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Impact of storage duration and temperature on sensory characteristics of *Moringa* Chocolate

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Abstract
Chocolate storage is critical to final product quality. Inadequate storage, especially temperature may lead to rearrangement of triglycerides which may affect sensory attributes. Hence the aim of the study was to evaluate the impact of storage duration and temperature on sensory characteristics of *Moringa* Chocolate. Developed chocolates were stored at two temperatures i.e. room temperature (25±3 °C) and low temperature (10±1 °C). The results revealed that *Moringa* chocolate was liked very much by panellists throughout the storage period of one year. *Moringa* chocolate stored at low temperature scored significantly higher sensory scores than control chocolate stored at room temperature with respect to all sensory parameters. Irrespective of storage temperature, there was a declining trend was observed from 0 days to 360 days of storage (p<0.05). However, there were no significant differences found between the chocolate's properties. From the storage study we conclude that, there was no major perceivable defects observed in *Moringa* chocolate up to 360 days of storage at room temperature and low temperature. *Moringa* chocolate gave a better nutritional confectionary option compared to the control chocolate which can provide an alternative use of M*oringa* and encourage its utilization.

Keywords: *Moringa* chocolate, duration, temperature, sensory evaluation

Introduction
Chocolate is one of the most popular confectionery in the world, people enjoyed it for its wonderful taste. Chocolate is a product of cocoa, made by mixing cocoa mass, cocoa butter and sugar (Abhishek *et al*., 2010) [1]. Chocolate is a luxury food that evokes a range of stimuli that activates pleasure during its consumption. Chocolate is not only consumed by children but also by youth and old age people too. It has been playing important social role being an inherent part of many celebrations (Zaid *et al.*, 2014; [8].
Chocolate is not only a common confectionery product but also has an important social role being an inherent part of many celebrations. Some of them are even crossing the confectionery industry line by aiming at consumer interest in health. The products benefit from the positive effects of cocoa as well as from various additional ingredients such as dried berries, herbs, seeds, nuts, dietary fibre or probiotics. Another group of products focuses on the ethical and ecological aspects of production (Abhishek *et al*., 2010) [1].
Chocolate has a shelf life of approximately 12 to 24 months. As chocolate is stored, structural changes occur, causes an increase in particle size, which is extremely important to mouth feel (Ali *et al.*, 2001) [3]. Storage conditions may lead to the development of either fat bloom or sugar bloom, both of which compromise visual and textural quality. Bloom is the main cause of quality loss in the chocolate industry (Toker *et al*., 2018) [7].

Materials and Methods
The study was conducted in the Department of Food Science and Nutrition, UAS, GKVK, Bengaluru. The material (dark chocolate compound, milk compound, dry fruits and sugar) used in the standardization of β-carotene enhanced chocolates was procured from local markets and *Moringa* Olifera leaves from Department of Horticulture UAS, GKVK, Bengaluru.

Moringa chocolate formulation
Moringa chocolates were standardized using 2, 4, 6, 8 and 10 per cent of processed *Moringa* leaf powder and with appropriate combinations of dark chocolate compound, milk compound, processed *Moringa* leaf powder, dry fruits and sugar. Chocolate prepared without the addition of *Moringa* was kept as control.

Sensory evaluation of *Moringa* chocolate during storage

Best accepted *Moringa* chocolate was subjected for storage study. The products were packed in silver wrappings foils as primary and MPP (Metalized polyester polyethylene) as secondary packaging material, were stored at room temperature (25±3ºC) and low temperature (10±1ºC). The *Moringa* chocolate was evaluated from the initial day (0 day) to throughout the study period for sensory attributes at regular intervals of 30 days for one year. *Moringa* chocolate along with control was evaluated for sensory characteristics by a panel of semi-trained judges on nine-point hedonic scale (n=32).

The sensory analysis (hedonic test) was conducted at the sensory laboratory of the Department of Food Science and Nutrition, UAS, GKVK, Bengaluru, between 11:00 am and 4:00 pm. Semi trained panellists, who were students, and non-smokers, aged between 24 to 30 years were asked to assess the coded samples. The sensory laboratories had adequate lighting from fluorescent tube bulbs and panellists were seated at individual booths. Water was provided for panellists to rinse their mouths in between sample tasting.

Statistical analysis

All the data were analysed using Statistical Package for Social Sciences (SPSS) IBM SPSS Statistics. Analysis of variance (ANOVA) was used to compare any significant differences between samples. Values were expressed as means ± standard deviations while differences were considered significant at (p< 0.05).

Results and Discussion

The shelf life of chocolate depends on various factors such as storage temperature and humidity, available oxygen in the packaging material used, as well as the addition of other ingredients such as fats, nuts *etc*. Chocolate has a shelf life of approximately 12 to 24 months. This work aimed to study the impact of storage duration and temperature on *Moringa* chocolate.

Sensory evaluation of β-Carotene enhanced chocolate

The appearance, texture, colour, flavour, taste, and odour are the important characteristics for the overall acceptability of products. Table 1 depicts the sensory evaluation score of chocolate during storage periods.

Moringa chocolate stored at low temperature scored significantly higher sensory scores than control chocolate stored at room temperature with respect to all sensory parameters. The sensory score of *Moringa* chocolates decreased significantly (p<0.05) from initial (0 day) to final day (360), on initial day the sensory score was 9.00 (appearance), 8.67 (texture), 8.95 (colour), 8.57 (flavour), 8.86 (taste), 8.88 (odour) and 8.82 (overall acceptability), which was significantly (p<0.05) decreased to 6.67 (appearance), 6.67 (texture), 7.00 (colour), 7.20 (flavour), 7.69 (taste), 6.14 (odour) and 7.05 (overall acceptability) at low-temperature. Whereas at room temperature higher reduction reported in sensory score such as 6.05 (appearance), 5.88 (texture), 6.55 (colour), 7.10 (flavour), 6.98 (taste), 6.31 (odour) and 6.48 (overall acceptability). The major reason behind the decrease in sensory score could be ascribed to the development of uneven fat, fat and sugar bloom in chocolate. Irrespective of storage temperature there was a declining trend was observed from 0 to 360 days of storage (p<0.05). There was less fluctuation in mean scores between the products. However, a significant difference was observed between storage temperature and storage periods. The mean scores of all the products stored at room temperature decreased considerably than the chocolate stored at low temperature. As the storage period increased the mean sensory score decreased (Fig.1). Similarly Gadhiya *et al.* (2018) [4] reported the declining trend of sensory evaluation (flavour, colour and appearance, body and texture, and overall acceptability) for probiotic chocolates and it was faster during the last fifteen days of storage. Ali *et al.* (2001) [3] stated that flavour of the chocolates stored at 18 ºC was significantly (P<0.05) less preferred than that of stored at 30 ºC. The overall acceptability of *Moringa* chocolate was higher at low temperature compared to that stored at room temperature.

Table 1: Sensory evaluation of β-carotene enhanced chocolates

Study Duration (Days)			0	30	60	90	120	150	180	210	240	270	300	330	360
Appearance	Control chocolate	LT	8.86	8.86	8.85	8.71	8.62	8.52	8.24	8.05	7.83	7.26	6.74	5.93	5.52
		RT	8.86	8.76	8.42	8.14	8.17	8.07	7.88	7.33	7.02	6.67	6.21	5.58	5.22
	Moringa chocolate	LT	9.00	8.93	8.83	8.76	8.67	8.60	8.45	8.44	8.24	7.93	7.76	7.29	6.67
		RT	9.00	8.83	8.74	8.50	8.41	8.60	8.21	8.05	7.77	7.52	7.00	6.48	6.05
	F-test		*	*	*	*	*	*	*	*	*	*	*	*	*
	SEm±		0.04	0.02	0.09	0.11	0.12	0.09	0.12	0.12	0.12	0.13	0.14	0.14	0.14
Texture	Control chocolate	LT	8.86	8.83	8.81	8.63	8.36	8.21	8.14	7.98	7.71	7.36	6.83	5.97	5.59
		RT	8.86	8.48	8.31	8.21	8.12	8.03	7.98	7.48	7.17	6.71	6.26	5.75	5.54
	Moringa chocolate	LT	8.67	8.76	8.76	8.79	8.74	8.62	8.36	8.10	7.98	7.71	7.36	7.00	6.60
		RT	8.67	8.74	8.67	8.41	8.36	8.26	7.95	7.86	7.57	7.45	6.88	6.55	5.88
	F-test		NS	*	*	*	*	*	*	*	*	*	*	*	*
	SEm±		0.08	0.9	0.09	0.11	0.10	0.12	0.13	0.14	0.13	0.15	0.14	0.13	0.14
Colour	Control chocolate	LT	8.98	8.88	9.00	8.48	8.52	8.45	8.26	7.95	7.69	6.98	6.52	5.82	5.44
		RT	8.98	8.50	8.14	8.02	7.93	7.71	7.55	7.05	7.21	6.67	6.14	5.46	5.25
	Moringa chocolate	LT	8.95	9.00	8.95	8.83	8.76	8.62	8.41	8.36	8.21	7.97	7.45	7.26	7.00
		RT	8.95	8.95	8.93	8.67	8.50	8.43	8.17	8.10	7.95	7.76	7.50	6.93	6.55
	F-test		NS	*	*	*	*	*	*	*	*	*	*	*	*
	SEm±		0.02	0.05	0.06	0.11	0.11	0.10	0.11	0.13	0.12	0.15	0.16	0.15	0.14
Flavour	Control chocolate	LT	8.74	8.67	8.86	8.41	8.45	8.41	8.31	8.24	8.17	8.05	8.00	8.02	7.81
		RT	8.74	8.64	8.31	8.29	8.26	8.21	8.08	7.57	7.10	6.62	7.26	7.29	7.07
	Moringa chocolate	LT	8.57	8.67	8.76	8.67	8.62	8.50	8.43	8.33	8.24	7.95	7.71	7.29	7.20
		RT	8.57	8.81	8.76	8.67	8.55	8.26	8.14	8.15	8.04	7.83	7.74	7.31	7.10

	F-test		NS	NS	NS	NS	NS	NS	NS	*	*	*	*	*	*
	SEm±		0.10	0.09	0.11	0.09	0.10	0.12	0.12	0.14	0.11	0.15	0.18	0.14	0.13
Taste	Control chocolate	LT	8.88	8.91	8.88	8.65	8.62	8.50	8.38	8.31	8.26	8.17	8.10	7.95	7.62
		RT	8.88	8.41	8.38	8.33	8.21	7.91	7.83	7.45	7.05	6.64	6.17	6.79	6.55
	Moringa chocolate	LT	8.86	8.62	8.76	8.74	8.52	8.43	8.43	8.33	8.23	7.95	8.05	7.86	7.69
		RT	8.86	8.62	8.69	8.55	8.43	8.33	8.24	8.12	7.98	7.86	7.68	7.17	6.98
	F-test		NS	*	*	*	*	*	*	*	*	*	*	*	*
	SEm±		0.07	0.09	0.10	0.10	0.10	0.11	0.14	0.14	0.13	0.14	0.17	0.11	0.13
Odour	Control chocolate	LT	8.80	8.81	8.84	8.60	8.62	8.45	8.26	8.10	7.93	6.91	6.79	6.34	6.11
		RT	8.80	8.31	8.27	8.29	8.12	7.91	7.76	7.52	6.98	6.52	6.36	6.03	5.89
	Moringa chocolate	LT	8.88	8.81	8.84	8.59	8.57	8.52	8.41	8.33	8.24	8.08	7.60	7.41	7.14
		RT	8.88	8.74	8.57	8.45	8.38	8.33	8.14	7.86	7.82	7.62	7.43	6.91	6.31
	F-test		NS	*	*	*	*	*	*	*	*	*	*	*	*
	SEm±		0.06	0.08	0.09	0.07	0.10	0.11	0.12	0.13	0.12	0.16	0.16	0.16	0.17
Overall Acceptability	Control chocolate	LT	8.85	8.86	8.87	8.58	8.53	8.42	8.27	8.10	7.93	7.46	7.16	6.67	6.34
		RT	8.85	8.52	8.30	8.21	8.13	7.98	7.85	7.41	7.09	6.64	6.40	6.15	5.93
	Moringa chocolate	LT	8.82	8.80	8.79	8.73	8.65	8.55	8.41	8.32	8.19	7.93	7.66	7.35	7.05
		RT	8.82	8.78	8.73	8.54	8.44	8.37	8.14	8.02	7.86	7.68	7.37	6.89	6.48
	F-test		NS	*	*	*	*	*	*	*	*	*	*	*	*
	SEm±		0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.06	0.05	0.08	0.07	0.06	0.06

LT: Low Temperature, RT: Room Temperature, *Significant ($p<0.05$), NS: Non-significant

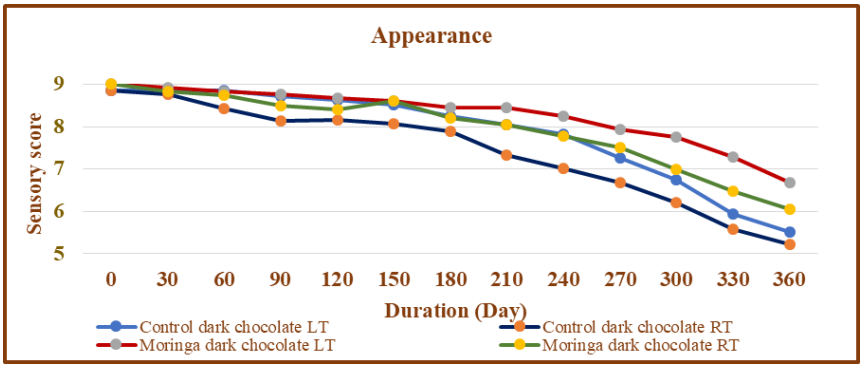

Fig. 1a: Sensory evaluation of β-carotene enhanced dark chocolates (Appearance)

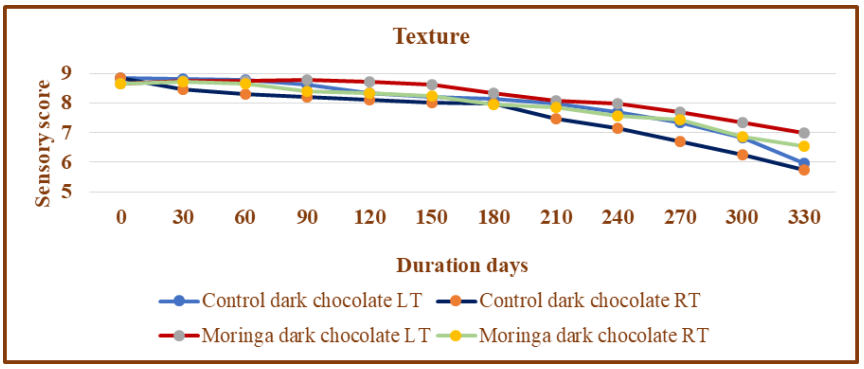

Fig. 1b: Sensory evaluation of β-carotene enhanced dark chocolates (Texture)

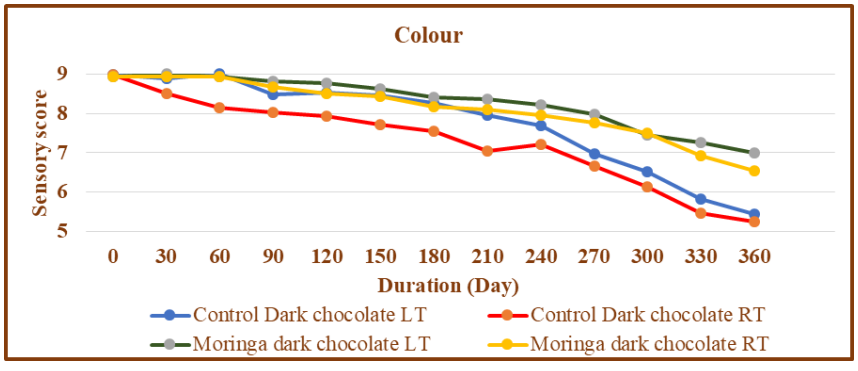

Fig. 1c: Sensory evaluation of β-carotene enhanced dark chocolates (Colour)

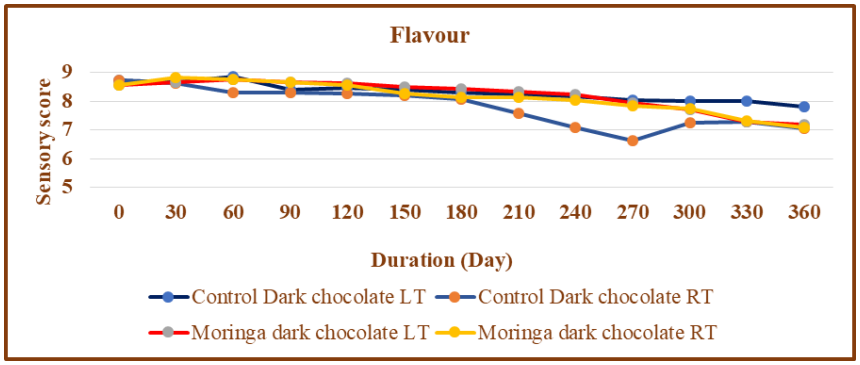

Fig. 1d: Sensory evaluation of β-carotene enhanced dark chocolates (Flavour)

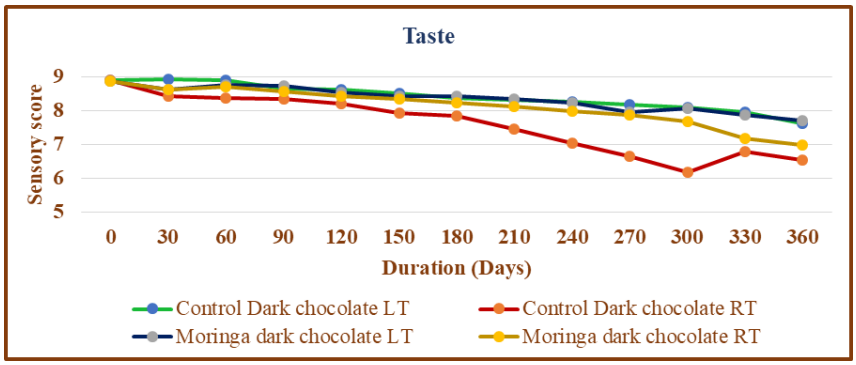

Fig. 1e: Sensory evaluation of β-carotene enhanced dark chocolates (Taste)

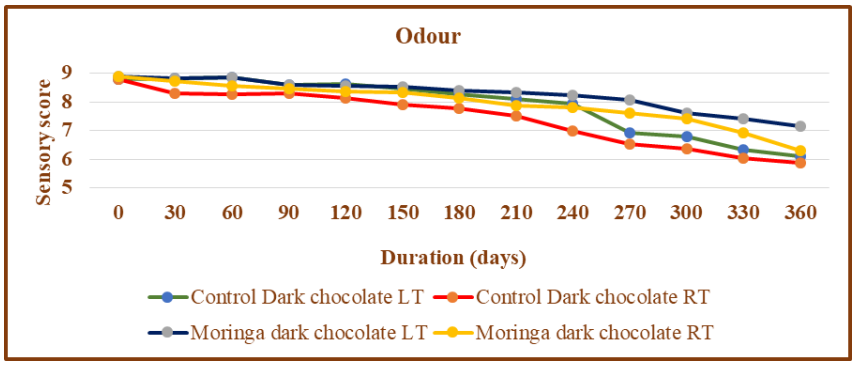

Fig. 1f: Sensory evaluation of β-carotene enhanced dark chocolates (Odour)

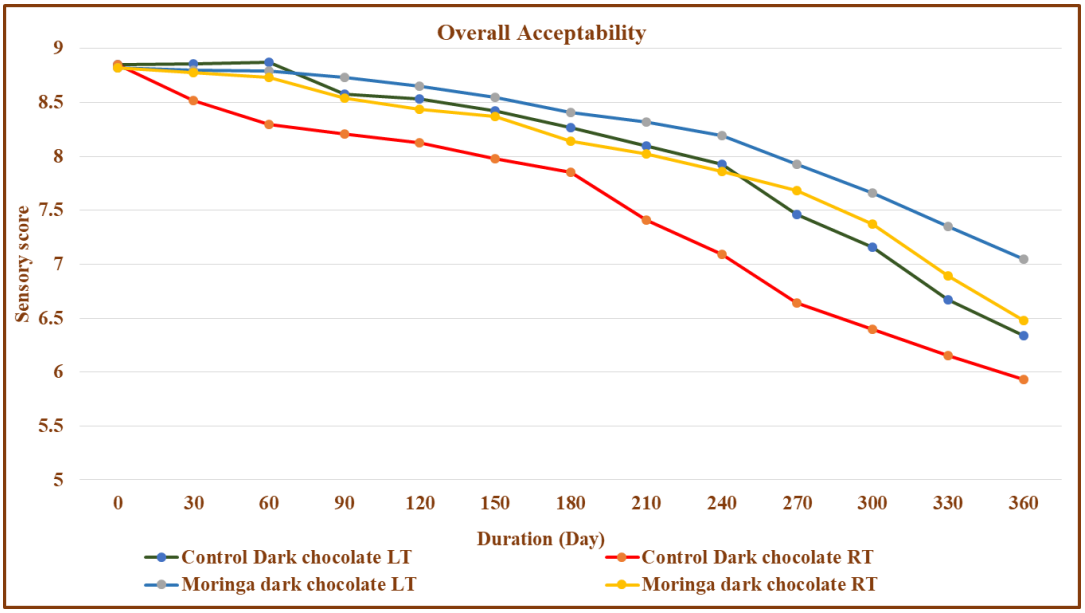

Fig. 1g: Sensory evaluation of β-carotene enhanced dark chocolates (Overall acceptability)

Conclusion

As per the storage study carried out for the duration of one year, it is concluded that the *Moringa* chocolate did not show any objectionable sensory changes and withstood at its best condition during the shelf life study. On the basis of the results, it is clear to say that, the product is safe for consumption for one year. The quality of the *Moringa* chocolate will not affect if it is well packed and stored under the recommended storage conditions. Our study suggests that chocolate containing *Moringa* has a shelf life of one year at room temperature as well as low temperature, without major degradation and is well accepted by sensory panellists who rated it better than the control chocolate in terms of all sensory attributes except flavour.

Acknowledgement

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Competing Interests

The authors declare no competing interests.

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