Temperature-Dependent Storage Stability and Shelf-Life Assessment Of Palmyra Blended Beverage

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Abstract
Nutraceuticals added ready to serve blended beverages was prepared from tender palmyra pulp and the storage study of the developed beverages was carried out in this research. Blended beverage was prepared by blending the tender palmyra pulp along with green chilly pulp and ginger extract. For each treatment the final TSS was adjusted to 12 °Brix (as per optimization) in the blended juice. After the finalization of the juice blend, the pasteurized juice was further packed with preservatives such as potassium meta-bisulphite and sodium benzoate at 300ppm. The Palmyra blended juice was stored under ambient (30±5 °C) and refrigerated condition (4±1 °C) in glass bottles. The effect of preservative treatment and storage condition on quality parameters during storage of PBJ was investigated for a period of 180 days. The quality parameters considered under study were biochemical, phytochemical, sensory and microbiological property. The palmyra blended juice with sodium benzoate performed best under both ambient and refrigerated storage conditions up to 90 and 180 days respectively.

Keyword: Nutraceuticals, Palmyra blended juice, phytochemicals, value added product**.**

1. Introduction

The local tribal people in India consume a significant quantity of native and underused fruit crops to meet their daily requirements of vitamins and minerals on regular basis. The underutilized fruits are well known from ancient times for their therapeutic and medicinal properties. In addition to their nutritional and medicinal value, underused fruits are also good in flavor and colour. India is a country with full of natural resources for indigenous varieties of fruits.

Most indigenous tropical fruits are currently underutilized due to a lack of knowledge of their potential, market demand, and unpredictable fruiting nature (Mitra et al., 2010). It is estimated that there are 102 million palms in India, making it the country with the most palms in the world (Khan & Sankaralingam, 2006). It has been predicted that as many as 40 million Borassus palms may be growing in Tamil nadu State alone. This makes it one of the most common plants in India, ranking second position in the worldwide production of palm in terms of frequency of occurrence. Palmyra is the palm that grows in the largest abundance in the tropical regions of India, and practically every component of this tree has some sort of practical application for people. Most cultivated plants are found in large numbers across India in the states of Kerala, Tamilnadu, Karnataka, Andhra Pradesh, Maharashtra, Orissa, Madhya Pradesh, Bihar, and West Bengal (Mazumdar, 2004).

Many palm trees that are tapped do not only produce sap but also serve multiple purposes (edible fruits, building materials, fuel, fibers, wax, and so on), and the socioeconomic significance of these trees can be extremely important for the underprivileged in rural areas: According to Gandhiji "*Borassus flabellifer*; acts as a cure for poverty" (http://agritech.tnau.ac.in/postharvest/pht palmintro.html, 2015). Value addition denotes the change in physical form of the food material and resulting a greater acceptability, extend availability, increase market viability, and improve cost benefit (Srivastava et al., 2017). The value-added products from Palmyra palms are Neera, Nungu, Jaggery, Toddy, Palmyra Vinegar, Wine, Cola, Spread, Yoghurt, Sugar, Barfi, Toffee, Jelly, Chocolate & some ready to serve products (RTS) (Mani et al., 2018).

The fruit of the Borassus flabellifer contains gums, albuminoids, and fats, and the sugary, dense, and edible mesocarp pulp of the ripe fruit is orange-yellow in colour. The ripe fruit is also rich in vitamins A and C. It has been said that the fresh sap is an excellent source of vitamin B-complex. As a direct consequence of this, more than sixty percent of the annual fruit yield is spoiled while it is being stored (Sankaralingam et al., 1996). According to Sandhya et al., (2010), Borassus also contains an astringent compound that is referred to as flabelliferrins. These compounds are steroidal saponins. The extremely bitter flavor of palmyra palm fruits prevents their widespread application as a food source, which results in crop being wasted. Even though it is a nutritious fruit, the primary reason why the fruit pulp is not utilized to its full potential is due to the characteristic bitter taste of the fruit pulp, which restricts the widespread use of the palmyra fruit pulp

2. Material and method

2.1 Sample collection

Palmyra fruits (tala) were collected from the regions of Bargarh & Sambalpur, Odisha. The physical properties of tender palmyra (endosperm along with endocarp) fruits were recorded first. The tender endosperms of palmyra fruits were washed and the outer tough layer (endocarp) was dehusked to obtain the white spongy palmyra. The tender endosperm was collected in a glass bottle and stored in a deep freezer maintained at -18 ^{o}C.

2.2 Preparation of juice

Palmyra blended juice (PBJ) was prepared from freshly harvested palmyra. Fruit was washed with tap water, and the endosperms were removed manually. A juicer (Bajaj Fx7 699W Food Processor) was used to extract pulp for preparation of PBJ. Furthermore, ginger rhizomes were cleaned, peeled, and ground to fine paste. Green chilies were collected separately and ground. The pastes were sieved by muslin cloth and clear pulp was collected. In order to facilitate the consumer, with variance of blended juice, the present investigation was carried out with different combination of palm, with these two flavor enhancers.

2.3 Storage of blended juice

The blended beverage was sweetened by addition of dextrose powder at 9 to 12%. The experiment tried with sucrose and maltose as sweetening agent. Immediately after preparation, the juice was subjected to heating at 70 °C for 10 min. Different preservatives (Sodium Benzoate and Potassium Metabisulphite) were added to pasteurized PBJ beverage and packed in glass bottles rinsed with chlorinated water. The hot filling of juices into the bottles was performed and then the bottles were immediately sealed. Among the filled bottles, one prepared batch was stored in a refrigerator at average 4±1 °C and another lot was stored in ambient temperature. Fresh samples were prepared as initial quality for sensory and nutritional analysis. The sample bottles were taken out at 30 days interval analyzed in triplicate for bio-chemical and microbiological properties. The storage period continued up to 180 days. The average temperature and the average relative humidity of ambient and refrigerated storage were between 30±5 °C, 80±10 and 4±1 °C, 90±5 respectively. The experimental plan for storage study of Palmyra blended juice is given in fig. 1.

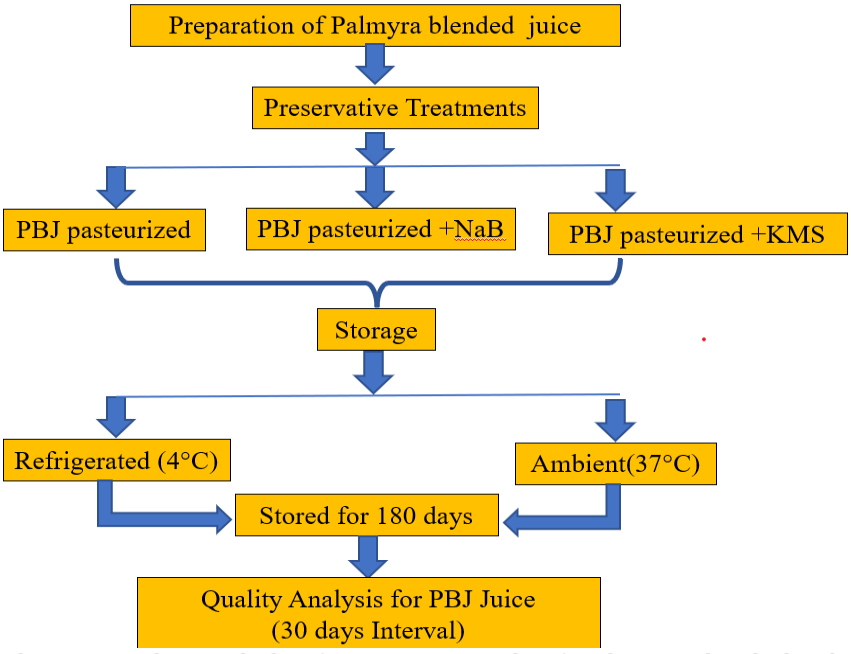

Fig 1: Experimental plan for storage study of Palmyra Blended Juice

2.4 Physiochemical analysis during storage for the developed product

Parameters like moisture, pH, acidity, total soluble solids, Vitamin C, TPC, TFC, TAC, total yeast mold count, and total sensory score during storage of developed palmyra juice at ambient temperature and refrigeration temperature was noted at 30 days interval up to 180 days. The physico-chemical properties of the jam samples were tested using AOAC recommended standard procedures (AOAC, 2005). Total soluble solids (TSS) were measured using a hand-held refractometer (Model ATAGO-S-28E). The pH was measured using a digital pH meter (Model HANNA HI 98130). By titrating the developed beverages with standard NaOH and reporting the results in percent citric acid, the titratable acidity of the juices RTS was determined. Using the air oven method, the moisture content was determined. Each variable was replicated three times during the experiment.

2.5 Determination of total phenolic content, total flavonoid content and total antioxidant capacity (TPC, TFC and TAC)

The total phenolic contents were determined using the Folin–Ciocalteau (FC) reagent method as stated by Sreeramulu et al. (2013), and the results were recorded as mg gallic acid equivalent (GAE)/ml. The TFC was measured using the colorimetric aluminum chloride method as described by Mishra et al. (2011), and the findings were stated as mg catechin equivalents (CE)/mL. TAC values were determined using the protocol described by Silva (2005) and the findings were reported as mg ascorbic acid (AA)/100 ml.

2.6Microbial Analysis

The microbiological study was performed by total plate counts in accordance with the procedure described by Pérez-Grijalva *et al.,* (2018). The nutrient agar plates were incubated at 37 °C, for 24-48h. For yeast and mold count, the same method was followed by using the potato dextrose agar plates (PDA; Himedia) and incubated at 25 °C for 96-120 days has described by Diliello, (1982). After incubation, colony-forming units were counted by multiplying the dilution factor by total plate count, yeast and mold count.

2.7 Data Analysis

All data is described as triplicate measurements mean ± SD. One-way ANOVA and post hoc Tukey-HSD tests were conducted for each parameter considered to detect discrepancies between the juices. The correlation coefficients of Pearson were determined to determine the effect of the proportions of ginger, and chili on the characteristics of the palmyra blended juice. All statistical research was performed using SPSS statistical software (Version 20.0, SPSS Inc., Chicago, Illinois, United States).

3. Result and Discussion

3.1. Changes in Determined parameters

The changes in moisture, pH, acidity, total soluble solids, Vitamin C, TPC, TFC, TAC, total yeast mold count, and total sensory score during storage of developed palmyra juice at ambient temperature and refrigeration temperature was noted at 30 days interval up to 180 days and are presented in Table 1 and 2.

3.2 Effect on pH during storage of PBJ

The pH was decreased constantly and significantly ($p<0.05$) up to 180 days of storage; from 5.85 to 4.80 in ambient temperature and from 5.85 to 5.16 in refrigerated temperature. Similarly, Benhura (2012) observed lower pH values in unpasteurized mango pulp than pasteurized mango pulp in storage. Trends of decreasing pH and increasing acidity found in both ambient temperature and refrigerated temperature were well supported by Iqbal et al., (2001) in mango pulp; Amin et al., (2008); Hussain et al., (2008); Sandhu et al., (2001) in guava pulp on storage. The fresh juice having pH 5.84±0.02 was found to decreased during 180 days of storage in the pasturised PBJ followed by PBJN and PBJK. The effect of pH during the storage of PBJ in refrigerated temperature was found significantly differing from each other after 180 days of storage among different preservative treated PBJ. During the refrigerated storage the decrease in pH was minimum.

3.3 Effect on Acidity during storage of PBJ

The acidity of the blended beverage that had been pasteurised and kept at a temperature of refrigeration increased during storage from 0.157% to 0.195%, while the acidity of the same beverage kept at ambient temperature increased from 0.172% to 0.222%. It was determined that there was a consistent increase from zero (0) to 150 days and a quick sharp rise in value after 150 days in all of the cases for ambient temperature, however during refrigeration temperature, there a consistent increase was found. During the storage period there was significant difference among PBJP, PBJN and PBJK at ambient and refrigerated temperature. As per Mir and Nath, 1993 the reactions for the above changes were temperature-dependent, and variable with the rate of change. Change in pH is directly related to the acid level. Thus, the increase / decrease in acid content as well as the pH level of the processed products showed an opposite trend during entire period of study. This might be due to deactivation of metabolic enzymes involved in the degradation process of polysaccharides for production of acids (Kumhar et al., 2014). The increase in acidity might be due to the formation of acid by degradation of polysaccharides and oxidation of reducing sugars or by breakdown of pectic substances and uronic acid (Iqbal et al., 2001; Hussain et al., 2008). The increase in titrable acidity could be due to breakdown of pectin substance which has been reported by Muhammad et al., (2011).

3.4 Effect on Total Soluble Solids during storage of PBJ

The total soluble solids were increased in each ambient (12.33 to 14.67 ˚ Brix) and refrigerated sample (12.33 to 13.80 ˚ Brix) during storage and comparatively the trend was higher in ambient temperature. Highest increase in TSS was observed in PBJB (14.67±0.11°Brix) whereas minimum increase was in PBJN (14.07±0.11°Brix) during ambient storage condition. After 180 days of storage in refrigerated condition, the TSS increase to (13.80±0.11°Brix) and (13.53±0.11°Brix) in PBJP and PBJN respectively. The increasing paten was found to be significant during 180 days of storage. This extend in TSS during storage might be due to acid hydrolysis of polysaccharides specially gums and pectin (Luh & amp; Woodroof, 1975). Similar result was stated by Jain et al., (2011) in guava and papaya fruit pulp; Bajpai et al., (1973); Tandon and Kalra (1984); Baramanray (1995); Sandhu (2001) in guava pulp and Sharma (2008) in guava and papaya pulp. The reason assigned for extended TSS content during storage would possibly be due to conversion of left over

polysaccharides into soluble sugar (Baramanray et al., 1995). Chingtham and Banik (2014) also observed that TSS was once increased with storage time in the KMS preserved varieties of ripe banana pulp.

3.5 Effect on Reducing sugar during storage of PBJ

The reducing sugar was significantly increased ($p< 0.05$) from 17.45 to 18.97% during ambient storage and from 17.47 to 18.48% during refrigerator storage up to 180 days of storage period. Highest increase in reducing sugar was observed in PBJK (19.85±0.17%) whereas minimum increased was in PBJP (18.970±0.12%) during ambient storage condition. There is no significant different in the PBJ stored for 180 days in refrigerated temperature. There was a minimal increase in reducing sugar, was found during ambient storage with PBJP followed by PBJN and PBJK whereas there has no significant difference was found for all the treatment in refrigeration temperature. The increment in reducing sugar during storage may be due to higher reaction rate at the ambient temperature due to the breakdown of sugar in presence of acid. Yadav et al., 2014 recorded similar pattern of increase in sugars in guava and mango drink and Satkar et al., 2013 in bitter gourd RTS drink. Khan et al., 2012 also mentioned the increase in reducing sugar; and the reducing sugar content reported in current research is similar to their report.

3.6 Effect on Vitamin C during storage of PBJ

Highest decrease in Vitamin C was observed in PBJP (9.58±1.80 mg/100 ml) during 180 days of storage at ambient temperature whereas minimum loss of vitamin C was found in PBJK (11.41±1.24 mg/100 ml). During refrigerated condition after 180 days' maximum restoration of vitamin C was found in PBJN (14.58±1.45 mg/100 ml) as compare to PBJK and PBJP. The Vitamin C content of both ambient and refrigerated was decreased significantly ($p<0.05$) on 180 days of storage period. The decreasing trend in Vitamin C after 60 days of storage was noted by Bajpai et al., (1973) in guava pulp; Sharma et al., (2008) in guava and papaya combined pulp. The reduction in ascorbic acid due to oxidation and might be because of the presence of residual oxygen in glass bottle; eliminating oxygen during filling can minimize it (Jain et al., 2011). In commercially available orange juices and beverages obtained from concentrate in sealed and open container, Johnston and Bowling, 2002 examined the stability of vitamin-C and concluded the linear decrease of vitamin-C with respect to heat in various cases. As per Table-2 the vitamin-C contain for ambient and refrigerated temperature has been gradually decreasing at a constant rate and found the loss of vitamin- C are same in both the condition with all preservation procedure. Environmental factor might have impacted on this breakdown on vitamin-C, similar finding has been reported in mango drinks Singh and Chopra, (2006).

3.7 Effect on TPC during storage of PBJ

The total phenolic content in Palmyra Blended Juice was influenced by storage timeand preservation treatment. Highest decrease in TPC was obeserve in PBJP (3.13±1.20 mg GAE/100 ml) after 180 days of storage at ambient temperature whereas minimum loss of TPC was found in PBJN (4.73±1.25 mg GAE/100 ml). During refrigerated condition after 180 days' highest restoration of phenolic compounds was found in PBJK (7.02±0.18 mg GAE/100 ml) as compare to PBJN and PBJP. The mean TPC value for PBJ decrease significantly ($p<0.05$) from 13.03 to 3.13 mg GAE/100 ml in ambient storage and from 13.03 to 6.14 mg GAE/100 ml maximum decrease was recorded in pasteurized PBJ and lowest was found in PBJ treated with sodium benzoate in refrigeration temperature. The lower temperature effects the rate of reaction hence slow down the rate of phenolic loss.The release of endogenous enzymes (Polyphenol oxidase, peroxidase, etc.) may responsible for oxidation and degradation of polyphenolic compounds (Renard *et al*., 2011).

3.9 Effect on TFC during storage of PBJ

The total flavonoid content in Palmyra Blended Juice was influenced by storage time and preservation treatment. The mean of TFC value for PBJ significantly decrease ($p<0.05$) from 8.67 to 4.67 mg QE/100 ml in ambient storage and from 8.67 to 6.25 mg QE/100 ml in refrigeration storage up to 120 days. A rapid decrease was noted after 120 days and diminishing at 1.12 mg QE/100 ml in PBJP during ambient storage, similarly in refrigerated storage the PBJP has minimum TFC (4.06±0.56 mg QE/100 ml). The loss of TFC is very high in case of ambient temperature as compare to refrigerated temperature. Highest decrease in TPC was observed in PBJP (3.13±1.20 mg QE/100 ml) after 180 daysof storage at ambient temperature whereas minimum loss of TPC was found in PBJN (4.73±1.25 mg QE/100 ml).

3.10 Effect on TAC during storage of PBJ

The storage of PBJ for 180 days under various preservative and storage conditions on total antioxidant capacity (TAC) showed a declining trend with days of storage. Maximum TAC was found to be 71.42±1.06 mg AAE/100ml in fresh PBJ, which reduced up 30.31±1.60, 34.96±1.71 and 36.11±1.82mg AAE/100ml in PBJP, PBJK and PBJN, while 45.98±1.42, 49.98±1.40 and 51.98±1.63mg AAE/100ml respectively in ambient and refrigerated storage condition. The minimum TAC values were observed in pasteurized bottles after 180 days of storage in both storage temperature conditions. Siddhuraju *et al*., (2002) considered that there is a correlation between free radical reducing power and antioxidant activity. A free radical chain interrupted by antioxidant through the hydrogen atom leads to stable product formation, thus preventing the chain elongation of free radicals (Miller *etal*., 1993). Khan *et al*., (2021) reported that the reduction in antioxidant activity may be attributed to the degradation of flavonoids and polyphenolic compounds which increases the juice's antioxidant capacity. These phytochemical losses may have occurred as a result of oxidation and enzyme activity.

Table-1. Biochemical properties during the storage of 180days

pH: (On 0 day= 5.84±0.02)							
	DAYS	30	60	90	120	150	180
Ambient	PBJP	**5.66±0.02^{a}**	**5.48±0.02^{b}**	**5.28±0.02^{c}**	**5.07±0.02^{de}**	**4.89±0.02^{fg}**	**4.80±0.02^{g}**
	PBJK	**5.68±0.02^{a}**	**5.52±0.02^{b}**	**5.31±0.02^{c}**	**5.10±0.02^{de}**	**4.99±0.02^{ef}**	**4.88±0.02^{fg}**
	PBJN	**5.69±0.02^{a}**	**5.50±0.02^{b}**	**5.30±0.02^{c}**	**5.13±0.02^{d}**	**5.05±0.02^{de}**	**4.88±0.02^{fg}**
Refrigerated	PBJP	**5.73±0.02^{abc}**	**5.65±0.02^{d}**	**5.39±0.02^{fg}**	**5.31±0.02^{hi}**	**5.23±0.02^{jk}**	**5.16±0.02^{l}**
	PBJK	**5.71±0.02^{ab}**	**5.68±0.02^{cd}**	**5.45±0.02^{ef}**	**5.37±0.02^{gh}**	**5.29±0.02^{ij}**	**5.21±0.02^{kl}**
	PBJN	**5.77±0.02^{a}**	**5.7±0.02^{bcd}**	**5.5±0.02^{e}**	**5.41±0.02^{fg}**	**5.32±0.02^{hi}**	**5.28±0.02^{ij}**
Acidity (%): (On 0 day= 0.154±0.003%)							
	DAYS	**30**	**60**	**90**	**120**	**150**	**180**
Ambient	PBJP	**0.172±0.003^{ij}**	**0.181±0.003^{Aghi}**	**0.190±0.003^{efg}**	**0.197±0.003^{cdefc}**	**0.205±0.003^{bc}**	**0.222±0.004^{a}**
	PBJK	**0.169±0.003^{j}**	**0.173±0.002^{ij}**	**0.185±0.004^{fgh}**	**0.195±0.002^{cdef}**	**0.202±0.003^{bcd}**	**0.216±0.003^{a}**
	PBJN	**0.168±0.003^{j}**	**0.178±0.003^{hij}**	**0.188±0.003^{efgh}**	**0.191±0.004^{defg}**	**0.199±0.003^{cde}**	**0.213±0.005^{ab}**
Refrigerated	PBJP	**0.157±0.003^{j}**	**0.164±0.005^{ij}**	**0.177±0.003^{fgh}**	**0.185±0.004^{ef}**	**0.195±0.002^{bcde}**	**0.205±0.004^{a}**
	PBJK	**0.159±0.003^{ghij}**	**0.167±0.003^{ghi}**	**0.174±0.002^{fg}**	**0.185±0.003^{cdef}**	**0.193±0.002^{bcd}**	**0.201±0.003^{abc}**
	PBJN	**0.155±0.002^{hij}**	**0.168±0.003^{ghi}**	**0.172±0.003^{fg}**	**0.184±0.003^{def}**	**0.190±0.004^{bcde}**	**0.197±0.004^{ab}**
TSS (°Brix): (On 0 day= 12.33±0.11°Brix)							
	DAYS	**30**	**60**	**90**	**120**	**150**	**180**
Ambient	PBJP	**12.87±0.11^{f}**	**13.47±0.11^{de}**	**13.73±0.11^{cd}**	**14.27±0.11^{ab}**	**14.47±0.11^{a}**	**14.67±0.11^{a}**
	PBJK	**12.73±0.11^{f}**	**12.33±0.11^{e}**	**12.47±0.11^{de}**	**12.93±0.11^{bc}**	**14.07±0.11^{bc}**	**14.27±0.11^{ab}**
	PBJN	**12.67±0.11^{f}**	**12.87±0.11^{f}**	**13.27±0.11^{e}**	**13.33±0.11^{e}**	**13.53±0.11^{de}**	**14.07±0.11^{bc}**
Refrigerated	PBJP	**12.47±0.11^{hi}**	**12.73±0.11^{fgh}**	**13.13±0.11^{cde}**	**13.47±0.11^{abc}**	**13.67±0.11^{ab}**	**13.80±0.11^{a}**
	PBJK	**12.53±0.11^{ghi}**	**12.87±0.11^{efg}**	**13.07±0.11^{def}**	**13.33±0.11^{bcd}**	**12.53±0.11^{ab}**	**13.67±0.11^{ab}**
	PBJN	**12.47±0.11^{i}**	**12.67±0.11^{ghi}**	**12.93±0.11^{efg}**	**13.13±0.11^{def}**	**13.33±0.11^{bcd}**	**13.53±0.11^{ab}**
Reducing Sugar (%) : (On 0day=17.49±0.06 %)							
	DAYS	**30**	**60**	**90**	**120**	**150**	**180**
Ambient	PBJP	**17.82±0.04^{jk}**	**17.17±0.08^{hi}**	**17.54±0.05^{fg}**	**18.07±0.13^{de}**	**18.63±0.08^{ab}**	**18.970±0.12^{a}**
	PBJK	**17.77±0.06^{k}**	**18.13±0.03^{hij}**	**18.43±0.10^{fgh}**	**18.96±0.04^{e}**	**19.30±0.03^{cd}**	**19.850±0.17^{ab}**
	PBJN	**17.72±0.04^{k}**	**17.93±0.04^{ijk}**	**18.26±0.06^{gh}**	**18.61±0.07^{f}**	**18.98±0.07^{de}**	**19.53±0.15^{bc}**
Refrigerated	PBJP	**17.55±0.03^{m}**	**17.83±0.08^{ijk}**	**17.95±0.08^{ghi}**	**18.13±0.08d^{ef}**	**18.34±0.08^{bc}**	**18.55±0.08^{a}**
	PBJK	**17.56±0.^{05lm}**	**17.73±0.03^{kl}**	**17.84±0.02^{ijk}**	**18.03±0.04^{fgh}**	**18.22±0.09^{cde}**	**18.48±0.08^{ab}**
	PBJN	**17.53±0.02^{m}**	**17.77±0.02^{jk}**	**17.91±0.02^{hij}**	**18.09±0.04^{efg}**	**18.27±0.05^{cd}**	**18.51±0.03^{ab}**

Table-2. Phytochemical properties during the storage of 180days

Vitamin C (mg/100mL): (On 0day= 18.42±0.16 mg/100mL)							
	DAYS	**30**	**60**	**90**	**120**	**150**	**180**
Ambient	PBJP	**17.16±0.68^{abc}**	**15.01±0.42^{cdef}**	**13.46±0.9^{1fg}**	**11.95±1.04^{ij}**	**10.05±1.68^{l}**	**9.58±1.80^{n}**
	PBJK	**17.90±0.34^{a}**	**16.07±0.78^{bcd}**	**15.51±0.52^{defg}**	**14.83±1.31^{gh}**	**13.08±1.73^{jk}**	**11.41±1.24^{m}**
	PBJN	**17.52±0.31^{ab}**	**16.33±0.84^{bcde}**	**14.18±0.46^{efg}**	**15.71±1.47^{hj}**	**12.50±1.58^{kl}**	**10.97±1.74^{mn}**
	PBJP	**17.77±0.69^{ab}**	**16.5±0.65^{bcd}**	**15.07±0.85^{efg}**	**14.29±0.98^{hij}**	**15.82±1.27^{kl}**	**12.58±1.84^{m}**

Refrigerated	PBJK	**19.11±0.62^{a}**	**16.16±0.90^{abcd}**	**15.07±0.69^{def}**	**14.49±0.88^{fgh}**	**15.15±1.36^{ijk}**	**13.42±1.81^{klm}**
	PBJN	**19.27±0.58^{abc}**	**17.5±0.21^{cde}**	**16.74±0.57^{efg}**	**16.87±0.82^{ghi}**	**15.28±1.41^{jkl}**	**14.58±1.45l^{m}**
TPC (mg GAE/100mL): (On 0day= 13.03±2.76 mg GAE/100mL)							
	DAYS	**30**	**60**	**90**	**120**	**150**	**180**
Ambient	PBJP	**11.02±1.83^{ab}**	**9.47±0.37^{bcd}**	**8.06±0.86^{ef}**	**7.25±0.95^{gh}**	**5.00±1.05^{ij}**	**3.13±1.20^{k}**
	PBJK	**11.10±1.66^{a}**	**9.59±1.77^{abc}**	**8.24±0.57^{cde}**	**7.67±0.51^{fg}**	**6.15±0.81^{gh}**	**4.49±0.92^{ij}**
	PBJN	**11.62±1.05^{ab}**	**9.73±0.43^{abc}**	**8.62±1.50^{def}**	**7.58±1.40^{fg}**	**6.53±0.54^{hi}**	**4.73±1.25^{jk}**
Refrigerated	PBJP	**12.35±1.14^{a}**	**11.12±1.25^{abc}**	**10.07±0.56^{cdef}**	**8.57±0.89^{fg}**	**7.22±1.61i**	**6.15±1.17^{j}**
	PBJK	**12.48±1.16^{ab}**	**11.83±1.29^{abc}**	**10.18±1.82^{bcd}**	**8.44±1.20^{def}**	**7.65±0.81^{gh}**	**7.02±0.18^{i}**
	PBJN	**12.52±1.29^{a}**	**12.07±1.69^{ab}**	**10.12±1.10^{cde}**	**9.57±0.92^{ef}**	**7.34±1.26^{hi}**	**6.14±1.08^{j}**

TFC (mg QE/100mL): (On 0day= 8.67±1.25 mg QE/100mL)							
	DAYS	**30**	**60**	**90**	**120**	**150**	**180**
Ambient	PBJP	**7.36±0.54^{a}**	**6.40±0.95^{ab}**	**5.67±0.11^{cd}**	**4.67±0.51^{fg}**	**2.82±0.43^{hij}**	**1.12±0.41^{j}**
	PBJK	**7.94±0.57^{a}**	**6.67±0.69^{abc}**	**4.67±1.04^{de}**	**3.00±0.95^{efg}**	**2.08±0.17^{ghi}**	**1.89±0.10^{j}**
	PBJN	**8.06±0.39^{a}**	**5.48±0.63^{a}**	**5.67±0.18^{bcd}**	**4.67±0.64^{def}**	**2.82±0.63^{fgh}**	**2.03±0.16^{ij}**
Refrigerated	PBJP	**8.46±1.06^{a}**	**7.43±0.93^{ab}**	**6.89±0.73^{bcd}**	**6.08±0.44^{efg}**	**5.58±0.28^{ghi}**	**4.06±0.56^{jk}**
	PBJK	**8.62±1.07^{ab}**	**7.31±0.67^{ab}**	**6.28±0.66^{cde}**	**6.25±0.51^{def}**	**5.48±0.91^{hi}**	**4.73±0.90^{k}**
	PBJN	**8.21±0.91^{a}**	**7.14±0.25^{ab}**	**7.67±1.11^{ab}**	**6.67±0.51^{cdef}**	**5.82±0.61^{fgh}**	**4.39±0.61^{ij}**
TAC (mg AAE/100mL): (On 0day= 71.42±1.06 mg AAE/100mL)							
	DAYS	**30**	**60**	**90**	**120**	**150**	**180**
Ambient	PBJP	**62.47±2.03^{ab}**	**55.30±1.66^{cd}**	**50.56±1.80^{ef}**	**44.64±1.45^{g}**	**38.31±2.39i**	**30.31±1.60^{j}**
	PBJK	**64.80±1.68^{ab}**	**59.83±1.40^{de}**	**52.47±2.08^{f}**	**48.08±0.46^{g}**	**41.98±0.84^{hi}**	**34.96±1.71^{i}**
	PBJN	**65.47±1.72^{a}**	**60.30±1.35^{bc}**	**54.56±1.58^{de}**	**49.74±1.55^{f}**	**44.64±1.79^{gh}**	**36.11±1.82^{i}**
Refrigerated	PBJP	**66.33±1.72^{ab}**	**63.82±1.44^{cd}**	**58.45±0.93^{ef}**	**55.8±0.82^{g}**	**52.08±1.61^{h}**	**45.98±1.42^{i}**
	PBJK	**68.28±1.51^{a}**	**65.18±1.73^{cd}**	**60.49±1.37^{f}**	**57.13±1.77^{g}**	**54.08±0.66^{h}**	**49.98±1.40^{i}**
	PBJN	**70.03±1.55^{a}**	**68.47±1.39^{bc}**	**64.78±1.08^{de}**	**61.48±1.02^{f}**	**58.08±0.84^{g}**	**51.98±1.63^{h}**

3.11 Effect on total plate count and yeast/ mold count during storage of PBJ.

During the storage of 180 days with different preservative is presented in Fig. 2. (a) and (b). The microbial assessment was carried out to identify the safety limits of PBJ at different storage temperature. The graphical presentation of total plate count (TPC) reveals that the count (log cfu/ml) in PBJ was increased from an initial value of 1.72 log cfu/ml to maximum 3.35, 3.29 and 3.25 log cfu/ml in PBJP, PBJK and PBJN respectively during ambient storage temperature condition, whereas under refrigerated temperature condition the values are 2.92, 2.86 and 2.79 log cfu/ml in PBJP, PBJK and PBJN respectively. The minimum plate count was observed in PBJN as compare to PBJK in both storage condition. The graphical presentation of total yest mold count indicates that intial value 'zero" to maximum 2.49, 2.44 and 2.38 log cfu/ml in PBJP, PBJK and PBJN respectively during ambient storage temperature condition, whereas under refrigerated temperature condition the values are 2.2, 2.15 and 2.02 log cfu/ml in PBJP, PBJK and PBJN respectively. The minimum yeast and mold count was observed in PBJN as compare to PBJK in both temperature storage condition. Considering the acceptable microbial load as per FSSAI 2018 (50 cfu/ml and 2 cfu/ml for TPC and Yeast mold respectively) the self-life of the product has been decided.

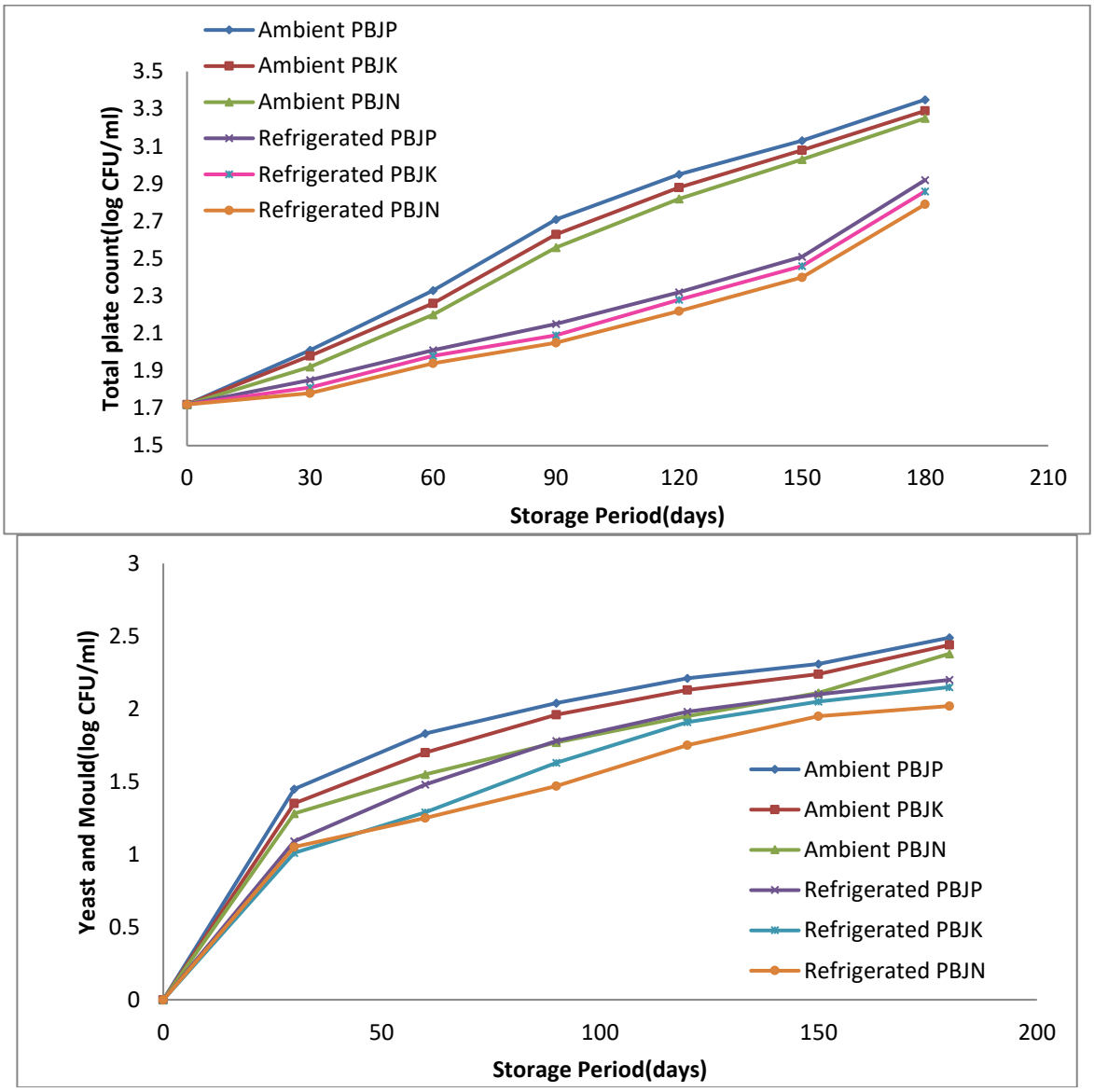

Fig.2. Effect of preservatives, storage condition and storage period on Microbialproperties of PBJ (a) Total Plate count (b) Yeast and Mould count for 180 days

3.12 Effect on overall acceptability during storage of PBJ.

The overall acceptability of fresh PBJ was found to be 7.5 as sensory attribute. During storage the value was found to be decreasing very sharply in case of ambient storage condition as compared to refrigerated. As per 9-point Hedonic scale the value '5 represents "neither like nor-dislike". Further decreasing the value, the product loses its acceptability. During the storage under ambient temperature condition the fruit juice have OA 5.28, 5.12 and 5.35 in PBJP, PBJK and PBJN respectively on a storage period of 90 days, but in case of refrigerated storage condition the value goes below 5 after 150 days in PBJK and after 180 days in PBJN. The sharp fall in OA may be due to undesirable flavor, colour or may be due to increase in microbial load during the storage for 180 days.

In sensory evaluation, all the parameters like colour, flavour, taste and mouthfeel are attributes for overall acceptability of the product. Colour determines the appealing behaviour of the consumers. Storage period and packaging significantly affected the colour of the blended juice. Packaging may result in loss of flavour either from permeation or migration through the bottle or due to loss of flavour resulting from sorption of containers (Strandburg *et al.,* 1991). The strength of the flavour of a product being packaged dependson the vapour pressure (influenced by other food components), the interaction between volatile organic molecules and other food components; and the package's barrier features. The taste and mouthfeel score of juice decreased with the storage process which indicates an increasing dislikeness. This could be due to degradation of phenolic compounds at a lower pH level, changes in turbidity during storage may be linked to polymerization and oxidation in the juice might be a reason for lowering overall acceptability score. In refrigerated environments, the samples fetched higher overall acceptability scores as the rate of

deterioration is slow.

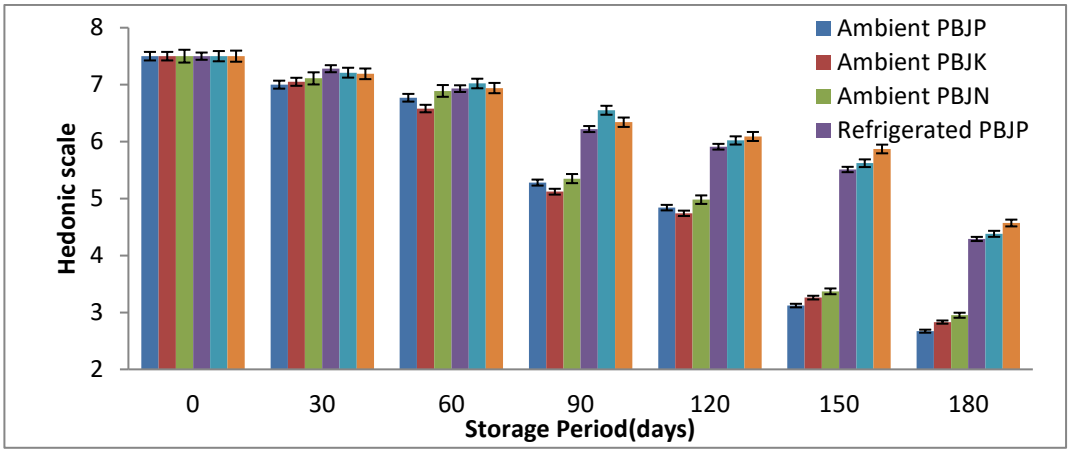

Fig.3. Effect of preservatives, storage condition and storage period on Sensory properties of PBJ for 180 days

The sample with all preservative techniques stored at refrigeration temperature were comparable to standard FSSAI norms for a fruit pulp at initial day of storage and after 180 days of storage. Overall analysis of these storage studies on quality characteristics of the stored PBJ, in different preservative treatments indicated that the pasteurized PBJ storedwith KMS lost its sensory quality attributes exceeding the safe limits of microbial load (asper FSSAI) after 90 days under ambient storage and 150 days under refrigerated storagemay be due to interference of sulphur compounds. Hence, the pasteurized juice treated with sodium benzoate as preservative was considered to be best among all with a shelf life of 90days and 180days at ambient and refrigerated storage respectively.

Table-3. Correlations coefficient (r) of Biochemical, phytochemical, sensory and microbial properties of PBJ during storage for180 days at ambient and refrigerated condition.

	pH	acidity	TSS	Red_ Sugar	Vit_c	TPC	TFC	TAC	Col_ sensory	Flav_ sensory	Taste_ sensory	Mouthfeel_ sensory	OAA_ sensory	TPC_ Microbial	Y&M_ Microbial
pH	1.000														
acidity	-0.952	1.000													
TSS	-0.932	0.928	1.000												
Red_ Sugar	-0.936	0.932	0.976	1.000											
Vitamin C	0.934	-0.962	-0.937	-0.935	1.000										
TPC	0.899	-0.935	-0.920	-0.944	0.943	1.000									
TFC	0.930	-0.947	-0.916	-0.906	0.936	0.908	1.000								
TAC	0.935	-0.948	-0.936	-0.932	0.943	0.908	0.957	1.000							
Col_ sensory	0.930	-0.954	-0.928	-0.938	0.954	0.942	0.944	0.972	1.000						
Flavour Sensory	0.959	-0.942	-0.915	-0.917	0.922	0.906	0.931	0.933	0.929	1.000					
Taste_ sensory	0.940	-0.915	-0.924	-0.937	0.898	0.919	0.891	0.890	0.893	0.948	1.000				
Mouthfeel_ sensory	0.935	-0.912	-0.921	-0.928	0.894	0.908	0.893	0.898	0.885	0.948	0.985	1.000			
OAA_ sensory	0.946	-0.941	-0.965	-0.979	0.942	0.952	0.914	0.925	0.934	0.946	0.971	0.960	1.000		
TPC_ Microbial	-0.836	0.857	0.920	0.936	-0.870	-0.920	-0.840	-0.887	-0.894	-0.862	-0.904	-0.903	-0.942	1.000	
Y&M_ Microbial	-0.893	0.891	0.947	0.955	-0.906	-0.940	-0.877	-0.896	-0.903	-0.893	-0.946	-0.935	-0.971	0.963	1.000

Table 3. shows correlations between biochemical, phytochemical, sensory and microbial properties of PBJ during storage for 180 days at ambient and refrigerated condition. Higher correlations were seen between TAC vs. total flavonoid content, followed by total phenolics, and vitamin C content. Overall acceptability was better correlated to taste, followed by flavour, mouthfeel and colour of all samples during 180days of storage. The increase in microbial count had strong negative correlation with overall acceptability.

4. Conclusion

The study revealed that the quality characteristic of palmyra blended juice could be improved by blending with various nutraceutical herbs like ginger, and chilly at different proportion. Minimum
change was observed in samples stored under refrigerated storage condition for all the juice samples. However, the rate of change was different and a significant influence of treatments and storage condition was observed over storage period. Overall analysis of these storage studies on quality characteristics of the stored PBJ, indicated in pasteurized juice rapidly lost its quality attributes exceeding the safe limits of microbial load after 60 days under ambient storage and after 120 days under refrigerated storage. However, the pasteurized juice with sodium benzoate as preservative performed best under both ambient and refrigerated storage conditions up to 90 days and 180 days respectively. The performance of pasteurized juice with potassium metabisulphite as preservative was in between 90 days and 150 days at ambient and refrigerated condition respectively. Though there was a reduction in all the quality characteristics of all the samples, the substantial amount of quality components could still be retained in the pasteurized juice with sodium benzoate as for the said period. However, the PBJ-NaB performed best under both ambient and refrigerated storage conditions up to 90 and 180 days respectively.

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