pooled treatment mean of developed spiced nectar was highest (18.31%) for treatment T_2 . Effect of (variety x treatment) and (treatment x storage) were found statistically significant for plum nectar irrespective of the cultivar used.

4.2.2 Acidity:

As is evident from Table-4, the plum nectar prepared from Santa Rosa and Satsuma cultivars of plum revealed significant increase in mean acidity during storage. The mean titrable acidity (as % maleic acid) increased from initial 0.400 per cent to 0.489 and 0.495 per cent in nectar of Santa Rosa and Satsuma respectively during 180 days of storage. The pooled storage mean for both cultivars showed a significant increase from 0.400 to 0.492 per cent. Plum nectar developed from Santa Rosa cultivar observed significantly higher varietal mean of 0.439 per cent compared to 0.435 per cent for Satsuma cultivar.

Spiced nectar treatment (T_2) showed highest increase in titrable acidity from initial value of 0.400 per cent to 0.502 per cent irrespective of the cultivar used during 180 days of storage, while as treatments T_1 and T_3 recorded lowest increase in titrable

TABLE-4: EFFECT OF STORAGE ON TITRABLE ACIDITY (%) AS MALEIC ACID OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma					Treatment Mean
	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days	Mean	
T ₀	0.400	0.412	0.495	0.501	0.452	0.400	0.406	0.412	0.504	0.403	0.441
T ₁	0.400	0.412	0.425	0.464	0.425	0.400	0.410	0.442	0.500	0.438	0.431
T ₂	0.400	0.424	0.445	0.502	0.442	0.400	0.420	0.442	0.502	0.441	0.442
T ₃	0.400	0.424	0.436	0.489	0.437	0.400	0.412	0.442	0.475	0.432	0.434
Mean	0.400	0.418	0.450	0.489		0.400	0.412	0.434	0.495		
Varietal Mean					0.439					0.435	
Storage Mean	0 days =0.400		60 days=0.415			120 days =0.442		180 days=0.492			

C.D at 5%

Variety = 0.0018
 Treatment = 0.0025
 Storage = 0.0025
 Variety x Treatment = 0.0036
 Variety x Storage = 0.0036
 Treatment x Storage = 0.0051
 Variety x Treatment x Storage = 0.0072

acidity from initial value of 0.400 per cent to 0.464 and 0.475 per cent for Santa Rosa and Satsuma nectar respectively. In case of treatment T₀ (control), acidity increased from initial 0.400 per cent to 0.501 and 0.504 per cent for Santa Rosa and Satsuma nectar respectively during 180 days of storage. Santa Rosa and Satsuma spiced nectar observed highest mean titrable acidity of 0.442 and 0.441 per cent for treatment T₂ while as lowest mean titrable acidity of 0.425 and 0.432 per cent were recorded for treatment T₁ and T₃ respectively. Pooled treatment mean was highest (0.442 %) for treatment T₂ and lowest (0.431 %) for treatment T₁. Effect of variety, treatment storage and all their interactions were statistically significant for developed plum nectars irrespective of cultivar used.

4.2.3 pH:

Table-5 reveals that plum nectar prepared from Santa Rosa and Satsuma cultivars showed a significant decrease in mean pH during storage. The mean pH decreased from initial value of 3.61 to 3.24 and 3.23 in the nectar of Santa Rosa and Satsuma during 180 days of storage. The pooled storage mean showed significant decrease from 3.61 to 3.24 during storage. It was further observed that there was a non-significant effect of variety on pH of the nectar developed from different cultivars. pH values of nectar prepared from Santa Rosa and Satsuma cultivars correlate well the values of titrable acidity. Spiced nectar treatment T₂ showed highest decrease in pH from initial value of 3.62 to 3.20 while as treatment T₃ recorded lowest decrease from initial value of 3.62 to 3.30 and 3.36 for Santa Rosa and Satsuma nectar respectively during 180 days of storage. Treatment T₀ (nectar developed without spices) observed decrease in pH from 3.60 to 3.20 and 3.18 in Santa Rosa and Satsuma nectar

TABLE-5: EFFECT OF STORAGE ON pH OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma					Treatment Mean
	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days	Mean	
T ₀	3.60	3.55	3.24	3.20	3.39	3.60	3.57	3.38	3.18	3.43	3.41
T ₁	3.61	3.56	3.41	3.27	3.46	3.60	3.50	3.41	3.21	3.43	3.44
T ₂	3.62	3.50	3.39	3.20	3.42	3.62	3.53	3.42	3.20	3.43	3.35
T ₃	3.62	3.49	3.44	3.30	3.40	3.62	3.55	3.43	3.36	3.49	3.47
Mean	3.61	3.52	3.37	3.24		3.61	3.53	3.41	3.23		
Varietal Mean					3.43					3.44	
Storage Mean	0 days =3.61		60 days=3.53			120 days =3.39		180 days=3.24			

C.D at 5%

Variety = N.S
 Treatment = 0.015
 Storage = 0.015
 Variety x Treatment = 0.022
 Variety x Storage = 0.022
 Treatment x Storage = 0.031
 Variety x Treatment x Storage = 0.044

respectively during storage. Santa Rosa and Satsuma spiced nectar observed highest mean pH of 3.46 and 3.49 for treatments T₁ and T₃. The pooled treatment mean was highest (3.47) for treatment T₃ and lowest (3.35) for T₂. Effect of treatment, storage, (variety x treatment), (variety x storage), (treatment x storage) and (variety x treatment x storage) were found statistically significant for developed spiced nectar for both cultivars.

4.2.4 Reducing Sugars:

Table-6 revealed significant increase in reducing sugar (%) during storage in plum nectar irrespective of cultivar used. During 180 days storage the mean value of reducing sugars increased significantly from initial values of 11.82 and 11.81 per cent to 13.58 and 13.25 per cent in Santa Rosa and Satsuma plum nectar respectively. The pooled storage mean also increased from 11.81 per cent to 13.14 per cent during same storage. Nectar developed from Santa Rosa cultivar showed significantly higher varietal mean of 12.79 per cent compared to 12.62 per cent for Satsuma cultivar.

Spiced nectar treatment T₃ in Santa Rosa and Satsuma showed the highest increase in reducing sugars from the initial values of 13.35 and 13.22 per cent to 15.96 and 15.37 per cent while as treatment T₁ showed the lowest increase in total sugars from initial values of 13.02 and 13.12 per cent to 15.02 and 14.70 per cent during 180 days of storage. Treatment T₀ (nectar without spices) of Santa Rosa and Satsuma cultivars showed increase in reducing sugars from initial value of 7.62 and 7.75 per cent to 8.12 and 8.20 per cent upto 60 days of storage while as it decreased to 7.86 and 8.00 per cent respectively after 180 days of storage.

TABLE-6: EFFECT OF STORAGE ON REDUCING SUGARS (%) OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma					Treatment Mean
	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days	Mean	
T₀	7.62	8.12	8.03*	7.86*	7.90	7.75	8.20	8.15*	8.00*	8.02	7.96
T₁	13.02	13.80	14.77	15.02	14.15	13.12	13.54	14.36	14.70	13.93	14.04
T₂	13.29	13.93	15.03	15.48	14.43	13.15	13.98	14.44	14.95	14.13	14.28
T₃	13.35	14.03	15.43	15.96	14.69	13.22	14.02	15.00	15.37	14.40	14.54
Mean	11.82	12.47	13.31	13.58		11.81	12.43	12.98	13.25		
Varietal Mean					12.79					12.62	
Storage Mean	0 days 11.81		60 days=12.45			120 days =13.14		180 days=13.41			

C.D at 5%

Variety = 0.009
 Treatment = 0.013
 Storage = 0.013
 Variety x Treatment = 0.018
 Variety x Storage = 0.018
 Treatment x Storage = 0.026
 Variety x Treatment x Storage = 0.037

* Microbial spoilage

Treatment T₀ recorded the lowest mean reducing sugar content of 7.96 per cent which was significantly lower than all spiced nectar Treatment T₁, T₂, T₃ (14.04 %, 14.28 %, and 14.54 %). Variety, treatment, storage and all interactions were statistically significant.

4.2.5 Total Sugars:

Plum nectar prepared from Santa Rosa and Satsuma cultivars revealed significant variation in mean total sugar (%) during 180 days of storage (Table-7). The mean values of total sugars for Santa Rosa and Satsuma nectar increased from initial value of 16.45 and 16.51 per cent to 16.59 and 16.62 per cent upto 60 days of storage but decreased to 16.44 and 16.12 per cent after 180 days of storage respectively. Even though there was increase in total sugars (%) in all spiced nectar treatments (T₁, T₂ and T₃) during storage, the decrease in mean total sugars after 60 days was due to large decrease of total sugars (%) in treatment T₀ (nectar without spices) where it decreased from 16.82 per cent and 16.93 per cent to 15.35 and 14.40 per cent after 180 days of storage in Santa Rosa and Satsuma nectars respectively. The pooled storage mean also showed similar trend as it increased from 16.48 per cent to 16.60 per cent upto 60 days and then decreased to 16.28 per cent after 180 days storage. Plum nectar prepared from Santa Rosa cultivar observed significantly higher varietal mean of 16.49 per cent compared to 16.43 per cent for Satsuma cultivar.

Spiced nectar treatments T₂ and T₁ from Santa Rosa and Satsuma showed highest increase in total sugars (%) from initial values of 16.38 and 16.35 per cent to 16.86 and 16.67 per cent respectively during storage nectar. Treatments T₂ and T₃ from Santa Rosa and Satsuma revealed lowest increase in total sugars (%) from initial

TABLE-7: EFFECT OF STORAGE ON TOTAL SUGARS (%) OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma					
Storage → ↓ Treatment	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days	Mean	Treatment Mean
T ₀	16.70	16.82	16.18*	15.35*	16.26	16.90	16.93	16.20*	14.40*	16.10	16.18
T ₁	16.44	16.56	16.65	16.85	16.62	16.35	16.51	16.60	16.67	16.53	16.57
T ₂	16.38	16.50	16.57	16.86	16.57	16.44	16.59	16.64	16.73	16.60	16.58
T ₃	16.30	16.48	16.58	16.70	16.51	16.38	16.46	16.53	16.68	16.51	16.51
Mean	16.45	16.59	16.49	16.44		16.51	16.62	16.49	16.12		
Varietal Mean					16.49					16.43	
Storage Mean	0 days =16.48		60 days=16.60			120 days =16.49		180 days=16.28			

C.D at 5%

Variety = 0.014

Treatment = 0.021

Storage = 0.021

Variety x Treatment = 0.029

Variety x Storage = 0.029

Treatment x Storage = 0.042

Variety x Treatment x Storage = 0.059

*** Microbial spoilage**

values of 16.30 and 16.44 per cent to 16.70 and 16.73 per cent respectively after 180 days. Santa Rosa and Satsuma spiced nectar treatment T₃ observed identical lowest mean total sugar (%) of 16.51 per cent while as treatment T₁ and T₂ from Santa Rosa and Satsuma cultivars observed the highest mean total sugars (%) of 16.62 and 16.60 per cent respectively. However pooled treatment mean was highest (16.58 %) for treatment T₂ and lowest (16.51 %) for treatment T₃. The effect of variety, treatment, storage and all their interactions were statistically significant.

4.2.6 Ascorbic Acid:

Nectar prepared from Santa Rosa and Satsuma cultivars of plum revealed significant decrease in mean ascorbic acid content during 180 days of storage (Table-8). The mean ascorbic acid content (mg/100 g.) decreased from 0.94 to 0.80 (mg/100g.) and 0.88 to 0.76 (mg/100g.) in plum nectar developed from Santa Rosa and Satsuma cultivars respectively. The pooled storage mean for both cultivars showed significant decrease from 0.91 to 0.78 (mg/100g.) during 180 days of storage. Nectar prepared from Santa Rosa cultivar showed significantly higher varietal mean of 0.88 (mg/100g.) compared to 0.83 (mg/100g.) for Satsuma.

In spiced plum nectar prepared from Santa Rosa and Satsuma treatment T₃ showed highest mean ascorbic acid content of 0.88 and 0.84 (mg/100g.) respectively while as treatment T₁ showed lowest mean ascorbic acid content of 0.86 (mg/100g.) for Santa Rosa and treatments T₁ and T₂ observed the lowest identical mean ascorbic acid mean of 0.82 (mg/100g.) for Satsuma nectar. The pooled treatment means also showed increasing trend from T₁ to T₃ as it increased from 0.84 to 0.86 (mg/100g.) respectively. Spiced nectar treatment T₁ in Santa Rosa

TABLE-8: EFFECT OF STORAGE ON ASCORBIC ACID (mg/ 100g.) OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma					Treatment Mean	
	Storage ↓ Treatment	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days		Mean
T ₀		0.96	0.93	0.89	0.82	0.90	0.92	0.89	0.84	0.79	0.86	0.88
T ₁		0.93	0.89	0.84	0.79	0.86	0.87	0.84	0.80	0.75	0.82	0.84
T ₂		0.93	0.89	0.85	0.80	0.87	0.87	0.85	0.80	0.75	0.82	0.85
T ₃		0.94	0.90	0.86	0.81	0.88	0.89	0.87	0.82	0.77	0.84	0.86
Mean		0.94	0.90	0.86	0.80		0.88	0.86	0.81	0.76		
Varietal Mean						0.88					0.83	
Storage Mean		0 days 0.91			60 days=0.88		120 days =0.83		180 days=0.78			

C.D at 5%

Variety = **0.013**
Treatment = **0.019**
Storage = **0.019**
Variety x Treatment = **N.S**
Variety x Storage = **N.S**
Treatment x Storage = **N.S**
Variety x Treatment x Storage = **N.S**

showed the highest decrease in ascorbic acid content from initial value of 0.93 to 0.79 (mg/100g.) while as for Satsuma all the three spiced nectar treatments (T_1 , T_2 and T_3) showed identical decrease from initial values of 0.87, 0.87 and 0.89 (mg/100g.) to 0.75, 0.75 and 0.77 (mg/100g.) during 180 days of storage. The effect of (variety x treatment), (variety x storage), (treatment x storage) and (variety x treatment x storage) were statistically non-significant.

4.2.7 Anthocyanins:

From the perusal of data in Table-9, it is evident that plum nectar prepared from Santa Rosa and Satsuma cultivars revealed significant decrease in anthocyanin content during storage. The mean anthocyanin content (mg/100g.) decreased from 9.92 to 4.96 (mg/100g.) and 17.90 to 8.22 (mg/100g.) in nectar prepared from Santa Rosa and Satsuma, during 180 days of storage. The pooled storage mean for both cultivars also decreased significantly from initial value of 13.91 to 6.59 (mg/100g.). Nectar prepared from Satsuma cultivar showed significantly higher varietal, mean of 12.67(mg/100g.) compared to 7.23 (mg/100g.) for Santa Rosa cultivar.

Santa Rosa and Satsuma spiced nectar showed highest mean anthocyanin content of 6.09 and 11.16 (mg/100g.) for treatment T_1 while as lowest anthocyanin content of 5.16 and 10.32 (mg/100g.) was recorded for treatment T_3 respectively. Treatment T_0 (nectar without spices) recorded the highest mean anthocyanin content of 11.88 and 18.72 (mg/100g.) for Santa Rosa and Satsuma which was significantly higher than all spiced nectar treatments (T_1 , T_2 and T_3). In spiced plum nectar prepared from Santa Rosa and Satsuma cultivars of plum treatment T_1 showed highest degradation of anthocyanins from initial values of 8.14 and 16.29 (mg/100g.) at zero

TABLE-9: EFFECT OF STORAGE ON ANTHOCYANINS (mg/100g.) OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma						
Storage → ↓ Treatment	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days	Mean	Treatment Mean	
T₀	16.29	12.83	10.18	8.25	11.88	24.94	20.36	16.30	13.29	18.72	15.30	
T₁	8.14	7.12	5.09	3.99	6.09	16.29	12.21	9.16	7.00	11.16	8.62	
T₂	8.14	6.10	5.05	4.02	5.82	15.27	12.21	8.15	6.35	10.49	8.15	
T₃	7.12	5.09	4.85	3.58	5.16	15.10	11.81	8.13	6.27	10.32	6.59	
Mean	9.92	7.78	6.29	4.96		17.90	14.14	10.43	8.22			
Varietal Mean					7.23					12.67		
Storage Mean	0 days 13.91		60 days=10.96			120 days =8.36			180 days=6.59			

C.D at 5%

Variety = **0.013**
Treatment = **0.019**
Storage = **0.019**
Variety x Treatment = **0.027**
Variety x Storage = **0.027**
Treatment x Storage = **0.038**
Variety x Treatment x Storage = **0.054**

days to 3.99 and 7.00 (mg/100g.) at 180 days respectively, while as lowest anthocyanin degradation was observed in treatment T₃ from initial values of 7.12 and 15.10 (mg/100g.) at zero days to 3.58 and 6.27 (mg/100g.) at 180 days of storage. However the initial anthocyanin showed decreasing trend with the increase in spice concentration from T₁ to T₃ as is decreased from 8.14 and 16.29 (mg/100g.) to 7.12 and 15.10 (mg/100g.) in Santa Rosa and Satsuma cultivars respectively. Effect of (variety x treatment), (variety x storage), (treatment x storage) and (variety x treatment x storage) were found to be statistically significant irrespective of the cultivars used.

4.2.8 Non-Enzymatic Browning:

Table-10 revealed that plum nectar prepared from Santa Rosa and Satsuma showed significant increase in NEB during storage. The mean values of NEB increased from 0.07 to 0.11 and 0.08 to 0.13 in case of Santa Rosa and Satsuma nectar during 180 days of storage. The pooled storage mean for both cultivars also showed significant increase in NEB from 0.07 to 0.12 during storage. Nectar developed from Satsuma cultivar observed significantly higher varietal mean of 0.11 compared to 0.08 for Santa Rosa.

Spiced nectar treatment T₃ recorded the highest NEB mean values of 0.10 and 0.13 for Santa Rosa and Satsuma respectively while as lowest NEB mean values of 0.08 and 0.10 were recorded for treatment T₁. Pooled treatment mean NEB for both cultivars also showed similar trend as it was 0.12 and 0.09 for treatment T₃ and T₁ respectively. For treatment T₀ (nectar without spices) the mean NEB values were lower (0.06 and 0.08) for Santa Rosa and Satsuma nectar respectively. Effect of

TABLE-10: EFFECT OF STORAGE ON NON ENZYMATIC BROWNING (NEB) OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma					Treatment Mean	
	Storage → ↓ Treatment	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days		Mean
T ₀		0.05	0.06	0.07	0.09	0.06	0.06	0.07	0.09	0.11	0.08	0.07
T ₁		0.06	0.07	0.07	0.12	0.08	0.08	0.10	0.12	0.13	0.10	0.09
T ₂		0.08	0.08	0.11	0.12	0.09	0.09	0.11	0.12	0.14	0.11	0.10
T ₃		0.09	0.10	0.10	0.13	0.10	0.10	0.13	0.14	0.15	0.13	0.12
Mean		0.07	0.08	0.09	0.11		0.08	0.10	0.11	0.13		
Varietal Mean						0.08					0.11	
Storage Mean		0 days 0.07			60 days=0.09		120 days =0.10		180 days=0.12			

C.D at 5%

Variety = **0.007**
 Treatment = **0.011**
 Storage = **0.011**
 Variety x Treatment = **N.S**
 Variety x Storage = **N.S**
 Treatment x Storage = **N.S**
 Variety x Treatment x Storage = **N.S**

variety, treatment and storage were statistically significant irrespectively cultivars used while as all their interactions were statistically non-significant.

4.2.9 Tannins:

The data presented in Table-11 reveals that nectar prepared from Santa Rosa and Satsuma cultivars of plum showed significant decrease in tannins during storage. The mean tannins content (as % tannic acid) decreased significantly from 0.09 per cent to 0.05 per cent and 0.11 per cent to 0.07 per cent in nectars prepared from Santa Rosa and Satsuma cultivars respectively after 180 days of storage. The pooled storage mean also decreased from 0.10 to 0.06 per cent during same storage. Satsuma nectar recorded significantly higher varietal mean of 0.09 per cent compared to 0.07 per cent for Santa Rosa.

Treatment T_3 of spiced plum nectar prepared from Santa Rosa and Satsuma cultivars observed the highest mean tannin content of 0.11 per cent and 0.12 per cent, while as treatment T_1 observed the lowest mean tannin content of 0.06 and 0.09 per cent respectively. Treatment T_0 (nectar prepared without spices) showed lowest mean tannin content of 0.02 and 0.03 per cent for Santa Rosa and Satsuma cultivars respectively which was significantly lower than all spiced nectar treatments (T_1 , T_2 and T_3). The pooled treatment mean also showed increasing trend with increase in spice concentration from T_0 (control) to treatment T_3 . Spiced nectar treatment T_1 , T_2 , and T_3 for Santa Rosa showed identical decrease in tannin content from 0.09, 0.11 and 0.13 per cent to 0.05, 0.07 and 0.09 per cent during 180 days of storage respectively. However in case of Satsuma nectar treatment T_1 and T_3 showed highest identical decrease of tannin content from 0.12 and 0.15 per cent to 0.07 and 0.10 per cent while

TABLE-11: EFFECT OF STORAGE ON TANNINS (% TANNIC ACID) OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma					
Storage ↓ Treatment	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days	Mean	Treatment Mean
T ₀	0.04	0.03	0.02	0.02	0.02	0.05	0.04	0.03	0.03	0.03	0.03
T ₁	0.09	0.07	0.06	0.05	0.06	0.12	0.10	0.09	0.07	0.09	0.08
T ₂	0.11	0.09	0.08	0.07	0.08	0.13	0.11	0.10	0.09	0.10	0.09
T ₃	0.13	0.12	0.10	0.09	0.11	0.15	0.13	0.12	0.10	0.12	0.11
Mean	0.09	0.07	0.06	0.05		0.11	0.09	0.08	0.07		
Varietal Mean					0.07					0.09	
Storage Mean	0 days 0.10		60 days=0.08			120 days =0.07		180 days=0.06			

C.D at 5%

Variety = 0.007
 Treatment = 0.010
 Storage = 0.010
 Variety x Treatment = N.S
 Variety x Storage = N.S
 Treatment x Storage = N.S
 Variety x Treatment x Storage = N.S

as treatment T₂ showed lowest decrease from 0.13 per cent to 0.09 per cent during 180 days of storage. The effect of variety, treatment, storage were statistically significant and all their interactions were non-significant.

4.3 Organoleptic Evaluation of Plum Nectar During Storage:

The changes in mean organoleptic scores for quality attributes (colour, flavour and overall acceptability) of plum nectar showed significant decrease during storage period of 180 days under ambient conditions (15 – 35°C, relative humidity 60 – 80%). The quality factors are presented as under.

4.3.1 Colour Scores:

It is evident from Table-12 that spiced nectar prepared from Santa Rosa and Satsuma cultivars observed significant variation among treatments for colour scores. Among spiced nectars treatment T₁ showed highest mean colour score of 3.16 and 3.25 while as treatment T₃ showed the lowest mean colour score of 2.42 and 2.51 for Santa Rosa and Satsuma nectar respectively. The mean colour scores for treatment T₀ (nectar without spices) were highest 3.65 and 3.71 for Santa Rosa and Satsuma nectar respectively which were significantly higher than all spiced nectar treatments (T₁, T₂ and T₃). The pooled treatment means also showed similar trend and was highest 3.68 for T₀ and lowest 2.46 for T₃. Spiced nectar treatment T₁ showed the highest initial score of 3.40 and 3.50 for Santa Rosa and Satsuma which decreased to 2.90 and 3.00 after 180 days of storage. The lowest initial colour of 2.70 and 2.85 were recorded in treatment T₃ for Santa Rosa and Satsuma which decreased to 2.08 and 2.11 after 180 days of storage.

TABLE-12: EFFECT OF STORAGE ON COLOUR SCORES OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma					
Storage Treatment	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days	Mean	Treatment Mean
T₀	3.80	3.72	3.58	3.50	3.65	3.85	3.75	3.67	3.59	3.71	3.68
T₁	3.40	3.24	3.10	2.90	3.16	3.50	3.35	3.18	3.00	3.25	3.20
T₂	2.96	2.93	2.72	2.50	2.77	3.19	3.00	2.80	2.60	2.89	2.83
T₃	2.70	2.55	2.36	2.08	2.42	2.85	2.70	2.40	2.11	2.51	2.46
Mean	3.21	3.11	2.94	2.75		3.34	3.20	3.01	2.82		
Varietal Mean					3.00					3.09	
Storage Mean	0 days 3.28		60 days=3.15			120 days =2.97		180 days=2.78			

C.D at 5%

Variety = **0.051**
Treatment = **0.073**
Storage = **0.073**
Variety x Treatment = **N.S**
Variety x Storage = **N.S**
Treatment x Storage = **N.S**
Variety x Treatment x Storage = **N.S**

4-Excellent, 3-Good, 2-Fair, 1-Poor

The plum nectar observed significant decrease in mean colour scores during storage irrespective of the cultivars used. The mean colour scores decreased from initial value of 3.21 to 2.75 and 3.34 to 2.82 for Santa Rosa and Satsuma nectars respectively during 180 days of storage. The pooled storage mean also decreased significantly during storage from 3.28 to 2.78. Varietal mean for Satsuma nectar was significantly higher (3.09) compared to (3.00) for Santa Rosa. Different interactions observed no effect on the colour score of nectar developed.

4.3.2 Flavour:

Table-13 reveals that plum nectar prepared from Santa Rosa and Satsuma cultivars showed significant variation among treatments for flavour scores. Among the spiced nectar treatments, T₁ showed highest mean flavour score of 3.40 and 3.24 while as treatment T₃ showed lowest mean flavour score of 2.72 and 2.47 for Santa Rosa and Satsuma respectively. Pooled treatment means also varied significantly being 3.24 for treatment T₁ and 2.60 for treatment T₃. The mean flavour scores for treatment T₀ (nectar without spices) was 1.60 and 1.57 for Santa Rosa and Satsuma which was significantly lower than all spiced nectar treatments (T₁, T₂ and T₃). Spiced nectar treatment T₁ showed highest initial flavour score of 3.60 and 3.40 for Santa Rosa and Satsuma which decrease to 3.20 and 2.70 after 180 days of storage. The lowest initial flavour score of 3.00 and 2.80 were recorded in treatment T₃ for Santa Rosa and Satsuma which decreased to 2.40 and 2.10 respectively. However the initial flavour scores in Santa Rosa and Satsuma nectar for treatment T₀ (nectar without spices) were lowest (2.30 and 2.15) which further decreased to 0.95 and 0.88 at 180 days of

TABLE-13: EFFECT OF STORAGE ON FLAVOUR SCORES OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma					
Storage ↓ Treatment	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days	Mean	Treatment Mean
T₀	2.30	2.10	1.05 *	0.95 *	1.60	2.15	2.33	0.93 *	0.88 *	1.57	1.58
T₁	3.60	3.48	3.35	3.20	3.40	3.40	3.25	3.00	2.70	3.08	3.24
T₂	3.25	3.12	3.00	2.83	3.05	3.00	2.85	2.65	2.20	2.67	2.86
T₃	3.00	2.86	2.65	2.40	2.72	2.80	2.61	2.40	2.10	2.47	2.60
Mean	3.03	2.89	2.51	2.34		2.83	2.76	2.24	1.97		
Varietal Mean					2.69					2.45	
Storage Mean	0 days 2.93 60 days=2.82 120 days =2.37 180 days=2.15										

C.D at 5%

Variety = 0.052
Treatment = 0.074
Storage = 0.074
Variety x Treatment = 0.015
Variety x Storage = 0.015
Treatment x Storage = 0.140
Variety x Treatment x Storage = N.S

*** Microbial spoilage**

4-Excellent, 3-Good, 2-Fair, 1-Poor

storage. The nectar prepared from Santa Rosa showed significantly higher varietal mean score of 2.69 for flavour compared to 2.45 for Satsuma.

The nectar prepared from Santa Rosa and Satsuma showed significant decrease in flavour scores during 180 days storage from initial values of 3.03 and 2.83 to 2.34 and 1.97 respectively. The pooled storage mean also showed decreasing trend as it decreased from 2.93 to 2.15 during same storage period. All interactions except (variety x treatment x storage) were statistically significant.

4.3.3 Overall Acceptability:

The data presented in Table-14 clearly indicates that nectar prepared from Santa Rosa and Satsuma cultivars showed significant variation among the treatments for overall acceptability scores. Among spiced nectar treatments, highest means overall acceptability score of 3.28 and 3.17 were observed in T₁ while as lowest mean overall acceptability scores of 2.55 and 2.47 were observed for T₃ in Santa Rosa and Satsuma cultivars respectively. Pooled treatment mean for overall acceptability was highest (3.22) for T₁ and lowest (2.51) for T₃. However for treatment T₀ (nectar without species) it was 2.63 which was significantly higher than T₃ (2.51). The higher overall acceptability scores of T₀ than T₃ was because T₀ had higher colour scores than all spiced nectars (T₁, T₂ and T₃). Spiced nectar treatment T₁ showed the highest initial overall acceptability score of 3.50 and 3.45 for Santa Rosa and Satsuma respectively which decreased to 3.05 and 2.85 at 180 days of storage.

The plum nectar prepared from Santa Rosa and Satsuma cultivars observed significant decrease in overall acceptability during 180 days of storage. The mean overall acceptability scores for Santa Rosa and Satsuma decreased from initial values

TABLE-14: EFFECT OF STORAGE ON OVERALL ACCEPTABILITY SCORES OF SPICED PLUM NECTAR

Cultivar	Santa Rosa					Satsuma					Treatment Mean
	0 days	60 days	120 days	180 days	Mean	0 days	60 days	120 days	180 days	Mean	
T ₀	3.03	2.90	2.53*	2.23*	2.67	3.00	2.87	2.28*	2.23*	2.59	2.63
T ₁	3.50	3.35	3.22	3.05	3.28	3.45	3.30	3.09	2.85	3.17	3.22
T ₂	3.12	3.00	2.86	2.66	2.91	3.11	2.92	2.70	2.40	2.78	2.84
T ₃	2.83	2.70	2.46	2.24	2.55	2.82	2.66	2.40	2.03	2.47	2.51
Mean	3.12	2.98	2.76	2.54		3.09	2.93	2.61	2.37		
Varietal Mean					2.85					2.75	
Storage Mean	0 days 3.10		60 days=2.96			120 days =2.69		180 days=2.46			

C.D at 5%

Variety = 0.050
 Treatment = 0.071
 Storage = 0.071
 Variety x Treatment = N.S
 Variety x Storage = N.S
 Treatment x Storage = 0.142
 Variety x Treatment x Storage = N.S

* Microbial spoilage

4-Excellent, 3-Good, 2-Fair, 1-Poor

of 3.12 and 3.09 to 2.54 and 2.37 respectively during 180 days of storage. The pooled storage mean also decreased significantly from 3.10 to 2.46 during storage. Overall acceptability score of 2.85 observed in Santa Rosa nectar was significantly higher than 2.75 observed for Satsuma nectar. All interactions except (treatment x storage) were statistically non-significant.

4.4 Microbiological Studies:

All nectar samples prepared from Santa Rosa and Satsuma cultivars of plum were subjected to microbiological studies at an interval of 60 days, to monitor number of bacterial and yeast/mould colonies formed (cfu/ml) if any, during six months storage, at ambient temperature. Table-15 revealed that spiced nectar treatments T₁, T₂ and T₃, did not show any microbial growth/spoilage upto six months storage irrespective of the cultivar used.

Nectar prepared without spices (T₀) showed microbial growth after 120 days of storage. After 120 days storage 500 and 2000 (cfu/ml) of yeast/mould were recorded in Santa Rosa and Satsuma nectar treatment T₀, which increased to 8400 and 30000 (cfu/ml) at 180 days storage respectively. No bacterial colony was recorded after 120 days storage in treatment T₀, however after 180 days storage 400 and 1200 (cfu/ml) bacterial colonies were recorded in Santa Rosa and Satsuma nectar treatment T₀ respectively.

TABLE-15: MICROBIAL LOAD AS (cfu/ml) AT VARIOUS STORAGE PERIOD FOR PLUM NECTAR

Cultivar	Santa Rosa				Satsuma									
	Microbial Load as cfu/ml													
Storage Treatment	0 days		60 days		120 days		180 days							
	B	Y/M	B	Y/M	B	Y/M	B	Y/M						
T ₀	-	-	-	-	500	400	8400	-	-	-	-	2000	1200	30000
T ₁	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T ₂	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T ₃	-	-	-	-	-	-	-	-	-	-	-	-	-	-

B = Bacteria
Y/M = Yeast and Moulds

4.5 Economics:

Economic studies on the nectar prepared from two plum cultivars viz Santa Rosa and Satsuma is presented in Table-16. It was observed that the spiced nectar prepared had significantly lower cost compared with RTS beverages of different brands available in the market. Table-16 observed that fixed capital expenditure on processing 5-kg spiced plum nectar (25 bottles of 200ml capacity each) amounted to Rs. 14.00. Working capital expenditure which includes expenditure on ingredients, processing charges, packaging, labelling transportation, breakage/incidentals amounted to Rs. 146.00. Management/producers share i.e. margin of producer, whole seller and retailer amounted to Rs. 65.00. The total expenditure was Rs. 225.00 for 25 bottles. Thus maximum retail price per bottle (200ml) was Rs. 9.00 while as market price of ordinary fruit beverages ranges from Rs. 10.00 to 15.00 per bottle.

**TABLE-16: INCOME, INVESTMENT AND FACTOR SHARES FOR
PROCESSING 5-KG SPICED PLUM NECTAR**

I. Fixed capital expenditure*

Machines Used	Depreciation (day⁻¹) (Rs.)
Bottle washing machine	1.77
Working table	2.00
Junior Pulper	5.55
Crown Corking machine	0.62
Juice Pasteurizer	3.33
Gas Stove	0.73
Total (I)	14.00

II. Working Capital Expenditure :

A. Expenditure on ingredients for five Kg Nectar

Particulars	Price Kg⁻¹ Rs.	Quantity used gms	Expenditure Rs.
Fruit	10	1180.0	11.80
Cardamon	800	8.0	6.50
Black Cumin	750	10.0	7.50
Black Salt	50	15.0	0.75
Sugar	19	800.0	15.20
Common Salt	8.5	5.0	0.12
Black Pepper	120	10.0	1.12
Ginger	40	50.0	2.00
Mint	20	50.0	1.00
Citric Acid	500	4.0	2.00
LPG	14	500.0	7.00
Sub Total (A)			55.00

B. Expenditure on Packaging, Labeling and processing etc. for 25 bottles of 200 ml.

	Rs.
Cost of Bottles	21.00
Crown Corks	7.50
Labeling	7.50
Labour charges on processing	12.50
Margin of producer	22.50
Sub Total (B)	71.00
S. P. of producer/Purchase Price of Wh. Seller (1+A+B)	140.00

C. Expenses incurred by Whole seller

	Rs.
Transportation	5.00
Handling/storage	6.25
Margin of Whole seller	15.00
	<hr/>
Sub Total (C)	26.25
	<hr/>
S. P of Wh Seller/ Retailers Purchase Price (1+A+B+C)	166.25

D. Expenditure incurred by Retailer

	Rs.
Transportation	12.50
Handling/storage	8.75
Breakage/incidentals	10.00
Margin of Retailer	27.50
	<hr/>
Sub Total (D)	58.75
	<hr/>
Retailers S.P/Purchase of Consumer (1+A+B+C+D)	225.00

III. Relative factor Shares **	Absolute Share (Rs.)	Factor Share
Fixed Capital	14.00	0.062
Working Capital	146.00	0.648
Management/Producers Share	65.00	0.288

* Depreciation calculated by straight line method on per day basis.

**These are factor shares of processed fruit in total income.

DISCUSSION

DISCUSSION

Stone fruits occupy important place in the economy of Jammu and Kashmir state. Plum is one of the important stone fruits grown in Jammu and Kashmir state, but due to its perishable nature it cannot endure long storage life after harvest under ambient conditions. Even at low temperature (4° C) its storage life does not exceed 3 to 4 weeks. Thus post-harvest operations such as transportation and storage of plums are quite difficult. So alternate method of preserving this perishable fruit lies in processing the fruit into beverages, syrup, fermented products etc.

An attempt has been made in present investigation to evaluate two plum cultivars for spiced nectar production and to monitor the quality changes in product developed during storage under ambient conditions.

5.1 Physico-Chemical Characteristics of Plum Cultivars:

The average fruit length , diameter and fruit weight recorded in Santa Rosa and Satsuma cultivars of plum were 39 and 40 mm, 37 and 42 mm and 32.6 and 36.0 g respectively. The pulp yield and pulp stone ratio recorded for Santa Rosa was 81.25 per cent and 21.66, while for Satsuma it was 83.33 per cent and 23.94 respectively. The results are in range of Dhuria *et al.* (1978); Chopra *et al.* (1981) and Gothwal *et al.* (1998).

In Santa Rosa and Satsuma plum cultivars the fruit TSS recorded was 11.8 and 9.4 per cent, acidity (as maleic acid) as 1.97 and 1.64 per cent and pH 3.00 and 3.04 respectively. The results obtained are in close proximity to that of Chopra *et al.* (1981); Barwal and Sharma (2001). However the acidity values are slightly higher

(1.64 and 1.35 %) than reported by Wani and Saini (1993) in Santa Rosa and Satsuma cultivars respectively.

The Total Sugar (%) reported in Santa Rosa and Satsuma cultivars were 8.80 and 6.72 per cent while as reducing sugars reported were 6.00 and 4.80 per cent. Chopra *et al.*, (1981) reported total sugars in Santa Rosa range from 6.7 – 9.9 per cent.

The ascorbic acid, anthocyanins and tannins recorded in Santa Rosa and Satsuma cultivars were 5.52 and 5.20 (mg/100g.), 84.52 and 127.29 (mg/100g.) and 0.18 and 0.24 per cent respectively. Westwood (1988) has reported ascorbic acid content of 5 (mg/100g.) in plums, Barwal and Sharma (2001) reported the ascorbic acid content of 5.80 (mg/100g.) and tannin content of 0.18 per cent in Santa Rosa pulp.

5.2 Changes in Quality Attributes of Plum Nectar During Storage:

5.2.1 Total Soluble Solids:

During 180 days of storage, nectar samples prepared from Santa Rosa and Satsuma cultivars of plum recorded significant increase in mean TSS from initial value maintained at 18.00 per cent to maximum 18.17 and 18.30 per cent respectively. The pooled storage mean also increased from an initial value of 18.00 per cent to 18.23 per cent during storage. All the interactions except (variety x storage) and (variety x treatment x storage) were statistically significant. The pooled treatment mean for the three spiced nectar treatments (T_1 , T_2 and T_3) were 18.21, 18.31 and 18.21 per cent which were significantly higher than initial value (18.00 %), while as for treatment T_0 (nectar without spices) the treatment mean decreased to 17.82 per cent during storage. The increase in TSS of fruit beverages have been reported by

Waskar and Khuridiya (1987) (phalsa nectar), Jain *et al.* (1988) (Litch squash) Wasker and Deshmukh (1994) (pomegranate Juice), Baranamray *et al.* (1995) (guava nectar), Pandey and Singh (1999) (guava R.T.S beverages), Deka and Sethi (2001) (spiced lime-aonla R.T.S beverages), Prasad and Mali (2000) (pomegranate squash), Sharma *et al.* (2001) (galgal juice concentration) and Kotecha and Kadam (2003) (tamarind R.T.S beverages). The increase in TSS may be due to conversion of polysaccharides into soluble sugars, during storage.

Santa Rosa and Satsuma nectar without spices (T_0) showed identical increase in TSS upto 60 days from initial value of 18.00 to 18.20 per cent which decreased to 17.20 and 17.60 per cent after 180 days of storage. Microbial spoilage was observed in T_0 after 120 days of storage. The decrease in TSS could be attributed to utilization of sugars for microbial growth.

5.2.2 Acidity:

The titrable acidity (as % maleic acid) exhibited significant increase during storage of 180 days in plum nectar irrespective of the cultivar and treatments. The mean acidity increased from an initial value of 0.400 per cent to 0.489 and 0.495 per cent in Santa Rosa and Satsuma nectar samples respectively. The pooled storage mean also increased significantly from 0.400 per cent to 0.492 per cent. All interactions viz (variety x treatment), (variety x storage), (treatment x storage) and (variety x treatment x storage) were statistically significant. Present findings are in agreement with that of Waskar and Deshmukh (1994) (pomegranate Juice), Baramanray *et al.* (1995) (guava nectar), Attri *et al.* (1998) (blended pear, apricot and plum RTS beverages), Pandey and Singh (1999) (guava RTS beverages), Prasad and Mali (2000) (pomegranate

squash), Krishnaveni *et al.* (2001) (jack fruit RTS beverages), Sogi and Singh (2001) (kinnow squash) and Kotecha and Kadam (2003) (tamarind RTS beverages). The increase in acidity during storage may be due to formation of organic acids by ascorbic acid degradation or increase in acidity could have occurred due to degradation of pectic substances present in pulp as reported by Cruess (1958) in jellies and jams.

No correlation was observed between increase in acidity and spice concentration of nectar formulations. However highest mean acidity of 0.442 per cent was recorded for treatment T₂ while as lowest mean acidity of 0.431 per cent was recorded for Treatment T₁.

5.2.3 pH

Decreasing trend was observed in pH of plum nectar samples during 180 days of storage, irrespective of cultivar used. The mean pH decreased significantly from an initial pH value of 3.61 to 3.24 and 3.23 in case of Santa Rosa and Satsuma nectar respectively during 180 days of storage. The storage mean also decreased significantly from 3.61 to 3.24 during storage. The decrease in pH values correlate well with the acidity values. The effect of treatment, storage and all interactions were statistically significant, however the effect of variety was non-significant. Doodnath and Badriel (2001) and Krishnaveni *et al.* (2001) also reported decrease in pH in watermelon nectar and jack fruit RTS beverages respectively. Spiced nectar (T₂) showed the lowest pooled mean pH of (3.35) while as (T₃) showed the highest pooled mean pH of 3.47. No correlation was observed between spice concentration and decrease in pH in all the treatment combinations which is in consonance with the acidity values.

5.2.4 Reducing Sugars:

Significant increase in reducing sugars percentage was observed in all spiced nectar formulations with increase in spice concentration from T_1 to T_3 , irrespective of plum variety used. Mean reducing sugars was 14.69 and 14.40 per cent in spiced nectar treatment T_3 prepared from Santa Rosa and Satsuma cultivars of plum which was significantly higher than 14.15 and 13.93 per cent recorded for spiced nectar treatment T_1 . Similar trend was reflected in pooled treatment mean as it was highest (14.54 %) for T_3 and lowest (14.04 %) for treatment T_1 . However the mean reducing sugar content was 7.90 and 7.96 per cent in nectar treatment T_0 from Santa Rosa and Satsuma which was significantly lower than all spiced nectar treatments. The increase in reducing sugar content with the increase in spice concentration may be due to the addition of spices which might have increased the inversion of sucrose or breakdown of polysaccharides. Treatment T_0 (nectar without spices) showed increase in percentage reducing sugar from initial values of 7.62 and 7.75 per cent to 8.12 and 8.20 per cent in Santa Rosa and Satsuma nectars upto 60 days of storage, there after decreased to 7.86 and 8.02 per cent after 180 days storage respectively. The decrease in reducing sugars after 120 days may be due to microbial spoilage observed in treatment (T_0). The microbes might have utilized sugars in various metabolic processes (growth and multiplication) and fermentation process thereby causing increased rate of respiration and decrease in reducing sugar content in treatment (T_0).

Significant increase in percentage reducing sugar during storage was observed in nectar samples irrespective of the cultivar used. During 180 days storage nectar

prepared from Santa Rosa and Satsuma cultivars of plum, showed significant increase in percentage reducing sugars from initial values of 11.82 and 11.81 per cent to 13.58 and 13.25 per cent respectively. Similar trend was reflected in storage mean as it increased from initial value of 11.81 per cent to 13.14 per cent during 180 days storage. The effect of variety, treatment, storage and all their interactions were statistically significant. The present findings regarding increase in reducing sugar content with storage are in agreement with that of Palaniswamy and Muthukrishanan (1974) (lemon Juice), Mehta and Bajaj (1983) (citrus juice), Waskar and Khuridya (1987) (phalsa nectar, squash and concentrate), Jain *et al.* (1988) (litchi Juice), Tripathi *et al.* (1992) (pineapple-guava RTS beverages), Sethi (1993) (litchi squash), Wani and Saini (1993) (plum juice, concentrate and pulp), Baramanray *et al.* (1995) (guava nectar), Tiwari (2000) (guava-papaya RTS beverages), Sogi and Singh (2001) (kinnow RTS beverages and squash). The increase in reducing sugars during storage may be due to inversion of sucrose to glucose and fructose or breakdown of polysaccharide into simple sugars.

5.2.5 Total Sugars:

Variety, treatment, storage and all their interactions revealed significant effect on the percentage total sugar content in plum nectar irrespective of cultivars used. No correlation was observed between increased spice concentration and percentage total sugars in spiced nectar treatments T₁, T₂ and T₃ in both cultivars as spiced nectar treatment T₁ from Santa Rosa and treatment T₂ from Satsuma recorded the highest mean total sugar of 16.62 and 16.60 per cent respectively while as spiced nectar

treatment T₃ recorded the lowest identical mean total sugar of 16.51 per cent for both cultivars.

Nectar prepared from Santa Rosa and Satsuma cultivars of plum showed significant variation in total sugar percentage during the storage of 180 days. Mean total sugar percentage for Santa Rosa and Satsuma increased from initial value of 16.45 and 16.51 per cent to 16.59 and 16.62 per cent upto 60 days of storage but decreased to 16.44 and 16.12 per cent after 180 days of storage. The decrease in percentage total sugars is attributed to large decrease in total sugar content of treatment T₀ (nectar without spices) from initial values of 16.70 and 16.90 per cent to 15.35 and 14.40 per cent after 180 days storage in Santa Rosa and Satsuma cultivars respectively. As microbial spoilage was observed in treatment T₀ of both cultivars after 120 days storage. The decrease in percentage total sugars of treatment T₀ may be attributed to utilization of sugar by microbes (Yeast/moulds) in metabolic processes and fermentation. Results presented indicate that even though the initial percentage total sugar varied significantly in all spiced nectar treatments T₁, T₂ and T₃ but all the treatments showed significant increase in percentage total sugars during 180 days of storage, irrespective of the cultivar used. The findings are in conformity with those of Bhatia *et al.* (1956) (jack fruit squash), Waskar and Khuridiya (1987) (phalsa nectar, squash and concentrate), Jain *et al.* (1988) (litchi squash and litchi juice), Waskar and Deshmukh (1994) (pomegranate juice), Baramanray *et al.* (1995) (guava nectar), Kotecha and Kadam (2003) (tamarind RTS beverages). Increase in total sugar content during storage may be attributed to breakdown of complex polysaccharides into simple sugars.

5.2.6 Ascorbic Acid:

Ascorbic acid content decreased significantly in plum nectar during storage irrespective of the cultivar used. The mean ascorbic acid content decreased from 0.94 and 0.88 (mg/100g.) to 0.80 and 0.76 (mg/100g.) for Santa Rosa and Satsuma nectar respectively during 180 days of storage. The storage mean also decreased from 0.91 to 0.78 (mg/100g.) during storage. Variety, treatment and storage had significant effect on ascorbic acid content of all the nectar samples, while as all interactions were statistically non-significant. The above findings regarding the decrease in ascorbic acid content during storage are in conformity with those of Aggarwal *et al.* (1992) in peach nectar, Gofur *et al.* (1994) in mango nectar, Baramanray *et al.* (1995) in guava nectar, Askar *et al.* (1996) in peach nectar, Iversen (1999) in black currant nectar, Pandey and Singh (1999) in guava RTS beverages, Krishnaveni *et al.* (2001) in jack fruit RTS beverages, Kotecha and Kadam (2003) in tamarind RTS beverages. Decrease in ascorbic acid during storage may be due to oxidation, by trapped oxygen in glass bottle, which might have resulted in formation of dehydro-ascorbic acid.

In spiced nectar treatments T₁, T₂ and T₃, the ascorbic acid content increased with increase in spice concentration, irrespective of cultivar. Treatment mean increased from 0.84 to 0.86 (mg/100g.) from T₁ to T₃ respectively. The increase in ascorbic acid content with increase in spice concentration could be attributed to ascorbic acid provided by spices. Similar findings were reported by Deka and Sethi (2001) in lime-aonla and mango-pineapple spiced beverages.

5.2.7 Anthocyanins:

Perusal of data reveals significant degradation of anthocyanins in plum nectar during storage irrespective of the cultivars used. During the storage of 180 days anthocyanin content (mg/100g.) decreased from 9.92 to 4.96 (mg/100g.) and 17.90 to 8.22 (mg/100g.) in nectars prepared from Santa Rosa and Satsuma cultivars of plum respectively. The pooled storage mean for both cultivars decreased significantly from initial value of 13.91 (mg/100g.) to 6.59 (mg/100g.). Variety, treatment, storage and all interactions were statistically significant. Similar findings were reported by Waskar and Khuridya (1987) in phalsa nectar, concentrate, crush and squash, Forni *et al.* (1993) in osmodehydrated cherries, Uygan and Acar (1995) in cherry nectar, and Iversen (1999) in black currant nectar. The anthocyanin degradation may be attributed to the fact that anthocyanins are prone to degradation during storage due to affect of temperature and light. Siddiq *et al.* (1994) reported that anthocyanin degradation is directly related to polyphenol oxidase level in plum juice.

Anthocyanin content of Treatment T₀ (nectar without spices) was significantly higher (15.30 mg/100g.) than all spiced nectar treatments T₁, T₂, T₃ (8.62, 8.15 and 6.59 mg/100g.), suggesting that addition of spices caused breakdown of anthocyanins. The Satsuma nectar recorded the higher anthocyanin content of 12.67 (mg/100g.) compared to 7.23 (mg/100g.) for Santa Rosa. This may be attributed to the higher concentration of anthocyanins recorded in Satsuma pulp.

5.2.8 Non-Enzymatic Browning (NEB):

The results presented indicate that NEB of nectars prepared from Santa Rosa and Satsuma cultivars of plum increased significantly during storage. During 180 days

of storage mean value of NEB increased from 0.07 to 0.11 and 0.08 to 0.13 in nectars prepared from Santa Rosa and Satsuma cultivars respectively. The pooled storage mean also increased from 0.07 to 0.12 during same storage. Variety, treatment, storage had significant effect on NEB of all nectar samples while as all interactions had non significant effect. These results are in agreement with that of Baramanray *et al.* (1995) in guava nectar, Saini *et al.* (1993) in plum juice and concentrate, Pandey and Singh (1999) in guava RTS beverages, Peters *et al.* (2001) in soursop nectar and Sharma *et al.*, (2001) in galgal juice concentrate. Browning may be due to reaction of organic acid with sugars or oxidation of phenols which leads to formation of brown pigment.

In spiced nectar treatments (T_1 , T_2 and T_3) the NEB treatment means increased with increase in spice concentration from 0.09 to 0.12 (T_1 to T_3). However the value of NEB was significantly lower (0.76) for T_0 (nectar without spices) than all spiced nectar treatments. Gowda and Jalali (1995) reported that NEB was either equal or slightly higher due to addition of spices in water melon juice, Deka and Sethi (2001) also reported increase in NEB on addition of spices to grape-mango blended RTS beverages.

5.2.9 Tannins:

The data presented reveals that variety, treatment and storage had significant effect on tannin content of all nectar samples while as all interactions were statistically non-significant. Significant decrease in tannin content was observed in all nectar samples irrespective of the cultivar used. Tannin content in Santa Rosa and Satsuma nectars decreased significantly from 0.09 and 0.11 per cent to 0.051 and 0.07 per cent respectively during 180 days storage. Pooled storage mean for both cultivars also

decreased from 0.10 to 0.06 per cent during storage. Similar findings were reported by Srivastava *et al.* (1985) in mango juice, Kalra *et al.* (1998) in anola preserve, Deka and Sethi (2001) in grape-mango and grape-pineapple blended RTS beverages. Loss of tannins/polyphenols during storage could be due to oxidation of polyphenols.

In spiced nectar treatments T₁, T₂ and T₃ the tannin content increased with increase in spice concentration irrespective of the cultivar used. Treatment mean increased from 0.08 to 0.11 per cent from T₁ to T₃ respectively. However the treatment mean for T₀ (nectar without spices) was 0.03 per cent which was significantly lower than all spiced nectar treatments. The increase in tannin content with increased concentration of spices might be due to tannins contributed by spices. Similar findings were reported by Joshi *et al.* (1991) in spiced plum vermouth. Deka and Sethi (2001) also reported increase in tannin/polyphenol content with addition of spices in grape-mango and pineapple-grape blended RTS beverages.

5.3 Organoleptic Evaluation:

Organoleptic evaluation of nectar samples was done by semi-trained panelists to evaluate the best cultivar and treatment (spice concentration) for the product development and to monitor quality changes during storage.

5.3.1 Colour Score:

The sensory scores for colour decreased significantly for all plum nectar treatments after 180 days of storage irrespective of cultivar used. The mean colour scores for Santa Rosa and Satsuma nectar decreased from initial values of 3.21 and 3.34 to 2.75 and 2.82 respectively during 180 days of storage. The storage mean scores for colour also decreased significantly from 3.28 to 2.78 in nectar samples.

Variety, treatment and storage had significant effect on colour while as all interactions were statistically non-significant. Jain *et al.* (1988), Gowda (1995), Askar *et al.* (1996), Doodnath and Badriel (2001), Prasad and Mali (2000) and Krishanaveni *et al.* (2001) reported decrease in colour scores during storage in litchi squash, mango-papaya blended RTS beverages, peach nectar, watermelon nectar, pomegranate squash and jack fruit RTS beverages. The decrease in colour score may be attributed to the increasing rate of oxidation of phenolic compounds.

Among spiced nectar treatments T₁, T₂ and T₃ significant variation was observed with respect to colour scores, highest colour scores of 3.61 and 3.71 were observed in treatment T₁ of Santa Rosa and Satsuma nectar while as lowest colour scores of 2.42 and 2.46 were observed in treatment T₃. It was further observed that with the increase in spice concentration from T₁ to T₃ the mean colour score decreased from 3.20 to 2.46. The colour scores for T₀ (nectar without spices) were higher (3.68) than all spiced nectar treatments. Thus it could be concluded that increased spice concentration has negative effect on colour scores of nectar.

5.3.2 Flavour Scores:

Significant variation was observed in flavour scores among the spiced nectar treatments prepared from Santa Rosa and Satsuma cultivars of plum. Spiced nectar treatment T₁ showed the highest mean flavour score of 3.40 and 3.24 for Santa Rosa and Satsuma nectars while as spiced nectar treatment T₃ showed the lowest mean flavour score of 2.72 and 2.47 respectively. Pooled treatment mean flavour scores also decreased from T₁ to T₃ (3.24 to 2.60). As T₁ with the minimum spice concentration had the highest flavour score irrespective of the cultivar used, it could be concluded

that flavour scores decreased with increase in spice concentration. It was further observed that T₀ (nectar without spices) had the lowest treatment mean flavour score of 1.58 which was significantly lower than all spiced nectar treatments. Variety, treatment, storage and all two factor interactions were statistically significant while as three factor interaction (variety x treatment x storage) was non-significant. Nectar prepared from Santa Rosa cultivars had a flavour score of 2.69 which was significantly higher than 2.45 recorded for Satsuma. Gothwal *et al.* (1998) reported that aroma retention during storage was slightly better in Santa Rosa than Mariposa and other cultivars.

The plum nectar showed significant decrease in flavour scores after 180 days of storage irrespective of the cultivar used. The mean flavour scores for Santa Rosa and Satsuma nectar decreased from 3.03 and 2.83 to 2.34 and 1.97 after 180 days storage. The pooled storage mean also decreased from 2.93 to 2.15 after 180 days storage. The results obtained are in consonance with the findings of Askar *et al.* (1996) in peach nectar, Krishnaveni *et al.* (2001) in jack fruit RTS, Prasad and Mali (2000) in pomegranate squash, Sogi and Singh (2001) in kinnow squash. The decrease in flavour scores could be due to loss of volatile aromatic substances and temperature also play important role in biochemical changes, leading to formation of off-flavour and discolouration, masking the original flavour of products with storage time.

5.3.3 Overall Acceptability:

Variety, treatment and storage revealed significant effect on the overall acceptability scores of all nectar samples while as all interactions except (treatment x storage) were statistically non-significant. Overall acceptability scores showed significant variation

among spiced nectar treatments. Spiced nectar treatment T₁ showed the highest mean acceptability score of 3.28 and 3.22 for Santa Rosa and Satsuma nectar while as treatment T₃ showed lowest mean acceptability score of 2.55 and 2.47 respectively. Treatment mean acceptability scores also decreased from T₁ to T₃ (3.22 to 2.51). Thus it was concluded that increase in spice concentration had a negative effect on acceptability scores of plum nectar irrespective of cultivar used and that treatment T₁ with minimum spice concentration was most acceptable. Nectar prepared from Santa Rosa cultivar had higher acceptability scores of 2.85 than 2.75 recorded for Satsuma nectar.

Significant decrease in overall acceptability scores was observed in all nectar samples during storage irrespective of the cultivar used. During storage of 180 days overall acceptability scores decreased from 3.12 and 3.09 to 2.54 and 2.37 in Santa Rosa and Satsuma nectar respectively. The pooled storage mean also decreased from 3.10 to 2.46 after 180 days of storage. Waskar and Khuridiya (1987), Krishnaveni *et al.* (2001), Sogi and Singh (2001), Kotecha and Kadam (2003) also reported decrease in overall acceptability during storage in phalsa squash and nectar, jack fruit RTS beverages, kinnow squash, and tamarind RTS beverages.

5.4 Microbial Quality:

Nectar samples prepared from Santa Rosa and Satsuma without spices (T₀), preserved by using 120 ppm sodium benzoate only, observed microbial spoilage after 120 days of storage. Sain *et al.* (2003) also reported microbial spoilage in pear pulp preserved by using sodium benzoate at 1200 mg/kg after 4 months of storage at ambient temperature. In the nectar treatments (T₁, T₂ and T₃) which were preserved by

pasteurization along with addition of spices in various proportions, no microbial spoilage/load was observed even after 180 days of storage. The zero microbial load in spiced nectar treatments could be due to inhibitory effect of spices. Ejachi *et al.* (1998) reported that heating mango juice to 55°C for 15 minutes and supplemented with nutmeg (4 % v/v) and ginger (4 % v/v) markedly inhibited microbial growth. Deka and Sethi (2001) reported negligible growth of moulds and yeast in lime-aonla and mango-pineapple spiced RTS beverages, which got further reduced during storage due to inhibiting effect of spices. Shah and Ray (2003) also reported the antimicrobial properties of black cumin especially against gram positive bacteria like *Staphylococcus aureus*, *Bacillus cereus* and *Streptococcus faecalis*.

5.5 Economics:

The cost analysis indicated better chances of value addition in case plum is processed into product like spiced nectar. Since no spiced beverage is presently available in the local market. The product will have advantage over other fruit beverages and the cost can compete with other fruit beverages available in the market. The cost per unit can be further reduced if bulk processing is carried out, thus the product has better chances of survival in the market.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The investigation entitled “Processing and Quality Evaluation of Spiced Plum Nectar as Health Drink” was carried during year 2002-2003 with following objectives

- To standardize the recipe for development of spiced nectar from different cultivars.
- To study the effect of variety on the quality of spiced nectar.
- To study the economics of formulated product.
- To study the effect of storage on the quality of the product.

The two plum cultivars viz Santa Rosa and Satsuma were procured from SKUAST-K Shalimar orchard. The fruits subjected to pulping by hot break method. The pulp was preserved by pasteurising it. The preserved pulp was analysed for various physico-chemical characteristics and utilized for nectar production. The nectar was prepared using 20 per cent pulp and spices were added in various proportions, filled in pre-sterilized bottles (200 ml capacity) and then pasteurized. However in control no spice was added and it was chemically preserved using 120 ppm sodium benzoate. The nectar developed was kept at ambient temperature (15 – 35° C, relative humidity 60 – 80 %) for a period of six months. The physico-chemical analysis of the product developed was carried out at 0, 60, 120, 180 days of storage to monitor the change in quality attributes. The silent features of the results are summarized below: -

6.1 Physico-Chemical Characteristics:

1. Physical characteristics of two plum cultivars revealed that Satsuma cultivar recorded the highest average fruit length (40 mm), fruit diameter (42 mm) and fruit weight (36 g.) compared to Santa Rosa cultivar which recorded these parameters as 39 mm, 37 mm and 32.6 g respectively.
2. Cultivar Satsuma recorded the highest pulp yield (83.33 %) and pulp stone ratio (23.94) than cultivar Santa Rosa (81.25 % and 21 :66)
3. TSS, acidity, reducing sugars, total sugars and vitamin-C recorded in Santa Rosa were 11.8 per cent, 1.97 per cent, 8.80 per cent, 6.00 per cent and 5.52 (mg/100g.) respectively which were higher than 9.4 per cent, 1.64 per cent, 6.72 per cent, 4.80 per cent and 5.20 (mg/100g.) recorded in Santa Rosa.
4. pH (3.04), anthocyanin (127.29 mg/100g.) and tannin (0.24 %) recorded in cultivar Satsuma were higher than Santa Rosa which recorded these parameters as 3.00, 84.52 (mg/100g.) and 0.18 per cent respectively.

6.2 Physico-Chemical Analysis of Plum Nectar:

1. The mean TSS of nectar prepared from Santa Rosa (18.18 %) was higher than the nectar prepared form Satsuma (18.13 %). Treatment T₂ recorded highest mean TSS (18.31 %) and T₀ recorded the lowest mean TSS (17.82 %) in all product formulations. Significant increase was observed in mean TSS from 18.00 per cent to 18.23 per cent during 180 days storage.
2. Nectar prepared form Santa Rosa recorded the higher mean acidity (0.439 %) than Satsuma cultivar (0.435 %). The mean acidity increased during 180 days of storage (0.400 % to 0.492 %) irrespective of the cultivar used. Highest

treatment mean (0.442 %) was recorded in treatment T₂ and lowest (0.431 %) in treatment T₁.

3. The results of pH were in consonance with that of acidity and pH showed relative decline with the increase in acidity in all product formulations.
4. The mean reducing sugars increased significantly during 180 days storage (11.81 % to 13.41 %). Mean reducing sugars also increased from T₁ to T₃ (14.04 % to 14.54 %) with increase in spice concentration. Mean reducing sugar content recorded was lowest (7.96 %) in treatment T₀.
5. The effect of storage was significant with respect to the change in total sugars of all the product formulations. Treatment T₂ recorded highest mean total sugars (16.51 %) and lowest mean total sugars were recorded in T₀ (16.18 %). The mean total sugars were higher (16.49 %) in nectar prepared from Santa Rosa than in Satsuma (16.43 %).
6. Mean Ascorbic acid content decreased significantly on storage of 180 days (0.91 to 0.78 mg/100g.) irrespective of formulations used. Nectar from Santa Rosa recorded higher ascorbic acid content (0.88 mg/100g.) than Satsuma (0.83 mg/100g.). The ascorbic acid content showed significant increase with increase in spice concentration T₁ to T₃ (0.84 to 0.86 mg/100g.)
7. Nectar prepared from Satsuma recorded higher anthocyanin content (12.67 mg/100g.) than Santa Rosa (7.23 mg/100g.). The addition and increase in spice concentration resulted in decrease of mean anthocyanin content (8.62 to 6.59 mg/100g.) and as such nectar without spices recorded higher mean anthocyanin content (15.30 mg/100g.).

8. Non-enzymatic browning of nectar samples showed significant increase with storage (0.07 to 0.12). Nectar from Satsuma recorded higher value for Non-enzymatic browning (0.11) compared to Santa Rosa (0.08). The addition and increase in spice concentration showed increase in non-enzymatic browning (0.07 to 0.12) of all product formulations.
9. The mean tannin content increased with the addition of spices T₁ to T₃ (0.08 % to 0.11 %). Maximum mean tannins (0.09 %) content was recorded in nectar prepared from Satsuma compared to (0.07 %) for Santa Rosa. The effect of storage was significant with respect to decrease in tannin content (0.10 to 0.06 %) in all product formulations.

6.3 Organoleptic Evaluation of Plum Nectar:

The changes observed in organoleptic scores for quality attributes (colour, flavour and overall acceptability) of nectar observed a significant decreasing trend during storage. The quality attributes are summarized as under.

1. The mean colour score observed a significant decrease during storage (3.28 to 2.78). Nectar prepared from Satsuma scored highest (3.09) for colour compared to that of Santa Rosa (3.00). Spice addition had a significant effect on colour score which decreased with increase of spice concentration (3.68 to 2.46).
2. Nectar prepared from Santa Rosa scored maximum for flavour (2.69) compared to Satsuma (2.45). The mean flavour scores also decreased during storage (2.93 to 2.15) and with increase in spice concentration from T₁ to T₃ (3.24 to 2.60). However, nectar without spices scored minimum (1.58) for flavour.

3. Like colour and flavour, the mean acceptability scores also decreased with storage (3.10 to 2.46). However, the nectar prepared from Santa Rosa scored maximum (2.85) than Satsuma (2.75). The treatment effect for overall acceptability was in consonance with that of colour and flavour scores.

6.4 Microbiological Studies:

Spiced nectar prepared from both the cultivars of plum observed no microbial load during entire storage period of 180 days. However, treatment T₀ i.e. nectar without spices underwent microbial spoilage (fermentation) after 120 days of storage and it had no consumer acceptability.

6.5 Economics:

Economics of spiced nectar prepared from Santa Rosa and Satsuma cultivar of plum revealed that the product developed had lower cost and more consumer acceptability compared to ordinary fruit beverages available in the market. It was observed that retail price per bottle (200 ml) was Rs. 9.00 which was lower than market price of ordinary beverages available in market (10.00 to 15.00 Rs)

Conclusion:

It was concluded from present studies that spiced nectar prepared from Santa Rosa cultivar proved superior with respect to quality stability during storage than nectar developed from Satsuma. Organoleptically it was found that Santa Rosa spiced nectar treatment T₁ recorded highest acceptability score followed by Satsuma spiced nectar treatment T₁ on 4.00 point scale. However spiced nectar treatments T₂ and T₃ from both cultivars were found within consumer acceptability range. Microbiologically all the three spiced nectar formulations proved free from any

microbial growth/spoilage during entire storage period while as Treatment T₀ which was preserved chemically observed spoilage after 120 days of storage. Thus addition of spices along with pasteurization proved to be better method of preservation than chemical preservation. The product developed was found economically profitable and viable for commercial production.

LITERATURE CITED

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- Aggarwal, P. Bajaj, M., Minhas, K. S. and Sidhu, J. S. 1992. Comparative studies on suitability of Shane-Punjab and Flordasun peach varieties for processing. *Journal of Plant Science and Research*. **8**: 77 – 80.
- Anonymous, 2002. *Fruit Production and area statement of the year 2002-2003*. Directorate of Horticulture, Jammu & Kashmir Government, Rajbagh, Srinagar. pp 1-2 .
- Anonymous, 2002. *Package of Practice for Temperate Fruits*. Directorate of Extension Education, SKUAST, Shalimar. pp 101-106.
- AOAC. 1984. *Official methods of Analysis*. 14th ed. Association of Official Analytical Chemists, Arlington, VA, USA. 415 pp.
- *Askar, A., Ghonaim, S. M., Fadeel, A. G. M. and Ali, A. M. 1996. Quality assurance of peach pulp and nectar. *Fruit Processing*. **6** : 151– 155. (C.F. FSTA Abstracts 1990-2003/05, AN; 1996-09-J0042).
- Attri, B. L., Lal, B. B. and Joshi, V. K. 1998. Physico-chemical characteristics, sensory quality and behaviour of sand pear juice blended with temperate fruit juice/pulps. *Indian Food Packer*. **52** : 36 – 41.
- Baramanray, A., Gupta, O. P. and Dhawan, S. S. 1995. Evaluation of guava (*Psidium guajava*) hybrids for making nectar. *Haryana Journal of Horticultural Science*. **24** : 102 – 109.

- Barwal, V. S. and Sharma, R. 2001. Standardization of recipe for the development of plum appetizer. *Journal of Food Science and Technology*. **38** : 248 – 250.
- Barwal, V. S., Sharma, R. and Lal, B. B. 2002. Use of sorbitol for the preparation of plum seasoned squash. *Journal of Food Science and Technology*. **39** : 413 – 417.
- Bhatia, B. S. and Siddhapa, G. S. 1956. Some physico-chemical changes in jack fruit squash. *Indian Journal of Agricultural Science*. **26** : 403 – 412.
- Chauhan, S.K., Tyagi, S. M. and Singh, D. 2001. Pectinolytic liquefaction of apricot, plum and mango pulps for juice extraction. *International Journal of Food Properties*. **4**: 103 – 109.
- Chopra, S. K., Misra, S. S., Bhutani, V. P. and Kashyap, A. S. 1981. Studies on maturity indices in relation to the length of storage in Santa Rosa plum (*Prunus saliciana* L.). *Advances in Research on Temperate Fruits*. pp 319 – 325.
- Claypool, L. L., Dempsey, W. H., Esau, P. and Miller, M. W. 1962. Physical and chemical changes in French prunes during maturation in costal valleys. *Hilgardia*. **33** : 311 – 318.
- Cruess, W. V. 1958. *Commercial Fruit and Vegetable Products*. McGraw Hill Book Company. Inc. New York. **448pp**.
- Deka, B. C. and Sethi, V. 2001. Preparation of mixed fruit Juice spiced RTS beverages. *Indian Food Packer*. **55** : 58 – 61.

- Dhuria, H. S., Kar, P. L., Tripathi, S. N. and Sood, G. 1978. Studies on maturity standards of plum cv. Santa Rosa. *Progressive Horticulture*. **9** : 74 – 78.
- Doodnath, L. and Badriel, N. 2001. Processing and quality evaluation of ready-to-serve watermelon nectars. *Indian Food Packer*. **4**: 71 – 78.
- Ejachi, B. O., Souzey, J. A. and Akomedaya, D. E. 1998. Microbial stability of mango juice preserved by combined application of mild heat and extracts of two tropical spices. *Journal of Food Protection*. **61** : 725 – 729.
- Forni, E., Polesello, A. and Tortregiani, D. 1993. Changes in anthocyanins in cherries (*Prunus avium* L.) during osmodehydration, pasteurization and storage. *Food Chemical Essex*. **48** : 295 – 299.
- Ganhar, A. and Karim. F. 1978. Effect of cold storage on the marketing and processing quality of plum ‘Fazle Manani’. *Journal of Agriculture Research*. **16** : 503 – 510.
- Gofur, M. A., Safique, M. Z., Helali, O. H., Ibrahim, M., Rahman, M. M. and Hakim, A. 1994. Studies on formulation and preservation of ripe mango nectar. *Bangladesh Journal of Scientific and Industrial Research*. **29** : 151 – 162.
- Gothwal, P. P., Satpute, D. B., Manan, J. K., Velu, V., Kumar, V. R. and Shukla, I. C. 1998. Preparation and storage of some processed products from varieties of plum (Santa Rosa, Meri Posa and Early Transparent Gage) grown in hills regions of Uttar Pradesh. *Indian Food Packer*. **52**: 21 – 24.

- Gowda, I. N. D. 1995. Studies on blending of mango and papaya pulp for ready-to serve beverage making. *Phala Samskarana*. **32** : 387 – 391.
- Gowda, I. N. D. and Jalali. 1995. Studies on juice making from watermelon juice. *Indian Food Packer*. **49** : 33 – 37.
- Griffin, J. 1992. Spicing up food profits. *Food Industries*, **45** : 3, 5, 7, 21.
- Halme, A. C. 1978. *Biochemistry of Fruits and their Products*. Vol-1. Academic Press London, **325pp**.
- Hansen, E. 1959. Maturity study of Italian prunes intended for drying. *Proc. Oregon Horticultural Society*. **51** : 73 – 75.
- *Iversen, C. K. 1999. Black currant nectar; effect of processing and storage on anthocyanin and ascorbic acid content. *Journal of Food Science*, **64** : 37 – 41. (C.F. FSTA Abstracts 1990-2003/05, AN; 1999-07-H1283).
- Jain, S. P., Tripathi, V. K. Ram, H. B. and Singh, S. 1988. Varietal suitability of litchi for squash making. *Indian Food Packer*. **1**: 29 – 33.
- Joshi, V. K., Attri, B. L. and Mahajan, B. V. C. 1991. Studies on the preparation and evaluation of vermouth from plum. *Journal of Food Science and Technology*. **28** : 138 – 141.
- Joshi, V. K., Chauhan, S. K. and Lal, B. B. 1991. Extraction of Juice from peaches, plums and apricots by pectinolytic treatment. *Journal of Food Science and Technology*. **28**: 64 – 65.

- Joshi, V. K., Chauhan, S. K. and Lal, B. B. 1993. Evaluation of enzymatically extracted plum juice for preparation of beverages. *Journal of Food Science and Technology*. **30** : 208 – 210.
- Kalra, S. K., Tandon, D. K. and Singh, B. D. 1998. Simplified processing of aonla fruits for preserve making. *Beverage and Food World*. **25** : 35 – 36.
- *Kamneva, A. P. and Lisakova, N. P. 1973. Jam preparation with sorbitol and xylitol. *Konservnaya-i-ovoshehesashil Naya. Promyshlennost*, **7** : 16 – 17. (C.F. FSTA Abstracts 1969-1994/06, AN; 1974-01-J0032).
- Kang, Y., Zheng, F.J. and Zou, H. X. 1994. Development of sour plum juice. *Food Science*. **10**: 17 – 20.
- Khurdiya, D. S. 1990. A study on fruit juice based carbonated drink. *Indian Food Packer*. **18** : 45 – 50.
- Kishore, D. K., Panday, R. M. and Sharma, Y. P. 1991. Plums: In : Temperate Fruits. [Mitra, S. K. , Bose, T. K. and Rathore, D. S. (eds)]. *Horticulture and Allied Publishers, Calcutta*. pp 241 – 278.
- Kotecha, P. M. and Kadam, S. S. 2003. Preparation of ready-to-serve beverage, syrup and concentrate from tamarind. *Journal of Food Science and Technology*. **40** : 76 – 79.
- Krishnaveni, A., Manimegali, G. and Saravanakumar, R. 2001. Storage stability of jack fruit (*Artocarpus heterophyllus L.*) RTS beverage. *Journal of Food Science and Technology*. **38** : 601 – 602.

- Lal, B. B., Joshi, V. K., Sharma, R. C. and Sharma, R. 1999. Preparation and evaluation of apple and ginger-based squashes. *Journal of Scientific and Industrial Research*. **58** : 530 – 532.
- Landerhoven, M. L., Kruger, M., Gouws, F. and Faber. M. 1991. *MCP Food Composition Tables – 3rd Edition*. South African Medical Research Council, Parow. South Africa. pp 312 - 314.
- Lutz, J. M. and Hardenburg, R. E. 1968. *The Commercial Storage of Fruit, Vegetables and Florists and Nursery Crops*. U S D A, Agri, Handbook. 610 pp.
- Mehta, U. and Bajaj, S. 1983. Effect of storage and methods of preservation on physico-chemical characteristics of citrus juices. *Indian Food Packer*. **37** : 42 – 51.
- Nagi, J. P. 2002. Preventing a near collapse. *Survey of Indian Agriculture*. pp 175 – 178.
- *Obodovich, A. N., Marinchenko, V. A., Kislaya, L. V. and Poznanskii, A. M. 1988. Manufacture of new non-alcoholic beverage with improved stability. *Pishchevaya Promyshlennost*. **2** : 17 – 19. (C.F. FSTA Abstracts 1990-2003/09, AN; 1990-09-H0078).
- Palaniswamy, K. P. and Muthukrishnan, 1974. Studies on the evaluation of certain lemon for juice making. *Indian Food Packer*. **28** : 21 – 28.
- Pandey, A. K. and Singh, I. S. 1999. Studies on preparation and preservation of guava ready-to-serve beverages. *Indian Journal of Horticulture*. **56**: 130 – 132.

- *Pavlyuk – Ryu .1988. New non-alcoholic beverages based on freeze-dried fruit. *Pishchevaya Promyshlennost.* **3** : **36 – 38.** (C.F. FSTA Abstracts 1990-2003/09, AN; 1990-01-H0092).
- *Peters, M., Badrie, N. and Comissiong, E. 2001. Processing and quality evaluation of soursop (*Annona muricata* L.) nectar. *Journal of Food Quality.* **24** : **361 – 374.** (C.F. FSTA Abstracts 1990-2003/05, AN; 2002-04-H0840).
- Prasad, R. N. and Mali, P. C. 2000. Changes in physico-chemical characteristics of pomegranate squash during storage. *Indian Journal of Horticulture.* **57** : **18 – 20.**
- Rangana, S. 1986. *Handbook of Analysis and Quality Control for Fruits and Vegetable Products.* Tata McGraw-Hill Publishing Co, Ltd, New Delhi. **1112pp.**
- Raynal, J., Mourgues, J. and Conte, T. 1991. Pectic substances from plum fruits (*Prunus domestica* L.) . *Wisse-u-Technol.* **24** : **263 – 264.**
- Rozmyslova, A. G. 1989. Chemical Composition of Japanese plum fruits in Krasnoder area, *Botanika Genetika-i-Selekisii.* **123** : **90 – 92.**
- Saigal, O. 2001. Food processing industry in India. *Indian Food Packer.* **55** : **77 – 79.**
- Sain, S., Sogi, D. S. and Bawa, A. S. 2003. Shelf-life studies and chemically preserved sand pear (*Pyrus pyrifolia* cv. Pathernakh) pulp. *Journal of Food Science and Technology.* **40** : **70 – 73.**

- Salunkhe, D. K., and Desai, B. B. 1984. Deciduous Fruits – Stone Fruits. *Post Biochemistry of Fruits*, Vol 1, CRC Press, Boca Raton, Florida. **141 pp.**
- Sethi, V. 1993. Changes in physico-chemical characteristics of litchi squash during storage at different temperatures. *Indian Journal of Horticulture*. **50** : 327 – 332.
- Shah, S. and Ray, K. S. 2003. Study of antioxidant and antimicrobial properties of black cumin (*Nigella sativa* Lin.). *Journal of Food Science and Technology*. **40** : 70 – 73.
- Sharma, S. K., Sharma, P. C. and Lal, K. B. B. 2001. Effect of storage temperature and folds of concentration on quality characteristics of galgal (*Citrus pseudolemon* Tan.) Juice concentrate. *Journal of Food Science and Technology*. **38**: 553 – 556.
- Siddiq, M., Arnold, J. F., Sinha, N. K. and Cash, J. N. 1994. Effect of polyphenol oxidase and its inhibitors on anthocyanin changes in plum juice. *Journal of Food Processing and Preservation*. **18** : 75 – 84.
- Siddiq, M., Chang, T. S., Sinha, N. K. and Cash, J. N. 1995. Commercial pectinases and the yield and quality of Stanley plum juice. *Journal of Food Processing and Preservation*. **19** : 103 – 118.
- Sogi, D. S. and Singh, S. 2001. Studies on bitterness development in kinnow juice, ready-to-serve, beverages, squash, jam and candy. *Journal of Food Science and Technology*. **38**: 433 – 438.

- Srivastava, R. K., Bist, N. S., Verma, R. A. and Tripathi, M. P. 1985. Studies on blending of mango varieties for juice preparation. *Progressive Horticulture*. **17** : 185 – 189.
- Tiwari, R. B. 2000. Studies on blending of guava and papaya pulp for RTS beverages. *Indian Food Packer*. **54** : 68 – 71.
- Tripathi, V. K., Lyndgoh, K. and Singh, S. 1992. Studies on blending of pineapple juice with different ratio of guava juice for preparation of RTS beverages. *Progressive Horticulture*. **24** : 60 – 65.
- Tsuji, M., Harakawa, M. and Komiyama, Y. 1984. Changes in shelf-life and quality of plum fruits during storage at high temperature. *Journal of Japanese society for Horticultural Sciences*. **52** : 469 – 472.
- Uygan, U. and Acar, J. 1995. Effect of pH, metallic ions, and storage temperature on colour and pigment content of cornelian cherry nectar. *Fruit Processing and Preservation*. **5** : 398 – 400.
- *Vorobeva, E. A. and Onishchuk, G. A. 1974. Effect of sugar concentration on the properties of Jam. *Tovarovedenie*. **7** : 56 – 58. (C.F. FSTA, Abstracts 1969-94/06, AN; 1975-09-I0098).
- Wang, K. F. and Liu, L. X. 1996. Causes of non-enzymatic browning in peach nectar during processing. *Food and Fermentation Industries*. **2** : 20 – 23.
- Wani, M.A. and Saini, S.P.S. 1990. Processing of plums, *Journal of food Science and Technology*. **27**: 304-306.

- Wani, M.A., Saini, S.P.S and Bains, G.S. 1990. Physico-chemical changes during preparation of plum Juice concentrate. *Journal of Food Science and Technology*. **27**: 29 – 32.
- Wani, M.A. and Saini, S.P.S. 1993. Enzymatic clarification of plum pulp for higher concentration. *Research and Industry*. **38**: 19 – 22.
- Waskar, D. P. and Deshmukh, A. M. 1994. Studies on methods of extraction of juice from pomegranate fruit. *Maharashtra Journal of Horticulture*. **8**: 85 – 88.
- Waskar, D.P. and Khurdiya, D.S. 1987. Processing and storage of phalsa beverages. *Indian Food Packer*. **41** : 7 – 16.
- Westwood, M. N. 1988. *Temperate Zone Pomology*. W. H. Freeman and Company, San Francaasco, **pp 234 – 235**
- Wills, R. B. H., Scriven, F. M. and Greenfield. H. 1983. Nutrient composition of stone fruits (*prunes spp*) cultivars: apricot, cherry, nactrine, peach and plum. *Journal of Science Food and Agriculture*. **34** : 1383 – 1385.
- Wills, R. B. M., Lee, T. H., Grahm, D., McGlasson, W. B. and Hall, E. G. 1982. *Post-Harvest*. AVI Westport, CT. **pp 24 -37**.

* Original not seen.

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CERTIFICATE

Certified that the corrections suggested by the External Examiner **Dr. F. C. Shukla**, have been incorporated in all the copies of the thesis entitled “**Processing and Quality Evaluation of Spiced Plum Nectar as Health Drink**” submitted by **Mr. Imtiyaz Ahmad (Registration No. 2001-A-635-M)** post graduate student of the Division of Post Harvest Technology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir, Shalimar, Srinagar.

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