

Standardisation and quality evaluation of jam using tender coconut pulp and fruit pulp

E. Shahanas*, Seeja Thomachan Panjikkaran, K.T. Suman, E.R. Aneena and C.L. Sharon

Department of Community Science,

College of Horticulture, Kerala Agricultural University, Thrissur-680 656, Kerala, India.

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ABSTRACT

Jam was standardised by incorporating tender coconut pulp at various levels with fruit pulp of pineapple, mango, grapes and papaya. On the basis of nutritional qualities, jam prepared with 25% TCP Tender coconut pulp and 75% pineapple pulp were found to be the best. Jam prepared with 25% TCP and 75% blended fruit pulp were organoleptically more acceptable. The highest gel strength was observed for jam prepared with 25% tender coconut pulp and 75 % blended fruit pulp. The maximum adhesiveness was in the jam prepared using 100% tender coconut pulp. Acidity, moisture, TSS and reducing sugar of the products slightly increased during storage. However, a decreasing trend was observed in the case of total sugar content during storage. The highest fat content was observed in jam prepared using 100% TCP. The mineral content gradually decreased with advancement of storage period.

Key words: Fruit pulp, Organoleptic evaluation, Physico-chemical qualities, Tender coconut pulp (TCP).

INTRODUCTION

Fresh and nutritious tender coconut water is the most refreshing thirst quencher, rich in potassium and other minerals. Young tender coconuts which consist of a soft white flesh and sweet aromatic juice are widely preferred and consumed. The flesh of the young coconut is an albuminous endosperm which is white in colour, edible, soft and more jelly like. It is sweet to taste and is relatively high in minerals such as iron, phosphorus and zinc (Silva and Bamunurachchi, 2009). The residual pulp left after removal of water from the kernels can be converted into value added products such as jam. Jam is an intermediate moisture food prepared by boiling fruit pulp with sugar, pectin, acid and other ingredients (preservatives, colouring and flavouring materials) to a reasonably thick consistency firm enough to hold the fruit tissues in position (Lal *et al*, 1998). Jams can be prepared from single fruit or in combination with two or more fruits (Manay and Shadaksharaswamy, 2005).

Even though India is a major producer of coconut, only 2% is utilized for value addition and industrial purposes (Muralidharan and Jayashree, 2011). Tender coconuts are generally cut and the inside water is consumed as such as a drink or used for the development of beverages.

Coconut water industry is picking up with coconut water in bottles and tetra packs which is mostly exported. However, the food use of residual pulp left after removal of water from the kernels has not been explored much. Thus, it has become essential to give emphasis to evolve technologies for the development of value added products from coconut

and tender coconut. It will also ensure stability to coconut based economy. Hence, the study is conducted to utilise residual tender coconut pulp for the development of blended products in combination with other fruit pulps.

The study is aims to develop jams in combination with tender coconut pulp and different fruit pulp with improved nutritional and organoleptic qualities.

MATERIALS AND METHODS

Raw Materials: Tender coconuts of around 7-8 months old and fruits like pineapple, mango, grapes and papaya were procured from the local markets. Flesh of the young coconut with albuminous endosperm, white in colour, edible and soft was selected for the study.

Preparation of jam: Jam was prepared using tender coconut pulp (TCP) as the base and blended with fruit pulp (FP) of different fruits at various proportions as per the treatment combinations *viz.* tender coconut pulp (TCP) and fruit pulp at the ratio of 75:25, 50:50 and 25:75 (Table 1). The experiment was conducted in CRD with three replications.

The mixture of tender coconut pulp and fruit pulp were taken in required ratio in an open pan and heated continuously with above ingredients. Heating was stopped when the TSS reached 68-69°Brix, and filled in clean sterilized and dried glass bottles of 200 ml capacity and sealed air tight. The bottles were then stored in ambient condition for storage study. Organoleptic evaluation of the products was carried out initially and at monthly intervals for a period of six months. Evaluation of jam were conducted

*Corresponding author's e-mail: shahanasjam@gmail.com

Table 1: Quantity of ingredients used to prepare jams.

Treatments	Pulp concentration	Sugar (gm)	Pectin (gm)	Citric acid (gm)
T ₁	TCP 100	100	1	0.5
T ₂	TCP 75: Pi 25	100	1	0.5
T ₃	TCP 50: Pi 50	100	1	0.5
T ₄	TCP 25: Pi 75	100	1	0.5
T ₅	TCP 75 : M 25	100	1	0.5
T ₆	TCP 50 : M 50	100	1	0.5
T ₇	TCP 25 : M 75	100	1	0.5
T ₈	TCP 75 : G 25	100	1	0.5
T ₉	TCP 50 : G 50	100	1	0.5
T ₁₀	TCP 25 : G 75	100	1	0.5
T ₁₁	TCP 75 : P 25	100	1	0.5
T ₁₂	TCP 75 : P 25	100	1	0.5
T ₁₃	TCP 75 : P25	100	1	0.5
T ₁₄	TCP75:Pi+ M+G+P 25	100	1	0.5
T ₁₅	TCP50:Pi+ M+G+P 50	100	1	0.5
T ₁₆	TCP25:Pi+ M+G+P 75	100	1	0.5

TCP- Tender coconut Pulp, Pi- Pineapple , M- Mango , G- Grapes , P- Papaya

using score card by a panel of 10 judges and the quality attributes such as appearance, colour, flavour, texture, taste and overall acceptability were assessed by a nine point hedonic scale.

Selection of Jam: The scores for appearance, colour, flavour, texture, taste and overall acceptability obtained for the 16 treatments with fruit pulps were analysed by Kendall Wallace Analysis of variance to select the most acceptable jam. Based on overall acceptability scores, most acceptable jam, one each from the five fruit pulps were selected for storage study. Thus, a total of six treatments (including control) were selected for further study.

Physico-chemical analysis: The selected products subjected to storage study were evaluated for the following physico-chemical properties initially and at monthly intervals for a period of six months.

Texture analysis: This important quality parameter which affects the consumer acceptability of jam was determined using Texture Analyser (Stable Micro Systems, UK). The instrument had a micro processor regulated texture analysis system interfaced to a personal computer. The instrument consists of two separate modules; the test bed and the control console (keyboard). Both are linked by a cable which route low voltage signal and power through it. The texture analyser measures force, distance and time and hence provide a three-dimensional product analysis. Forces may be measured to achieve set distances and distances may be measured to achieve set forces.

The sample was kept on the flat platform of the instrument and was subjected to double compression by a cylindrical probe with 5mm diameter. The test was conducted at a speed of 10 mm/s using 50 N load cell. The sample was allowed for double compression of 40% with trigger force of 0.5 kg and various textural parameters *viz.* gel strength,

rupture strength, brittleness and adhesiveness were determined from the force deformation curve.

Total soluble solids (TSS): TSS of the products was recorded using an Erma hand juice brix refractometer at room temperature and the values were expressed in degree brix (Ranganna, 1986).

pH: The pH of the products was measured using food grade pH meter. The solution for reading pH was prepared in a ratio of 1:10 (Berwal *et al.*, 2004)

Reducing sugar: Reducing sugar in the products was estimated by adopting the method given by Lane and Eyon (Ranganna, 1986). To 5 g of the product, 25 ml distilled water was added and then filtered and transferred to a 250 ml conical flask, then neutralized by 1 N sodium hydroxide using phenolphthalein as indicator. The solution was clarified with lead acetate and then added potassium oxalate to settle down the precipitate. The filtered solution was made up to a volume of 250 ml. An aliquot of the solution was titrated against a mixture of Fehling's solution A and B using methylene blue as indicator. The reducing sugar was expressed as percentage.

Total sugar: The total sugar was determined using the method given by Lane and Eyon (Ranganna, 1986). From the clarified solution used for the estimation of reducing sugar, 50 ml was taken and boiled gently after adding citric acid and water. It was then neutralised with sodium hydroxide and the volume was made up to 250 ml. An aliquot of this solution was titrated against Fehlings solution A and B. The total sugar content was expressed as percentage.

Moisture: Moisture content of the products were estimated by the method of A.O.A.C (1980). To determine the moisture content, ten grams of the sample was taken in a petridish and dried at 60 to 70°C in a hot air oven, cooled in a

Desiccator and weighed. The process of heating and cooling was repeated till constant weight. The moisture content of the sample was calculated from the loss in weight during drying.

Fat: The fat content of the products was estimated using the method A. O. A. C. (1980). Five grams of the product was taken in a thimble and plugged with cotton. The material was extracted with petroleum ether for six hours without interruption by gentle heating in a Soxhlet apparatus. The extraction flask was then cooled and ether removed by heating and then the weight was taken. The fat content was expressed in $g\ 100\ g^{-1}$ of the sample.

Calcium: The calcium content of the sample was estimated by atomic absorption spectrophotometric method using the diacid extract prepared from the sample (Perkin-Elmer 1982). A sample of 0.20 g was predigested with 10 ml of 9:4 mixture of nitric acid and perchloric acid and made up the volume to 50 ml and used directly in atomic absorption spectrophotometer for the estimation of calcium and expressed in $mg\ 100\ g^{-1}$ of sample.

Iron: The iron content was estimated by atomic absorption spectrophotometric method using the diacid extract prepared from the sample (Perkin-Elmer 1982). The prepared diacid extract was directly read in atomic absorption spectrophotometer. The iron content was expressed in $mg\ 100\ g^{-1}$ of the sample.

Zinc: The zinc content of the products was estimated by atomic absorption spectrophotometric method using the diacid extract prepared from the sample (Perkin-Elmer, 1982).

The diacid solution was directly read in atomic absorption spectrophotometer to find out the zinc content and expressed in $mg\ 100\ g^{-1}$ of sample.

Sodium: The sodium content of the product was estimated using flame photometer as suggested by Jackson (1973). The diacid extract prepared was directly read in the flame photometer and sodium content was expressed in $mg\ 100\ g^{-1}$ of sample.

Potassium: The potassium content of the product was estimated using the same procedure used for estimation of sodium suggested by Jackson (1973) and the content was expressed in $mg\ 100\ g^{-1}$ of the jam.

Microbial enumeration of the selected products during storage: The selected jam was evaluated for the presence of bacteria, fungi and yeast initially and at the end of the storage period. The method used for evaluation was serial dilution and plate count method. Ten ml of sample was added to 90 ml of sterile water and shaken for 20 minutes. One ml of this solution was transferred to a test tube containing 9 ml of sterile water to get 10^{-2} dilution and similarly 10^{-3} , 10^{-4} , 10^{-5} and 10^{-6} dilutions were also prepared (Agarwal and Hasija, 1986).

Enumeration of total micro flora was carried out using Nutrient Agar media for bacteria, Potato Dextrose Agar media for fungi and Sabouraud's Dextrose Agar media for yeast.

Statistical analysis: The observations recorded were tabulated and the data was analysed statistically using Completely Randomised Design. The scores of organoleptic evaluation were assessed by Kendall's Coefficient of Concordance (W) and quality evaluation of jam during storage was analysed using one way ANOVA.

RESULTS AND DISCUSSION

Organoleptic evaluation of jam: The mean score obtained for different quality attributes of blended jam prepared using tender coconut pulp and fruit pulp in three proportions are presented in Table 2. Based on Kendall's (w) value, significant agreement among the judges was noticed in the evaluation of different quality attributes of tender coconut blended jams. The highest overall acceptability scores were attained for treatments T_4 , T_6 , T_{10} , T_{11} and T_{16} with scores of 8.9, 8.1, 8.8, 8.9 and 8.8 respectively.

Products selected for the storage study: Thus, from the preliminary study, the treatments T_1 (100% Tender Coconut Pulp), T_4 (25% TCP + 75% PiP), T_6 (50% TCP + 50% MP), T_{10} (25% TCP + 75% GP), T_{11} (75% TCP + 25% PP) and T_{16} (25% TCP + 75% (PiP, MP, GP and PP)) were selected for detailed study.

Physico-Chemical Characteristics of selected tender coconut jam during storage.

Textural property: The textural quality parameters such as gel strength, adhesiveness, brittleness and rupture strength of the tender coconut blended jams were evaluated using a Texture Analyser in freshly prepared jam.

The gel strength of the jam varied from 0.2640 N to 0.0333 N (Table 3). The highest value for gel strength of jam was noticed in the jam prepared using 25% TCP + 75% blended pulp (T_{16}) and was statistically significant. This was followed by jam prepared using 100% TCP.

The adhesiveness of the jam varied from 0.0229 N to 0.6075 N with the maximum adhesiveness in the jam prepared using 100% tender coconut pulp (T_1) followed by the jam prepared using 75% TCP and 25% papaya pulp and T_6 (50% TCP + 50% mango pulp).

The brittleness of the jam varied from 58.489 mm to 104.26 mm with the maximum brittleness (the lowest value of brittleness in mm) of 58.489, was recorded in jam prepared using 25% TCP and 75% grapes pulp and the lowest brittleness (highest value of 104.26 mm) was noticed for 25% TCP and 75% pineapple jam.

Among the jams, the highest rupture strength of 0.2996 N was recorded in jams prepared using 25% TCP and 75% grapes pulp (T_{10}) and was statistically significant. The lowest rupture strength was recorded in jam prepared using 50% TCP and 50% mango pulp (Table 3).

Chemical constituents of selected products: The chemical constituents like pH, moisture content, total soluble solids, reducing sugar, total sugar, fat, sodium, potassium, phosphorus, calcium, iron and zinc present in the selected tender coconut blended jam were estimated initially and at monthly intervals for a period of six months and analysed statistically using one way ANOVA. (Table 4,5,6,7,8 and 9)

pH: pH of various treatments during each month of storage was interpreted using one way ANOVA (Table 4). No significant difference in acidity was observed in majority of treatments (T_1 , T_4 , T_{10} , T_{11} and T_{16}) at the end of first month of storage. The same trend was observed for acidity at the end of second month of storage. The least acidity (4.34 per cent) was observed in jam prepared using 100 per cent tender coconut pulp. The highest acidity among all treatments right from

the freshly prepared till the end of six months of storage study was recorded in T_{10} ranging from 3.37 per cent to 3.12 per cent.

No significant difference in moisture content was observed in treatments T_4 , T_6 and T_{11} at the end of first and second month of storage. After the end of 4th month of storage up to the end of six month of storage no significant difference was observed in all treatments statistically. The highest moisture content among all treatments from initial to the end of six month of storage was recorded in T_{16} ranging from 23.41 per cent to 27.51 per cent (Table 5).

No significant difference in TSS was observed initially and at the end of first month of storage between all treatments of blended tender coconut jams. A slight increase in TSS was observed after the end of first month of storage for all treatments (Table 6).

Table 2: Organoleptic evaluation of jam.

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
T_1 - (100% TCP)	7.4(3.50)	7.4(3.80)	7.2(3.25)	7.6(3.90)	7.3(3.40)	7.3(3.45)
T_2 - (75% TCP + 25% PiP)	8.0(1.10)	7.7(1.00)	7.8(1.25)	7.8(1.00)	7.7(1.05)	7.8(1.00)
T_3 - (50% TCP + 50% PiP)	8.7(2.25)	8.5(2.30)	8.5(2.40)	8.5(2.20)	8.4(2.25)	8.6(2.20)
T_4 - (25% TCP + 75% PiP)	8.9(2.65)	8.9(2.70)	8.4(2.35)	8.6(2.80)	8.8(2.70)	8.9(2.80)
T_5 - (75% TCP + 25% MP)	7.8(1.95)	8.1(2.30)	7.9(1.85)	7.7(1.70)	7.7(1.95)	8.0(1.70)
T_6 - (50% TCP + 50% MP)	8.0(2.15)	8.0(2.05)	8.1(2.45)	8.0(2.45)	8.1(2.35)	8.1(2.45)
T_7 - (25% TCP + 75% MP)	8.0(1.90)	7.7(1.65)	7.9(1.70)	7.9(1.85)	7.9(1.70)	7.8(1.85)
T_8 - (75% TCP + 25% GP)	7.3(1.15)	7.4(1.05)	7.4(1.05)	7.7(1.35)	7.8(1.15)	7.7(1.35)
T_9 - (50% TCP + 50% GP)	8.0(1.85)	8.1(1.95)	8.1(2.00)	8.3(1.80)	8.1(1.85)	8.1(1.80)
T_{10} - (25% TCP + 75% GP)	8.9(3.00)	8.9(3.00)	8.9(2.95)	8.8(2.85)	8.8(3.00)	8.8(2.85)
T_{11} - (75% TCP + 25% PP)	8.9(3.00)	8.8(2.85)	8.6(2.95)	8.3(2.85)	8.5(3.00)	8.9(2.85)
T_{12} - (50% TCP + 50% PP)	7.8(1.80)	7.4(1.40)	7.7(1.90)	7.9(1.50)	7.8(1.45)	7.8(1.50)
T_{13} - (25% TCP + 75% PP)	7.4(1.20)	7.5(1.75)	7.5(1.35)	7.9(1.65)	7.8(1.55)	7.9(1.65)
T_{14} - (75% TCP + 25% PiP, MP, GP and PP in equal proportions)	7.6(1.25)	7.5(1.15)	7.4(1.15)	7.7(1.05)	7.3(1.20)	7.4(1.05)
T_{15} - (50% TCP + 50% PiP, MP, GP and PP in equal proportions)	7.9(1.80)	8.0(1.85)	7.9(1.85)	8.1(1.95)	7.9(1.80)	7.9(1.95)
T_{16} - (25% TCP + 75% PiP, MP, GP and PP in equal proportions)	8.9(2.95)	8.9(3.00)	8.7(3.00)	8.7(3.00)	8.8(3.00)	8.8(3.00)
Kendall's value	0.723**	0.600**	0.591**	0.884**	0.786**	0.884**

Values in parentheses is mean rank score based on Kendall's W

** Significant at 1% level TCP- Tender coconut Pulp, PiP- Pineapple Pulp, MP- Mango Pulp, GP- Grapes Pulp, PP- Papaya Pulp

Table 3: Textural properties of freshly prepared blended jam.

Treatments	Textural properties			
	Gel Strength (N)	Adhesiveness (N)	Brittleness (mm)	Rupture Strength (N)
T_1 - (100% TCP)	0.0321 ^b	0.6075 ^a	67.143 ^{cd}	0.0839 ^d
T_4 - (25% TCP + 75 % PiP)	0.0264 ^c	0.0218 ^c	104.26 ^a	0.0975 ^d
T_6 - (50% TCP + 50 % MP)	0.0275 ^d	0.1201 ^c	91.634 ^b	0.0425 ^e
T_{10} - (25% TCP + 75 % GP)	0.0286 ^c	0.1126 ^c	58.489 ^d	0.2996 ^a
T_{11} - (75% TCP + 25 % PP)	0.0286 ^c	0.1548 ^b	65.476 ^{cd}	0.1331 ^c
T_{16} - (25% TCP + 75 % PiP, MP, GP and PP)	0.0333 ^a	0.0635 ^d	74.444 ^c	0.2054 ^b
Commercial pineapple jam	0.0233 ^e	0.0218 ^c	102.78 ^a	0.0846 ^d
Commercial mixed fruit jam	0.0341 ^a	0.0618 ^d	75.231 ^c	0.2021 ^b

TCP- Tender coconut Pulp, PiP- Pineapple Pulp, MP- Mango Pulp, GP- Grapes Pulp, PP- Papaya Pulp

Means in each column with atleast one letter in common are not significantly different at 1 % level of probability.

Based on one way ANOVA, significant variation in the initial values of reducing sugar content was observed only for the jam prepared using 25% TCP + 75% GP (T₁₀) and 75% TCP + 25% PP (T₁₁). All other freshly prepared

tender coconut jams were found to be on par when analysed statistically. Among the prepared jams, the lowest reducing sugar content was observed in jam prepared using 25% TCP + 75% GP (T₁₀) which varied from 13.73 g/100g to 14.92 g/100g (Table 7).

Table 4: Acidity of blended jam during storage.

Treatments	Acidity (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS
T ₁ - (100% TCP)	4.34 ^a	4.23 ^a (2.53)	4.15 ^a (1.89)	■	■	■	■
T ₄ - (25% TCP + 75 % PiP)	3.73 ^c	3.62 ^c (2.94)	3.55 ^b (1.93)	3.52 ^b (0.84)	3.51 ^a (0.28)	3.46 ^a (1.42)	3.42 ^a (1.15)
T ₆ - (50% TCP + 50 % MP)	4.10 ^b	4.02 ^{ab} (1.95)	3.97 ^a (1.24)	3.91 ^a (1.51)	3.44 ^b (12.02)	■	■
T ₁₀ - (25% TCP + 75 % GP)	3.37 ^d	3.29 ^d (2.37)	3.26 ^c (0.91)	3.21 ^c (1.53)	3.18 ^c (0.93)	3.16 ^b (0.62)	3.12 ^b (1.26)
T ₁₁ - (75% TCP + 25 % PP)	4.11 ^b	3.96 ^b (3.64)	3.93 ^{ab} (0.75)	■	■	■	■
T ₁₆ - (25% TCP + 75 % PiP, MP, GP and PP)	3.60 ^c	3.53 ^c (1.94)	3.52 ^b (0.28)	3.48 ^b (1.13)	3.44 ^b (1.14)	3.41 ^a (0.87)	3.37 ^a (1.17)

TCP- Tender coconut Pulp, PiP- Pineapple Pulp, MP- Mango Pulp, GP- Grapes Pulp, PP- Papaya Pulp. MAS- Months after storage
 ■ - Spoiled

Values with same alphabet for different treatments represented in each column form a homogenous group

Figures in parentheses indicates per cent deviation over the previous month.

Means in each column with atleast one letter in common are not significantly different at 1 % level of probability.

Table 5: Moisture of blended jam during storage.

Treatments	Moisture (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS
T ₁ - (100% TCP)	23.38 ^a	23.78 ^a (1.71)	24.80 ^a (4.28)	■	■	■	■
T ₄ - (25% TCP + 75 % PiP)	22.48 ^{ab}	22.59 ^a (0.48)	22.64 ^{ab} (0.22)	23.53 ^{ab} (3.93)	24.82 ^b (5.48)	26.22 ^a (5.64)	27.07 ^a (3.24)
T ₆ - (50% TCP + 50 % MP)	19.53 ^c	20.13 ^b (3.07)	21.03 ^b (4.47)	22.53 ^b (7.01)	23.80 ^b (5.63)	25.86 ^a (8.65)	26.83 ^a (3.75)
T ₁₀ - (25% TCP + 75 % GP)	19.53 ^c	20.13 ^b (3.07)	21.03 ^b (4.47)	22.53 ^b (7.01)	23.80 ^b (5.63)	25.86 ^a (8.65)	26.83 ^a (3.75)
T ₁₁ - (75% TCP + 25 % PP)	21.53 ^{bc}	22.05 ^{ab} (2.41)	22.92 ^{ab} (3.94)	■	■	■	■
T ₁₆ - (25% TCP + 75 % PiP, MP, GP and PP)	3.60 ^c	3.53 ^c (1.94)	3.52 ^b (0.28)	3.48 ^b (1.13)	3.44 ^b (1.14)	3.41 ^a (0.87)	3.37 ^a (1.17)

TCP- Tender coconut Pulp, PiP- Pineapple Pulp, MP- Mango Pulp, GP- Grapes Pulp, PP- Papaya Pulp. MAS- Months after storage
 ■ - Spoiled

Values with same alphabet for different treatments represented in each column form a homogenous group

Figures in parentheses indicates per cent deviation over the previous month

Means in each column with atleast one letter in common are not significantly different at 1 % level of probability

Table 6: TSS of blended jam during storage.

Treatments	TSS(°brix)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS
T ₁ - (100% TCP)	68.33 ^{ab}	68.44 ^{ab} (0.160)	69.00 ^b (0.81)	■	■	■	■
T ₄ - (25% TCP + 75 % PiP)	68.33 ^a	68.89 ^a (0.0)	70.11 ^a (1.77)	71.00 ^a (1.26)	71.55 ^a (0.77)	72.22 ^a (0.93)	73.00 ^a (1.08)
T ₆ - (50% TCP + 50 % MP)	67.89 ^{bc}	67.89 ^b (0.0)	68.67 ^b (1.14)	69.00 ^b (0.28)	70.00 ^b (1.44)	■	■
T ₁₀ - (25% TCP + 75 % GP)	68.11 ^b	68.44 ^{ab} (1.30)	69.33 ^b (1.30)	70.00 ^{bc} (0.96)	71.00 ^a (1.42)	71.67 ^b (0.94)	72.00 ^b (0.46)
T ₁₁ - (75% TCP + 25 % PP)	68.66 ^a	68.66 ^b (0)	69.33 ^b (0.97)	■	■	■	■
T ₁₆ - (25% TCP + 75 % PiP, MP, GP and PP)	68.00 ^b	68.00 ^b (0)	68.89 ^b (1.30)	69.55 ^{cd} (0.95)	70.00 ^b (0.64)	71.33 ^b (1.9)	72.00 ^b (0.93)

TCP- Tender coconut Pulp, PiP- Pineapple Pulp, MP- Mango Pulp, GP- Grapes Pulp, PP- Papaya Pulp. MAS- Months after storage
 ■ - Spoiled

Values with same alphabet for different treatments represented in each column form a homogenous group

Figures in parentheses indicates per cent deviation over the previous month

Means in each column with atleast one letter in common are not significantly different at 1 % level of probability

The total sugar content of blended tender coconut products had no significant difference between the treatments T₁, T₄, T₆, T₁₀, T₁₁ and T₁₆ at the end of 1st and 2nd month of storage. No significant difference was observed for jams till the end of fifth month of storage for T₄, T₆, T₁₀, and T₁₆. The remaining treatments for jams were spoiled from third month onwards (Table 8).

The highest fat content was observed in jam prepared using 100% TCP which varied from 2.21 to 2.06 per cent. The lowest fat content among all treatments right from the freshly prepared till the end of six months of storage study was recorded in T₄ (25% TCP + 75% PiP) ranging from 1.14 to 0.93 per cent. A steady decrease in fat content during storage was observed among all treatments (Table 9).

A decrease in calcium content with advancement of storage was observed in all treatments. It is evident from the line graph (Fig 1) that, the highest calcium content was seen in jam prepared using 25% TCP + 75% grapes pulp (T₁₀). The lowest calcium content was recorded for the jam prepared using 100% TCP (T₁).

The jam prepared with 25% TCP and 75% Pineapple pulp (T₄) recorded the highest value for the iron

content. The lowest iron content during the entire period was noticed in T₁₀ (25% TCP+75% GP). A negligible decrease in iron content with advance of storage was noticed in all treatments (Fig 2).

The initial zinc content was maximum in T₁₁ (3.32 mg/ 100g) and there was a general decrease in zinc content during storage (Fig 3). Comparatively, the reduction in zinc content was drastic in all treatments.

Maximum sodium content was observed in jam prepared using 75% TCP+ 25% PP (T₁₁). Fig 4 shows that sodium content of blended tender coconut products decreased with advancement in storage period.

Initially, the highest potassium content was observed in T₁ and T₆ and least was observed in T₁₀. The Fig 5 shows that the potassium content of blended tender coconut products decreased during storage. A low potassium content was noticed in T₁₀ (25% TCP +75% GP) from the freshly prepared till the end of six months of storage period.

Based on visual observation (fungal contamination) the products were discarded from shelf life studies. The treatments T₁ (control) and T₁₁ (75% TCP + 25 % PP) were discarded at the end of second month of storage. The

Table 7: Reducing sugar of blended jam during storage.

Treatments	Reducing sugar (g/100g)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS
T ₁ - (100% TCP)	19.58 ^a	20.65 ^a (5.46)	20.84 ^b (0.92)	■	■	■	■
T ₄ - (25% TCP + 75 % PiP)	20.68 ^a	21.86 ^b (3.43)	22.51 ^b (2.97)	23.50 ^a (4.39)	23.96 ^a (1.95)	24.17 ^a (0.87)	24.47 ^a (1.24)
T ₆ - (50% TCP + 50 % MP)	18.92 ^{ab}	19.57 ^d (3.43)	20.12 ^d (2.81)	20.53 ^b (2.03)	20.87 ^b (1.65)	■	■
T ₁₀ - (25% TCP + 75 % GP)	13.73 ^c	14.29 ^c (4.07)	14.44 ^c (1.04)	14.58 ^c (0.96)	14.67 ^c (0.61)	14.86 ^b (1.29)	14.92 ^c (0.40)
T ₁₁ - (75% TCP + 25 % PP)	17.58 ^b	18.29 ^c (4.03)	17.72 ^c (3.11)	■	■	■	■
T ₁₆ - (25% TCP + 75 % PiP, MP, GP and PP)	19.58 ^a	20.38 ^{ab} (4.08)	20.67 ^b (1.42)	21.65 ^{ab} (4.74)	21.94 ^b (1.33)	22.36 ^a (1.91)	22.51 ^b (0.67)

TCP- Tender coconut Pulp, PiP- Pineapple Pulp, MP- Mango Pulp, GP- Grapes Pulp, PP- Papaya Pulp. MAS- Months after storage
 ■ - Spoiled

Values with same alphabet for different treatments represented in each column form a homogenous group

Figures in parentheses indicates per cent deviation over the previous month

Means in each column with atleast one letter in common are not significantly different at 1 % level of probability

Table 8: Total sugar of blended jam during storage.

Treatments	Total sugar (g/100g)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS
T ₁ - (100% TCP)	41.74 ^b	40.74 ^c (2.39)	39.85 ^c (2.78)	■	■	■	■
T ₄ - (25% TCP + 75 % PiP)	49.17 ^a	47.00 ^b (2.39)	46.51 ^b (2.18)	45.43 ^a (2.32)	43.25 ^a (4.79)	40.40 ^a (6.58)	37.42 ^b (7.37)
T ₆ - (50% TCP + 50 % MP)	52.08 ^a	51.19 ^a (1.70)	51.19 ^a (0)	48.13 ^a (5.97)	45.44 ^a (5.38)	■	■
T ₁₀ - (25% TCP + 75 % GP)	36.86 ^b	34.51 ^d (6.37)	34.31 ^d (0.57)	33.70 ^b (1.77)	32.72 ^b (2.90)	31.80 ^b (2.81)	30.75 ^c (3.30)
T ₁₁ - (75% TCP + 25 % PP)	43.43 ^b	42.33 ^{bc} (2.53)	40.72 ^c (3.80)	■	■	■	■
T ₁₆ - (25% TCP + 75 % PiP, MP, GP and PP)	53.23 ^a	50.29 ^a (5.52)	49.00 ^a (2.56)	47.58 ^{ab} (2.9)	45.56 ^a (4.24)	44.39 ^a (2.56)	42.25 ^a (4.82)

TCP- Tender coconut Pulp, PiP- Pineapple Pulp, MP- Mango Pulp, GP- Grapes Pulp, PP- Papaya Pulp. MAS- Months after storage
 ■ - Spoiled

Values with same alphabet for different treatments represented in each column form a homogenous group

Figures in parentheses indicates per cent deviation over the previous month

Means in each column with atleast one letter in common are not significantly different at 1 % level of probability

Table 9: Fat content of blended jam during storage.

Treatments	Fat (g/100g)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS
T ₁ - (100% TCP)	2.21 ^a	2.13 ^a (3.61)	2.06 ^a (3.2)	■	■	■	■
T ₄ - (25% TCP + 75 % PiP)	1.14 ^d	1.11 ^{cd} (2.63)	1.08 ^c (2.70)	1.02 ^d (5.55)	0.98 ^c (3.92)	0.95 ^b (3.06)	0.93 ^b (2.10)
T ₆ - (50% TCP + 50 % MP)	1.51 ^c	1.44 ^{cd} (4.63)	1.40 ^c (2.77)	1.37 ^{bc} (2.14)	1.29 ^{ab} (5.83)	■	■
T ₁₀ - (25% TCP + 75 % GP)	1.40 ^c	1.38 ^d (1.42)	1.33 ^c (3.62)	1.22 ^c (8.27)	1.17 ^b (4.09)	1.08 ^b (7.69)	1.05 ^a (2.77)
T ₁₁ - (75% TCP + 25 % PP)	1.81 ^b	1.75 ^b (3.31)	1.68 ^b (4.00)	■	■	■	■
T ₁₆ - (25% TCP + 75 % PiP, MP, GP and PP)	1.60 ^{bc}	1.55 ^c (3.12)	1.53 ^{bc} (1.29)	1.50 ^a (1.96)	1.40 ^a (6.66)	1.33 ^a (5.00)	1.13 ^a (15.03)

TCP- Tender coconut Pulp, PiP- Pineapple Pulp, MP- Mango Pulp, GP- Grapes Pulp, PP- Papaya Pulp. MAS- Months after storage
 ■ - Spoiled

Values with same alphabet for different treatments represented in each column form a homogenous group

Figures in parentheses indicates per cent deviation over the previous month

Means in each column with atleast one letter in common are not significantly different at 1 % level of probability

Table 10: Microbial population of tender coconut blended jam during storage.

Treatments	Period of storage					
	Bacteria (x10 ⁴ cfu/g)		Yeast (x10 ² cfu/g)		Mould (x10 ² cfu/g)	
	Initial	6 MAS	Initial	6 MAS	Initial	6 MAS
T ₁ - (100% TCP)	ND		ND	-	ND	-
T ₄ - (25% TCP + 75 % PiP)	ND	0.66	ND	2.22	ND	1.66
T ₆ - (50% TCP + 50 % MP)	ND		ND	-	ND	-
T ₁₀ - (25% TCP + 75 % GP)	ND	0.66	ND	1.66	ND	1.33
T ₁₁ - (75% TCP + 25 % PP)	ND		ND	-	ND	-
T ₁₆ - (25% TCP + 75 % PiP, MP, GP and PP)	ND	0.33	ND	1.66	ND	2.22

TCP- Tender coconut Pulp, PiP- Pineapple Pulp, MP- Mango Pulp, GP- Grapes Pulp, PP- Papaya Pulp, ND- Not detected.

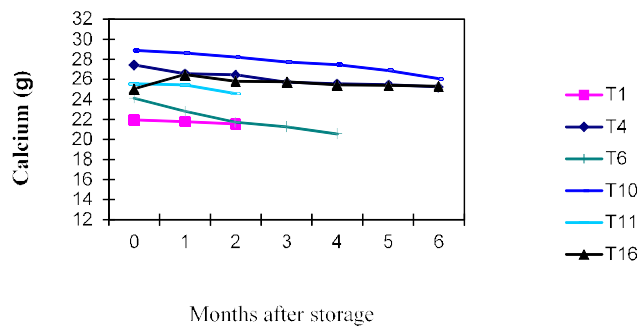


Fig 1: Calcium content of blended jam during storage.

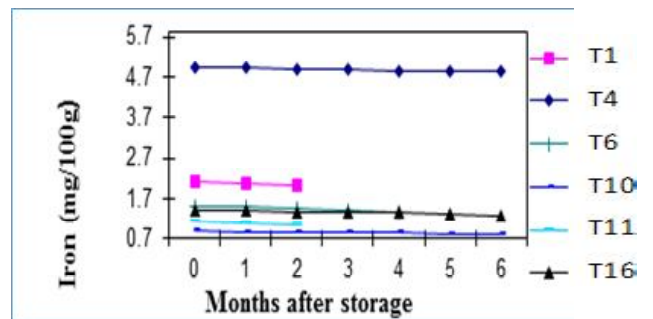


Fig 2: Iron content of blended jam during storage.

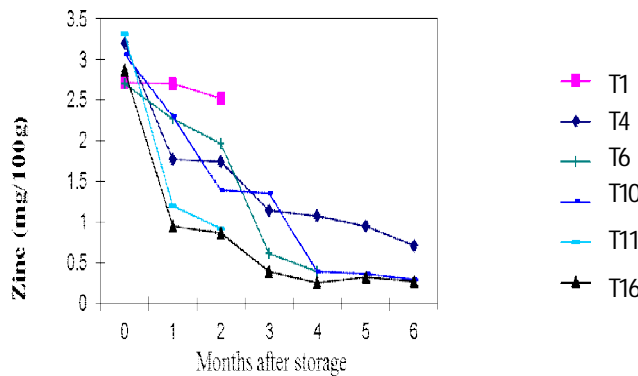


Fig 3: Zinc content of blended jam during storage.

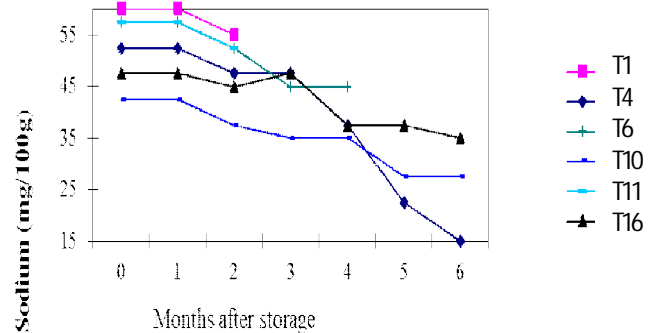


Fig 4: Sodium content of blended jam during storage.

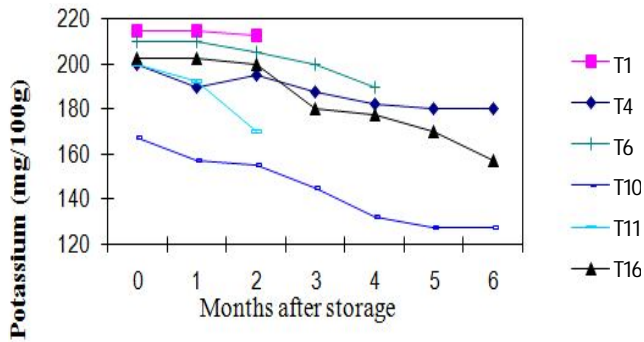


Fig 5: Potassium content of blended jam during storage.

treatment T_6 (50% TCP + 50 % MP) was discarded at the end of fourth month of storage. All other treatments without spoilage were subjected to microbial enumeration.

Microbial count of tender coconut blended jam during storage: The presence of microbes was not detected in freshly prepared jam. The presence of bacteria, yeast and mould was detected at the end of six months of storage (Table 10). However, it was within safe limits (For bacteria 0.44×10^4 cfu/ g, Yeast 1.33×10^2 cfu/ g, mould 1.66×10^2 cfu/ g).

The treatments T_4 (25% TCP + 75% PiP), T_6 (50% TCP + 50% MP), T_{10} (25% TCP + 75% GP), T_{11} (25% TCP + 75% GP) and T_{16} (25% TCP + 75% PiP, MP, GP and PP) secured a good score for all quality attributes like appearance, colour, flavor, texture, taste and overall acceptability.

Increase in the concentration of coconut pulp results in high fat content making it more prone to rancidity. Hence in this study, the treatments T_1 , T_{11} with 100% TCP and 75% TCP, respectively were discarded after two months of storage. The treatments T_6 with 50% TCP had a shelf life of four months, whereas the remaining selected treatments with 25% TCP had an extended shelf life until six months. Chauhan *et al.* (2012) also found that the 100% TCP formulation recorded the highest percentage of fat (6.80 %) as against the 100% pineapple jam which showed the lowest (0.52 %).

The highest gel strength of T_{16} may be attributed to the combined effects of fruits in the preparation. Chauhan *et al.* (2012) reported that the modifications occurring in the food matrix composition and gel strength of the jam is probably due to changes in the interactions between food matrix ingredients. The maximum adhesiveness was in the jam prepared using 100% tender coconut pulp (T_1) followed by the jam prepared using 75% TCP and 25% papaya pulp. An increase in adhesiveness with increase in TCP was evident. The increase in tender coconut concentration was found to increase adhesiveness. This may be due the sticky nature of the coconut pulp as reported by Chauhan *et al.* (2012). The maximum brittleness was recorded in jam prepared with 25% TCP and 75% grape pulp. This may be due the high pectin content of grapes. The highest rupture

strength was recorded for T_{10} (0.2996 N) followed by T_{11} and T_4 . This may be attributed to the highest brittleness of these products.

A decreasing pH that is an increase in acidity of blended products during storage might be due to the interaction of organic acids present in the blended jam. Remya mol (2006) observed an increase in acidity of cashew apple product. Shakir *et al.*, (2009) also noticed an increase in the acidity in apple pear mixed jams with the progress of storage period. Chauhan *et al.* (2012) also reported a similar trend in the tender coconut blended pineapple jam which recorded a decrease in the pH from 3.25 to 3.22 under ambient conditions after six months of storage.

The increased moisture content over a period of time might be due to the breakdown of carbohydrates into carbon dioxide and water during storage. Alessandra *et al.* (2004) also made a similar opinion while working with different fruit products. An increase in moisture content during storage was also reported by Neelofar (2006) in coconut kernel candy.

A slight increase in TSS observed might be due to the hydrolysis of polysaccharides in to mono and soluble disaccharides as reported by Safdar *et al.* (2012). Stability in TSS content is reported in wood apple jam (Vidhya and Narain, 2011). Ahmed *et al.* (2011) reported that the TSS of sapota jam remained as 67 °brix from initial to four months of storage period. As in the present study, Ehsan *et al.* (2003) also reported a negligible increase in TSS of watermelon jam from 68.6 to 68.9 °brix.

A slight gain in reducing sugar was noticed during the storage. This is tune with the results of Vidhya and Narain (2011) in wood apple jam; Shakir *et al.* (2009) in pear apple mixed jam and Riaz *et al.* (1999) in strawberry jam. Sindumathi and Amutha (2014) also reported a gradual increase in reducing sugar from 15.00 to 15.75 g/ 100g in the coconut blended jam stored at room temperature. The increase in reducing sugar could be due to the inversion of sucrose to glucose and fructose (Lotha, 1992) or due to the breakdown of poly saccharides into simple sugars.

The total sugar content generally decreased during the storage. The loss of total sugar during storage might be due to maillard's reaction, other chemical reaction of sugar in presence of acids and co- polymerization of sugars with organic acids particularly at high temperature (Takur and Barwal, 1998). Chauhan *et al.* (2012) also reported a reduction in total sugar content with storage time in tender coconut blended pineapple jam. Sindumathi and Amutha (2014) also reported a gradual decrease in total sugar from 52.20 to 51.28 in coconut jam stored at room temperature.

A significantly highest initial fat content was recorded in the jam prepared by using 100% TCP and the lowest was in T_4 25% TCP + 75% pineapple pulp. Chauhan

et al. (2012) also found that the 100% TCP formulation recorded the highest percentage of fat (6.80 %) as against the 100% pineapple jam which showed the lowest (0.52 %). With the increase in the concentration of coconut pulp which is high in fat content as compared to the pineapple pulp, the fat content was found to increase. The fat content reduced slightly during storage.

A reduction in calcium content of the tender coconut blended products was observed during storage (Fig 1). Sindumathi and Amutha, (2014) made a similar observation where the initial calcium content of coconut based jam was 15.20 mg/100g which was decreased to 15.08 mg/100g during storage when packed in glass bottles at room temperature. Vidhya and Narain (2011) also reported a considerable reduction of 15% calcium content during storage for three months in wood apple jam.

A negligible decrease in iron content with advance of storage was noticed in all treatments (Fig. 2). Yousif *et al.* (1998) also reported an initial iron content of 5 mg/100g in grapes blended jams.

There was a general decrease in zinc content of blended tender coconut products during storage (Fig 3). Damiani *et al.*, (2012) reported a zinc content of 8.7 mg/100g in guava mixed jam.

The sodium content of blended tender coconut products decreased with advancement in storage period (Fig 4). Chauhan *et al.* (2012) also reported an initial sodium

content of 56.86 mg/100g in tender coconut pineapple blended jam.

The potassium content of blended tender coconut products decreased during storage (Fig. 5). Chauhan *et al.* (2012) also reported the highest potassium content of 199 mg/100g in 100% TCP jam as compared to lowest content of 132 mg/100g in the 100% pineapple jam. The increase in potassium content with increased proportion of TCP in blended products is due to the richness of tender coconut pulp in potassium.

CONCLUSION

The study has shown that the residual tender coconut pulp left in the tender coconuts after the consumption of coconut water can be effectively utilized by blending with different fruit pulp for the preparation of jam. Jam prepared by blending tender coconut pulp and fruit pulps were found to be organoleptically acceptable. Blended jam (T₁₄) with 25% tender coconut pulp and 75% pineapple pulp were nutritionally superior. Higher organoleptic scores were recorded for jams prepared with 25% tender coconut pulp and 75% blended fruit pulp (T₁₆). The treatments, T₄ and T₁₆ had a shelf life of six months at ambient condition and microbial count was within the permissible limits. The residual coconut pulp left in the tender coconuts after removal of coconut water can be utilized for the preparation of jams. Blending with fruit pulps increased the nutritional and acceptability of the products.

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