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Effect of different drying conditions on the quality of apple and guava fruit leather

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Abstract
Fruits are the important part of our diet. Consuming fruits everyday helps in boosting the immunity levels and maintains good health. The only drawback of the fruits is that presence of high moisture content which easily makes the fruits vulnerable to microbial spoilage. And so processing them to different value added products is the best way to reduce post harvest losses. Fruit leather is an example of a processed product that appeals to individuals of all ages. Apple and guava leather (70:30) standardized in the study of Harshini and Bakshi, 2021 was used in this study. The mixture was dried using a variety of methods, including sun drying, hot air oven drying (70 °C), microwave oven drying (180W), and tray drying (50 °C), until the moisture content reached 12-20%. Drying plays a prominent role in the leather preparation. Drying reduces the product's water activity, reduces enzymatic and microbiological activity, and minimizes physical and chemical interactions during the storage term. Moisture content, TSS, pH, Titratable acidity, and Vitamin C, as well as sensory characteristics of leather dried under various drying methods were analyzed. Microwave oven and Hot air oven dried samples has shortest duration of drying and resulted in less moisture content, high TSS, less degradation of vitamin C and titratable acidity than tray drying and sun drying. Among all the drying methods the leather dried by tray dying was best accepted by the panelists based on its quality.

Keywords: Fruit leather, apple and guava, drying, microwave oven, sun drying, hot air oven and tray drying

Introduction
Fruits are the rich sources of vitamins, minerals, dietary fiber and antioxidants are the protective foods and are considered as the gift of nature which helps maintaining health and well being of human. Due to the presence of high moisture content they are highly perishable in nature. Though India ranks second in fruit production the fruit processing unit is still in nascent stage and at present only 4% of the horticultural produce is industrially processed. The best way to prevent post-harvest loss is processing them into value added products like toffees, candies, juice, nectar, squash, cheese, leather etc.

Fruit leathers can be referred as dried sheets of fruit pulp having soft and rubbery texture sweeter in taste. Leather is the most preferred product by people of all age groups. Leathers are generally packed up with nutrients and combats fatigue. In this study Apple and Guava blend (70:30) which was standardized in the study of Harshini and Bakshi, 2021 was spread on the trays smeared with olive oil and is dried under four different drying methods like Microwave 180 W, Hot air Oven at 70 ℃, Tray drying at 50 ℃ and sun drying. In manufacturing of the high quality fruit leather the most important step is drying under optimum drying conditions. Drying is important for removing moisture from a product and extending its shelf life. Excessive drying results in degradation of the nutrients from the product as well as less duration of drying results in retaining of the excess moisture and results in spoilage of the product. Drying technique greatly effects the characteristics of leather like flavor, palatability of food, aroma, hardness, viscosity, enzymatic activity and microbial spoilage. The moisture content of the samples was noted periodically during the process of drying. The physico chemical properties of the leather like drying time, pH, TSS, Titratable Acidity, Vitamin C and also the Organoleptic properties like taste, texture, flavor, overall acceptability etc. were evaluated to compare the drying methods and for obtaining the best quality leather dried under different drying conditions.

Materials and Methods
The present study was conducted during 2020-21 at Post Graduate Laboratory,

Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, India. The details of the experiment that were employed during the course of experiment are as follows.

Experimental material

The apple and guava fruit leather blend was standardized (Harshini and Bakshi, 2021) having a composition of apple (70%) + Guava (30%) + citric acid (0.5%) + Pectin (1%) + Maltodextrin (2%) + Sugar (5%) + Honey (6 ml) + Cardamom powder (0.2%). The fruit leather was topped with nuts (almonds) and this fruit leather was subjected to different drying conditions under a set of four treatments *viz*. Hot air oven drying at 70 ℃, tray drying at 50 ℃, microwave drying (180W) and sun drying.

Parameters analyzed

Sensory evaluation of the fruit leather for colour, texture, taste, flavour, appearance and overall acceptability was done as per 9 point structured hedonic scale involving 10 panelists among staff and graduated students of the Food Science department (Lovely Professional University). Moisture content was analyzed using a hot air oven method and the titratable acidity of the fruit leather was analyzed by titrating against NaoH as recommended by AOAC (2005). pH of the fruit leather was recorded using digital pH meter. TSS was analyzed by using hand refractometer. Vitamin C content of the sample was analyzed by using 2, 6- dichlorophenol indophenol dye method as described by Ranganna (1986).

Statistical Analysis

The experiment was laid in a CRD design. Statistical analysis was performed using SPSS V. 21 software to ascertain homogenous sets among the treatments using DUNCAN multiple range test (DMRT).

Results and Discussion

The results of the physio chemical parameters were analyzed using different methods and are given in Table 1.

Moisture Content

The moisture content of the Apple and Guava leather under different drying conditions is presented in Table I and Figure 1. The moisture content of the samples ranged in between 12.2-16.38%. The technique of drying significantly influences the duration of drying in order to attain the final content of moisture. In this study, the microwave oven drying had the lowest moisture content (12.20%), followed by hot air oven (12.9%), tray drying (13.8%), and sun drying (16.38%). Microwave drying at 180W took the shortest time (15 minutes), followed by hot air oven (50 minutes), tray dryer (660 minutes), and sun drying (1080 minutes). Microwave drying resulted in the fastest water dissipation, making it the fastest (Arslan and Ozcan, 2010) [2] Many authors also reported that on increasing the temperature of drying the process of drying speeds up and so the time of drying shortens as such in Rose hip Leather (Ruiz *et al.*,2013) [6] and Pomegranate Leather (Tontul *et al.*,2017) [18].

Samples dried under different drying methods

Plate 1: Microwave Drying

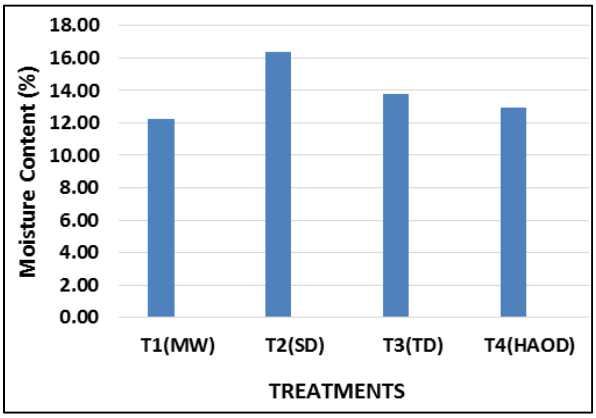

Fig 1: Variations in Moisture Content (%) of Apple: Guava (70:30) blended leather dried by different drying methods

TSS

The TSS of the apple and guava leather dried under different drying conditions was presented in Table I and Figure 2. The TSS ranged in between (76.1-78.2°B).The samples dried in a microwave oven had the highest TSS (78.2°B), followed by those dried in a hot air oven (77.9°B) and tray drying (77.15°B).TSS greatly increases with reduction in the moisture content as the sugars becomes more concentrated on drying.(Blessing Offia *et al.*,2012) [4]. The samples with high moisture content consists of low TSS and the samples with low moisture content contains high TSS. The low TSS was found in the sample dried under sun (76.10° B) as longer exposure of the leather to sun results in loss of sugars and acids which gradually leads to decrease in TSS.

Plate 2: Sun Drying

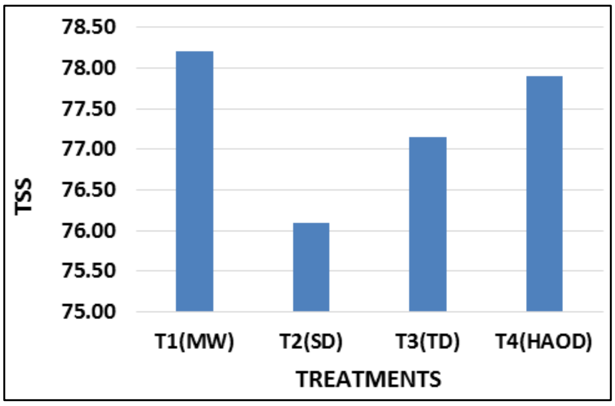

Fig 2: Variation in TSS of Apple: Guava (70:30) blended leather dried by different drying methods

pH

The variations in the pH of the samples under different drying conditions can be observed in Table I and figure 3. The pH values ranges from 3.1-3.9. The role of pH plays a major role in the prevention of the spoilage from microorganisms (Owolade *et al.*,2011) [13]. The temperature greatly influences the pH where increase in the temperature results in decrease in the pH (Ozgur *et al.*, 2011) [13]. Microwave drying had the lowest pH (3.1), followed by the Hot air Oven (3.3) due to the presence of higher temperature and shorter period of drying. Whereas the pH of Tray drying (3.8) and sun drying (3.9) are slightly higher due to low temperature and slow drying time which leads to degradation of more organic acids.The lower pH indicates the stability of shelf life against contamination of microbes (Abe-Inge *et al*.,2018) [1].

Plate 3: Tray Drying

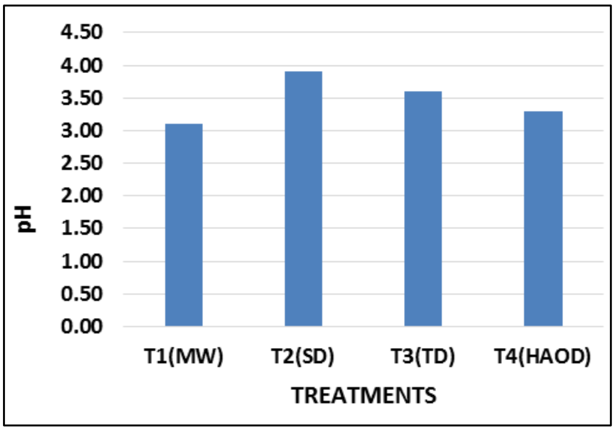

Fig 3: Variation in pH of Apple: Guava (70:30) blended leather dried by different drying methods

Titratable Acidity

The titratable acidity of the leather dried under different drying conditions was presented in Table I and Figure 4. The titratable acidity ranged in between (1.29%-1.46%). The highest titratable acidity was found in the sample dried by microwave (1.46%) followed by hot air oven (1.44%) which holds higher temperature drying for shorter period of time and the lowest titratable acidity is found in Tray drying (1.42%) and sun drying (1.39%) which requires lower temperature and longer period to dry. The titratable acidity is directly proportional to temperature and is inversely proportional to pH. As the temperature increases the conversion of available sugars into organic acids takes place and so titratable acidity increases which also results in decrease in the pH (Raj *et al*., 2006) [14].

Plate 4: Hot Air Oven Drying

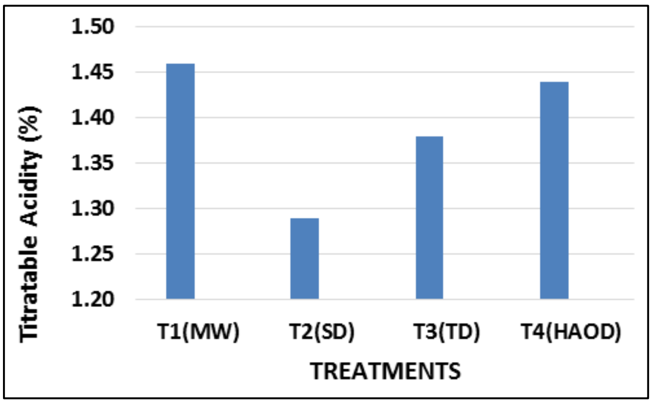

Fig 4: Variation in Titratable Acidity of Apple: Guava (70:30) blended leather dried by different drying methods

Vitamin C

Vitamin C is highly heat sensitive vitamin and evaporates easily it is mainly used as the indicator or reference for the conservation of nutrients in dried fruit products like leather. And so if Vitamin C is well maintained during the drying conditions, the other nutrients can also be preserved well (Lin *et al*., 1998). The content of Vitamin C in leather dried under different drying conditions was presented in Table I and Figure 5. Vitamin C ranged in between 13.6 - 18.7 mg/.100gm.The highest Vitamin C was noted in Microwave Oven (18.7mg/100gm) followed by hot air oven (18.5mg/100gm), Tray drying (18.14 mg/100gm) and the lowest Vitamin C was found in Sun dried sample (13.60 mg/100gm). Khraisheh *et al*., 2004 reported that degradation of ascorbic acid is dependent on heat and time. Shortest duration with high temperature results in less reduction in Vitamin C than low temperature and long duration of drying (Shadle *et al*., 1983) [16]. As the ascorbic acid is highly sensitive to sunlight, oxygen and long duration of drying the ascorbic acid is lowest in the sun dried samples when compared to other drying treatments.

Table 1: Physio Chemical properties of samples dried by different drying conditions

Treatments	Moisture (%)	TSS (ºBrix)	pH	Titrable cidity (%)	Vitamin C mg/100gm
Microwave	12.2ᵃ	78.20ᵈ	3.1ᵃ	1.46ᶜ	18.70ᵈ
Sun drying	16.38ᵈ	76.10ᵃ	3.9ᵈ	1.29ᵃ	13.60ᵃ
Tray drying	13.8ᶜ	77.15ᵇ	3.6ᶜ	1.38ᵇ	18.14ᵇ
Hot air drying	12.9ᵇ	77.90ᶜ	3.3ᵇ	1.44ᵈ	18.50ᶜ
CD	0.18	0.13	0.10	0.02	0.09
S.Em	0.06	0.04	0.03	0.01	0.03
S.Ed	0.08	0.06	0.05	0.01	0.04

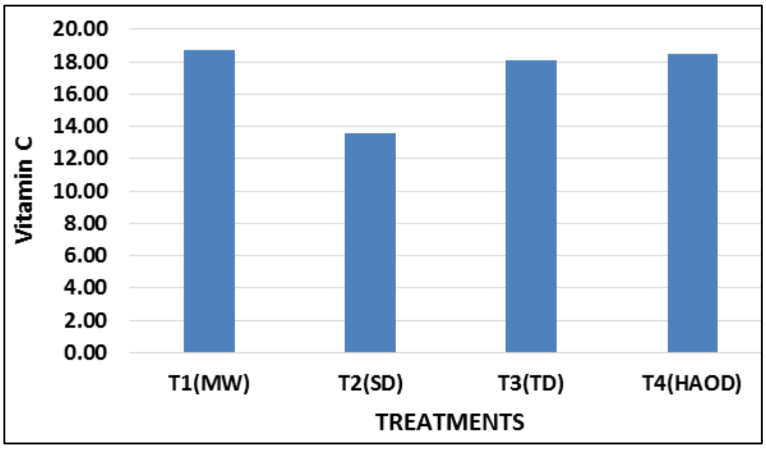

Fig 5: Variation in Vitamin C of Apple: Guava (70:30) blended leather dried by different drying methods

Sensory Attributes

The sensory evaluation data of the fruit leather prepared with different drying methods is presented in Table II. The colour of the Apple and guava leather was yellowish orange. Among all the treatments the highest score to the colour was given to the sample dried by Tray drier followed by microwave oven. The samples dried by hot air oven showed brightest orange colour due to the higher temperature. Whereas the sample dried by sun drying showed browning due to long term exposure of the product to drying. The texture of the tray dried samples was smoother and was given higher score followed by hot air oven, sun drying and microwave oven. Samples dried by microwave oven was given least scores in the texture due to the roughness of the surface of product. The highest scores for the flavour and taste was given to the samples dried by microwave oven followed by hot air oven and tray drying. Though the TSS and flavour of the tray dried samples was slightly lower than the microwave and hot air oven drying but the overall acceptability score was given high than all the treatments because of its good texture, colour, less moisture, moderate TSS and flavor attracted most of the panelists than other treatments. The sun drying being cheaper drying method it was not accepted and was given least scores because of its unhygienic conditions and poor quality of leather.

Table 2: Sensory evaluation of apple and guava fruit leather (70:30)prepared using different drying conditions

Treatments	Flavour	Colour	Taste	Texture	Appearance	Acceptability	Overall score
Microwave	7.83ᵈ	7.47ᶜ	7.63ᶜ	6.36ᵃ	7.02ᵇ	7.25ᵇ	7.08ᵇ
Sun drying	6.71ᵃ	6.37ᵃ	6.58ᵃ	7.18ᵇ	6.37ᵃ	6.65ᵃ	6.61ᵃ
Tray drying	7.17ᵇ	7.92ᵈ	7.24ᵇ	7.8ᵈ	7.85ᵈ	7.86ᵈ	7.81ᵈ
Hot air oven	7.45ᶜ	7.16ᵇ	7.28ᵇ	7.33ᶜ	7.43ᶜ	7.57ᶜ	7.34ᶜ

Conclusion

Drying plays a major role in the fruit leather preparation. Excessive drying results in loss of nutritional properties whereas less time of drying results in retaining of moisture and results in microbial spoilage.. The Apple: Guava (70:30) blend which was standardized in the study of Harshini and Bakshi, 2021 was used in this study for drying studies. The sample was spread on the trays and is dried under four different drying methods like sun drying, Microwave Oven (180W), Hot air Oven drying (70 ℃) for about 45 minutes and Tray drying (50 ℃) for about 660 minutes. The physico chemical and sensorial properties are analyzed. The leather dried by sundrying resulted in poor quality due to presence of slight higher moisture content and high degradation of Vitamin C and titratable acidity and drastic colour change which caused browning. Microwave and hot air oven drying took very short time to dry and showed less degradation of Vitamin C and titratable acidity whereas these treatments was recorded less scores in sensory analysis due to the changes in the texture and colour.Among all the drying treatments followed the tray drying resulted in retaining of less moisture, high TSS moderate levels of pH and titratable acidity and medium degradation of vitamin C and also resulted in production of good quality leather with good sensorial properties which was much accepted by the panelists.

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