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Studies on effect of blending and storage of value-added *Rhododendron* based ready to serve beverage

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Abstract
Background: The goal of this study was to develop a value-added RTS beverage from rhododendron flowers and to look into the effects of storage and blending ratios on the chemical properties and sensory quality of the finished product.
Methods: The flowers utilised in the study were obtained from district Kangra, Himachal Pradesh. After removing the inedible portion of the flower, the juice was collected and RTS beverage was made using various blends of rhododendron, lemon, and plum juice. Chemical parameters (TSS, acidity, Brix acid ratio, ascorbic acid, total sugars a) of the formulated RTS beverage were examined.
Results: RTS beverage acidity was increased from 0.43 to 0.53 per cent, while TSS was reduced from 13.00 to 12.83ºB. During storage, total sugars declined from 13.21 to 13.20 percent.

Keywords: *Rhododendron*, lemon, plum, RTS beverage, chemical parameters, sensory attributes, blending, storage

Introduction
Rhododendrons are a prominent flower at high altitudes in Himachal Pradesh. Hill people have long used the petals of *Rhododendron arboreum* blossoms to make chutney. The primary pigments in flowers are anthocyanins and flavonols (Krishna *et al.* 2010) [6]. In Himachal Pradesh, uncooked flowers have a sourish-sweet flavour. They are traditionally used to make chutneys, cool drinks, and squash; they are also a key component of the local wine 'sur' (Kharwal and Rawat 2013) [5], which aids in the prevention of high-altitude illness. On a smaller scale, little amounts of flower juice are extracted and used to make jelly, squash, and syrup. The dried flowers are quite effective in the treatment of diarrhoea and bleeding dysentery, blood poisoning, and other gastrointestinal problems (Laloo *et al.* 2006) [7].
Rhododendron flowers have a variety of nutritional, therapeutic, and fragrant benefits. It holds a significant place in the people of Himachal Pradesh's cultural and economic lives. It has, however, been overlooked, and its nutritional characteristics and value-added products have gotten little attention to yet. Rhododendron blossoms are a good source of micronutrients, according to studies, but they aren't utilized commercially despite their enormous potential. Because the juice obtained from its flower can be used in a variety of products, investigator set out to develop and standardize techniques for making value-added ready-to-serve (RTS) beverages from Rhododendron flowers, as well as determine their nutritional qualities, consumer acceptability, and storage stability. Using rhododendron juice to boost the utility of this important flower, which is a good source of ascorbic acid, antioxidants, and flavonoids, an attempt was made to attain the health advantages of the Rhododendron flower.

Material and Methods
Flowers from *Rhododendron arboreum* were collected from local farmers in Palampur, district Kangra, Himachal Pradesh. The flowers were cleaned and evaluated according to size and colour, and the petals were washed under running tap water after the sexual organs, calyx, and stem were removed. The additional ingredients for the RTS beverage preparation/ formulation were also purchased from the local market.

Preparation of RTS beverage
Extraction of juices used: The petals of the flowers were blanched in boiling water for one to two minutes to extract the juices. The flowers were immediately immersed in cold water after

treatment. In the grinder, the pulp was extracted and homogenized. For juice extraction, the fibrous material was separated using muslin cloth. Sodium benzoate (0.5 g/ litre of juice) was added to the homogenized juice. Pre-sterilized glass bottles were used to fill the treated juice. For all of the treatments, heating at 80±5 ˚C for 30 minutes was done after filling. Processed juice was stored at room temperature for further use.

To produce clean juice, lemons were washed and sliced into two halves with a squeezer. The RTS beverages were made with freshly squeezed juice. Plum fruits were chosen for their sound quality and cleansed with tap water. In the grinder, the pulp was extracted and homogenized. With the use of muslin fabric, the juice was extracted by separating the fibrous particles. The RTS beverage was made with the fresh juice that was received.

RTS beverage preparation

Rhododendron juice, lemon juice, and plum juice were mixed together in various proportions (Table 1). To make the syrup, combined 130 g sugar, 1.3 g citric acid, and 767 ml water in a saucepan and heated just until the sugar dissolves. The syrup was then correctly added to 100 ml juice, filtered through muslin cloth, and placed into previously sterilized glass bottles (200 ml) with 2.5 cm headspace and sealed airtight by crown corking. The bottle was then heated for 30 minutes at 80±5 ºC, cooled to room temperature, and kept in the refrigerator.

Table 1: Ratios of blended juices

Sr. No	Treatment	Fruit Combination	Ratios
1	RJ	*Rhododendron* Juice + Lemon Juice	100:00
2	RLJ1	*Rhododendron* Juice + Lemon Juice	80:20
3	RLJ2	*Rhododendron* Juice + Lemon Juice	60:40
4	RLJ3	*Rhododendron* Juice + Lemon Juice	50:50
5	RLJ4	*Rhododendron* Juice + Lemon Juice	00:100
6	RPJ1	*Rhododendron* Juice + Plum Juice	75:25
7	RPJ2	*Rhododendron* Juice + Plum Juice	50:50
8	RPJ3	*Rhododendron* Juice + Plum Juice	25:75
9	RPJ4	*Rhododendron* Juice + Plum Juice	00:100

Quality evaluation of RTS beverage

Nutritional parameters: The nutritional properties of the prepared RTS beverage were examined. The total soluble solids were calculated using a refractometer, and the results were represented in degrees Brix (Ranganna 2007) [10]. Acidity, sugars, and ascorbic acid were measured while the fruit was fresh, 60 days later, and 120 days later. AOAC (1990) [1].

Organoleptic evaluation: The sensory scores of the prepared RTS beverage were assessed when it was fresh, 60 days later, and 120 days later. The 9 point Hedonic scale was employed for the sensory evaluation of prepared products. (Larmond 1977) [8].

Statistical Analysis: With the use of a computer and the CRD design, the data obtained from various parameters were statistically analysed. Analysis of variance was used to examine the data. (Gupta 2000) [4].

Results and Discussion

Chemical characteristics of Ready to serve beverages

Effect of blending and Storage on ascorbic acid of RTS beverages: The effect of blending and storage on the ascorbic acid level of RTS Beverage is shown in Table 2. According to the findings, blending Rhododendron juice with lemon and plum juice significantly (P≤0.05) reduced the ascorbic acid content of RTS beverages from 16.95 to 10.96 mg/100g and 16.95 to 4.91 mg/100g, respectively. In 120 days of storage, the mean ascorbic acid content of RTS beverages fell significantly (P≤0.05) from 11.67 to 9.56 mg/100g for Rhododendron: lemon RTS beverage and from 8.64 to 6.33 mg/100g for Rhododendron: plum RTS beverage. Because ascorbic acid is particularly susceptible to oxygen in its surroundings, the decrease in ascorbic acid level during storage could be due to oxidation of ascorbic acid to dehydroascorbic acid. The findings are more similar to those of Bhuiyan and Kabir (2012) [12] and Malav *et al.* (2014) [9].

Table 2: Effect of blending and storage on ascorbic acid (mg/100g) content of *Rhododendron* based RTS beverage

	Storage Days								
Blends	**0**	**60**	**120**	**Mean**	**Blends**	**0**	**60**	**120**	**Mean**
RJ	16.95	15.24	14.01	15.40	RJ	16.95	15.24	14.01	15.40
RLJ1	14.72	13.92	12.73	13.79	RPJ1	12.20	11.32	10.03	11.18
RLJ2	12.10	11.63	10.81	11.51	RPJ2	8.76	7.18	5.92	7.29
RLJ3	10.96	9.73	8.89	9.86	RPJ3	4.91	2.91	1.53	3.12
RLJ4	3.63	2.80	1.38	2.61	RPJ4	0.40	0.24	0.13	0.26
Mean	11.67	10.66	9.56	10.63	Mean	8.64	7.38	6.33	7.45
C (P ≤ 0.05)	Blends (A)	Storage (B)		A x B	C (P ≤ 0.05)	Blends (A)	Storage (B)		A x B
	0.20	0.15		0.34		0.12	0.09		0.20

Effect of blending and Storage on acidity, total soluble solids and Brix/ acid Ratio of RTS beverages: The change in acidity value of fresh RTS beverage (Table 3) demonstrated that when the quantity of lemon and plum juice increased, the acidity of the product increased as well, from 0.43 to 0.56 percent and 0.43 to 0.52 percent, respectively. In RTS beverages combined with lemon, the mean acidity increased significantly (P≤0.05) following storage from 0.51 to 0.58 and 0.63 percent. After 60 and 120 days of storage, the mean acidity of RTS beverages blended with plum increased significantly (P≤0.05) from 0.48 to 0.55 and 0.59 percent, respectively. The creation of organic acid via ascorbic acid breakdown could explain the rise in acidity. Rustagi and Kumar (2013) [11] found that after 60 days of storage, the acidity of an amla mango blended RTS beverage increased.

The effect of blending and storage on total soluble solids of RTS beverages prepared with various blending ratios is shown in Table 3. TSS increases were non-significant (P≤0.05) in RTS beverages made by combining Rhododendron juice with lemon, but significant with storage intervals. In 60 days and 120 days of storage, the mean total soluble solids (ºB) fell from 13.01 to 12.92 and 12.83, respectively. With the addition of different proportions of plum, *i.e.* 25, 50, and 75 percent, the initial value of total soluble solids (ºB) was found to be 13.00 in a 100:00 proportion of Rhododendron: plum, which increased to 13.10,

13.17, and 13.23 with the addition of different proportions of plum, respectively. After 60 and 120 days of storage, the mean total soluble solids content of RTS beverages reduced significantly (P≤0.05) from 13.29 to 12.55 and 12.33 ºB, respectively. This drop could be due to carbohydrates being converted to acid. Sheela and Sruthi (2014) [12] reported similar outcomes.

The Brix/ acid ratio amount of RTS beverage in pure Rhododendron RTS the beverage was 30.04, which fell considerably (P≤0.05) from 28.06 to 23.10 and from 29.60 to 25.65, respectively, as the quantity of lemon and plum rose, as shown in the results (Table 3). The values of Brix/ acid ratio decreased significantly with storage in both the beverages in all the blending proportions. The change in Brix/ acid ratio with storage may be attributed to the reason that Brix/ acid ratio was calculated by dividing the degree Brix values by the titrable acidity.

Table 3: Effect of blending and duration of storage on Sugar content of *Rhododendron* based RTS beverage

		Storage Days								
	Blends	**0**	**60**	**120**	**Mean**	**Blends**	**0**	**60**	**120**	**Mean**
Acidity (% CA)	RJ	0.43	0.49	0.53	0.48	RJ	0.43	0.49	0.53	0.48
	RLJ1	0.46	0.53	0.57	0.52	RPJ1	0.44	0.51	0.56	0.50
	RLJ2	0.49	0.56	0.61	0.55	RPJ2	0.47	0.54	0.58	0.53
	RLJ3	0.56	0.60	0.65	0.61	RPJ3	0.52	0.59	0.64	0.58
	RLJ4	0.61	0.73	0.81	0.72	RPJ4	0.54	0.64	0.68	0.62
	Mean	0.51	0.58	0.63	0.58	Mean	0.48	0.55	0.59	0.54
TSS (ºBrix)	RJ	13.00	12.90	12.83	12.91	RJ	13.00	12.90	12.83	12.91
	RLJ1	13.00	12.87	12.82	12.90	RPJ1	13.10	12.33	12.03	12.49
	RLJ2	13.01	12.97	12.84	12.94	RPJ2	13.17	12.30	12.10	12.52
	RLJ3	13.01	12.93	12.83	12.92	RPJ3	13.23	12.40	12.13	12.59
	RLJ4	13.02	12.93	12.83	12.93	RPJ4	13.93	12.83	12.53	13.10
	Mean	13.01	12.92	12.83	12.92	Mean	13.29	12.55	12.33	12.72
Brix/ acid ratio	RJ	30.04	26.53	24.25	26.94	RJ	30.04	26.53	24.25	26.94
	RLJ1	28.06	24.17	22.62	24.95	RPJ1	29.60	24.20	21.62	25.14
	RLJ2	26.75	23.29	21.18	23.74	RPJ2	27.93	22.69	20.99	23.87
	RLJ3	23.10	21.46	19.65	21.40	RPJ3	25.52	21.06	19.07	21.88
	RLJ4	21.24	17.63	15.84	18.24	RPJ4	25.65	20.05	18.52	21.41
	Mean	25.84	22.62	20.71	23.05	Mean	27.75	22.91	20.89	23.85
C (P ≤ 0.05)		Blends (A)	Storage (B)		A x B	C (P ≤ 0.05)	Blends (A)	Storage (B)		A x B
Acidity (% CA)		0.02	0.01		0.03	Acidity (% CA)	0.02	0.01		NS
TSS (ºBrix)		NS	0.054		NS	TSS (ºBrix)	0.11	0.08		0.19
Brix/ acid ratio		0.67	0.52		NS	brix/ acid ratio	0.92	0.71		NS

Effect of blending and Storage on the sugar content of RTS beverages: The sugar content of a ready-to-serve beverage made by blending lemon and plum juice with Rhododendron juice in various quantities is shown in Table 4. On the total sugar level of Rhododendron: lemon-based RTS beverages, the effect of blending proportions and storage time was observed to be non-significant (P≤0.05). Rhododendron: plum-based RTS beverages, on the other hand, were found to be significant. The total sugar level of fresh RTS beverages increased significantly (P≤0.05) from 13.21 to 13.81 percent when the quantity of plum juice in the beverage was increased. The mean total sugar level of RTS beverages blended with plum juice increased significantly (P≤0.05) after storage, from 13.61 to 13.82 percent.

The effect of blending, as well as the interaction between blends and storage, on reducing sugars in ready-to-drink beverage formulations prepared from Rhododendron: lemon and Rhododendron: plum, was found to be non-significant (P≤0.05), whereas the effect of storage was found to be significant (P≤0.05). After storage, the mean reducing sugar content in Rhododendron: lemon and Rhododendron plum based RTS beverages increased significantly from 2.45 to 2.95 and 2.73 to 2.99 percent, respectively. The conversion of non-reducing sugars to reducing sugars during storage might result in an increase in reducing sugar. Similar findings were obtained by Malav *et al.* (2014) [9] in orange-based blended RTS beverages that had been held for 90 days.

Table 4: Effect of blending and duration of storage on Sugar content of *Rhododendron* based RTS beverage

		Storage Days								
	Blends	**0**	**60**	**120**	**Mean**	**Blends**	**0**	**60**	**120**	**Mean**
Total Sugars (%)	RJ	13.21	13.20	13.20	13.20	RJ	13.21	13.20	13.20	13.20
	RLJ1	13.25	13.20	13.19	13.21	RPJ1	13.43	13.45	13.55	13.48
	RLJ2	13.26	13.23	13.20	13.23	RPJ2	13.61	13.75	13.86	13.74
	RLJ3	13.29	13.24	13.20	13.24	RPJ3	13.81	13.88	13.95	13.88
	RLJ4	13.36	13.30	13.26	13.31	RPJ4	13.98	14.08	14.54	14.20
	Mean	13.27	13.23	13.21	13.24	Mean	13.61	13.67	13.82	13.70
Reducing Sugars (%)	RJ	2.76	2.83	2.91	2.83	RJ	2.76	2.83	2.91	2.83
	RLJ1	2.61	2.78	2.89	2.76	RPJ1	2.74	2.85	2.96	2.85
	RLJ2	2.49	2.57	2.79	2.61	RPJ2	2.74	2.84	2.92	2.83
	RLJ3	2.34	2.43	3.71	2.83	RPJ3	2.73	2.81	3.00	2.85
	RLJ4	2.03	2.18	2.45	2.22	RPJ4	2.72	2.87	3.17	2.92
	Mean	2.45	2.56	2.95	2.65	Mean	2.73	2.84	2.99	2.85

C (P ≤ 0.05)	Blends (A)	Storage (B)	A x B	C (P ≤ 0.05)	Blends (A)	Storage (B)	A x B
Total Sugars (%)	NS	NS	NS	Total Sugars (%)	0.20	0.16	NS
Reducing Sugars (%)	NS	0.33	NS	Reducing Sugars (%)	NS	0.06	NS

Sensory acceptability of Ready to serve beverages

Effect of blending and Storage on Sensory acceptability of Ready to serve beverages: Table 5 shows the colour and taste scores of Rhododendron-based RTS beverages as they are affected by blending and storage. According to the results, the colour score of pure Rhododendron-based RTS beverage was 8.30, which decreased to 7.35 and 6.80 when 50 and 75 parts lemon and plum juice were added, respectively. After 120 days of storage, the average colour score for all treatments/blends declined from 7.65 to 6.92 in RTS beverage blended with lemon and from 7.16 to 6.44 in RTS beverage blended with plum. The effect of storage on the colour pigment may be the cause of the decline in colour score as the storage interval increases.

The highest taste score was observed for 80:20 (8.30) proportion in RTS blended with lemon whereas in RTS beverage blended with plum the taste scores were higher in RTS beverage prepared from pure *Rhododendron* juice (8.20) followed by RTS prepared by using 50, 25, and 75 parts of plum juice with recorded scores as 7.50, 7.40 and 7.00, respectively. Irrespective of the blends, the mean taste scores of freshly prepared RTS decreased from 7.82 to 7.20 and 6.64 in RTS beverage blended with lemon and from 7.24 to 7.10 and 6.42 in RTS beverage blended with plum after storage of 60 and 120 days, respectively. A similar decrease in taste scores was observed by Rustagi and Kumar (2013) [11] in *amla* mango blended RTS beverage.

The data (Table 6) reveal that the highest flavour scores were recorded in a Rhododendron-based RTS beverage mixed with 20 parts lemon juice (8.00), while the lowest flavour scores were obtained in a pure plum-based RTS beverage (6.40). Overall, adding plum juice decreased flavour scores, but combining lemon in 20 and 40 parts enhanced flavour scores. With the passage of time, the mean flavour scores for freshly prepared RTS beverages declined from 7.46 to 7.14 and 6.54, respectively, and from 7.03 to 6.73 and 5.76 in RTS beverages mixed with lemon and plum, respectively. The breakdown of volatile flavouring chemicals during storage could be the cause of the reduction in flavour scores (Shukla *et al.*, 2004, Shubhra *et al.*, 2004) [15, 14].

The consistency of an RTS beverage prepared with pure/100 parts Rhododendron juice was evaluated as (7.80), then slightly lowered to 7.75 with the addition of 20 parts lemon juice, and then steadily decreased to 7.15 and 7.04 with the addition of 40 and 50 parts lemon juice. Consistency scores in RTS beverages blended with plum juice declined from 7.80 to 7.40 as the quantity of plum juice in RTS beverages increased. The mean consistency scores fell as the storage period increased, from 7.33 to 6.56 and 7.52 to 6.42 after 120 days, respectively.

Data pertaining to sensory scores of *Rhododendron* based RTS beverage as affected by blending and storage are presented in Fig 1. The overall acceptability scores were computed by averaging scores of colour, flavor, taste and consistency attributes for the ready to serve beverage. The effect of blending and storage were found significant (P≤0.05). Though combining Rhododendron with lemon juice decreased overall acceptability of RTS significantly (P0.05), it was acceptable up to the level of 50:50 with a mean value of 7.35, which was higher than that of lemon RTS (00:100). The ratio of 80:20 had the highest acceptability in fresh juice. When combining with plum juice, similar patterns appeared.

With an increased proportion of plum juice in all blends, the overall acceptability decreased. The use of lemon juice in place of plum juice was found to be more acceptable. The overall acceptability decreased with storage. The highest overall acceptability scores initially recorded 8.04 decreased to 7.11 in the proportion of 80:20 *Rhododendron*: lemon RTS and 7.44 to 6.43 in 75:25 *Rhododendron*: plum RTS beverage, after 120 days of storage. The loss of flavour and colour after storage could explain the progressive drop in overall acceptance rankings. Shubhra *et al.* (2014) [14] discovered similar results in kinnow nectar treated with aloe juice.

Table 5: Effect of blending and duration of storage on color and taste scores of *Rhododendron* based RTS beverage

	Storage Days								
	Blends	**0**	**60**	**120**	**Mean**	**Blends**	**0**	**60**	**120**	**Mean**
Color	RJ	8.30	8.10	7.60	8.00	RJ	8.30	8.10	7.60	8.00
	RLJ1	8.10	7.50	7.10	7.57	RPJ1	7.20	7.10	6.20	6.83
	RLJ2	7.50	7.40	6.40	7.10	RPJ2	7.40	7.25	6.30	6.98
	RLJ3	7.35	6.70	6.50	6.85	RPJ3	6.80	6.65	6.00	6.48
	RLJ4	7.00	7.10	7.00	7.03	RPJ4	6.10	5.95	6.10	6.05
	Mean	7.65	7.36	6.92	7.31	Mean	7.16	7.01	6.44	6.87
Taste	RJ	8.20	8.10	7.60	7.97	RJ	8.20	8.10	7.60	7.97
	RLJ1	8.30	7.50	7.00	7.60	RPJ1	7.50	7.30	6.40	7.07
	RLJ2	7.70	7.20	6.40	7.10	RPJ2	7.00	6.90	6.00	6.63
	RLJ3	7.60	6.90	6.10	6.87	RPJ3	6.10	6.10	5.50	5.90
	RLJ4	7.30	6.30	6.10	6.57	RPJ4	7.24	7.10	6.42	6.92
	Mean	7.82	7.20	6.64	7.22	Mean	7.21	7.10	6.38	6.90
C (P ≤ 0.05)		Blends (A)		Storage (B)	A x B	C (P ≤ 0.05)		Blends (A)	Storage (B)	A x B
Color		0.36		0.28	NS	Color		0.34	0.27	NS
Taste		0.25		0.19	0.44	Taste		0.41	0.32	NS

Table 6: Effect of blending and duration of storage on flavor and consistency scores of *Rhododendron* based RTS beverage

	Storage Days								
	Blends	**0**	**60**	**120**	**Mean**	**Blends**	**0**	**60**	**120**	**Mean**
Flavor	RJ	7.67	7.30	6.40	7.12	RR	7.67	7.30	6.40	7.12
	RLJ1	8.00	7.70	7.10	7.60	RPR1	7.30	6.65	5.95	6.63
	RLJ2	7.70	7.50	7.00	7.40	RPR2	6.80	6.65	6.00	6.48
	RLJ3	7.35	6.90	6.00	6.75	RPR3	7.00	7.10	5.05	6.38
	RLJ4	6.60	6.30	6.20	6.36	RPR4	6.40	5.95	5.40	5.92
	Mean	7.46	7.14	6.54	7.05	Mean	7.03	6.73	5.76	6.51
Consistency	RJ	7.80	7.10	7.00	7.30	RR	7.80	7.10	7.00	7.30
	RLJ1	7.75	7.50	7.30	7.52	RPR1	7.60	7.60	6.80	7.33
	RLJ2	7.15	7.30	6.50	6.98	RPR2	7.50	7.25	6.10	6.95
	RLJ3	7.05	6.70	6.00	6.58	RPR3	7.40	7.10	6.10	6.87
	RLJ4	6.90	6.30	6.00	6.40	RPR4	7.30	7.05	6.10	6.82
	Mean	7.33	6.98	6.56	6.96	Mean	7.52	7.22	6.42	7.05
C (P ≤ 0.05)		Blends (A)	Storage (B)		A x B	C (P ≤ 0.05)		Blends (A)	Storage (B)	A x B
Flavor		0.42	0.33		NS	Flavor		0.44	0.34	NS
Consistency		0.32	0.25		NS	Consistency		0.32	0.25	NS

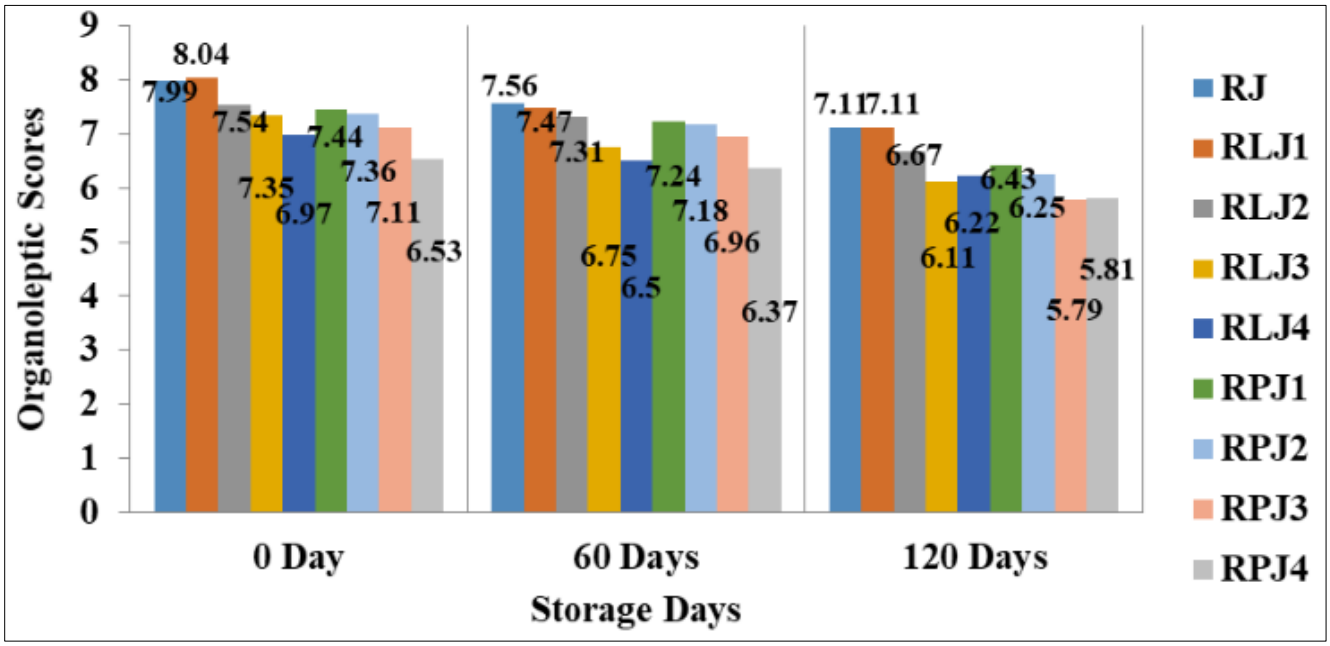

Fig 1: Effect of blending and duration of storage on overall acceptability of *Rhododendron* based RTS beverage

Conclusions

Based on the foregoing findings, it was stated that declining tendencies in acceptability scores were seen when blending proportions increased in all blending ratios except sample RLJ1, which is an 80:20 Rhododendron: lemon juice RTS beverage. Maximum preference was also given to RLJ1 sample. The RLJ1 ready-to-drink beverage also scored highest in terms of maintaining quality over time. As a result, in terms of commercial application and large-scale industrial production, the 80:20 ratio of Rhododendron and lemon juice for combining RTS beverage is better recommended.

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Conflict of interest

No conflict of interest to declare.

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