Journal of American Science

Websites:
http://www.jofamericanscience.org
http://www.sciencepub.net

Emails:
editor@sciencepub.net
sciencepub@gmail.com

MARSLAND PRESS
Multidisciplinary Academic Journal Publisher

Preparation and Characterization of Composite Fruit Leather of Peach and Tomato

Hira Ijaz[1]*, Manazza Ayub[2], Ayesha Waqar[1], Atka Afzal[3], Khadija Kausar[1], Ali Akbar Gill[4], Komal Rehman[1]

[1]National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan
[2]Erciyes University, Department of Food Engineering, Talas yolu 38039, Melikgazi, Kayseri, Turkey
[3]Institute of Home and Food Science, Government College University Faisalabad, Pakistan
[4]State key Laboratory of Food Science and Technology, Jiangnan University, Wuxi, Jiangsu, China National
Corresponding author's Email Address: itshiraijaz1996@gmail.com

Abstract: In human diet fruits play a very important role and are very good for health due to their beneficial effects and great nutritional value. Peach and tomato have high nutritional content and are very favorable for the growth, treatment of various diseases and for maintaining good health. Shelf-life and nutritional value of fruits can be preserved by making different products that contained low moisture content and preservation of fruits by dehydration is the best method to preserve fruit. Fruit leather is a meticulous produce which are made by using the puree of the fruits (like apple, mango, peach, tomato etc.) and are eaten as snack food. In present study, composite fruit leather, with improved nutritional value, was produced by using peach and tomato puree. The physicochemical analysis of fruit leather including proximate, TSS, pH, color, TPC and lycopene content were carried out. There was increase in moisture and fat content of leather and there was decrease in amount of ash. The pH and TSS of samples was decreased from 4.04 to 3.29 and 13.00 to 9.87 from T0 to T5. Results showed high TPC and antioxidant activity in all treatments. There was also observed increase in lycopene content in all the treatments ranging from 0.14 to 5.59. Sensory evaluation shows that the control is the most liked treatment. Thus, the results indicated that by incorporating tomato puree it is possible to improve nutritional quality and improved lycopene content of composite leather.

[Hira Ijaz, Manazza Ayub, Ayesha Waqar, Atka Afzal, Khadija Kausar, Ali Akbar Gill, Komal Rehman. **Preparation and Characterization of Composite Fruit Leather of Peach and Tomato.** *J Am Sci* 2021;17(3):28-35]. ISSN 1545-1003 (print); ISSN 2375-7264 (online). http://www.jofamericanscience.org. 4. doi:10.7537/marsjas170321.04.

Key words: Fruits Leather Peach Tomato Lycopene

Introduction

Fruits are very beneficial for health and play an important role in human diet. The meaning of fruit is enjoy and it comes from Latin word frui. Fruits not only contain nutrients but they are also appetizing and refreshing(Khan *et al.*, 2006). They are natural source of dietary fiber, vitamins, minerals and energy. The amount of carbohydrates in fruits range from 10 to 25%, minute amount of fat and less than 1.0% protein. Important minerals present in fruits are Ca, Na, P, Mg, S and Cl and minerals that are present in small amounts in fruits are Cu, Fe, I, Zn, Co and Mn. Increase consumption of fruits helps to reduce the load of ischemic stroke, ischemic heart diseases, lung and colorectal cancer by 2 to 31%. For positive health benefits consumption of fruits are highly recommended (Orrego *et al.*, 2014). Large amounts of fruits are produced but only small amount of fruits are processed. There are various factors that increase the deterioration of fruits like chilling injury, poor transportation and storage of fruit, poor networks of road, wilting, shriveling and lower processing of fruits. Metabolic activity of fruits is very high than other food obtaining from plants and after harvesting metabolic activity continues and decrease the shelf life of fruit by making fruits perishable. It is very essential to utilize the fruits to increase the shelf life by making different products like jams, jellies and leather(Offia-Olua and Ekwunife, 2015a). Consumers have great interest towards the nutritional benefits of fruits that play an important role in protection of various diseases. Natural bioactive components and minerals are present in fruits which are beneficial for human health and consumers have great demand towards the fruit product that contained hundred percent fruit puree and juice and food processors are trying to make the valuable product like leather that contained fruit puree and juice(Chen and Martynenko, 2018). Throughout the season access of fruits are not achieved but they are important to human health and due to low shelf life fruits are processed into number of products like snacks and leather (Saikia *et al.*, 2015).

Fruit leathers are tasty and chewy dried slabs and are fruit based product. The name leather has given due to leathery appearance. Mixed and individual fruits can be used for its production. For the preparation of leather frozen, canned or fresh fruits are used. These are very beneficial for the health conscious and diabetic consumers because of less sugar and more fruit flavor utilization(Khan *et al.*, 2014a). It is a low moisture product which is made by drying of fruit puree and also known as fruit bar, fruit sheet and fruit roll. Sugars and acids are naturally present in leather but to give the softness to leather and to decrease the water activity humectants are incorporated. Leather contained water activity lower than 0.6 and amount of moisture present in range of 8 to 15 percent(Shakoor *et al.*, 2015a). It is a very good source of minerals, nutrients, energy and consumed as a snack and nutritional value of leather greatly depends on the raw material and temperature used for drying of leather. Drying temperature and amount of moisture affect the texture of the leather and high temperature for longer period results hard texture (Momchilova *et al.*, 2016). In different types of products such as breakfast cereals and biscuits fruit leathers are used as an ingredient. In processing of fruit leathers some of the drying methods used like solar drying, direct sunlight, electric cabinet drying and convection oven drying. Dehydration permit storage of fruits for great period and preserve the nutrients and vitamins of fresh fruits(Offia-Olua and Ekwunife, 2015a). Different fruits like apricot, grapes, orange, tomato, apple, berries, peaches, kiwifruits and papaya are used for the production of fruit leather. It is a complete snack and easy to pack and eat (Huang and Hsieh, 2005).

Peach is well liked summer fruit. *Prunus persica* is a scientific name of the peach. Worldwide it is third dominant fruit. China produced 55% of the world's peach (Roknul Azam *et al.*, 2019). It contain single oval shaped seed which is red-brown in color. In Pakistan cultivation of peach mostly occur in Swat valley, Quetta, Kalat, Peshawar, and Kohistan and its production is 48284 tonnes and it covers the area of 4543 ha(Ashraf *et al.*, 2011). Due to the short shelf life of peach it can be preserved when the season is high for the production of different product. Peach is a delicious fruit contains 2% protein and fiber and amount of sugar present in peach is 10-14%. Calcium, zinc, folic acid, and ascorbic acid are also present in peach and a wonderful source of potassium which is very useful in preventing the risk of high blood pressure and maintaining the good heart health and makes the heart muscles strong(Nida Saleem *et al.*, 2011). Peach play an important role in the prevention of constipation(Manzoor *et al.*, 2012). As peach contain phenolic compounds, it is also a good source of bioactive polyphenol which have positive effect on human health. Their consumption provides health benefits against long term diseases due to its good scavenging potential. They carry large amount of flavonoids and proanthocyanidin which kills the cancer cells and reduction in formation of tumor organoid in colorectal cancer. Peaches are wonderful source of antioxidant and bioactives are used for their health promoting values in different food products and can be used for natural functional cosmetics(Jung *et al.*, 2019). Long term diseases like cancer, diabetes and cardiovascular diseases can be reduced by increased consumption of peach. Obesity-induced metabolic disorders like dyslipidemia and hyperglycemia can be prevented by peach juice consumption. The valuable effects of peach consumption is due to the minerals, vitamins and phytochemicals that includes flavonoids, anthocyanin and phenolic compounds that are available in peach(Saidani *et al.*, 2017).

Tomatoes are the fruits not a vegetable and it is very beneficial for health. The scientific name of tomato is *Solanum Lycopersicum* and it belongs to the *Solanaceae* family. Tomatoes are available in different shapes like round, oval and cherry but the nutritional value of these tomatoes are same(Bhowmik *et al.*, 2012b). Number of products like tomato juice, tomato paste and ketchup are consumed all around the world. In the world tomatoes are the broadly grown product with the production of 136 mt. In the production of tomato china ranked at the top followed by Turkey, Iran, India and Bangladesh. From other countries like China, Bangladesh, Sri Lanka, Azerbaijan, India, turkey and Iran, Pakistan has the highest growth rate that is 8 percent. Pakistan producing 561.9 thousand tons of tomato and the production of tomato in Punjab is 72.5 thousand tons(Tahir *et al.*, 2012). Lycopene content is one of the most important benefit of the tomato (Bhowmik *et al.*, 2012a). The red color of the tomato is due to lycopene. Fresh tomato contain 0.72-20 mg/100g of the lycopene content. In fresh tomatoes the lycopene amount depends on the maturity, environmental conditions and variety (Shi *et al.*, 2000). It is naturally present in the tomatoes not synthesized in the body and it is a dominant antioxidant that is very helpful in preventing the cancer. The high amount of lycopene is very good for skin. Tomato is very helpful in preventing heart attacks and lowering the cholesterol level. It is very useful in controlling the blood sugar level and makes the hair strong and shiny. Tomato is a good source of vitamin A, B and C. There is a significant amount of Calcium and vitamin k present in tomato which play important role in maintaining strong bones. Tomatoes are very effective in lowering the migraine attacks because it is a very good source of riboflavin. High

blood pressure is also reduced by eating tomatoes because it carry considerable amount of potassium. Risk of night blindness is also reduced by tomatoes because it contains vitamin A and very helpful in improving vision (Bhowmik *et al.*, 2012b).

1 Related Work:

Offia-Olua and Ekwunife (2015a) manufactured fruit leather with combination of pineapple, apple and banana. Organoleptic, physicochemical and proximate analysis were performed. In total soluble solid large variation occurred. High titratable acidity and total solids were examined in sample contained forty percentage of pineapple, banana and 40:20 percentage of apple when compared to other leather samples and this sample named 819. High contents of vitamin C and acidity were found in samples that carried forty percent apple and pineapple ratio and twenty percent banana and this sample named 443. Results of proximate analysis showed that there were high amount of protein, carbohydrates and ash in sample number 819. Fat and moisture content was high in sample 443.

Khan *et al.* (2014a) prepared olive apple blended leather. T_0, T_1, T_2 and T_3 were the treatments. Aluminum foil was used for wrapping of samples and the samples were packed into polyethylene bags and the estimation was achieved for duration of 150 days. At 30 days interval the physiochemical analysis like acidity, texture, color and moisture were evaluated. In color, taste, moisture, texture and overall acceptability a remarkable decrease was recorded. In acidity a notable increase was recorded. Organoleptically and Physiochemically T_3 was the most acceptable from all the treatments.

Ayu *et al.* (2020) used different combination of okra and pineapple for pestil formation. The aim of this study was to develop the finest combination of okra and pineapple on sensory and chemical properties of pestil. This study was based on four treatments that contained four replicates. Various concentrations of okra and pineapple were used. Results of this research showed significant effect of okra and pineapple on total solids, fiber, sensory evaluation on flavor, taste, texture, color, pH, moisture and ash content. Treatment that showed best result on all parameter was treatment 4 with ratio of 80:20 and liked by the panelist.

2 Research Methodology:

3.1 Material

Fresh and ripened peach and tomatoes were purchased from local market and chemicals that were required were purchased from well reputed companies.

3.2 Puree formation

Peach and tomatoes were taken and washed with clean water to remove the dust, dirt and other foreign particles. After washing fruits were peeled and deseeded and then cutting of fruits were done manually. These peeled and deseeded fruits were placed into the blender for the formation of puree.

3.3 Leather drying

Leather were prepared by drying of blends of peach and tomato puree in an electronic cabinet dryer. Measured amount of peach and tomato puree were added to aluminum trays and trays were greased with oil before adding the sample in trays to prevent sticking of leather with trays and then trays were placed into an electronic cabinet dryer at set temperature of 60°C for 7 to 8 hours. After completing the time of drying the aluminum trays containing sample were removed from the dryer and were cooled at room temperature. After cooling leather were removed from trays and cut into strips and rolls.

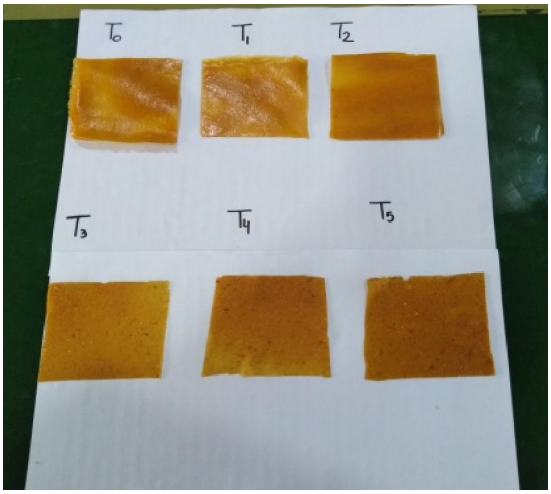

Figure 1: Different Treatments of Prepared Leather

3.4 Determination of Moisture Content, Ash Content and Crude Fat


Figure 2: Determination of Moisture Content

The moisture content of composite fruit leather samples were determined by oven drying method at 105°C. The ash content was determined as a total

inorganic matter. Oven dried sample of the leather were charred on the burner and then ignited in a muffle furnace at a temperature of 550-600°C for 5-6 hours or till the grayish ash obtained. Crude fat was determined by using the moisture free sample through the Soxhlet apparatus Sarkar *et al.* (2018b).

Figure 3: Determination of Fat Content

Figure 4: Determination of Ash Content

3.5 Determination of Total Soluble Solids (TSS)

Total soluble solids was estimated by the hand held Refractometer. Prism of the refractometer must be kept clean and distilled water was used for instrument calibration and then the sample was placed on the prism of refractometer and readings were done in duplicates by following the method of Sarkar *et al.* (2018b)

3.6 Determination of pH

pH of every sample was determined by the help of digital pH meter. Required amount of sample was taken into beaker andpH was measured with the help of pH meter and was recorded by dipping the electrodes of pH meter in the sample by following the method of Ruiz *et al.* (2012).

3.7 Determination of Color

Color of the leather was determined with the help of colorimeter. The color intensity of each leather sample was expressed and measured as L*, a* and b* values. The colorimeter was standardized by using black and white tiles. The L* represented whiteness or blackness, a* represented red and green and b* represented yellow and blue. The color was determined according to the method of Sarkar *et al.* (2018b).

3.8 Determination of Total Phenolic Contents

Folin-Ciocalteu method was used for the determination of total phenolic contents of leather with gallic acid standards. Extract of the sample was used and pipetted the sample extract into test tubes that contained deionized water and Folin-Ciocalteus reagent was added into the mixture and vortexed and kept at dark for 8 minutes. Sodium carbonate was added and then stand in dark medium for 30 minutes and spectrophotometer was used to check the absorbance of every sample at 750 nm against blank. Calibration curve was plotted by different gallic acid concentrations and expressed as mg GAE/kg. Total phenolic contents were determined by the procedure described by Yılmaz *et al.* (2017).

3.9 Determination of Lycopene Content

Lycopene content was determined by use of spectrophotometer. Lycopene was extracted from the leather with help of hexane: ethanol: acetone (2:1:1) mixture and then rotary mixer was used in which the 25 ml of hexane: ethanol: acetone and 1 g of homogenized sample were placed for thirty minutes and then agitation was continued for 2 minutes after adding distilled water. There were the formation of two distinct layers in which the solution was left that are polar and non-polar layers. Absorbance was read at 472 and 502 nm and hexane was used as blank. Concentration of lycopene was showed as mg/100g product and lycopene content was analyzed by following the method of Alda *et al.* (2009).

3.10 Sensory Analysis

Sensory evaluation test of the leather samples were done by the members that were selected from the university community and the panelist were guided that how to perform the evaluation. Sensory response of the samples of leather texture, taste, color and overall acceptability were done by the use of hedonic scale according to the method of Offia-Olua and Ekwunife (2015b).

3.11 Statistical Analysis

The data obtained from each parameter was subjected to statistical analysis to determine the level of significance and comparison of means was also

carried out according to the method described by Montgomery (2017).

3 Results and Discussion:

4.1 Proximate Analysis of Composite Leather

4.1.1 Moisture Content

Moisture content is an important parameter in determining the shelf life of fruit leather. It is very important to maintain the quality of product by maintaining the moisture content. Moisture content can be vary with humidity of environment. Mean values of all the treatments of ash contents were described in table 4.1 which showed that moisture level was increased by increasing tomato puree. Moisture content of composite leather is highly significantly affected by the addition of tomato puree in different ratios. Treatment T_0 has the lowest and T_5 has the highest moisture content. Similar results were found by the Khan *et al.* (2014b) they worked on blended leather made from olive and apple and found increase trend in moisture content of leather.

4.1.2 Ash Content

Ash content of a product is the amount of minerals and trace element that are very important and play a vital role in body. Ash contents are inorganic residues that remains after water and organic have been removed by combustion and provides a measure of total amount of minerals present in food. Mean values of all the treatments of ash contents were described in table 4.1 which showed that there is significant decrease in ash content was occurred by increasing tomato puree in composite leather. T_0 consist on highest ash content and T_5 contain the lowest ash content. Ash content was decreased from T_0 to T_5. Similar results were found by Ayu *et al.* (2020) they worked on fruit leather made with combination of okra and pineapple and also observed decrease trend in ash content of leather.

4.1.3 Crude Fat

Fat provides large amount of energy and also a source of stored energy of our body. Mean values of all the treatments of ash contents were described in table 4.1 which showed that crude fat was increased by addition of tomato puree in composite leather and highly significant difference is present in between different treatments. Treatment T_0 (2.14) contain less percentage of fat and T_5 (2.86) has the highest percentage. Crude fat increased from T_0 to T_5. Offia-Olua and Ekwunife (2015b) also found increase in fat content when leather was prepared with combination of three different fruits like apple, banana and pineapple.

Table 4.1 Proximate composition of composite fruit leather samples

Treatments	Moisture	Ash content	Crude fat
T_0	12.59 ± 1.57^{c}	1.29 ± 0.35^{a}	2.14 ± 0.14^{c}
T_1	14.32 ± 1.41^{bc}	1.20 ± 0.18^{a}	2.25 ± 0.03^{bc}
T_2	16.16 ± 2.26^{bc}	1.03 ± 0.25^{ab}	2.33 ± 0.04^{bc}
T_3	17.40 ± 2.36^{bc}	0.91 ± 0.21^{ab}	2.40 ± 0.04^{bc}
T_4	19.66 ± 2.76^{ab}	0.79 ± 0.17^{ab}	2.54 ± 0.13^{b}
T_5	23.03 ± 3.69^{a}	0.62 ± 0.23^{b}	2.86 ± 0.27^{a}

T0= Peach puree 100%
T1= Peach puree 95% + tomato puree 5%
T2= Peach puree 90% + tomato puree10%
T3= Peach puree 85% + tomato puree15%
T4= Peach puree 80% + tomato puree 20%
T5= Peach puree 75% + tomato puree 25%

4.2 Total Soluble Solids

Total soluble solids are the measurement of absorbed solids present in the product and sugar is the major component of TSS. The mean values of fruit leather total soluble solids were described in table 4.2 which showed that TSS was decreased with addition of tomato puree and addition of tomato puree significantly affected the total soluble solids of composite leather. Treatment T_0 has the highest value of total soluble solids and T_5 has the lowest value for TSS. Same results had been observed by the Anju *et al.* (2014) they worked on preparation, quality evaluation and storage stability of peach-soy fruit leather.

4.3 pH

pH is the acidity of the leather or any increase or decrease in acidity cause increase or decrease in pH. The results of fruit leather pH values were presented in table 4.2 which showed that the mean values of pH are decreasing with the increase of tomato puree and addition of tomato puree in peach leather highly significantly affected the pH value of composite leather. Treatment T_0 has the highest value of pH and treatment T_5 has the lowest value. Similar results were found by the Shakoor *et al.* (2015b) they worked on effect of different levels of Sucrose-Glucose mixture on overall quality of guava bar and the found decrease trend in pH.

4.4 Total Phenolic Contents

Mean values of total phenolic contents of fruit leather were described in table 4.2 which showed that that increasing trend in TPC was observed due to increase in percentage of tomato puree in leather and all treatments have highly significant difference. Mean

table for TPC showed that T_0 has minimum TPC value 47.11 and T_5 has highest TPC value 61.90. It is evident that increase in TPC is due to addition of tomato puree. Basumatary *et al.* (2020b) worked on characterization and quality attributes of olive leather observed similar results of leather.

4.5 Lycopene Content

Lycopene is present naturally in tomatoes not synthesized in body and it is a major phytochemical and carotenoid and provide deep red color to tomatoes. The results of lycopene content was presented in table 4.2 showed that amount of lycopene content was increased by increasing amount of tomato in peach leather. Pasupuleti *et al.* (2014) worked on the fortification of lycopene from tomato puree into the beverage made from pink guava and also observed the similar increase in lycopene content by addition of tomato puree in guva beverage.

Table 4.2 Some physicochemical composition of composite fruit leather

Treatments	TSS	pH	TPC	Lycopene
T_0	13.00 ± 2.10^{a}	4.04 ± 0.30^{a}	47.11 ± 3.75^{d}	0.14 ± 0.07^{d}
T_1	12.22 ± 1.02^{ab}	3.77 ± 0.08^{ab}	50.34 ± 1.36^{cd}	1.15 ± 1.05^{cd}
T_2	11.31 ± 1.43^{ab}	3.64 ± 0.04^{bc}	54.27 ± 3.42^{bc}	2.08 ± 0.62^{bcd}
T_3	10.76 ± 0.09^{ab}	3.59 ± 0.007^{bcd}	56.03 ± 2.05^{abc}	2.90 ± 0.56^{bc}
T_4	10.63 ± 0.02^{ab}	3.41 ± 0.14^{cd}	57.98 ± 1.49^{ab}	3.99 ± 1.26^{ab}
T_5	9.87 ± 0.007^{b}	3.29 ± 0.002^{d}	61.90 ± 4.11^{a}	5.59 ± 2.11^{a}

4.6 Color

Color has significant effect on quality and acceptability of final product. Mean values for L*, a* and b* value of color analysis of composite leather was presented in table 4.3 which showed that L* value and b* value was decreased due to addition of tomato puree and a* value of color was increased. Similar results of color were observed by Khaliq *et al.* (2018) they worked on effect of skim milk and sucrose on quality and storage stability of mango leather.

Table 4.3. Color values of composite fruit leather

Treatments	L*	a*	b*
T_0	41.95 ± 3.90^{a}	13.98 ± 0.007^{d}	33.30 ± 2.58^{a}
T_1	39.74 ± 3.51^{ab}	16.73 ± 2.65^{cd}	28.94 ± 3.30^{ab}
T_2	37.04 ± 3.42^{ab}	18.66 ± 2.48^{bcd}	27.52 ± 3.04^{ab}
T_3	33.73 ± 3.40^{bc}	20.90 ± 2.26^{abc}	25.03 ± 3.40^{bc}
T_4	29.77 ± 3.45^{c}	22.30 ± 2.42^{ab}	22.78 ± 3.42^{bc}
T_5	28.98 ± 0.007^{c}	24.77 ± 3.51^{a}	19.92 ± 3.59^{c}

4.7 Sensory Analysis

Sensory evaluation was performed to check the acceptability of product for consumption and to know the behavior of consumer regarding rejection or acceptance of product. The parameters involve in sensory evaluation are color, texture, taste and overall acceptability of composite leather. Results of sensory analysis were presented in table 4.4 which showed that increasing tomato puree in peach fruit leather showed decrease trend in all parameters of sensory analysis.

Table 4.4 Sensory analysis of composite fruit leather samples

Treatments	Color	Texture	Taste	Overall acceptability
T_0	8.44 ± 0.71^{a}	8.75 ± 0.60^{a}	8.45 ± 0.72^{a}	8.52 ± 0.49^{a}
T_1	7.87 ± 0.23^{ab}	8.22 ± 0.24^{ab}	7.87 ± 0.23^{ab}	7.96 ± 0.31^{ab}
T_2	7.45 ± 0.26^{abc}	7.69 ± 0.35^{ab}	7.39 ± 0.37^{ab}	7.34 ± 0.47^{ab}
T_3	7.01 ± 0.28^{bc}	7.35 ± 0.26^{b}	6.99 ± 0.30^{b}	6.98 ± 0.40^{b}
T_4	6.63 ± 0.18^{cd}	7.13 ± 0.05^{bc}	6.63 ± 0.18^{bc}	6.66 ± 0.11^{bc}
T_5	5.56 ± 1.00^{d}	5.87 ± 1.18^{c}	5.47 ± 1.10^{c}	5.52 ± 1.13^{c}

4 Conclusion:

Current study is concluded that consumption of fruits are very important due to their beneficial effects and large number of fruits are produced but lost due its low shell-life and lower processing. It is important to preserve the fruits by making different products which increase shelf-life of fruits like leather. Peach and tomatoes are rich source of nutrients and it is observed that utilization of these fruits together in formation of composite fruit leather enhance the nutritional profile of the fruit leather. Treatment T_5 was noticed best

treatment with regards to antioxidant activity, polyphenol content and lycopene content.

References:

1. Alda, L.M., I. Gogoasa, D.-M. Bordean, I. Gergen, S. Alda, C. Moldovan, L.J.J.O.a.P. Nita and Technologies. 2009. Lycopene content of tomatoes and tomato products. Journal of Agroalimentary and Proceses Technologies. 15:540-542.
2. Anju, B., K. Kumari, V. Anand and M.J.S.J.O.A. Anjum. 2014. Preparation, quality evaluation and storage stability of peach-soy fruit leather. SAARC Journal of Agriculture. 12:73-88.
3. Ashraf, C., S. Iqbal and D.J.J.O.M.P.R. Ahmed. 2011. Nutritional and physicochemical studies on fruit pulp, seed and shell of indigenous Prunus persica. Journal of Medicinal plants research. 5:3917-3921.
4. Ayu, D., O. Rumengan and U. Pato. Combination of Pineapple and Okra on Chemical and Sensory Characteristics of Fruit Leather. IOP Conference Series: Earth and Environmental Science, 2020. IOP Publishing, 012049.
5. Basumatary, B., S. Bhattacharya and A.B.J.J.O.F.E. Das. 2020a. Olive (Elaeagnus latifolia) pulp and leather: Characterization after thermal treatment and interrelations among quality attributes. Journal of Food Engineering. 278:109948.
6. Basumatary, B., S. Bhattacharya and A.B.J.J.O.F.E. Das. 2020b. Olive (Elaeagnus latifolia) pulp and leather: Characterization after thermal treatment and interrelations among quality attributes. Journal of Food Engineering. 278:109948.
7. Bhowmik, D., K.S. Kumar, S. Paswan, S.J.J.O.P. Srivastava and Phytochemistry. 2012a. Tomato-a natural medicine and its health benefits. Journal of Pharmacognosy Phytochemistry. 1:33-43.
8. Bhowmik, D., K.S. Kumar, S. Paswan, S.J.J.O.P. Srivastava and Phytochemistry. 2012b. Tomato-a natural medicine and its health benefits. Journal of Pharmacognosy Phytochemistry. 1:33-43.
9. Chen, Y. and A.J.L. Martynenko. 2018. Combination of hydrothermodynamic (HTD) processing and different drying methods for natural blueberry leather. International Journal of Food Science. 87:470-477.
10. Huang, X. and F.H.J.J.O.F.S. Hsieh. 2005. Physical properties, sensory attributes, and consumer preference of pear fruit leather. Journal of Food Science. 70:E177-E186.
11. Jung, K.-M., S.-Y. Kim, G.-W. Lee, I.-D. Kim, Y.-S. Park, S.K. Dhungana, J.-H. Kim and D.-H.J.I.J.O.F.S. Shin. 2019. Quality Characteristics and Antioxidant Activity of Unripe Peach (Prunus Persica L. Batsch) Extracts with Distilled Water Coupled with Ultrasonication and Prethanol-A. International Journal of Fruit Science. 1-12.
12. Khaliq, A., M.R. Khan, S. Ahsan, M.F. Jahangir, M.N. Chughtai, A.J.R.J.O.F.S. Aslam and Nutrition. 2018. Effect of skim milk powder and sucrose on quality and storage stability of mango leather. Research Journal of Food Science and Nutrition. 3:41-49.
13. Khan, A., A. Zeb, M. Khan and W.J.I.J.F.S. Shah, Nutr Diet. 2014a. Preparation and evaluation of olive apple blended leather. International Journal of Food Science and Nutrition. 3:134-137.
14. Khan, A., A. Zeb, M. Khan and W.J.I.J.F.S. Shah, Nutr Diet. 2014b. Preparation and evaluation of olive apple blended leather. International Journal of Food Science, Nutrition. 3:134-137.
15. Khan, D., S.J.I.J.O.B. Shaukat and Biotechnology. 2006. The fruits of Pakistan: Diversity, distribution, trends of production and use. International Journal of Biology and Biotechnology 3:463-499.
16. Lee, G. and F.J.T.O.T.A. Hsieh. 2008. Thin-layer drying kinetics of strawberry fruit leather. Transactions of the ASABE. 51:1699-1705.
17. Manzoor, M., F. Anwar, Z. Mahmood, U. Rashid and M.J.M. Ashraf. 2012. Variation in minerals, phenolics and antioxidant activity of peel and pulp of different varieties of peach (Prunus persica L.) fruit from Pakistan. Journal of Molecules. 17:6491-6506.
18. Momchilova, M., G. Zsivanovits, I. Milkova-Tomova, D. Buhalova and P.J.B.C.C. Dojkova. 2016. Sensory and texture characterisation of plum (Prunus domestica) fruit leather. Journal of Bulgarian Chemical Communications. 48:428-434.
19. Montgomery, D.C. 2017. *Design and analysis of experiments*, John wiley & sons.
20. Nida Saleem, M.K., S.A. Shaikh, O.M. Tarar and K.J.P.J.B.M.B. Jamil. 2011. Studies on processing and preparation of peach squash. Journal of Biochemistry Molecular Biology. 44:12-17.
21. Offia-Olua, B.I. and O.J.N.F.J. Ekwunife. 2015a. 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.

22. Offia-Olua, B.I. and O.J.N.F.J. Ekwunife. 2015b. 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.
23. Orrego, C., N. Salgado, C.J.C.R.I.F.S. Botero and Nutrition. 2014. Developments and trends in fruit bar production and characterization. Critical Reviews in Food Science and Nutrition 54:84-97.
24. Pasupuleti, V., S.G.J.J.O.F.S. Kulkarni and Technology. 2014. Lycopene fortification on the quality characteristics of beverage formulations developed from pink flesh guava (Psidium guajava L.). Journal of Food Science and Technology. 51:4126-4131.
25. Roknul Azam, S., M. Zhang, C.L. Law and A.S.J.D.T. Mujumdar. 2019. Effects of drying methods on quality attributes of peach (Prunus persica) leather. Journal of Drying Technology. 37:341-351.
26. Ruiz, N.a.Q., S.M. Demarchi, J.F. Massolo, L.M. Rodoni and S.a.J.L. Giner. 2012. Evaluation of quality during storage of apple leather. Journal of Food Science and Technology. 47:485-492.
27. Saidani, F., R. Giménez, C. Aubert, G. Chalot, J.A. Betrán, Y.J.J.O.F.C. Gogorcena and Analysis. 2017. Phenolic, sugar and acid profiles and the antioxidant composition in the peel and pulp of peach fruits. Journal of Food Composition. 62:126-133.
28. Saikia, S., N.K. Mahnot, C.L.J.J.O.F.P. Mahanta and Preservation. 2015. Effect of spray drying of four fruit juices on physicochemical, phytochemical and antioxidant properties. Journal of Food Processing Preservation. 39:1656-1664.
29. Sarkar, T., R.J.a.J.O.W. Chakraborty, Environment and Pollution. 2018a. Formulation, Physicochemical Analysis, Sustainable Packaging-Storage Provision, Environment Friendly Drying Techniques and Energy Consumption Characteristics of Mango Leather Production: A Review. Asian Journal of Water, Environment Pollution 15:79-92.
30. Sarkar, T., R.J.a.J.O.W. Chakraborty, Environment and Pollution. 2018b. Formulation, Physicochemical Analysis, Sustainable Packaging-Storage Provision, Environment Friendly Drying Techniques and Energy Consumption Characteristics of Mango Leather Production: A Review. 15:79-92.
31. Shakoor, A., M. Ayub, S. Wahab, M. Khan, A. Khan, Z.J.J.O.F.P. Rahman and Technology. 2015a. Effect of different levels of sucrose-glucose mixture on overall quality of guava bar. Journal of Food Processing Technology. 6:1-7.
32. Shakoor, A., M. Ayub, S. Wahab, M. Khan, A. Khan, Z.J.J.O.F.P. Rahman and Technology. 2015b. Effect of different levels of sucrose-glucose mixture on overall quality of guava bar. Journal of Food Processing and Technology 6:2-7.
33. Shi, J., M.L.J.C.R.I.F.S. Maguer and Nutrition. 2000. Lycopene in tomatoes: chemical and physical properties affected by food processing. Critical Reviews in Food Science Nutrition. 40:1-42.
34. Tahir, A., H. Shah, M. Sharif, W. Akhtar and N.J.P.J.O.a.R. Akmal. 2012. An overview of tomato economy of Pakistan: comparative analysis. Pakistan Journal of Agricultural Research. 25.
35. Yılmaz, F.M., S. Yüksekkaya, H. Vardin and M.J.J.O.T.S.S.O.a.S. Karaaslan. 2017. The effects of drying conditions on moisture transfer and quality of pomegranate fruit leather (pestil). Journal of the Saudi Society of Agricultural Science. 16:33-40.

3/16/2021