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Studies on physico-chemical properties of noni fruit (*Morinda citrifolia*) blended jam

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Abstract

Noni fruit has a long history of use as food in tropical regions throughout the world. It is a rich source of antioxidant, vitamin C and various phytochemicals. The present investigation was envisioned to juice was extracted from noni fruit by hot and cold processing methods at varying temperature and time. The optimum proportion of the fruits in preparing blended jam to suit the consumers were found as a) Noni: Amala -60:40 b) Noni: Sathukkudi 70:30 and c) Noni: Orange -80-20. Each blended jam and the control sample (100% noni) was prepared in large scale and packed individually in two types of containers such as and Glass bottle (P₁) PET bottle (P₂). All the blended jam along with the control were stored in room temperature for a period of 90 days to study their storage stability. The nutrient content of the freshly prepared noni fruit juice blended jam had more or less similar TSS – 68 and 68.5°brix and other constituents ranged from acidity - 1.18 to 1.02 percent, pH – 3.31 to 4.52 and 3.23 to 3.24, reducing sugar – 6.06 to 8.26 g/100 g, total sugar – 58.30 to 57.60 g/100 g, ascorbic acid – 18.76 to 16.21 and 20.63 to 19.44 mg/100 g, tannin – 0.716 to 0.611 percent tannic acid, non-enzymatic browning – 0.208 to 0.259 and 0.265 to 0.312 absorbance respectively. From the observation that a slight reduction in the moisture, acidity, total sugar tannin and vitamin C whereas increasing trend in TSS, pH, reducing sugar, non-enzymatic browning of the jam during storage irrespective of the packaging materials. The consumer acceptability scores were gradually decreased during storage in all the stored products. This blended jam from noni fruits as new food products will definitely attract the consumers and have high potential for commercialization and marketability.

Keywords: Noni fruit, blended jam, physico-chemical properties, sensory evaluation, shelf life

Introduction

In India this plant is known as Indian Mulberry or Nuna whereas in Hawalli it is known as Noni. The Noni plant is a small evergreen tree found growing in open coastal regions at sea level and in forest areas up to about 1300 feet above sea level [1]. The plant is often found growing along lava flows. It's identifiable by its straight trunk, large, bright green and elliptical leaves, white tubular flowers, and its distinctive, ovoid, "grenade-like" yellow fruit. The fruit can grow in size up to 12 cm or more and has a lumpy surface covered by polygonal-shaped sections. The seeds which are triangular shaped and reddish brown, have an air sac attached at one end, which makes the seeds buoyant. This could explain, in part, the wide distribution of the plant throughout the Polynesian islands. The mature Noni fruit has a foul taste and odour [14].

Noni (*Morinda citrifolia*, L.) popularly known as Indian Noni or Indian mulberry is grown in Andaman and Nicobar by tribes. Noni fruits were traditionally being utilized as food and medicine. In the main land of India it is found along the coastal areas of Kerala, Karnataka, Tamil Nadu and many other places. Noni is termed as "Ayushka" (meaning "longevity") in ancient Indian practice Ayurveda [2]. Traditionally it is being known by various names under different locations including Baratundi (Maharashtra), Nuna WNRF Technical Bulletin: 172 or Manjanathi (Tamil Nadu), Bandamaddi (Andhra Pradesh), etc. It is also called as Indian Mulberry. Noni juice is in high demand in alternative medicine for different kinds of illnesses such as arthritis, diabetes, high blood pressure, muscle aches and pains, menstrual difficulties, headaches, heart disease, AIDS, cancers, gastric ulcer, sprains, mental depression, senility, poor digestion, arteriosclerosis, blood vessel problems, and drug addiction [3].

The noni fruit is a multiple fruit that has a pungent odour when ripening, and hence also known as cheese fruit or even vomit fruit. Despite its strong smell and bitter taste, the fruit is nevertheless eaten as a famine food [4].

It is due to the presence of high concentration of major volatile compounds octanoic, hexanoic acid and 3-methyl-3buten-1-ol [5]. Hence, it is a challenging task to prepare food products from noni juice and jam with sensory acceptability. Due to these reasons, blending of two or more fruit juices or pulp and their jam with the addition of noni juice are thought to be a convenient alternative for its utilization in order to have value added fruit product which are of high quality in respect of both sensory and nutritional aspects. In the present study squash was prepared with blending of noni fruit jam with other fruit jam to reduce the unpleasant flavour and further improve the nutritional characteristics of the developed blended product were also evaluated [15].

Materials and Methods

Raw materials

Fully mature, noni fruit (*Morinda citrifolia L.*) was purchased from Horticultural College and Research Institute, Periyakulam, Tamil Nadu, India and brought to the working spot in a well cushioned container. Fully mature ripe orange, amla and sathukudi were purchased from the local market in Madurai city, Tamil Nadu.

Methods

Extraction of noni juice

The extraction of noni juice was commercially produced by the natural fermentation process process using drip extraction

method (traditional method) as described by Nelson (2003) [15]. The ripened fruit was packed into a food grade air tight container for the period of 4 to 8 weeks. The juice seeps out of the fruit was decanted from the container after 8 weeks, filtered and bottled. This aging process is imple but time consuming and the colour of the juice wa black in colour. The fruit was often subjected to intense light and temperature in the tropics, resulting in the breakdown of phytochemicals and nutrient.

Physico-chemical analysis

The proximate compositions of noni fruit blended jam were done for different parameters. Hand refractometer ranged from 0 to 45° brix was used to measure the total soluble solids. Total acidity was determined as per the method described [6]. The pH of the sample was estimated by the method described by [7]. Shaffer Somogyi micro method was followed for the estimation of reducing sugar and total sugar content [8]. The 2, 6- dichlorophenol-indophenol titration method was used for the estimation of ascorbic acid content [6]. The tannin content was determined using on ultra violet-visible recording spectrophotometer at 700 nm (Systronics - Model 2201, India) as per the standard method described by [9]. The non-enzymatic browning was measured as per the standard procedure described by [6], spectrophotometrically at 440 nm.

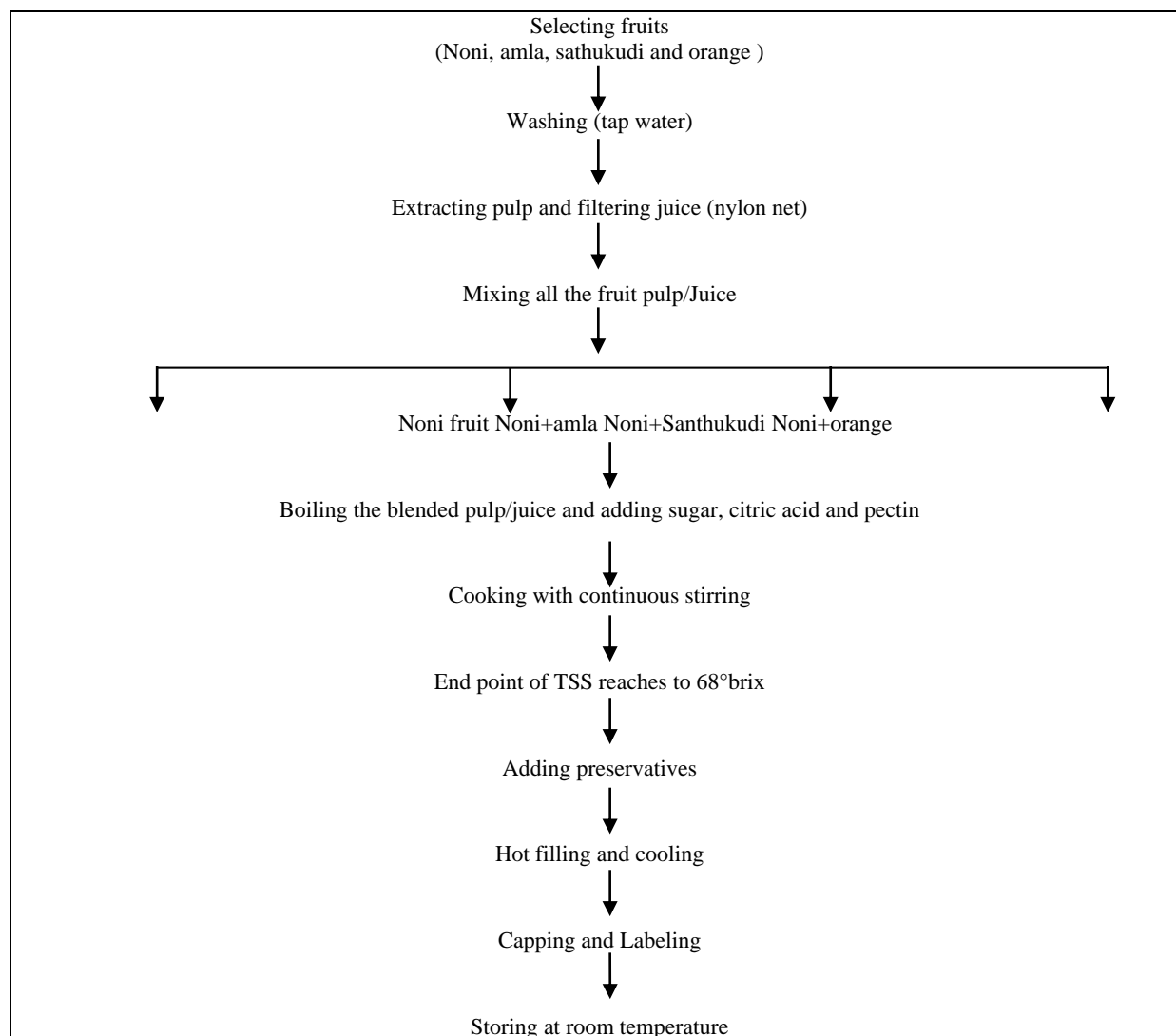


Fig 1: Preparation of jam from noni fruit blended with other fruit

Organoleptic evaluation

The developed noni fruit blended jam was evaluated for organoleptic characteristics namely colour, appearance, flavour, texture, taste and overall acceptability by using score card with nine point hedonic rating scale [9-11].

Statistical analysis

The data obtained from the various experiments were subjected to statistical analysis to find out the impact of storage condition used and storage period. Factorial Completely Randomized Design (FCRD) was applied for the analysis of the study as described [10].

Processing of noni fruit blended jam

The noni fruit blended jam was prepared by using the fruits of amla, sathukkudi and orange. The optimum proportion of the fruits in preparing blended jam to suit the consumers were found as a) Noni: Amala -60:40 b) Noni: Sathukkudi 70:30 and c) Noni: Orange -80:20. Each blended jam and the control sample (100% noni) was prepared in large scale and packed individually in two types of containers such as and Glass bottle (P₁) PET bottle (P₂).

All the blended jam along with the control were stored in room temperature for a period of 90 days to study their storage stability. The observations viz., chemical, microbiological and organoleptic evaluation were analyzed periodically (once in 30 days) throughout the study period for in all the stored samples selected for the study.

Results and Discussion

Chemical changes of the noni fruit blended jam

The chemical constituents such as pH, acid content, TSS, total sugar, reducing sugar, ascorbic acid, tannin, non-enzymatic browning, of all the prepared jam stored in different containers were analyzed at regular intervals (once in 30 days) during the study of 90 days and the results were tabulated.

pH

The changes noted in the pH among the jam during storage packed in P₁ and P₂ stored at room temperature was presented in Table 1. As the pH of the samples was found to be increased. The initial pH of N, NA, NS and NO was ranges in

2.31, 4.31, 3.23 and 3.42 whereas the final pH was noted as 3.43 in N, 4.43 in NA, 3.45 in NS and 3.54 in NO packed in P₁. The corresponding values were 3.49, 4.43, 3.52 and 3.58 for N, NA, NS and NO respectively packed in P₂ stored at room temperature.

Table 1: Changes in pH contents of jam from noni fruit blended with other fruits

Storage period (days)	Glass Container (P ₁)				Pet Bottle (P ₂)			
	C ₀ P ₁	C ₁ P ₁	C ₂ P ₁	C ₃ P ₁	C ₀ P ₂	C ₁ P ₂	C ₂ P ₂	C ₃ P ₂
0	3.31	4.31	3.32	3.42	3.31	4.31	3.32	3.42
30	3.36	4.38	3.40	3.49	3.31	4.33	3.29	3.49
60	3.48	4.43	3.47	3.53	3.36	4.38	3.36	3.51
90	3.49	4.52	3.58	3.72	3.43	4.43	3.45	3.54

Glass container- P₁

Pet bottle - P₂

SED	CD (0.05)	C ₀ P ₁	-	Noni Control
0.307459	0.576*	C ₁ P ₁	-	Noni + Amla
1.126039	0.953**	C ₂ P ₁	-	Noni + Sathukkudi
0.444525	0.892**	C ₃ P ₁	-	Noni + Orange
0.639228	0.613**	C ₀ P ₂	-	Noni Control
0.127850	0.946**	C ₁ P ₂	-	Noni + Amla
0.132708	0.341	C ₂ P ₂	-	Noni + Sathukkudi
0.091279	0.613**	C ₃ P ₂	-	Noni + Orange
0.922960	0.405			

Statistical analysis of the data revealed that a significant difference in the jam was observed between the samples packaging materials and in the periods of storage.

Acidity

The acid content was decreased in all the samples in both the storage containers as the storage period increased (Table 2). The noni jam (N) showed an decreased acidity from 1.18 percent to 1.04 percent stored in glass bottles (P₁) and 1.02 percent in PET bottles (P₂) at the end of the storage period at room temperature.

In all the blended jam a gradual decrease in their acid content was observed throughout the storage period in glass and Pet bottles. The values noted were for 0 to 90 days ranged from 1.42 – 1.29 (NA), 1.39 – 1.28 (NS) and 1.64 – 1.21 (NO) percent in P₁ and 1.18 – 1.04 (NA), 1.42-1.29 (NS), 1.39 - 1.24 percent (NO) in P₂ stored at room temperature.

Table 2. Changes in acidity (%) of jam from noni fruit blended with other fruits

Storage period (days)	Glass Container (P ₁)				Pet Bottle (P ₂)			
	C ₀ P ₁	C ₁ P ₁	C ₂ P ₁	C ₃ P ₁	C ₀ P ₂	C ₁ P ₂	C ₂ P ₂	C ₃ P ₂
0	1.18	1.42	1.39	1.64	1.18	1.42	1.39	1.64
30	1.12	1.38	1.35	1.58	1.15	1.40	1.34	1.57
60	1.03	1.32	1.32	1.33	1.08	1.38	1.26	1.50
90	1.02	1.29	1.28	1.21	1.04	1.29	1.24	1.48

Glass container - P₁

Pet bottle - P₂

SED	CD (0.05)	C ₀ P ₁	-	Noni Control
0.07387	0.650*	C ₁ P ₁	-	Noni + Amla
0.06112	0.603*	C ₂ P ₁	-	Noni + Sathukkudi
0.05695	0.865**	C ₃ P ₁	-	Noni + Orange
0.18655	0.894**	C ₀ P ₂	-	Noni Control
0.06476	0.693*	C ₁ P ₂	-	Noni + Amla
0.05541	0.691*	C ₂ P ₂	-	Noni + Sathukkudi
0.07218	0.716**	C ₃ P ₂	-	Noni + Orange
0.12439	0.805*			

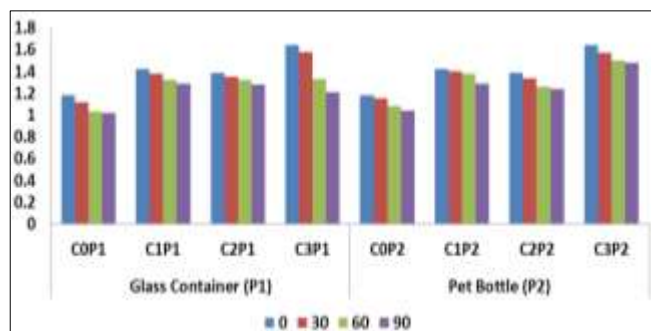


Fig 2: Acidity (%) of jam from noni fruit blended with other fruits

Statistical analysis of the data revealed that a significant different in acidity of the jam was observed between the sample, packaging materials and in the periods of storage.

Total soluble solids (TSS)

The TSS of the stored samples did not show any significant changes during the storage period neither in the storage temperature not in the storage containers (Table 3). The TSS values noted at 0 days 68.00, 68.10, 68.00 and 68.50 °brix and

at the end of the storage period 68.20, 68.30, 68.20 and 68.60° brix in glass container, 68.00, 68.10, 68.00, 68.50 °brix PET bottles respectively in N, NA, NS and NO.

Table 3: Changes in TSS (°brix) content of jam from noni fruit blended with other fruits

Storage period (days)	Glass Container (P1)				Pet Bottle (P2)			
	C0P1	C1P1	C2P1	C3P1	C0P2	C1P2	C2P2	C3P2
0	68.0	68.1	68.0	68.5	68.0	68.1	68.0	68.5
30	68.0	68.1	68.1	68.5	68.0	68.1	68.1	68.5
60	68.2	68.2	68.2	68.6	68.1	68.2	68.2	68.5
90	68.2	68.3	68.3	68.6	68.2	68.3	68.2	68.5

Glass container - P1

Pet bottle- P2

SED	CD (0.05)	C0P1	-	Noni Control
1.769395	0.035	C1P1	-	Noni + Amla
1.527779	0.356	C2P1	-	Noni + Sathukkudi
1.469256	0.226	C3P1	-	Noni + Orange
0.759648	0.236	C0P2	-	Noni Control
1.564079	0.129	C1P2	-	Noni + Amla
2.017783	0.115	C2P2	-	Noni + Sathukkudi
0.984168	0.356	C3P2	-	Noni + Orange
1.528489	0.873			

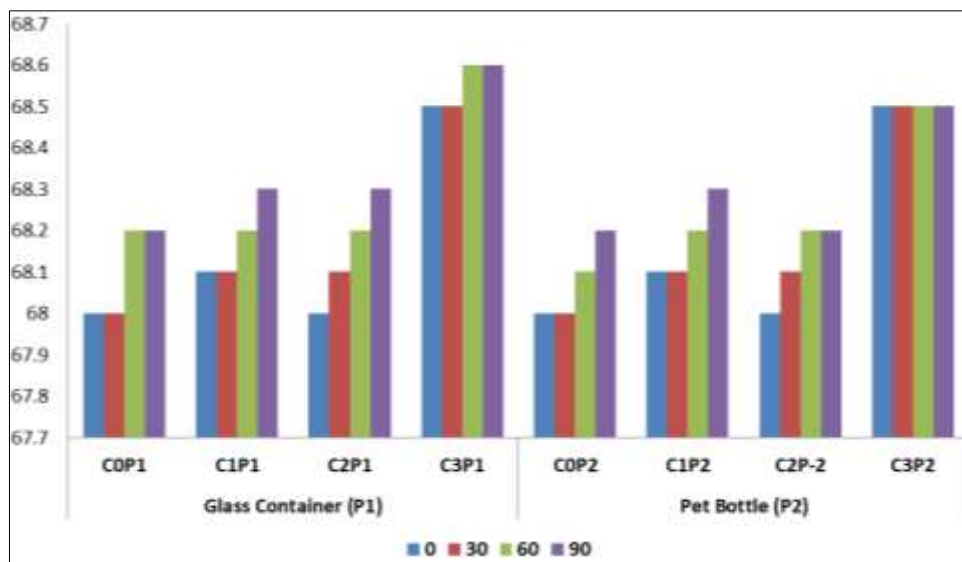


Fig 3: TSS (°brix) content of jam from noni fruit blended with other fruits

Statistical analysis of the data revealed that a significant different in TSS of the jam was observed between the sample, packaging materials and in the periods of storage.

Reducing sugar (Table 4)

The conversion of total sugar into simple sugar might have increased the reducing sugar content of stored noni fruit blended jam. Similar to total sugar, the type of fruits used for blending with noni fruit for the preparation of jam showed an influence on their reducing sugar content from 0 to 90 days of storage at the storage containers (P1 and P2).

A highly significant increase in the reducing sugar content of jam was noticed in the samples stored at room temperature. The initial reducing sugar content of N, NA, NS and NO was 6.06, 8.15, 7.12, 8.00 g/100 g respectively stored at room temperature. The corresponding final values of reducing sugar in P1 were 6.53, 8.37, 7.32, 8.26 g/100 g were in P2 6.83, 8.71, 7.81 and 8.49 g/100 g respectively.

Table 4: Changes in reducing sugar (g/100 g) content of jam from noni fruit blended with other fruits

Storage Period (days)	Glass Container (P1)				Pet Bottle (P2)			
	C0P1	C1P1	C2P1	C3P1	C0P2	C1P2	C2P2	C3P2
0	6.06	8.15	7.12	8.00	6.06	8.15	7.12	8.00
30	6.67	8.52	7.19	8.23	6.34	8.24	7.20	8.04
60	6.73	8.63	7.70	8.36	6.44	8.31	7.24	8.08
90	6.83	8.71	7.81	8.49	6.53	8.37	7.32	8.26

Glass container- P1

Pet bottle- P2

SED	CD (0.05)	C0P1	-	Noni Control
0.335874	0.610*	C1P1	-	Noni + Amla
0.945134	0.827**	C2P1	-	Noni + Sathukkudi
0.499477	0.515*	C3P1	-	Noni + Orange
0.266369	0.724**	C0P2	-	Noni Control
0.937949	0.531*	C1P2	-	Noni + Amla
0.299187	0.444	C2P2	-	Noni + Sathukkudi
0.262068	0.707**	C3P2	-	Noni + Orange
0.339572				

Total sugar

The changes noted in the total sugar content of the control and noni fruit blended jam are given in the (Table 5). The type of the fruit used for blending with noni fruit for the preparation of jam had exhibited their influence on the changes of total sugar during the storage period. The initial total sugar content of N, NA, NS and NO were 58.3, 38.2, 57.94 and 58.34

percent respectively. At the end of storage period, a remarkable change in the total sugar content was noted in NO followed by NA, NS and NO stored in P₁ and P₂. The values at the end of 90 days of storage were 57.30, 57.63, 57.06 and 57.53 g/100 g in P₁ and 57.56, 57.86, 57.62 and 58.00 g/100 g in P₂ for N, NA, NS and NO respectively.

Table 5: Changes in total sugar (g/100 g) content of jam from noni fruit blended with other fruits

Storage period (days)	Glass Container (P ₁)				Pet Bottle (P ₂)			
	C ₀ P ₁	C ₁ P ₁	C ₂ P ₁	C ₃ P ₁	C ₀ P ₂	C ₁ P ₂	C ₂ P ₂	C ₃ P ₂
0	58.30	58.20	57.94	58.34	58.30	58.20	57.94	58.34
30	57.90	58.10	57.82	58.29	58.20	58.02	57.86	58.30
60	57.50	58.09	57.43	58.02	57.79	57.90	57.83	58.14
90	57.36	57.63	57.10	57.53	57.56	57.86	57.62	58.00

Glass container - P₁

Pet bottle- P₂

SED	CD (0.05)	C ₀ P ₁	-	Noni Control
1.8588134	0.246	C ₁ P ₁	-	Noni + Amla
1.086052	0.266	C ₂ P ₁	-	Noni + Sathukkudi
1.734876	0.348	C ₃ P ₁	-	Noni + Orange
1.251458	0.246	C ₀ P ₂	-	Noni Control
1.707121	0.375	C ₁ P ₂	-	Noni + Amla
0.888772	0.411	C ₂ P ₂	-	Noni + Sathukkudi
1.637845	0.564*	C ₃ P ₂	-	Noni + Orange
1.637453	0.285			

Ascorbic acid

The changes noticed in the ascorbic acid content of noni fruit blended jam and control during the study period is presented in (Table 6) and the storage containers and storage period and the type of fruits used for blending had greatly influenced the ascorbic acid content of the jam at the end of 90 days of storage. The retention of ascorbic acid content was more in the samples packed in P₂ (PET bottle) stored at room temperature. The highest percentage loss of ascorbic acid was

observed in all the samples stored at room temperature packed in P₁ (glass container).

Among these control had and 18.76 to 16.88 percent loss in P₁, 18.76 and 16.21 P₂ respectively. The noni fruit blended with amla fruit jam and noni fruit blended with sathukkudi fruit jam had more vitamin C content than orange at 0 and 90 days of storage. The percentage loss of vitamin C in NA, NS and NO were and 17.89, 16.63 and 19.08 in P₁ were 16.88, 17.09 and 19.44 in P₂ respectively stored at room temperature.

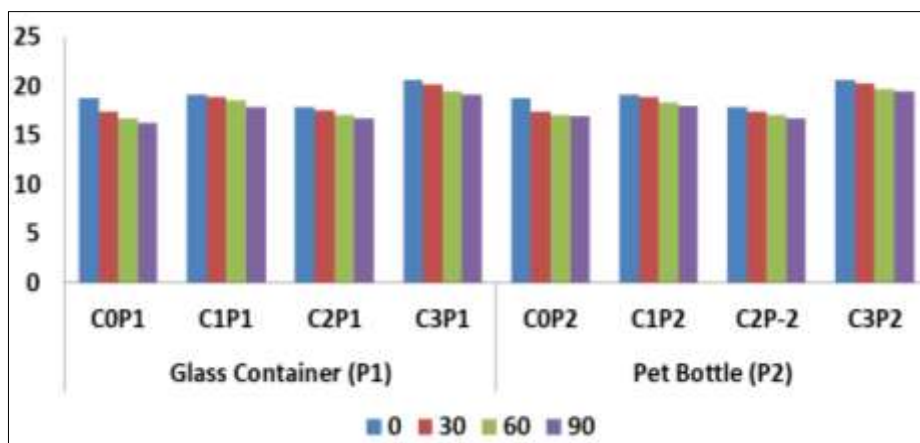


Fig 4: Vitamin C (mg/100 g) content of jam from noni fruit blended with other fruits

Table 6. Changes in Vitamin C (mg/100 g) content of jam from noni fruit blended with other fruits

Storage period (days)	Glass Container (P ₁)				Pet Bottle (P ₂)			
	C ₀ P ₁	C ₁ P ₁	C ₂ P ₁	C ₃ P ₁	C ₀ P ₂	C ₁ P ₂	C ₂ P ₂	C ₃ P ₂
0	18.76	19.06	17.85	20.63	18.76	19.06	17.85	20.63
30	17.33	18.85	17.44	20.11	17.34	18.88	17.43	20.22
60	16.67	18.48	17.01	19.43	17.06	18.34	17.02	19.64
90	16.21	17.89	16.63	19.08	16.88	17.96	16.64	19.44

Glass container - P₁

Pet bottle- P₂

SED	CD (0.05)	C ₀ P ₁	-	Noni Control
4.548282	0.958**	C ₁ P ₁	-	Noni + Amla
4.616734	0.727**	C ₂ P ₁	-	Noni + Sathukkudi
3.929719	0.993*	C ₃ P ₁	-	Noni + Orange
4.456384	0.985**	C ₀ P ₂	-	Noni Control
4.442603	0.742**	C ₁ P ₂	-	Noni + Amla
3.530072	0.981**	C ₂ P ₂	-	Noni + Sathukkudi
2.900420	0.978**	C ₃ P ₂	-	Noni + Orange
3.343555	0.966**			

The statistical analysis of the data revealed that a significant decrease in ascorbic acid content throughout the storage period between the samples, storage period and packaging materials in noni fruit juice blended jam.

Tannin

A decreasing trend in the tannin content was observed in all the jam during storage (Table 7). Among the jam noni fruit blended with amla jam (NA) had higher tannin content than N, NS and NO throughout the study period. The initial tannin content of N, NA, NS and NO was ranged between 0.715 and 0.830 percent of tannic acid, whereas the final tannin content was noted as 0.611 in N, 0.723 in NA, 0.627 in NS and 0.617 in NO percent of tannic acid packed in glass bottles (P₁). The corresponding values were 0.628, 0.765, 0.645 and 0.641 percent of tannic acid respectively packed in P₂ stored at room temperature.

Table 7: Changes in tannin (% tannic acid) content of jam from noni fruit blended with other fruits

Storage period (days)	Glass Container (P ₁)				Pet Bottle (P ₂)			
	C ₀ P ₁	C ₁ P ₁	C ₂ P ₁	C ₃ P ₁	C ₀ P ₂	C ₁ P ₂	C ₂ P ₂	C ₃ P ₂
0	0.716	0.83	0.734	0.715	0.716	0.830	0.734	0.715
30	0.687	0.77	0.711	0.688	0.695	0.802	0.714	0.692
60	0.632	0.753	0.659	0.646	0.643	0.783	0.685	0.634
90	0.611	0.723	0.627	0.617	0.628	0.765	0.645	0.641

Glass container- P₁

Pet bottle- P₂

SED	CD (0.05)	C ₀ P ₁	-	Noni Control
0.04224	1.000	C ₁ P ₁	-	Noni + Amla
0.04882	0.720**	C ₂ P ₁	-	Noni + Sathukkudi
0.04458	0.888**	C ₃ P ₁	-	Noni + Orange
0.04715	0.947**	C ₀ P ₂	-	Noni Control
0.04658	0.926**	C ₁ P ₂	-	Noni + Amla
0.04379	0.800**	C ₂ P ₂	-	Noni + Sathukkudi
0.04666	0.953**	C ₃ P ₂	-	Noni + Orange
0.04195	0.931**			

Statistical analysis of the data indicated a significant difference in tannin content between the noni fruit juice blended with other fruit jam storage period and packaging materials.

Non enzymatic browning (NEB)

The changes noted in the non-enzymatic browning of noni

fruit blended jam and control are furnished in Table 8. A gradual increase in the non-enzymatic browning was observed in all the noni fruit blended jam during the study period stored at room temperature. The packaging materials selected for the study had exhibited their influence in the changes of non-enzymatic browning packed in them during the study period. The freshly prepared jam N, NA, NS and NO contained 0.208, 0.221, 0.232 and 2.265 absorbance of non-enzymatic browning which had increased to 0.259, 0.257, 0.27 and 0.317 in P₁, 0.251, 0.252, 0.267 and 0.312 in P₂ respectively at the end of 90 days of storage.

Table 8: Changes in non-enzymatic browning (absorbance) of jam from noni fruit blended with other fruits

Storage period (days)	Glass Container (P ₁)				Pet Bottle (P ₂)			
	C ₀ P ₁	C ₁ P ₁	C ₂ P ₁	C ₃ P ₁	C ₀ P ₂	C ₁ P ₂	C ₂ P ₂	C ₃ P ₂
0	0.208	0.221	0.232	0.265	0.208	0.221	0.232	0.265
30	0.223	0.236	0.244	0.28	0.221	0.232	0.246	0.272
60	0.248	0.242	0.261	0.295	0.243	0.241	0.258	0.284
90	0.259	0.257	0.27	0.317	0.251	0.252	0.267	0.312

Glass container- P₁

Pet bottle- P₂

SED	CD (0.05)	C ₀ P ₁	-	Noni Control
0.01879	0.915**	C ₁ P ₁	-	Noni + Amla
0.01321	0.917**	C ₂ P ₁	-	Noni + Sathukkudi
0.01495	0.860**	C ₃ P ₁	-	Noni + Orange
0.01979	0.921**	C ₀ P ₂	-	Noni Control
0.02133	0.836**	C ₁ P ₂	-	Noni + Amla
0.01525	0.844**	C ₂ P ₂	-	Noni + Sathukkudi
0.01757	0.921**	C ₃ P ₂	-	Noni + Orange
0.02047	0.816			

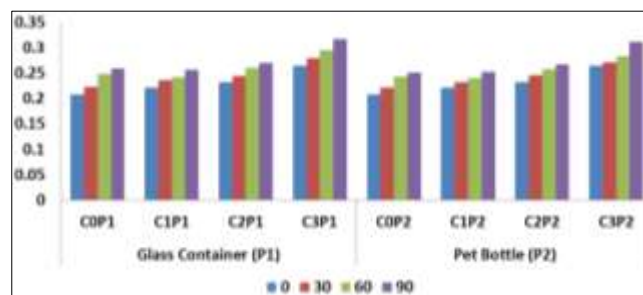


Fig 5: Non enzymatic browning (absorbance) of jam from noni fruit blended with other fruits

The statistical analysis of the data showed a significant increase in the non-enzymatic browning among the jam storage temperature, storage period and packaging materials.

Organoleptic characteristics of noni fruit blended jam (Table 9)

The change in the quality attributes directly influence in the organoleptic scores. As the storage period progress there was a slight change in the colour and appearance, flavor which in term affected the taste of the product. The organoleptic profile of the noni fruit blended jam control stored at room temperature is presented in Table. The quality attributes of the samples packed in glass and PET bottles showed very slight difference during the storage period stored at room temperature. The maximum score values were found in NO jam followed by NA, NS and N throughout the storage period in terms of colour and appearance, flavor, taste and overall acceptability packed in P₁ and P₂ and stored at room condition. The initial colour and appearance score values of N, NA, NS and NO were 8.30, 8.80, 9.60 and 8.50 respectively. The corresponding values at the end of 90 days

were ranged between 8.37 to 9.69 in P₁ and 8.34 to 9.64 in P₂ at room temperature.

As the storage period increased the strong noni flavor of all the jam was slightly increased irrespective of the storage temperature and packaging materials. The score values noted initially 5.40, 7.60, 6.40, and 8.30 in N, NA, NS and NO respectively. AT the end of 90 days the flavor score values were ranged from 5.30 to 8.23 and 5.35 to 8.24 respectively in glass container and pet bottles at room temperature.

At zero days the control and noni fruit blended jam had the consistency score values as 8.00, 8.90, 9.50, 8.90 in N, NA, NS and NO respectively. A gradual change in the score values 7.88, 8.78, 9.38 and 8.76 in P₁ and 7.91, 8.83, 9.41 and 8.83 in P₂ were noticed at the end of 90 days in the jam stored at room temperature. At zero days the control and noni fruit blended jam had the taste score values as 6.50, 7.80, 7.50, 8.50 in N, NA, NS and NO respectively. A gradual change in the score values 6.41, 7.73, 7.43, 8.41 in P₁ and 6.44, 7.74, 7.43, 8.41 in P₂ were noticed at the end of 90 days in the jam stored at room temperature.

Table 9: Organoleptic evaluation of jam for during storage

Sl. No.	Quality attributes	Storage period	Glass Container (P ₁)				Pet Bottle (P ₂)			
			C ₀ P ₁	C ₁ P ₁	C ₂ P ₁	C ₃ P ₁	C ₀ P ₂	C ₁ P ₂	C ₂ P ₂	C ₃ P ₂
1	Colour and appearance	0	8.30	8.80	9.60	8.50	8.30	8.80	9.60	8.50
		30	8.31	8.82	9.63	8.51	8.30	8.84	9.61	8.51
		60	8.34	8.85	9.65	8.58	8.32	8.86	9.63	8.54
		90	8.37	8.88	9.69	8.63	8.34	8.89	9.64	8.61
2	Flavour	0	5.40	7.60	6.40	8.30	5.40	7.60	6.40	8.30
		30	5.38	7.56	6.37	8.27	5.39	7.58	6.39	8.29
		60	5.37	7.55	6.34	8.25	5.37	7.57	6.36	8.27
		90	5.30	7.51	6.33	8.23	5.35	7.53	6.34	8.24
3	Consistency	0	8.00	8.90	9.50	8.90	8.00	8.90	9.50	8.90
		30	7.96	8.85	9.45	8.83	7.97	8.88	9.47	8.86
		60	7.92	8.82	9.41	8.78	7.94	8.87	9.45	8.85
		90	7.88	8.78	9.38	8.76	7.91	8.83	9.41	8.83
4	Taste	0	6.50	7.80	7.50	8.50	6.50	7.80	7.50	8.50
		30	6.46	7.77	7.48	8.46	6.49	7.78	7.49	8.48
		60	6.44	7.75	7.43	8.41	6.46	7.77	7.46	8.45
		90	6.41	7.73	7.39	8.38	6.44	7.74	7.43	8.41
5	Overall acceptability	0	6.20	7.90	7.20	7.90	6.20	7.90	7.20	7.90
		30	6.16	7.86	7.14	7.86	6.18	7.87	7.17	7.88
		60	6.12	7.82	7.08	7.83	6.15	7.83	7.13	7.87
		90	6.02	7.79	7.03	7.81	6.12	7.81	7.09	7.83

The overall acceptability scores of the noni fruit blended jam was highly influenced by the colour and appearance, body, flavor and taste. The change noted in the original characteristics of the attribute would decrease the score values of overall acceptability. The initial overall acceptability score values of N, NA, NS and NO were 6.20, 7.90, 7.20, 7.90 respectively and at the end of 90 days the scores ranged from 6.02 to 7.81 in glass container and from 6.12 to 7.83 in pet bottle at room temperature. From the results it was found that the noni fruit blended with amla jam (NO) had the higher organoleptic score values followed by NS, NA and N.

Microbial changes of the noni fruit blended jam

The changes in the microbial load of the jam prepared from noni fruit blended with other fruits given in the Table 10. As the storage period progresses a slight increase in the microbial load was also noted in P₁ and P₂ stored at room temperature. The initial bacterial load in N sample (3×10^{-6} cfu/ml) was found to be slightly higher compared to NA, NS and NO (2.0 , 2.0 and 2.0×10^{-6} cfu/ml). At the end of storage period (90 days), an increase in the bacterial load was observed in all the jam stored at room temperature. In room temperature the bacterial load in N, NA, NS and NO were 3.0 , 5.0 , 2.0 and 3.0×10^{-6} cfu/ml in P₁ and in P₂ 6.0 , 2.0 , 3.0 and 3.0×10^{-6} cfu/ml respectively at the end of 90 days of storage.

Table 10: Microbial changes of the noni fruit blended jam during storage

Particulars	Storage period (days)	Glass Container (P ₁)				Pet Bottle (P ₂)			
		C ₀ P ₁	C ₁ P ₁	C ₂ P ₁	C ₃ P ₁	C ₀ P ₂	C ₁ P ₂	C ₂ P ₂	C ₃ P ₂
Bacterial x 10 ⁻⁶ cfu/g	0	3.0	2.0	2.0	2.0	3.0	2.0	2.0	2.0
	90	5.0	2.0	2.0	3.0	6.0	2.0	3.0	3.0
Yeast x 10 ⁻³ cfu/g	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	90	3.0	2.0	2.0	3.0	3.0	1.0	1.0	2.0
Fungi x10 ⁻⁴ cfu/g	0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
	90	2.0	1.0	1.0	1.0	2.0	1.0	1.0	1.0

During storage the yeast population was increased slightly in the storage conditions. The initial fungal population was noticed in N, NS and NO as 1×10^{-4} cfu/ml stored at room temperature packed in P₁ and P₂ except NA. Initially the fungal population was not observed in NA but at the end of 90 days of storage the population 2×10^{-4} cfu/ml was developed from temperature in glass bottles and pet bottles as 1.0×10^{-4} cfu/ml.

Conclusion

The extracted juice from noni fruit could be successfully utilized in the processing of noni fruit juice blended jam with suitable fruits *viz.*, amla, sathukudi and orange. It enhances the nutritional and sensory quality with reducing the pungent flavour and rancid taste of the noni fruit. The It could be possible to extract juice from noni fruit by adopting cold process without changes in the physico-chemical characteristics of the juice. The extracted juice can be successfully utilized in the processing of noni fruit juice blended jam. The fruits such as amla, sathukudi and orange were found to be highly suitable for the preparation of noni fruit juice blended jam. From the results it was found that the noni fruit blended with amla jam (NO) had the higher organoleptic score values followed by NS, NA and N. The noni fruit jam showed an increasing trend in acidity, reducing sugar and non-enzymatic browning whereas a decreasing trend in pH, total sugar, ascorbic acid, tannin, total antioxidant activity and colour values during storage. A very slight increase in the microbial population was observed in jam. The storage stability of the blended jam packed in PET bottles and stored at refrigeration temperature was found to be good. The introduction of blended jam from noni fruits as new food products will definitely attract the consumers. The blended jam are having high potential for commercialization and marketability.

Reference

1. Ali M, Kenganora M, Manjula SN. Health benefits of *Morinda citrifolia* (Noni): A review. *Pharmacognosy Journal*. 2016; 8:321-334.
2. Dittmar A, *Morinda citrifolia* L. use in indigenous Samoan medicine. *Journal of herbs Spices and Medicine Plants*. 1993;1:7792
3. Wang MY, West BJ, Jensen CJ, Nowicki D, Palu AK, Anderson G. *Morinda citrifolia* (Noni): A literature review and recent advances in Noni research. *Acta Pharmacol. Sin*. 2002;23(12):1127-1141.
4. Mathivanan N, Surendiran G, Srinivasan K, Sagadevan E, Malavizhi K. Review on current scenario of noni research: Taxonomy, distribution, chemistry, medicinal and therapeutic values of *Morinda citrifolia*. *Intl. J. Noni Res*. 2005;1(1):1-4. 5.
5. Potterat O, Hamburger M. *Morinda citrifolia* (noni) fruit

phyto chemistry, pharmacology and safety. *Planta. Med*. 2007;73:191-199.

6. Mathivanan N, Surendiran G, Srinivasan K, Sagadevan E, Malavizhi K. Review on current scenario of noni research: Taxonomy, distribution, chemistry, medicinal and therapeutic values of *Morinda citrifolia*. *Intl. J. Noni Res*. 2005;1(1):1-4.
7. Potterat O, Hamburger M. *Morinda citrifolia* (noni) fruit phyto chemistry, pharmacology and safety. *Planta. Med*. 2007;73:191-199.
8. Ranganna S. *Manual of analysis of fruits and vegetables products*, Tata McGraw Hill publishing Co., Ltd., New Delhi. 1995;1-2:7-11-13.
9. Hart AM, Fisher HJ. *Modern Food Analysis*. Springer Varley, Belrin, Heidelberg, New York; c1971. p.64-74.
10. Mc Donald, Efoley JBY. *Journal of Agricultural Chemistry*. 1960;43:645.
11. Schanderl SH. In: *Method in food analysis*, Academic press, New York; c1970. p.709.
12. Lim YY, Lim TT, Tee JJ. Antioxidant properties of several tropical fruits: A comparative study. *Food Chemistry*. 2007;103:1003-1008.
13. Amerine MA, Pangborn RM, Roseller EB. *Principles of sensory evaluation of food*. Academic Press. New York; c1965. p.131.
14. Lohar PS, Kshirsagar RB, Mundhe SA, Patil BM. Effect of carbonation of shelf life of RTS beverage from Karonda (*Carissa carandas* L.) fruits. *Beverage and Food World*. 2010;37(4):41-43.
15. Nelson SC. Noni cultivation and production in Hawaii. *Proceedings of the 2002 Hawaii Noni conference*, S.C. Nelson (Ed.) University of Hawaii at Manoa, College of Tropical Agriculture and Human Resources; c2003. p.33-50.