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Value addition and processing of *Diospyros melanoxylon* Roxb. tendu fruit ice-cream a new product

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Abstract

The present investigation entitled "Value Addition and Processing of *Diospyros melanoxylon* Roxb. Tendu Fruit Ice-cream." The study was conducted during 2022 in Department of Forestry, College of Agriculture, IGKV, Raipur (C.G). The preservation of tendu fruit pulp (preserved with ascorbic acid and KMS) and processing of tendu Ice-cream from the well-preserved tendu pulp. Treatments comprised for tendu Ice-cream recipe T₁ (35% Pulp+ 55% Full fat milk+ 10 gm sugar), T₂ (40% Pulp+ 50% Full fat milk+ 50 gm sugar), T₃ (45% Pulp+ 45% Full fat milk+ 10 gm sugar), T₄ (50% Pulp+ 40% Full fat milk+ 10 gm sugar), T₅ (55% Pulp+ 35% Full fat milk+ 10 gm sugar). The experiment was designed in Completely Randomized Design (CRD) with 4 replications. The storage period of the tendu pulp preserved for 90 days and the pulp preserved with KMS gives the best results as compared with ascorbic acid preservative. Ice-cream was prepared with KMS preserved pulp and stored up to 150 days under refrigeration Condition. Chemical parameters (total sugars, reducing sugars & non-reducing sugars, pH, TSS, acidity, ascorbic acid) were analyzed in 1-month interval for the tendu pulp up to 90 days and for tendu Ice-cream up to 150 days. Results revealed that the Chemical parameters (total sugars, reducing sugars & non-reducing sugars, pH, TSS and ascorbic acid) are decreasing in the tendu pulp and in tendu Ice-cream as storage period increased and vice-versa in acidity was observed in increasing order. Due to the underutilized and highly perishability of tendu fruit, value addition and processing technology plays a vital role and also provides income generation to the forest fringe people.

Keywords: Tendu fruit pulp, KMS, ascorbic acid, preservation, processing, tendu ice-cream, chemical analysis

Introduction

India is the core of origin for many tropical wild underutilized forest fruit species, most of which are not commercially cultivated but provide a significant source of livelihood and nutrition to the tribes residing inside and outside of the forest. Since the beginning of time, mankind has been aware of underutilized fruits, and they have been the main source of nourishment for the local population. These fruits are said to be underutilized, not because they are used less but because they are not used to their full potential. Despite their economic value, many fruits are still not being used to their full potential. Underutilized plant species are those that exist as life support systems in harsh environments and have traits that are important for both nutrition and industry, serving a variety of functions. If adequately managed, these underutilized plants could provide benefits for the environment, income development, food security, nutrition, and health.

According to the Government of India's Tribal Co-operative Marketing Development Federation of India Limited, 20 to 40% of yearly tribal revenue comes through NTFPS. One of these NTFPS, Tendu tree (*Diospyros melanoxylon*) leaves, is a significant source of income for tribal people (Husain, 2015)^[6] as well as state Govt.

Jamil Z and Sharma N. (2019)^[8] documented that Tendu is a tree that is indigenous to India, Pakistan and Nepal and belongs to the Ebenaceae family. India's western peninsula, Madhya Pradesh, Chhattisgarh, Maharashtra, Orissa, Uttar Pradesh, Bihar, and Jharkhand are among the places where it is found. Fruit is known as ebony, persimmon, and coromandel ebony in English. The plant's leaves are more popular by the tribal people than its fruits. The leaves are utilised in the production of "bidi" and "cigarettes" in the bidi industries.

Fruit is an abundant supply of carbohydrates, calcium, phosphorus, and beta-carotene. Fruit pulp has significant potassium and phosphorus concentrations, exceeding 311.6 and 163.9 mg/100 gm, respectively. Minerals like calcium, magnesium, sodium, vitamin C, thiamine, riboflavin, niacin, and beta-carotene are rich in fruits (Jamil Z and Sharma N. 2019)^[8].

In the summer, tribal members collect Tendu fruits, and the fruit pulp is dried for use as food in the winter. When the fruit is fully mature, it has a nice and sweet flavour. However, the Tendu fruit's potential as food has not yet been fully investigated. Due to the carminative and astringent qualities of the fruit pulp, tribal groups in India utilise it as a traditional remedy. Only a small number of studies have been conducted to determine whether the fruit's high nutritional value is due in part to the presence of several phytochemicals such as beta-carotene, terpenoids, flavonoids, saponin, tannin, and betulin (Natural Medicine Facts, 2015) [13]. The fresh pulp can be used as a recipe for making a variety of organic foods that are offered locally in the Indian and worldwide markets, including pakora, upama, pickle, paratha, jam, etc. (Vivek *et al.* 2016; Vivek *et al.* 2018) [15-16].

Since the fruit is seasonal and has a shorter shelf life, its nutritional content and energy-rich qualities have not been used to add value to Tendu pulp. Therefore, preservation methods are essential to improve the fruit pulp's ability to be stored (Hmar *et al.* 2017b) [5]. Alternative methods of using abundant fruits to decrease waste and generate revenue include processing them into other value-added products. In order to make better use of the Tendu fruit during the off-season, this study was examined.

Materials and Methodology

The study was conducted during 2022 in Department of Forestry, College of Agriculture, IGKV, Raipur (C.G). The preservation of tendu fruit pulp (treated with ascorbic acid and KMS) and processing of tendu Ice-cream from the well preserved tendu pulp. Treatments comprised for tendu Ice-cream recipe T₁ (35% Pulp+ 55% Full fat milk+ 10 gm sugar), T₂ (40% Pulp+ 50% Full fat milk+ 50 gm sugar), T₃ (45% Pulp+ 45% Full fat milk+ 10 gm sugar), T₄ (50% Pulp+ 40% Full fat milk+ 10 gm sugar), T₅ (55% Pulp+ 35% Full fat milk+ 10 gm sugar). The experiment was designed in Completely Randomized Design (CRD) with 4 replications. The storage period of the tendu pulp preserved for 90 days and tendu Ice-cream from the well-preserved pulp (KMS is used as a preservative) of 150 days under refrigeration Condition.

Statistical Analysis

The completely randomized design (CRD) is used with 5 treatments and 4 replications.

Results and Discussion

Chemical parameters of tendu pulp

The Chemical analysis of total sugars, reducing sugars and non-reducing sugars, pH, TSS and Ascorbic acid shows the decreasing trend with increasing storage period and Acidity content was increasing as the storage period increases up to 3 months in tendu pulp preservation. The total sugars, reducing sugars and non-reducing sugars, pH, TSS, Acidity and Ascorbic acid were recorded for KMS treated tendu pulp as 23.64%, 3.82%, 19.82%, 4.73, 19.39 °Brix, 0.20% and 13.97 mg/100mg and for Ascorbic acid treated tendu pulp 22.94%, 3.55%, 19.39%, 4.56, 18.31 °Brix, 0.21% and 12.85 mg/100mg. The decreasing trend in total sugars, reducing sugars and non-reducing sugars might be due to inversion of sugars to monosaccharides by acid hydrolysis. The results were similar with Muralikrishnan *et al.* (1969) [11] and Ghosh

et al. (1981) [2]. The decrease trend in the pH of tendu pulp, as the storage period increases, might be due to the formation of free acids and pectin hydrolysis reported by Yadav *et al.* (2017) [16] and Jain *et al.* (2011) [7]. However, the decrease in the total sugars in the TSS as the storage period increases, might be the formation of ice crystals in preserved pulp, increases the moisture content and might be presence of acidity in tendu pulp leads to reduce in total sugars as storage period increases. Contrary with Jain *et al.* (2011) [11]. The acidity increases as the storage period increasing this is due to the formation of organic acids by degradation of ascorbic acids. Similar results are founded by Jain *et al.* (2011) [11]. The ascorbic acid content decreases as the storage period increases, this is due to the oxidation of ascorbic acid and then further degraded to 2, 3-diketo-gluconic acid by the action of ascorbic acid oxidase enzyme reported by Yadav *et al.* (2017) [16].

Chemical parameters of tendu Ice-cream

The Chemical analysis of total sugars, reducing sugars and non-reducing sugars, pH, TSS, Ascorbic acid shows the decreasing trend with increasing storage period and acidity of the tendu Ice-cream increasing by the increase in storage period up to 150 days. The highest content of reducing sugars, total sugars and non-reducing sugars were observed in the treatment T₅ (55% Pulp+ 35% Full fat milk+ 10 gm sugar), which has the highest tendu pulp concentration and decreasing trend of sugars in tendu ice-cream as the storage period increases is due to the formation of ice crystals in ice-cream, which ultimately increases the moisture. The decreasing trend was also observed as storage period increases in Tendu ice-cream. Similar findings were observed by Ubale *et al.* (2014) [14] and Nasr, W. I. A. (2021) [12]. The minimum pH value (5.10) recorded in treatment T₅ (55% Pulp+ 35% Full fat milk+ 10 gm sugar). This is due to the highest pulp concentration in T₅ and the decreasing trend is due to the presence of ascorbic acid in the tendu fruit. Similar findings were reported by Bajwa *et al.* (2003) [1]; Karaman *et al.* (2014) [9]; Makwana *et al.* (2014) [10]; Hashim, I. B., and Shamsi, K. S. A. (2016) [3]. The value of TSS recorded highest, (32.75 °Brix) in treatment T₃ (45% Pulp+ 45% Full fat milk+ 10 gm sugar) and minimum (29.99 °Brix) in treatment T₄ (50% Pulp+ 40% Full fat milk+ 10 gm sugar). Due to its milk and pulp quantity of Ice-cream. The value of acidity recorded highest, (0.29%) in treatment T₅ (55%Pulp+ 35% Full fat milk+ 10 gm sugar) and minimum (0.22%) in treatment T₁ (35% Pulp+ 55%Full fat milk+ 10 gm sugar). As the tendu pulp ratio decreases the titration acidity also decreasing this might be due to the formation of organic acids by the decomposition of ascorbic acid and use of sugars to produce organic acids. Hashim, I. B., & Shamsi, K. S. A. (2016) [3]; Ubale *et al.* (2014) [14]; Makwana *et al.* (2014) [10] reported the same. The value of Ascorbic acid recorded highest, (15.38 mg/100 mg) in treatment T₃ (45% Pulp+ 45% Full fat milk+ 10 gm sugar) and there is a gradual decreasing trend in ascorbic acid as the storage period increases, this is due to the Ascorbic acid is sensitive to heat and oxidized quickly in the presence of oxygen. So, it might have been destroyed during the processing and subsequently during storage period due to its oxidation. Similar findings reported by Makwana *et al.* (2014) [10].

Table 1: Chemical analysis of Tendu pulp during storage

| S. No | Days of storage | pH | TSS (°Brix) | Total Sugars (%) | Reducing sugars (%) | Non-reducing sugars (%) | Acidity (%) | Ascorbic acid (mg/100 mg) |
|----------------------------|-----------------|------|-------------|------------------|---------------------|-------------------------|-------------|---------------------------|
| Pulp(KMS) | | | | | | | | |
| 1 | D1 (0 day) | 5.05 | 20.05 | 26.52 | 5.5 | 21.02 | 0.18 | 14.56 |
| 2 | D2(30 day) | 4.98 | 19.53 | 24.45 | 4.1 | 20.35 | 0.19 | 14.29 |
| 3 | D3 (60 day) | 4.55 | 19.01 | 22.51 | 3.2 | 19.31 | 0.22 | 14.01 |
| 4 | D4 (90 day) | 4.34 | 18.97 | 21.1 | 2.5 | 18.6 | 0.23 | 13.02 |
| | Mean | 4.73 | 19.39 | 23.64 | 3.82 | 19.82 | 0.20 | 13.97 |
| Pulp(Ascorbic acid) | | | | | | | | |
| 1 | D1 (0 day) | 5.01 | 19.17 | 25.05 | 5 | 20.05 | 0.20 | 13.25 |
| 2 | D2 (30 day) | 4.97 | 18.52 | 23.47 | 3.9 | 19.57 | 0.21 | 13.07 |
| 3 | D3 (60 day) | 4.23 | 18.33 | 22.25 | 3.0 | 19.25 | 0.21 | 13.01 |
| 4 | D4 (90 day) | 4.03 | 17.22 | 21.01 | 2.3 | 18.12 | 0.23 | 12.09 |
| | Mean | 4.56 | 18.31 | 22.94 | 3.55 | 19.39 | 0.21 | 12.85 |

Table 2: Effect of Storage duration on reducing sugar (%) of Tendu Ice-cream

| Notation | Treatment | 0 Day | 30 Day | 60 Day | 90 Day | 120 Day | 150 Day | Mean |
|----------------|--|-------|--------|--------|--------|---------|---------|------|
| T ₁ | (35% Pulp+ 55% Full fat milk+ 10 gm sugar) | 2.12 | 2.09 | 2.06 | 2.03 | 2.02 | 2.01 | 2.05 |
| T ₂ | (40% Pulp+ 50% Full fat milk+ 10 gm sugar) | 2.04 | 2.03 | 1.98 | 1.97 | 1.96 | 1.94 | 1.98 |
| T ₃ | (45% Pulp+ 45% Full fat milk+ 10 gm sugar) | 3.09 | 3.04 | 2.98 | 2.95 | 2.94 | 2.91 | 2.98 |
| T ₄ | (50% Pulp+ 40% Full fat milk+ 10 gm sugar) | 3.21 | 3.18 | 3.17 | 3.16 | 3.14 | 3.10 | 3.16 |
| T ₅ | (55% Pulp+ 35% Full fat milk+ 10 gm sugar) | 4.08 | 4.04 | 3.98 | 3.93 | 3.9 | 3.88 | 3.96 |
| | S.Em± | 0.046 | 0.055 | 0.056 | 0.051 | 0.055 | 0.055 | |
| | CD at 5% | 0.140 | 0.166 | 0.171 | 0.154 | 0.166 | 0.167 | |

Table 3: Effect of Storage duration on Total sugar (%) of Tendu Ice-cream

| Notation | Treatment | 0 Day | 30 Day | 60 Day | 90 Day | 120 Day | 150 Day | Mean |
|----------------|--|-------|--------|--------|--------|---------|---------|-------|
| T ₁ | (35% Pulp+ 55% Full fat milk+ 10 gm sugar) | 26.17 | 26.00 | 25.82 | 25.71 | 25.45 | 24.72 | 25.64 |
| T ₂ | (40% Pulp+ 50% Full fat milk+ 10 gm sugar) | 24.07 | 23.9 | 23.82 | 23.74 | 23.68 | 23.49 | 23.78 |
| T ₃ | (45% Pulp+ 45% Full fat milk+ 10 gm sugar) | 29.65 | 29.27 | 28.75 | 28.35 | 27.75 | 26.35 | 28.35 |
| T ₄ | (50% Pulp+ 40% Full fat milk+ 10 gm sugar) | 32.25 | 31.75 | 31.57 | 31.35 | 30.75 | 29.5 | 31.19 |
| T ₅ | (55% Pulp+ 35% Full fat milk+ 10 gm sugar) | 35.3 | 35.10 | 34.75 | 34.35 | 33.22 | 32.55 | 34.21 |
| | SEM± | 0.067 | 0.065 | 0.075 | 0.095 | 0.097 | 0.071 | |
| | CD at 5% | 0.205 | 0.198 | 0.228 | 0.288 | 0.295 | 0.215 | |

Table 4: Effect of Storage duration on Non-Reducing sugar (%) of Tendu Ice-cream

| Notation | Treatment | 0 Day | 30 Day | 60 Day | 90 Day | 120 Day | 150 Day | Mean |
|----------------|---|-------|--------|--------|--------|---------|---------|-------|
| T ₁ | (35% Pulp+55% Full fat milk+ 10 gm sugar) | 24.05 | 23.90 | 23.76 | 23.67 | 23.42 | 22.71 | 23.58 |
| T ₂ | (40% Pulp+50% Full fat milk+ 10 gm sugar) | 22.03 | 21.86 | 21.83 | 21.76 | 21.72 | 21.55 | 21.79 |
| T ₃ | (45% Pulp+45% Full fat milk+ 10 gm sugar) | 26.55 | 26.23 | 25.76 | 25.39 | 24.80 | 23.43 | 25.36 |
| T ₄ | (50% Pulp+40% Full fat milk+ 10 gm sugar) | 29.03 | 28.57 | 28.40 | 28.19 | 27.61 | 26.39 | 28.03 |
| T ₅ | (55% Pulp+35% Full fat milk+ 10 gm sugar) | 31.21 | 31.06 | 30.76 | 30.41 | 29.32 | 28.66 | 30.23 |
| | SEM± | 0.074 | 0.066 | 0.107 | 0.120 | 0.125 | 0.100 | |
| | CD at 5% | 0.225 | 0.201 | 0.325 | 0.365 | 0.379 | 0.303 | |

Table 5: Effect of Storage duration on pH of Tendu Ice-cream

| Notation | Treatment | 0 Day | 30 Day | 60 Day | 90 Day | 120 Day | 150 Day | Mean |
|----------------|--|-------|--------|--------|--------|---------|---------|------|
| T ₁ | (35% Pulp+ 55% Full fat milk+ 10 gm sugar) | 5.32 | 5.30 | 5.23 | 5.10 | 5.10 | 5.06 | 5.18 |
| T ₂ | (40% Pulp+ 50% Full fat milk+ 10 gm sugar) | 5.42 | 5.31 | 5.20 | 5.15 | 5.15 | 5.06 | 5.21 |
| T ₃ | (45% Pulp+ 45% Full fat milk+ 10 gm sugar) | 5.52 | 5.42 | 5.33 | 5.23 | 5.22 | 5.13 | 5.30 |
| T ₄ | (50% Pulp+ 40% Full fat milk+ 10 gm sugar) | 5.62 | 5.61 | 5.52 | 5.41 | 5.32 | 5.24 | 5.45 |
| T ₅ | (55% Pulp+ 35% Full fat milk+ 10 gm sugar) | 5.22 | 5.21 | 5.13 | 5.11 | 5.03 | 4.92 | 5.10 |
| | SEM± | 0.011 | 0.008 | 0.010 | 0.010 | 0.012 | 0.017 | |
| | CD at 5% | 0.034 | 0.023 | 0.030 | 0.029 | 0.037 | 0.051 | |

Table 6: Effect of Storage duration on TSS of Tendu Ice-cream

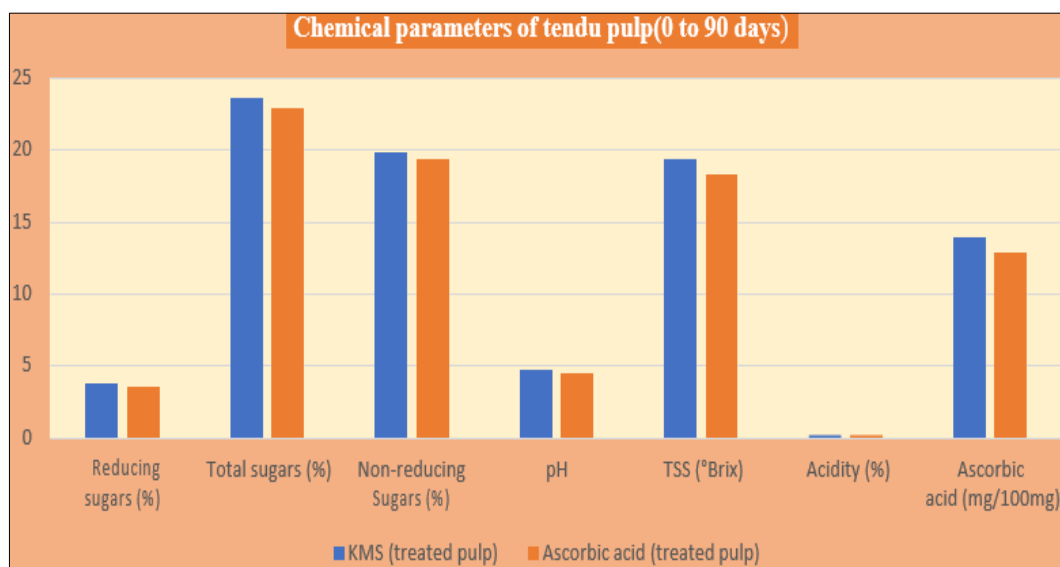
| Notation | Treatment | 0 Day | 30 Day | 60 Day | 90 Day | 120 Day | 150 Day | Mean |
|----------------|--|-------|--------|--------|--------|---------|---------|-------|
| T ₁ | (35% Pulp+ 55% Full fat milk+ 10 gm sugar) | 32.25 | 32.15 | 31.27 | 30.15 | 29.32 | 28.30 | 30.57 |
| T ₂ | (40% Pulp+ 50% Full fat milk+ 10 gm sugar) | 34.32 | 33.22 | 32.37 | 31.30 | 30.45 | 29.25 | 31.81 |
| T ₃ | (45% Pulp+ 45% Full fat milk+ 10 gm sugar) | 35.15 | 34.30 | 33.25 | 32.25 | 31.40 | 30.20 | 32.75 |
| T ₄ | (50% Pulp+ 40% Full fat milk+ 10 gm sugar) | 32.30 | 31.30 | 30.50 | 29.17 | 28.50 | 28.22 | 29.99 |
| T ₅ | (55% Pulp+ 35% Full fat milk+ 10 gm sugar) | 33.30 | 32.15 | 31.40 | 30.20 | 29.30 | 28.65 | 30.83 |
| | SEm± | 0.110 | 0.092 | 0.141 | 0.097 | 0.181 | 0.156 | |
| | CD at 5% | 0.335 | 0.280 | 0.428 | 0.295 | 0.549 | 0.476 | |

Table 7: Effect of Storage duration on Acidity (%) of Tendu Ice-cream

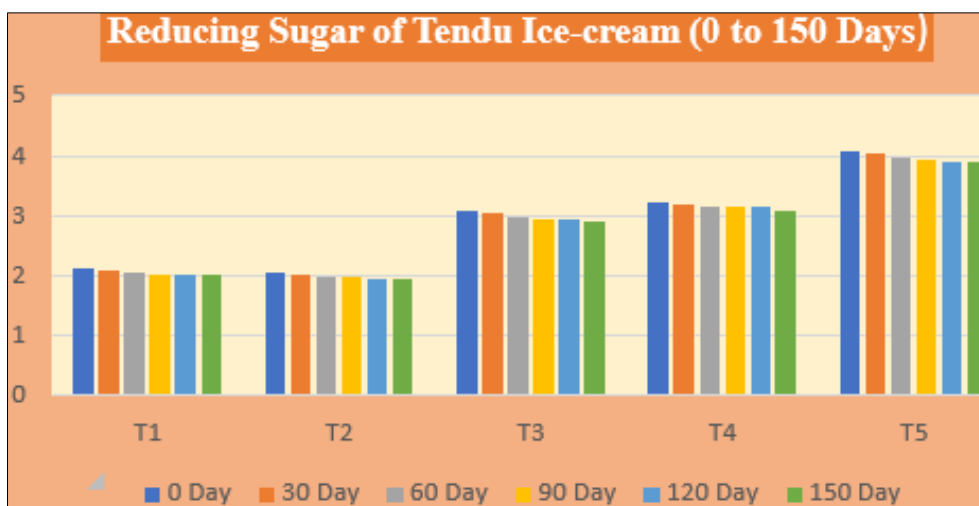
| Notation | Treatment | 0 Day | 30 Day | 60 Day | 90 Day | 120 Day | 150 Day | Mean |
|----------------|--|-------|--------|--------|--------|---------|---------|------|
| T ₁ | (35% Pulp+ 55% Full fat milk+ 10 gm sugar) | 0.15 | 0.15 | 0.22 | 0.26 | 0.27 | 0.28 | 0.22 |
| T ₂ | (40% Pulp+ 50% Full fat milk+ 10 gm sugar) | 0.21 | 0.23 | 0.30 | 0.31 | 0.32 | 0.34 | 0.28 |
| T ₃ | (45% Pulp+ 45% Full fat milk+ 10 gm sugar) | 0.18 | 0.20 | 0.26 | 0.28 | 0.32 | 0.34 | 0.26 |
| T ₄ | (50% Pulp+ 40% Full fat milk+ 10 gm sugar) | 0.22 | 0.24 | 0.27 | 0.28 | 0.33 | 0.35 | 0.28 |
| T ₅ | (55% Pulp+ 35% Full fat milk+ 10 gm sugar) | 0.24 | 0.27 | 0.28 | 0.31 | 0.32 | 0.36 | 0.29 |
| | SEm± | 0.005 | 0.006 | 0.006 | 0.005 | 0.005 | 0.006 | |
| | CD at 5% | 0.014 | 0.017 | 0.018 | 0.016 | 0.016 | 0.019 | |

Table 8: Effect of Storage duration on Ascorbic acid (mg/100mg) of Tendu Ice-cream

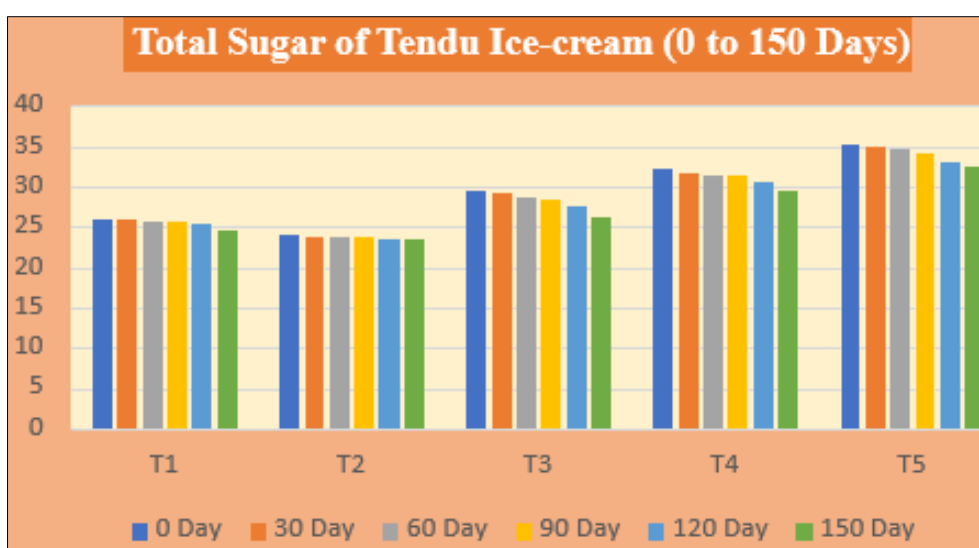
| Notation | Treatment | 0 Day | 30 Day | 60 Day | 90 Day | 120 Day | 150 Day | Mean |
|----------------|--|-------|--------|--------|--------|---------|---------|-------|
| T ₁ | (35% Pulp+55% Full-fat milk 10 gm sugar) | 14.65 | 14.15 | 13.65 | 13.15 | 12.70 | 12.30 | 13.43 |
| T ₂ | (40% Pulp+50% Full fat milk+10 gm sugar) | 15.25 | 15.15 | 14.65 | 14.02 | 13.55 | 13.27 | 14.31 |
| T ₃ | (45% Pulp+45% Full fat milk+10 gm sugar) | 16.65 | 16.15 | 15.60 | 15.20 | 14.45 | 14.27 | 15.38 |
| T ₄ | (50% Pulp+40% Full fat milk+10 gm sugar) | 12.35 | 12.12 | 11.70 | 11.18 | 10.55 | 10.35 | 11.37 |
| T ₅ | (55% Pulp+35% Full fat milk+10 gm sugar) | 13.60 | 13.01 | 12.67 | 12.17 | 11.65 | 11.40 | 12.41 |
| | SEm± | 0.065 | 0.060 | 0.077 | 0.074 | 0.080 | 0.091 | |
| | CD at 5% | 0.196 | 0.182 | 0.233 | 0.226 | 0.242 | 0.278 | |



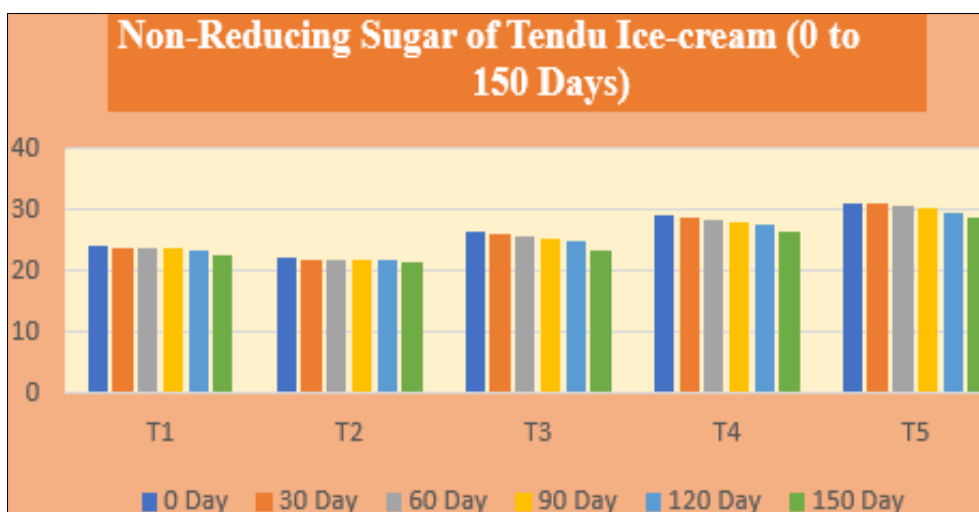
Graph 1: Chemical parameter of tendu pulp



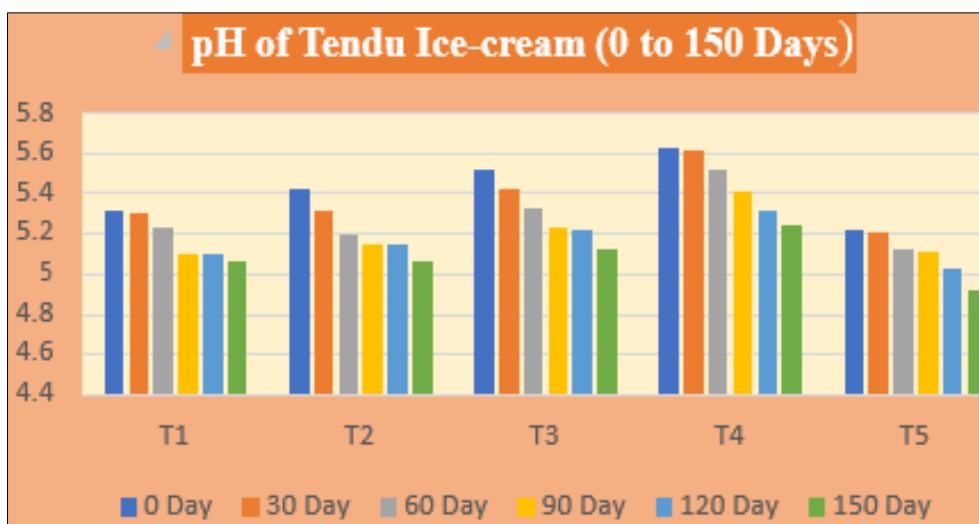
Graph 2: Trend of reducing sugar (%) of tendu Ice-cream during storage



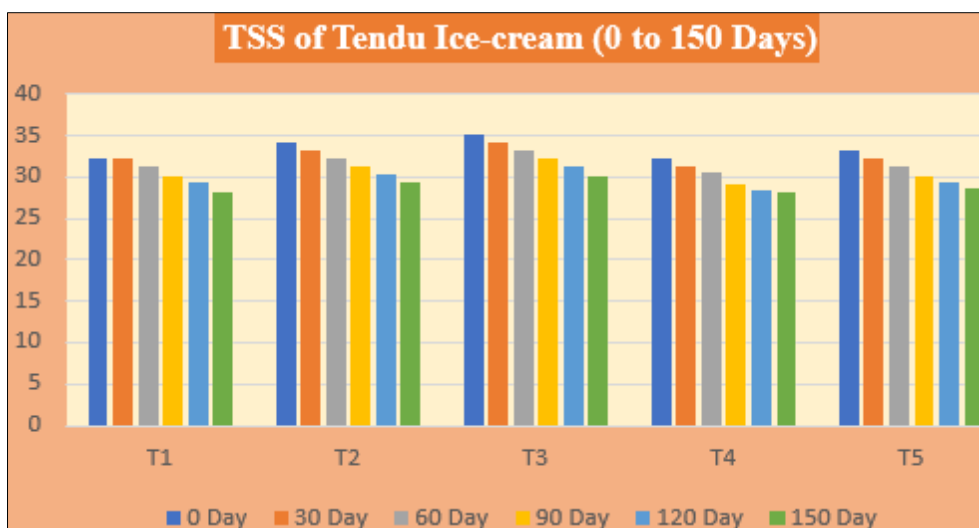
Graph 3: Trend of Total Sugar (%) of tendu Ice-cream during storage



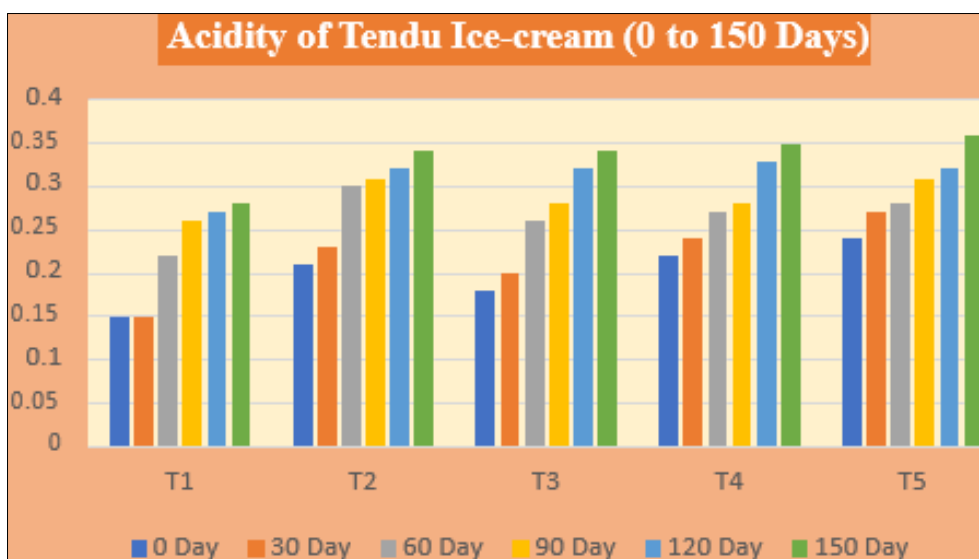
Graph 4: Trend of Non-Reducing sugar (%) of tendu Ice-cream during storage



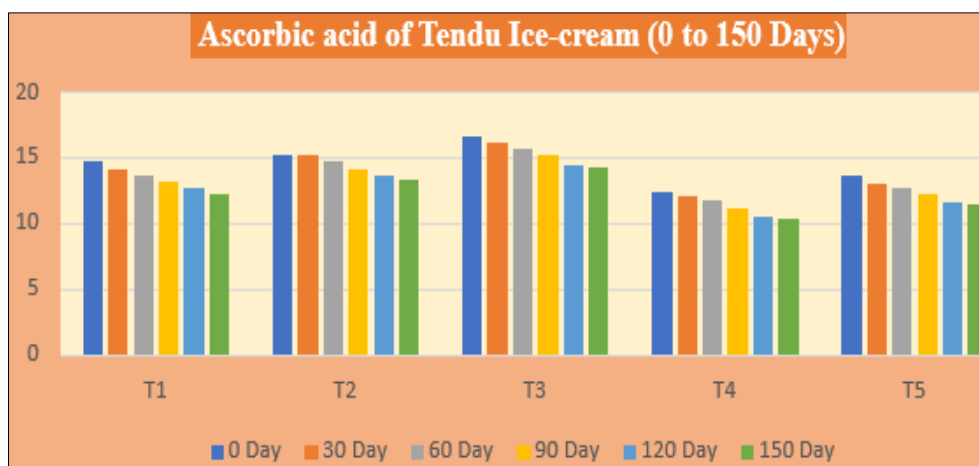
Graph 5: Trend of pH of tendu Ice-cream during storage



Graph 6: Trend of TSS of tendu Ice-cream during storage



Graph 7: Trend of Acidity (%) of tendu Ice-cream during storage



Graph 8: Trend of Ascorbic acid (mg/100mg) of tendu Ice-cream during storage

Conclusion

It can be concluded that the pulp preserved with KMS preservative gives the best results as compared to ascorbic acid preservative pulp in the entire storage period and the tendu Ice-cream is stored and acceptable up to 4 months from the day of preparation. There was a decreasing trend in all Chemical parameters of tendu pulp and in tendu Ice-cream as the storage period increases. Except in acidity, it showed vice-versa trend.

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