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Effect of drying on Physico-chemical properties of protein fortified kesar mango leather

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Abstract
The study was carried out to find out the effect of drying on Phyisco-chemical properties of protein fortified mango leather by using mechanical drying of tray drying. Protein fortified mango leather was prepared by tray drying technique using process variables *viz.* whey protein powder (4.92%), sugar (12.50%), citric acid (0.45%) and thickness of pulp (6 mm). The study was undertaken at 50, 55, 60, 65 and 70 °C drying temperatures in 4, 5 and 6 mm thickness of pulp and dependent variables like protein content, overall acceptability, ascorbic acid, color values, cutting force and stretchability were analyzed by statistical method of analysis using CRD factorial. Optimum value of overall acceptability (8.69), protein content (11.36g/100g) and ascorbic acid (56.65mg/100g) was found at drying temperature of 65 °C in 5 mm of thickness of pulp for production of tray dried protein fortified mango leather.

Keywords: Mango, drying, physic-chemical, mango leather

Introduction
Fruit leathers can be made from the most popular fruits like mango, banana, papaya and kiwi etc. They are dried sheets of fruit pulp which have a soft, rubbery texture and sweet taste. It may be consumed as snack foods as a healthy alternative to boiled sweets and also used in the manufacture of cookies, cakes and ice cream as an ingredient (Food Safety and Standards Regulations Act, 2011) [5]. The process of creating fruit leather using a range of fruits like apple, jackfruit and sapota has been documented in various sources. Traditionally, mango leather is prepared from ripe fruit pulp using sun drying. However, the conventional sun-drying method leads to color changes and is considered unhygienic and time-consuming.

Content of fruit leather rich in minerals and low in fat and protein (Pramanik and Sengupta, 1978) [9]. Whey, a natural and pure high-quality protein complex, is obtained from the process of cheese production. Recognized for its positive effects on health, whey protein is a functional ingredient associated with benefits such as immune system enhancement, prevention of dental plaques and tooth decay, cholesterol reduction and lowered blood pressure. Whey serves as an excellent dietary supplement for creating energy bars and fruit leather. Incorporating whey protein into sports and snack items provides beneficial nutrients that impact body composition positively (Burrington, 2012) [3]. The popularity of protein-fortified products is on the rise, heavily promoted as an ideal protein source (Bhutani, 2010) [2]. Protein-fortified mango leather presents significant advantages, including protein enrichment, simplicity, lower production costs, enhanced consumer appeal, and increased popularity among children.

A dynamic marketing network can boost this product in India and abroad. Nutritionally, leather is low in protein. Enhancing and fortifying food represents the most economically viable and sustainable approach to combat malnutrition. Therefore, this study was carried out to study the effect of drying on phyisco-chemical properties of mango leather using whey to prepare nutritious leather from mango pulp with highest consumer acceptance.

Materials and Methods
The detailed experimental protocols, instruments and software etc. used in the study should be described here with their proper references. The details of the study area should also be provided.

Results

Experimental Site: Kesar variety mango canned pulp (pasteurized, unsweetened and without added preservatives were canned) was specially processed and prepared for this project at processing plant of PFE Department, CAET, Junagadh Agricultural University, Junagadh, Gujarat. The processing of ingredients and drying was conducted at Processing and Food Engineering Department, College of Agricultural Engineering & Technology, Anand Agricultural University, Godhra, Gujarat, India.

Raw Materials: Whey protein powder (WPC-80, sourced from Arla) was obtained from the Anand local market in Gujarat. Sugar (Madhur Brand, sulphur-free, pure, and hygienic), citric acid, and packaging materials were acquired from the local market in Godhra, Gujarat.

Mango Leather Formulation: The protein fortified mango leathers were prepared as per the standard procedure mentioned in Fig.1. Mango pulp having 17-20ºBrix was taken and sugar (10-15g) was added to adjust the TSS of pulp to 30°Brix. Citric acid at 0.5% level was mixed in pulp thoroughly. After that, heat treatment (80 ºC for 5 minutes) was given to mixture. Very thin layer of glycerin was applied to SS plates for easier removal of mango leather from the plate after drying. Mango pulp was spread in SS plates and dried in sun condition up to a product having moisture content of 17±2% (w.b.). Mango leathers were packed in different selected packaging materials and sealed. The mango leather was stored in ambient condition.

Optimization of drying parameters for preparation of mango leather by tray drying technique: Mango leather was prepared based on standardized formulations obtained from earlier study of mango leather. The optimum values reported for formulation of whey protein, sugar, citric acid and pulp thickness were 4.92%, 12.50%, 0.45% and 6mm, respectively (Jethva *et al.*, 2021) [7].

In this experiment two process variables like drying temperature with five levels and thickness of pulp with three levels, each were evaluated for various physico-chemical, sensory and textural properties (Table 1). Two factorial Central Randomized Design was used to optimize drying temperature and thickness by using tray drying technique based on sensory and various physico-chemical, textural properties.

Table 1: Experimental plan for optimization of drying parameters

Independent variables		
(i)	Drying Temperature (°C)	50, 55, 60, 65, 70
(ii)	Thickness of Pulp (mm)	4, 5, 6
Dependent variables		
(i)	Physicochemical parameters (Protein & Vitamin-C)	
(ii)	Sensory (Aroma, Taste, Texture, Colour & Overall Acceptability)	
(iii)	Textural Analysis (cutting force & stretch ability)	
Design details		
(i)	Design	CRD factorial
(ii)	Drying condition	Tray drying
(iii)	Replication	3
(iv)	Total experiments	45

Discussion

Effect of drying on physico-chemical properties of protein fortified kesar mango leather

Effect on protein content: It was observed from the Table 2 that drying temperature and thickness had significant effect (p<0.5) on protein content. The highest mean protein content of 11.36 g/100 g was found at D_4T_2 combination (65 °C and 5 mm thickness), which is significantly higher than the other treatments (Fig.1). Retention of protein at higher temperatures may be due to faster drying rate. At higher thickness, protein might have denatured due to more drying time. Similar types of findings were also reported for Papaya leather by Ahmad *et al.*, (2005) [1], fortified mango bars by Mir and Nath (1993) [8] and fortified mixed fruit bar using whey protein concentration by Chauhan (2013) [4], sun dried mango leather by Jethva *et al.*, (2021) [7].

Table 2: Mean Value of Protein Content of tray dried protein fortified mango leather

	T1	T2	T3	Mean T
D1	8.503	8.937	9.113	8.851
D2	9.283	9.397	9.537	9.406
D3	10.263	10.557	10.627	10.482
D4	11.067	11.363	11.223	11.218
Mean D	9.779	10.063	10.125	
	D	T		D X T
SEM	0.024	0.021		0.042
CD (0.05)	0.071	0.061		0.122
CV%	0.73			

Table 3: Mean Value of OAA of tray dried protein fortified mango leather

	T1	T2	T3	Mean T
D1	7.447	7.127	6.960	7.178
D2	7.663	7.393	7.050	7.369
D3	7.713	7.127	6.780	7.207

D4	8.000	8.693	7.320	8.004
Mean D	7.705	7.585	7.028	
	D	T		D X T
SEM	0.061	0.053		0.105
CD (0.05)	0.178	0.154		0.308
CV%	2.45			

Effect on OAA

It was observed from the Table 3 that drying temperature and thickness had significant effect (p<0.5) on overall acceptability. The highest mean overall acceptability of 8.69 was found at D_4T_2 combination (65 °C and 5mm thickness), which is significantly higher than all other treatments. Moreover, the interaction of drying temperature and thickness of pulp was also found significant. Increase in overall acceptability may be due to faster drying rate resulting in good taste & color to the product (Fig.2). Similar types of findings for overall acceptability were found for papaya leather by Ahmad *et al.*, (2005) [1], fortified mango bars by Mir and Nath (1993) [8] and fortified mixed fruit bar using whey protein by Chauhan (2013) [4].

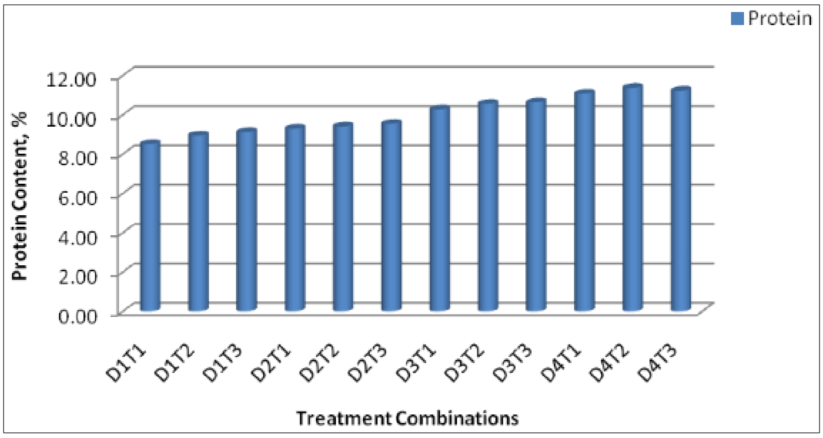

Fig 1: Variations in protein content during tray drying at different temp. and thickness

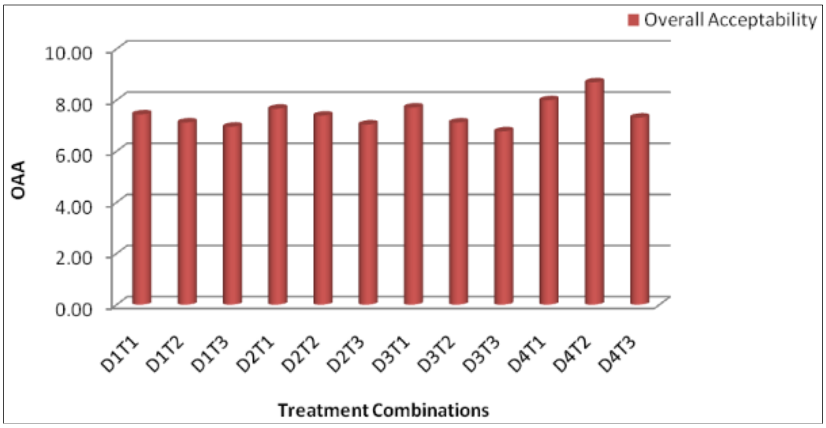

Fig 2: Variations in OAA during tray drying at different temp. and thickness

Effect on Ascorbic Acid

It was observed from Table 4 that drying temperature and thickness had significant effect on ascorbic acid. Highest ascorbic acid of 56.65 mg/100g was found at D_4T_2 combination (65 °C and 5 mm thickness), which is significantly higher than all other treatments. Moreover, the interaction of drying temperature and thickness of pulp was also found significant. Similar effect was also found for ascorbic acid as described in protein content (Fig.3).

Table 4: Mean Value of ascorbic acid of tray dried protein fortified mango leather

	T1	T2	T3	Mean T
D1	41.953	42.057	42.437	42.149
D2	43.477	43.643	44.450	43.857
D3	48.307	48.533	50.570	49.137
D4	52.437	56.653	53.607	54.232
Mean D	46.543	47.722	47.766	
	D	T		D X T
SEM	0.045	0.039		0.077
CD (0.05)	0.131	0.113		0.226
CV%	0.28			

Table 5: Mean Value of pH of tray dried protein fortified mango leather

	T1	T2	T3	Mean T
D1	3.020	3.107	3.123	3.083
D2	3.163	3.170	3.230	3.188
D3	3.307	3.383	3.397	3.362
D4	3.553	3.660	3.673	3.629
Mean D	3.261	3.330	3.356	
	D	T		D X T
SEM	0.073	0.064		0.127
CD (0.05)	0.214	NS		NS
CV%	6.64			

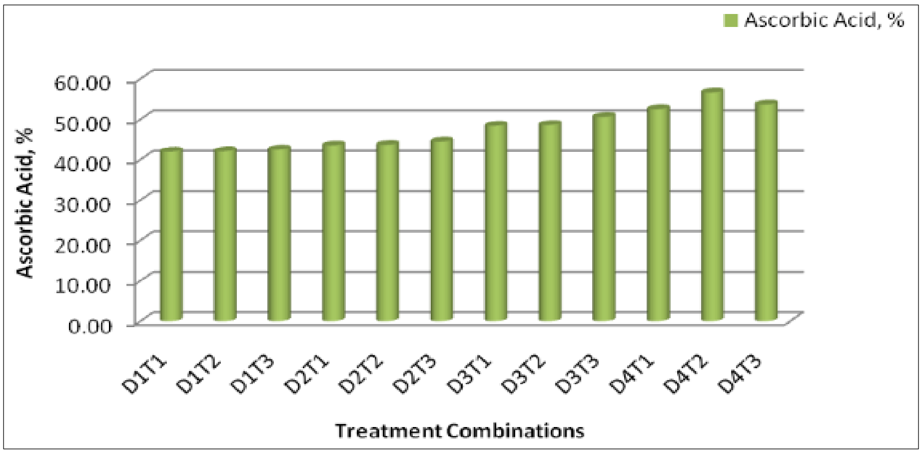

Fig 3: Variations in ascorbic acid during tray drying at different temp. and thickness

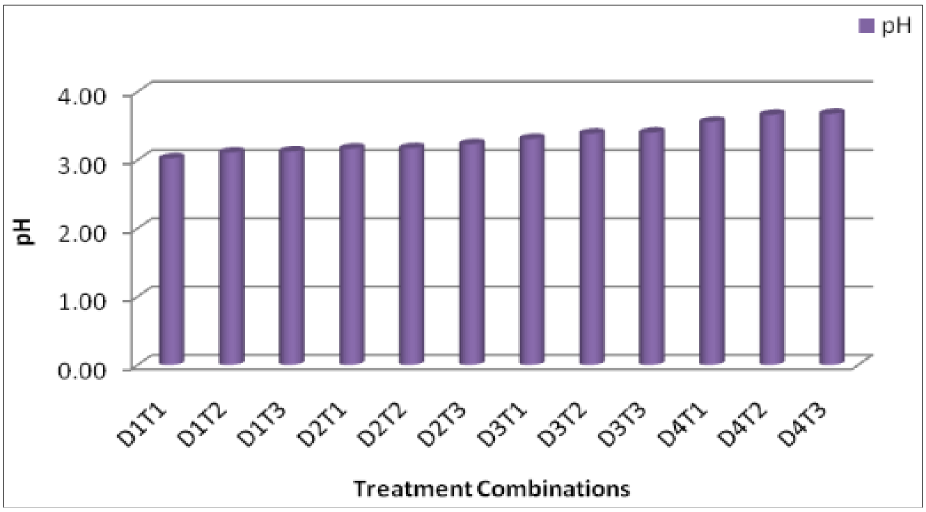

Fig 4: Variations in pH during tray drying at different temp. and thickness

Effect on pH

It was observed from Table 5 that pH values varied from 3.020 to 3.673. The drying temperature had significant, and thickness had non-significant effect on pH value of mango leather (Fig.4). Moreover, the interaction of drying temperature and thickness of pulp was found non-significant. pH value increases with increase in temperature (Fig.4). Similar findings regarding pH was found by Rajkumar *et al.* (2007) [10] for foam mat dried mango powder and Housalmal (2018) [6] for foam mat dried mango leather.

Effect on color value of Mango leather

Effect on Color Value (L*): Color value (L*) indicates degree of darkness to lightness. It was observed from Table 7 that color value (L*) of protein fortified leather varied from 35.503 to 42.460. It was observed from the table that drying temperature had non-significant effect and thickness of pulp had significant (p<0.05) effect on color value (L*). Moreover, the interaction of drying temperature and thickness of pulp was found to be significant. Color value (L*) decreased with increase in thickness. It may be due to the fact that at higher thickness more drying time is required and may lead to darker product. Lighter products may be highly accepted by consumers.

Effect on Color Value (a*): Color value (a*) indicates degree of lightness from green to red. Positive color value (a*) value denotes redness and negative color values (a*) represents greenness. It was observed from Table 8 that color value (a*) of protein fortified mango leather varied from 12.080 to 12.923. It was observed from the table that drying temperature, thickness of pulp and their interaction had non-significant effect on color value (a*).

Table 6: Mean Value of Color Value L* of tray dried protein fortified mango leather

	T1	T2	T3	Mean T
D1	42.460	36.647	35.503	38.203
D2	41.353	38.083	35.593	38.343
D3	40.607	39.270	35.677	38.518
D4	40.447	38.497	36.123	38.356
Mean D	41.217	38.124	35.724	
	D	T		D X T
SEM	0.293	0.254		0.508
CD (0.05)	NS	0.742		1.483
CV%	2.29			

Table 7: Mean Value of Color Value a* of tray dried protein fortified mango leather

	T1	T2	T3	Mean T
D1	12.677	12.567	12.080	12.441
D2	12.587	12.493	12.300	12.460
D3	12.550	12.717	12.487	12.584
D4	12.923	12.420	12.790	12.711
Mean D	12.684	12.549	12.414	
	D	T		D X T
SEM	0.270	0.234		0.468
CD (0.05)	NS	NS		NS
CV%	6.46			

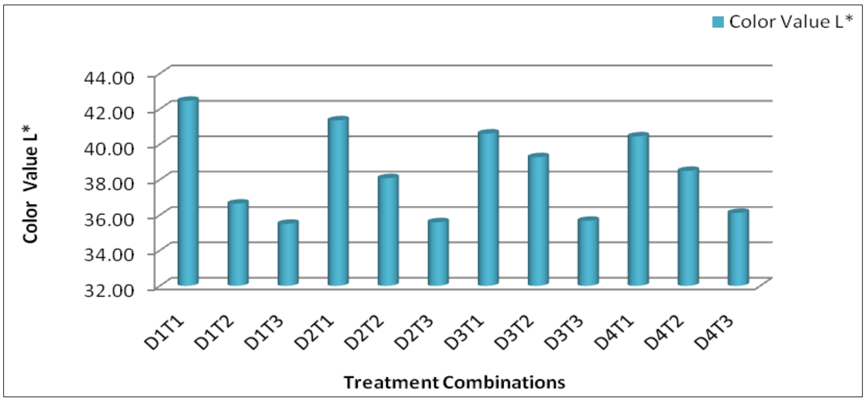

Fig 5: Variations in color value L* during tray drying at different temp. and thickness

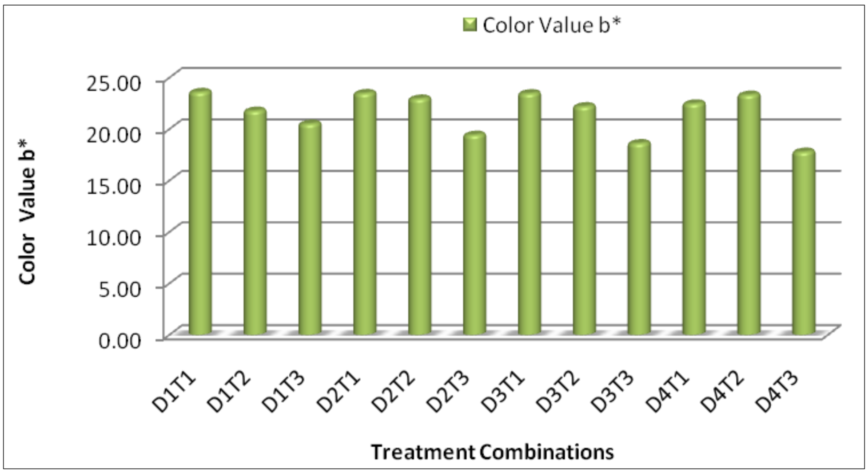

Fig 6: Variations in color value b* during tray drying at different temp. and thickness

Effect on Textural Properties of Mango Leather

Cutting Force: Cutting force of mango leather varied from 11.57 to 32.807 N. It was observed from Table 8 that drying temperature and thickness of pulp had significant effect ($P<0.05$) on cutting force. Moreover, interaction of drying temperature and thickness of pulp was also found significant. More cutting force was required for higher thickness of product. At higher temperature, product was dried faster resulted in more cutting force (Fig. 7). Similar findings for increase in cutting force at higher temperature were reported by Vijayanand *et al.*, (2000) for guava and mango bars and Housalmal (2018) [6] for foam mat dried mango leather.

Stretchability: Stretchability of mango leather varied from -10.790 to -32.253 N. It was observed from Table 9 that drying temperature and thickness of pulp had significant effect ($p<0.05$) on stretchability. Moreover, the interaction of drying temperature and thickness of pulp was also found significant. Stretchability increases with increase in temperature and thickness (Fig. 8). More stretchability was found at higher temperature due to the spontaneous exudation of fluid from a gel (syneresis) caused by excess of acid and gelatinization of sugar (Srivastava and Sanjeev, 2006; Jethva *et al.*, 2021) [7] for sun dried mango leather. Usually, consumers prefer more chewable product.

Table 8: Mean Value of cutting force of tray dried protein fortified mango leather

	T1	T2	T3	Mean T
D1	11.570	20.587	23.327	18.494
D2	15.433	21.620	24.247	20.433
D3	19.457	22.807	24.500	22.254
D4	21.410	25.627	32.807	26.614
Mean D	16.968	22.660	26.220	
	D	T		D X T
SEM	0.405	0.351		0.702
CD (0.05)	1.183	1.024		2.049
CV%	5.54			

Table 9: Mean Value of stretchability of tray dried protein fortified mango leather

	T1	T2	T3	Mean T
D1	-10.790	-18.710	-24.407	-17.969
D2	-13.613	-20.620	-26.877	-20.370
D3	-19.750	-22.830	-28.853	-23.811
D4	-21.307	-32.253	-25.373	-26.311
Mean D	-16.365	-23.603	-26.378	
	D	T		D X T
SEM	0.422	0.365		0.731
CD (0.05)	1.231	1.066		2.132
CV%	5.72			

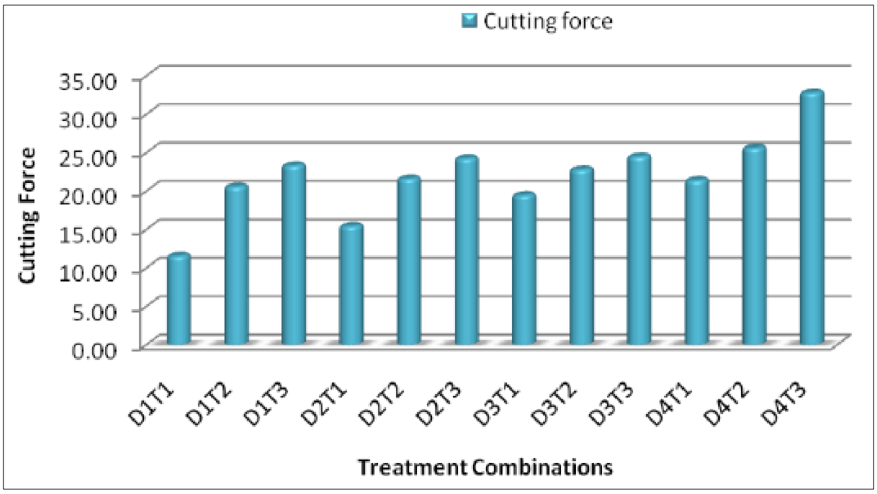

Fig 7: Variations in cutting force during tray drying at different temp. and thickness

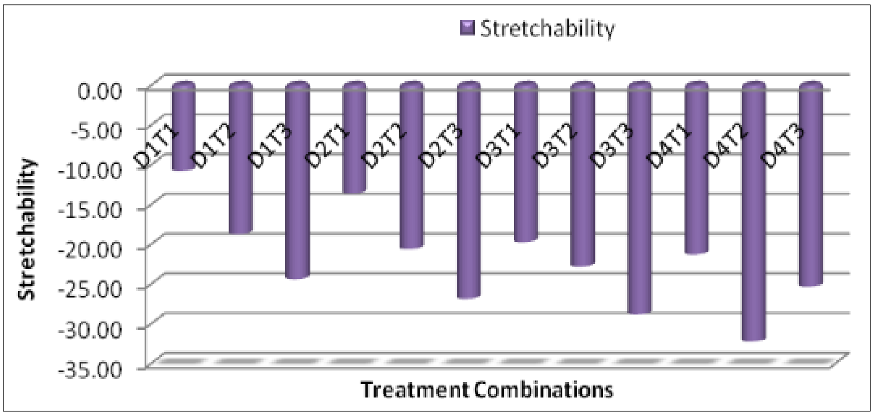

Fig 8: Variations in stretchability during tray drying at different temp. and thickness

Standardization of drying parameters for production of protein fortified mango leather: Drying parameters (like temperature and thickness of pulp) of mango leather was optimized by considering sensory score values in terms of overall acceptability and protein content.

Table 9: Optimum values of drying parameters

Combination		Based on highest overall l acceptability and protein content
Drying Parameters	Temperature (°C)	65
	Thickness of pulp(mm)	5
Responses	Overall acceptability	8.69
	Protein content(g/100g)	11.36

Sensory score in term of overall acceptability is the main criteria for development of any new product. It was observed from the above Table 9 that highest value of overall acceptability 8.69 was found for D_4T_2 combination (65 ºC temperature and 5 mm thickness). Mango leather having highest protein content was selected for optimization which was found in D_4T_2 combination (11.36%).

Conclusion
Drying temperature and thickness had significant effect on protein content, overall acceptability and ascorbic acid of protein fortified mango leather. Optimum values of overall acceptability (8.69), protein content (11.36%) and ascorbic acid (56.65%) was found at drying temperature of 65 °C and 5 mm of thickness of pulp for production of tray dried protein fortified mango leather with maximum retention of physico-chemical qualities.

References

1. Ahmad S, Vashney AK, Srivastava PK. Quality attributes of fruit bar made from papaya and tomato by incorporating hydrocolloids. Int. J Food Prop. 2005;8(1):89-99.
2. Bhutani A. Whey protein- Nutritional powerhouse for sports persons. Indian Food Ind. 2010;29:46-47.
3. Burrington K. Whey ingredients in nutrition bars and gels. U. S. Dairy Council. 2012:1-8.
4. Chauhan N. Development of fortified mixed fruit bar using whey protein concentrate. [Master Thesis]. University of Anand Agricultural, Anand. Retrieved from krishikosh.egranth.ac.in/bitstream/1/5810002111/1/NIRALI%20PDF-FINAL.pdf. 2013.
5. Food Safety and Standards Act. 2011. Retrieved from https://www.fssai.gov.in/cms/food-safety-and-standards-act-2006.php
6. Housalmal SS. Optimization of process for production of kesar mango leather using foam mat drying technique. [Doctorate Thesis]. Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Retrieved from krishikosh.egranth.ac.in/handle/1/5810040954. 2018.
7. Jethva KR, Sutar RF, Kumar N, Vyas DK. Effect of whey protein on sun dried protein-enriched kesar mango leather. J Pharmacogn Phytochem. 2021;10(2):824-830.
8. Mir MA, Nath N. Storage changes in fortified mango bars. J Food Sci Technol. 1993;30:279-282.
9. Pramanik WK, Sengupta JP. A preliminary study of composition of mango sheets. Inst Chemists. 1978;50:25-26.
10. Rajkumar P, Kailappan R, Viswanathan R, Raghavan GSV, Ratti C. Foam mat drying of alphonso mango pulp. Drying Technol. 2007;25(2):357-365.
11. Srivastava RP, Sanjeev K. Fruit & Vegetable Preservation, Principles and Practices. USA: Oxford and IBH Publishers. 2006.
12. Vijayanand P, Yadav AR, Balasubramanyam N, Narasimham P. Storage stability of guava fruit bar prepared using a new process. Lebensmittel-Wissenschaft & Technology. 2000;33:132–137.