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Studies on acceptability and storage of spice blended tender coconut water cv. Banawali

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Abstract
The experiment was conducted at Post-Harvest technology laboratory, College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. – Ratnagiri during the year 2020-2021 to study the acceptability and storage of spice blended tender coconut water cv. banawali. For the study, six treatments (T_0 – Control, T_1 – 0.1g Cumin/100ml TCW, T_2 – 0.2g Nutmeg/100ml TCW, T_3 – 0.4g Black pepper/100 ml TCW, T_4 – 0.15g Cardamom/100ml TCW and T_5 – 0.1g Chat masala/100ml TCW) and three storage conditions (S_1 – Ambient temperature, S_2 – Cold storage and S_3 – Refrigerated storage) were selected. Treatment T_4 (0.15g cardamom/100ml TCW) was stored at S_3 (Refrigerated storage) performed best quality up to 90 days of storage according to the taste testing panel.

Keywords: TCW – tender coconut water, acceptability, ambient, testing panel

1. Introduction
Coconut (*Cocos nucifera* L.) is revered as the "KALPAVRUKSHA," or "tree of heaven," since it is India's most important and extensively spread commercial palm. After the three indentations on the coconut shell that mimic face features, the name "coconut" is derived from the 16th century Portuguese and Spanish word "coco," which means "head" or "skull.". Coconuts are farmed in approximately 96 nations across the tropical belt, with around 10 million families relying on them as their primary source of food and income. India, Indonesia, the Philippines, and Sri Lanka are the four biggest coconut-producing countries in the world, accounting for 78 percent of global production.

Coconut water is the liquid endosperm of an immature coconut about 7-9 months after pollination, when the solid endosperm or white flesh appears. In its natural state, it is a pure and nourishing beverage. Because of its high potassium and mineral content, coconut water is regarded a sports drink in its natural state. Minerals such as salt, potassium, phosphorus, chlorides, magnesium, ascorbic acids, vitamins B, and sugars are abundant in this nutritional beverage. It's also high in arginine, alanine, and cystine, among other amino acids. Delta-lactones contribute to the distinctive flavour of soft coconut. The volatile chemicals are responsible for the fresh aroma of coconut water. The taste of coconut water is influenced by organic acids such as malic, succinic, citric, acetic, and tartaric acids.

Tender coconut water is a delicious and pleasant drink that can also be used to replace saline glucose in intravenous infusions. Tender coconut water is a delightful beverage that contains electrolytes (ionic minerals) that are similar to those found in human plasma (Jayasundera and Dharmasena, 2014) [10]. It is also used to prevent dehydration of the bodily tissues in severe episodes of diarrhoea and vomiting. It produces excessive diuresis by increasing blood circulation in the kidneys. In cases of mineral poisoning, it acts as a urinary antiseptic, removing toxins through the kidneys. It helps to prevent and treat a variety of health issues, such as dehydration, constipation, digestive issues, exhaustion, and heatstroke. “It is unctuous, pleasant, boosting semen, improving digestion, and cleaning the urinary path,” says Ayurveda. It's a natural isotonic beverage with an electrolytic balance that's identical to that of human blood. FAO's Agricultural Industries and Post-Harvest Management Service Chief Mortan Satin says. “The fluid of life is tender coconut water.”

2. Materials and Methodology
The experiment was conducted at Post-Harvest Technology laboratory, College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri during the year 2020-2021. The experiment was laid out in factorial completely randomized design with six treatments (T_0 – Control, T_1 – 0.1g Cumin/100ml TCW, T_2 – 0.2g Nutmeg/100ml

TCW, T_3 – 0.4g Black pepper/100 ml TCW, T_4 – 0.15g Cardamom/100ml TCW and T_5 – 0.1g Chat masala/100ml TCW) and three storage conditions (S_1 – Ambient temperature, S_2 – Cold storage and S_3 – Refrigerated storage). Eighteen treatment combinations were replicated three times.

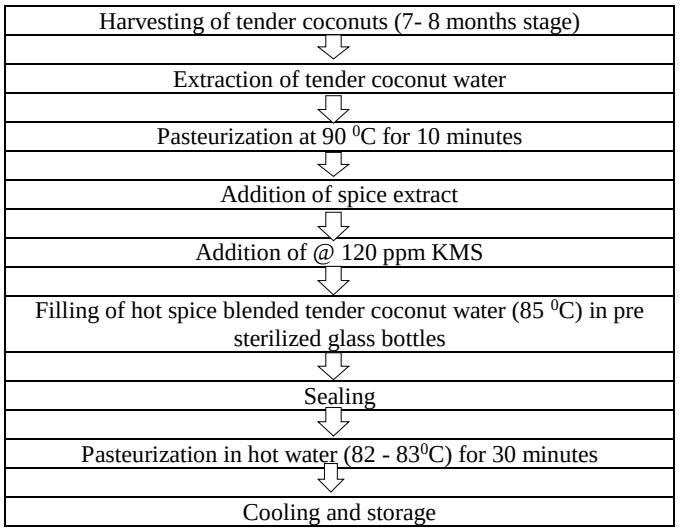

Fig 1: Flow chart for spice blended tender coconut water

The treatment and storage conditions are as follows:
T_0 – Control
T_1 – 0.1g cumin/100ml TCW
T_2 – 0.2g nutmeg/100ml TCW
T_3 – 0.4g black pepper/100ml TCW
T_4 – 0.15g cardamom/100mlTCW
T_5 – 0.1g chat masala/100mlTCW
S_1 – Ambient temperature (27 – 29 ℃)
S_2 – Cold Storage (12± 2℃)
S_3 – Refrigerated conditions (5 -7℃)

3. Results and Discussions

The product was analysed for the changes in their chemical constituents, microbial analysis and sensory evaluation for a period of 90 days.

3.1 Chemical parameters

3.1.1 Total soluble solids (ºBrix)

A continuous increasing trend was observed in TSS content throughout the entire storage period [Table 1(A)]. The T.S.S. content differs non-significantly with respect to interactions during the entire storage period of spice blended tender coconut water. During initial day of storage, T_4S_3 (5.10°B) showed maximum T.S.S. At 30 days of storage, interactions between treatment and storage conditions, maximum T.S.S. was seen in T_4S_3 (5.27°B) and minimum T.S.S was seen in T_0S_1 (4.77°B). At 60 days of storage, T_4S_3 (5.37°B) showed significantly maximum T.S.S and was at par with T_3S_3 (5.23°B) and significantly superior over others. At 90 days of storage, T_4S_3 (5.43°B) showed maximum T.S.S while T_5S_1 (5.03°B) showed minimum T.S.S. At the end of the storage, treatments differ non-significantly however T_4 showed maximum T.S.S. In storage conditions, S_3 recorded significantly maximum T.S.S than others. It may be due to faster conversion of leftover polysaccharides into soluble sugars. The interactions differ non-significantly however T_4S_3 recorded maximum T.S.S over others. In conformity of this, similar results were reported by Patel *et al.* (2019) [16] and Jayasundera and Dharmasena (2014) [10].

3.1.2 Reducing sugars (%)

The data presented in [Table 1(A)] indicates that the reducing sugar content differs significantly with respect to treatments, storage conditions and interactions during the entire storage period of spice blended tender coconut water. During initial day of storage, T_4S_3 (3.07%) recorded maximum reducing sugar and others. At 30 days of storage, in interactions, T_4S_3 (3.37%) showed significantly maximum reducing sugars and was at par with T_3S_3 (3.33%) and T_5S_3 (3.33%) and significantly superior over others. At 60 days of storage, T_4S_3 (3.61%) showed significantly maximum reducing sugars and was at par with T_0S_2 (3.55%), T_1S_2 (3.55%), T_3S_1 (3.55%), T_4S_1 (3.55%) and T_5S_3 (3.55%) and significantly superior over others. At 90 days of storage, T_4S_3 (3.80%) showed significantly maximum reducing sugar and was at par with T_0S_2 (3.74%), T_3S_1 (3.73%), T_4S_1 (3.73%) and was significantly superior over others. At the end of the storage, T_4 recorded significantly maximum reducing sugar over others. It might be due to high T.S.S and low pH. In storage condition, S_3 recorded significantly maximum reducing sugar over others. The interaction T_4S_3 recorded significantly maximum reducing sugars over others which might be due to the high T.S.S and low pH in T_4 and S_3 respectively. The increase in sugars during storage may be due to gradual inversion of non-reducing sugars to the reducing sugars by the hydrolysis process. Similar results were reported by Patel *et al.* (2019) [16], Amaravathi *et al.* (2014) [2] and Shubhashree *et al.* (2014) [21].

3.1.3 Non reducing sugars (%)

The data presented in [Table 1(A)] indicates that the non-reducing sugar differs significantly with respect to storage conditions and differs non-significantly with respect to treatments during the entire storage period of spice blended tender coconut water. During initial day of storage, interactions, T_4S_3 (0.33%) recorded significantly maximum non-reducing sugar and significantly superior over others. At 30 days of storage, T_4S_3 (0.30%) showed significantly maximum non-reducing sugar and was at par with T_0S_2 (0.28%), T_1S_2 (0.28%), T_2S_3 (0.27%), T_4S_1 (0.27%), T_5S_1 (0.27%) and T_5S_3 (0.27%) and significantly superior over others. At 60 days of storage, interactions between treatments and storage conditions, T_4S_3 (0.25%) showed maximum non-reducing sugar and T_0S_1 (0.19%) and T_1S_1 (0.19%) showed minimum non-reducing sugar. At 90 days of storage, interactions, T_4S_3 (0.19%) showed maximum non-reducing sugar while T_1S_1 (0.14%) showed minimum non-reducing sugar. At the end of the storage, treatments differ non-significantly however T_4 recorded maximum non-reducing sugars. In storage conditions, S_3 recorded significantly maximum non-reducing sugar. The interaction differs non-significantly however T_4S_3 recorded maximum non-reducing sugar. The increase in reducing sugar as well as total sugar corresponded to the increase in total soluble solids (TSS) and ultimate decrease in nonreducing sugar during storage period. The variation in different fractions of sugar might be due to hydrolysis of polysaccharides like starch, pectin and inversion of nonreducing sugar into reducing sugar, as increase in reducing sugar was correlated with the decrease in non-reducing sugar. Similar results were reported by Patel *et al.* (2019) [16].

3.1.4 Total sugar (%)

The data presented in [Table 1(A)] indicates that the total

sugar differs significantly with respect to storage conditions, treatments and interactions during the entire storage period of spice blended tender coconut water. At 30 days of storage, interactions, T_4S_3 (3.66%) showed significantly maximum total sugar and was at par with T_3S_1 (3.60%), T_0S_2 (3.60%), T_1S_2 (3.60%) and T_5S_3 (3.60%) and significantly superior over others. At 60 days of storage, interactions, T_4S_3 (3.85%) showed significantly maximum total sugar and was at par with T_0S_2 (3.79%), T_1S_2 (3.78%), T_3S_1 (3.79%), T_4S_1 (3.79%) and T_3S_3 (3.79%) and was significantly superior over others. At 90 days of storage, T_4S_3 (4.00%) showed significantly maximum total sugar and was at par with T_3S_1 (3.90%), T_4S_1 (3.91%), T_1S_2 (3.90%), T_2S_3 (3.90%) and T_3S_3 (3.91%) and was significantly superior over others. At the end of storage, T_4 showed significantly maximum total sugar. It may be due to the conversion of complex starch or carbohydrate into simple sugars. In storage condition, S_3 showed significantly maximum total sugar whereas in interactions, T_4S_3 showed significantly maximum total sugar which might be due to faster conversion of carbohydrate into simple sugars in T_4 and S_3. The increased level of total sugar was probably due to conversion of starch and pectin into simple sugars. Similar results were reported by Patel *et al.* (2019) [16], Lavanya *et al.* (2011) [15] and Gangwar *et al.* (2018) [6].

3.1.5 Titratable acidity (%)

The data presented in [Table 1(B)] indicates that the titratable acidity differs significantly with respect to storage conditions and differs non-significantly with respect to treatments and interactions during the entire storage period of spice blended tender coconut water. At 30 days of storage, T_4S_1 (0.13%) showed maximum titratable acidity. At 60 days of storage, T_4S_1 (0.14%) recorded maximum titratable acidity. At 90 days of storage, T_4S_1 (0.15%) recorded maximum titratable acidity. At the end of storage, treatments and interactions differ non-significantly however T_4 recorded maximum titratable acidity. In storage conditions, S_1 recorded significantly maximum titratable acidity while T_4S_1 recorded maximum titratable acidity. The increase in acidity of spice blended tender coconut water during 90 days of storage may be due to formation of organic acids by ascorbic acid degradation as well as progressive decrease in the pectin content. The low temperature and high humidity prevalent in refrigerated and cold storage might have restricted the growth and activity of microbes and hence less fermentation and formation of acids. Similar results were reported by Patel *et al.* (2019) [16], Attri *et al.* (1999) [3] and Chowdhury *et al.* (2009) [5].

3.1.6 pH

The data presented in [Table 1(B)] indicates that the pH differs significantly with respect to storage conditions and differs non-significantly with respect to treatments and interactions during the entire storage period of spice blended tender coconut water. At the initial stage of storage, T_4S_3 (5.12) showed maximum pH than other interactions. At 30 days of storage, T_4S_2 (5.08) showed maximum pH while T_1S_1 (5.04), T_2S_1 (5.04), T_2S_1 (5.04) and T_0S_2 (5.04) showed minimum pH. At 60 days of storage, T_4S_3 (5.06) showed maximum pH while T_1S_1 (5.01), T_2S_1 (5.01) and T_3S_1 (5.01) showed minimum pH. At 90 days of storage, T_4S_3 (5.04) recorded maximum pH while T_1S_1 (4.80) and T_5S_2 (4.80) showed minimum pH. At the end of storage, treatments differ non-significantly however T_4 recorded maximum pH. In storage conditions, S_3 recorded significantly maximum pH and interaction T_4S_3 recorded maximum pH. The increased acidity and TSS under all the treatments during storage had a corresponding decrease in pH. Hence, the reduction in pH could be attributed to simultaneous increase in acidity and TSS of coconut water irrespective of their storage temperature. Similar results were reported by Patel *et al.* (2019) [16] and Gunathilake *et al.* (2012) [7].

Table 1(A): Change in chemical composition (TSS, reducing sugar, non-reducing sugar and total sugar) during storage of spice blended tender coconut water Cv. Banawali.

Sr. No.	Treatment Combinations	TSS (°Brix)				Reducing sugar (%)				Non reducing sugar (%)				Total sugar (%)			
		0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days
1	T_0S_1	4.60	4.77	5.03	5.13	3.03	3.26	3.45	3.60	0.27	0.23	0.19	0.15	3.30	3.48	3.64	3.76
2	T_0S_2	4.80	4.97	5.07	5.13	3.04	3.32	3.55	3.74	0.32	0.28	0.21	0.18	3.36	3.60	3.79	3.92
3	T_0S_3	4.80	5.00	5.13	5.23	3.06	3.31	3.51	3.68	0.31	0.25	0.22	0.16	3.38	3.56	3.84	5.00
4	T_1S_1	4.80	4.93	5.03	5.17	3.02	3.25	3.44	3.59	0.27	0.23	0.19	0.14	3.29	3.48	3.64	3.73
5	T_1S_2	4.80	4.90	5.00	5.13	3.04	3.32	3.55	3.72	0.32	0.28	0.22	0.18	3.35	3.60	3.78	3.90
6	T_1S_3	4.80	5.00	5.10	5.23	3.06	3.31	3.51	3.67	0.30	0.25	0.22	0.17	3.38	3.56	3.71	3.84
7	T_2S_1	4.80	4.90	5.07	5.13	3.02	3.27	3.48	3.65	0.29	0.25	0.20	0.17	3.31	3.52	3.69	3.82
8	T_2S_2	4.70	4.93	5.00	5.10	3.04	3.31	3.52	3.70	0.30	0.26	0.21	0.17	3.35	3.58	3.74	3.87
9	T_2S_3	4.97	5.10	5.13	5.20	3.05	3.32	3.54	3.72	0.31	0.27	0.22	0.18	3.39	3.59	3.76	3.90
10	T_3S_1	4.70	4.87	4.97	5.07	3.03	3.31	3.55	3.73	0.32	0.27	0.21	0.16	3.35	3.60	3.79	3.90
11	T_3S_2	4.80	4.87	5.03	5.13	3.04	3.30	3.51	3.69	0.31	0.26	0.21	0.18	3.35	3.56	3.72	3.87
12	T_3S_3	4.90	5.17	5.23	5.37	3.06	3.33	3.56	3.73	0.31	0.26	0.22	0.17	3.37	3.61	3.79	3.91
13	T_4S_1	4.90	5.10	5.07	5.20	3.03	3.31	3.55	3.73	0.32	0.27	0.22	0.16	3.36	3.59	3.79	3.91
14	T_4S_2	4.80	4.93	5.10	5.20	3.06	3.32	3.52	3.70	0.30	0.26	0.21	0.17	3.36	3.57	3.72	3.88
15	T_4S_3	5.10	5.27	5.37	5.43	3.07	3.37	3.61	3.80	0.33	0.30	0.25	0.19	3.39	3.66	3.85	4.00
16	T_5S_1	4.60	4.80	4.93	5.03	3.02	3.29	3.51	3.68	0.30	0.27	0.20	0.18	3.32	3.56	3.72	3.86
17	T_5S_2	4.80	5.00	5.17	5.23	3.05	3.30	3.50	3.66	0.30	0.25	0.20	0.16	3.35	3.55	3.69	3.82
18	T_5S_3	4.90	5.13	5.17	5.20	3.05	3.33	3.55	3.72	0.31	0.27	0.22	0.17	3.37	3.60	3.77	3.89
	SEm±	0.067	0.061	0.042	0.046	0.005	0.010	0.016	0.022	0.009	0.009	0.007	0.007	0.010	0.019	0.024	0.029
	CD at 1%	N. S	N. S	0.163	N. S	N. S	0.039	0.063	0.085	0.036	0.036	N. S	N. S	0.037	0.073	0.090	0.110

3.1.7 Ascorbic Acid (mg/100ml)

The data presented in [Table 1(B)] indicates that the ascorbic acid differs significantly with respect to storage conditions and differs non-significantly with respect to treatments and interactions during the entire storage period of spice blended tender coconut water. At the initial stage of storage, T_4S_3 (2.03mg/100ml) recorded maximum ascorbic acid. At 30 days of storage, T_4S_3 (2.02mg/100ml) recorded maximum ascorbic acid while T_0S_1 (1.95mg/100ml), T_1S_1 (1.95mg/100ml). At 60 days of storage, T_4S_1 (2.01mg/100ml) recorded maximum

ascorbic acid while T_0S_1 (1.94mg/100ml), T_1S_0 (1.94mg/100ml), T_2S_0 (1.94mg/100ml), T_3S_0 (1.94mg/100ml), and T_5S_0 (1.94mg/100ml) recorded minimum ascorbic acid. At 90 days of storage, T_4S_3 (1.99mg/100ml) recorded maximum ascorbic acid while T_5S_1 (1.93mg/100ml) recorded minimum ascorbic acid. At the end of storage, treatments differ non-significantly however T_4 recorded maximum ascorbic acid. In storage conditions, S_3 recorded significantly maximum ascorbic acid while interaction T_4S_3 recorded maximum ascorbic acid. The decrease in ascorbic acid in spice blended tender coconut water during storage might be due to oxidation or irreversible conversion of L-ascorbic acid into dehydroascorbic acid in the presence of enzyme ascorbic acid oxidase (ascorbinase) caused by trapped or residual oxygen in the glass bottles. Similar results were reported by Patel *et al.* (2019) [16] and Purohit *et al.* (2017) [18].

3.1.8 Proteins (%)

The data presented in [Table 1(B)] indicates that the proteins differ significantly with respect to storage conditions and differs non-significantly with respect to treatments and interactions during the entire storage period of spice blended tender coconut water. At the initial stage, T_4S_3 (0.54%) recorded maximum proteins. At 30 days of storage, T_4S_3 (0.27%) showed maximum proteins while T_0S_1 (0.23%), T_2S_1 (0.23%), T_3S_1 (0.23%) and T_5S_1 (0.23%). At 60 days of storage, T_4S_3 (0.23%) showed maximum proteins while T_0S_1 (0.20%), T_1S_1 (0.20%), T_2S_1 (0.20%), T_3S_1 (0.20%), T_5S_1 (0.20%) and T_2S_2 (0.20%) showed minimum proteins. At 90 days of storage, T_4S_3 (0.18%) recorded maximum proteins while T_0S_1 (0.14%), T_1S_1 (0.14%) and T_5S_1 (0.14%). At the end of storage, treatments differ non-significantly however T_4 recorded maximum proteins. It may be due to the proteins present in T_4 (0.15g/100ml) is more than other spices. Similar result was reported by Sileshi *et al.* (2019). In storage conditions, S_3 recorded significantly maximum proteins while interaction T_4S_3 recorded maximum proteins. The decrease in protein content could be explained by the action of micro-organisms that would use the nutrients for food, thus making the medium poor in nitrogenous substances, in amino acids. Similar results were reported by Adingra *et al.* (2017) [1] and Subrahmanyan and Swaminathan (1959) [23].

3.1.9 Carbohydrates (%)

The data presented in [Table 1(C)] indicates that the carbohydrate differs significantly with respect to storage conditions and differs non-significantly with respect to treatments and interactions during the entire storage period of spice blended tender coconut water. At the initial stage, T_4S_3 (3.19%) recorded maximum carbohydrate. At 30 days of storage, T_4S_3 (3.63%) showed maximum carbohydrates while T_3 (3.47%) showed minimum carbohydrates. At 60 days of storage, T_4S_3 (3.87%) showed maximum carbohydrates while T_1S_1 (3.71%) and T_2S_1 (3.71%) showed minimum carbohydrates. At 90 days of storage, T_4S_3 (4.12%) recorded maximum carbohydrates while T_1S_1 (4.00%) recorded minimum carbohydrates. At the end of storage, treatments differ non-significantly however T_4 recorded maximum carbohydrates. In storage conditions, S_3 recorded maximum carbohydrates. It may be due to maximum conversion of nonreducing sugars into reducing sugars by hydrolysis during the storage which leads to increase in carbohydrate content. In interactions, T_4S_3 recorded significantly maximum carbohydrates which might be due to the faster conversion in T_4 and S_3. Similar results were reported by Shubhashree *et al.* (2014) [21].

3.1.10 Potassium (mg/100ml)

The data presented in [Table 1(C)] indicates that the potassium differs significantly with respect to storage conditions and differs non-significantly with respect to treatments during the entire storage period of spice blended tender coconut water. At the initial stage of storage, T_4S_3 (254.97mg/100ml) recorded maximum potassium. At 30 days of storage, T_4S_3 (235.97mg/100ml) recorded maximum potassium while T_0S_1 (228.47mg/100ml) recorded minimum potassium. At 60 days of storage, T_4S_3 (219.33mg/100ml) recorded significantly maximum potassium and was at par with T_0S_3 (218.60mg/100ml) and T_1S_3 (218.20mg/100ml) while T_0S_1 (209.43mg/100ml) recorded significantly minimum potassium. At 90 days of storage, T_4S_3 (205.00mg/100ml) recorded significantly maximum potassium and was significantly superior over others. At the end of storage, treatments differ non-significantly however T_4 recorded maximum potassium. In storage conditions, S_3 recorded significantly maximum potassium while interaction T_4S_3 recorded significantly maximum potassium. It may be due to the low temperature which shows gradual decrease in potassium than the ambient temperature which shows faster reduction. Similar findings were given by Hassan and Emifoniye (2018) [9], Jean *et al.* (2009) [11], Ramaswamy *et al.* (2017) [19] and Kannangara *et al.* (2018) [12].

3.1.11 Calcium (mg/100ml)

Table 1(B): Change in chemical composition (titratable acidity, pH, ascorbic acid and protein) during storage of spice blended tender coconut water Cv. Banawali.

Sr. No.	Treatment Combinations	Titratable acidity (%)				pH				Ascorbic Acid (mg/100ml)				Protein (%)			
		0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days
1	T_0S_1	0.10	0.12	0.12	0.13	5.07	5.05	5.02	4.97	1.96	1.95	1.94	1.94	0.43	0.23	0.20	0.14
2	T_0S_2	0.09	0.11	0.11	0.13	5.08	5.04	5.02	4.90	1.99	1.99	1.97	1.96	0.50	0.25	0.21	0.17
3	T_0S_3	0.08	0.09	0.10	0.11	5.10	5.07	5.04	5.01	2.01	2.00	1.98	1.97	0.48	0.26	0.22	0.17
4	T_1S_1	0.10	0.10	0.11	0.12	5.07	5.04	5.01	4.80	1.97	1.95	1.94	1.94	0.43	0.24	0.20	0.14
5	T_1S_2	0.09	0.10	0.12	0.13	5.09	5.06	5.03	5.01	2.00	1.99	1.98	1.97	0.46	0.25	0.21	0.16
6	T_1S_3	0.08	0.09	0.10	0.11	5.10	5.07	5.03	5.01	2.02	2.01	2.00	1.97	0.46	0.26	0.21	0.17
7	T_2S_1	0.10	0.12	0.12	0.13	5.06	5.04	5.01	4.90	1.97	1.96	1.94	1.94	0.44	0.23	0.20	0.15
8	T_2S_2	0.09	0.09	0.11	0.11	5.09	5.07	5.04	5.02	2.00	1.99	1.98	1.96	0.42	0.25	0.20	0.16
9	T_2S_3	0.08	0.09	0.10	0.11	5.10	5.06	5.04	4.97	2.01	2.01	1.99	1.98	0.48	0.26	0.22	0.17
10	T_3S_1	0.10	0.11	0.12	0.13	5.06	5.04	5.01	4.90	1.96	1.95	1.94	1.93	0.42	0.23	0.20	0.15
11	T_3S_2	0.09	0.10	0.11	0.12	5.08	5.06	5.03	4.97	2.00	1.99	1.98	1.96	0.43	0.25	0.21	0.16
12	T_3S_3	0.08	0.09	0.10	0.11	5.10	5.08	5.04	5.02	2.01	2.01	1.99	1.98	0.52	0.26	0.22	0.17
13	T_4S_1	0.12	0.13	0.14	0.15	5.07	5.05	5.03	4.90	1.99	1.98	1.96	1.95	0.48	0.24	0.21	0.16
14	T_4S_2	0.10	0.11	0.12	0.13	5.10	5.06	5.03	4.97	2.00	1.99	1.99	1.97	0.54	0.26	0.22	0.17
15	T_4S_3	0.08	0.09	0.10	0.11	5.12	5.08	5.06	5.04	2.03	2.02	2.01	1.99	0.54	0.27	0.23	0.18

16	T_5S_1	0.10	0.11	0.12	0.13	5.08	5.05	5.03	4.90	1.97	1.96	1.94	1.93	0.42	0.23	0.20	0.14
17	T_5S_2	0.09	0.10	0.11	0.13	5.08	5.05	5.03	4.80	1.99	1.98	1.97	1.96	0.50	0.25	0.21	0.16
18	T_5S_3	0.08	0.09	0.10	0.11	5.11	5.07	5.04	5.02	2.01	1.99	1.99	1.97	0.47	0.26	0.22	0.17
	SEm±	0.004	0.004	0.004	0.004	0.006	0.005	0.006	0.040	0.007	0.007	0.007	0.005	0.011	0.004	0.005	0.005
	CD at 1%	N. S	N. S	N. S	N. S	N. S	0.019	N. S	N. S	N. S	N. S	N. S	N. S	N. S	N. S	N. S	N. S

The data presented in [Table 1(C)] indicates that the calcium differs significantly with respect to storage conditions and differs non-significantly with respect to treatments and interactions during the entire storage period of spice blended tender coconut water. At the initial stage of storage, T_4S_3 (43.73mg/100ml) recorded maximum calcium. At 30 days of storage, T_4S_3 (39.57mg/100ml) recorded maximum calcium while T_1S_1 (35.27mg/100ml) recorded minimum calcium. At 60 days of storage, T_4S_3 (32.87mg/100ml) recorded maximum calcium while T_0S_1 (29.27mg/100ml) and T_1S_1 (29.27mg /100ml). At 90 days of storage, T_4S_3 (30.60mg/100ml) recorded maximum calcium while T_0S_1 (25.40mg/100ml). At the end of storage, treatments differ non-significantly however treatment T_4 recorded maximum calcium. In storage conditions, S_3 recorded maximum calcium while interaction T_4S_3 recorded maximum calcium. It may be due to low temperature which retains the calcium and shows very slow decrease in it than in ambient temperature. The degradation of calcium is less at low temperatures. Similar findings were reported by Hassan and Emifoniye (2018) [9]. The interactions differ non-significantly however T_4S_3 recorded maximum calcium. Similar findings were reported by Satyavati (1995) [20], Jean *et al.* (2009) [11] and Kannangara *et al.* (2018) [12].

3.1.12 Sodium (mg/100ml)

The data presented in [Table 1(C)] indicates that the sodium differs significantly with respect to storage conditions and differs non-significantly with respect to treatments and interactions during the entire storage period of spice blended tender coconut water. At the initial stage of storage, T_4S_3 (48.73mg/100ml) recorded maximum sodium. At 30 days of storage, T_4S_3 (45.80mg/100ml) recorded maximum calcium while T_2S_1 (38.90mg/100ml) recorded minimum calcium. At 60 days of storage, T_4S_3 (40.43mg/100ml) recorded maximum sodium while T_5S_1 (34.53mg/100ml) recorded minimum sodium. At 90 days of storage, T_4S_3 (34.60mg/100ml) recorded maximum sodium while T_5S_1 (30.23mg/100ml) recorded minimum sodium. At the end of the storage, treatments differ non-significantly however T_4 recorded maximum sodium. In storage conditions, S_3 recorded significantly maximum sodium. It may be due to low temperature which retains the sodium content in the refrigerated condition. In ambient condition, the reduction of sodium is more. Similar finding was reported by Hassan and Emifoniye (2018) [9]. The interactions differ non-significantly however T_4S_3 recorded maximum sodium. Similar findings were given by Shubhashree *et al.* (2014) [21] and Kannangara *et al.* (2018) [12].

3.1.13 Magnesium (mg/100ml)

The data presented in [Table 1(D)] indicates that the magnesium differs significantly with respect to storage conditions and differs non-significantly with respect to treatments during the entire storage period of spice blended tender coconut water. At the initial stage of storage, T_4S_3 (10.50mg/100ml) recorded significantly maximum magnesium and was at par with T_1S_3 (10.40mg/100ml), T_2S_3 (10.37mg/100ml) and T_3S_3 (10.40mg/100ml) and was significantly superior over others. At 30 days of storage, T_4S_3 (10.40mg/100ml) recorded significantly maximum magnesium and was at par with T_1S_3 (10.30mg/100ml), T_2S_3 (10.27mg/100ml), T_3S_3 (10.30mg/100ml) and was significantly superior over others. At 60 days of storage, T_4S_3 (10.30mg/100ml) recorded maximum magnesium while T_2S_1 (8.60mg/100ml) recorded minimum magnesium. At 90 days of storage, T_4S_3 (10.20mg/100ml) recorded maximum magnesium while T_2S_1 (8.50mg/100ml) recorded minimum magnesium. At the end of storage, treatments differ non-significantly however treatment T_4 recorded maximum magnesium. In storage conditions, S_3 recorded maximum magnesium. It may due to low temperature which retains the magnesium content during the storage period. Similar finding was reported by Hassan and Emifoniye (2018) [9]. The interactions differ non-significantly however T_4S_3 showed best result. Similar findings were reported by Shubhashree *et al.* (2014) [21] and Jean *et al.* (2009) [11].

3.1.14 Phosphorus (mg/100ml)

The data presented in [Table 1(D)] indicates that the phosphorus differs significantly with respect to storage conditions and differs non-significantly with respect to treatments and interactions during the entire storage period of spice blended tender coconut water. At the initial stage of storage, T_4S_3 (9.33mg/100ml) recorded maximum phosphorus. At 30 days of storage, T_4S_3 (9.20mg/100ml) recorded maximum phosphorus while T_0S_1 (8.70mg/100ml) and recorded minimum phosphorus. At 60 days of storage, T_4S_3 (9.13mg/100ml) recorded maximum phosphorus while T_2S_1 (8.53mg/100ml) and T_1S_1 (8.53mg/100ml) recorded minimum phosphorus. At 90 days of storage, T_4S_3 (9.00mg/100ml) recorded significantly maximum phosphorus and was at par with T_1S_2 (8.77mg/100ml), T_0S_3 (8.80mg/100ml), T_1S_3 (8.80mg/100ml) and T_3S_3 (8.80mg/100ml) and significantly superior over others. At the end of storage, treatments differ non-significantly however treatment T_4 recorded maximum phosphorus. In storage conditions, S_3 recorded maximum phosphorus. It might be due to slow degradation of phosphorus in low temperature than in ambient condition. Similar finding was reported by Hassan and Emifoniye (2018) [9]. In interactions, T_4S_3 recorded significantly maximum phosphorus. Similar findings were given by Satyavati (1995) [20] and Jean *et al.* (2009) [11].

3.2 Sensory qualities

With respect to colour, flavour, and overall acceptance, interaction T_4S_3 (0.15g cardamom/100ml TCW stored at refrigerated storage) was found to be the best (Table 2). As a result of the foregoing findings,

Table 1(C): Change in chemical composition (carbohydrate, potassium, calcium and sodium) during storage of spice blended tender coconut water Cv. Banawali.

Sr. No.	Treatment Combinations	Carbohydrate (%)				Potassium (mg/100ml)				Calcium (mg/100ml)				Sodium (mg/100ml)			
		0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days
1	T_0S_1	3.15	3.52	3.73	4.01	247.44	228.47	209.43	194.33	38.57	36.37	29.27	25.40	42.17	39.07	36.23	31.27
2	T_0S_2	3.16	3.53	3.79	4.11	250.61	231.70	213.77	198.77	41.33	37.27	30.37	27.43	42.27	41.37	36.43	32.93
3	T_0S_3	3.18	3.53	3.83	4.05	252.34	235.68	218.60	203.23	43.07	38.27	33.43	29.37	44.87	41.60	39.57	33.60
4	T_1S_1	3.15	3.48	3.71	4.00	249.54	230.47	210.23	195.23	40.43	35.27	29.27	26.47	42.63	40.60	36.33	31.37
5	T_1S_2	3.16	3.52	3.83	4.11	249.29	233.13	214.17	199.13	41.33	37.40	31.43	27.37	43.90	41.90	36.43	32.43
6	T_1S_3	3.18	3.58	3.84	4.04	252.37	233.43	218.20	203.23	42.30	38.43	33.57	30.33	44.93	42.07	39.40	32.27
7	T_2S_1	3.14	3.52	3.71	4.02	248.22	230.28	211.30	196.27	39.43	36.25	29.47	26.07	41.63	38.90	35.63	31.43
8	T_2S_2	3.16	3.53	3.82	4.08	249.82	234.17	212.33	197.37	41.43	37.30	31.27	27.50	44.33	40.17	36.50	32.33
9	T_2S_3	3.19	3.55	3.83	4.09	253.43	233.47	214.03	199.03	42.20	38.50	32.40	30.27	46.77	45.17	39.33	33.73
10	T_3S_1	3.15	3.47	3.75	4.04	249.67	229.47	210.77	195.70	40.37	35.40	30.50	25.90	41.90	39.77	35.43	30.37
11	T_3S_2	3.16	3.51	3.76	4.04	250.67	229.97	214.33	199.30	41.50	37.17	31.30	27.37	45.70	41.53	36.53	32.54
12	T_3S_3	3.18	3.59	3.79	4.08	253.90	234.33	215.57	200.93	42.50	38.33	32.43	30.13	44.73	41.13	39.37	33.17
13	T_4S_1	3.15	3.49	3.82	4.07	250.35	232.07	213.53	198.47	40.37	36.33	32.07	25.47	41.70	39.53	36.40	32.87
14	T_4S_2	3.18	3.62	3.81	4.05	253.35	233.87	212.33	197.33	43.23	38.40	32.53	28.47	46.83	43.07	37.50	33.77
15	T_4S_3	3.19	3.63	3.87	4.12	254.97	235.97	219.33	205.00	43.73	39.57	32.87	30.60	48.73	45.80	40.43	34.60
16	T_5S_1	3.14	3.50	3.74	4.02	247.33	230.43	210.47	195.30	40.37	35.33	30.57	27.60	42.53	39.10	34.53	30.23
17	T_5S_2	3.16	3.53	3.83	4.03	252.16	231.40	215.03	201.00	41.33	37.33	31.40	28.43	45.03	39.10	37.43	33.70
18	T_5S_3	3.18	3.56	3.80	4.11	254.40	235.40	216.30	201.13	41.67	38.47	31.97	28.33	45.33	42.47	39.50	33.77
	SEm±	0.005	0.020	0.022	0.010	0.935	0.892	0.856	0.856	0.595	0.610	31.97	0.556	0.801	0.863	0.564	1.057
	CD at 1%	N. S	N. S	N. S	0.038	N. S	N. S	3.292	3.291	N. S	N. S	N. S	N. S	N. S	N. S	N. S	N. S

Table 1(D): Change in chemical composition (magnesium and phosphorus) during storage of spice blended tender coconut water Cv. Banawali.

Sr. No.	Treatment Combinations	Magnesium (mg/100ml)				Phosphorus (mg/100ml)			
		0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days
1	T_0S_1	8.80	8.70	8.70	8.60	8.80	8.70	8.53	8.30
2	T_0S_2	9.63	9.53	9.43	9.33	8.97	9.00	8.93	8.67
3	T_0S_3	10.20	10.10	10.10	10.00	9.03	9.00	8.90	8.80
4	T_1S_1	8.90	8.80	8.70	8.60	8.90	8.80	8.53	8.47
5	T_1S_2	9.30	9.20	9.20	9.10	9.00	9.00	8.93	8.77
6	T_1S_3	10.40	10.30	10.20	10.10	9.03	9.00	8.90	8.80
7	T_2S_1	8.87	8.70	8.60	8.50	8.90	8.80	8.67	8.50
8	T_2S_2	9.33	9.27	9.13	9.03	8.90	8.80	8.70	8.60
9	T_2S_3	10.37	10.27	10.17	10.03	9.07	8.90	8.80	8.70
10	T_3S_1	8.90	8.80	8.70	8.60	8.90	8.80	8.57	8.50
11	T_3S_2	9.50	9.40	9.30	9.20	8.93	8.90	8.73	8.70
12	T_3S_3	10.40	10.30	10.20	10.10	9.13	9.00	8.83	8.80
13	T_4S_1	8.90	8.90	8.70	8.60	8.97	9.00	8.80	8.70
14	T_4S_2	9.50	9.40	9.30	9.20	9.10	9.00	8.77	8.60
15	T_4S_3	10.50	10.40	10.30	10.20	9.33	9.20	9.13	9.00
16	T_5S_1	8.90	8.80	8.70	8.60	8.90	8.80	8.80	8.60
17	T_5S_2	9.40	9.30	9.20	9.10	8.93	8.80	8.70	8.60
18	T_5S_3	10.07	10.00	9.90	9.80	8.87	9.13	8.77	8.60
	SEm±	0.069	0.068	0.068	0.068	0.084	0.097	0.078	0.067
	CD at 1%	0.265	0.262	N. S	N. S	N. S	N. S	N. S	0.256

Table 2: Change in sensory qualities during storage of spice blended tender coconut water Cv. Banawali.

Sr. No.	Treatment Combinations	Colour				Flavour				Overall acceptability			
		0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days
1	T_0S_1	7.50	7.20	6.90	6.87	7.40	7.20	6.73	6.50	7.45	7.20	6.82	6.68
2	T_0S_2	7.73	7.30	7.13	7.00	7.27	7.10	6.70	6.60	7.50	7.20	6.92	6.80
3	T_0S_3	7.60	7.33	7.17	6.93	7.30	7.10	6.80	6.57	7.45	6.98	6.98	6.75
4	T_1S_1	7.17	6.90	6.80	6.50	7.07	6.80	6.10	5.60	7.12	6.85	6.45	6.05
5	T_1S_2	7.30	7.10	7.00	6.80	7.23	7.10	6.60	6.20	7.27	7.10	6.80	6.50
6	T_1S_3	7.10	6.80	6.70	6.53	6.90	6.80	6.50	6.33	7.00	6.80	6.60	6.43
7	T_2S_1	7.10	6.80	6.63	6.50	7.83	7.77	6.30	6.13	7.47	6.85	6.47	6.32
8	T_2S_2	7.10	7.00	6.90	6.57	7.23	7.10	6.80	6.10	7.17	7.05	6.85	6.33
9	T_2S_3	8.20	7.80	7.67	7.40	7.87	7.70	6.90	6.77	8.03	6.75	7.28	7.08
10	T_3S_1	6.90	6.77	6.63	6.47	6.57	6.30	6.20	5.80	6.73	6.53	6.42	6.13
11	T_3S_2	6.83	6.67	6.53	6.37	6.70	6.40	6.10	5.90	6.77	6.53	6.32	6.13
12	T_3S_3	7.00	6.80	6.60	6.50	6.70	6.40	6.10	5.87	6.85	6.60	6.35	6.18
13	T_4S_1	8.10	7.83	7.50	6.90	7.47	7.20	7.00	6.50	7.78	7.52	7.25	6.70
14	T_4S_2	8.20	7.87	7.77	7.50	8.17	7.73	7.00	6.33	8.12	6.95	7.38	6.92
15	T_4S_3	8.17	7.90	7.80	7.47	8.17	7.80	7.20	6.87	8.17	7.85	7.50	7.17
16	T_5S_1	6.93	6.77	6.63	6.40	6.60	6.40	6.20	5.90	6.77	6.58	6.42	6.15
17	T_5S_2	6.87	6.63	6.53	6.33	6.73	6.60	6.20	5.90	6.80	6.62	6.37	6.12

18	T_5S_3	6.87	6.67	6.63	6.33	6.80	6.53	6.60	5.97	6.83	6.73	6.62	6.15
	SEm ±	0.079	0.078	0.079	0.079	0.096	0.069	0.067	0.081	0.075	0.069	0.057	0.049
	CD at 1%	0.302	0.299	0.302	0.305	0.369	0.267	0.258	0.313	0.290	0.265	0.218	0.188

Table 3: Change in fungal and bacterial count during storage of spice blended tender coconut water Cv. Banawali.

Sr. No.	Treatment Combinations	Fungal count (cc x 10^{-3})				Bacterial count (cc x 10^{-3})			
		0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days
1	T_0S_1	0	0	1.70	1.80	0	0.57	1.70	2.67
2	T_0S_2	0	0	1.30	1.70	0	0.47	1.37	2.40
3	T_0S_3	0	0	0.63	1.00	0	0.57	0.69	1.30
4	T_1S_1	0	0	1.80	1.93	0	0.60	1.80	2.87
5	T_1S_2	0	0	1.40	1.80	0	0.50	1.40	2.47
6	T_1S_3	0	0	0.80	0.90	0	0.50	0.56	1.30
7	T_2S_1	0	0	1.80	1.90	0	0.50	1.60	2.70
8	T_2S_2	0	0	1.50	1.80	0	0.50	1.30	2.50
9	T_2S_3	0	0	0.87	1.20	0	0.50	0.52	1.50
10	T_3S_1	0	0	1.80	2.00	0	0.57	1.50	2.70
11	T_3S_2	0	0	1.30	1.70	0	0.60	1.30	2.30
12	T_3S_3	0	0	0.80	0.97	0	0.50	0.53	1.40
13	T_4S_1	0	0	1.60	1.80	0	0.63	1.30	2.50
14	T_4S_2	0	0	1.20	1.60	0	0.50	1.20	2.20
15	T_4S_3	0	0	0.60	0.80	0	0.40	0.38	1.20
16	T_5S_1	0	0	1.70	1.90	0	0.60	1.50	2.60
17	T_5S_2	0	0	1.60	1.80	0	0.60	1.20	2.40
18	T_5S_3	0	0	0.70	0.83	0	0.47	0.66	1.23
	SEm±	0.069	0.068	0.056	0.068	0	0.056	0.152	0.066
	CD at 1%	0.265	0.262	N. S	N. S	0	N. S	N. S	N. S

Interaction T_4S_3 produced the greatest outcomes in terms of changes in sensory quality of spice blended tender coconut water throughout storage. Similar findings were given by Carvalho *et al.* (2007) [4], Kathiravan *et al.* (2014) [13], Purohit *et al.* (2017) [18], Patel *et al.* (2019) [16], Ramaswamy *et al.* (2017) [19], Chowdhury *et al.* (2009) [5], Sindumathi and Amutha (2015) [222], Jayasundera and Dharmasena (2014) [10] and Gunathunga *et al.* (2018) [8].

3.3 Microbial analysis

The bacterial and fungal count of spice blended tender coconut water was found to be significantly increased, irrespective of treatments and storage conditions (Table 3). Among the six treatments, T_4 (0.15g cardamon/100ml TCW) showed minimum microbial count. In storage conditions, S_3 (refrigerated condition) showed significantly minimum microbial count whereas S_1 (ambient condition) showed significantly maximum microbial count. Among different interactions tried, interaction T4S3 (0.15g cardamom/100ml of tender coconut water at refrigerated condition) recorded lowest bacterial and fungal count at 90 days of storage period. Similar findings have been reported by Lavanya *et al.* (2015), Sindumathi and Amuta (2015) [22] and Kumar *et al.* (2017) [14].

4. Conclusion

Considering the above findings of analysis, it was observed that the T_4S_3 (0.15g cardamom/100 ml TCW stored at refrigerated condition) preserved in glass bottles performed best quality after 90 days of storage at refrigerated conditions. This processed coconut water will be suitable for commercial processing.

5. References

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