The Pharma Innovation Journal 2022; 11(11): 169-182

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(11): 169-182

www.thepharmajournal.com
Received: 11-08-2022
Accepted: 18-10-2022

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Development of blended pineapple (*Ananas comosus* L.) and nutmeg (*Myristica fragrans* L.) jelly cubes with studying changes in the physical and sensory quality parameters during storage

Kunal S Birnale, Dr. Keshav H Pujari, Vishal B Yadav and Ajay S Kudale

Abstract
An experiment entitled, "Development of blended pineapple (*Ananas comosus* L.) and nutmeg (*Myristica fragrans* L.) jelly cubes" with studying changes in the physical and sensory quality parameters during storage was conducted in the Department of Post-Harvest Management of Fruit, Vegetable and Flower Crops, P.G. Institute of Post Harvest Management., Killa- Roha during the year 2017-2018. It was aimed to develop the blended jelly cubes by using various proportions of pineapple and nutmeg rind fruit juices *viz*. 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50. The blended pineapple and nutmeg rind jelly cubes were evaluated for physical and sensory quality parameters during 90 days of storage period.
The colour of the blended jelly was determined by recording L*, a* and b* values. L* value was decreased from 66.76 to 63.75 during storage indicating the increase in darkness of colour of the blended jelly. Moreover, increased in a* 2.63 to 4.66 and decreased in b* 45.95 to 37.75 was observed in the blended jelly during storage. Sensory evaluation of the blended pineapple and nutmeg rind jelly cubes showed that the sensory score for colour, flavour and texture decreased during storage. Based on the organoleptic evaluation and economics of the jelly cubes, the blended pineapple and nutmeg rind jelly cubes could be prepared by blending pineapple and nutmeg rind juice in the ratio of 70:30 with optimum consumer acceptability upto 90 days of storage at ambient condition.

Keywords: Blended pineapple, *Ananas comosus* L., jelly cubes

1. Introduction

1.1 Pineapple

Pineapple (*Ananas comosus*) is one of the most important horticultural crops and is the third most important tropical fruit in the world after banana and citrus in terms of production.
The world total annual production of pineapple during 2016-2017 was 67,434 tonnes. The area of pineapple production in India is 89,000 ha, with a production of 1.42 million tonnes and a productivity of 15.9 tonnes/ha.. According to Samson (1986) [15], pineapple mainly contains water, carbohydrates, sugars, vitamin A, vitamin C and β carotene. It contains low amounts of protein, fat, ash, fiber and antioxidants namely flavonoids in addition to citric and malic acid and moderate amounts of ascorbic acid (Tochi *et al.*, 2008) [19].
Pineapple is cultivated predominantly for its fruit that is consumed fresh or as canned fruit and juice. Pineapple is the only source of bromelain, a complex proteolytic enzyme used in the pharmaceutical market and as a meat-tenderizing agent. The stems and leaves of pineapple plant are also a source of fibre that is white, creamy and lustrous as silk. Pineapple fibre has been processed into paper with remarkable qualities of thinness, smoothness and pliability. Parts of the plant are used for silage and hay for cattle feed. Processing wastes in the form of shell, core materials and centrifuged solids from juice production are also used as animal feed. Alcoholic beverages can also be made from juice. (International tropical fruit network, 2018)
Pineapple helps several enzymes present in the body to produce energy as it contains magnesium and vitamin B1, which are essential for the normal functioning of some enzymes. It is an excellent source of antioxidant vitamin C, which is required for the collagen synthesis in the body. Pineapples can be consumed fresh, cooked, juiced or preserved. The edible portion of pineapple contains 81.2-86.2% moisture and 13-19% total solids.

1.2 Nutmeg

Nutmeg (*Myristica fragrans*) is unique among spices as it produces two spices, nutmeg and mace. It belongs to the myristicaceae family with about 18 genera and 300 species.

Indonesia and Grenada are the major producers of nutmeg. Nutmeg was introduced in India for quite a long time. It is seen mainly in Kerala, Tamil Nadu and Karnataka (Purseglove *et al*., 1981) [13]. The fruit is a fleshy drupe usually pendulous, broadly pyriform, yellow and smooth. It is 60-90 mm long. When ripe, the yellow pericarp splits open into two halves, exposing the shiny brown testa surrounded by a laciniate red aril. The testa contains a brown kernel, which is 20-30 mm long and 15-20 mm broad. The kernel is wrinkled and contains a lighter coloured endosperm and a small embryo (Purseglove *et al*., 1981) [13]. Fresh ripe pericarp has an acidic, astringent, aromatic juice. Fruit rind, contains 86.8% moisture, 1% protein, 0.4% ether extract, 11.2% carbohydrates, 0.6% mineral matter with 0.04% calcium, 0.01% phosphorous, 2 mg iron and 8 i.u/100 g carotene.

Fruits, which are rich in nutrients but are not accepted due to high acidity or poor taste and flavour, can be blended with other fruits to improve their acceptability and make use of available nutrients.

Hence, blending vitamin rich pineapple juice with spicy flavour nutmeg juice may improve the nutritional quality and enhance taste of the pineapple: nutmeg blended jelly cubes. When pineapple is used as fruit base in the preparation of blended jelly.

Keeping this in view, the experiment entitled, "Development of blended pineapple (*Ananas comosus* L.) and nutmeg (*Myristica fragrans* L.) jelly cubes" with studying changes in the physical and sensory quality parameters during storage with following objectives-

1. To standardize the proportion of pineapple and nutmeg rind juice in the blended jelly.
2. To study the storage behavior of pineapple and nutmeg rind blended jelly.

2. Material and Methods

The present research entitled, "Development of blended pineapple (*Ananas comosus* L.) and nutmeg rind (*Myristica fragrans* L.) jelly cubes" was conducted at the Department of Post-Harvest Management of Fruit, Vegetable and Flower Crops, Post Graduate Institute of Post-Harvest Management, Killa-Roha, Dist. Raigad, during the year 2017-2018.

2.1 Experimental material

The mature fruits of pineapple local and nutmeg rind fruit were procured from local farmers of Raigad district (MS). After washing, fruits were used for the preparation of jelly. For making jelly, pectin, sugar and chemicals like citric acid and sodium benzoate were added. The above material was procured from the Department of Post- Harvest Management of Fruit, Vegetable and Flower Crops, Post Graduate Institute of Post-Harvest Management, Killa-Roha, and Dist-Raigad.

2.2 Experimental details

Experimental details

Crop: Pineapple (*Anana scomosus* L.) and Nutmeg (*Myristica fragrans* L.)
Cultivar: Pineapple Local and Nutmeg local Cultivar
Design: Factorial Completely Randomized Design (FCRD)
Number of treatment combinations: 6 × 4 = 24
Replications: 3

2.3 Treatment details

Main treatments

Treatments		Proportion of pineapple and nutmeg juice
T_1	:	100:00
T_2	:	90:10
T_3	:	80:20
T_4	:	70:30
T_5	:	60:40
T_6	:	50:50

Sub treatments

Sub treatments		Storage period (Days)
S_1	:	0
S_2	:	30
S_3	:	60
S_4	:	90

2.4 Methods

2.4.1 Physical parameters of pineapple and nutmeg rind:

2.4.1.1 Juice recovery

The consumable part of the fruit was weighted and known amount was taken for blending. The blended homogenized pulp was passed through a set of muslin cloth to separate the solid particles. The juice was collected in a measuring cylinder and recovery of juice content was given as follows:

$$\text{Juice recovery (\%)} = \frac{\text{Volume of juice}}{\text{Weight of fruit}} \times 100$$

2.4.1.2 Colour

The colour of pineapple and nutmeg fruit juices were measured by using colour reader (make Konica Minolta, Japan CR-400) and expressed as L*, a* and b* values.

2.4.2. Chemical parameters of pineapple and nutmeg rind:

2.4.2.1 Moisture

The moisture content was measured directly by using Contech moisture analyzer made in India (model CA-123) at 100 ^{0}C temperature and expressed as per cent moisture content on electronic display directly.

2.4.2.2 Total Soluble Solids

The total soluble solids were determined by using Hand Refractometer (Atago Japan, 0-32^{0}B) and the values were corrected at 20 ^{0}C with the help of temperature correction chart (A.O.A.C., 1975) [1].

2.4.2.3 Titratable acidity

A known quantity of sample was titrated against 0.1 N NaOH solution using phenolphthalein as an indicator (A.O.A.C., 1975) [1]. The sample of known quantity with 20 ml distilled water was transferred to 100 ml volumetric flask, made up the volume and filtered. A known volume of aliquot (10 ml) was titrated against 0.1N sodium hydroxide (NaOH) solution using phenolphthalein as an indicator (Ranganna, 2003) [20]. The results were expressed as per cent anhydrous citric acid.

$$\text{Titratable acidity (\%)} = \frac{\text{Normality of alkali X Titre reading X Volume made X Equivalent weight of acid}}{\text{Weight of sample taken X Volume of sample taken for estimation X 1000}} X100$$

2.4.2.4 Reducing sugars

The reducing sugars were determined by the method of Lane and Eynon (1923) [21] as described by Ranganna (2003) [20]. A known weight of sample was taken in 250 ml volumetric flask. To this, 100 ml of distilled water was added and the contents were neutralized by 1 N sodium hydroxide. Then 2 ml of 45 per cent lead acetate was added to it. The contents were mixed well and kept for 10 minutes. Two ml of 22 per cent potassium oxalate was added to it to precipitate the excess of lead. The volume was made to 250 ml with distilled water and solution was filtered through Whatman No. 4 filter paper. This filtrate was used for determination of reducing sugars by titrating it against the boiling mixture of Fehling 'A' and Fehling 'B' solutions (5 ml each) using methylene blue as indicator to a brick red end point. The results were expressed on per cent basis.

$$\text{Reducing sugars (\%)} = \frac{\text{Factor X Dilution}}{\text{Titre reading X Weight of sample}} \text{ X } 100$$

2.4.2.5 Total sugars

For inversion at room temperature, a 50 ml aliquot of clarified deleaded solution was transferred to 250 ml volumetric flask, to which, 10 ml of 50 per cent HCl was added and then allowed to stand at room temperature for 24 hrs. It was then neutralized with 40 per cent NaOH solution. The volume of neutralized aliquot was made to 250 ml with distilled water. This aliquot was used for determination of total sugars by titrating it against the boiling mixture of Fehling 'A' and Fehling 'B' (5ml each) using methylene blue as indicator to a brick red end point. The results were expressed on per cent basis.

$$\text{Total sugars (\%)} = \frac{\text{Factor X Dilution}}{\text{Titre reading X Weight of sample}} \text{X } 100$$

2.4.3 Preparation of jelly cubes

The product was prepared as per the steps given below

2.4.3.1 Extraction of juice

Fresh ripe pineapple fruits were crushed by mixer grinder. Then, the pulp was squeezed through muslin cloth for the juice extraction. Nutmeg rind cut into small pieces and crushed into mixer grinder then squeezed through muslin cloth for the juice extraction.

2.4.3.2 Straining of juice

The juice of both pineapple and nutmeg was strained by passing it through four fold muslin cloth to remove all colloidal particles and scum.

2.4.3.3 Addition of water

The potable water was then added in both juices in 1:1 proportion.

2.4.3.4 Blending of juices

The juices of pineapple (Cv. Local) and nutmeg were blended in different proportions as per the treatments.

2.4.3.5 Addition of sugar

About 750g of blended juice of pineapple and nutmeg was used in each replication for the preparation of jelly. The sugar was added in 1:1 proportion in the juice.

2.4.3.6 Boiling

After addition of the sugar, the mixture was boiled as rapidly as possible to avoid destruction of pectin as well as to maintain the colour and flavour of the jelly. The scum was removed with the help of spoon as and when it appeared.

2.4.3.7 Addition of pectin

Out of the total required sugar, $1/10^{th}$ part of sugar was mixed with 2 per cent pectin powder so as to dissolve the pectin easily in juice. After reaching 60^0B TSS, pectin extract was sprinkled on mixture with continuous stirring to avoid loss of jelly forming strength of pectin.

2.4.3.8 Addition of citric acid

Upon reaching 65^0B TSS, the citric acid was added @ 0.5 per cent in order to prevent sucrose crystallization in the finished product and to establish the optimum gel formation. The citric acid was added at the end of cooking for proper sugar inversion.

2.4.3.9 Addition of sodium benzoate

After reaching 65^0B TSS, the sodium benzoate was also added @ 200 ppm at the end as a chemical preservative.

2.4.3.10 Filling, packing and processing of jelly

When the TSS of jelly reached to 68^0B, the blended jelly was poured hot in the cube shape moulds and allowed the jelly to set for 15 minutes in moulds. After jelly was set, the blended jelly cubes were packed in the glass bottles. Glass bottles were processed for 10 minutes in boiling water and then the jelly cubes were stored in ambient condition for further investigation.

2.4.4 Changes in the physical quality parameters of the blended pineapple and nutmeg rind jelly cubes during storage

2.4.4.1 Colour

The colour of blended pineapple and nutmeg jelly cube was measured by using colour reader (make Konica Minolta, Japan CR-400) and expressed as L*, a* and b* values.

2.4.5 Changes in sensory quality parameters of the blended pineapple and nutmeg rind jelly cubes during storage

Blended pineapple and nutmeg jelly cubes were evaluated for their organoleptic qualities like colour, flavour, texture and overall acceptability on a hedonic scale (Amerine *et al*., 1965) [24] as given below.

Organoleptic Score	Rating
9	Like extremely
8	Like very much
7	Like moderately
6	Like slightly
5	Neither like nor dislike
4	Dislike slightly
3	Dislike moderately
2	Dislike very much
1	Dislike extremely

The overall rating was obtained by averaging the score for colour, flavour and texture of blended pineapple and nutmeg rind jelly cubes. The samples with score of 5.5 and above were rated as acceptable.

2.4.5 Statistical analysis of the blended pineapple and nutmeg rind jelly cubes

The data collected on chemical parameters of pineapple and nutmeg rind such as moisture, TSS, titratable acidity and sugars were represented as mean values. The data collected on the changes in physico-chemical and sensory quality parameters of blended pineapple and nutmeg jelly cubes during storage were statistically analyzed by the standard procedure given by Panse and Sukhatme (1985) [22] and Amdekar (2014) [23] using Factorial Completely Randomized Design and valid conclusions were drawn only on significant differences between treatment mean at 5 per cent level of significance.

2.4.6 Economics of the blended pineapple and nutmeg rind jelly cubes

The economics of the product was worked out by considering existing rates of various inputs such as cost of raw material (fruits), labour, fuel, chemicals, packaging material, depreciation charges (repairing charge) and interest on the fixed capital. The gross returns as per the treatments were worked out by considering prevailing market price. The sale price of the product was calculated by adding 20 per cent profit margins to the cost of product for different treatments of the experiment.

Extraction of pineapple and nutmeg rind juice

1. Extraction of pineapple juice

Selection of fruits
↓
Washing and cleaning of fruits
↓
Peeling and cutting

Homogenizing in the mixer
↓
Squeezing the pulp through muslin cloth for juice extraction

Flow chart 1: Extraction of pineapple juice

2. Extraction of nutmeg rind juice

Selection of fruitpericarp
↓
Cleaning of pericarp
↓
Blanching in 2% brine solution for 10 min.

Peeling
Cutting into pieces and crushing in grinder
↓
Extraction of juice by squeezing the pulp through muslin cloth

Flow sheet 2: Extraction of nutmeg rind juice

3. Preparation of blended pineapple and nutmeg rind jelly cubes

Selection of pineapple and nutmeg pericarp
↓
Cleaning of fruits
↓
Extraction of juice
↓
Straining of juice
↓
Blending of juices in different Proportions as per the treatments
↓
Addition of sugar in 1:1 proportion
↓
Heating the mixture up to TSS level of 60° Brix
↓
Addition of pectin
↓
Heating the mixture till TSS level of to, 65° Brix
↓
Addition of citric acid to maintain 1% acidity and sodium benzoate @200 ppm
↓
Heating mixture to TSS level of to 68° Brix
↓
Hot filling in the cube molds
↓
Hot filling in the cube molds
↓
Setting of jelly
↓
Removing of jelly from molds and filling jelly cubes in glass bottles
↓
Capping of bottles
↓
Processing of bottles for 10 minutes in boiling water
↓
Cooling
↓
Labeling
↓
Storing at ambient temperature

Flow chart 3: Preparation of blended pineapple and nutmeg rind jelly cubes

3. Results and Discussion

The present investigation entitled, "Development of blended pineapple (*Anana scomosus* L.)and nutmeg (*Myristica fragrans* L.) jelly cubes" was undertaken in the Department of Post-Harvest Management of Fruit, Vegetable and Flower Crops, Post Graduate Institute of Post-Harvest Management, Killa-Roha, during the year 2017-2018.

The local cultivar of pineapple and nutmeg rind fruit were selected standardize the proportion of pineapple and nutmeg rind juices in the preparation of jelly and to study storage behaviour of blended pineapple and nutmeg rind jelly cubes. The experiment consisted of six treatments, comprising different proportions of pineapple and nutmeg rind juices i.e. 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50. The experimental data was analysed statistically using Factorial

Completely Randomized Design (FCRD). The observations on the changes in physical and sensory quality parameters of blended pineapple and nutmeg rindjelly cubes during storage were recorded at 0, 30, 60 and 90 days of storage. The results obtained from the investigation are presented and discussed in this chapter.

3.1 Physical parameters of pineapple and nutmeg rind:

Pineapple and nutmeg rind fruits were evaluated for physical composition and observed 72 per cent fruit recovery in pineapple fruit and 67.70 per cent in nutmeg rind juice.

Regarding the physical quality parameters of the pineapple fruit juice, it was observed that the L*, a* and b* value for colour in pineapple fruits are 35.85, -1.73 and 3.68, respectively.

The data related to the chemical parameters of pineapple and nutmeg fruit are presented in Table 1.

Table 1: Chemical parameters of pineapple and nutmeg rind juice:

Sr. No.	Parameters	Pineapple	Nutmeg rind
1	Moisture content (%)	84.00	91.24
2	Total soluble solids (^{0}B)	12.00	4.00
3	Titratable acidity (%)	0.51	2.30
4	Reducing sugars (%)	8.22	1.30
5	Total sugars (%)	10.90	2.55
6	Juice recovery (%)	71.10	67.70
7	Colour Value L*	35.85	-
8	Colour Value a*	-1.73	-
9	Colour Value b*	3.68	-

*Values are the average (mean) of three observations.

3.1.1 Juice recovery (%)

The data regarding juice recovery of pineapple fruit presented in Table 1 revealed that the average juice recovery of pineapple fruit was 72 per cent. The similar result 72.20 per cent was reported by Khalid *et al.* (2015) in pineapple fruit juice. The recovery of nutmeg rind juice was recorded as 67.70 per cent.

3.1.2 Colour

The mean colour in terms of tri-stimulus values of L*, a* and b* of pineapple fruit juice was recorded as 35.85, -1.73 and 3.68, respectively. Similar 36.28, -1.80 and 3.84 results are recorded by the Assawarachan, R.,and Noomhorm, A. (2010) in pineapple juice.

3.2 Chemical parameters of pineapple and nutmeg rind fruit

The data related to the chemical parameters of local types of pineapple fruit and nutmegrind are presented in Table 1.

3.2.1 Nutmeg rind

3.2.1.1 Moisture

Moisture content of nutmeg was recorded as 91.24 per cent. Closely related result for moisture content of nutmeg fruit was observed by Simenthy (2015) [17], Gopal krishnan(1992) [8]. They recorded 88.4 and 88 per cent moisture content in nutmeg fruit, respectively. The slight variation in the moisture content was due to variation in the sample for study by various worker.

3.2.1.2 Total Soluble Solids

The total soluble solid content of nutmeg was 4 ^{0}Brix. Identical result for the TSS i.e. 3.8 ^{0}Brix of nutmeg fruit was recorded by Simenthy (2015) [17].

3.2.1.2 Titratable acidity

The data regarding titratable acidity of nutmeg presented in Table 1 revealed that the average acidity of nutmeg fruit was 2.3 per cent. The result in similar line was reported by Gopalkrishnan (1992) [8]. They recorded 2.5% acidity in nutmeg fruit rind.

3.2.1.3 Reducing sugars

The data with respect to reducing sugars of nutmegfruit was presented in Table 1. The per cent reducing sugars of nutmeg fruit rind was recorded as 1.3 per cent. Closely related result for the reducing sugar content (1.58 per cent) of nutmeg fruit rind was reported by Gopalkrishnan (1992) [8].

3.2.1.4 Total sugars

The data with respect to total sugars of nutmeg fruit presented in Table 1 reveals that the per cent total sugars of nutmeg fruit was 2.55 per cent. Similarly Simenthy (2015) [17] recorded 2.69 per cent total sugar in nutmeg fruit.

3.2.2 Pineapple

3.2.2.1 Moisture

Moisture content of pineapple was recorded as 84 per cent. Closely related result for moisture content of pineapple fruit was observed by Hossain *et al* (2015) [9]. They recorded 81 to 85 per cent moisture content in pineapple fruit, respectively.

3.2.2.2 Soluble Solids

Total soluble solids content of the pineapple fruit juice was recorded about 12 ^{0}B similar results are observed by Balaswamy (2012) [3] reported that ripe pineapple fruits with total soluble solid content 12º Brix.

Expedito *et al.*,(1996) [5] reported that fully ripe, medium sized Queen variety fruits, with soluble solid content from 10 to 12º Brix, were used in these experiments.

3.2.2.3 Titratable acidity

0.51 per cent titratable acidity was recorded into the pineapple fruit juice, similar results are recorded by, Balaswamy (2012) [3] reported that ripe pineapple fruit juice acidity content 0.46 per cent and Khurdiya (1987) [12] reported the acidity of pineapple juice in the range of 0.3 to 0.8 per cent.

3.2.2.4 Reducing sugars

Reducing sugar content 8.22 per cent was recorded into the pineapple fruit, similar results are recorded by the Balaswamy (2012) [3] reported that ripe pineapple fruit juice reducing sugar content 8.4 per cent.

3.2.2.5 Total sugars

10.90 per cent total sugar content was observed into the pineapple similar results are recorded by, Balaswamy (2012) [3] reported that ripe pineapple fruit juice total sugar content 10.6 per cent.

3.6 Changes in the physical quality parameters of the blended pineapple and nutmeg rind jelly cubes during storage

3.6.1 Colour

Colour of jelly was evaluated by recording L* value for

lightness, a* value for redness and b* value for yellowness with digital colorimeter (make Konica Minolta, Japan).

3.6.1.1 L* value for colour

The data for L* value for colour of blendedpineapple and nutmeg rind jelly cubes during storage are presented in Table 2 and depicted in Fig 1.

L* value was recorded to determine lightness of jelly cubes which decreased significantly with corresponding decrease in the amount of pineapple juice in the blended jelly cubes.

Highest mean L* value for lightness (66.76) of jelly cubes was found in the treatment T_1 [pineapple (100%): nutmeg rind (0%)] which was significantly superior over all other treatments, followed by the treatment T_2 [pineapple (90%): nutmeg rind (10%)] and T_3 [pineapple (80%) + nutmeg rind (20%)].However treatments T2, T3 and T4 are at par with each other. However, the treatment T_6 [pineapple (50%): nutmeg rind (50%)] was at par with the treatment T_4 [pineapple (70%): nutmeg rind (30%)] and the treatment T_5 [pineapple (60%): nutmeg rind (40%)]. It was noticed from the data that the darkness of jelly cubes decreased continuously with increase in the proportion of pineapple juice in the blended jelly cubes. Similar observations were recorded in sapota and beetroot blended jelly by Gaikwad (2016) [6].

Table 2: Effect of different proportions of pineapple and nutmeg rind juices on the L* value for colour of blended jelly cubes during storage

Treatments	L* value for colour				Mean
	Storage period (Days)				
	0	30	60	90	
T1	67.32	67.11	66.62	66.01	66.76
T2	65.49	65.00	64.58	64.07	64.79
T3	65.35	64.99	64.51	63.83	64.67
T4	65.25	64.66	63.96	62.94	64.20
T5	65.22	64.45	63.33	62.44	63.86
T6	65.21	64.14	63.29	62.35	63.75
Mean	65.73	65.24	64.60	63.86	64.86
		S.Em ±		CD at 5%	
Treatments (T)		0.26		0.74	
Storage (S)		0.21		0.60	
Interaction (T×S)		0.51		NS	

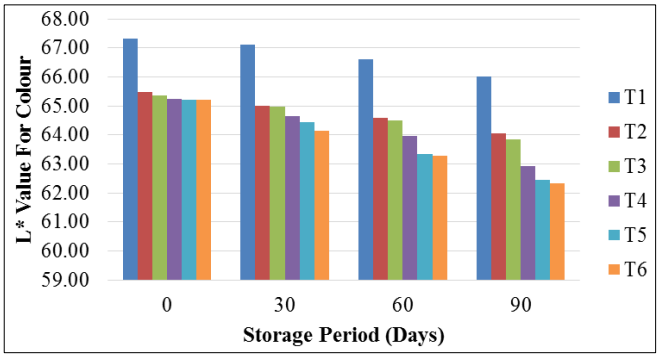


Fig 1: Effect of different proportions of pineapple and nutmeg rind juices on the L* value for colour of blended jelly cubes during storage

A significant decrease was recorded for mean L* values of jelly cubes during the storage period of 90 days. It was decreased from 66.76 to 63.75 up to 90 days of storage. Thus, it can be concluded that darkness of the colour in jelly cubes increased with increase in storage period. It might be due to change in colour of pineapple from yellow to reddish yellow due to phenolic and non-enzymatic browning during storage. The results in accordance with these findings were reported by Deokar (2017) [4] in sapota and tamarind pulp blended jelly.

Interaction effect between proportions of pineapple and nutmeg rind juices in blended jelly cubes and storage period was found to be statistically non-significant for mean L* value for colour of the jelly cubes at 5 per cent level of significance.

3.6.1.2 a* value for colour

The data pertaining to a* value for colour of the blended pineapple and nutmeg rind jelly cubes during storage are presented in Table 3 and illustrated graphically in Fig 2.

Table 3: Effect of different proportions of pineapple and nutmeg rind juices on the a* value for colour of blended jelly cubes during storage

Treatments	a* value for colour				Mean
	Storage period (Days)				
	0	30	60	90	
T1	2.49	2.54	2.63	2.83	2.63
T2	3.66	3.82	3.93	4.01	3.85
T3	3.80	3.94	4.08	4.23	4.01
T4	4.34	4.49	4.55	4.63	4.50
T5	4.49	4.58	4.65	4.78	4.63
T6	4.55	4.61	4.68	4.79	4.66
Mean	3.76	3.87	3.97	4.10	3.92
		S.Em ±		CD at 5%	
Treatments (T)		0.12		0.34	
Storage (S)		0.10		0.28	
Interaction (T×S)		0.24		NS	

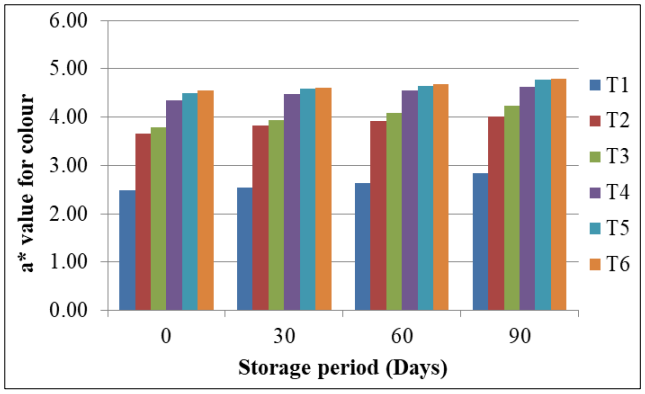


Fig 2: Effect of different proportions of pineapple and nutmeg rind juices on the a* value for colour of blended jelly cubes during storage

The redness of the blended jelly cubes was determined from a* value for colour of jelly cubes.The present data explicit that the redness of blended pineapple and nutmeg cubes jelly changed significantly due to the treatments as well as storage period. Maximum mean a* value for colour (4.66) of jelly was observed in the treatment T_6 [pineapple (50%): nutmeg rind (50%)] which was at par with the treatments T_5 [pineapple (60%): nutmeg rind (40%)] and T4 [pineapple (70%): nutmeg rind (30%)]. Minimum mean a* value for colour (2.63) of the jelly was observed in the treatment T_1 [pineapple (100%): nutmeg rind (0%)] followed by T2 [pineapple (90%): nutmegrind (10%)] However, the

treatments T_2 [pineapple (90%): nutmeg rind (10%)] and T_3 [pineapple (80%): nutmeg rind (20%)]were at par with each other. It was observed from the data that redness of jelly cubes increased due to increase in the proportion of nutmeg rind juice in the blended jelly cubes. Similar result was recorded by Deokar (2017) [4] in sapota and tamarind blended jelly cubes for a* value of colour.

Data on a* value for colour revealed that the redness of jelly cubes increased significantly during storage period of 90 days. At the time of preparation, mean a* value for colour was 2.49 which was increased significantly to 4.79 at 90 days of storage period. Redness of jelly increased due to some browning reaction during storage. Similar findings for a* value were recorded in strawberry jelly.

Interaction effect between different proportions of pineapple and nutmeg rind juices in blended jelly cubes and storage period was found to be statistically non-significant for mean a* value for colour of the jelly cubes at 5 per cent level of significance.

3.6.1.3. b* value for colour

The data related to the b* value for colour of blended pineapple and nutmeg rind jelly cubes during storage are presented in Table 4 and illustrated in Fig 3.

Yellowness of jelly was determined from b* value for colour. The present data indicated that the yellowness of blended pineapple and nutmeg rind jelly cubes changed significantly due to the treatments as well as storage period.

Maximum mean b* value for colour (45.95) was recorded in the treatment T_1[pineapple (100%): nutmeg rind (0%)] which was significantly superior to all other treatments, followed by the treatment T_2 [pineapple (90%): nutmeg rind (10%)]. Minimum mean b* value for colour (37.75) was recorded in the treatment T_6 [pineapple (50%): nutmeg rind (50%)], but at par with the treatment T_5 [pineapple (60%): nutmeg rind (40%)]. It was clear from the data that the b* value for colour decreased with corresponding decrease in the proportion of pineapple juice in the blended jelly cubes. Similar result was observed by Gaikwad (2016) [6] in sapota and beetroot blended jelly.

Table 4: Effect of different proportions of pineapple and nutmeg rind juices on the b* value for colour of blended jelly cubes during storage

Treatments	b* value for colour				Mean
	Storage period (Days)				
	0	30	60	90	
T1	47.20	46.53	45.59	44.49	45.95
T2	45.42	45.08	44.38	43.52	44.60
T3	41.26	40.78	39.49	38.10	39.91
T4	39.55	38.46	37.83	37.05	38.22
T5	39.37	38.19	37.51	36.80	37.97
T6	38.95	38.23	37.40	36.42	37.75
Mean	42.56	41.81	40.96	39.99	
		S.Em ±		CD at 5%	
Treatments (T)		0.11		0.30	
Storage (S)		0.09		0.24	
Interaction (T×S)		0.21		NS	

A continuous decreasing trend with significant differences was observed in mean b* value for colour during storage. It was 45.95 at the time of preparation which decreased to 37.75 at 90 days of storage. It is clear from the data that the b* value for colour decreased with corresponding decrease in the proportion of pineapple juice in the blended jelly cubes. The observation in accordance with this finding was recorded by Gaikwad (2016) [6] in sapota and beetroot blended jelly for b* value of colour.

Interaction effect between different proportions of pineapple and nutmeg rind juices in blended jelly cubes and storage period was found to be statistically non-significant for mean b* value for colour of the jelly cubes at 5 per cent level of significance.

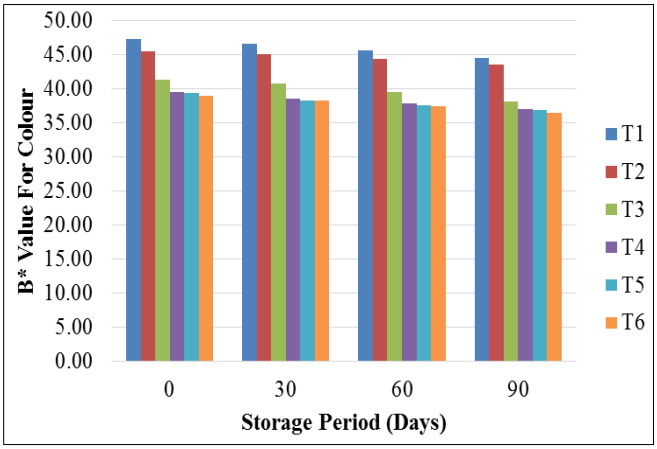


Fig 3: Effect of different proportions of pineapple and nutmeg rind juices on the b* value for colour of blended jelly cubes during storage

3.7 Changes in the sensory quality parameters of the blended pineapple and nutmeg rind jelly cubes during storage

3.7.1 Colour

The data pertaining to the changes in the sensory score for colour of blended pineapple and nutmeg rind jelly cubes during storage are presented in Table 11 and illustrated in the Fig 9. It is evident from the data that the sensory score for colour of the blended pineapple and nutmeg jelly cubes varied significantly due to the treatments as well as storage period.

Maximum (7.72) mean score for colour of jelly was observed in the treatment T_4[pineapple (70%): nutmeg rind (30%)], which was at par with the treatments T_3[pineapple (80%): nutmeg rind (20%)], T_5 [pineapple (60%): nutmeg rind (40%)]and T_6 [pineapple (50%):nutmeg rind (50%)]. Minimum (7.36) mean score for colour of jelly was obtained by the treatment T_1 [pineapple (100%): nutmeg rind (0%)] and it was at par with the treatment T_2 [pineapple (90%): nutmeg rind (10%)]. Thus, it is clear from the data that the sensory score for colour of blended jelly increased with increase in the proportion of nutmeg rind juice in the jelly which imparted attractive red colour to the product. Singh and Chandra (2012) observed similar results in the guava-carrot blended jelly.

The mean sensory score for colour varied significantly during storage period of 90 days. It was highest (8.00) at the time of preparation and lowest (7.13) at 90 days of storage. It was revealed from the data that the likeness for colour of jelly decreased during storage period of 90 days. It might be due to the darkening of the jelly due to browning reactions during storage. Similar trend of decrease in sensory score for colour was observed by Raut (2015) [14] in nutmeg and sapota juice blended jelly and Deokar (2017) [4] in sapota and tamarind blended jelly cubes.

Table 11: Effect of different proportions of pineapple and nutmeg rind juices on the sensory score for colour of blended jelly cubes during storage

Treatments	Sensory score for colour				Mean
	Storage period (Days)				
	0	30	60	90	
T1	7.50	7.47	7.33	7.13	7.36
T2	7.82	7.75	7.40	7.17	7.53
T3	7.93	7.80	7.47	7.20	7.60
T4	8.00	7.97	7.57	7.33	7.72
T5	7.97	7.90	7.53	7.30	7.67
T6	7.87	7.73	7.43	7.23	7.57
Mean	7.84	7.78	7.46	7.23	
		S.Em ±		CD at 5%	
Treatments (T)		0.07		0.20	
Storage (S)		0.06		0.16	
Interaction (T×S)		0.14		NS	

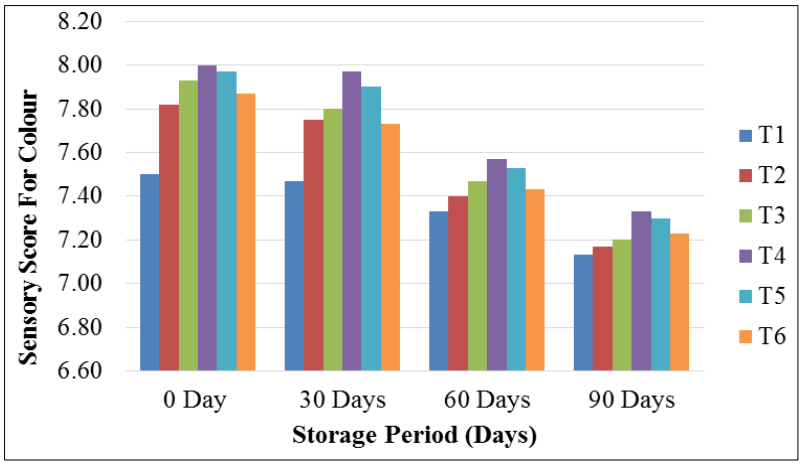


Fig 9: Effect of different proportions of pineapple and nutmeg rind juices on the sensory score for colour of blended jelly cubes during storage

The interaction effect between treatments and storage period was found to be statistically non-significant for sensory score for colour of blended pineapple and nutmeg rind jelly cubes at 5 per cent level of significance.

3.7.2 Flavour

The data related to the sensory score for flavour of blended pineapple and nutmeg rind jelly cubes during storage are presented in Table 12 and graphically illustrated in the Fig 10. It was apparent from the results that the mean sensory score for flavour was varied significantly due to the treatments and storage period. Maximum mean score for flavour (7.71) of the blended jelly was obtained by the treatment T_4 [pineapple (70%): nutmeg rind (30%)], which was at par with the treatments T_3 [pineapple (80%): nutmeg rind (20%)] and T_5 [pineapple (60%): nutmeg rind (40%)]. The treatment T_6 [pineapple (50%): nutmeg rind (50%)] and T_2 [pineapple (90%): nutmeg rind (10%)] showed minimum mean score for flavour (6.98), but at par with the treatments T_1 [pineapple (100%): nutmeg rind (0%)]. This clearly indicates that nutmeg level up to 20 per cent improved the flavour of the blended pineapple and nutmeg rind jelly cubes due to optimum sugar: acid blend in the blended jelly cubes.

Table 12: Effect of different proportions of pineapple and nutmeg rind juices on the sensory score for flavour of blended jelly cubes during storage

Treatments	Sensory score for flavour				Mean
	Storage period (Days)				
	0	30	60	90	
T1	7.43	7.40	7.23	6.67	7.18
T2	7.50	7.37	7.33	6.73	7.23
T3	7.60	7.53	7.37	7.1	7.40
T4	8.07	7.8	7.57	7.4	7.71
T5	7.73	7.63	7.4	7.17	7.48
T6	7.60	7.47	7.00	5.83	7.01
Mean	7.66	7.53	7.32	6.82	
		S.Em ±		CD at 5%	
Treatments (T)		0.12		0.33	
Storage (S)		0.10		0.27	
Interaction (T×S)		0.23		NS	

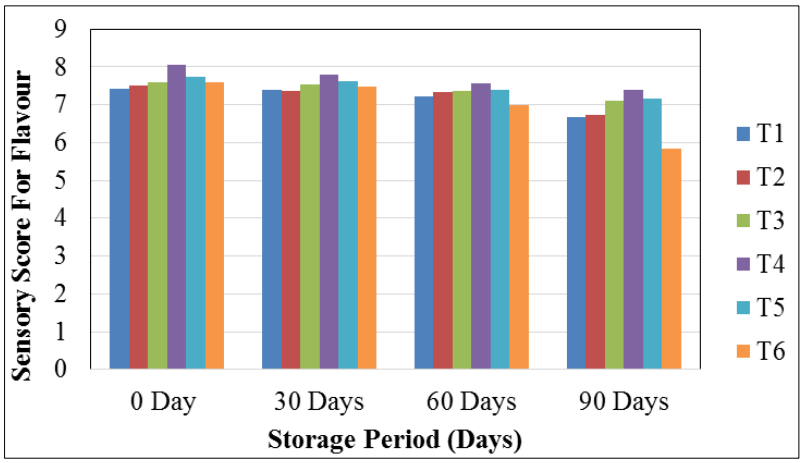


Fig 10: Effect of different proportions of pineapple and nutmeg rind juices on the sensory score for flavour of blended jelly cubes during storage

Regards storage, the mean score for flavour of the blended jelly was decreased significantly during 90 days of storage. It was maximum (8.07) at the time of preparation which decreased to (5.83) at 90 days of storage period. This indicates that as the storage period increased the flavour of blended jelly cubes declined. Deokar (2017) [4] observed same results in sapota and tamarind blended jelly.

The interaction effect between treatments and storage period was found statistically to be non-significant for sensory score for flavour of blended pineapple and nutmeg rind jelly cubes at 5 per cent level of significance.

4.7.3 Texture

The data related to the changes in sensory score for texture of blended pineapple and nutmeg jelly cubes during storage are presented in Table 13 and depicted graphically in Fig 11.

The statistically non-significant differences were observed in the mean score for texture of blended pineapple and nutmeg rind jelly cubes due to the treatments at 5 per cent level of significance.

Table 13: Effect of different proportions of pineapple and nutmeg rind juices on the sensory score for texture of blended jelly cubes during storage

Treatments	Sensory score for texture				Mean
	Storage period (Days)				
	0	30	60	90	
T1	7.87	7.83	7.80	7.60	7.78
T2	7.90	7.87	7.83	7.63	7.81
T3	7.93	7.90	7.87	7.67	7.84
T4	8.00	7.97	7.90	7.8	7.92
T5	7.97	7.93	7.87	7.77	7.88
T6	7.97	7.90	7.83	7.67	7.84
Mean	7.93	7.90	7.85	7.68	
		S.Em ±		CD at 5%	
Treatments (T)		0.07		NS	
Storage (S)		0.06		0.16	
Interaction (T×S)		0.14		NS	

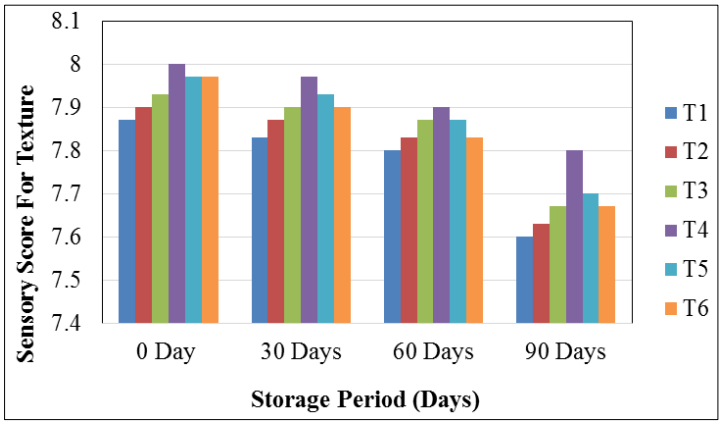


Fig 11: Effect of different proportions of pineapple and nutmeg rind juices on the sensory score for texture of blended jelly cubes during storage

The statistical analysis of sensory score for texture of blended jelly cubes reveals that there was a significant difference in mean score for texture during 90 days of storage period. The mean score for texture of the blended jelly was decreased significantly with increase in the storage period. Maximum mean score for texture (8.00) was obtained at the time of preparation which was decreased to (7.60) at 90 days of storage period. This indicates that as the storage period prolonged the texture of the blended pineapple and nutmeg rind jelly cube declined. Singh and Chandra (2012) recorded similar trend for sensory score for texture of guava and carrot jelly.

The interaction effect between treatments and storage period was found to be statistically non-significant for sensory score for texture of blended pineapple and nutmeg rind jelly cubes at 5 per cent level of significance.

3.7.4 Overall acceptability

The data on the changes in the sensory score for overall acceptability of blended pineapple and nutmeg rind jelly

cubes during storage period are presented in Table 14 and illustrated graphically in the Fig 12.

Table 14: Effect of different proportions of pineapple and nutmeg rind juices on the ensory score for overall acceptability of blended jelly cubes during storage

Treatments	Sensory score for overall acceptability				Mean
	Storage period (Days)				
	0	30	60	90	
T1	7.42	7.39	6.89	6.58	7.07
T2	7.46	7.28	6.83	6.61	7.04
T3	7.62	7.56	7.67	7.33	7.54
T4	7.71	7.80	7.80	7.44	7.69
T5	7.49	7.50	7.56	7.22	7.44
T6	7.60	7.33	7.20	6.99	7.28
Mean	7.54	7.50	7.35	7.04	7.36
		S.Em ±		CD at 5%	
Treatments (T)		0.09		0.24	
Storage (S)		0.07		0.20	
Interaction (T×S)		0.17		NS	

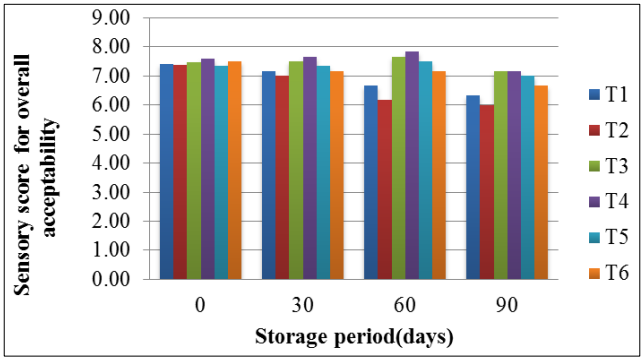


Fig 12: Effect of different proportions of pineapple and nutmeg rind juices on the sensory score for overall acceptability of blended jelly cubes during storage

Non-significant differences were observed in the mean score for overall acceptability of blended pineapple and nutmeg rind jelly cubes due to the treatments at 5 per cent level of significance.

Significant differences were observed in the mean sensory score for overall acceptability of blended pineapple and nutmeg rind jelly cubes during at 90 days of storage period. The mean score for overall acceptability of the blended jelly was decreased significantly with increase in the storage period. Maximum mean score for overall acceptability was (7.71) obtained at the time of preparation which was decreased to (6.58) at 90 days of storage period. Singh and Chandra (2012) recorded similar trend for sensory score for overall acceptability of guava and carrot jelly.

The interaction effect between treatments and storage period was found to be statistically non-significant for sensory score for overall acceptability of blended pineapple and nutmeg rind jelly cubes at 5 per cent level of significance.

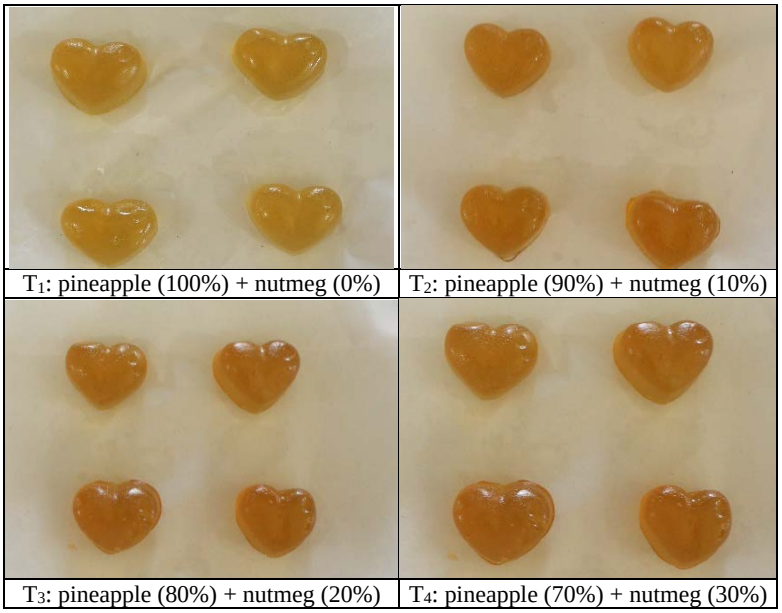
4. Economics of blended pineapple and nutmeg rind jelly cubes

The total cost of production of 100 kg jelly cubes was maximum (Rs. 27710.40) in the treatment T_1 [pineapple (100%): nutmeg rind 0%)], followed by the treatment T_2 [pineapple (90%): nutmeg rind (10%)]. It might be due to higher quantity of costlier pineapple juice required for the preparation of the jelly. The lowest (Rs. 26052.70) cost of production of 100 kg jelly was observed in the treatment T_6 [pineapple (50%): nutmeg rind (50%)] due to low quantity of pineapple juice required for preparation of jelly cubes. It is clear from the economics of 100 kg jelly production that increasing the proportions of pineapple juices in the jelly increased the total cost of production of the blended pineapple and nutmeg jelly cubes.

Sale price of the blended pineapple and nutmeg jelly cubes was evaluated by adding 20 per cent margin to the cost of production. It was observed from the data that the maximum (Rs.66.50 per bottle) sale price was for the treatment T_1 [pineapple (100%): nutmeg rind (0%)]. However, sale price of the jelly prepared from the treatment T_6 [pineapple (50%): nutmeg rind (30%)] was Rs.62.53 per bottle.

Highest net profit (Rs.5542.08) was observed in the treatment T_1 [pineapple (100%): nutmeg rind (0%)] while lowest net profit (Rs. 5210.54) was observed in the treatment T_6 [pineapple (50%): nutmeg rind (50%)].

For the treatment T_4 [pineapple (70%): nutmeg rind (30%)] which was mostly rate by the organoleptically, net profit of (Rs.5290.33) was observed.



T_1: pineapple (100%) + nutmeg (0%) | T_2: pineapple (90%) + nutmeg (10%)

T_3: pineapple (80%) + nutmeg (20%) | T_4: pineapple (70%) + nutmeg (30%)

	
T_5: pineapple (60%) + nutmeg (40%)	T_6: pineapple (50%) + nutmeg (50%)

Plate 1: Effect of pineapple and nutmeg juices on the blended jelly cubes at 30 day of storage

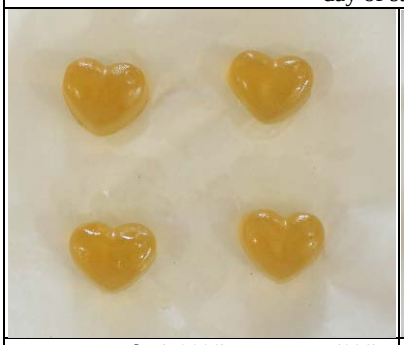
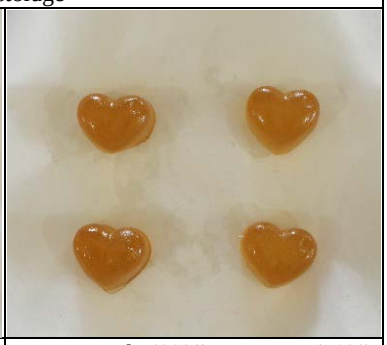
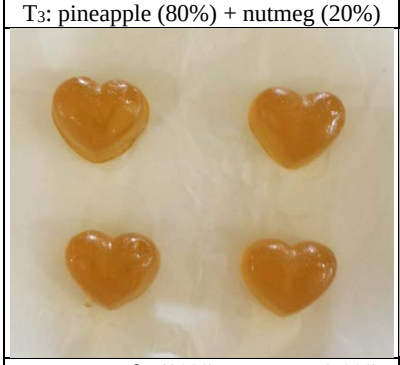
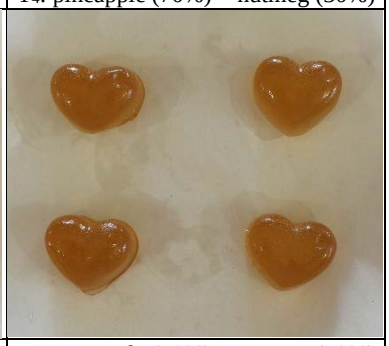
	
T_1: pineapple (100%) + nutmeg (0%)	T_2: pineapple (90%) + nutmeg (10%)
	
T_3: pineapple (80%) + nutmeg (20%)	T_4: pineapple (70%) + nutmeg (30%)
	
T_5: pineapple (60%) + nutmeg (40%)	T_6: pineapple (50%) + nutmeg (50%)

Plate 2: Effect of pineapple and nutmeg juices on the blended jelly cubes after 60 days of storage

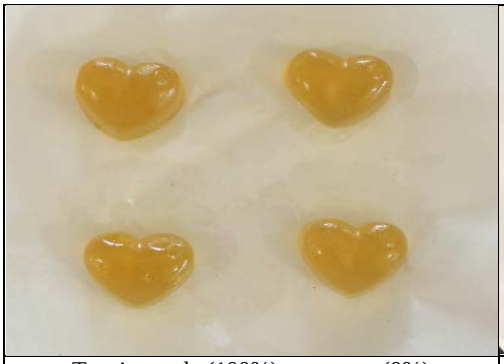
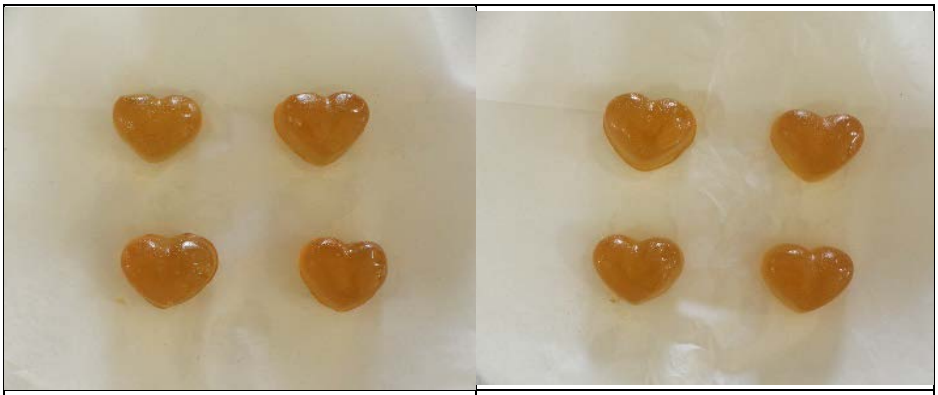
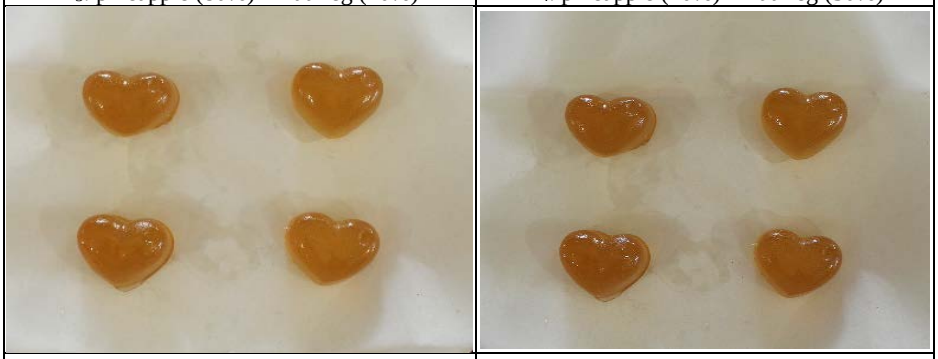
	
T_1: pineapple (100%) + nutmeg (0%)	T_2: pineapple (90%) + nutmeg (10%)
	
T_3: pineapple (80%) + nutmeg (20%)	T_4: pineapple (70%) + nutmeg (30%)
	
T_5: pineapple (60%) + nutmeg (40%)	T_6: pineapple (50%) + nutmeg (50%)

Plate 3: Effect of pineapple and nutmeg juices on the blended jelly cubes after0 days of storage

	
T_1: pineapple (100%) + nutmeg (0%)	T_2: pineapple (90%) + nutmeg (10%)



T_3: pineapple (80%) + nutmeg (20%) | T_4: pineapple (70%) + nutmeg (30%)



T_5: pineapple (60%) + nutmeg (40%) | T_6: pineapple (50%) + nutmeg (50%)

Plate 4: Effect of pineapple and nutmeg juices on the blended jelly cubes after 90 days of storage

5. Conclusion and Future scope

It was observed from the data that the blended pineapple and nutmeg rind jelly cubes irrespective of ratios were acceptable during three months of storage at ambient conditions. Blending of pineapple and nutmeg rind improved physical and sensory quality characteristics like colour, flavour, etc. of the jelly. The sensory evaluation of jelly revealed that the colour, flavour and firmness of the jelly retained upto 90 days of storage period at ambient conditions. Blending of pineapple with nutmeg rind improved colour and flavour of the blended jelly. Based on the organoleptic evaluation and economics of the jelly, it is concluded that the blended pineapple and nutmeg rind jelly cubes could be prepared successfully by blending pineapple and nutmeg rind juice in the ratio of T_4 [pineapple (70%): nutmeg rind (30%)].

Future scope for blended pineapple and nutmeg rind jelly cubes was also that helps whole utilization of wasted nutmeg rinds with increasing value addition of pineapple juice which helps to increases nutritional value as well as farmers income.

6. Acknowledgement

I extend my sincere thanks to Dr. K. H. Pujari (Guide/Chairman and Associate Dean, PGI-PHM, Killa-Roha) and to my advisory committee members for giving me proper guidance throughout the course of study. I also sincerely thank Post Graduate Institute of Post-Harvest Management, Killa-Roha (Dr. Balasaheb Sawant Konkan Krishi Vidhyapeeth, Dapoli) for supporting the research financially.

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