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Effect of post harvest treatments on quality and shelf-life of dehydrated ginger (*Zingiber officinale* Rosc.)

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SUMMARY :

Ginger (*Zingiber officinale* Rosc.) is one of the important high value crop, cultivated widely in the North Eastern Region of India. Of the total ginger production, around 93.4 per cent becomes a marketable surplus. This huge amount of marketable surplus is sold by the farmers at a very low price. The ginger producers of the region have not been benefited to the desired extent due to absence of proper processing units and storage facility locally. The traditional ginger drying methods used by the farmers are varied, haphazard and risky, resulting in mould growth and destruction of some heat sensitive pungent properties. Considering the huge production, potentiality, market demand and its agro-climatic suitability in the region, an experiment on post harvest treatments on shelf-life and quality of dehydrated ginger var. 'Bhola' was conducted in the Quality Control and PHT Laboratory of Department of Horticulture, Assam Agricultural University, Jorhat. The freshly harvested ginger rhizomes were washed, peeled and cut into small shreds. The ginger shreds were pretreated with different combinations of salt solutions *viz*., 4 per cent,6 per cent, 8 per cent and 10 per cent, citric acid *viz*., 1 per cent, 2 per cent,3 per cent and 4 per cent and ascorbic acid 2 per cent in general. The treated samples were dried in oven for 7 hours at 60°C and stored in plastic containers at ambient conditions. The dehydrated ginger shreds treated with 10 per cent salt solution + 4 per cent citric acid + 2 per cent ascorbic acid recorded the highest crude protein (5.73%), oleoresin (4.31%), total soluble carbohydrate (12.89%) and overall sensory score (7.93%) without microbial growth till 180 days of storage. The dehydrated ginger shreds could be safely stored upto 180 days.

KEY WORDS : Post harvest treatments, Dehydrated ginger,

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Ginger (*Zingiber officinale* Rosc.) is one of the commercially important spice crop of North Eastern region of India. This region contributes about 26 per cent of the country's total ginger production (Johnykutty, 1997). Fresh ginger suffers from severe weight loss and sprouting if stored at ambient condition. Post harvest losses in ginger occur due to factors like lack of proper storage of fresh ginger beyond three

months, problem of drying due to high relative humidity and existence of a few processing plants in this region. A large quantum of ginger harvest becomes marketable surplus. Value addition to fresh ginger is a good option to minimize the post harvest losses and also to utilize the marketable surplus. So far, work on value addition and product development in ginger have not received much attention in this region. Considering the huge production, potentiality and market demand for ginger, the present investigation was undertaken in order to study the effect of post harvest treatments on shelf-life and quality of dehydrated ginger.

EXPERIMENTAL METHODS

The present experiment was conducted in the Quality Control and PHT Laboratory of the Department of Horticulture, Assam Agricultural University, Jorhat-13. The rhizomes of ginger var. 'Bhola' were sampled at 270 days after planting. The rhizomes were washed, peeled and cut into small shreds. The ginger shreds were dipped in solutions containing salt (4-10%), citric acid (1-4%) and ascorbic acid (2%) for 30 min. The salt solution was drained off and the ginger shreds were dried in an oven at 60º C for 7 hours and stored in plastic containers at ambient condition. The treatment combinations were as follows :

T_1 : 4% salt + 1% citric acid + 2% ascorbic acid
T_2 : 4% salt + 2% citric acid + 2% ascorbic acid
T_3: 4% salt + 3% citric acid + 2% ascorbic acid
T_4 : 4% salt + 4% citric acid + 2% ascorbic acid
T_5: 6% salt + 1% citric acid + 2% ascorbic acid
T_6 : 6% salt + 2% citric acid + 2% ascorbic acid
T_7 : 6% salt + 3% citric acid + 2% ascorbic acid
T_8 : 6% salt + 4% citric acid + 2% ascorbic acid
T_9 : 8% salt + 1% citric acid + 2% ascorbic acid
T_{10} : 8% salt + 2% citric acid + 2% ascorbic acid
T_{11} : 8% salt + 3% citric acid + 2% ascorbic acid
T_{12} : 8% salt + 4% citric acid + 2% ascorbic acid
T_{13} : 10% salt + 1% citric acid + 2% ascorbic acid
T_{14} : 10% salt + 2% citric acid + 2% ascorbic acid
T_{15} : 10% salt + 3% citric acid + 2% ascorbic acid
T_{16} : 10% salt + 4% citric acid + 2% ascorbic acid
T_{17} : Control

Observations were recorded at 60 days interval till 180 days of storage. The moisture content(%), crude fibre(%) and crude protein(%) of the treated samples were determined by the method described by Ranganna (1997). Standard methods for estimation of total soluble carbohydrate (Thimmaiah,1999) and oleoresin (Winterson and Richardson, 1965) were used. Overall sensory evaluation of the ginger samples was done by a group of semi-trained panels for taste, texture and visual colour using 9 point hedonic scale (Amerine *et al*., 1965). Shelf- life was evaluated based on the visual quality of the products following the method suggested by Bhowmik and Pan (1992). Microbial load of ginger samples was tested as per method described by Seeley and Van Denmark (1970).The experiment was laid out in Completely Randomized Block Design with 3 replications and the data were statistically analyzed (Panse and Sukhatme, 1978).

EXPERIMENTAL FINDINGS AND ANALYSIS

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Moisture content :

A perusal of data on moisture content (Table 1) indicated its increasing trend with storage time. The lowest moisture content (4.73%) was recorded in the dehydrated ginger treated with10 per cent salt + 4 per cent citric acid + 2 per cent ascorbic acid. Increase in moisture content was because of high hygroscopic nature of dehydrated products and salt. The gain in moisture varied in the rate of water removal and uptake of salt by the ginger shreds at different salt concentrations. Similar trend was also observed by Sagar and Kumar (2006) in dehydrated gooseberry shreds.

Crude fibre :

The crude fibre content of dehydrated ginger decreased significantly with the progress of storage period (Table 1). The dehydrated ginger treated with 10 per cent salt + 4 per cent citric acid + 2 per cent ascorbic acid possessed the lowest crude fibre content of 1.97 per cent. The decrease in crude fibre content could probably due to the application of heat for dehydration and loss of soluble crude fibre during storage which led to the degradation of crude fibre. Similar observations were reported by Saikia (1992) in dehydrated banana powder.

Crude protein :

The crude protein content declined across storage (Table 2). Decrease in crude protein content of ginger shreds stored at ambient temperature could be due to denaturation of soluble protein by salt and heat (Potter, 1984); hydrolysis to amino acids and loss through volatilization during oven dehydration. Treatment of dehydrated ginger shreds with 10 per cent salt + 4 per cent citric acid + 2 per cent ascorbic acid resulted in the highest crude protein content (5.73%).

Total soluble carbohydrate :

The total soluble carbohydrate content (Table 2) decreased during storage and the highest total soluble carbohydrate (12.89%) was recorded in the dehydrated ginger treated with 10 per cent salt + 4 per cent citric acid + 2 per cent ascorbic acid. Crude fibre is composed of different carbohydrate compounds like cellulose, hemi-cellulose, lignin, pectic substances, gum, mucilage etc. Decrease in soluble crude fibre might result in decrease in total soluble carbohydrate.

Oleoresin :

Oleoresin is a complex mixture of volatile oil, pungent principles, together with lipids, resins and carbohydrate and its sensitive to heat. In the present study, oleoresin content (Table 3) was found to decrease due to application of heat for dehydration and increased temperature during storage (Raina *et al*., 1980 and Das and Sarma, 2001). More gain in moisture by samples might also result in loss of oleoresin content.

Sensory evaluation :

Overall sensory quality of dehydrated ginger decreased during storage (Table 3). The taste quality declined due to the loss of oleoresin content which is responsible for the pungency in ginger and increase in moisture content in the shreds affected the taste. Textural changes were due to increased moisture content in all the samples during storage. Browning of the dehydrated ginger was due to Maillard reaction (Srivastava and Kumar, 1994 and Singh *et al.*, 2006). The highest overall

Table 1 : Effect of post harvest treatments on moisture content(%) and crude fibre(%) content of dehydrated ginger

Treatments (T)	Moisture content(%)				Crude fibre(%)			
	Days in storage(D)				Days in storage(D)			
	D_1 (60)	D_2 (120)	D_3 (180)	Mean	D_1 (60)	D_2 (120)	D_3 (180)	Mean
T_1	5.50	6.00	6.20	5.90	2.38	2.34	2.32	2.35
T_2	5.40	5.50	5.90	5.60	2.38	2.35	2.32	2.35
T_3	5.60	5.80	6.00	5.80	2.35	2.31	2.25	2.30
T_4	5.65	5.80	6.00	5.82	2.31	2.28	2.27	2.29
T_5	5.20	5.40	5.50	5.37	2.38	2.32	2.18	2.29
T_6	5.30	5.52	5.60	5.47	2.29	2.25	2.21	2.25
T_7	5.00	5.25	5.50	5.25	2.28	2.24	2.20	2.24
T_8	4.80	5.00	5.50	5.10	2.30	2.20	2.17	2.22
T_9	4.80	5.02	5.20	5.01	2.25	2.18	2.10	2.18
T_{10}	4.68	5.00	5.30	4.99	2.28	2.20	2.08	2.19
T_{11}	4.80	4.90	5.10	4.93	2.28	2.22	2.15	2.22
T_{12}	4.80	4.90	5.10	4.93	2.17	2.13	2.10	2.13
T_{13}	4.53	4.75	4.90	4.73	2.17	2.07	2.03	2.09
T_{14}	4.70	4.90	5.10	4.90	2.13	2.08	2.07	2.09
T_{15}	4.60	4.82	5.00	4.81	2.12	2.03	2.03	2.06
T_{16}	4.60	4.70	4.90	4.73	2.03	1.93	1.93	1.97
T_{17}	5.50	5.60	5.70	5.60	2.23	2.18	2.17	2.19
Mean	5.03	5.23	5.44		2.26	2.20	2.15	
	S.E.±	C.D. (P=0.05)			S.E.±	C.D. (P=0.05)		
Treatment (T)	0.04	0.08			0.04	0.08		
Days(D)	0.02	0.03			0.02	0.03		
T×D	0.07	0.13			0.07	NS		

Initial value = 2.50

NS= Non-significant

Table 2 : Effect of post harvest treatments on crude protein (%) and total soluble carbohydrate (%) content of dehydrated ginger

Treatments (T)	Crude protein (%)				Total soluble carbohydrate (%)			
	Days in storage (D)				Days in storage (D)			
	D_1 (60)	D_2 (120)	D_3 (180)	Mean	D_1 (60)	D_2 (120)	D_3 (180)	Mean
T_1	6.03	5.53	5.03	5.53	11.82	11.63	11.52	11.66
T_2	6.03	5.53	5.00	5.52	12.32	12.21	12.07	12.20
T_3	6.30	5.50	4.97	5.59	12.43	12.25	12.11	12.27
T_4	6.07	5.57	5.02	5.55	12.63	12.26	11.75	12.22
T_5	6.10	5.60	5.07	5.59	12.40	12.24	12.07	12.24
T_6	6.03	5.53	5.02	5.53	12.37	12.25	12.14	12.25
T_7	6.07	5.57	5.03	5.56	12.50	12.33	12.03	12.29
T_8	6.10	5.57	5.07	5.58	12.58	12.28	12.07	12.31
T_9	6.00	5.50	4.98	5.49	12.60	12.34	12.24	12.39
T_{10}	6.07	5.57	5.00	5.54	12.73	12.34	12.18	12.42
T_{11}	6.03	5.53	5.00	5.52	12.65	12.47	12.30	12.48
T_{12}	6.03	5.53	5.02	5.53	12.67	12.52	12.42	12.54
T_{13}	6.00	5.50	4.97	5.49	12.77	12.53	12.46	12.59
T_{14}	6.13	5.60	5.10	5.61	12.83	12.71	12.47	12.67
T_{15}	6.17	5.67	5.17	5.67	12.90	12.68	12.51	12.70
T_{16}	6.23	5.73	5.23	5.73	13.00	12.93	12.75	12.89
T_{17}	6.03	5.50	4.93	5.49	11.93	11.82	11.72	11.83
Mean	6.08	5.56	5.04		12.54	12.34	12.17	
	S.E.±	C.D. (P=0.05)			S.E.±	C.D. (P=0.05)		
Treatment (T)	0.05	0.09			0.10	0.19		
Days(D)	0.02	0.04			0.04	0.08		
T×D	0.08	NS			0.16	NS		

Initial value = 6.30 Initial value = 13.50 NS=Non-significant

Table 3 : Effect of post harvest treatments on oleoresin content (%) and overall sensory score (9-point Hedonic scale) of dehydrated ginger

Treatments (T)	Oleoresin content (%)				Overall sensory score (9-point hedonic scale)			
	Days in storage (D)				Days in storage (D)			
	D_1 (60)	D_2 (120)	D_3 (180)	Mean	D_1 (60)	D_2 (120)	D_3 (180)	Mean
T_1	3.60	3.20	3.00	3.27	6.33	5.63	5.00	5.66
T_2	3.50	3.30	2.97	3.26	6.27	5.37	4.89	5.51
T_3	3.90	3.67	2.97	3.51	6.00	5.33	5.13	5.49
T_4	4.00	3.70	3.52	3.74	6.73	6.00	5.67	6.13
T_5	4.10	3.97	3.77	3.94	6.90	6.10	5.30	6.10
T_6	4.00	3.77	3.77	3.85	6.93	6.20	5.64	6.26
T_7	4.10	3.99	3.87	3.98	7.13	6.60	5.80	6.51
T_8	4.11	3.54	3.52	3.72	7.20	6.64	5.90	6.58
T_9	4.20	4.08	3.73	4.00	7.27	6.70	6.10	6.69
T_{10}	4.20	4.08	3.97	4.08	7.40	6.83	6.13	6.79
T_{11}	4.17	4.10	3.90	4.06	7.17	6.67	6.00	6.61
T_{12}	4.20	4.10	3.93	4.08	7.33	6.93	6.30	6.86
T_{13}	4.20	4.07	3.90	4.06	8.00	6.88	6.17	7.01
T_{14}	4.20	4.07	3.97	4.08	8.10	6.83	6.33	7.09
T_{15}	4.20	4.07	3.93	4.07	8.18	7.08	6.38	7.21
T_{16}	4.40	4.35	4.18	4.31	8.38	7.94	7.46	7.93
T_{17}	4.20	4.00	3.94	4.05	7.33	6.83	6.33	6.83
Mean	4.08	3.89	3.70		7.22	6.50	5.91	
	S.E.±	C.D. (P=0.05)			S.E.±	C.D. (P=0.05)		
Treatment (T)	0.10	0.19			0.04	0.09		
Days(D)	0.04	0.08			0.02	0.04		
T×D	0.17	NS			0.07	0.15		

Initial value = 4.50 NS=Non-significant

sensory score (7.93) was obtained in dehydrated ginger treated with 10 per cent salt + 4 per cent citric acid + 2 per cent ascorbic acid.

Microbial growth:

Microbial count data of dehydrated ginger (Table 4) indicated that the non-treated along with few treated

Table 4 : Total microbial load of dehydrated ginger at the end of 180 days

Treatment (T)	Colony forming unit per g	
	NA	PDA
T_1	1.7×10^5	1.0×10^5
T_2	1.0×10^5	1.2×10^5
T_3	-	-
T_4	2.9×10^5	2.5×10^5
T_5	2.7×10^5	2.5×10^5
T_6	-	-
T_7	-	-
T_8	0.8×10^5	1.0×10^5
T_9	-	-
T_{10}	1.0×10^5	0.8×10^5
T_{11}	-	-
T_{12}	-	-
T_{13}	-	-
T_{14}	-	-
T_{15}	-	-
T_{16}	-	-
T_{17}	3.1×10^5	3.3×10^5

NA = Nutrient agar, PDA = Potato dextrose agar

Table 5 : Effect of post harvest treatments on the visual quality of dehydrated ginger

Treatment (T)	Days in storage (D)			
	D_1 (60)	D_2 (120)	D_3 (180)	Mean
T_1	7.00	6.00	5.50	6.17
T_2	6.85	5.55	5.08	5.83
T_3	6.50	5.50	5.25	5.75
T_4	6.85	5.80	5.50	6.05
T_5	7.25	6.15	5.45	6.28
T_6	7.15	6.10	5.72	6.32
T_7	7.25	6.50	5.80	6.52
T_8	7.25	6.47	5.45	6.39
T_9	7.35	6.55	5.75	6.55
T_{10}	7.50	6.75	5.75	6.67
T_{11}	7.15	6.50	5.75	6.47
T_{12}	7.25	6.70	5.95	6.63
T_{13}	8.00	6.57	5.75	6.77
T_{14}	8.15	6.50	6.00	6.88
T_{15}	8.27	6.77	5.92	6.98
T_{16}	8.32	7.92	7.33	7.86
T_{17}	8.50	7.75	7.00	7.75
Mean	7.45	6.47	5.82	
	S.E.±	C.D. (P=0.05)		
Treatment (T)	0.07	0.13		
Days (D)	0.03	0.05		
T×D	0.11	0.23		

dehydrated ginger shreds showed microbial growth at the end of 180 days storage. The highest microbial count was recorded in the non-treated dehydrated ginger ($3.1x10^5$ and 3.3×10^5 cfu/g in NA and PDA media, respectively). Dehydrated ginger shreds treated with 10 per cent salt + 4 per cent citric acid + 2 per cent ascorbic acid were free from microbial growth. Absence of microbial contamination in most of the treated dehydrated ginger shreds might be due to reduced water activity and the use of salt which inhibited the growth of microbes.

Shelf-life:

Shelf-life was assessed based on the visual quality of dehydrated ginger (Table 5). The dehydrated ginger shreds treated with 10 per cent salt + 4 per cent citric acid + 2 per cent ascorbic acid were in very good condition scoring 7.86 which indicated the possibility of extending the shelf-life beyond 180 days. Though non-treated dehydrated shreds showed better score value (6.83), its taste was comparatively poor.

Cost analysis of dehydrated ginger shreds showed the highest benefit : cost ratio of 2.94 in the treatment with 10 per cent salt solution acidified with 4 per cent citric acid and 2 per cent ascorbic acid.

Thus, the study established that ginger can be processed into value added products like dehydrated ginger. Maximum retention of physico-chemical and sensory qualities in dehydrated ginger shreds can be achieved with 10 per cent salt solution acidified with 4 per cent citric acid and 2 per cent ascorbic acid. The dehydrated ginger shreds could be stored safely up to 180 days at ambient condition without microbial growth.

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