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Effect of humectants on mineral composition and microbial count of intermediate moisture beetroot (*Beta vulgaris* L.) cubes

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ABSTRACT

A lab experiment was conducted during 2015-16 at Division of FST, SKUAST-Jammu. In the present study, intermediate moisture beetroot cubes were prepared by soaking the beetroot cubes in the soaking solution containing sugar:glycerol/sorbitol in the ratio of 100:00, 90:10, 80:20, 70:30, 60:40, 50:50 and 40:60. Fresh beetroot had moisture, total soluble solids, acidity, reducing sugar, total sugars, ash, calcium, phosphorous, and ascorbic acid as 86.12% 6.50^0 Brix, 0.02%, 0.96%, 4.16%, 1.20%, 15 mg 100g^{-1}, 3.61 mg100g^{-1} and 3.61 mg100g^{-1}, respectively. The processed product was stored at ambient conditions and subjected to mineral composition, microbial count and sensory evaluations for a period of three months at an interval of one month. However with the advancement of storage a decreasing trend was observed in calcium and phosphorus content during the three months of storage. No microbial count was observed in all the treatments during first two months of storage. During the third month of storage, the lowest microbial count was observed in treatment T_6 (Sugar: Glycerol: 50:50)and the highest in treatment T_1(Sugar:Glycerol::100:00). The intermediate moisture beetroot cubes prepared from treatment T_6(Sugar:Glycerol::50:50)was adjudged the best on the basis of overall acceptability followed by treatment T_1(Sugar:Glycerol::100:00). Storability studies revealed that all the treatments could be kept for at least 90 days without affecting the quality attributes.

Keywords: Humectants, intermediate moisture food, beet root

INTRODUCTION

Beetroot (*Beta vulgaris* L.) having bright crimson colour also known as beet, chard, spinach beet, sea beet, garden beet, white beet and *Chukander* (in Hindi) belongs to Chenopodiaceae family. It is famous for its high valued juice and medicinal properties.The beetroot can be kept for 4-5 days when refrigerated in the vegetable crisper.Garden beet juice is a popular health food obtained from the roots, are used industrially as red food colourantse*.g.* to improve the colour of tomato paste, sauces, desserts, jams and jellies, ice cream, sweets and cereals. Red beet also makes a rich red Burgundy style wine.The wild sea beet is the earliest form of beetroot and is supposed to be the source for all the different beetroot varieties available today (Kumar, 2015). The usually deep-red roots of beetroot are eaten boiled either as a cooked vegetable, or as *salad* after cooking and adding oil and vinegar, or raw and shredded, either alone or combined with any *salad* vegetable. A large proportion of the commercial production is processed into boiled and sterilized beets or into pickles. In Eastern Europe, beet soup, such as cold borscht, is a popular dish. Yellow-coloured beetroots are grown on a very small scale for home consumption. Pickled beets are a traditional food of the South Americans. It is also common in Australia and New Zealand for pickled beetroot to be consumed on a burger. Fresh beetroots are exposed to spoilage due to their high moisture content. One of the preservation methods ensuring microbial safety of biological products is drying (Mathlouthi,2001). Dried beetroots can be consumed directly in the form of chips as a substitute of traditional snacks, that are rich in trans fatty acids, or after easy preparation as a component of instant food (Krejcova*et al.*, 2007).Keeping in view the commercial potential for IMF, the present study has been undertaken for preparation of intermediate moisture beetroot cubes.

MATERIALS AND METHODS

Medium sizedgood quality beetroots were purchased from NarwalMandi, Jammu and transported to Division of Food Science and Technology (FST), SKUAST-Jammuduring the year 2015-16 for its further processing.Fresh beetroots were washed, cleaned, peeled and cut

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into cubes of 1×1×1cm. The cubes were blanched and soaked for 12-16 hours in the soaking solution and kept in the refrigerator at 4^0C. The soaking solution was prepared by dissolving glycerol/sorbitol, sugar, water, potassium sorbate and sodium benzoate in different proportions as per the treatment ratios (Table 1). Permissible additives such as sugar, glycerol and sorbitol as humectants, potassium sorbate as fungistat and sodium benzoate as preservative were mixed in the soaking solution for increasing the concentration and lowering the water activity (aw) values. The soaking solution was drained from the beetroot cubes which were then dried at 60-65^0C in cabinet drier for 2 hours. The processed product was packed in air tight polythenejars and stored at room temperature.The samples were evaluated for mineral composition, microbial and overall acceptability during 90 days of storage at an interval of 30 days. The estimation of calcium was done as per the protocol described in (AOAC, 1995). Phosphorus content was estimated with the help of UV-Visible Spectrophotometer (UV-1601) (Singh *et al.*, 1999). Total plate count (TPC) was made as per standard method (Ranganna, 2006). The results obtained were statistically analyzed using factorial completely randomized design for interpretation of results through analysis of variance (Gomez and Gomez, 1984).

Table 1: Preparation of Intermediate Moisture Beetroot cubes

Treatments	Sugar (%)	Glycerol (%)	Sorbitol (%)
T_1	100	00	
T_2	90	10	
T_3	80	20	
T_4	70	30	
T_5	60	40	
T_6	50	50	
T_7	40	60	
T_8	90		10
T_9	80		20
T_{10}	70		30
T_{11}	60		40
T_{12}	50		50
T_{13}	40		60

RESULTS AND DISCUSSION

Chemical Characteristics of Fresh Beetroot

The total soluble solids, titratable, acidity, ascorbic acid of beetroot was found to be 6.50^0B, 0.02% and 3.61 mg100 g^{-1}, respectively which were in close compliance to the findings of Thakur and Gupta (2005). The ash content was 1.20% in fresh beetroot. Total Sugars and reducing sugars of 4.16and 0.96%, respectively were recorded in beetroot which were also in accordance with the findings of Thakur and Gupta (2005) and Wruss *et al.* (2015) and calcium and phosphorus were found to be 15 and 36 mg $100g^{-1}$, respectively which were in accordance with the finding of Kumar (2015).

Calcium

The data (Table 2) showed the effect of various treatments and storage period on calcium content of intermediate moisture beetroot cubes. The data revealed that the treatments significantly influenced the calcium content of intermediate moisture beetroot cubes. At initial day of storage the highest calcium content of 19.88 $mg100g^{-1}$ was recorded in treatment T_1 (Sugar: Glycerol:: 100:00) and the lowest (18.10mg100 g^{-1}) in treatment T_7(Sugar:Glycerol::40:60). After 90 days of storage the value decreased to 19.72$mg100g^{-1}$ in treatment T_1 (Sugar: Glycerol: 100:00) and 17.91 mg100 g^{-1}in treatment T_7 (Sugar: Glycerol: 40:60).Thus, the calcium content was significantly affected by the different storage period. There was significant decrease in calcium content of intermediate moisture beetrootcubes from 0 to 90 days of storage. Mean values decreased from 19.02 to 18.88 mg100 g^{-1}after 90 days of storage. The decrease may be due to the microbial activities. Gupta (2007) also reported that calcium contents decreased in osmo dehydratedber during storage of six months.

Table 2: Effect of treatments and storage period on Ca, P (mg $100g^{-1}$) of intermediate moisture beetroot cubes

D	Storage period (months)									
	0	1	2	3	Mean	0	1	2	3	Mean
T_1: Sugar:Glycerol::100:00	19.88	19.86	19.86	19.72	19.83	24.60	24.59	24.59	24.48	24.56
T_2: Sugar:Glycerol::90:10	19.74	19.74	19.72	19.68	19.72	24.10	24.10	24.07	23.94	24.05
T_3: Sugar:Glycerol::80:20	19.34	19.31	19.30	19.22	19.29	23.92	23.90	23.87	23.74	23.85
T_4: Sugar:Glycerol::70:30	19.08	19.05	19.05	18.88	19.01	23.61	23.61	23.60	23.48	23.57
T_5: Sugar:Glycerol::60:40	18.91	18.90	18.87	18.78	18.86	23.43	23.43	23.41	23.31	23.39
T_6: Sugar:Glycerol::50:50	18.78	18.78	18.75	18.64	18.74	23.28	23.26	23.25	23.18	23.24
T_7: Sugar:Glycerol::40:60	18.10	18.06	18.04	17.91	18.03	22.56	22.53	22.54	22.41	22.51
T_8: Sugar:Sorbitol::90:10	19.42	19.40	19.36	19.30	19.37	24.02	24.00	24.00	23.86	23.97
T_9: Sugar: Sorbitol::80:20	19.23	19.21	19.21	19.14	19.20	23.93	23.92	23.91	23.80	23.89
T_{10}: Sugar: Sorbitol ::70:30	19.04	19.04	19.01	18.86	18.98	23.76	23.76	23.75	23.65	23.73
T_{11}: Sugar: Sorbitol ::60:40	18.76	18.75	18.72	18.61	18.71	23.52	23.50	23.50	23.37	23.47
T_{12}: Sugar: Sorbitol ::50:50	18.60	18.59	18.57	18.42	18.54	23.21	23.20	23.20	23.12	23.18
T_{13}: Sugar: Sorbitol ::40:60	18.48	18.48	18.45	18.38	18.45	23.06	23.06	23.03	22.85	23.00
Mean	19.02	19.01	18.99	18.88		23.61	23.60	23.59	23.48	
CD(P = 0.05)	T 0.02, S 0.01, T X S 0.03					T 0.02, S 0.01, T X S 0.03				

T = Treatment, S = Storage

Phosphorus

The data (Table 2) showed the effects of various treatments and storage periods on phosphorous content of intermediate moisture beetroots cubes. At initial day of storage, the highest phosphorus content of 24.60 mg 100 g^{-1} was recorded in treatment T_1 (Sugar:Glycerol: :100:00)and the lowest 22.56 mg100 g^{-1} in treatment T_7(Sugar:Glycerol::40:60). After 90 days of storage, the value decreased to 24.48 mg100 g^{-1} in treatment T_1 (Sugar: Glycerol: 100:00) and 22.41 mg100 g^{-1} in treatment T_7 (Sugar: Glycerol: 40:60). Phosphorus content was significantly affected by the different storage period. There was significant decrease in phosphorus content of intermediate moisture beetroot cubes from 0 to 90 days of storage. The decrease may be due to the leaching effects of osmo dehydration and microbial activity. Gupta (2007) also reported that phosphorous content decreased in osmodehydrated ber during storage of six months in the study on processing and preservation of ber.

Table 3: Effect of treatments and storage periods on microbial population (x102 cfu g^{-1}) of intermediate moisture beetroot cubes

Treatments	Storage period (months)			
	0	1	2	3
T_1: Sugar:Glycerol::100:00	N. D.	N. D.	N. D.	1.55
T_2: Sugar:Glycerol::90:10	N. D.	N. D.	N. D.	1.40
T_3: Sugar:Glycerol::80:20	N. D.	N. D.	N. D.	1.40
T_4: Sugar:Glycerol::70:30	N. D.	N. D.	N. D.	1.35
T_5: Sugar:Glycerol::60:40	N. D.	N. D.	N. D.	1.40
T_6: Sugar:Glycerol::50:50	N. D.	N. D.	N. D.	1.33
T_7: Sugar:Glycerol::40:60	N. D.	N. D.	N. D.	1.40
T_8:Sugar:Sorbitol::90:10	N. D.	N. D.	N. D.	1.40
T_9: Sugar: Sorbitol::80:20	N. D.	N. D.	N. D.	1.36
T_{10}: Sugar: Sorbitol ::70:30	N. D.	N. D.	N. D.	1.50
T_{11}: Sugar: Sorbitol ::60:40	N. D.	N. D.	N. D.	1.35
T_{12}: Sugar: Sorbitol ::50:50	N. D.	N. D.	N. D.	1.40
T_{13}: Sugar: Sorbitol ::40:60	N. D.	N. D.	N. D.	1.40
Mean	0	0	0	1.37

Microbial Count

It is clear from the data (Table3) that up to 60 days of storage there was no microbial growth. During 90 days of storage the maximum microbial count of 1.55x 10^2cfug^{-1} was recorded in treatment T_1 (Sugar: Glycerol:: 100:00) and a minimum of 1.33 x 10^2cfug^{-1} in treatment T_6 (Sugar:Glycerol::50:50). There was an increase in mean value of microbial count from 0.00 to 1.37x10^2cfug^{-1}during 90 days of storage period, which is considered as significantly low and safe for consumption.Chaturvedi*et al.* (2013) reported a least microbial count and low rate of growth throughout the storage period of six months in intermediate moisture carrot shreds.

Overall acceptability

The data pertaining to score of overall acceptability (Table 4) revealed that at initial day, the highest score of 7.90 was recorded in treatment T_6(Sugar:Glycerol::50:50)followedby 7.60 in treatment T_1(Sugar:Glycerol::100:00). During 90 days of storage the values decreased to 7.40 in T_6 (Sugar: Glycerol:: 50:50) and 7.30 in T_1(Sugar:Glycerol::100:00). The mean values of treatments varied significantly and the highest mean score of 7.67 assigned to T_6 (Sugar: Glycerol:: 50:50) followed by 7.46 in treatment T_1 (Sugar:Glycerol::100:00). During storage period, there was a significant decrease in mean score from 7.16 at initial day to 6.81 at the end of 90 days of storage period. The decrease in overall acceptability scores in IMF products may be due to the change in chemical composition of the product and loss of colour and flavor during storage period of 90 days. Kumar and Sagar (2010) observed a decreasing trend in overall acceptability sensory score of osmodehydrated guava slices with increase in storage period of six months. Panwar *et al.* (2013) reported a decrease in overall acceptability of intermediate moisture aonla segments during six months of storage. Muzzaffar *et al.* (2016) observed that the overall acceptability of pumpkin candy decreased during three months of storage. However it was acceptable even after three months of storage.

Table 4: Effect of treatments and storage period on overallacceptabilityof intermediate moisture beetroot cubes

Treatments	Storage period (months)				
	0	1	2	3	Mean
T_1: Sugar:Glycerol::100:00	7.60	7.55	7.40	7.30	7.46
T_2: Sugar:Glycerol::90:10	6.82	6.76	6.64	6.52	6.68
T_3: Sugar:Glycerol::80:20	7.26	7.11	7.08	6.92	7.27
T_4: Sugar:Glycerol::70:30	7.30	7.25	7.16	7.02	7.28
T_5: Sugar:Glycerol::60:40	7.32	7.26	7.20	7.04	7.30
T_6: Sugar:Glycerol::50:50	7.90	7.74	7.65	7.40	7.67
T_7: Sugar:Glycerol::40:60	7.40	7.35	7.18	7.00	7.24
T_8:Sugar:Sorbitol::90:10	6.48	6.36	6.24	6.06	6.28
T_9: Sugar: Sorbitol::80:20	6.75	6.64	6.48	6.32	6.54
T_{10}: Sugar: Sorbitol ::70:30	6.90	6.70	6.65	6.58	6.70
T_{11}: Sugar: Sorbitol ::60:40	6.90	6.71	6.60	6.59	6.71
T_{12}: Sugar: Sorbitol ::50:50	7.35	7.28	7.15	7.02	7.20
T_{13}: Sugar: Sorbitol ::40:60	7.10	6.96	6.82	6.76	6.91
Mean	7.16	7.05	6.94	6.81	
	T 0.02, S 0.01, T X S 0.03				

Conclusion

It is concluded from the study that on the basis of sensory evaluation treatment T_6 (Sugar: Glycerol: 50:50) was found to be the best treatment followed by treatment T_1 (Sugar: Glycerol: 100:00).

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