

Original Research Article

"Evaluating the Storage Stability of Ready-to-Drink Beverages Prepared from Noni and Kokum Extracts"

Abstract

The noni extract was blended with kokum extract in varying proportions to enhance the color, flavor, and sensory qualities of a ready-to-serve blended beverage, while masking the pungent smell of noni. Beverages containing 12.5 and 15% pulp, 15° Brix TSS, and 0.30% acidity were prepared with cumin and black pepper oleoresins added at 10 µl and 6.5 µl, respectively. These were filled into pre-sterilized 200 ml glass bottles, heat-processed, and stored for up to three months under ambient conditions (18-35°C). Chemical analyses and sensory evaluations of the RTS beverages were conducted at 15-day intervals over 90 days of storage. Minimal changes were observed in quality parameters such as TSS, titratable acidity, and ascorbic acid content during storage. However, the whiteness index (WI), as determined by Hunter's L*, a*, and b* values, antioxidant activity, and total phenol content decreased over the 90 days. The organoleptic quality score was highest for the noni-kokum blended beverage T₅ (60% NE: 40% KE) at 7.84 after 90 days of storage. The results indicate that increasing the concentration of kokum extract enhances the acceptability of the beverages.

Keywords: Noni extract, Kokum extract, blended beverage, RTS, Storage stability

Introduction

India, endowed with vast geographical diversity and a wide range of agro-climatic conditions, stands as the largest producer of fruits and the second largest producer of vegetables globally, underscoring its pivotal role in global agriculture (Surendran *et al.*, 2020). The demand for fresh fruits and their products, particularly juices and juice-based drinks, has surged due to increasing consumer awareness of healthier dietary choices (Campos *et al.*, 2002; Andrea Da *et al.*, 2009). Fruits and vegetables are not only rich sources of essential nutrients but also possess medicinal properties attributed to their antioxidant content and dietary fiber (Eastwood, 1999). These properties are crucial in combating various ailments including cardiovascular diseases and certain cancers (Li, 2008).

In this context, noni (*Morindacitrifolia*) and kokum (*Garcinia indica*) emerge as noteworthy fruits with significant health benefits. Noni, historically used in Ayurvedic medicine for over two millennia, is renowned for its immune-boosting properties and therapeutic potential against a spectrum of ailments (Earle, 2001). Its medicinal efficacy is attributed to compounds such as scopoletin, alkaloids, and antioxidants (Dixon *et al.*, 1999; Solomon, 1999). Similarly, Kokum, indigenous to the Western Ghats of India, offers

medicinal uses ranging from treating digestive disorders to possessing anticancer properties due to its rich content of anthocyanins, hydroxycitric acid, and garcinol (Krishnamurthy *et al.*, 1982; Ranveer and Sahoo, 2017).

The blending of Noni and Kokum in ready-to-serve (RTS) beverages represents a novel approach to harnessing their combined health benefits and enhancing consumer acceptability. This blending not only mitigates the pungent taste of noni but also leverages the complementary medicinal properties of both fruits, potentially yielding beverages with enhanced nutritive value and therapeutic efficacy (Joshi *et al.*, 2012). Moreover, the incorporation of these fruits into functional beverages aligns with current consumer preferences for natural, nutrient-rich products that promote overall well-being (Soto-Silva *et al.*, 2016).

Despite their individual merits, limited research has explored the synergistic effects of noni and kokum in blended RTS beverages. This paper aims to bridge this gap by investigating the nutritional composition of noni -kokum blended RTS beverages under ambient storage of 90 days.

Materials and methods

The current study was conducted at the Department of Post Harvest Technology, College of Horticulture, University of Horticultural Sciences, Bagalkote, during the academic year 2019-20. Organically cultivated Noni fruits were sourced from a farm located in Ramankoppa village, Shivamogga. Kokum rinds were obtained from a farmer in Sirasi, Uttar Kannada. Specifically, Noni fruits selected for extraction were identified by their characteristic yellowish to white coloration.

Extraction of juices

Noni extract (NE)

To obtain pure noni extract, organically grown mature yellow fruits are first washed, followed by a 3-4 day storage period until their color changes to white and then black. The fruits are boiled in water (1:3 ratios) at 80°C for 4 hours, filtered, and finally bottled, ensuring preservation of its natural properties and medicinal benefits.

Kokum extract (KE)

The extraction of kokum rind extract begins with collecting fresh rinds, washing them thoroughly, and soaking them overnight in water (1:2ratios). The softened rinds are then ground and filtered through a stainless steel sieve to obtain a clear extract. This purified extract is bottled, preserving its natural properties and making it suitable for various applications in food, pharmaceuticals, and beverages.

In the formulation process of noni and kokum blended beverage, the first step involves blending the extracts of noni and kokum. To achieve the desired flavor and consistency, water is added to the blend. Additionally, spices such as 6.5 µl of black pepper

and 10 µl of cumin oleoresin per 200 ml of ready-to-drink (RTD) beverage are incorporated to enhance both the taste and the potential health benefits of the final product. The total soluble solids (TSS) and acidity levels of the mixture are then carefully adjusted to specific standards, aiming for 15 °Brix and 0.30% acidity respectively. Finally, the blended beverage is bottled in 200 ml glass containers, ensuring the preservation of its nutritional integrity and appealing to consumers.

Table 1: Treatment combinations

Treatments	Juice blend (%)	Sugar (gm)	Black pepper oleoresin (µl)	Cumin oleoresin (µl)	Water (ml)	Citric acid (mg)
T ₁	12.5 (NE 100: KE 0)	28.5	13	20	143	248
T ₂	12.5 (NE 52: KE 48)	28.5	13	20	143	0
T ₃	15 (NE 100: KE 0)	25.8	13	20	140	290
T ₄	15 (NE70: KE30)	25.8	13	20	140	150
T ₅	15 (NE 60: KE 40)	25.8	13	20	140	0

Note: Two sets based on preliminary work

Set 1: 12.5 % juice blend

Set 2: 15 % juice blend

*Preservative- Sodium benzoate (100 ppm)

Biochemical analysis

Biochemical properties of blended RTD were determined by following methods. TSS (Total Soluble Solids) measured by hand refractometer at room temperature and expressed in °Brix. pH of RTD measured by digital pH meter. Total titratable acidity was determined by visual titration method and was expressed in percentage (Ranganna, 1997). Ascorbic acid content was analyzed by titrimetric method using 2, 6-dichlorophenol indophenols dye as per modified procedure of AOAC (Anon., 1984).

Anti-oxidant activity (%)

The percentage of 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity of blended juice was determined by a method explained by Kathiravan *et al.* (2015).

0.1 ml of juice sample and 0.1 ml of (control) methanol were mixed with 2.9 ml of DPPH solution. Here methanol is used as blank. The mixture was kept 30 minutes in darkness and then the spectrophotometer absorbance reading was taken against blank at 517 nm. DPPH free radical scavenging activity (%) was calculated by following formula:

$$\text{Anti-oxidant activity (\%)} = \frac{A_{517\text{nm of control}} - A_{517\text{ nm of sample}}}{A_{517\text{nm of control}}} \times 100$$

Where, A = Absorbance value

Total phenol (mg GAE/100 ml)

Total phenol content of noni kokum blended beverage was evaluated by Folin-ciocalteu reagent (FCR) method and expressed as mg gallic acid equivalent per 100 ml.

Folin-ciocalteu reagent technique by using gallic acid as a standard was applied for the assessment of total phenol content in the sample. Known volume of 0.2 ml and 1 ml samples was made up to 3 ml volume by adding distilled water and add 2.5 ml of 10 per cent v/v folin-ciocalteu reagent to this. Again 2 ml of 20 per cent sodium carbonate was added after 5 minutes and incubated at room temperature for about 15 minutes. The

absorbance of samples was measured at 765 nm and total phenol content was expressed as mg GAE/100 g of the sample (Madaan *et al.*, 2011).

Sensory evaluation

Sensory evaluation of noni kokum blended beverage was carried out by semi-trained panel of judges. It was evaluated for colour, flavour, consistency and mouth feels. Sensory score card was distributed to all panel members comparing 9 point hedonic scale developed by Quarter Master Food and Container Institute, U.S.A. (Gupta, 1976).

The score of various treatments with respect to colour, flavour, taste, consistency and overall acceptability was worked out. All parameters are analyzed at 15 days interval for 90 days of storage period under ambient condition. The data was analyzed using completely randomized design (CRD) with WASP Software.

Result and discussion

Total soluble solids

The data exhibited in table 2 depicted that there was non significant difference among the treatments up to 75 days of storage but notable difference was documented at the end. This is because, initially TSS of all the treatment was maintained 15 °Brix and all of these stored in same temperature and humidity under ambient condition.

Highest TSS (15.5 °Brix) was recorded in the treatment T₅ (NE 60: KE 40). Lowest TSS content (15.28 °Brix) was reported by the treatment T₁ (NE 100 %). All the treatments exhibited increasing trend in TSS during the storage period. The increase in TSS attributes to the conversion of polysaccharides, pectin and other constitutes in juices to monosaccharides (Sasi *et al.*, 2013). Similar results were reported by Lanjhiyana *et al.* (2010) in lime and ginger juice and Mane *et al.* (2019) in fresh turmeric rhizome juice-based orange RTS beverage.

pH

The pH of ready to drink health beverage decreased gradually during storage under ambient condition (Table 3). The mean pH content of RTD health beverage of noni and kokum exhibits decreasing trend from 2.88 to 2.54 at the end of storage (90 DAS) irrespective of treatments. At 90 days of storage highest pH observed in T₁ (2.72) While lowest found in T₅(2.45). The main reason for decrease in pH is enzymatic and chemical changes in RTS during storage (Heamalatha *et al.*, 2018) and also due to increase in acidity (Karpagavalli and Amutha, 2015). The result is in conformity with studies of Sasikumar (2015) in beverages prepared from aloevera blended with bael fruit.

Titrateable acidity (%)

The mean highest titrateable acidity (0.36%) irrespective of storage period reported in T₅(NE 60%: KE 40%) and which was on a level with T₂ (NE 52: KE 48 %)and T₄ (NE 70: KE30) (0.35 % each) and lowest titrateable acidity (0.32 %) was noticed in T₁ (NE 100%). The mean titrateable acidity of RTD increased from (initial) 0.32 to 0.36 per cent (90 DAS) during storage of 3 months in ambient condition and it is exhibited in table 4.

Increase in acidity of RTD might be due to the degradation of pectin substance, ascorbic acid and slight increase in microbial population in juices during storage (Barman and Barooah, 2016). The outcomes are corresponding with findings of Gupta (2019) in blended karonda, beet root ready to serve beverages.

Instrumental colour (L^* , a^* and b^*) values

Instrumental L^* value

It was obvious from the data, there was gradually decrease in instrumental L^* values for colour of RTD health beverage during storage period which is exhibited in table 5. The mean instrumental L^* values for colour of RTD decreased.

The mean highest instrumental L^* values for colour (12.54) with irrespective of storage period were recorded in T_1 (NE 100%) which was on a level with T_3 (NE 100%) and lowest instrumental L^* values (7.88) for colour was reported in T_2 (52 % NE: 48% KE).

The darkening of the juice during the storage might be reason for decreasing L^* value. Oxidation of phenolic compounds also contribute for darkening of the juices (Bhardwaj and Nandal, 2014). This was supported by observations of Gaikawad (2016) in blended pineapple and pomegranate RTS.

Instrumental a^* value

The mean maximum instrumental a^* value (7.45) for colour recorded in T_2 (52% NE: 48% KE) followed by T_5 (60% NE: 40% KE) and lowest instrumental a^* values (-0.68) for colour was noticed in T_1 (NE 100%). There was gradually decrease in instrumental a^* values for colour of RTD health beverage from noni and kokum beverage during storage period except T_1 and T_3 in these treatments a^* values slightly increased which was depicted in Table 6.

This decrease might be due to polymerization of anthocyanin at higher temperature resulting into fading of the juice colour. This was supported by the studies of Alighourchi and Barzegar (2009) in pomegranate juices.

Instrumental b^* value

The mean highest b^* value (6.27) recorded in treatment T_1 (NE 100%) and minimum b^* value (3.49) observed in treatment T_2 (52 % NE: 48% KE). From the data which was evident that b^* value is decreasing gradually and it is exhibited in table 7.

This might be because of polymerization and slightly browning of the juice and the results were in accordance with the findings recorded by Alighourchi and Barzegar (2009) in pomegranate juices.

Ascorbic acid (mg/100 ml)

The mean highest ascorbic acid (19.67 mg/100 ml) was recorded in T_3 (NE 100%) and it was onpar with T_1 (NE 100%) and lowest ascorbic acid (15.59 mg/100 ml) was noticed in T_5 (60% NE: 40% KE). It obvious from the data presented in table 8 and

Fig. 1, there was gradual reduction in ascorbic acid of RTD health beverage from noni and kokum during storage period. The mean ascorbic acid content of RTD reduced from (initial) 18.17 to 16.76 mg/100 ml (final) during storage period of 3 months in ambient condition.

This decline in ascorbic acid content might be because of irreversible conversion of L-ascorbic acid into dehydroascorbic acid oxidase because of heat processing and presence of air at the head space of the bottles (Malavaet *al.*, 2014) and also due to oxidation by enzymatic and non-enzymatic catalyst (Mgaya-Kilimaet *al.*, 2015). This present study is in conformity with studies of Lanjhiyanaet *al.* (2010) in lime and ginger juice, Thakur *et al.* (2018) in RTS juice based beverage from wild aonla fruit.

Antioxidant activity (%)

Mean maximum antioxidant activity (56.21%) irrespective of storage duration was recorded in T₃ (NE 100%) and it was on a level with T₁ (NE 100%) and least antioxidant activity (51.86%) was noticed in T₂ (52 % NE: 48% KE).

It was obvious from the data, there was decreasing trend observed in antioxidant activity of RTD health beverage from noni and kokum during storage period and it is represented in table 9 and Fig. 2. The mean antioxidant activity of RTD reduces from 55.70 to 53.22 per cent (90 DAS) during storage period of 3 months under ambient condition.

This decrease in antioxidant activity is due to decrease in ascorbic acid, flavonoids and anthocyanins. The degradation of these constituents is due to chemical reaction, enzymatic and non-enzymatic reactions, heat and light sensitivity which lead to reduction in antioxidant activity (Sherzad *et al.*, 2017). Similar results were observed by Del caroet *al.* (2004) in orange juice and Porto *et al.* (2017) in beet and orange mixed juices.

Total phenol (mg GAE/100 ml)

The highest mean phenol content (132.99 mg GAE/100 ml) irrespective of storage duration was observed in the treatment T₃ (NE 100%) and least phenol content (125.87 mg GAE/100 ml) was recorded in treatment T₂(52 % NE: 48% KE).

It was evident from the data, there was gradual decrease in phenolic content of blended beverage during storage period and it is represented in table 10. The mean total phenol content reduced from 130.23 to 127.56 mg GAE/100 ml during 3 months of ambient storage. Decrease in phenolic content might be due to the oxidation process and polymerization reaction of the pigments (Saci *et al.*, 2015). Karpagavalli and Amutha (2015) in pomegranate squash and Devra *et al.* (2017) in aonla based blended RTS also found decrease in total phenol content.

Sensory evaluation

Colour and appearance

Colour is a one of the predominant parameter which determines the consumer preference. It is mainly due to anthocyanin content of kokum juice which enhanced the colour and eye catching appeal of the blended noni kokum RTD. Notably, highest mean score for colour (7.83) was registered in T₅ (60% noni extract : 40% kokum extract) which was statistically followed by T₂ (52% noni extract: 48% kokum extract), and lowest score (7.23) was reported in T₃ (NE 100%). The maximum mean sensory score for colour was recorded during initial period (7.94) followed by 15 DAS (7.93) and lowest at the end of storage period (7.01). The score for colour and appearance decreased throughout the storage duration (table 11, Fig. 3). The decrease in score is due to degradation of pigments and oxidative reduction of pigments (Sarakar and Bulu, 2017). The present study was with conformity with studies of Rashid *et al.* (2018) in guava RTS and Bhardwaj and Nandal (2014) in kinnow mandarin juice blends.

Consistency

It was apparent from data as storage duration advances consistency of the RTD appeared to be decreasing trend throughout the storage period (table 12). Significantly highest mean score for consistency (7.67) was registered in T₅ (60% NE: 40% KE) which was statistically followed by T₂(52 % NE: 48% KE), T₄ (70% NE: 30 % KE) and least score was recorded in T₁ (NE 100%) (7.17).

This decrease in consistency might be due to breakdown of the pigments during storage (Jhoshi, 1994). The result is found to be similar with the findings of other researchers like Byanna and Gouda (2013) in sweet orange and kokum blended RTS.

Taste

It was cleared from the data sensory score for taste decreasing with increasing storage period (table 13). At the end storage period maximal sensory score for taste of RTD reported in T₄ (7.14) and which was on par with T₅ (7.04) and T₂ (6.92) and lowest sensory score was reported in T₃ (6.29) followed by T₁ (6.39).

Flavour

The highest mean flavour was recognized by treatment T₅ (60% NE: 40% KE) (8.15) which was followed by T₂(52 % NE: 48% KE) and lowest flavour (7.25) was noticed in T₁ (NE 100%). The mean flavour of RTD decreased from (initial) 8.23 to 7.09 (90 DAS) during storage of 3 months in ambient condition which was depicted in Table and 14. Decrease in flavour might be due to loss of volatile components (Sogi and Singh, 2001).

Overall acceptability

Significantly, maximum mean score for colour was recorded in T₅(60% NE: 40% KE) (7.84) which was statistically followed by T₂ (52 % NE: 48% KE) and lowest score was recorded in T₁ (NE 100%) (7.24). It is obvious from the data that overall acceptability of the RTD shows decreasing trend throughout the storage period (Table 15). The highest mean score for overall acceptability was observed during initial period (8.07) followed by 15 DAS (8.02) and minimum at the end of storage period (6.94). The main reason was reduction in flavour, taste, colour, consistency which leads to decrease in score of overall acceptability. This is in conformity with the studies of Rani *et al.* (2018) in mandarin and strawberry mixed fruit juices and Balaswamy *et al.* (2011) in sour grape beverages.

Microbial population

The data from the table 16 shows minimum increase of microbial population. The very less microbial growth is detected in all the treatments at the end of storage period and the microbial count which was observed in this experiment was within acceptable limit. Based on Food safety and standard regulations, 2010, acceptable limit of microbial population for RTD was 2 CFU/ml. So, the noni and kokum blended beverage was considered safe for consumption even after 3 months of storage under ambient condition. The lower number of microbial population might be due to inhibitory effect of spices added in beverage, pasteurization of juice after bottling and sodium benzoate preservative which was added during the preparation showing the inhibitory effect on growth of microbes. Deka (2000) in mango- pineapple and lime-aonla spiced RTS, Ejechiet *al.* (1998) in spiced mixed fruit juices and Mishra and Sangma (2017) in blended aloe vera RTS also recorded similar results for microbial population ambient condition. The lower number of microbial population might be due to inhibitory effect of spices added in beverage, pasteurization of juice after bottling and sodium benzoate preservative which was added during the preparation showing the inhibitory effect on growth of microbes. Deka (2000) in mango- pineapple and lime-aonla spiced RTS, Ejechiet *al.* (1998) in spiced mixed fruit juices and Mishra and Sangma (2017) in blended aloe vera RTS also recorded similar results for microbial population.

Conclusion

The ready-to-drink health beverage prepared from 60% noni extract and 40% kokum extract demonstrated excellent flavor, taste, color, and overall acceptability. It remained acceptable even after 3 months of ambient storage. The kokum juice effectively masks the pungent flavor of noni fruit juice, enhancing its acceptability while preserving and utilizing its medicinal properties.

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Table 2: Effect of storage period on total soluble solids of ready to drink health beverage

Treatments	Total soluble solids (°Brix)							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	15.00	15.05	15.20	15.25	15.38	15.45	15.53	15.28
T ₂	15.00	15.10	15.25	15.38	15.55	15.65	15.75	15.41
T ₃	15.00	15.08	15.18	15.33	15.43	15.55	15.63	15.33
T ₄	15.00	15.10	15.25	15.38	15.48	15.58	15.75	15.38
T ₅	15.00	15.13	15.33	15.53	15.63	15.80	16.00	15.50
Mean	15.00	15.09	15.24	15.37	15.49	15.61	15.73	
S.Em±	0.06	0.06	0.06	0.06	0.03	0.06	0.06	
CD @ 1%	NS	NS	NS	NS	NS	NS	0.29	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract *KE: Kokum Extract

*CA: Citric Acid *DAS: Days After Storage

Table 3: Effect of storage period on pH of ready to drink health beverage

Treatments	pH							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	2.99	2.91	2.86	2.84	2.81	2.77	2.72	2.84
T ₂	2.83	2.77	2.61	2.56	2.51	2.48	2.44	2.60
T ₃	2.98	2.94	2.80	2.74	2.69	2.64	2.59	2.77
T ₄	2.71	2.87	2.79	2.66	2.60	2.55	2.50	2.67
T ₅	2.88	2.84	2.78	2.68	2.65	2.56	2.45	2.69
Mean	2.88	2.86	2.77	2.69	2.65	2.60	2.54	
S.Em±	1.05	1.13	0.04	1.18	1.05	0.82	0.97	
CD @ 1%	0.01	0.02	0.06	0.01	0.01	0.01	0.01	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30%

T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage

Table 4: Effect of storage period on titratable acidity of ready to drink health beverage

Treatments	Titratable acidity (%)							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	0.30	0.30	0.31	0.32	0.32	0.33	0.35	0.32
T ₂	0.33	0.34	0.35	0.35	0.36	0.36	0.37	0.35
T ₃	0.3	0.32	0.33	0.34	0.34	0.35	0.36	0.34
T ₄	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.35
T ₅	0.34	0.35	0.35	0.36	0.36	0.37	0.38	0.36
Mean	0.32	0.33	0.33	0.34	0.34	0.35	0.36	
S.Em±	1.53	0.65	1.43	1.29	0.59	1.15	0.87	
CD @ 1%	0.02	0.01	0.01	0.01	0.01	0.01	0.01	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract *KE: Kokum Extract

*CA: Citric Acid*DAS: Days After Storage

Table 5: Effect of storage period on instrumental L^* value for colour of ready to drink health beverage

Treatments	Instrumental L^* value							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	14.55	14.25	13.37	12.10	11.76	11.25	10.50	12.54
T ₂	9.09	8.85	8.23	7.82	7.33	7.59	6.26	7.88
T ₃	14.46	14.13	12.71	11.78	11.50	11.06	10.24	12.27
T ₄	9.77	9.52	9.31	8.79	8.45	7.95	7.52	8.76
T ₅	9.44	9.26	8.83	8.44	8.20	7.45	6.93	8.36
Mean	11.46	11.20	10.49	9.78	9.44	9.06	8.29	
S.Em±	0.03	0.03	0.11	0.05	0.03	0.33	0.03	
CD @ 1%	0.08	0.07	0.45	0.21	0.13	1.38	0.07	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage

Table 6: Effect of storage period on instrumental a^* value for colour of ready to drink health beverage

Treatments	Instrumental a^* value							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	-1.09	-0.73	-0.66	-0.65	-0.63	-0.53	-0.46	-0.68
T ₂	9.36	9.08	8.86	7.74	6.76	5.34	4.97	7.45
T ₃	-1.21	-0.85	-0.57	-0.56	-0.56	-0.46	-0.43	-0.66
T ₄	8.37	7.65	6.18	6.12	5.85	4.89	4.34	6.2
T ₅	9.19	8.48	8.13	7.35	6.17	5.71	5.02	7.15
Mean	4.92	4.72	4.39	4.00	3.52	2.99	2.69	
S.Em±	0.09	0.02	0.03	0.05	0.02	0.03	0.04	
CD @ 1%	0.38	0.18	0.15	0.17	0.19	0.10	0.06	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30%

T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage

Table 7: Effect of storage period on instrumental b^* value for colour of ready to drink health beverage

Treatments	Instrumental b^* value							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	6.55	6.43	6.35	6.28	6.17	6.10	6.02	6.27
T ₂	3.89	3.72	3.60	3.53	3.38	3.21	3.13	3.49
T ₃	6.53	6.36	5.77	5.68	5.55	5.40	5.29	5.80
T ₄	4.92	4.72	4.64	4.57	4.45	4.34	4.24	4.55
T ₅	4.62	4.32	4.28	4.25	4.17	4.07	3.94	4.24
Mean	5.30	5.11	4.92	4.86	4.74	4.62	4.52	
S.Em±	0.08	0.08	0.06	0.07	0.07	0.06	0.05	
CD @ 1%	0.32	0.33	0.27	0.26	0.24	0.23	0.22	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage

Table 8: Effect of storage period on ascorbic acid content of ready to drink health beverage

Treatments	Ascorbic acid (mg/100 ml)							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	19.60	19.52	19.20	19.14	19.14	19.04	18.56	19.17
T ₂	16.16	15.83	15.78	15.73	15.68	15.20	14.72	15.59
T ₃	20.96	20.16	19.68	19.52	19.20	19.14	19.04	19.67
T ₄	17.47	16.90	16.87	16.47	16.37	16.32	15.78	16.60
T ₅	16.64	16.40	16.31	16.21	16.16	15.78	15.68	16.17
Mean	18.17	17.76	17.57	17.41	17.31	17.09	16.76	
S.Em±	0.61	0.81	0.73	0.69	0.68	0.81	0.62	
CD @ 1%	2.53	3.38	3.1	2.87	2.83	3.38	2.59	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage

Table 9: Effect of storage period on antioxidant activity of ready to drink health beverage

Treatments	Antioxidant activity (%)							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	56.52	56.10	55.30	55.08	54.53	54.18	53.75	55.07
T ₂	53.18	52.90	52.09	51.65	51.35	51.14	50.74	51.86
T ₃	57.31	57.13	56.48	56.13	55.77	55.52	55.12	56.21
T ₄	56.73	56.32	55.75	55.32	54.76	54.49	54.08	55.35
T ₅	54.78	54.32	53.85	53.32	52.93	52.70	52.40	53.47
Mean	55.70	55.35	54.69	54.30	53.87	53.60	53.22	
S.Em±	0.68	0.72	0.75	0.76	0.75	0.74	0.74	
CD @ 1%	2.85	2.99	3.12	3.15	3.12	3.09	3.10	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage

Table 10: Effect of storage period on total phenol content of ready to drink health beverage

Treatments	Total phenol (mg GAE/100 ml)							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	130.17	129.60	129.44	128.75	128.19	127.95	127.57	128.81
T ₂	126.65	126.62	126.49	125.90	125.45	125.17	124.82	125.87
T ₃	134.27	133.70	133.54	132.87	132.62	132.12	131.81	132.99
T ₄	130.40	129.45	129.03	128.69	127.43	127.18	126.93	128.45
T ₅	129.67	128.08	127.83	127.57	127.18	126.93	126.65	127.70
Mean	130.23	129.49	129.26	128.75	128.17	127.87	127.56	
S.Em±	0.49	0.36	0.39	1.52	1.65	1.90	1.79	
CD @ 1%	2.08	1.53	1.63	1.10	1.20	1.37	1.28	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml waterT₁- NE 100% + CA 248 mgT₂- NE 52%+ KE 48%**Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water**T₃- NE 100%+ CA 290 mgT₄- NE 70%+ KE 30%T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

CA: Citric Acid

*DAS: Days After Storage

Table 11: Effect of storage period on organoleptic evaluation for colour and appearance of ready to drink health beverage (based on 9- point hedonic scale)

Treatments	Colour and appearance							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	7.74	7.63	7.40	7.35	7.27	7.13	6.50	7.29
T ₂	8.25	8.23	7.80	7.75	7.59	7.40	7.20	7.75
T ₃	7.30	7.47	7.47	7.38	7.13	7.00	6.88	7.23
T ₄	8.17	8.08	8.00	7.66	7.55	7.30	7.09	7.69
T ₅	8.27	8.25	8.07	7.90	7.48	7.45	7.39	7.83
Mean	7.94	7.93	7.75	7.61	7.40	7.26	7.01	
S.Em±	0.08	0.08	0.08	0.06	0.09	0.08	0.09	
CD @ 1%	0.32	0.33	0.38	0.26	0.33	0.34	0.40	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage

Table 12: Effect of storage period on organoleptic evaluation for consistency of ready to drink health beverage (based on 9- point hedonic scale)

Treatments	Consistency of RTD							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	7.63	7.43	7.37	7.25	7.19	6.88	6.43	7.17
T ₂	8.11	8.04	7.86	7.75	7.34	7.17	7.04	7.62
T ₃	7.73	7.80	7.65	7.62	7.32	7.17	6.98	7.47
T ₄	7.91	8.00	7.70	7.80	7.43	7.20	7.00	7.58
T ₅	8.28	8.21	7.70	7.63	7.57	7.24	7.08	7.67
Mean	7.93	7.89	7.66	7.61	7.37	7.13	6.90	
S.Em±	0.07	0.08	0.07	0.08	0.06	0.07	0.09	
CD @ 1%	0.30	0.36	0.27	0.36	0.25	0.23	0.41	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage

Table 13: Effect of storage period on organoleptic evaluation for taste of ready to drink health beverage (based on 9- point hedonic scale)

Treatments	Taste							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	7.74	7.65	7.53	7.25	7.17	6.54	6.39	7.18
T ₂	8.25	8.13	8.00	7.83	7.59	7.24	6.92	7.71
T ₃	7.94	7.62	7.50	7.34	7.22	6.60	6.29	7.22
T ₄	8.45	8.37	7.62	7.40	7.30	7.27	7.14	7.65
T ₅	8.73	8.75	7.80	7.62	7.49	7.12	7.04	7.79
Mean	8.22	8.10	7.69	7.49	7.35	6.95	6.75	
S.Em±	0.10	0.10	0.05	0.06	0.07	0.06	0.07	
CD @ 1%	0.37	0.42	0.28	0.30	0.26	0.28	0.32	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage

Table 14: Effect of storage period on organoleptic evaluation for flavour of ready to drink health beverage (based on 9-point hedonic scale)

Treatments	Flavour							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T₁	7.83	7.62	7.45	7.30	7.24	7.09	6.84	7.34
T₂	8.22	8.05	8.00	7.76	7.80	7.59	7.39	7.83
T₃	7.67	7.58	7.42	7.28	7.14	6.92	6.74	7.25
T₄	8.69	8.50	7.82	7.55	7.48	7.28	7.12	7.78
T₅	8.74	8.78	8.42	8.17	7.87	7.69	7.39	8.15
Mean	8.23	8.10	7.82	7.61	7.50	7.31	7.09	
S.Em±	0.05	0.07	0.03	0.06	0.05	0.07	0.06	
CD @ 1%	0.22	0.26	0.20	0.25	0.25	0.25	0.29	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30%

T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage

Table 15: Effect of storage period on organoleptic evaluation for overall acceptability of ready to drink health beverage (based on 9-point hedonic scale)

Treatments	Overall acceptability of RTD							Mean
	Initial	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	
T ₁	7.74	7.59	7.37	7.29	7.22	6.91	6.54	7.24
T ₂	8.21	8.11	7.92	7.77	7.57	7.35	7.12	7.73
T ₃	7.62	7.70	7.51	7.40	7.23	6.86	6.76	7.30
T ₄	8.31	8.24	7.78	7.61	7.41	7.25	7.09	7.67
T ₅	8.51	8.49	8.00	7.82	7.60	7.38	7.21	7.84
Mean	8.07	8.02	7.71	7.58	7.40	7.15	6.94	
S.Em±	0.04	0.04	0.04	0.02	0.04	0.05	0.04	
CD @ 1%	0.15	0.16	0.20	0.17	0.14	0.16	0.15	

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage

Table 16. Effect of storage on microbial population of ready to drink health beverage

Treatments	90 DAS (CFU/ml)		
	Molds	Bacteria	Yeast
T ₁	0.75	0.75	0.76
T ₂	0.80	0.75	0.63
T ₃	0.88	0.83	0.58
T ₄	0.83	0.58	0.50
T ₅	0.75	0.70	0.80
Mean	0.80	0.72	0.65
S.Em±	0.30	0.40	0.32
CD @ 1%	NS	NS	NS

Set 1:- 12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100%+ CA 248 mg

T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg

T₄- NE 70%+ KE 30%

T₅- NE 60%+ KE 40%

*NE: NoniExtract *KE: KokumExtract

*CA: Citric Acid *NS: Non Significant

UNDER PEER REVIEW

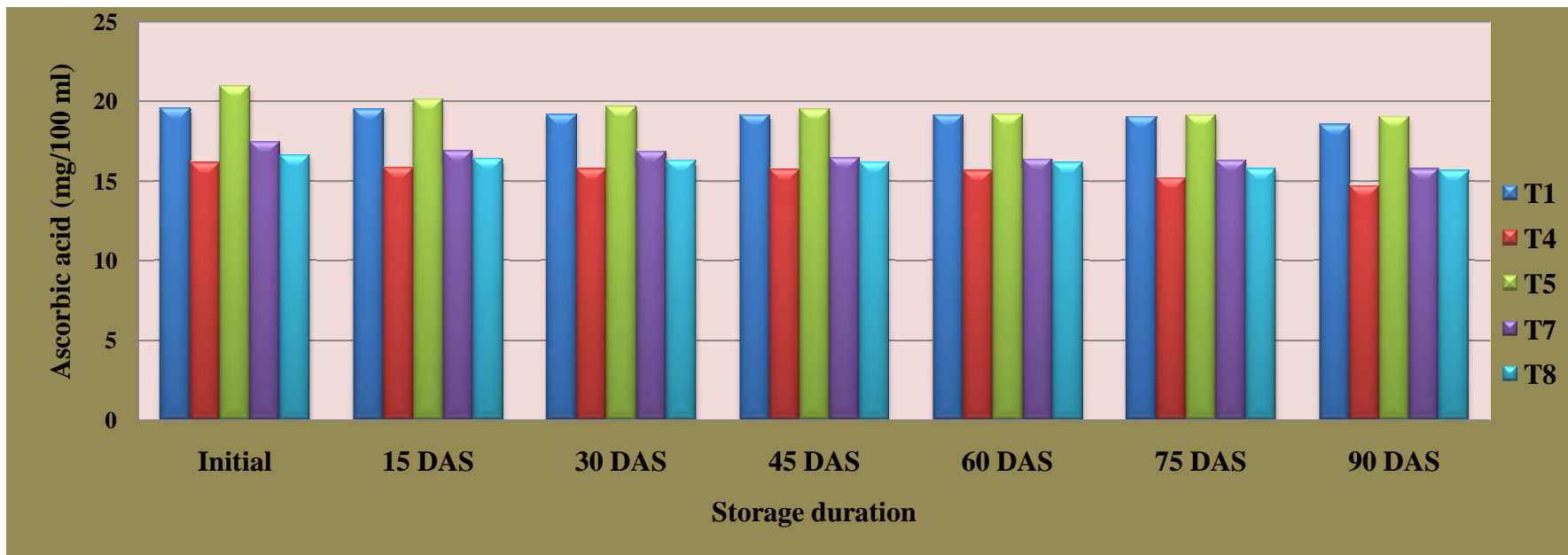


Fig. 1. Effect of storage period on ascorbic acid content of ready to drink health beverage

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

T₃- NE 100%+ CA 290 mg T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract *KE: Kokum Extract

*CA: Citric Acid *DAS: Days After Storage

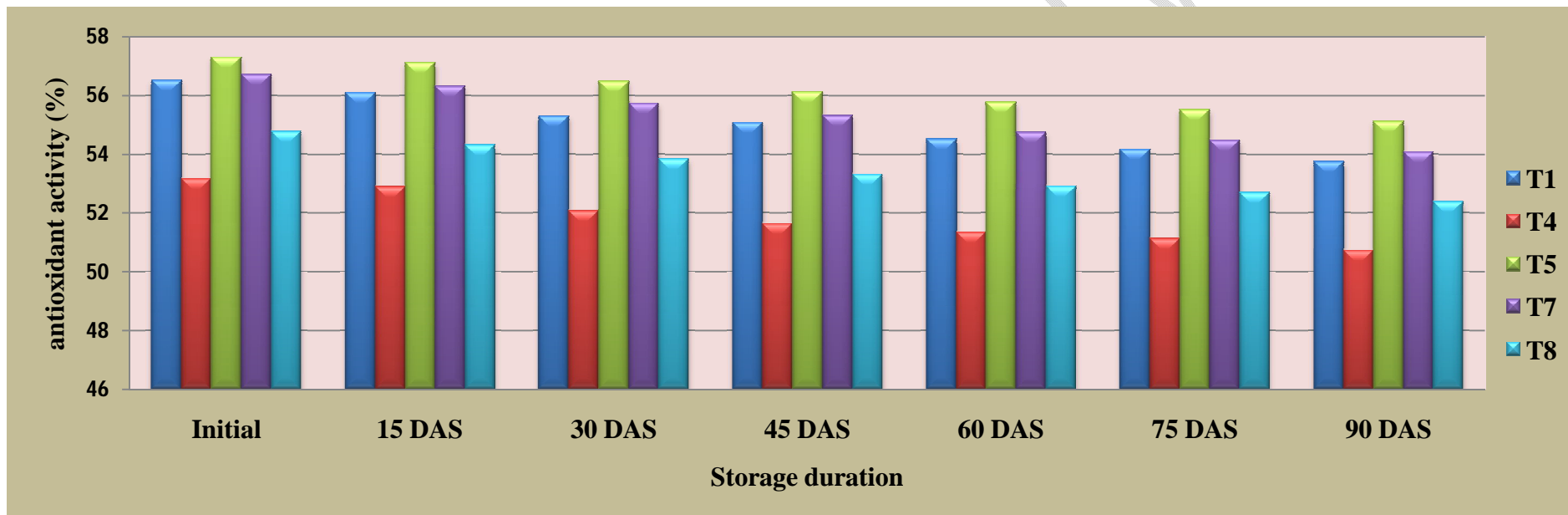


Fig. 2. Effect of storage period on antioxidant activity of ready to drink health beverage

Set 1:-12.5 per cent pulp extract of noni and kokum + sugar 28.5 gm+ 143 ml water

T₁- NE 100% + CA 248 mg T₂- NE 52%+ KE 48%

Set 2:- 15 per cent pulp extract of noni and kokum+ 25.8 gm sugar+ 140 ml water

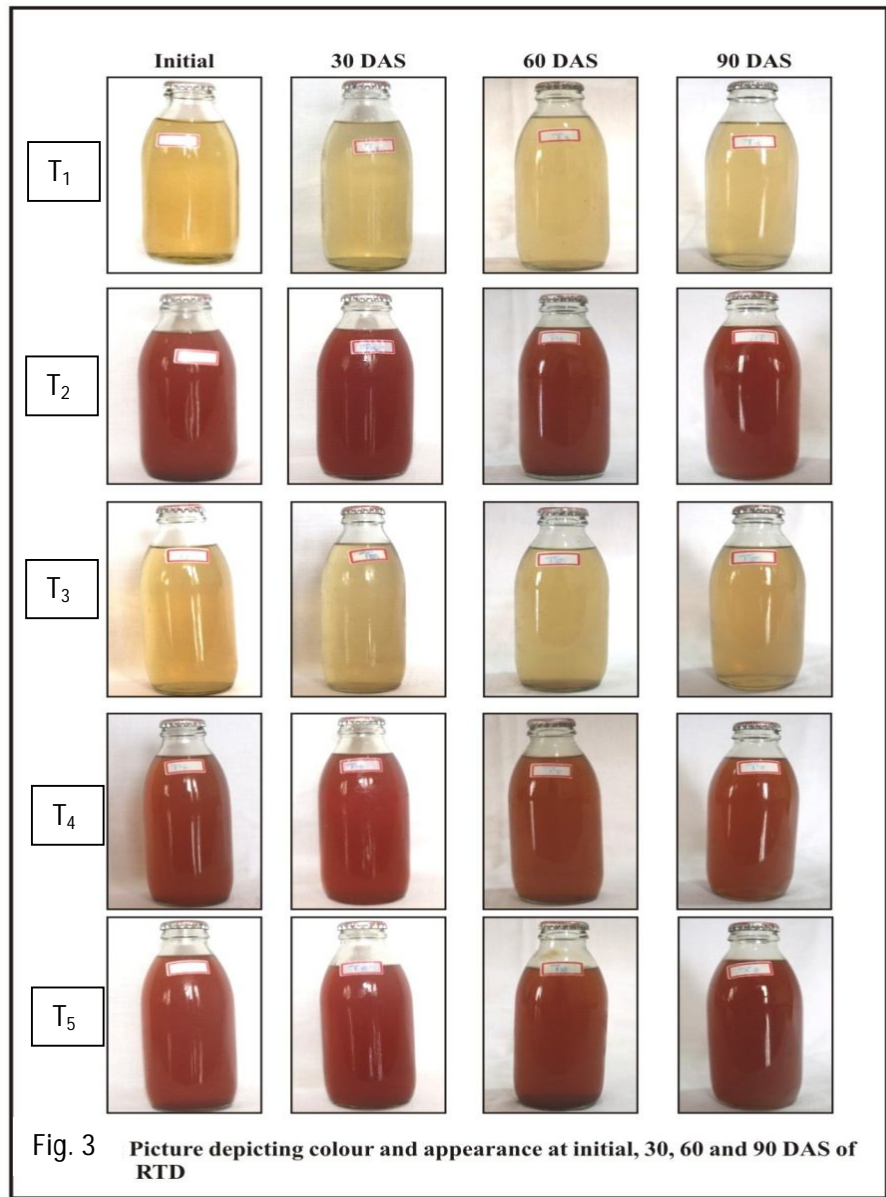
T₃- NE 100%+ CA 290 mg T₄- NE 70%+ KE 30% T₅- NE 60%+ KE 40%

*NE: Noni Extract

*KE: Kokum Extract

*CA: Citric Acid

*DAS: Days After Storage



M