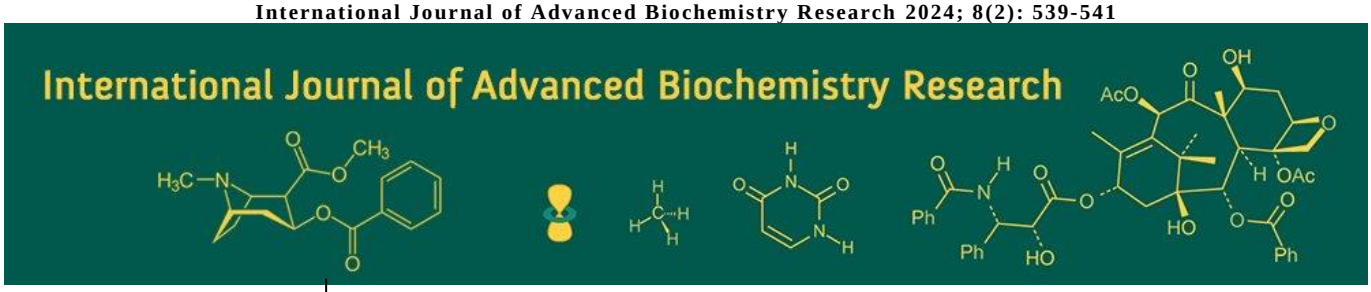

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Quality attributes of thirst-quenching dehydrated lime slices

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Abstract
Lime (*Citrus aurantiifolia*) is a commercial crop rich in ascorbic acid, antioxidants and other nutrients. A study was conducted to prepare thirst-quenching dehydrated lime slices using low-cost technology. A good quality organoleptically acceptable thirst-quenching dehydrated lime slices can be obtained by blanching fruits for five minutes and mixing fruit slices with cooking salt (75 g kg^{-1}) for 10 days, followed by steeping in 50°B sugar syrup for 24 h and adding with spice mixture (25 g kg^{-1} fruit slices) containing dry cumin (10 g), ginger (6 g), ajwain (6 g), black pepper (4 g), followed by drying in poly-solar dryer. The dehydrated slices recorded significantly highest sensory scores (out of 5 points on the hedonic scale) for colour and appearance (4.06), texture (4.08), mouth feel (4.17) and overall acceptability (4.11) and retained the highest ascorbic acid content (9.58 mg 100 g^{-1}) as compared to control.

Keywords: Lime, dehydrated slices, thirst-quenching

Introduction
Lime (*Citrus aurantiifolia*) is a commercial crop rich in ascorbic acid, antioxidants and other nutrients. The consumption of this fruit increases bodily resistance against various diseases. The preparation of lime beverages and pickles is very common. Highly refreshing and thirst-quenching beverages are prepared from lime. The preparation and utilization of dehydrated lime slices have a high potential to combat market price falls during winter. Dehydrated whole lime is a unique product consumed mainly in the Middle East. However, reports on systematic drying and changes in its proximate composition were unavailable (Yadav and Singh, 2012) [9]. Hitherto, information available on preparing dehydrated thirst-quenching lime slices is scarce. With this view, the present investigation focuses on preparing good-quality, highly acceptable thirst-quenching dehydrated lime slices.

Materials and Methods
Preparation of thirst-quenching dehydrated lime slices
Lime fruits completely in yellow colour procured from Sirsi local market, Uttara Kannada district (Karnataka) were used. The experiment was laid out in Completely Randomized Design (CRD) with three replications consisting of eight treatments. The fruit slices were dried in poly solar drying, where the maximum temperature reached was about 65°C. Fresh fruits were washed in clean water and blanched for five minutes in hot water, surface dried and cut into slices. The commercial product in the local area was obtained from local vendors and used as a check. The details of treatments are as follows:

Treatment details
T_1: Fruits + slicing + mixing with black salt (75 g/kg) for 10 days + spice mixture + drying

T_2: Fruits + slicing + Mixing with cooking salt (75 g/kg) for 10 days + spice mixture + drying

T_3: Blanching for five minutes + slicing + mixing with cooking salt (75 g/kg) for 10 days + spice mixture + drying

T_4: Blanching for five minutes + slicing + mixing with cooking salt (75 g/kg) & spice mixture for 10 days + + drying

T_5: Blanching for five minutes + slicing + mixing with cooking salt (75 g/kg) for 10 days + Steeping in 50°B sugar syrup for 24 h + drying

T_6: Blanching for five minutes + Slicing + mixing with cooking salt (75 g/kg) for 10 days + Steeping in 50°B sugar syrup for 24 h + spice mixture + drying

T_7: Control (Blanching for five minutes + slicing + drying)

T_8: Local commercial product (Slicing + mixing with cooking salt (75 g/kg) + spice mixture + drying)

Spice mixture (25 g kg^{-1} fruit slice) containing dry ginger (6 g), black pepper (4 g), ajwain (6 g) and cumin (10 g) was added to fruit slices and then dried using a poly-solar dryer.

Physico-chemical and sensorial analysis

The dehydrated lime slices were analysed for physico-chemical parameters. The recovery of dehydrated slices was calculated by the ratio of the weight of dehydrated slices to the weight of fresh slices. The drying time was determined by counting the hours to attain constant moisture. The salt content of dehydrated slices was analysed using a saline meter. Titratable acidity and ascorbic acid were estimated using the AOAC method (Anon, 1984) [2].

The sensory evaluation of dehydrated lime slices, along with control and locally available commercial products, was carried out immediately after preparation. The sensorial characters like colour and appearance, texture, mouth feel and overall acceptability were evaluated on a five-point hedonic scale *viz*., highly acceptable (5), acceptable (4), fairly acceptable (3), poorly acceptable (2) and not acceptable (1). The mean score given by 15 semi-trained judges was used for statistical analysis.

The data obtained was analysed statistically using OP STAT software and reported a significance level of 1% (Panse and Sukhatme, 1985) [8].

Results and Discussion

The results obtained on physico-chemical and sensorial characteristics are presented in Tables 1 and 2.

Significantly highest recovery (41.62%) was recorded in blanched lime slices mixed with salt (75 g/kg) for ten days, followed by steeping in 50°B syrup, while the lowest (13.21%) was recorded in blanched lime slices mixed with salt for ten days followed addition of spice mixture and drying in poly solar dryer. It was also observed that the recovery was highest in sugar syrup-treated slices. The increase in recovery of dehydrated slices may be due to the osmosis of sugars from syrup to lime fruit slices during Osmo-dehydration pre-treatment. Similarly, Harshitha (2018) [5] reported higher recovery in syrup-treated samples compared to untreated control in pumpkin candy.

The drying time was significantly minimal in T_7 (14.17 h), followed by T_1 (15.92 h), whereas the maximum was observed in T_5 (22.75 h) and T_6 (22.58 h). The presence of sugar syrup has increased the time taken for drying because the sugar layer present at the surface of slices hinders the free escape of moisture from the slices, especially during later periods of drying. Similar results of enhanced drying period in fruit slices treated with sugar syrup have been reported by Lavanya (2018) [7] in fig.

The highest residual moisture content was recorded in T_6 (13.56%), which was on par with T_5 (12.18%), whereas the lowest moisture content was recorded in commercial product T_8 (5.47%). The percent moisture content of dehydrated lime slices, irrespective of treatments, was found to be significantly higher in sugar syrup-treated samples than in others. This is due to the presence of sugar syrup, which has trapped the escape of moisture from the slices. Similarly, Brochier *et al*. (2019) [3] reported higher moisture content in osmotically dehydrated kiwi fruit.

Salt concentration (°Brix %) of dehydrated lime slices was significantly lowest in control T_7 (0.96%), whereas the highest salt concentration was recorded in T_2 (2.59%), which was on par with commercial product T_8 (2.58%).

Titratable acidity was significantly maximum in control (1.97%). In contrast, minimum acidity (1.14%) was observed in blanched lime fruit slices mixed with cooking salt for 10 days, followed by dipping in 50°Brix sugar syrup for 24 h and dried in a poly-solar dryer (T_5), which was on par with T_6 (1.15%) due to the presence of sugar syrup, which has reduced the acid content of dehydrated slices. Similarly, Kumar and Pathak (2020) [6] reported lower acidity levels in syrup-treated slices in aonla candy enriched with ginger.

Significantly highest ascorbic acid was observed in control (14 mg 100 g^{-1}), whereas lowest ascorbic acid (9.34 mg 100 g^{-1}) blanched lime slices mixed with cooking salt for 10 days followed by steeping in 50°Brix sugar syrup for 24 h added with spice mixture and dried in poly-solar dryer (Table 1) due to heat and leaching loss of ascorbic acid during blanching and syrup treatments. Similarly, Adoeye *et al*. (2019) [1] reported a loss of ascorbic acid in osmo-dehydrated *Hibiscus sabdariffa* candy.

Thirst quenching dehydrated lime slices prepared by mixing the blanched slices in salt for ten days followed by steeping in 50°B sugar syrup for 24 h added with spice mixture and dried in poly-solar dryer had highest sensory scores (out of 5.00) for texture (4.40), mouth feel (4.54) and overall acceptability (4.48). The addition of sugar and salt through osmosis, reduction in acidity and presence of spice mixture in the fruit might have contributed to the better taste and overall acceptability of dehydrated lime slices.

The higher sensory score for colour and appearance was observed in blanched lime slices mixed in cooking salt for ten days, followed by steeping in 50°B sugar syrup for 24 hours and drying in a poly-solar dryer (4.40). It might be attributed to the glossy appearance of the slices due to surface coating with sugar. Similar results of superiority concerning the sensory quality of dehydrated products have been reported by Ganachari *et al.* (2020) [4] in aonla.

Table 1: Physico–chemical characters of thirst-quenching dehydrated lime slices

Treatment	Drying period (h)	Recovery (%)	Residual Moisture (%)	Salt Concentration (ºBrix %)	Titratable acidity (%)	Ascorbic acid (mg 100 g^{-1})
T_1	15.92	20.84	7.67	2.33	1.58	11.25
T_2	16.17	20.93	6.97	2.59	1.56	11.25
T_3	16.17	20.76	6.17	2.40	1.55	11.04
T_4	16.42	21.25	6.47	2.34	1.51	10.92
T_5	22.75	41.62	12.81	1.78	1.14	9.46
T_6	22.58	41.13	13.56	1.77	1.15	9.34
T_7	14.17	13.21	7.97	0.96	1.97	14.00
T_8	-	-	5.47	2.58	1.52	11.50
Mean	17.74	25.68	8.38	2.09	1.50	11.10
S.Em ±	0.28	0.32	0.37	0.07	0.02	0.31
C.D.@ 1%	1.19	1.33	1.53	0.28	0.07	1.30

Table 2: Sensory evaluation of thirst-quenching dehydrated lime slices (Hedonic scale out of 5.00)

Treatment	Colour and appearance	Texture	Mouth feel	Over all acceptability
T_1	3.29	3.59	3.53	3.39
T_2	3.31	3.62	3.55	3.53
T_3	3.50	3.64	3.64	3.57
T_4	3.49	3.56	3.76	3.53
T_5	4.40	4.38	4.23	4.24
T_6	4.24	4.40	4.54	4.48
T_7	2.66	3.62	1.83	1.00
T_8	3.25	3.65	3.64	3.50
Mean	3.52	3.81	3.59	3.41
S.Em ±	0.09	0.04	0.06	0.05
C.D.@1%	0.39	0.17	0.24	0.19

Conclusion

A good quality, highly acceptable thirst-quenching dehydrated lime slices can be obtained by blanching (5 min), slicing, and mixing with roasted cooking salt (75 g kg^{-1}) for 10 days, followed by steeping in 50°B sugar syrup for 24 hours and coated with spice mixture (25 g kg^{-1} fruit slices) containing dry ginger (6 g), black pepper (4 g), ajwain (6 g), cumin (10 g) followed by poly-solar drying. These slices enhance nutritional and livelihood security.

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