International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 17, 2018, pp.-7115-7118
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

EFFECT OF FOOD ADDITIVES IN EXTENDING SHELF LIFE OF MANGO WASTES FOR UTILIZATION AS SECONDARY RESOURCE OF FOOD FORTIFICANTS

GURUMEENAKSHI G.*[1], VARADHARAJU N.[2] AND RAJESWARI R.[3]
[1,3]Centre for Post-Harvest Technology, Agricultural Engineering College & Research Institute, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu, India
[2]Dean, Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu, India
*Corresponding Author: Email- gurumeenakshi@rediffmail.com

Received: September 01, 2018; Revised: September 11, 2018; Accepted: September 12, 2018; Published: September 15, 2018

Abstract: The available amount of β carotene in one tonne of the mango waste is approximately 3 Kg. But the shelf life of Mango wastes is not less than 48 h. Even if the mango processing industry is involved in simultaneous use of the mango waste, a concentrated effort of it does not occur. Industries divert the work only on production of products as the fruit is seasonal and less importance is given for wastes. Hence, technology for storing the mango wastes, so that it can be used as a secondary resource for product development is the need of the hour. The mango peel and pomace were individually ground to fine pastes. To the paste varying levels of citric acid (0.25 to 2.0 %) and KMS (0.01 to 0.05 %) was added. The mango peel and the pomace with the food additives were packed in three different packaging materials *viz*., PET bottles, Polypropylene covers and Metallised Polypropylene covers and stored in cool, dark condition for shelf life studies. The study revealed that Mango peel and Pomace paste with the addition of 2 % Citric acid and 0.05 % KMS gave the maximum shelf life of 80 -90 days without any change in colour and texture. There was also no loss of b carotene upon storage. It was highly suitable for further extraction of b carotene from the wastes.

Keywords: Mango peel, Pomace, Additives, Citric acid, Packaging material, B carotene

Citation: Gurumeenakshi G., *et al*. (2018) Effect of Food Additives in Extending Shelf Life of Mango Wastes for Utilization as Secondary Resource of Food Fortificants. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 17, pp.- 7115-7118.

Introduction

Vitamin A, once perceived as relating only to vision, is now understood to have a far more important function relating to the body's immune response. Children who are Vitamin A deficient are at risk of increased morbidity, and, as a result, at far greater risk of child mortality and this continue to be a public health problem in India. In Tamil Nadu, Dharmapuri and Krishnagiri is the Mango processing belt. There are about 75 industries with a turn over Rs. 10 crore in these two areas. The major activities of these industries are canning of Mango pulp for export. The peak season of the factories are from March – August, where in the units functions in two shifts. On an average 13,500 tonnes of mango wastes is produced in the state in a year which of vitamin A from the wastes. The available amount of β carotene in one tonne of the mango waste is approximately 3 Kg. The total β carotene available from 13,500 tonnes is 40,500 Kg. If the available β carotene in the mango wastes is efficiently extracted and encapsulated would yield (70 % efficiency) it would provide 28350 Kg from 13,500 tonnes. The recommended dietary allowance of β carotene for children in 2400 µg per day, which accounts for 0.876 g in a year. So the β carotene extracted from mango wastes can meet the RDA of 32 million children. The Govt of India had spent an additional amount of Rs. 48 crores in the India Micro nutrient national investment plan (2007 - 2011) to eliminate Vitamin A deficiency, in 11,853,054 children in the state of Bihar alone and every year the cost incurred on elimination of micronutrient deficiency is increasing. Utilizing the mango waste by extracting the valuable components from it will not only save the cost incurred but also address the micronutrient deficiency and environmental pollution.

Materials and Method

Selection of Mango Processing Industry

The mango pulp industry in Krishnagiri and Dharmapuri district of Tamil Nadu are the second largest exporter of pulp in the country, after Chittoor in Andhra Pradesh. There are about 75 industries with a turnover of Rs. 10 crore in these two areas. The major activities of these industries are canning of mango pulp for export. The peak season of the factories is from March to August, where in the unit functions in two shifts. Export of mango pulp is the most promising venture of mango processing industries. The industry selected for the study was M/S Paiyur food products, one of the leading Mango Pulp, Concentrate and other Processed Fruit Pulp Manufacturer in Krishnagiri, Tamilnadu, India.

Selection of Variety

Several varieties of mango are grown in India, which include Banganapalli, Suvarnarekha, Neelum, Totapuri, Kesar, Alphonso, Rajapuri, Jamadar, Chausa, Dashehari, Fazli, Gulabkhas, KishenBhog, Himsagar, Zardalu and Langra. For this study Alphonso and Totapuri has been selected.

Collection of Sample

After pulp extraction from fruit (mesocarp part), peel, pomace and kernel are discarded as waste and becoming a source of pollution and hence these were collected and used for the study.

Proximate Analysis of the Fresh Peel and Pomace

Fresh mango peel contains significant amount of moisture and are rich in pectin, cellulose, hemicelluloses, lipids, proteins, polyphenols and carotenoids. In general, the level of reducing sugars, non - reducing sugars, protein and cellulose varies depending on cultivar. The freshly collected peel and pomace were analyzed for the following qualities as given in [Table-1]

Table-1 *Proximate analysis*

SN	Chemical constituents	Method adopted
1	Moisture (%)	Hot air oven
2	Total Soluble Solids (°B)	Refractometer
3	Acidity (g)	Titration
4	Reducing sugars (g)	Shaffer somogyi
5	Non reducing sugars (g)	Shaffer somogyi
6	β carotene (µg)	Colorimetric
7	Cellulose and lignin (µg)	Acid and alkali titration

Microbiological Examination of the Fresh Peel and Pomace

The microbial loads of the samples were enumerated by the method described by Istavankiss (1984). The total plate count, bacterial and fungal count were analysed.

Sensory quality of Fresh Peel and Pomace

The quality parameters like color, flavor, texture, taste and overall acceptability of the fresh samples were organoleptically evaluated using 9 - point hedonic scale by a panel of 15 semi trained judge.

Extension Of Shelf Life Of Mango Wastes

After processing the mango waste storage for preserving quality is potentially problematic, and therefore they are forced to discard it. Attempts were made to increase the shelf life of the mango peel and pomace by giving the following treatments as furnished in [Table-2]

Table-2 *Treatments for extension of shelf life of mango wastes*

Variety	Treatment (%)			
	$T_{0\ (Control)}$	T_1	T_2	T3
Alphonso (V1) (Peel/ Pulversed peel/ pomace)	-	Citric acid (0.5 to 2 %)	KMS (0.01 to 0.05 %)	Citric acid + KMS (0.5 to 2 %) + (0.01 to 0.05 %)
Totapuri (V2)	-	Citric acid (0.5 to 2 %)	KMS (0.01 to 0.05 %)	Citric acid + KMS (0.5 to 2 %) +(0.01 to 0.05%)

The collected mango wastes were classified as mango peel and mango pomace from both the varieties. For T1, citric acid was added from 0.25,0.5, 1.0,1.5 and 2 % per Kg of the mango peel and mango pomace individually. Apart from this mango peel was pulverized and to it citric acid (0.5 to 2 %) was added. Similarly for T2 KMS (Potassium Meta bi sulphite) was added from 0.01 to 0.05 % per Kg of the mango peel and mango pomace individually. Apart from this mango peel was pulverized and to it KMS (0.01 to 0.05 %) was added. T3 had both the food additives *viz.*, Citric acid + KMS in the proportion (0.25 +0.01 %, 0.5 +0.02 %, 1.0 +0.03 %, 1.5 +0.04 % and 2.0 + 0.05 %) respectively. This was added to 1.0 kg of mango peel and mango pomace individually. Apart from this mango peel was pulverized and to it also Citric acid + KMS in the proportion (0.25 +0.01 %, 0.5 +0.02 %, 1.0 +0.03 %, 1.5 +0.04 % and 2.0 + 0.05 %) was added. The samples without any additives served as control. The control and treated samples were than packed in Poly propylene (P1), Metallised polypropylene (p2) and PET bottles (p3) and kept under refrigerated conditions for shelf life studies. The stored product were studied for proximate analysis, microbial and sensory studies.

Results and Discussion

The wastage from the mango industry was evaluated and is presented in the [Table-3]

Table-3 *Wastage from Mango Industries*

Description	Percentage	Wastage in Kgs
Unloading wastage	1	1
Ripening fruit weight loss	15	14.9
Fruit damages in the ripening chamber	8	6.7
Tip removal wastage	2	1.5
Peel and stone removal (de - stoning)	15	11.4
Fibres and small peel (pulping)	14.5	9.4
De-canter / Separator wastage	1	0.6
Processing wastage	1	0.5
Total wastage out of 100 kg		46.0

Proportion of Mango pulp, Peel and Pomace in Alphonso and Totapuri

After pulp extraction from fruit, the peel and pomace are discarded as waste and they account for 35 to 55 percent of the fruit. The percentage of different components obtained during mango pulp extraction are mango pulp (45-65%), peel (15-20%), pulpier waste (15-20%) and stone (10-20%) depending on the variety. The different components obtained during the mango processing are presented in [Table-4]

Table-4 *Proportion of Mango Peel, Pulp and Pomace*

SN	Variety	Proportion	Weight (g)	%
1	Totapuri	Mango	165.4	100
		Peel	28.118	17
		Pomace	24.81	15
		pulp	112.472	68
		Overall	165.4	100
2	Alphonso	Mango	187.7	100
		Peel	28.155	15
		Pomace	30.032	16
		pulp	129.513	69
		Overall	187.7	100

After pulp extraction from fruit, the percentage of peel and pomace in both the variety accounted for 15 to 16 percent and the pulp was ranging from 68 to 69 percent. The pomace was more in Alphonso compared to Totapuri, which might be due to a varietal difference.

Proximate Analysis of the Fresh Peel and Pomace

Fresh mango peel contains significant amount of moisture and are rich in pectin, cellulose, hemicelluloses, lipids, proteins, polyphenols and carotenoids. In general, the level of reducing sugars, non - reducing sugars, protein and cellulose varies depending on cultivar. The freshly collected peel and pomace were analyzed for the following qualities and are furnished in the [Table-5].

Table-5 *Proximate Analysis of the Fresh Peel and Pomace*

SN	Chemical constituents	Method adopted	Alphonso		Totapuri	
			Peel	Pomace	Peel	Pomace
1	Moisture (%)	Hot air oven	72	80	70	82
2	Total Soluble Solids (°B)	Refractometer	23	26	20	25
3	Acidity (g)	Titration	4.3	4.1	4.0	4.2
4	Reducing sugars (g)	Shaffer somogyi	8	10	7	9
5	Non reducing sugars (g)	Shaffer somogyi	4	5	3	4
6	β carotene (µg)	Colorimetric	274	214	263	205
7	Cellulose and lignin (µg)	Acid and alkali titration	26	28	26	28

From the table it could be seen that, the moisture content ranged from 70 - 85 percent, TSS 20 - 270 bx, acidity 4.0 - 4.4 percent, reducing sugars 7 - 12 g, non reducing sugars 3 to 6 g per 100 g respectively. The β carotene content of the fresh mango peel ranged between 274 - 286 µg, while that of the pomace ranged between 214 - 233 µg per 100 g.

Microbiological Examination of the Fresh Peel and Pomace

The microbial loads of the samples were enumerated by the method described by Istavankiss (1984).

Table-6 *Microbial quality of the Fresh Peel and Pomace*

Variety	Proportion	Total plate count (10^6/ cfu/ g)	Fungi 10^3 Cfu/g	Yeast 10^2 cfu/g
Alphonsa	Peel	1.0	0	0
	Pomace	1.0	0	0
Totapuri	Peel	1.0	0	0
	Pomace	1.0	0	0

From the table it could be inferred that, there was a minimum total plate count, while the fungi and yeast were below detectable level. This ensured that the product is safe for further utilization.

Sensory quality of Fresh Peel and Pomace

The quality parameters like color, flavor, texture, taste and overall acceptability of the fresh samples were organoleptically evaluated using 9 - point hedonic scale by a panel of 15 semi trained judge and the results are presented in [Table-7].

Table-7 *Sensory quality of the Fresh Peel and Pomace*

Variety	Proportion	Sensory Attributes				
		Color and Appearance	Flavor	Texture	Taste	Overall Acceptability
Alphonso	Peel	8.5	8.7	8.5	8.8	8.8
	Pomace	8.7	8.8	8.7	8.9	8.9
Totapuri	Peel	8.3	8.4	8.3	8.6	8.6
	Pomace	8.5	8.5	8.3	8.6	8.6

The colour and appearance of the peel and pomace of both the varieties were highly acceptable as it is evident from the table above. The results also indicated that there was no off flavor or a bitter taste in the peel and pomace. The texture was not very slimy in the peel and the pomace was not extremely coarse. Though both the variety has scored good overall acceptability level Totapuri variety ranks first due to its sweeter taste compared to Alphonso variety. The results established that the peel and pomace though considered as waste by the industry had highly acceptable sensory qualities.

Table-8 *Storage life of samples under different treatments in MPP covers*

Proportion	Treatment	Storage days (90 days)-MPP covers	
		Alphonso	Totapuri
Mango peel	T_0	1	2
	T_{1a}	10	12
	T_{1b}	12	14
	T_{1c}	14	16
	T_{1d}	16	18
	T_{1e}	17	20
	T_{2a}	21	23
	T_{2b}	23	25
	T_{2c}	24	27
	T_{2d}	26	29
	T_{2e}	28	31
	T_{3a}	30	32
	T_{3b}	31	33
	T_{3c}	33	34
	T_{3d}	34	36
	T_{3e}	35	37
Pulverised peel	T_0	4	6
	T_{1a}	36	37
	T_{1b}	37	39
	T_{1c}	39	41
	T_{1d}	40	42
	T_{1e}	42	44
	T_{2a}	46	48
	T_{2b}	48	49
	T_{2c}	49	52
	T_{2d}	51	53
	T_{2e}	53	55
	T_{3a}	62	65
	T_{3b}	64	66
	T_{3c}	65	68
	T_{3d}	68	70
	T_{3e}	70	73
Pomace	T_0	5	7
	T_{1a}	21	25
	T_{1b}	22	23
	T_{1c}	24	26
	T_{1d}	25	29
	T_{1e}	27	33
	T_{2a}	52	54
	T_{2b}	54	56
	T_{2c}	56	58
	T_{2d}	58	62
	T_{2e}	60	68
	T_{3a}	72	75
	T_{3b}	80	82
	T_{3c}	80	82
	T_{3d}	82	84
	T_{3e}	83	87

Shelf life study of mango peel and pomace

The samples under different treatments and packaging material were subjected to shelf life studies under refrigerated conditions. The study indicated that the samples stored in Metallised polypropylene packs had the highest shelf life comparatively. The shelf life of the samples in MPP covers under different treatments is furnished in the [Table-8]. From the above table, it could be inferred that T3E samples had the maximum shelflife upon storage. Hence these samples alone were taken for further quality analysis.

Proximate Analysis of Stored Mango Peel and Pomace

The proximate analysis of the stored mangopeel, pulverized peel and pomace with the additive citric acid (2 %) and KMS (0.05%) was analysed and presented in the [Table-9]. From the table it could be inferred that, there was a significant difference in the proximate contents of the samples of control and treatment. The control samples had the maximum moisture and acidity while the TSS, reducing and total sugars and b carotene were very low compared to the control. The treated samples had retained the quality even after 80 days of the storage with the maximum b carotene content. This indicated that, the mango peel, pulverized peel and pomace can be stored up to 80 days in Metallised polypropylene packs in refrigerated condition.

Microbiological Examination of the Stored Peel and Pomace

The microbiological examination of the stored peel and pomace were done and it is depicted in [Table-10]. The table shows that the control samples had recorded the highest growth of microorganisms *viz*., the total plate count, bacteria and fungi. The treated sample had the minimal growth with no fungal attack.

Sensory quality of the Stored Peel and Pomace

Similar to the fresh samples the sensory quality for the stored peel and pomace was also assessed and it is displayed in [Table-11]. The addition of preservatives during the storage period has prevented the browning of the peel and pomace and resembled as the fresh sample. Therefore, the sample scored the similar value to that of the fresh sample. Similarly, the scores for texture, taste, flavor and overall quality were equal to the scores of the fresh samples. On the contrary the control samples were highly unacceptable in terms of colour, texture, flavor, taste and overall quality.

Conclusion

Several varieties of mango are grown in India, out of which alphonso and totapuri variety has been selected for the study. The percentage of peel and pomace in both the variety accounted for 15 to 16 percent and the pulp was ranging from 68 to 69 percent. The β carotene content of the fresh mango peel ranged between 2.74 – 2.86 mg, while that of the pomace ranged between 2.14 – 2.33 mg per Kg. Minimum total plate count and below detectable level of fungi and yeast was found in both fresh and stored mango waste and that ensures the product is safe for utilization. The fresh and stored peel and pomace though considered as waste by the industry had highly acceptable sensory qualities. The usual shelf life of mango peel is only one day under ambient conditions. Storing of the samples with addition of 2.0 % citric acid + 0.05 % KMS has extended the shelf life of the mango peel, pulverized peel and pomace to more than 70 days. The most suitable packaging material was Metallised Polypropylene covers under refrigerated conditions.

Application of research: The stored sample had retained the proximate composition with low microbial load and high snsory qualities. Extending the shelf life of mango waste will pave way for its utilization as a secondary resource for extraction of b carotene and fibre that can be used as food fortificants and development of functional foods.

Research Category: Food Technology

Acknowledgement/Funding: Author thankful to Indian Council of Agricultural Research, New Delhi for funding the research. Author also thankful to Agricultural Engineering College & Research Institute, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu, India

Table-9 Proximate Analysis of Stored Mango Peel and Pomace per 100g

SN	Component	Alphonso			Totapuri		
		Peel	Pulverised peel	Pomace	Peel	Pulverised peel	Pomace
1	Moisture (%)						
	T_0	83	89	94	89	92	96
	T_{3e}	67	71	72	65	68	70
2	Total Soluble Solids (° B)						
	T_0	5	6	10	3	5	8
	T_{3e}	20	22	27	18	20	25
3	Acidity (%)						
	T_0	4.3	4.5	4.1	3.2	3.5	3.7
	T_{3e}	2	2.2	1.8	1.6	1.8	2
4	Reducing sugars (g/100g)						
	T_0	2	3	6	2	2	3
	T_{3e}	15	17	22	13	15	17
5	Non reducing sugars(g/100g)						
	T_0	1	1	2	1	1	2
	T_{3e}	3	3	4	2	3	4
6	β carotene (µg)						
	T_0	23	36	44	32	48	57
	T_{3e}	270	279	211	283	286	230

Table-10 Microbiological Examination of the Stored Peel and Pomace

SN	Component	Alphonso			Totapuri		
		Peel	Pulverised peel	Pomace	Peel	Pulverised peel	Pomace
1	Total Plate count						
	T_0	7	8	6	8	9	11
	T_{3e}	1	1	0	1	1	0
2	Bacteria						
	T_0	6	7	5	6	7	6
	T_{3e}	1	1	0	1	1	0
3	Fungi						
	T_0	1	2	2	2	2	2
	T_{3e}	0	0	0	0	0	0

Total plate count – 10^6, Fungi 10^3 and Yeast 10_2 cfu/g

Table-11 Sensory quality of the Stored Peel and Pomace

SN	Component	Alphonso			Totapuri		
		Peel	Pulverised peel	Pomace	Peel	Pulverised peel	Pomace
1	Colour & appearance						
	T_0	2	2	3	1.5	2	2
	T_{3e}	8.5	8.5	8.7	8.3	8.3	8.5
2	Flavour						
	T_0	2	2	2	1	1	1
	T_{3e}	8.7	8.8	8.8	8.4	8.5	8.5
3	Texture						
	T_0	1	1	1	1	1	1
	T_{3e}	8.5	8.6	8.7	8.3	8.5	8.3
4	Taste						
	T_0	0	0	0	0	0	0
	T_{3e}	8.8	8.8	8.9	8.6	8.6	8.6
5	Overall acceptability						
	T_0	1	1	1	0	0	0
	T_{3e}	8.8	8.8	8.9	8.6	8.6	8.6

***Principle Investigator: Dr G. Gurumeenakshi,**
***Co-Principle Investigator: Dr N. Varadharaju**
University: Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu
Research project name or number: ICAR –EMF Project on "Conversion of Mango fruit waste in to fortifying agent for functional foods", AEC & RI, TNAU, Coimbatore

Author Contributions: All author equally contributed

Author statement: All authors read, reviewed, agree and approved the final manuscript

Conflict of Interest: None declared
Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

References

[1] AOAC. (2000) *Official Method of Analysis. 17th edition. Association of Official Analytical Chemists. Maryland*.
[2] Government of India. (2017) *Nourishing India: National Nutrition Strategy. Niti Aayog*
[3] Gopalan C., Ramasastri B.V. and Balsubramaniyan S.C. (2004) *Nutritive value of Indian Foods. National Institute of Nutrition. Hyderabad. India,* 20-50.
[4] Ranganna S. (1995) *Manual of analysis of fruits and vegetable products. Tata Mc Graw Hill Publishing Co., Ltd., New Delhi*, 71.
[5] Rangaswamy R. (1995) *Randomized Complete Block Design. A Text book of Agricultural Statistics. New Age International Publishers, New Delhi,* 281.
[6] Watts B.M., Ylimaki G.L., Jeffery L.E. & Elias L.G. (1989) *Basic Sensory Methods for Food Evaluation. Ottawa, Ontario (Canada): International Development Research Centre*