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Quality attributes of fermented beverages from rose (*Rosa* species) and cinnamon (*Cinnamomum verum* J. Presl)

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ABSTRACT

An investigation was carried out to examine the quality attributes of fermented beverages obtained from the combination of rose petals and cinnamon powder. The experiment consisted of 12 treatments and 3 replications in CRD design. The treatment T_1 and T_2 were made of 100% rose and 100% cinnamon each. The other treatments consists of; T_3 (99% rose + 1% cinnamon), T_4 (98% rose + 2% cinnamon), T_5 (97% rose + 3% cinnamon), T_6 (96% rose + 4% cinnamon), T_7 (95% rose + 5% cinnamon), T_8 (94% rose + 6% cinnamon), T_9 (93% rose + 7% cinnamon), T_{10} (92% rose + 8% cinnamon), T_{11} (91% rose + 9% cinnamon), T_{12} (90% rose + 10% cinnamon) respectively. The yeast *Saccharomyces cerevisiae* was used for fermentation. The maximum nutritional values in freshly fermented beverages were; phenol (199.76 GAE/100 ml), anthocyanin (7.00 mg/100 ml), alcohol (12.41%), ascorbic acid (5.46 mg/100 ml), reducing sugar (1.58%), non-reducing sugar (8.00%), total sugar (1.99%) and TSS (19.67 ^{o}B). The treatment with 100% cinnamon showed strong antimicrobial properties throughout experimentation. However, the proportion of cinnamon added to the beverages significantly improved the nutritional value of the beverages. With the storage period, phenol, ascorbic acid, and alcohol content in the beverages increased whereas other parameters were found to be fluctuating during storage. The beverages obtained from the combination of rose petal and cinnamon powders contained a high amount of vitamins and antioxidants and were highly acceptable.

Key words : *Alcoholic beverages, Cinnamon, Fermented beverages, Flower fermentation, Wine*

Introduction

Fermentation, a metabolic process in which carbohydrates rich substrates are converted into alcohol, carbonic acid and carbon dioxide with the help of microorganisms such as yeast and bacteria anaerobically is one of the oldest, simplest and cheapest techniques adopted by man for the preservation of food since ancient times, which is still prevalent in different cultures and regions. The yeast *Saccharomyces cerevisiae* is mostly used which predominantly controls the flavor of the final products of the fermented products (Joshi *et al*., 2009). Fermentation process enhances the nutritional and functional properties of substrate and formation of bioactive and bioavailable end products due to transformation. Fermented food provides many health benefits such as antioxidants, antimicrobial, antifungal, anti-inflammatory, antidiabetics and atherosclerotic activity (Sanlier *et al.* 2017), anticancer, anti-HIV

(Almeida *et al.* 2011) reduce anti-nutritional components (Onkuwa *et al.* 2007). Besides, fermentation is used for bio-economy, green chemistry, which gives us important products like medicines, bioethanol, antibiotics, plant growth regulators etc. According to archaeological evidences, fermentation method is as old as 7000-6000 B.C in Jiahu China, 6000 in Georgia and 5000 in India.

Fermentation is commonly done with carbohydrate-rich organic substrates mostly cereals or fruits. However, there are about 30,000 flower species in the world that are reported to be edible and many are rich in fermentable sugar, phytochemicals, and bioactive compounds (Shaheen *et al*., 2017). Flowers are particularly rich in antioxidants; phenol, flavonol, flavonoids, carotenoids, anthocyanin, etc. which mitigates the excess oxidative stress. The consumption of flowers has been in practice since ancient times in Rome, Greece, and China for thousands of years. They used flowers to add aesthetic looks to various dishes and to enhance the organoleptic synergy between traditional foods and flower aromas (Benvenuti and Mazzoncini, 2020). Rose flower is one such, which has been used since time immemorial for various purposes. A woody perennial plants native to Asia, Europe and Africa is valued for its effective medicinal properties which were first documented in Sumerians and Chinese. The rose petals have been consumed in many cultures for many years especially as jam (Jat *et al*., 2018, Butcaru *et al.*, 2017) teas, cakes, flavor extracts and used in medicinal practices for remedy of various illness (Friedman *et al*., 2007). Rose petal extracts act as antioxidants (Kart and Cagindi, 2017), anticancer (Tatke *et al.*, 2015), neuroprotective (Esfandiary *et al*., 2015), antidepressant (Tirupati and Golla, 2016), anti-HIV (Gao *et al*., 2013), anticonvulsant (Homayoun *et al*., 2015), antidiabetic (Ju *et al*., 2014), antimicrobial (Swati *et al*., 2016; Laxmi *et al*., 2017), and hepatoprotective (Achutan *et al.* 2003; Akbari *et al*., 2013).

Whereas, cinnamon (*Cinnamomum verum* J. Presl) is one of the oldest and dearest spices known to mankind since time immemorial. The word cinnamon is derived from Greek word 'Kinnamon' which means 'sweet wood'. The cinnamaldehyde and eugenol are two principle constituents of cinnamon oil which attributed to its aroma and flavor. Almost every parts of cinnamon tree; bark, leaves, flowers, fruits and roots are of medicinal or culinary uses. Cinnamon is used for essential oil extraction, perfumes, pharmaceutical products, condiments and flavoring additives (Kumar, 2014) processed foods. It acts as antidiabetic (Sartorius *et al*., 2014; Song *et al*., 2013), anti-cardiovascular activities (Rahman *et al*., 2013), anticancer (Xie *et al*., 2018; Yang *et al*., 2015), antioxidants (Ervina *et al*., 2016; Abeysekara *et al*., 2013), neuroprotective (Bae *et al*., 2018; Peterson *et al*., 2009), hepatoprotective (El-Kholy *et al*., 2019), antimicrobial (Utcharikiat *et al*., 2016), anti-HIV (Cornell *et al*., 2016), anti-convulsant (Cuan *et al*., 2018), anti-inflammatory (Han and Parker, 2007; Hong *et al*., 2012), and antidepressant (Sohrabi *et al*., 2017) etc. The main chemical constituents of cinnamon are mostly cinnamyl alcohol, coumarin, cinnamic acid, cinnamaldehyde, anthocyanin, eugenol and linalool.

People's awareness about such nutraceutical values of flowers and other plant products, and changes in modern food habits have them started to think about rediscovering the ancient ethnobotanical traditions. There has been a report of a rapid increase in demand for fresh edible flowers and its consumptions worldwide in recent times and studies are going on to explore the edible flower having potential for human diet as food, supplements, or additives (Loizzo *et al*., 2016). However, there is a research gap in processing these nutritious flowers into drinkable beverages through the fermentation process and their nutritional assessment. This may be because the plant contains numerous anti-nutritional components, which may be poisonous sometimes, or maybe the scepticism about the undesirable end product after fermentation. Therefore, considering the importance of both rose and cinnamon as ethnomedicinal plants the present investigation was carried out to analyze the combined effects of rose and cinnamon on the nutraceutical quality of beverages obtained through the fermentation process. The rose was used as a major component in the study, while the cinnamon was added as a small supplement.

Materials and Method

The experiment was carried out in the laboratory of the Department of Horticulture, North Eastern Hill University, Tura Campus, Meghalaya, India. The average temperature during the study period was 16.71 to 30.62 °C, whereas humidity was 64.13 to 82.37%. The experiment consisted of 12 treatment combinations comprised of grounded rose petals

and cinnamon; T_1= (100% rose); T_2= (100% cinnamon; T_3= (99% rose + 1% cinnamon); T_4= (98% rose + 2% cinnamon); T_5= (97% rose + 3% cinnamon); T_6= (96% rose + 4% cinnamon); T_7= (95% rose + 5% cinnamon); T_8= (94% rose + 6% cinnamon); T_9= (93% rose + 7% cinnamon); T_{10}= (92% rose + 8% cinnamon); T_{11}= (91% rose + 9% cinnamon) and T_{12}= (90% rose + 10% cinnamon) respectively.

The TSS of the mixed solution was maintained at 20 °Brix by the addition of sugar, while pH was maintained at 3.5 by adding citric acid. Each treatment was prepared separately and poured into a sterilized conical flask of 500 ml in 3/4th of the total volume. The conical flasks were sealed airtight with polythene and nylon thread and then pasteurized for 15 minutes. After cooling down the samples, yeast (20ml/180 ml) was inoculated and then kept in a dry, dark, and ambient environment for fermentation. Racking, fining and filtration were done after completion of fermentation of samples (18.27 days). The TSS (Refractometer), reducing sugar (Lane and Enyon, 1923), non-reducing sugar (Lane and Enyon, 1923), acidity (AOAC, 1990), ascorbic acid (Ranganna, 2004), total sugar (Lane and Enyon, 1923), phenolic content (Ranganna, 2004) alcohol (digital alcoholometer Alex-500 in % by v/v), anthocyanin (Ranganna, 2004) were analyzed in the freshly fermented product as well as during its storage periods. The acceptability of the beverages was measured by score by panelists on 5.00 points Hedonic Scale. The statistical analysis of the significance of data was analyzed with the method described by Panse and Sukhatme (1967) and the analysis of variance (ANOVA) of data was carried out by techniques suggested by Raghuramula *et al*. (1983).

Results and Discussion

Sensory evaluation of beverages

As shown in Figure 1 the acceptability of the beverages was significantly different among the treatments in fresh stage as well as during storage. The highest acceptability score was found in treatment T_{10} (3.79) which was at par with T_9 (3.51), and the lowest was in T_4 (2.35) in freshly fermented beverages. The acceptability score changed over the storage period which was in line with Mukisa *et al*. (2012a). In the subsequent months T_9 had the highest score of acceptability. Treatment T_4 had the lowest acceptability throughout study period. The freshly fermented beverages had a clear reddish-pink color with a sweet rosy aroma and slight astringency which could be due to the presence of phenolic compounds reported by Lopez *et al*. (1983a). The color of beverages changed from clear reddish-pink to dark red during storage, which might be due to continuous oxidation or an increase in phenolic content during storage. This was in accordance to

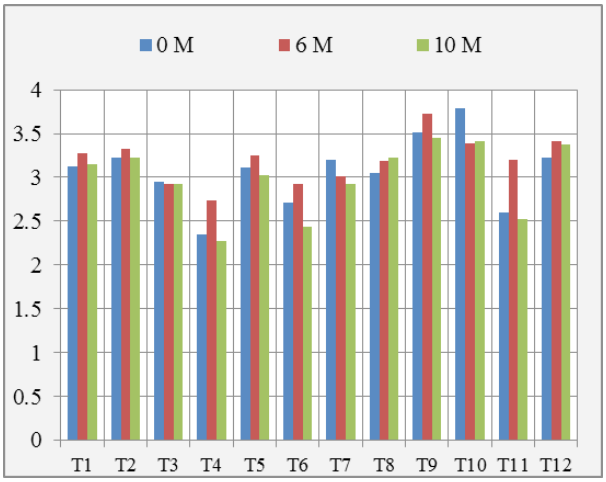

Fig. 1. Changes in the organoleptic score (5.00 points Hedonic Scale) of fermented beverages during storage

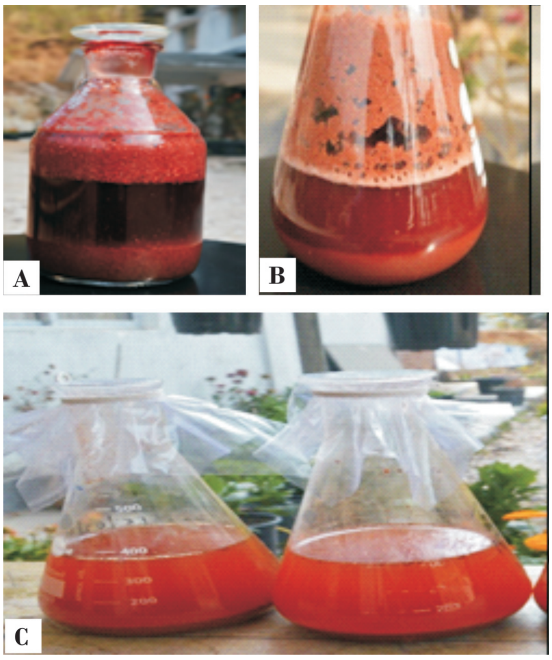

Fig. 2A. Mother Culture for inoculation; B. Treatment with combination of rose and cinnamon; C. Pure treatment of cinnamon

Lopez *et al*. (1983b) that the phenolic component contributes greatly to the color of the fermented products.

Nutritional assessment of fermented beverages from rose and cinnamon

TSS

As depicted in Table 1 the treatment T_2 had the highest TSS (19.67 °Brix) which was significantly different from rest of the treatments. Treatment T_{12} (8.73 °Brix) had second highest TSS which was at par with T_1 (8.20), T_4 (8.47), T_9 (8.27) and T_{11} (8.20) in freshly fermented beverages. The TSS content in beverages fluctuates during the storage. After 10th months of storage, the highest TSS was observed in T_2 (19.64 °Brix, with just 0.16% reduction) which was significantly different from other treatments. With 8.34 °Brix, T_4 had second highest TSS content which was at par with rest of the treatments. A minor and irregular change in TSS content was noticed during storage. A similar of fluctuation in TSS of fermented beverages from Mahua flower was reported by Singh *et al*. (2013a).

Total sugar

As shown in Table 2 the treatment T_{12} had the highest (1.99%) total sugar content followed by T_5 (1.91%) which was at par with T_3 (1.88%), and T_6 (1.89%) in freshly fermented beverages. While the lowest (1.67%) was in T_1. The total sugar content in the beverages decreased over the storage period in all treatments. After 10 months of storage, T_1 had the highest total sugar (1.57%) content which was at par with T_2, T_3 (1.54%), T_6 (1.55%), and T_{12} (1.53%). These were in line with Okemini *et al*. (2017) reported 1.25% total sugar in fermented Tiger Nut beverages. Over the storage period, the lowest reduction of total sugar content was recorded in T_1 (5.98%) followed by T_2 (12.92%), whereas, maximum in T_{11} (30.89%), followed by T_{10} (29.03%). The reduction percent of total sugar in the treatments with higher concentration of cinnamon was relatively higher than the pure treatments of rose and cinnamon alone. The regular decreased in total sugar content might be due to the continuous conversion of sugar into alcohol by viable yeast as reported by Mukisa *et al.* (2012b) in fermented Obushera beverages; Singh *et al*. (2013b) in fermented Mahua flower.

Reducing sugar

As depicted in Table 3 the reducing sugar content in beverages changed throughout the storage period irregularly. In freshly fermented beverages, the highest reducing sugar was found in T_{10} (1.58%) which was at par with T_3 (1.56%) whereas the lowest was in T_7 (1.15%) which was at par with T_8 (1.19%). This was in agreement with Yadav *et al.* (2009a) who reported 0.08-2.21% reducing sugar in the fermented beverage from Mahua flower. After 10 months of storage, treatment T_2 and T_6 had the highest (1.46%) reducing sugar content which was at par with T_3 (1.45%), T_1, T_5, and T_8 (1.42%) whereas the minimum was in T_{12} (1.15%) which was at par with T_{11} (1.20%). The highest increment of reducing sugar after 10 months of storage was found in T_2

Table 1. Changes in TSS content in beverages during beverages during storage (%)

Treatments	0 M	6 M	10 M
T_1	8.20	7.80	8.00
T_2	19.67	19.60	19.64
T_3	8.13	7.93	8.03
T_4	8.47	8.20	8.34
T_5	8.00	8.07	8.04
T_6	7.80	8.20	8.00
T_7	8.00	7.60	7.80
T_8	7.80	8.00	7.90
T_9	8.27	8.20	8.24
T_{10}	8.47	7.20	7.84
T_{11}	8.20	7.87	8.04
T_{12}	8.73	7.73	8.23
C.D (5%)	0.53	0.59	0.56
S.E(m)	**0.18**	**0.20**	**0.19**

Table 2. Changes in Total Sugar content in storage (p Brix)

Treatments	0 M	6 M	10 M
T_1	1.67	1.64	1.57
T_2	1.78	1.75	1.55
T_3	1.88	1.84	1.54
T_4	1.79	1.72	1.40
T_5	1.91	1.88	1.46
T_6	1.89	1.85	1.55
T_7	1.79	1.77	1.39
T_8	1.84	1.79	1.45
T_9	1.74	1.71	1.34
T_{10}	1.86	1.82	1.32
T_{11}	1.78	1.73	1.23
T_{12}	1.99	1.96	1.53
C.D (5%)	0.04	0.02	0.06
S.E(m)	**0.01**	**0.01**	**0.02**

and T_6 (20.66%) whilst it decreased by 18.35% (highest) in treatment T_{10} followed by 14.17% in T_{12}. This was in accordance to Singh *et al*. (2013b) who reported decreasing reducing sugar with a storage period from 5.76 to 0.48% in fermented beverages from Mahua flower during storage.

Non-reducing sugar

From the perusal of data shown in Table 4 the non-reducing sugar content in the fermented beverages were significantly different among the treatments and decreased continuously with the storage period. The T_5 (0.80%) had the highest non-reducing sugar which was at par with T_8 (0.74%), T_{12} (0.73%), and T_6 (0.72%) in fresh conditions. While the least was recorded in T_{10} (0.25%) followed by T_3 (0.38%). Similar was resulted by Thakur and Sharma (2017a) with 0.82% non-reducing sugar in fermented pomegranate beverages. A slight increase in non-reducing sugar was noticed in treatment T_3 (0.55%), and T_{10} (0.48%) while in other treatments it was reduced after 6 months of storage. After 10 months of storage, the maximum non-reducing sugar content was found in T_{12} (0.43%) and the minimum was recorded in T_9 and T_{11} (0.09%) which was at par with T_5, T_6 (0.11%) and T_7, T_8 and T_{10} (1.10%) respectively. The minimum reduction of non-reducing sugar (41.09%) with storage period was also recorded in T_{12}, while maximum reduction (86.48%) was recorded in T_8.

Acidity

From the data shown in Table 5 the acidity of fermented beverages was recorded to be reducing over the time of storage except for the treatments T_3 and T_{10} where acidity remained unchanged till the tenth months of storage. The treatment T_5 (0.32%) had the highest acidity and minimum in T_2 (0.22%) which was at par with T_6 and T_{10} (0.24%) in freshly fermented beverages which were in line with Yadav *et al*. (2009b) reported 0.63% acidity in fermented beverages from Mahua flower. The acidity of the beverage remained unchanged in treatment T_3 (0.29%), T_{10} (0.24%), T_{11} (0.28%), and T_{12} (0.25%) after 6 months of storage, while in rest, it was reduced. After 10 months of the storage period, the acidity of beverages was found maximum in T_5 (0.28%) which was at par with T_3 (0.27%). The maximum reduction in acidity was recorded in pure treatments; T_2 (22.72%) and T_1 (13.79%) respectively after 10 months. It was observed that reduction (%) in acidity in combined treatment of rose and cinnamon was comparatively lower than pure treatments (T_1 and T_2). The least reduction of acidity was found in T_7 and T_{11} with 3.57% each. A similar finding of decreasing acidity was reported by Iheke *et al*. (2017) in fermented locust bean flour.

Ascorbic acid

As depicted in Table 6 the treatment T_4 contained a maximum amount of ascorbic acid (5.51 mg/100ml) which was at par with T_5 (4.80 mg/100 ml) and T_9 (5.46 mg/100 ml) and the least was in T_1 and T_{12} (4.32 mg/100 ml). A similar was reported by Yadav *et al.* (2009c) 4.27 mg/100 ml ascorbic acid in fermented beverages from Mahua flower. In the sixth month of storage, an increment of ascorbic acid was

Table 3. Changes in reducing sugar in beverages during storage (%).

Treatments	0 M	6 M	10 M
T_1	1.26	1.49	1.42
T_2	1.21	1.29	1.46
T_3	1.56	1.36	1.45
T_4	1.29	1.30	1.33
T_5	1.21	1.25	1.42
T_6	1.21	1.32	1.46
T_7	1.15	1.33	1.35
T_8	1.19	1.38	1.42
T_9	1.40	1.44	1.32
T_{10}	1.58	1.41	1.29
T_{11}	1.30	1.44	1.20
T_{12}	1.34	1.44	1.15
C.D (5%)	0.14	0.08	0.07
S.E(m)	0.04	0.03	0.02

Table 4. Changes in non-reducing sugar in beverages during storage (%)

Treatments	0 M	6 M	10 M
T_1	0.46	0.22	0.14
T_2	0.63	0.53	0.12
T_3	0.38	0.55	0.13
T_4	0.55	0.49	0.14
T_5	0.80	0.69	0.11
T_6	0.72	0.59	0.11
T_7	0.69	0.51	0.10
T_8	0.74	0.48	0.10
T_9	0.45	0.35	0.09
T_{10}	0.25	0.48	0.10
T_{11}	0.54	0.36	0.09
T_{12}	0.73	0.60	0.43
C.D (5%)	0.08	0.08	0.01
S.E(m)	0.02	0.03	0.01

recorded in all treatments. However, it was noticed that it started to decline at tenth month. The maximum ascorbic acid content after 10 months of storage was found in T_7 (4.75 mg/100 ml) which was at par with T_8 (4.56 mg/100 ml), T_{12} (4.48 mg/100 ml), and T_9 (4.42 mg/ 100 ml). About 80.95% to 98.06% of ascorbic acid was retained in different treatments till the tenth month of storage. This reduction in ascorbic acid content might be due to the oxidation and reduction reaction in beverages, as reported by Wahab *et al*. (2005) that growing yeast metabolizes the ascorbic acid and reduce it. Furthermore, Fleet and Heard (1993) also resulted that yeast uses ascorbic acid as a source of carbon. On the contrary, a small decrease in ascorbic acid content at the tenth month may be due to the presence or continuous increase of phenol which prevents the oxidation reactions reported by Mancini *et al*. (1998a) that phenolic content inhibits the oxidative process in fermented beverages.

Anthocyanin

As shown in Table 7 the treatment T_{12} contained maximum amounts of anthocyanin (7.00 mg/ 100ml), which was at par with T_1 (6.71 mg/100 ml), T_3 (6.77 mg/100 ml), T_4 (6.72 mg/100 ml), T_5 (6.59 mg/100 ml), and T_{11} (6.67 mg/100 ml) whereas the least was in T_2 (0.50 mg/100 ml) in the freshly fermented beverage. At sixth months of storage, there was huge reduction in anthocyanin content in the beverages with maximum reduction in T_{12} (80%) to lowest in T_2 (38%) respectively. Except T_2, the antho-

Table 5. Changes in acidity content in beverages during storage (%)

Treatments	0 M	6 M	10 M
T_1	0.29	0.28	0.25
T_2	0.22	0.21	0.17
T_3	0.29	0.29	0.29
T_4	0.26	0.25	0.25
T_5	0.32	0.31	0.30
T_6	0.24	0.22	0.22
T_7	0.28	0.27	0.27
T_8	0.27	0.26	0.26
T_9	0.27	0.26	0.26
T_{10}	0.24	0.24	0.24
T_{11}	0.28	0.28	0.27
T_{12}	0.25	0.25	0.24
C.D (5%)	0.03	0.04	0.05
S.E(m)	0.01	0.01	0.01

Table 6. Changes in the ascorbic acid content in beverages during storage (mg/100ml)

Treatments	0 M	6 M	10 M
T_1	4.32	6.08	3.70
T_2	4.37	4.87	3.34
T_3	4.40	5.85	3.96
T_4	5.51	6.47	4.39
T_5	4.80	6.08	4.36
T_6	4.46	6.98	4.32
T_7	4.51	6.97	4.75
T_8	4.65	4.82	4.56
T_9	5.46	6.92	4.42
T_{10}	4.40	7.34	4.05
T_{11}	4.43	6.22	4.08
T_{12}	4.32	6.10	4.48
C.D (5%)	0.75	0.66	0.68
S.E(m)	0.26	0.22	0.23

Table 7. Changes in anthocyanin content in beverages during storage (mg/100ml)

Treatments	0 M	6 M	10 M
T_1	6.71	1.71	1.19
T_2	0.50	0.31	0.25
T_3	6.77	1.62	1.30
T_4	6.72	1.78	1.33
T_5	6.59	1.74	1.25
T_6	5.68	1.69	1.25
T_7	6.17	1.63	1.21
T_8	6.18	1.56	1.30
T_9	5.80	1.52	1.19
T_{10}	6.20	1.50	1.18
T_{11}	6.67	1.43	1.16
T_{12}	7.00	1.40	1.21
C.D (5%)	0.64	0.2	0.13
S.E(m)	0.21	0.07	0.04

Table 8. Changes in phenolic content in beverages during storage (mg/100ml/GAE)

Treatments	0 M	6 M	10 M
T_1	157.96	172.45	215.25
T_2	29.23	78.69	72.87
T_3	151.97	164.63	205.59
T_4	157.13	171.62	218.91
T_5	116.33	148.14	192.1
T_6	164.63	173.12	212.42
T_7	169.29	171.79	217.58
T_8	165.12	177.95	208.59
T_9	199.76	202.59	221.58
T_{10}	182.11	192.94	215.58
T_{11}	169.62	174.78	198.6
T_{12}	166.62	174.78	202.59
C.D (5%)	30.52	29.93	14.47
S.E(m)	10.39	10.19	4.92

cyanin content in all treatments was reduced to more than 70% at 6th month.

After 10 months, T_4 (1.33 mg/100 ml) had the highest anthocyanin content which was at par with all the treatments except T_2 (0.25 mg/100 ml). The maximum retention of anthocyanin was recorded in T_4 (19.89%), whereas maximum reduction was observed in T_{12} (82.71%) followed by T_1 (82.26%) during storage. This reduction in anthocyanin content in beverages could be due to changes in pH, temperature, exposure to light, and oxidation during handling of the beverages which causes degradation or maybe continuously metabolized by the viable yeast. Mousavi *et al.* (2011a) reported a similar result of decreasing anthocyanin content with storage period in fermented pomegranate juice.

Phenol

From the perusal data in Table 8 it can be seen that the phenolic content in fermented beverages increased with the storage period, except in treatment T_2 which declined at tenth month of storage. In freshly fermented beverages, T_9 had highest amount of phenol (199.76 GAE/100 ml) which was at par with T_7 (169.29 GAE/100 ml), T_{10} (182.11 GAE/100ml), and T_{11} (169 GAE/100 ml). At sixth months of storage, maximum increment in phenolic content was recorded in cinnamon pure treatment (T_2) with 49.46 GAE/100ml) whereas least increment was recorded in T_7 (2.5 GAE/100ml).

After 10 months, T_9 (221.58 GAE/100 ml) had maximum phenol content which was on par with T_4 (218.91 GAE/100 ml) and T_7 (217.58 GAE/100 ml), whereas the lowest was in T_2 (72.87 GAE/100 ml). The phenolic content in T_9 remained consistently highest throughout the study period. The maximum increase in phenolic content was recorded in T_5 (from 116.33 to 192.10 GAE/100 ml) by 65.13% after 10 months. This was in agreement with Ifie *et al*. (2016) reported a continuous increase in phenolic content in fermented wine from *Hibiscus sabdariffa* by 41.26% to 45.70% after 40 days of storage; Thakur and Sharma (2017c) also resulted 206.64 mg/100 ml phenolic content in fermented pomegranate beverage. This is also in line with Mousavi *et al*. (2011b) that enzymes such as â- glycosidase derived from fermentative microorganisms hydrolyze the complex phenolic compounds to simpler types and increased the quantitative amount of total phenolic compounds during fermentation.

Alcohol

The alcohol content changed concomitantly with the storage period except in treatment T_1 (100% rose) where it declined as depicted in Table 9. The maximum alcohol content was recorded in T_3 (12.41%) which was at par with T_1 (12.32%), T_5 (12.24%), and T_6 (12.27%) in freshly fermented beverages while the least was in T_2 (0.10%). The alcohol content in treatment T_2 was incomparable with other treatments. It might be due to the antimicrobial (anti-yeast) properties of cinnamon which inhibited the fermentation process, and consequently slowed down the conversion of sugar into an alcohol. A similar study was reported by Fraser *et al*. (2007); Moritz *et al*. (2012) that cinnamon inhibits the fermentation action and microbial counts in the culture. The antimicrobial effect of cinnamaldehyde is also reported by Utchariyakiat *et al.* (2016).

Table 9. Changes in alcohol content in beverages during storage (%)

Treatments	0 M	6 M	10 M
T_1	12.32	12.24	12.04
T_2	0.10	0.64	0.71
T_3	12.41	12.49	12.93
T_4	12.03	12.51	12.96
T_5	12.24	12.52	13.18
T_6	12.27	12.95	13.17
T_7	12.17	12.68	13.27
T_8	12.13	12.39	13.17
T_9	12.19	12.33	13.22
T_{10}	11.89	12.27	13.09
T_{11}	12.19	12.43	13.51
T_{12}	12.07	12.15	13.41
C.D (5%)	0.17	0.45	0.25
S.E(m)	0.05	0.15	0.08

After 6 months, maximum alcohol content was found in T_6 (12.95%) which was at par with T_7 (12.68%) and T_5 (12.65%) and the minimum was in T_2 (0.64%). After 10 months, the maximum alcohol content was recorded in T_{11} (13.51%) which was at par with T_{12} (13.41%) and T_7 (13.27%) whereas the least was in T_2 (0.71%). The increasing rate of alcohol content was noticed from 9.77-9.99% in various treatments which was following Okemini *et al*. (2017) reported that alcohol content in fermented Tiger nut increased with storage period. While decreasing in alcohol content was noticed in T_1 up to 2.27%. The small increments of alcohol content in T_2

and decreasing trend in T_1 could be attributed to slower conversion of total sugar, in which reduction of total sugar was recorded comparatively lower than others during storage period.

Summary and Conclusion

The fermented beverages from rose and cinnamon had an attractive reddish-pink in color with rosy aroma. In freshly fermented condition, the highest acceptability was recorded in T_{10} (3.79) which was at par with T_9 (3.52) and least in T_4 (2.35). In the subsequent storage period, the acceptability of the beverages changed. The T_9 (3.73) had the highest acceptability at tenth month. While T_4 remained the least acceptable treatment throughout the study period.

The TSS content in the freshly fermented beverages was recorded highest in T_2 (19.67pB) which was significantly different from all the treatments. It remained highest till 10th month of the storage study. The total sugar content was recorded highest in T_{12} (1.99%) while lowest in T_1 (1.67%). After 10 months of storage, the total sugar content declined with highest recorded in T_1 (1.57%) which was at par with T_2, T_3 (1.54%), T_6 (1.55%) and T_{12} (1.53%). The reduction in total sugar content in the beverages with storage period was recorded lowest in pure treatments of rose and cinnamon compare to the treatments with combination of two.

The reducing sugar content of the freshly fermented beverages was found highest in T10 (1.58%) which was at par with T_3 (1.56%) while lowest in T_7 (1.15%) which was at par with T_8 (1.19%). After 10 months of storage, T_2 and T_6 had the highest reducing sugar (1.46%) which was at par with T3 (1.45%), T_1, T_5 and T_8 (1.42%). Meanwhile the highest non-reducing sugar was recorded in T_5 (0.80%) which was at par with T_8 (0.74%), T_{12} (0.73%) and T_6 (0.72%) respectively in fresh condition. Whereas least was found in T_{10} (0.25%).

The acidity of the treatment T_3 and T_{10} remained unchanged throughout the study period. The highest acidity was recorded in T_5 (0.32%) while minimum in T_2 (0.22%) which was at par with T_6 and T_{10} (0.24%). After 10 months, the highest acidity was recorded in T_5 (0.28%) which was at par with T_3 (0.27%). The maximum reduction in acidity was observed in pure treatments T_2 (22.72%) and T_1 (13.79%) respectively. The initial highest ascorbic acid content was found in T_4 (5.51 mg/100ml) which was at par with T_5 (4.80 mg/100ml) while least in T_1 and T_{12} (4.32 mg/100 ml). The highest increment in ascorbic acid content in fermented beverages was recorded in sixth month. However, it started to decline in tenth month. The highest ascorbic acid content was found in T_7 (4.75 mg/100 ml) which was at par with T_8 (4.56 mg/100 ml), T_{12} (4.48 mg/100 ml) and T_9 (4.42 mg/100 ml). About 80.95% to 98.06% ascorbic acid was retained at tenth month of storage.

The highest anthocyanin content was recorded in T_{12} (7.00 mg/100 ml) which was at par with T_1 (6.71 mg/100 ml), T_3 (6.77 mg/100 ml), T_4 (6.72 mg/100 ml), T_5 (6.59 mg/100 ml) and T_{11} (6.67 mg/100 ml) respectively while least was in T_2 (0.50 mg/100 ml). A huge reduction in anthocyanin content was recorded during sixth month of storage (38-80%). After 10 months of storage, highest anthocyanin content was recoded in T_4 (1.33 mg/100 ml) which was at par with all the treatments except T_2 (0.25 mg/100 ml). At tenth month, highest retention of anthocyanin was recorded in T_4 (19.89%) whereas maximum reduction was in T_{12} (82.71%).

The phenolic content in the beverages was found highest in T_9 (1.99.76 GAE/100 ml) which was at par with T_7 (169.29 GAE/100 ml), T_{10} (182.11 GAE/100 ml) and T_{11} (169.00 GAE/100ml). The highest increment in phenolic content was recorded in T_2 while lowest in T_7 during sixth month of storage. After 10 months of storage, T_9 (221.58 GAE/100 ml) had highest phenolic content which was at par with T_4 (218.91 GAE/100 ml) and T_7 (217.58 GAE/100 ml) while lowest in T (72.87 GAE/100 ml). The highest increment in phenolic content was recorded in T_5 (65.13%) with storage period.

The alcohol content in the beverages changed concomitantly with the storage period except in T_1 (100% rose) where it declined continuously. In fresh condition, the maximum alcohol content in the beverages was recorded highest in T_3 (12.41%) which was at par with T_1 (12.32%), T_5 (12.24%) and T_6 (12.27%) while least was in T_2 (0.10%). After 10 months of storage, T_{11} (13.51%) had the highest alcohol content which was at par with T_{12} (13.41%) and T_7 (13.27%) while least in T_2 (0.71%). The alcohol content increased from 9.77% to 9.99% in various treatments.

Based on the analyses of certain characteristics and quality of fermented beverages, the treatment T_9 (93% rose + 7% cinnamon) was the best treatment in terms of organoleptic score, vitamin C content (ascorbic acid) and anti-oxidants counts (anthocyanin, phenol). However, in terms of alcohol content in

the beverages, the best treatment was T_{11} (91% rose + 9% cinnamon). The pure treatment of cinnamon (100% cinnamon) in T_2 showed strong antimicrobial property by inhibiting the fermentation process throughout the study period. However, it was found that the proportion of cinnamon added in the beverages in combination with rose improved the nutritional quality of the beverages as well as prevent the oxidation of important nutrients such as ascorbic acid.

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Conflicts of interest

The authors declare no conflict of interest.

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