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Studies on development of process and product of plum fruit leather

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Abstract
Plum leather was prepared by using different combinations of sugar (50%, 40%, 30%, 20%, 10%, 0%) and plum pulp with varying concentrations by drying thin layer in hot air oven (60 ºC, 70 ºC 80 ºC). The TSS of plum leather was found to be in the range (77.36 to 78.38ºB). The standardization of most palatable recipe was done by evaluating sensory properties and highest score was obtained by sugar: plum (30:70). The plum leather contained comparatively higher amount of ascorbic acid (5.05mg/100g), TSS (78.38mg/100), moisture content (14.30 %), pH (5.864) and titratable acidity (1.60). The leather was found most stable when packaged in Low density Polyethylene (LDPE) pouches during storage. The leather did not exhibit appreciable changes in titratable acidity, ascorbic acid, TSS, moisture content, and pH after 2 months. Thus, the plum leather can be stored under ambient storage after packing.

Keywords: plum, plum leather, sugar, packaging material, ascorbic acid

1. Introduction
Fruits are the edible plant products which are usually soft, fleshy and because of their high moisture content are relatively perishable in the freshly harvested state. Beside these facts they are the rich source of energy, minerals, vitamins and fibers. The perishable nature of the fruits causes hindrance in its optimum utilization. Hence, preparation of fruit leather can be an effective way for the preservation of the taste and other nutritive values of the fruit (Laxman *et al*, 2017).

Fruit leather or fruit bar also known as fruit roll means a sheet of dried pureed fruit prepared by blending fruit pulp, fat or milk solids & other ingredients required for the product which can be molded into desired shape or size (FSSAI, 2011) [9]. Simply fruit leathers are the fruit-based confectionary which are often eaten as snack or desert. Fruit leather can be made by using drying processes. These are the dried sheets of fruit pulp having a soft and rubbery texture. Drying can be achieved by either sun drying, oven drying or try trying etc. The pulp of the fruit is pureed and is mixed with several other ingredients in order to improve its sensory and physicochemical attributes (Madhav and Parimita, 2016) [21].

Plum (*Prunus domestica*) is one of the important fruit crops cultivated in temperate regions of the world. Plums are usually consumed as fresh (Pino and Quijano, 2012) [27]. Plums are the excellent source of antioxidants and minerals such as calcium, magnesium. Iron. Potassium etc. Moreover, these fruits are attractive in appearance and have got a decent flavor and taste. These are also rich in fibers and vitamin C (Sabarez *et al*. 1997) [29]. The highly nutritious plum fruit can be utilized for the preparation of serval value added products and dried fruit leather.

Objectives
1. To standardize the ratio of Plums pulp and sugar in the leather
2. To study the effect of different time and temperature combination on quality of Plum leather.
3. To Study the storage behavior of plums fruit leather.

2. Material and Method
The experiment "Studies on development of process and product of plum fruit leather" was carried out at the the food process engineering laboratory of the Vaugh Institute of Agricultural Engineering and Technology, SHUATS, Prayagraj (UP). The details of the experimental techniques that were employed during the course of investigation are as follows.

2.1 Procurement and purchasing of raw materials.
1. Plum: Plum (*Prunus domestica*) was purchased from the local market of the Prayagraj city. The plums were well ripened with perfect purple color.
2. Sugar: Sugar was purchased from the local shop of the Prayagraj city.

2.2 Equipment required in preparation of fruit leather
Electric fruit juicer was used for the extraction of pulp from the fruit. A laboratory scale hot air oven which consisted of drying chambers, fan and temperature controller (50-300ºC) was used to dry the fruit leathers.

The uniform circulation of heat was maintained by the fans and the content in the oven was monitored at the regular intervals. Moreover, digital weighing balance was used for the analytical works.

2.3 Methodology

2.3.1 Extraction of pulp

The oven was preheated to 400° F. The plum was washed, cut and pitted. The halved plums were laid out on a rimmed cookie sheet with a cut side up and then they were placed in the oven for 20 minutes. The plums were checked in every 5 minutes to avoid burning of those. Then the plums were removed and were allowed to cool. Using the blade attachment in the food processor, the plums were blended until they were smooth. Then the mixture was poured into a large bowl. Blending of the pulp was done with sugar and then the mixture was subjected to boil.

Table 1: Different ratio of pulp and sugar

Treatments	Pulp	Sugar
T1	50%	50%
T2	60%	40%
T3	70%	30%
T4	80%	20%
T5	90%	10%
T6	100%	0%

2.3.2 Dehydration

After the sugar was added, boiling was done with continuous stirring for 5 minutes.

The mixture was then spread on a tray greased with butter and was dried in the hot air oven at 60ºC for 24 hours. After 24 hours the trays were taken out from the hot air oven, cooled and leather was cut in to rectangular shape (3.5x3.5x0.5cm) and packed into LDPE and HDPE at ambient temperature. The procedure was repeated three times at different temperatures (60ºC, 70 ºC, and 80 ºC) for respective time as replication.

2.3.3 Sensory evaluation

The Sensory quality attributes such as color, flavor, taste, texture and overall acceptability of plum leather was evaluated as recommended by (Ranganna, 1986) [28]. This was evaluated using points Hedonic rating test method. This test measures the consumer acceptability. A panel of members of different age groups having different eating habits was selected to evaluate the quality through properly-planned experiment.

The panelists were selected from the experienced staff and students of the university. Numerical scores were allocated for the various sensory attributes and the overall acceptability of the product was evaluated.

The sensory quality of the product was indicated by the numerical score assigned to the attributes.

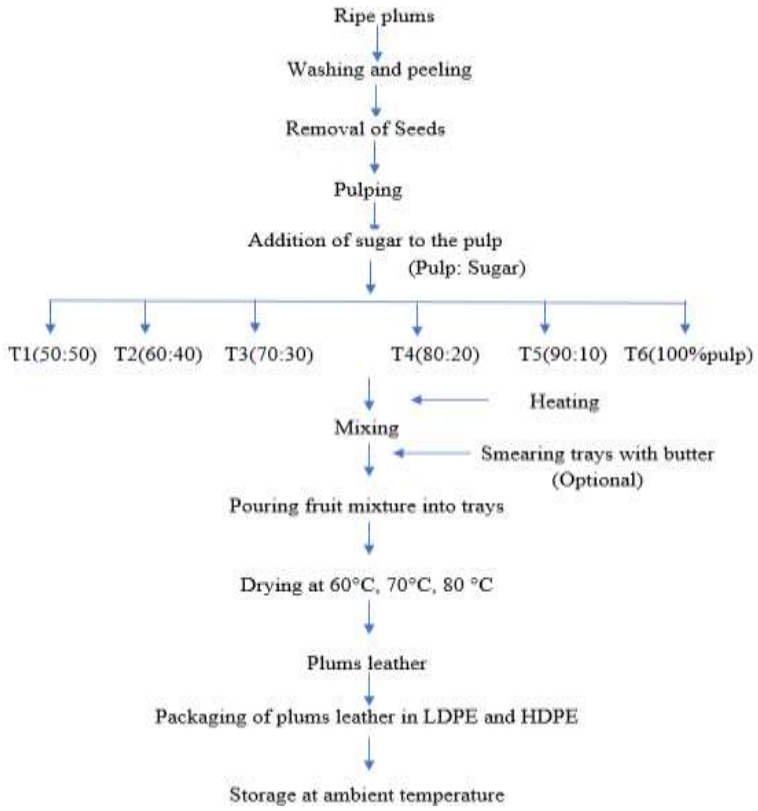

Fig 1: Schematic diagram for the preparing process of plum fruit leather

2.3.4 Analytical methods

Various methods that were employed for the physio-chemical and microbiological analysis are mentioned below:

- Total Soluble Solids: Total soluble solids were determined with the help of hand refractometer (Atago India instrument Pvt. Ltd, Mumbai) and were expressed in ºBrix.
- Titratable acidity: Titratable Acidity was determined by titrating the suspension against 0.1N NaOH solution to an end point using phenolphthalein as an indicator (AOAC,1990) [2]
- Vitamin C: The vitamin content was determined by 2, 6-dichlorophenol indophenols dye method of Johnson (1948) as described by Ranganna (1986) [28].
- Reducing Sugar: The reducing sugar content was determined by method of Lane and Eynon (1923) as reported by Ranganna (1986) [28].
- Total Sugar: The total sugar content was determined by

method of Lane and Eynon (1923) as reported by Ranganna (1986) [28].

- PH: The pH was measured using the digital pH meter (Metzer-M, 2001M) which was calibrated using 7 pH and 4 pH standard buffer solutions.
- Moisture content: Moisture content of the sample was determined by using hot air oven method as recommended by AOCC.
- Total Plate count: Microbial analysis was done to determine the Total Plate Count (TPC) of the sample on nutrient Agar media for bacterial count as method recommended by (Harrigan and Mc Cance, 2014) [10].

2.3.5 Statistical Analysis

Calculation of the standard deviation (SD) and Analysis of Variance (ANOVA) were the statistical tool used for the statistical analysis.

3. Results and Discussion

The present investigation entitled "Studies on Development of Product and Process of Plum Fruit Leather" was carried out in the Department of Food Process Engineering, VIAET, SHUATS, Prayagraj (UP). During the year 2018-2019.

3.1 Physio-chemical characteristics of fresh plump pulp

The moisture content in the fresh plum pump was estimated to be 85 %. The plum fruits contribute 20°B total soluble solids with 0.60 percent of titratable acidity acid, with an appreciable amount of ascorbic acid (6 mg/100g),Total sugar (9.36 %) and pH (3.8).Thus, keeping in view of the nutritional value of the plum, leather was prepared with an acceptable acidity, colour, flavour without the addition of any exogenous ingredients.

3.2 Standardization of recipe for leather preparation

The result corresponding to the sensory evaluation of the plum leather prepared by dehydrating at different temperatures are tabulated in the table 3, 4 and 5. As regards sensory evaluation T3 (30% sugar) (70ºC, Hot air Oven) showed better results with respect to high colour score (8.36),taste (8.98) better flavour (8.44) and overall-acceptability(8.62) as shown in table 4.Thus, this proves that Plum fruit leather with high temperature drying was more acceptable up to two month's storage than that of other treatments. The treatment T6 (100% plum) with 60 ºC was better with respect to sensory qualities among all other treatments. Study revealed that the fresh sample of Plum leather prepared on the 70 ºC was exhibited better sensory score for the colour, taste and overall acceptability. From ANOVA for the sensory characteristic of fresh Plum leather it concluded that effect of the temperature of drying, and dryer used has significant effect on sensory parameters of the fresh plum leather.

3.3 Drying Behaviour

In comparison to total drying period, the rate of dehydration was fast during initial period of drying. The gradual decrease in moisture content with respect to time due to high temperature at all the temperatures i.e 80 ºC,70 ºC and 60 ºC. In the interval of each 2 hours the moisture content was checked and final when the moisture content reached the desired level (up to 20 ºC) the leather was taken off the hot air oven it took about 8-12 hours for the sample to dry. The rate of drying was faster at the higher temperature and slowed down with the decrease in the temperature of drying. The mean moisture level was observed lowest (14.30 %) in the treatment T2 and it was highest (18.60%) in the treatment T4.

3.4 Physio-chemical characteristics of plum leather

The data in table 6 shows the physio-chemical characteristics of the plum leather sample T3.The plum leather thus prepared had moisture content of 18.02%, Total soluble solids 78.12ºB, Titratable acidity of 1.43, ascorbic acid content of 4.95mg/100g and pH of 5.75.The titratable acidity and pH seemed to be higher in the leather as compared to that of plum whereas there seemed to be a slight reduction in the ascorbic acid content.

3.5 Storage studies

The storage stability of plum leather prepared and after packing them in LDPE pouches was evaluated at periodic intervals of 0, 15, 30,45 and 60 days at ambient temperature. Changes in the chemical composition of plum leather during storage:

- **Moisture:** It is clear from the data in table 7 that the maximum mean 16.62 moisture content was noticed in T4 and T5 followed by T2 and T1. The treatment T3 showed the mean minimum level of the moisture content (16.22). The moisture level of the leather decreased with decrease in the temperature of the processing. Regarding the storage period, it was noticed that the moisture content of the leather decreased significantly from 20 to 18.46 % during storage period of 60 days. The moisture loss might be due to evaporation of moisture to the atmosphere by the package during storage.
- **Total soluble solids:** It is evident from the data that the TSS content of the product increased irrespective of the treatments from 77 to 78.60° B after 60 days of storage at ambient conditions. An increase in the TSS might be due to the change in the moisture content of the product during storage period of 60 days. The effect of interaction between treatment and storage was found significant. Among the treatments, the highest (78.33°B) TSS was recorded in the treatment T1 at 0 day of storage which was at par with the treatment T2 (78.23) during initial period of storage. The lowest (77 B) TSS was recorded in the treatment T6 at 60 days of storage. The data corresponding to the result are tabulated in table 8.
- **Titratable acidity:** The data in respect of the acidity of Plum Fruit leather influenced by the treatment are presented in Table 9. Acidity was increased as days of storage were decreased up to 60 days' storage period. At 0 day the storage of T2 was found to have highest acidity percentage (1.75) which was significantly superior to value (1.74) of T1.
- **Vitamin C:** It could be revealed from the results cited in Table 10 that the ascorbic acid content of the Plum fruit leather was (4.68 mg/100g) in the treatment T6, followed by the treatments T3 (4.82mg/100g) and T5 (4.71/100g). The treatment T1 exhibited the lowest (4.86 mg/100gm) ascorbic acid content, followed by the treatments T2 (4.83mg/100g) and T4 (4.79 mg/100g). Thus, the ascorbic acid level decreased with increase in the drying temperature and oven used in the leather.

The oxidative reactions influenced by the temperature might have resulted into decline in the ascorbic acid content of the product during storage at ambient conditions

- **Microbial Analysis:** Microbial analysis conducted every after 15 days was found to be not detected. Since the drying condition, packaging and temperature had reduced the moisture content so the microbial growth didn't occur. Hence it states that it is a preserve which can be stored for longer duration, when kept at clean and dry place.

According to the obtained reading the leather prepared at 70 ºC was the best in its sensory score, hence the further analysis was carried out on 70 ºC samples. The average values of the sensory, physio-chemical and microbiological parameters of different treatments of the samples are tabulated in table 3, 4 and 5.

Table 2: Chemical composition of Fresh Plum Pulp

Sr. No	Parameters	Mean Value*	Range #
1.	Moisture (%)	85%	85-87 %
2.	T.S.S. (°Brix)	20° Brix	15.6 – 22.34 ° Brix
3.	Titratable Acidity (%) citric acid	0.60%	0.55 – 1.28%
4.	Total Sugar (%)	9.36%	6.96– 12.9
5.	Ascorbic acid (Vit. C)(mg/100g)	06	08-10
6.	pH	3.8	2.8 – 4.6

Table 3: Effect of Different temperature and Dryers on the sensory characteristics of Plum leather at various temperatures

Treatment At 80 ºC	Recipe Sugar	Color	Taste	Flavor	Texture	Overall Acceptability
T1	50%	7.90	7.62	7.56	7.42	7.50
T2	40%	7.80	7.56	7.58	7.38	7.48
T3	30%	7.66	7.52	7.60	7.36	7.48
T4	20%	7.68	7.54	7.58	7.40	7.52
T5	10%	7.60	7.50	7.62	7.36	7.48
T6	0%	7.56	7.48	7.64	7.34	7.44
AT 70 ºC						
T1	50%	8.45	8.35	8.62	8.34	8.44
T2	40%	8.56	8.32	8.58	8.18	8.41
T3	30%	8.36	8.98	8.44	8.68	8.62
T4	20%	8.34	8.50	8.46	8.70	8.50
T5	10%	8.32	8.26	8.20	8.60	8.35
T6	0%	8.30	8.32	8.18	8.68	8.37
AT 60 ºC						
T1	50%	7.50	7.25	7.50	7.20	7.36
T2	40%	7.40	7.20	7.45	7.25	7.33
T3	30%	7.40	7.25	7.00	7.40	7.39
T4	20%	7.30	7.25	7.30	7.60	7.36
T5	10%	7.25	7.20	7.25	7.50	7.30
T6	0%	7.20	7.15	7.50	7.30	7.30

Table 4: Physio chemical characteristics of Plum fruit leather

Sr.no.	Parameters	Sample T3 (70:30)
1.	Moisture content	18.02%
2.	Total soluble solids	78.12ºB
3.	Vitamin C	4.95mg/100g
4.	Titratable acidity	1.43
5.	pH	5.75

Table 5: Effect of Different temperature and Dryers on Various physio-chemical properties of Plum leather during storage study

Moisture content						
DAYS>	0 Days	15 Days	30 Days	45 Days	60 Days	MEAN
T1	18.01	17.10	16.40	15.90	14.50	16.382
T2	18.10	18.60	16.30	15.60	14.40	16.40
T3	18.02	17.30	16.10	15.40	14.30	16.224
T4	18.00	17.70	16.80	15.81	14.80	16.622
T5	18.05	17.60	16.70	15.70	14.66	16.542
T6	18.10	17.20	16.20	15.46	14.40	16.272
TSS (ºB)						
T1	78.33	78.6	78.35	78.32	78.30	78.38
T2	78.23	78.4	78.18	78.16	78.14	78.22
T3	78.12	78.2	78.10	77.05	78.03	78.1
T4	78.06	78.05	78..04	78.3	78.01	78.09
T5	78	78	78.	78	77.9	77.98

T6	77.5	77.8	77.3	77.2	77	77.36
Titratable acidity						
T1	1.74	1.65	1.58	1.50	1.45	1.606
T2	1.75	1.65	1.61	1.54	1.48	1.584
T3	1.43	1.42	1.40	1.37	1.34	1.392
T4	1.50	1.48	1.45	1.40	1.37	1.44
T5	1.46	1.32	1.31	1.28	1.25	1.324
T6	1.37	1.34	1.33	1.31	1.28	1.326
Vitamin C						
T1	5.05	4.95	4.80	4.75	4.71	4.86
T2	5.01	4.92	4.85	4.72	4.65	4.83
T3	4.95	4.89	4.84	4.78	4.64	4.82
T4	4.91	4.87	4.82	4.76	4.62	4.79
T5	4.86	4.75	4.71	4.67	4.60	4.71
T6	4.81	4.77	4.68	4.62	4.55	4.68

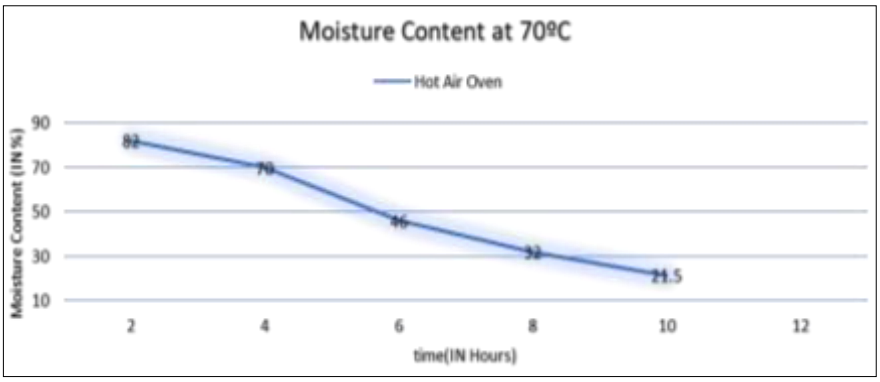

Fig 2: Drying curve of the Plum fruit leather

4. Conclusion

The present investigation entitled, "Studies on development of process and product of Plum fruit leather" was undertaken to assess the effects of different levels of temperature viz. (60 ºC, 70 ºC, 80 ºC) Hot air oven on the physio-chemical as well as sensory qualities of the Plum fruit leather. A decreasing trend in moisture, titratable acidity, vitamin C, pH of the leather was noticed with increasing trend in the TSS was observed during storage at ambient condition. The plum fruit leather product could be successfully prepared and stored at ambient temperature condition without any deterioration for the period of 2 months. Considering sensory quality and the cost of production, the Plum fruit leather having Plum pulp with 70 ºC temperatures could be the best combination for the preparation of high-quality Plum fruit leather.

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