Plant Archives Volume 20 No. 2, 2020 pp. 4181-4186 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

STUDY ON DEVELOPMENT AND STORAGE ANALYSIS OF POMEGRANATE LEATHER

Mohit Kumar, Kaustubh Das and Ankan Das*

Department of Horticulture, Institute of Agricultural Science, University of Calcutta, 51/2 Hazra Road, Kolkata - 700 019 (West Bengal), India.

Abstract

Pomegranate leather from the mature pomegranate fruits of cultivar "Kabul" was developed. During preparation of leather pomegranate arils was grinded thoroughly in a mixer grinder followed by boiling and addition of food grade pectin (3g/150ml of pomegranate paste). Subsequently this warm paste was mixed with seven different treatments and allowed was to cool down. Thereafter the mixture was dehydrated inside a hot air oven at a temperature of 65°C for the leather to develop. Thereafter the leather was cut into square shapes and was prepacked and sealed and storage was done at ambient condition by placing these sealed packets inside desiccators. Different physical and chemical parameters were analyzed at timely intervals during storage. From the study it was found that pomegranate leather prepared with addition of 5% lemon juice with combination of 1% ascorbic acid and 600 ppm of potassium sorbate was the most effective. The leather prepared under this treatment showed minimum accumulation of acidity, total sugar and also demonstrated good maintenance of antioxidant activity and phenolic content throughout the storage period. Furthermore, the fungal infestation was less under this treatment.

Key words: pomegranate, juice, pectin, dehydration, leather, product

Introduction

Pomegranate is a powerhouse of many health benefitting functional components (Kulkarni *et al*., 2004; Ngangom *et al*., 2019). But irrespective of the fruit being a tremendous nutrient reserve, the consumption gets difficult as arils are edible part which are located deep inside and the external anatomy of the fruit along with high internal moisture content arises more problems (Das *et al*., 2019). So, something can be made out of the fruit which may contain the nutritional property of the mother material, possessing a longer shelf life and most importantly well accepted by the consumers of all age group.

Fruit leather is one such entity where dehydration technology is employed to generate a different type of output. Fruit leather can be said as those substances where the fruit pastes or purees and also the juice concentrates obtained by fruits by variable methods can be further cooked with addition of sweeteners or food grade colours etc. The prepared paste is then subjected to dehydration at suitable temperature condition in an even but a non sticky surface (Bryk, 1997; Huan & Hsieh 2005; Blessing *et al*., 2015). Later on these prepared leathers can be transformed or cut into different shapes or sizes (FSSAI, 2009; Parimita and Kumar, 2015). A wide array of fruits can be employed for the preparation of these fruit leathers (Raab and Oehler, 1999; Blessing *et al*., 2015). However, in the present study considering the importance of pomegranate as well as its difficulty to consume, an attempt was made to develop leather from pomegranate with various pretreatment combinations so that the leather formed, may have an elongated and accepted shelf life.

***Author for correspondence :** E-mail : ankandas660@gmail.com

Materials and Methods

The experiment on the mentioned topic was carried and conducted in the Department of Horticulture, Institute of Agricultural Science, University of Calcutta. The study was done during the academic year of 2018-19. For the investigation pomegranate fruits of variety Kabul were selected and were brought to the laboratory of the Department at their full maturity. The fruits after washing in running tap water were carefully cut and arils from them were precisely brought out. Then the arils were sorted out properly to discard the damaged ones. Henceforth the sorted arils were grinded in a mixer grinder. The juicy paste obtained from it was boiled and

then pectin powder was added in it. Repeated trials were conducted under here to standardize the exact concentration of the pectin powder. Ultimately it was obtained that a pectin concentration of 3 gm per 100 ml juicy paste was good enough for development of the leather. After addition of the pectin powder to the paste different chemicals as treatments or treatment combinations were also incorporated in it as a part of the study *viz.* T_1- Lemon Juice 5%, T_2- Ascorbic acid 1%, T_3- Sodium Benzoate 600ppm, T_4- Lemon Juice 5%+Ascorbic acid 1%+Sodium Benzoate 600ppm, T_5- Potassium Sorbate 600ppm, T_6- Lemon Juice 5%+Ascorbic acid 1%+Potassium Sorbate 600ppm, T_7- Control.

After that the pomegranate pastes containing different treatments were allowed to cool down and spread over aluminium trays (wrapped internally with aluminium foils to make the surface non sticky) and dehydrated inside hot air oven at a temperature of 60^0C. Similar technique was used by Das *et al*., (2019) in their study to find out proper packaging material and storage condition for pomegranate leather. Then when the leathers were formed, they were prepacked inside LDPE packets of 50 microns and sealed by the help of a sealing machine and stored inside a dessicator at room temperature situation. Each of the treatments was replicated three times and Completely Randomized Design was used to layout the experiment (Gomez & Goryez, 1984). Data's were analyzed by the help of an online statistical software (Sheoran *et al.,* 1988).

Different parameters were analyzed and observations were recorded at 0 days, 15 days, 30 days, 45 days and 60 days of storage. Following parameters were calculated at the periodic intervals of study.

Moisture content (dehydrated produce): Oven drying method as per A.O.A.C., (2000) was used to calculate the moisture content.

Total sugar: Total sugar percentage was estimated as per formula or calculations given by Raangana, (2003).

Titrable Acidity: Titrable acidity was again calculated as per the formula provided in the works of Raangana, (2003). The Milli. Equivalent weight of acid used for the calculation was 0.064.

Total Phenolic Content: Spectrophotometric analysis was used to determine the Total Phenolic Content where the absorbance was calculated at 570 nm, by the help of folin-ciocalteu which is used as a reagent in this method (Singleton *et al*., 1999).

Radical Scavenging Activity: DPPH (2, 2-diphenyl-1-picrylhydrazyl) assay was used to estimate the Radical Scavenging Activity. The change in the absorbance was recorded by the help of a spectrophotometer at 517nm. (Brand –Williams *et al*., 1995).

Total Fungal Count: The total fungal count was determined as per the method of Allen (1953). The fungal growth or the contaminations were expressed as colony forming units per gram at 10^{-2} dilutions.

Results and Discussion

Moisture Content of Dried Sample

The moisture content table 1 of the different treatments as compared to the initial day increased during the study in considerable fractions for different treatments. At 15 days of storage the highest moisture gain of 3.13% was seen for control followed by 2.79% and 2.62% for T_1 (Lemon Juice 5%) & T_5 (Potassium Sorbate 600ppm). T_6 (Lemon Juice 5%+Ascorbic acid 1%+Potassium Sorbate 600ppm) treatment gained the least moisture value of 1.75%. The trend was very much similar at 30, 45 & 60 days storage analysis interval. At the end of study T_6 (Lemon Juice 5%+Ascorbic acid 1%+Potassium Sorbate 600ppm) gained the least moisture content of 2.99%. Significant higher value of moisture gain was seen for T_3 (Sodium Benzoate 600ppm), T_5 (Potassium Sorbate 600ppm), T_1 (Lemon Juice 5%) & control with highest moisture absorbance of 6.49%.

Total Sugar

From table 2 we can see that the initial day recorded 18.80% (total sugar concentration) for all the treatments. However thereafter from the 0 days gradual accumulation in the total sugar was seen for all the treatments throughout the storage intervals. At 15 days and 30 days the sugar gain increase to a certain extent with minimum accumulation seen for T_6 (Lemon Juice 5%+Ascorbic acid 1%+Potassium Sorbate 600ppm) followed by T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm) and T_3 (Sodium Benzoate 600ppm) and control gained the maximum content. This trend was similar for 45 days as well as 60 days of storage. From the table we can see that at the end of the experiment minimum sugar presence was seen for T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm) and T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm) which was followed by T_2 (Ascorbic acid 1%), T_3 (Sodium Benzoate 600ppm) and T_5 (Potassium Sorbate 600ppm) and control was with the highest sugar content of 31.22%.

Acidity

At 15 days interval the titrable acid content table 3

increased slightly for T_1 (Lemon Juice 5%), T_2 (Ascorbic acid 1%), T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm) and T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm) with no alteration for T_3 (Sodium Benzoate 600ppm), T_5 (Potassium Sorbate 600ppm) and T_7 (Control). Thereafter at 30 days of interval the titrable acidity value remain unchanged for T_5 (Potassium Sorbate 600ppm) and T_3 (Sodium Benzoate 600ppm) with slight increase for T_7 (Control) and T_2(Ascorbic acid 1%). T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm), T_1 (Lemon Juice 5%) and T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm) recorded the value of 0.128% again. At 45 days of storage the titrable acidity content for T_3 (Sodium Benzoate 600ppm), T_2 (Ascorbic acid 1%) and T_7 (Control) was at a range of 0.128% and highest value of 0.257% was obtained for T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm) and T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm). Likewise, at 60 days of interval of storage T_3 (Sodium Benzoate 600ppm) recorded the lowest acid gain of 0.320% which was followed by 0.341% in T_5 (Potassium Sorbate 600ppm), T_2 (Ascorbic acid 1%) and T_7 (Control). The highest accumulation of 0.448% of titrable acid content was seen for T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm), T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm) and T_1 (Lemon Juice 5%).

Table 1: Moisture content of the pomegranate leathers prepared with different treatments at different days of storage.

Treat/Time	0 DAS	15 DAS	30 DAS	45 DAS	60 DAS
T_1	1.62	2.79	3.70	4.69	5.68
T_2		2.21	2.66	3.52	4.39
T_3		2.57	3.11	3.94	4.76
T_4		2.16	2.61	3.40	4.19
T_5		2.62	3.44	4.46	5.49
T_6		1.75	2.18	2.59	2.99
T_7		3.13	3.71	4.48	6.49
CD at 5%		0.298	0.270	0.532	0.999
SE m±		0.097	0.088	0.174	0.326

T_1-(Lemon Juice 5%) ,T_2- (Ascorbic acid 1%), T_3-(Sodium Benzoate 600ppm), T_4-(Lemon Juice 5%+Ascorbic acid 1%+Sodium Benzoate 600ppm), T_5-(Potassium Sorbate 600ppm), T_6-(Lemon Juice 5%+Ascorbic acid 1%+Potassium Sorbate 600ppm), T_7-(Control).

Table 2: Total sugars (%) content of the pomegranate leathers prepared with different treatments at different days of storage.

Treat/Time	0 DAS	15 DAS	30 DAS	45 DAS	60 DAS
T_1	18.80	20.55	28.89	29.71	30.55
T_2		20.00	25.00	26.35	27.78
T_3		20.00	25.00	26.35	27.78
T_4		20.00	25.00	25.00	25.00
T_5		18.89	27.78	27.78	27.78
T_6		20.00	20.00	22.50	25.00
T_7		20.55	30.55	30.55	31.22
CD at 5%		N/A	1.468	1.043	1.288
SE m±		0.355	0.479	0.341	0.421

T_1-(Lemon Juice 5%) ,T_2- (Ascorbic acid 1%), T_3-(Sodium Benzoate 600ppm), T_4-(Lemon Juice 5%+Ascorbic acid 1%+Sodium Benzoate 600ppm), T_5-(Potassium Sorbate 600ppm), T_6-(Lemon Juice 5%+Ascorbic acid 1%+Potassium Sorbate 600ppm), T_7-(Control).

Total Phenolic Content

Table 3: Acidity content (%) of the pomegranate leathers prepared with different treatments at different days of storage.

Treat/Time	0 DAS	15 DAS	30 DAS	45 DAS	60 DAS
T_1	0.064	0.085	0.128	0.149	0.448
T_2		0.085	0.085	0.128	0.341
T_3		0.064	0.064	0.128	0.320
T_4		0.085	0.128	0.257	0.448
T_5		0.064	0.064	0.128	0.341
T_6		0.085	0.128	0.257	0.448
T_7		0.064	0.085	0.128	0.341
CD at 5%		N/A	0.035	0.027	N/A
SE m±		0.016	0.011	0.009	0.050

T_1-(Lemon Juice 5%) ,T_2- (Ascorbic acid 1%), T_3-(Sodium Benzoate 600ppm), T_4-(Lemon Juice 5%+Ascorbic acid 1%+Sodium Benzoate 600ppm), T_5-(Potassium Sorbate 600ppm), T_6-(Lemon Juice 5%+Ascorbic acid 1%+Potassium Sorbate 600ppm), T_7-(Control)

Table 4: Total phenolic content (mgGAE/g) of the pomegranate leathers prepared with different treatments at different days of storage.

Treat/Time	0 DAS	15 DAS	30 DAS	45 DAS	60 DAS
T_1	39.678	18.99	14.84	6.12	3.87
T_2		22.72	16.47	7.17	5.20
T_3		19.69	16.42	7.04	5.00
T_4		39.47	16.83	10.23	5.20
T_5		18.99	15.69	7.03	4.11
T_6		39.47	18.36	9.40	5.40
T_7		18.80	14.00	5.09	3.00
CD at 5%		1.623	1.042	0.462	0.623
SE m±		0.530	0.340	0.151	0.204

T_1-(Lemon Juice 5%) ,T_2- (Ascorbic acid 1%), T_3-(Sodium Benzoate 600ppm), T_4-(Lemon Juice 5%+Ascorbic acid 1%+Sodium Benzoate 600ppm), T_5-(Potassium Sorbate 600ppm), T_6-(Lemon Juice 5%+Ascorbic acid 1%+Potassium Sorbate 600ppm), T_7-(Control)

The 0 day of storage recorded the best value of phenolic content (mgGAE/g) for all the treatments table 4. There after the 15 days of storage T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm) showed 39.47 (mgGAE/g) of phenols and a same value was recorded for T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm). Other treatments T_2 (Ascorbic acid 1%), T_3 (Sodium Benzoate 600ppm), T_1 (Lemon Juice 5%), T_5 (Potassium Sorbate 600ppm) and T_7 (Control) were on the lower side. Trend for the phenolic content (mgGAE/g) at 30 days for similar as like of 15 days with the highest value 18.36 (mgGAE/g) for T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm) followed by other treatments. At 45 days interval T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm) documented the highest phenolic content 10.23 (mgGAE/g) followed by T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm) with 9.40 (mgGAE/g). Treatments like T_5 (Potassium Sorbate 600ppm), T_3 (Sodium Benzoate 600ppm) and T_2 (Ascorbic acid 1%) were more or less in a similar range of around 7 (mgGAE/g) and T_7 (Control) showed the content of 5.09%. At 60 days interval T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm) recorded the highest value of 5.40 (mgGAE/g) and a slight lower value of 5.20 (mgGAE/g) was shown by T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm) and T_2 (Ascorbic acid 1%) whereas other treatments followed after and T_7 (Control) was recorded with the lowest phenolic content with 3.00 (mgGAE/g).

Table 5: Antioxidants content (percent inhibition of DPPH) of the pomegranate leathers prepared with different treatments at different days of storage.

Treat/Time	0 DAS	15 DAS	30 DAS	45 DAS	60 DAS
T_1	72.67	65.42	56.41	31.97	16.67
T_2		70.18	64.29	40.36	18.42
T_3		70.18	62.30	40.36	18.42
T_4		72.55	64.29	45.24	29.70
T_5		65.42	62.30	31.97	18.42
T_6		72.55	64.28	49.66	29.93
T_7		65.42	56.41	29.70	16.67
CD at 5%		0.649	1.909	1.744	0.846
SE m±		0.212	0.623	0.569	0.276

T_1-(Lemon Juice 5%) ,T_2- (Ascorbic acid 1%), T_3-(Sodium Benzoate 600ppm), T_4-(Lemon Juice 5%+Ascorbic acid 1%+Sodium Benzoate 600ppm), T_5-(Potassium Sorbate 600ppm), T_6-(Lemon Juice 5%+Ascorbic acid 1%+Potassium Sorbate 600ppm), T_7-(Control).

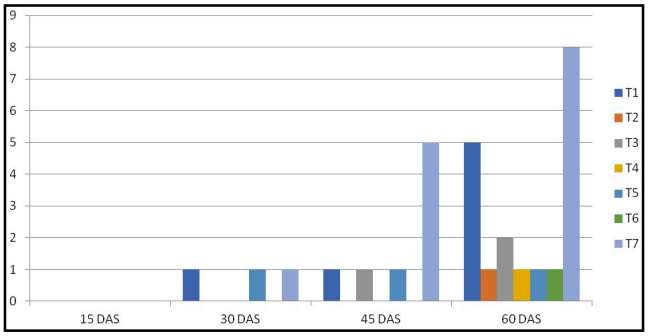

Fig. 1: Total Fungal Count of the pomegranate leathers prepared with different treatments at different days of storage.

T_1-(Lemon Juice 5%) ,T_2- (Ascorbic acid 1%), T_3-(Sodium Benzoate 600ppm), T_4-(Lemon Juice 5%+Ascorbic acid 1%+Sodium Benzoate 600ppm), T_5-(Potassium Sorbate 600ppm), T_6-(Lemon Juice 5%+Ascorbic acid 1%+Potassium Sorbate 600ppm), T_7-(Control).

Antioxidant Activity

At 15 days interval antioxidant activity (% inhibition of DPPH) for all the treatment where at the higher sides with miner decrease from the initial day of the leather preparation table 5. The antioxidant activity (% inhibition of DPPH) further lowered at 30 days of storage but still the declination was not very much steep as compare to 15 days of storage. However during 45 days and 60 days of storage the antioxidant content reduced at considerable amounts. At the 45 days interval the antioxidant content where at the range of higher Forties to lower thirties and at 60 days interval the antioxidant become further lower with highest content recorded by T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm) and T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm) of 29.93% and 29.70% respectively. This was followed by similar values from T_2 (Ascorbic acid 1%), T_3 (Sodium Benzoate 600ppm) & T_5 (Potassium Sorbate 600ppm) and the antioxidant activity (% inhibition of DPPH) of the control group of pomegranate leather showed the least content of 16.67%.

Total Fungal Count

At 30 days interval slight fungal contamination Fig. 1 was observed with development of one colony each in treatment T_1 (Lemon Juice 5%), T_5 (Potassium Sorbate 600ppm) and T_7 (Control). No infestation was seen for other treatments. At 45 days interval the fungal colony were yet to be development of treatment T_2 (Ascorbic acid 1%), T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm) and T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm) and one number of colony was seen for T_1 (Lemon Juice 5%), T_3 (Sodium Benzoate 600ppm) & T_5 (Potassium Sorbate 600ppm). Control was observed with five fungal colonies. At the end of the storage all the treatments

were observed fungal infection with one fungal colonies for T_2 (Ascorbic acid 1%), T_4 (Lemon Juice 5% + Ascorbic acid 1% + Sodium Benzoate 600ppm), T_5 (Potassium Sorbate 600ppm) and T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm). T_3 (Sodium Benzoate 600ppm) developed 2 number of colonies. 5 number of colonies for T_1 (Lemon Juice 5%) was seen whereas T_7 (Control) was reported with the highest fungal contamination showing 8 number of fungal colonies.

In the study various pomegranate parameters like total sugar, antioxidant, moisture content, phenolic content, acidity and fungal count varied accordingly during the storage interval. It was observed that the total sugar content increased during the study. The results were very much similar which were obtained in case of fruit leather prepared from jackfruit (Che Man YB and & Taufik, 1995) sweet potato (Collins and Hutsell, 1987) and from blending of guava and papaya (Vennilla, 2004). The titratable acidity during the study also got increased with the progress of storage time which was also similar as per to the previous findings with respect to mango leather (Rao and Roy, 1980) fig leather (Kotlawar, 2008) and high protein tamarind leather (Kharche, 2012). Microbial growth observed during the study was lower in the treated pomegranate leather as compared to control. The chemical used for pre-treatment might have helped to reducing the fungal infestation and furthermore the process of dehydration is a very important preservation method which itself hinders the growth and development of the microorganisms by reducing the biologically active water (Esper & Mühlbauer, 1998). Kordylus, (1990) also in his work mentioned that if the moisture from the product can be reduced to the safe minimum content then the commodities can be kept for a very long period of time with least microbial infestation. The other parameters like total phenolic content and antioxidant activity decreased during the period of study. However maximum maintenance for these two parameters was seen in the pre-treated pomegranate leather as compared to control. This might be because of the effect of the treatments which helped in withholding the antioxidant and as well as the phenolic content as compare to the control where no such chemical was used. The result was similar to the previous work of Das and Dhua (2019) with respect to dehydration of banana inflorescence.

Conclusion

Form the overall study we can conclude that the pomegranate leather prepared with combination of Lemon Juice 5%, Ascorbic acid 1% and Potassium Sorbate 600ppm can be said as the superior one amongst other treatments with minimum accumulation of total sugar and less loss with respect to antioxidant (% inhibition of DPPH) and phenolic content (mgGAE/g) through the storage period. Also, the fungal infection was less in this treatment. Though the accumulation of titratable acidity was seen maximum here, but overall, we can say that T_6 (Lemon Juice 5% + Ascorbic acid 1% + Potassium Sorbate 600ppm.) combination can be used as a pre-treatment to develop pomegranate leather which can be kept successfully for a considerable period of storage time.

References

A.O.A.C. (2000). Official Methods of Analysis. 17th Ed. Association of Official Analytical Chemists, Horwitz, USA.

Allen, O.N. (1953). Experiments in Soil Bacteriology. Burgess Co., Minneapolis, Minn. pp. 69-70.

Blessing, I. Offia-Oluan and O. A. 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.

Brand-Williams, W., M.E. Cuvelier and C. Berset (1995). Use of a free radical method to evaluate antioxidant activity, *LWT Food Sci Tech*., **28:** 25-30.

Bryk, N. (1997). Fruit Leather.) #http//www.highbeam.com/doc/ig2_2896900052. html*# (accessed 5 August 2008).

Che, Y.B. Man and Taufik (1995). Development and Stability of jack fruit leather. *Tropical Sci.,* **35(3):** 245-250.

Collins, J.L. and L.W. Hutsell (1987). Physical Chemical Sensory and Microbiology attributes of sweet potato leather. *J. Food Sci*., **52:**.

Das, K., M. Kumar and A. Das (2019). Standardization of packaging material and storage condition for pomegranate leather. *International Journal of Current Microbiology and Applied Sciences*., **8(08):** 2748-2760.

Das, A. and R.S. Dhua (2019). Standardization of Drying Techniques to Develop Ready to Cook Banana Inflorescence. *International Journal of Current Microbiology and Applied Sciences*., **8(03):** 1523-1536.

Esper, A. and W. Mühlbauer (1998). Solar drying-an effective means of food preservation. *Renew Energy*, **15:** 95–100.

FSSAI, Food Safety and Standards Authority of India (2011). Food Safety and Standards Regulations, 2009, 435-436.

Gomez, K.A. and A.A. Gomez (1984). *Statistical Procedures for Agricultural Research* (2nd Ed.). Wiley-Inter Science Publication), New York, USA.

Huang, X. and F.H. Hsieh (2005). Physical properties, sensory attributes and consumer preference of pear fruit leather. *J. Food Eng*., **100(2):** 254–260.

Kharche, K.M. (2012). Studies on preparation of high protein

leather from tamarind. M.Sc. Thesis.

Kordylas, J.M. (1990). Processing and Preservation of Tropical and Subtropical Foods. Macmillan Publishers Ltd. London.

Kotlawar, N.G. (2008). Investigations on preparation and shelf life of fig leather. M.Sc. Thesis., M.P.K.V., Rahuri.

Kulkarni, P.A., S.M. Aradhya and S. Divakar (2004). Isolation and identification of radical scavenging antioxidant punicalogin from pith and capillary membrane of pomegranate food. *Food Chem*., **87:** 551-557.

Ngangom, R., P. Reang and A. Das (2019). Study on development of suitable ways for preparation and preservation of dehydrated pomegranate arils. *International Journal of Chemical Studies*, **7(5):** 1034-1038.

Parimita and M. Kumar (2015). Development of Tomato leather from Ingredients Level in Low Calorie-High Calcium. *International Journal of Applied Research*, **1(12):** 599-601.

Raab, C. and N. Oehler (1999). Making dried fruit leather fact sheet. Oregon State University Extension Service. USA. *Fact Sheet,* **232:** 1–4.

Rangana, S. (2003). Handbook Of Analysis and Quality Control for Fruit and Vegetables Products 2nd ed., Tata McGraw Hill.pp. 12-16.

Rao, S.V. and S.K. Roy (1980). Study on dehydration of mango pulp (II) Storage study of mango sheets/leather., *Indian Food Packer*, **34(3):** 72-79.

Sheoran, O.P., D.S. Tonk, L.S. Kaushik, R.C. Hasija and R.S. Pannu (1998). Statistical Software Package for Agricultural Research Worker. Recent Advances in information theory, Statistics and Computer Applications by D.S. Hooda and R.C. Hasija, Department of Mathematics Statistics, CCS HAU, Hisar (139-143).

Singleton, V.L., R. Orthofer and R.M. Lamuela- Raventos (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin- Ciocalteau reagent. *Methods Enzymol*., **299:** 152-178.

Vennilla, P. (2004). Studies on storage behaviour of guava-papaya fruit bar., *Beverage Food World.,* **31(2):** 63-66.