How to Cite:
Saleem, A., Ahmad, T., Yasir, A., Yasir, A., Tahir, F., Ali, E., Ahmad, H., Ali, H., & Ahsan, S. (2023). Development and evaluation of fruit leather from guava and jujube blend. *International Journal of Health Sciences*, *6*(S7), 6893-6914. Retrieved from https://sciencescholar.us/journal/index.php/ijhs/article/view/13919

Development and evaluation of fruit leather from guava and jujube blend

Ayesha Saleem
National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan

Tanveer Ahmad*
National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan
*Correspondence Author email: tanveerahmad7304@gmail.com

Amaad Yasir
National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan

Fizza Tahir
National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan

Eman Ali
National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan

Hamza Ahmad
National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan

Hakim Ali
National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan

Samreen Ahsan
National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan

***Abstract*---**Fruits and vegetables have become as essential basis of human nutrition because they are nutrient rich foods. They contain many nutrients as well as many non-nutrient food ingredients that have role in preventing diseases. Guava (*Psidium guajava*) is a nutrient rich fruit having high amount of phytonutrients such as

International Journal of Health Sciences ISSN 2550-6978 E-ISSN 2550-696X © 2023.
Manuscript submitted: 18 Oct 2022, Manuscript revised: 9 Nov 2022, Accepted for publication: 18 Dec 2022

carotenoids and lycopene. Due to presence of antioxidants in lycopene it helps in the prevention of prostate cancer. Guava is highly fibre rich fruit and therefore helps diabetic's patient to control their blood sugar level. Jujube (*Ziziphus lotus*) is multifunctional, nutritionally important and commercially viable fruit. Fresh fruit decay is a critical challenge in food industry. Jujube has great potential to deteriorate due to its higher water content which resulting in massive production loss of fruit after cultivation. Various techniques have been designed based on the characteristics of fruit in order to construct and utilize an appropriate treatment to make fruits easily assessable most of the year. Food drying is frequently used approach for extending the shelf life of fruits after cultivation through converting them into the multiple products such as edible fruit leather in order to minimize costs and enhance consumer profit. guava and jujube blended leather was made according to different concentrations of pulp and it was also evaluated that which treatment was best according to all parameters. In this study six treatments were made and all treatment contained different concentrations of pulp. Treatments included T_0(100% guava pulp), T_1(80% guava pulp and 20% jujube pulp), T_2(60% guava pulp and 40% jujube pulp), T_3 (40% guava pulp and 60% jujube pulp), T_4 (20% guava pulp and 80% jujube pulp) and T_5 (100% jujube pulp). Guava and jujube blended leather was then analyzed for proximate analysis, pH analysis, ascorbic acid determination, antioxidant analysis, total soluble acids determination, titratable acidity and sensory analysis.

***Keywords*---**Fruit Leather, Guava, Jujube, Dehydration.

Introduction

Fresh fruits are well known for their high levels of macronutrients and micronutrients. Fruits nutritional value is determined by the amount of their nutritive substances. The moisture content of fruits is very high. Every year 30-50 percent of world's fruits are lost due to high moisture content and limited processing capacity. Fruits have a relatively high metabolic activity, which continues after harvesting. As a result, there is a demand for variety in commercial utilization. The main reasons for a decrease in daily food consumptions are unhealthy diet choices in developed countries and poverty in developing countries. The primary concern is the development of consumer friendly fruit products(Vázquez-Sánchez *et al.*, 2021). Fruits can be used and processed in numerous ways; one of them is fruit leather which is nutritious and getting popular to consumers(Offia-Olua and Ekwunife, 2015). Fruit leather is a thin sheet of fruit puree with a low water content that has been processed. It is primarily consumed as snack, but it can also be used in breakfast cereals. Fruit leathers have pleasant flavour and aroma and are easy to chew. It is an attractive way for children and adolescent to incorporate fruits into diet. Fruit leather has a long shelf life, is easy to make and its nutrients do not change over time(Sukotjo *et al.*, 2021).

Drying is a method of preserving food; it reduces moisture content by inhibiting enzyme activity and microorganisms, resulting in a longer shelf life. Fruit leathers have been formed from variety of fruits including guava, jujube, apple, peach, strawberry, mango and banana. In recent years, foreign and domestic scientists have been interested in the development of combined food product technologies for healthy nutrition. Different types of fruits are being combined to develop fruit leathers in order to improve their nutritional value(Santos *et al.*, 2021). Fruits contain several bioactive compounds that prevent risk of many diseases. Fruits contain high amount of flavonoids, terpenoids, vitamins and antioxidants, all of which are essential for management of diseases such as cancer, cardiovascular diseases and hypertension. A daily dietary intake of 400 g of fruits has been recommended for prevention of these chronic conditions. Fruits consumption per capita in Pakistan is approximately 33 kg per year(Barbalho *et al.*, 2012).

Guava is Pakistan's most popular fruit and total guava production in Pakistan is approximately 498.05 tonnes, with 61.37 thousand hectares under cultivation. Guava has a very short shelf life so we can't keep it for very long. Therefore, it can be used in variety of commercial applications such as fruit leather. Guava (*Psidium guajava*) is a berry of myrtle family. It is frequently referredas the "Queen of fruits" and is grown for its numerous nutritive and medicinal properties. Guava is low caloric fruit that is high in dietary fibre, Vitamin A, B and C as well as minerals like potassium, phosphorus and iron. It has high vitamin C content which is four times higher than oranges. This fruit has many health benefits particularly in the treatment of diarrhea, vomiting and stomach-ache. Carotenoids found in it aid in prevention of cardiovascular diseases(Kumar *et al.*, 2021). It is considered most important fruit among other fruits. Fresh guava is in high demand among consumers but consumers worldwide have increased their demand for minimally processed guava products that are nutritious and have better taste. Due to presence of many nutrients, good taste and extremely good flavor this fruit has high economic demand worldwide. Guava is a seasonal fruit and it remains to grow or mature even after it has been harvested. A rapid increase in rate of oxygen consumption and biochemical processes cause spoilage of fruit(Yadav *et al.*, 2022).

Jujube (*Ziziphus lotus)* belongs to the Rhamnaceae family, also known as desert apple or Chinese apple is multifunctional, nutritionally important and profitable fruit. More than 170 species of jujube fruit are found throughout the world's tropical, subtropical and temperate zone at elevation of up to 2800 meters above sea level. China, Africa, South Korea and Iran are the most cultivated areas of jujube. Jujube also known as Chinese date was first grown in China over 400 years ago. It has been grown in Pakistan in Sargodha, Hyderabad and Multan.

Pakistan's total jujube production ranges from 3716 to 5395 metric tonnes. Drying and diversifying methods of processing jujube into value added food have increased significantly around the world(Yao, 2016).Jujube fruit is an elongated berry, 1.5-3 cm long, varying in shape from round to elongated and size from cherry to plum depending on cultivar. The immature fruit is green while the fully mature fruit is completely red. Jujubes lose moisture, shrivel and become spongy on the inside when exposed to dry conditions. Jujube trees are more resistant to biotic and a biotic stress particularly salinity and drought. Chinese jujube has

been grown in temperate climates whereas Indian jujube has been grown in hot and arid regions of India. Although jujube pulp is typically consumed fresh but it can also be dehydrated into many food items such as cakes, breads, leather and candy. Jujube contains 23 amino acids which are not present in most of other fruits, due to which it has numerous health benefits, making it well known as traditional and functional Chinese food. Chinese jujube is lower in moisture but higher in carbohydrates and polyphenolic compounds. Chinese jujube has higher ascorbic acid content ranges of 559mg/100g fresh weight after maturation.

Phosphorus, potassium, calcium and manganese are the most abundant minerals in jujube. There is also large amount of sodium, copper, iron and zinc present in jujube fruit. When dried jujube fruit is high in fibre and good source of nutrition.

Jujube could also be used as an additive in other foods(Shahrajabian *et al.*, 2019).

Demand for nutritious and safe food is increasing around the world because eating a balanced diet is the recommended way to prevent health problems such as overweight, sugar and nutritional deficiencies that are largely caused by dietary errors. The new trend of eating healthy, innovative and healthy food has led to gradual increase in the fruit bar market. Snack bar consumption is very popular in some countries, constantly rising, prompting the food industry to invest in new fruit bar formulations and ingredients(da Silva *et al.*, 2014).To improve texture of fruit bars high pectin content is added which also act as stabilizer and helps to extend shelf life without significantly affecting nutritional composition of fruits(Salleh *et al.*, 2017). Fruit leathers are frequently produced using advanced drying systems which including tunnel drying systems and compelled air flow drying systems that are more vibrant in color and flavor.

Drying occurs as result of volatilization of liquid caused as a result of heat to the wet material (Diamante *et al.*, 2014). Fruit leather retains its functional character only when dried using efficient and modern dehydrating method such as vacuum drying and stored at refrigerated temperature. Different packaging materials are required to prolong the shelf life of fruit leather (Ruiz *et al.*, 2011).

The present study was designed to achieve following objectives:

- To develop guava fruit leather in combination with jujube fruit for preservation of nutrients.

- To analyze compositional and physicochemical properties of guava and jujube blended leather.

Material and Methods

Development and evaluation of fruit leather from guava and jujube blend was carried out in the department of National Institute of Food Science and

Technology, University of Agriculture Faisalabad. Fruit leathers are drying products that have leather like appearance and can be eaten as snack or used as an ingredient in a variety of products. The materials, experiments and methods used during the experimentation period are listed below.

Procurement of raw material

Ripe guava and jujube fruit were obtained from the Faisalabad local market. Pectin, citric acid and sodium benzoate were available in the laboratory of National Institute of Food Science and technology.

Fruit pulp preparation

Selection of guava and jujube

Guava and jujube were sorted on the basis of shape, color, size. Over riped guava and jujube were separated from ripe fruits. Fresh guava and jujube were picked for development of leather in canning hall of the university.

Washing of raw material

Guava and jujube were washed thoroughly to remove any dirt to avoid contamination and with the help of sharp knife seeds were removed from guava and jujube.By using sharp knife, guava and jujube were cut in same size to aid in blanching process.

Blanching Treatment

Guava and jujube were blanched to deactivate enzymes at 90°C for 5 minutes and were cooled at room temperature. Guava and jujube were blanched and then to make a pulp passed through blender available in canning hall of national institute of food science and technology Faisalabad.

Fruit leather preparation

Equipment and Protocol

A cabinet dryer, a type of dehydrator that includes a drying chamber, a fan for circulation and electric heater available at NIFSAT department was used to dry fruit pulp blended with other ingredients. The drying chamber was kept at 1-1.5 m/s air velocity and 65°C temperature; it was checked on regular basis. I used stainless ruler to measure thickness of the blend from all four corners of the trays to ensure even distribution. Trays were then placed on drying chamber shelves.

weighing balance was available in canning hall and it was used to accurately weighing ingredients. To dry fruit leather, stainless steel trays were used and before drying trays were smeared. Both pulps were homogenized using a grinder.A burner was used to heat the pulp in order to mix the pectin without causing lumps in the mixture. Butter paper was used to prevent leather from sticking to the trays surfaces.

Process

Fruit leather was made by blending guava and jujube pulp in various proportions (100:0, 80:20, 60:40, 40:60, 20:80, 0:100). Fruit extract along with pectin, citric acid, sugar and sodium benzoate heated on stove for few seconds to homogenize this mixture. After heating mixture was poured onto smeared trays which were covered with butter paper. Then these trays were placed in dehydrator.

Temperature of dehydrator was maintained at 60 to 70°C. It was checked every 10 hours to see whether it was completely dry or not. When it was completely dried it was removed from trays and cut into thin sheets. It was packed and stored in plastic containers for further analysis as detailed below.

Experiment details

Crop: Jujube (*Ziziphuslotus*) and Guava (*Psidium guajava)*

Product Name: Guava and jujube blend leather

Material Used: Guava Pulp, Jujube pulp, Sugar, Sodium Benzoate, Pectin, Citric acid

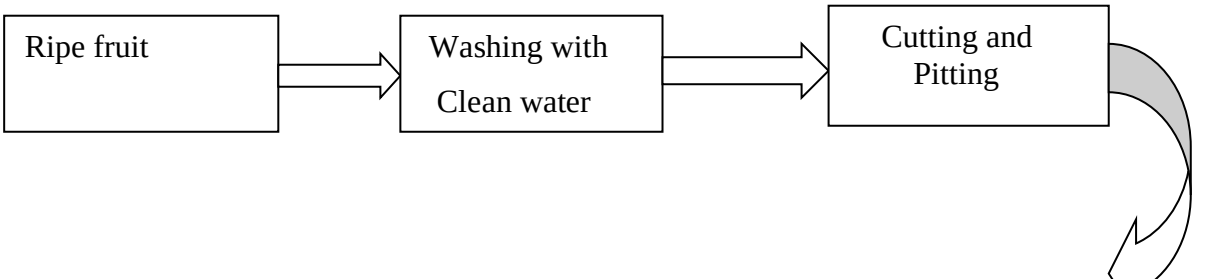
Design Used: CRD

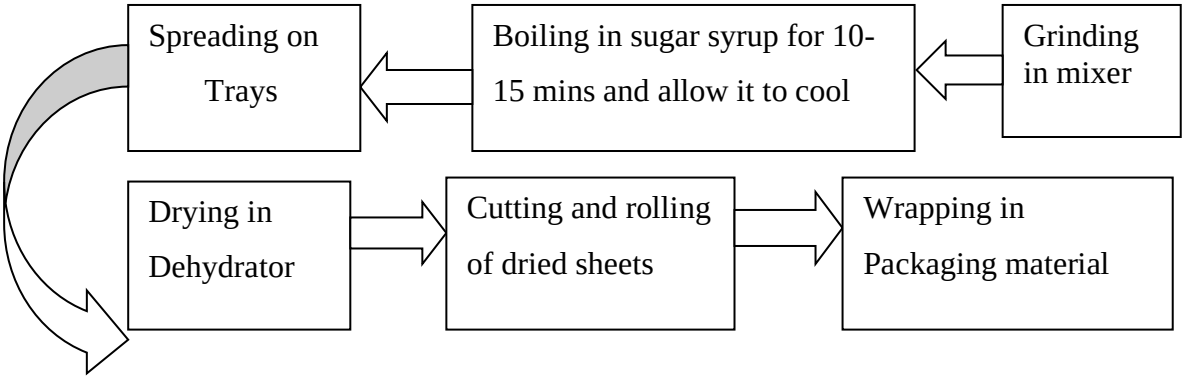
No. of Treatment: 06

No. of Replication: 03

Treatments	Guava pulp (%)	Jujube pulp (%)
T_o	100	0
T_1	80	20
T_2	60	40
T_3	40	60
T_4	20	80
T_5	0	100

Flow diagram for leather preparation





Analysis of Raw materials and fruit leather

Proximate analysis

Samples of dried guava and jujube were evaluated for moisture, crude fibre, crude fat, crudeprotein and nitrogen free extract according to their respective procedures (AOAC,2016).

Moisture content

The moisture content of raw samples was calculated by method proposed by AOAC (2016). The required number of washed and dried china dishes was taken. China dishes were weighed using an automatic weighing balance and the results were recorded. 20g sample was taken in china dish which was weighed before. The sample was placed in china dish and placed in hot air oven for twenty-four hours at 105°C.Sample was removed from hot air oven and placed in desiccators to cool. The dried sample was weighed again and then final reading was recorded. Weighing the samples initial and final weights yielded the moisture content.

$$\% \text{ Moisture} = W1\text{-}W3/W2\times100$$

W1= wight of sample + dish (before drying)

W2= weight of sample

W3= weight of sample + dish (After drying)

Ash content

Amount of ash in dried guava and jujube was determined by using procedure as mentioned in AOAC (2016). Required empty crucibles were thoroughly washed

and dried. Before adding the samples, the crucibles were weighed and the readings were recorded. In each crucible 10 g of dried guava and jujube was added separately. The crucibles containing the sample were weighed again and readings were taken. The samples filled crucibles were then placed at 550°C in muffle furnace. The samples were removed from muffle furnace after 24 hours and weighed after cooling in desiccators.

$$\% \text{ Ash} = \frac{W3 - W1}{W2} \times 100$$

Whereas,

W1=weight of empty crucible

W2=sample weight

W3=weight of ash containing crucible

Crude protein

The crude protein content of guava and jujube was evaluated by Kjeldahl apparatus as methods given by AOAC (2016). Nitrogen and all nitrogen contacting compound present in protein are converted into ammonium sulphate. To distill ammonia standard boric acid solution is used which digest the alkaline. Crude protein is the percentage of nitrogen after being multiplied to a factor.

Reagents

Sulphuric acid (diluted form)

Digestion mixture

Methyl red indicator

4% boric acid

40% sodium hydroxide

0.1 N sulphuric acid

Digestion

In a digestion flask 10ml sample was taken. Add 5g digestion mixture in a filter paper and pour into digestion flask. 25ml sulphuric acid was added in digestion

flask and covered whole apparatus with a lid. To avoid frothing, initial temperature was 40°C and the final temperature was 80°C. 6-8 hours were taken by this process to complete. To cool down it was kept in desiccator. After cooling, 100ml of distilled water was added. Then this mixture was added into 100ml volumetric flask. The digestion flask was washed twice to get accuracy.

Distillation

For distillation micro kjeldahl apparatus was used. In this apparatus 10ml digested sample and 40% sodium hydroxide was added. 2-3 drops of methyl red indicator were added into 10 ml boric acid (4% solution). Then this boric acid solution was added into apparatus. Time was monitored when the color of boric acid turns to red. Stop this until no bubbles formed.

Titration

Pre-tested sample was titrated against 0.1N HCl until pink color appeared**.** Methods described by AOAC (2016) determined protein fraction. By multiplying nitrogen percentage with 6.25 factor, the protein percentage was obtained.

N%= 0.0014× normality of sulphuric acid× volume of sulphuric acid× dilution factor volume used for titration× weight of original sample× 100

Protein % = Nitrogen (%) × Respective factor according to the type of sample

Crude fat

Soxhlet apparatus was used to determined crude fat content**.** 5g moisture free sample was taken in a thimble and inserted into apparatus. The sample was subjected with n-hexane (500ml) for half an hour. Hexane was dipped over the sample once at speed of three to four drops for every second for 2-3 hours. The thimble was removed after six to seven siphons. For possible removal of solvent residues, the sample was placed for 1 hour in an oven at 100±5°C. Beakers were taken from the extraction thimble and arranged in desiccators after rinsing and drying. After cooling to room temperature beakers were weighed and crude fat calculated.

$$\% \text{ Fat} = \frac{W3 - W1}{W2} \times 100$$

Whereas,

W1= Empty beaker weight

W2=sample weight

W3= Beaker weight which containing crude fat

Crude fiber content

10g dried and fat free sample was heated in 1.25% H2SO4 for 30 mins in beaker. This sample was cooled and for 30 minutes again boiled in 1.25% NaOH. Then through the Tecator fibertac system digested materials were washed and filtered.

The residue was dried for 60 minutes in hot air oven at 130°C; it was weighed and ignited in a muffle furnace at 550°C for almost 16 hours before being cooled and weighed again. Crude fibre was calculated using the weight reduction after ignition.

% crude fibre = W2-W3/W1×100

W1= sample weight

W2= before ashing the weight of residue

W3= ash weight

NFE (Nitrogen free extract)

The following formula was used to calculate nitrogen free extract

NFE (%)= (100-% moisture-% ash-% crude protein-% crude fat- % crude fibre)
Analysis of mineral

Analysis of minerals was done by wet digestion of samples according to the method described by AOAC (2016). To calculate zinc in samples, atomic absorption spectrophotometry was used. In 100ml flask on hot plate 0.5g of sample was digested with 7ml of HClO4 and 3ml HNO3. For 3 hours the sample was heated with acids. It was heated until a transparent residue of 2ml remained.

The flask was removed from heat and allowed to cool. Then 100-250ml volume of distilled water was prepared. The calibration curve was made by first running minerals of known strength. The mineral concentration was calculated using a calibration curve for each constituent.

pH

pH of guava and jujube slices was calculated by using pH meter according to methods given by (Singh *et al.*, 2019). By using buffer solution, the pH meter was calibrated. 10 g of guava and jujube was blended with 10ml distilled water separately. The blended guava and jujube was poured into beaker separately and electrode was inserted into beaker contacting juice.

Titratable acidity

Titratable acidity of guava and jujube slices was examined separately as described by

(Sukotjo *et al.*, 2021). 10 ml of guava and jujube juice was mixed with 250 ml of distilled water; 2-3 drops of phenolphthalein indicator were added and mix thoroughly. It was then titrated against 0.1N NaOH solution until it turned light pink.

Titratable acidity % = 0.1 × Equivalent weight of acid × Normality of the NaOH × Volume of NaOH used for titration /10

Ascorbic acid determination

Vitamin C content of fruit leather was examined by titration method as explained by (Sukotjo *et al.*, 2021). 30ml of guava juice leather was mixed with 70 ml of oxalic acid. Filter paper was used to filter this solution. Titrated 15ml of filtrate against 2,6 dichlorophenolindophenol dye until pink color appeared and initial and final dye volumes were recorded. Ascorbic acid content of fruit leather was calculated according to given formula:

Principle

The indicator dye is reduced to a colorless solution by ascorbic acid. 2,6-dichlorophenol indophenol is rendered colorless by ascorbic acid. Ascorbic acid has a unique reaction at pH 1 - 3.5, which is only possible at this pH range. In acidic solutions, the indicator dye turns red, whereas in alkaline solutions, it turns blue. After filtering with (Whatman® No# 1 Filter paper), fruit juice was extracted from all samples. The quantity of ascorbic acid in the food sample is determined by the volume of titration used.

Preparation and standardization of dye

Soda benzoate, sodium dichlorophenol indophenol and the distilled water were measured out, dissolved in the final volume of 250ml, and mixed well.To produce another Oxalic acid solution, 1liter of distilled water was mixed with 4 grams of oxalic acid salt. Using 2ml of that ascorbic acid solution, an indicator dye solution was titrated against it until the appearance of a pink color lasting 15-20 seconds was attained.

Titration

A 30 ml sample from each treatment was individually mixed with 70ml of 0.4 oxalic acid solution. All these contents were transferred to a 100ml volumetric flask. 15ml of diluted beverage sample was collected after filtration using filter paper in another flask and titrated against indicator dye until the appearance of the pink color and that color persisted for about 15 seconds. Three consecutive values were taken for each sample.

Calculation

Vitamin C contents in the sample were calculated according to the given formula,
Ascorbic Acid (mg 100 g-1) = (D1× V) **/** (D × A × B) × 100

Where;

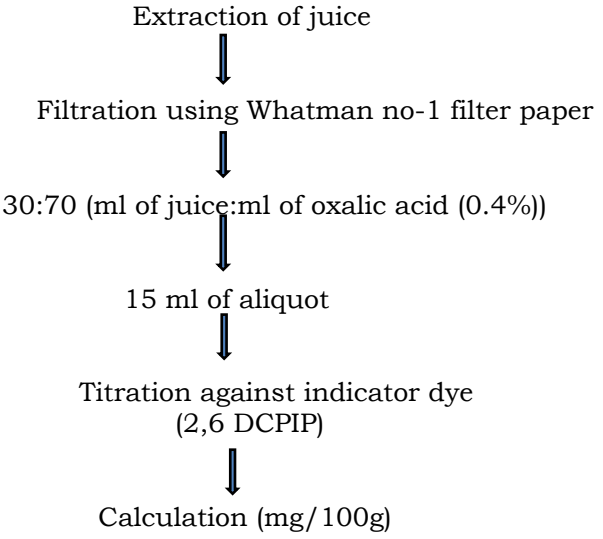
D1= milliliter of the indicator dye used in the titration of aliquot

V= Aliquot volume prepared by adding 0.4% of oxalic acid solution

B= milliliter of aliquot used for the titration process

A= milliliter of juice used

D= Dye (ml) used in the titration procedure of solution of standard ascorbic acid (1-ml) formulated by the addition of 0.1% of ascorbic acid (1-ml) + 0.4% of oxalic acid (1.5ml)



Sensory evaluation

Nine-point hedonic scale was used for sensory evaluation of fruit leather. For each sensory characteristic (aroma, color, texture, flavor, overall acceptability) 9 was given as the highest score and 1 as lowest score(Chauhan, 2015). Combined fruit leather was done by students and teachers in NIFSAT. Panelists were asked to circle the number of products that they preferred based on their appearance, texture, color, flavor, aroma and overall acceptability of the samples.

Statistical analysis

The data from each parameter was statistically analyzed using ANOVA (one factor factorial) as described in Montgomery (2017). Significant ranges were further described using the LSD mean comparison test in Statistix 8.1 software.

Results

Fruit leather is regarded as a nutrient dense food with numerous health benefits. Different amounts of guava and jujube pulp were used to access the

physicochemical properties, proximate analysis as well as nutritional content of guava and jujube fruit. This chapter discussed the findings of proximate, physicochemical and sensory as well as the facts and conclusions drawn by other scientists. All readings were taken in triplicates and mean can be seen in tables.

Analysis of Raw Material

Table:Proximate composition of guava

Proximate	**Value**
Moisture content	83.38±0.01
Ash content	5.47±0.01
Crude fat	1.81±0.01
Crude fibre	18.04±0.01
Crude protein	7.68±0.01
Nitrogen free extract	77.27±0.01

Table: Proximate analysis of jujube

Proximate	**Value**
Moisture content	62.51±0.01
Ash content	3.22±0.01
Crude fat	1.46±0.01
Crude fibre	6.3±0.1
Crude protein	5.1±0.05
Nitrogen free extract	62.21±0.01

Table: Zinc analysis of guava and jujube

Raw material	**Value**
Guava	0.22±0.01
Jujube	0.52±0.01

Table: pH of raw material

Raw material	**Value**
Guava	3.7±0.05
Jujube	5.2±0.01

Table:Titratable acidity of raw material

Raw material	**Value**
Guava	0.76±0.01
Jujube	0.48±0.01

Table: Total soluble solids of raw material

Raw material	Value
Guava	12.7±0.1
Jujube	13.57±0.01

Proximate analysis of fruit leather

Table:Mean values for moisture content of guava and jujube blend leather

Treatment	Mean
T_o	10.417±0.005
T1	8.5700±0.01
T2	8.6200±0.01
T3	5.1200±0.01
T4	3.2200±0.01
T5	6.2500±0.01

Table: Mean values for Ash content of guava and jujube blend leather

Treatment	Mean
T_o	5.4700± 0.01
T1	4.5800 ±0.01
T2	3.1700±0.01
T3	3.1500±0.01
T4	3.2000 ±0.01
T5	3.2700 ±0.01

Table: Mean values for crude protein of guava and jujube blend leather

Treatment	Mean
T_o	2.6800±0.01
T1	2.4800±0.01
T2	2.5700±0.01
T3	3.6700±0.01
T4	1.3800±0.01
T5	1.5100±0.01

Table: Mean values for crude fat of guava and jujube blend leather

Treatment	Mean
T_o	1.8200±0.01
T1	1.5800±0.01
T2	1.4200±0.01
T3	1.3800±0.01
T4	1.3600±0.01
T5	1.4500±0.01

Table: Mean values of crude fibre of guava and jujube blend leather

Treatment	Mean
T_o	17.110 ±0.01
T1	12.170±0.01
T2	10.170±0.01
T3	7.1800±0.01
T4	6.2800±0.01
T5	5.8000±0.1

Table: Mean values for pH of guava and jujube blend leather

Treatment	Mean
T_o	4.8067± 0.005
T1	5.1567±0.005
T2	5.0800±0.01
T3	6.4700±0.01
T4	6.8600±0.01
T5	4.7700±0.01

Table: Mean values for Titratable acidity of guava and jujube blend leather

Treatment	Mean
T_o	0.5500 ±0.01
T1	1.2200 ±0.01
T2	1.1200±0.01
T3	0.2300 ±0.01
T4	0.1600 ±0.01
T5	0.2800±0.01

Table: Mean values for TSS of guava and jujube blend leather

Treatment	Mean
T_o	10.417±0.005
T1	8.5700±0.01
T2	8.6200±0.01
T3	5.1200±0.01
T4	3.2200±0.01
T5	6.2500±0.01

Table:Mean values for Ascorbic acid content of guava and jujube blend leather

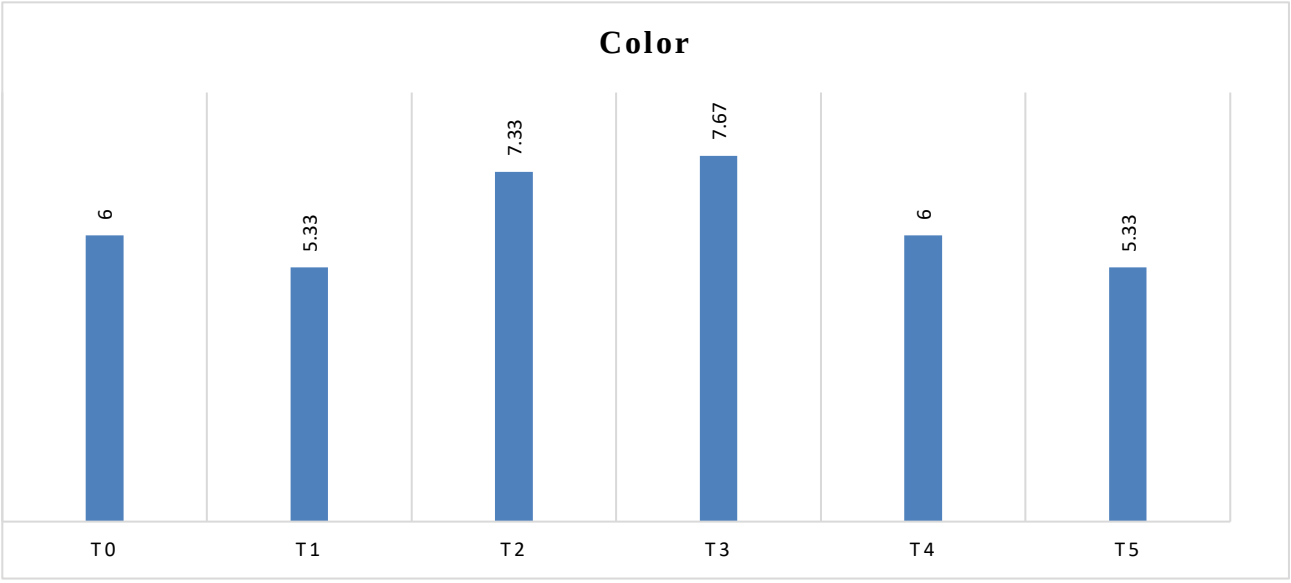
Treatment	Mean
T_o	64.680±0.01
T1	60.180±0.01
T2	54.250±0.01
T3	50.250 ±0.01
T4	40.280±0.01
T5	28.220±0.01

Table: Mean values for zinc analysis of guava and jujube leather

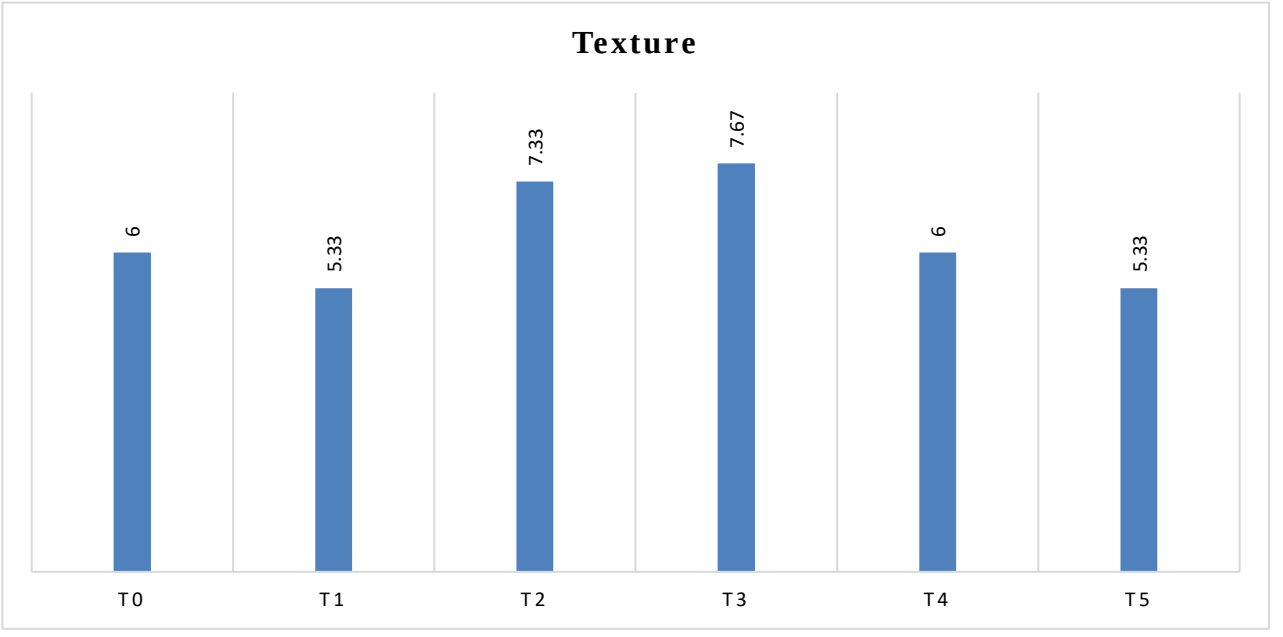
Treatment	Mean
T_o	0.2100±0.01
T1	0.7400 ±0.01
T2	0.7100 ±0.01
T3	0.7500±0.01
T4	0.7700±0.01
T5	0.5200±0.01

Sensory Analysis

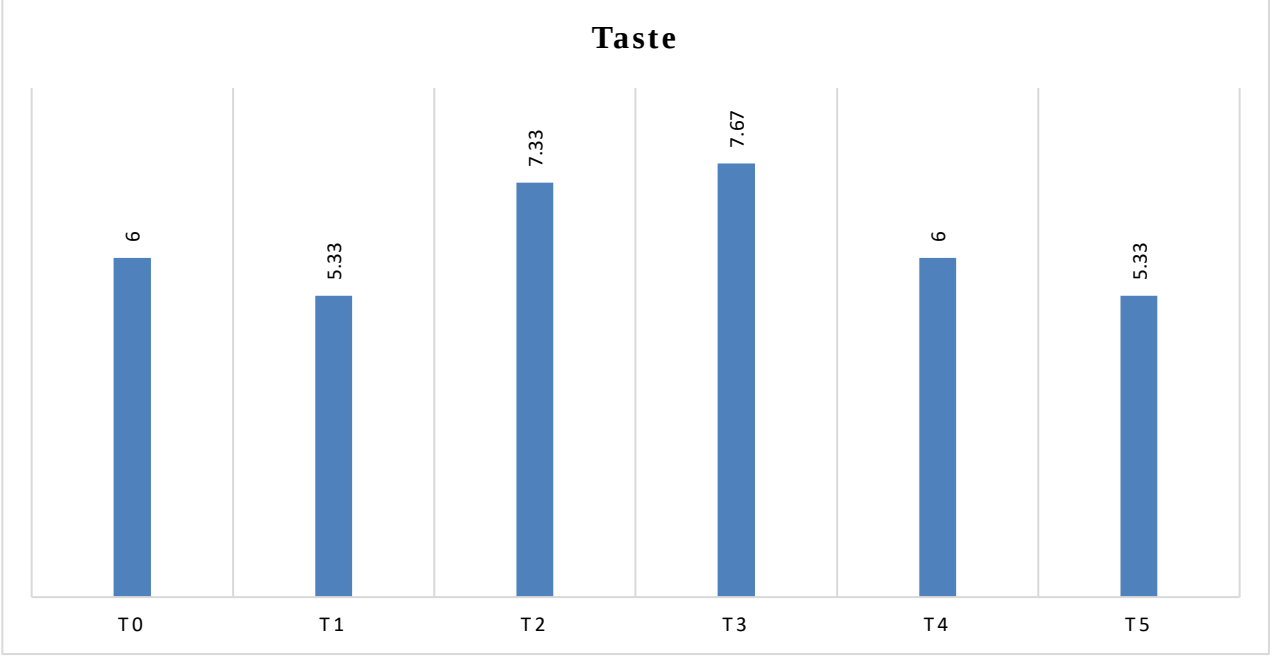
Color



Texture

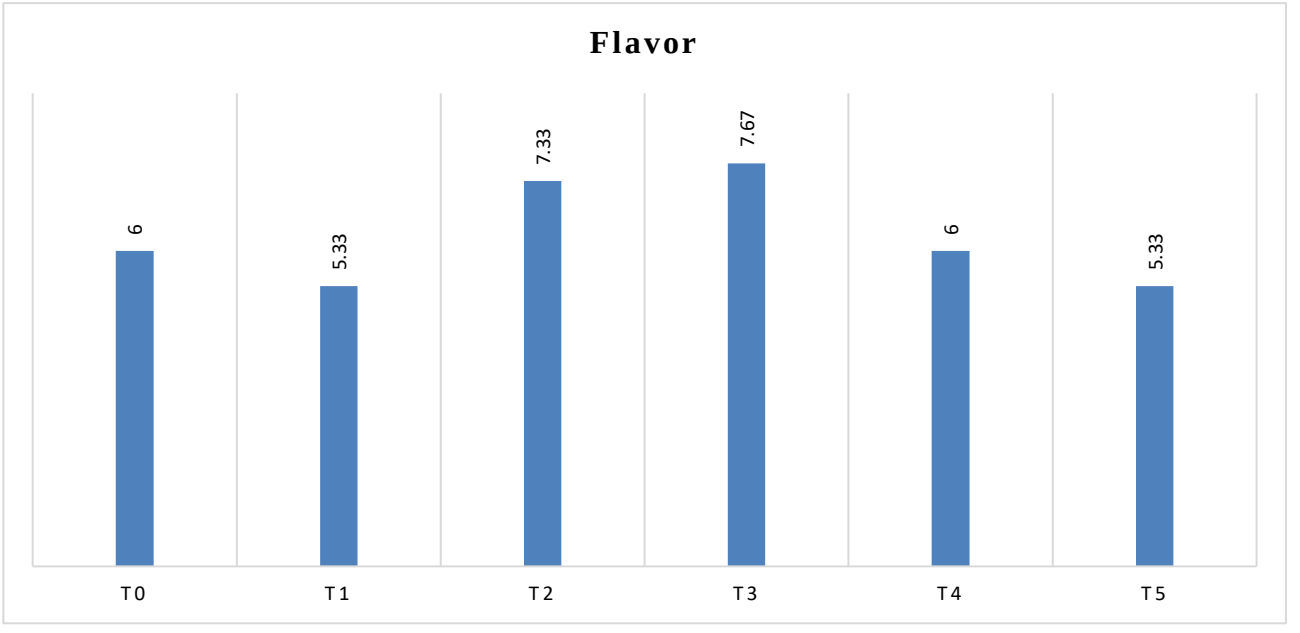


Taste

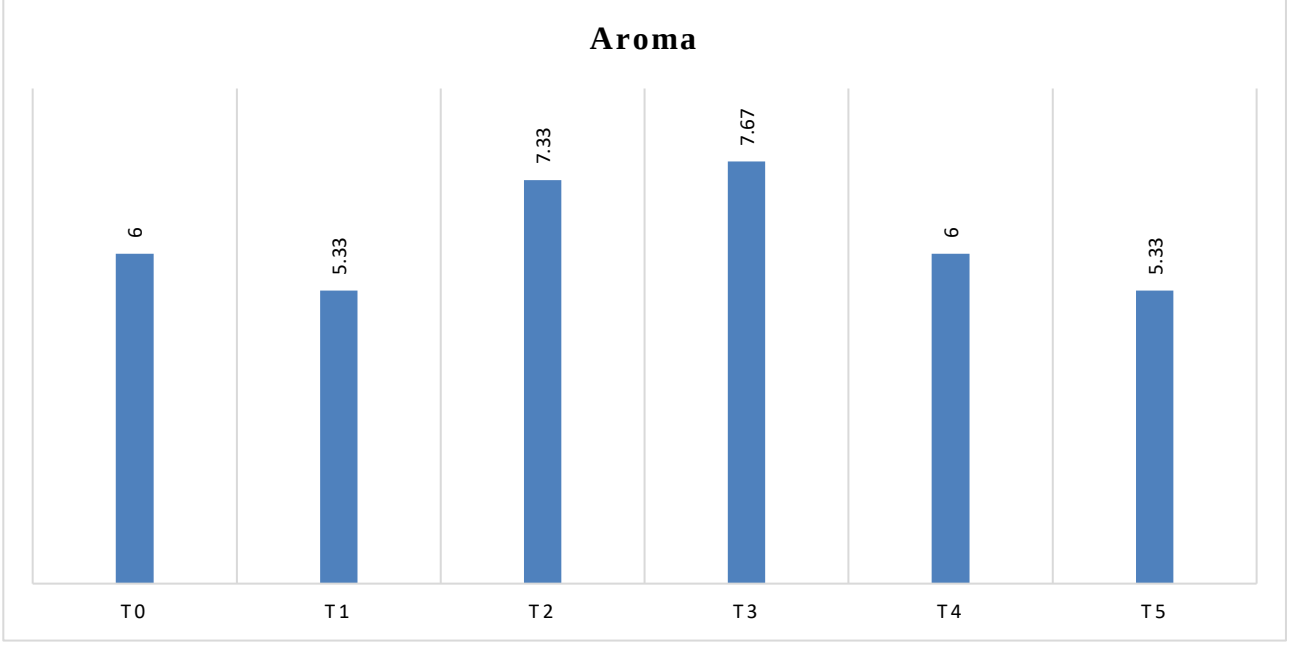


6910

Flavor



Aroma



Discussion

Proximate composition is essential to the proper growth and development of body**.**

Proximate composition of guava fruit has shown in table.In guava fruit, the moisture content, ash content, crude fat, crude fibre, crude protein and nitrogen free extract are 83.38%, 5.47%, 1.81%, 18.04%, 7.68% and 77.27% respectively.

The guava had highest percentage of moisture and crude fibre and moderate to low percentage of protein and fat. High moisture content of guava shown that storage period of guava was very limited due to shelf life of few days. Low fat content indicated that guava is not good source of lipid. These values are closely related to results of (Rakhi *et al.*, 2021) who prepared the edible fruit leather from blend of guava pulp and alovera. These values are very close to range described by (Srivastava *et al.*, 2019) who demonstrated the proximate properties of guava fruit and developed a fruit bar from different ratios of guava and orange pulp.The proximate composition of jujube has shown in table. In jujube moisture content, ash content, crude fat, crude fibre, crude protein and nitrogen free extract are 62.51%, 3.22%, 1.46%, 6.3%, 5.1% and 62.21% respectively. These values are closely related to proximate analysis of jujube given by (Hasan *et al.*, 2022). In this study the ash content, fat and fibre content was higher while the content of moisture, carbohydrates and protein was low.

The proximate composition of edible leather made from blend of guava and jujube has shown in table 4.2. Treatments have impact on moisture content of edible leather and the range of moisture content from 11.44 to 17.86%. T_3 (40% guava pulp and 60% jujube pulp) had highest moisture content and T5 (100% jujube pulp) had lowest moisture content. T1 (80% guava pulp and 20% jujube pulp), T2 (60% guava pulp and 40% jujube pulp), T3 (40% guava pulp and 60% jujube pulp). T4 (20% guava pulp and 80% jujube pulp), T5 (100% jujube pulp) showed moisture content in range of 17.86, 16.17, 15.18, 18.28, 13.38 and 11.44 respectively as shown in table. The analysis of variance for ash content of leather made from blend of guava and jujube had significant effect. After addition of different concentrations of guava and jujube blend treatments had ash content in range of 5.47±0.01% ($T_{o)}$, 4.58±0.01% (T1), 3.17±0.01% (T2), 3.15±0.1% (T3), 3.20±0.01% (T4) and 3.27±0.01% (T5). Table 4.8 showed that T_0 (100% guava pulp had highest ash content and T2 (80% guava pulp and 20% jujube pulp) had lowest ash content.

The crude protein content of fruit bar made with different concentrations of guava and jujube pulp varied significantly. T3 (3.67%) had highest crude protein content followed by T_0 (2.68%), T2 (2.57%), T1 (2.48%), T5 (1.51%) and T4 (1.38%).

Comparison between the treatment mean has shown in table 4.2.3and the results from table shows that the concentration of guava and jujube pulp added to make fruit bar is an important factor in evaluating the protein content of fruit bar.Fat content of fruit bar was varied by different concentrations of guava and jujube pulps. These concentrations significantly affected the treatments and it ranges from 1.36% to 1.82% in developed leather of guava and jujube. $T_o$have high fat content (1.82%) and the treatment T4 have lowest fat content (1.36%). Other

treatments T1, T2, T3 and T5 had fat content in range of 1.58%, 1.42%, 1.38% and 1.45% respectively as shown in table. These findings were similar to findings of (Vasanthakaalam *et al.*, 2018) who developed a fruit bar from guava and papaya blend and he evaluated the proximate analysis of that developed leather.

Results indicated that pH values of guava and jujube were in range of 3.7 and 5.26 respectively which showed that guava has lower pH as compared to jujube thus it can be stored for longer period of time than jujube. A pH of 3.7 is considered critical for trying to control bacterial growth particularly all spore forming bacteria. As shown in table the pH of fruit bars prepared with various concentrations of guava and jujube pulp varied significantly between treatments.

The maximum pH was observed in T4 (6.866%) while the minimum pH was observed in T5 (4.77%). The highest pH value was found in treatment T4 and it was gradually decreased followed by T3 (6.47%), T1 (5.15%), T2 (5.08%) and T_0 (4.80%). A drop in pH could be related to the increased concentration of loosely ionized acids as well as salts(Bisen and Ruchi, 2020). The titratable acidity of fruit bars treated with different concentrations of guava and jujube pulp varied significantly as shown in table 4.4 (b). Highest percentage of acidity was present in T1 (1.22) and lowest percentage of acidity was present in T4 (0.16). The range of titratable acidity in different treatments was in range of T_0 (0.55%), T1 (1.22%), T2 (0.28%), T3 (0.23%), T4 (0.16%) and T5 (0.28%) respectively. The increase in acidity could be caused by increase in acid concentration in pulp.

Minerals are necessary for maintenance of human health. Fruits have large variety of minerals such as zinc, magnesium, potassium. Zinc is an important mineral that is required by human body. It is a key element that is essential for our body. Jujube contains high amount of zinc than guava as shown in table. These both fruits provide amount of zinc which fulfills daily requirement of humans. Amount of zinc in guava and jujube was 0.22 mg and 0.52 mg respectively. All treatments varied significantly according to concentration of guava and jujube pulp as shown in table 4.8 b. In current study only zinc was analyzed in all fruit bars having different combinations of guava and jujube pulp.

Lowest value of zinc was observed in T_0 which is followed by other treatments T1 (0.74 ±0.01), T2 (0.71 ±0.01), T3 (0.7500±0.01), T4 (0.7700±0.01) and T5 (0.5200±0.01) respectively. Highest zinc content was observed in T4 treatment having 20% guava pulp and 80% jujube pulp this finding showed that with increased concentration of jujube pulp the zinc content was also increased. These findings were similar to zinc content of fruit bar made from guava and apple (Arinzechukwu and Nkama, 2019).

The analysis of variance for the ascorbic acid content of guava and jujube blend fruit leather made with various concentrations of guava and jujube pulp had significant effect ($p<0.01$) on treatments as shown in table. Highest ascorbic acid content was present in T_0 (64.68±0.01) while treatment T5 (28.22±0.01) had lowest ascorbic acid content. Ascorbic acid content of other treatmentT1, T2, T3, T4 was in range of 60.18±0.01, 54.25±0.01, 50.25 ±0.01 and 40.280±0.01 respectively. It is assumed that the addition of guava pulp inhibits oxidation of

ascorbic acid to some degree and preventing the extra loss, deterioration of quality; ascorbic acid is a predictor of quality of fruit bar.

Sensory Analysis

T3 was highly preferable by color and it got maximum score as compared to all other treatments. These color scores were closely related to scores of guava leather. Results specified that the dark color was due to high reducing sugar contents. Color of fruit leather is one of their most important parameters that affect consumer acceptance and purchase intention. The analysis of variance for texture of guava and jujube blend showed significantly results. All treatments varied significantly according to concentration of guava and jujube pulp (Graph).

T3 got highest score among all other treatments. These findings were closely related to findings of (Vasanthakaalam *et al.*, 2018).The taste properties of leather (T3) prepared with incorporation of 40% guava and60% jujube pulp having higher sweetness level was found to be better compared with other treatments. Results indicate that T3 has given the maximum scores for flavor (7.6667±0.57) followed by T4 (5.6667±0.57), T5(5.3333±0.57), T1(6.3333±1.15), T2 (6.6667±0.57), T_o (5.3333±0.57). It has been observed that mixing of guava pulp and jujube pulp enhanced the flavor of the fruit leather.

References

AOAC (Association of Official Analysis Chemists). 2016. The Official Methods of Analysis of AOAC International, 20th Ed. AOAC International, ARL, USA

Arinzechukwu, C. and I. Nkama. 2019. Production and quality evaluation of fruit bars from banana (Musa sapientum) and cashew (Anacardium occidentale) apple fruit blends. Asian Food Science Journal. 10:1-16.

Barbalho, S.M., F.M. Farinazzi-Machado, R. De Alvares Goulart, A.C.S. Brunnati, A. Otoboni and B. Ottoboni. 2012. Psidium guajava (Guava): A plant of multipurpose medicinal applications. Med Aromat Plants. 1:1-6.

Bisen, B. and V. Ruchi. 2020. Standardization of recipes on chemical characteristics and storability of guava and papaya mixed fruit bar. International Journal of Chemical Studies. 8:824-29.

Chauhan, A. 2015. Product Development and Sensory Evaluation of Value Added Food Products Made by Incorporating Dried Cauliflower Green Leaves. Journal of Nutrition & Food Sciences. 5:1.

Da Silva, E.P., H.H. Siqueira, R.C. Do Lago, C.M. Rosell and E.V.D.B. Vilas Boas. 2014. Developing fruit-based nutritious snack bars. Journal of the Science of Food and Agriculture. 94:52-56.

Diamante, L.M., X. Bai and J. Busch. 2014. Fruit leathers: method of preparation and effect of different conditions on qualities. International journal of food science. 2014.

Hasan, S.K., M.R. Kabir, M.R. Kabir, M.R. Islam, M.J. Akhter and J.Y. Moury. 2022. Proximate composition, minerals, phytochemicals, and functional activities of jujube fruits grown in Bangladesh. Journal of Agriculture and Food Research. 8:100302.

Kumar, M., M. Tomar, R. Amarowicz, V. Saurabh, M.S. Nair, C. Maheshwari, M. Sasi, U. Prajapati, M. Hasan and S. Singh. 2021. Guava (Psidium guajava L.)

leaves: nutritional composition, phytochemical profile, and health-promoting bioactivities. Foods. 10:752.

Offia-Olua, B.I. and O. Ekwunife. 2015. Production and evaluation of the physico-chemical and sensory qualities of mixed fruit leather and cakes produced from apple (Musa pumila), banana (Musa sapientum), pineapple (Ananas comosus). Nigerian Food Journal. 33:22-28.

Rakhi, A.a.M., A. Singh and L.K. Rawat. 2021. Development and quality evaluation of guava leather incorporated with aloe vera (Aloe barbadenis miller).

Ruiz, N., S. Demarchi and S. Giner. Research on dehydrated fruit leathers: a review. Procedings of the 11th International Congress on Engineering and Food, 2011.

Salleh, R.M., T.L. Ying and L. Mousavi. 2017. Development of fruit bar using sapodilla (Manilkara zapota L.). Journal of Food Processing and Preservation. 41:e12806.

Santos, K.L., P.H.M. De Sousa, M.E.R.M. Cavalcanti-Mata and L.B. De Vasconcelos. 2021. Mixed leather of açaí, banana, peanut, and guarana syrup: the effect of agar and gellan gum use on quality attributes. International Journal of Gastronomy and Food Science. 26:100407.

Shahrajabian, M.H., M. Khoshkharam, P. Zandi, W. Sun and Q. Cheng. 2019. Jujube, a super-fruit in traditional Chinese medicine, heading for modern pharmacological science. Journal of Medicinal Plants Studies. 7:173-178.

Singh, A., C. Sonkar and S. Shingh. 2019. Studies on development of process and product of plum fruit leather. Studies. 4:74-79.

Srivastava, A., D. Kohli, S. Vishnoi, S. Kumar and R. Badola. 2019. Quality evaluation of prepared guava-orange fruit bar. International Journal of Chemical Studies. 7:1574-1581.

Sukotjo, S., D. Nurani and M. Juliansyah. Sensory analysis and physicochemical characteristics of carica [Vasconcellea pubescens] fruit leather with seaweed [Eucheuma cottonii] addition. IOP Conference Series: Earth and Environmental Science, 2021. IOP Publishing, 012017.

Vasanthakaalam, H., J. Muhimpundu, A. Karayire and M. Fabien. 2018. STABILITY OF VITAMIN C AND ß-CAROTENE DURING PROCESSING OF PAPAYA GUAVA FRUIT LEATHER. Carpathian Journal of Food Science & Technology. 10.

Vázquez-Sánchez, A.Y., R. Corfield, N. Sosa, D. Salvatori and C. Schebor. 2021. Physicochemical, functional, and sensory characterization of apple leathers enriched with acáchul (Ardisia compressa Kunth) powder. LWT. 146:111472.

Yadav, A., N. Kumar, A. Upadhyay, O.A. Fawole, M.K. Mahawar, K. Jalgaonkar, D. Chandran, S. Rajalingam, G. Zengin and M. Kumar. 2022. Recent advances in novel packaging technologies for shelf-life extension of guava fruits for retaining health benefits for longer duration. Plants. 11:547.

Yao, S. 2016. Jujube, an alternative fruit crop for the Southwestern United States. HortScience. 51:1329-1332.