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Formulation and acceptability studies of Rough lemon (*Citrus jambhiri* Lush.) squash

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Abstract

Rough lemon fruits are highly acidic and possess greater nutraceutical value Studies were conducted to formulate and assess acceptability of squash of rough lemon .The varying juice concentration 50, 40, 30, 20 & 10 per cent were used for preparing squesh and stored at ambient temperature (28 ± 3°C). Periodical observation were recorded at fresh (0), 3 and 6 month interval. Squash prepared with 40 per cent juice was found to be the best recipe with respect to organoleptic qualities *viz.* colour, flavour, taste and overall acceptability till 180 days of storage under ambient conditions.

Key words: *Rough Lemon, Citrus jambhiri, Squash, formulation, sensory acceptability*

Introduction

Rough lemon (*Citrus jambhiri* Lush.) is the most commonly used citrus rootstock belonging to the family Rutaceae. It is considered to be native to Assam state of India. It is considered as a hybrid between the citron and the lemon, with character traits similar to rangpur lime or *mandarin orange* (Bhuyan *et al.*, 1998). The fruits are yellow colored, rough skinned and generally used as a rootstock for other citrus fruits. This is widely used rootstock for Kinnow mandarin crop and popular in Punjab, Rajasthan and Haryana belt of India. Among various commercial citrus species, this is non-traditional due to high acidic nature and poor appearance. Hence, the fruits of this plants are of negligible use inspite of its high yield potential (more than one quintal tree^{-1}). This species of citrus hardy enough and profuse in fruiting and could act as an alternate source of income for the farmers. The fruits are perishable in nature and are available during the winter months (Ladaniya, 2008).

Citrus fruits and their juices have various health benefits owing to the presence of bioactive and nutritive components. They are basically free of fat, sodium and cholesterol. In addition they possess rich amounts of potassium, calcium, folate, thiamin, niacin, vitamin B6, phosphorus, magnesium and copper. They might also reduce the risk of heart diseases and certain kinds of cancer. They are also known to help in reducing the risk for pregnant ladies to have children with neonatal diseases. Rough lemon fruit processing generates various byproducts with significant value. These by-products are known to act as a rich source of edible and health promoting agents as polymethoxylated flavonoids, many of which were found exclusively in citrus peel (Hatamipour *et al.*, 2004). The rough lemon peel contain sugars, edible fiber and many other components that offer excellent opportunities as value-added products, particularly those components that have biological activities (antioxidant, anti-cancer, cardioprotective, and food/drug-interactions) or other attributes that are useful in the development of high-value food products from citrus peel (Widmer and Montanari, 1994). Hence, the morphological characteristics, juice extraction of rough lemon and storage study of squash at room and refrigerated temperature were carried out. Hence, an attempt was made to study the morphological characteristics, juice extraction and standardize the procedure for preparation of squash from the juice of rough lemon harvested at fully mature stage.

Material and Methods

Raw material and Squash preparation

The fruits were procured from the research plots of ICAR-Central Institute for Arid Horticulture, Bikaner, Rajasthan. Fully matured, uniformly developed fruits of rough lemon were harvested in the early morning hours using secateurs and transported to the Postharvest Laboratory for further use. In the laboratory, the fruits are washed thoroughly under the running tap water to remove the adhering soil and dust particles. Later the fruits are peeled manually and juice is extracted from the sliced halves using citrus juice press. The juice was filtered and kept at ambient temperature for 24 hours for sedimentation. The supernatant was siphoned out without disturbing the debris and used for the preparation of squash. The protocol standardized for preparation of squash from the rough lemon fruits was illustrated here under:

Fig 1: Flow chart showing the procedure for preparation of Rough lemon squash

Fig 2: Rough lemon fruit bearing branch

Fig 3: Rough lemon Squash

Physical analysis

The fruit measurements *viz.* length, width, cavity radius, flavedo thickness etc. were taken with the help Vernier calipers. Weight of the fruits was taken using a precision balance. The weight of the pulp and peel was recorded separately and expressed in g and pulp peel ratio was determined accordingly.

Chemical analysis

Freshly extracted juice was used for analysis of proximate composition initially. Total soluble soilds (TSS) was determined using digital refractometer and is expressed as ° Brix. Titratable acidity (%) and ascorbic acid content of fresh juice was estimated using the standard procedures described by Ranganna (1986).

Sensory analysis

Organoleptic evaluation was done for the developed rough lemon products by a semi-trained panel. For each sensory parameter, such as colour & appearance, body or texture, flavour, taste and overall acceptability, 100 marks were allotted and the products were given to the panelist in coded form (Attri *et al.*, 1998). The panelists washed their mouths with water intermittently during evaluation of the samples.

Results and Discussion

The obervaction regarding morphological and biochemical composition of the rough lemon fruits were depicted in the Table 1. The morphological parameters viz. average whole fruit weight (148.6 g) average fruit length (78.6 mm) and width (66.4 mm).Were recorded the flavedo weight was observed 59.13 g with a thickness of 0.36 mm. The internal fruit cavity radius was recorded 1.96 mm. The pulp and peel contents accounted for 34 and 67 per cent, respectively while the average pulp: peel ratio was observed 1.97. The average biochemical parameters were observed 9.5, 5.86 and 20.45 for total soluble solids (°B), titratable acidity (%) and ascorbic acid (mg/100g), respectively (Table 1).

The squashes were prepared from fresh juice after diluting it in lieu of maintaining strong acidity of juice *viz.*, 50 % (T_1), 40 % (T_2) , 30% (T_3), 20% (T_4)and 10 % (T_5) as per standard methodology mentioned in flow chart(Figure 1). The prepared squashes were evaluated organioleptically by a panel of eight jugdes by following nine point hedonic scale (Amerin *et al.*, 1965). Serving ratio maintained 1:3 for all the squashes.

The squash was stored at room temperature and the sensory acceptability was checked at theree month inteval *viz.* 0, 3rd and 6th month during storage. The orgnaoleptic scores were depicted in the tables 2, 3 and 5 at three month intervals. Among various treatments, the senosry acceptability of the rough lemon squash prepared with 40 per cent juice (T_2) has attained greater score for all the sensory attributes as well as the overall acceptability score followed by T_1 (50 per cent juice) and T_3 (30 per cent juice) (Table 2).

During storage at ambient conditions, the sensory acceptability of the rough lemon squash has declined gradually with time irrespective of the treatment imposed. However, among various concentrations used, the squash prepared using 40 percent juice has scored relatively higher sensory scores compared to other treatments (Table 3 & 4).

The gradual decline in the sensory attributes with storage period was clearly illustrated in the radar chart (Fig. 4) where in the colour, flavor and taste decreased significantly but the overall acceptability of the rough lemon squash remained relatively higher. Similar decline of sensory attributes with storage was also observed in Assam lemon squash (Singh *et al.*, 2015). Sweet orange squash (Syed *et al.*, 2012) and Lime (Lad *et al.*, 2013).

Thus, it can be concluded that, among squashes prepared from various juice concentrations of rough lemon juice, the squash prepared with 40 per cent juice has recorded highest sensory scores and the rough lemon fruits has the greater potential for value addition and commercialization.

Table 1. Morphological and biochemical composition of the rough lemon fruits.

S.No.	Parameters	Mean value (± SE)
1	Fruit weight (g)	148.6 ± 2.078
2	Fruit length (mm)	78.6 ± 1.101
3	Fruit width (mm)	66.4 ± 1.744
4	Flavedo weight (g)	59.13 ± 1.607
5	Flavedo thickness (mm)	0.36 ± 0.023
6	Cavity radius (mm)	1.96 ± 0.060
7	Pomace weight (g)	20.14 ± 1.136
8	Peel weight (%)	34 ± 1.155
9	Pulp weight (%)	67 ± 1.000
10	Pulp : Peel ratio	1.97 ± 0.100
11	TSS (°B)	9.5 ± 0.208
12	Acidity titrable (%)	5.86 ± 0.226
13	Ascorbic acid (mg/100 ml)	20.45 ± 1.134

Table 2. Organoleptic scores of freshly prepared rough lemon squash

Treatment	Squashes specification	Sensory evaluation of fresh squashes			
		Colour (9)	Taste (9)	Flavour (9)	Overall (9)
T_1	Juice 50%	8.5	8.5	8.0	8.3
T_2	Juice 40%	8.5	8.5	8.5	8.5
T_3	Juice 30%	8.5	8.0	8.5	8.3
T_4	Juice 20%	8.0	8.0	8.0	8.0
T_5	Juice10%	8.0	7.5	7.5	7.7

Table 3. Organoleptic scores of rough lemon squash after 3 month storage

Treatment	Squashes specification	Sensory evaluation after 3 month of storage			
		Colour (9)	Taste (9)	Flavour (9)	Overall (9)
T_1	Juice 50%	7.5	8.0	7.0	7.5
T_2	Juice 40%	8.0	8.0	7.5	7.8
T_3	Juice 30%	8.0	8.0	7.5	7.8
T_4	Juice 20%	8.0	8.0	7.0	7.6
T_5	Juice10%	8.0	7.5	7.5	7.6

Table 4. Organoleptic scores of rough lemon squash after 6 month storage

Treatment	Squashes specification	Sensory evaluation after 6 month of storage				Total of overall month of storage (27)
		Colour (9)	Taste (9)	Flavour (9)	Overall (9)	
T_1	Juice 50%	6.5	7.0	6.0	6.5	22.3
T_2	Juice 40%	7.0	7.0	6.5	7.5	23.8
T_3	Juice 30%	7.0	7.0	6.5	6.8	22.9
T_4	Juice 20%	7.5	7.0	6.0	6.8	22.4
T_5	Juice10%	7.5	6.5	6.5	6.8	22.1

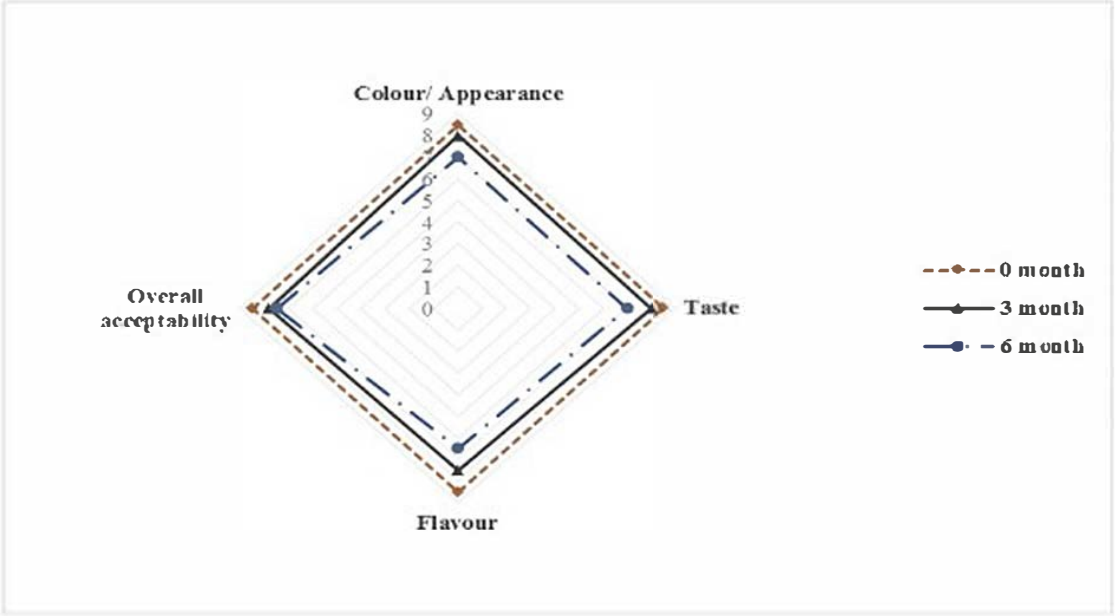

Fig 4: Radar chart depicting the changes in sensory attributes of the best treatment (T2) over the storage time.

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