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Study on the effect of packaging materials on quality attributes of dried coriander greens

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Abstract
The present investigation was carried out with an objective to study the effect of packaging materials on quality of dried coriander greens during storage under ambient conditions. Fresh coriander greens of two different varieties *viz.,* Sudha and Suguna, were dried using tray drier at 50 °C and packed in different packaging materials namely low density polyethylene, PET containers, polythene lined paper covers and aluminium pouches. The changes in quality attributes of dried coriander greens in different packaging materials were recorded at monthly interval up to 3 months. There was a decrease in the rehydration ratio, chlorophyll and ascorbic acid as the storage duration progressed. Dried greens prepared from Sudha variety showed maximum rehydration ratio, chlorophyll and ascorbic acid throughout the storage. Among packaging materials, PET containers showed better results for rehydration ratio and ascorbic acid retention whereas aluminium pouches showed better retention of chlorophyll by the end of storage period.

Keywords: Coriander greens, packaging materials, quality parameters

Introduction
Coriander (*Coriandrum sativum* L.) is an annual herbaceous plant of Apiaceae family commonly called as 'hara dhania' (fresh coriander leaves) in India. The name coriander is derived from the Greek word "*koris*" meaning stink bug and is named as such due to its strong aroma. Coriander is often confused with parsley due its close resemblance. However, the former has strong aroma and flavour while parsley is mild in flavour.

The fresh leaves and stems of coriander are commonly used for seasoning and garnishing foods. It is an everyday herb used as an ingredient in Indian and Central Asian cuisines to enhance the flavour of cooked foods. For centuries, the coriander plants and their parts, primarily their leaves and ripe seeds, have been used in folk medicines in addition to culinary uses (Devi *et al.,* 2020) [1]. The leaves are a rich source of vitamin A, vitamin C, vitamin K, iron, manganese, magnesium and antioxidants. Fresh juice of coriander leaves is extremely advantageous in curing many deficiencies related to vitamins and iron. Coriander leaves have also been reported to cure digestive tract disorders, promote healthy vision, improve immunity, manage blood sugar levels and possess diuretic properties (Bhat *et al.,* 2014) [2].

However, coriander being highly perishable in nature due its high moisture content, requires proper preservation and processing techniques to reduce postharvest losses and for off season availability at reasonable price. Dehydration is one of the oldest technique employed for preserving leaves. The removal of moisture from foods required for enzyme activity and growth of micro-organisms is the core principle of preservation by drying. Thus, the storage life of foods is enhanced due to reduced moisture content and water activity. This greatly helps in improving the income of farmers, product diversification and it also ensures year round supply of nutrient rich healthy greens to the people at affordable prices which can be stored for longer period of time. The studies on varieties of coriander suitable for drying and packaging were limited. Hence the present study was conducted to evaluate the characteristics of dried coriander greens in different packaging materials for safe storage and future use.

Material and Methods
Plant materials
The fresh coriander herbs of varieties Sudha (V1) and Suguna (V2) were procured from Horticultural Research Station, Lam, Guntur. The stems with leaves were separated from roots and washed with clean water to remove adhering dust and soil particles.

Drying
The washed coriander greens are evenly spread on trays and dried in a tray drier at 50 ℃ till a moisture content of 7-8% was obtained in the dried product.

Packaging materials and storage
The dried coriander greens were packed in Low Density Polyethylene (LDPE) 200 gauge pouches (P1), Polyethylene terephthalate (PET) containers (P2), polythene lined paper covers (P3), aluminium pouches (P4) and stored under ambient conditions (32-35 ℃) for 3 months. The physico-chemical analysis was carried out at 30 days interval.

Physico-chemical analysis
The effect of packaging materials on rehydration ratio, chlorophyll and ascorbic acid of dried coriander greens during storage was studied. The rehydration ratio was calculated using the procedure suggested by Ranganna, 1986 [3]. The chlorophyll content was estimated using acetone as a solvent (Ranganna, 1995) [4] and ascorbic acid content was determined using 2,6- dichloro phenol indophenol dye titration method (Ranganna, 1986) [3].

Statistical analysis
The experiment was laid out in Completely Randomized Factorial Design with two factors at unequal levels each replicated thrice. The data was analysed using the standard procedure of Sukhatme and Amble, 1985 [7]. Means were taken for the comparison and interpretation of the results. The significance of the data was tested using F-test ($p \leq 0.05$).

Results and Discussion
The results regarding the changes in quality attributes (rehydration ratio, chlorophyll and ascorbic acid) of dried coriander greens in different packaging materials during storage are presented as follows.

Rehydration ratio
The changes in rehydration ratio of dried coriander greens during storage are presented in table 1. The rehydration ratio showed a declining trend as the storage progressed. Dried greens prepared from Sudha variety showed maximum rehydration ratio. Among packaging materials, the rehydration ratio was highest in case of PET containers (P2) whereas, LDPE pouches (P1) showed lowest rehydration ratio throughout the storage. This might be due to the high resistance of PET bottles against transmission of water vapour as rehydration ratio decreases with increase in moisture content. LDPE on the other hand, is more permeable to moisture transmission (Jawake *et al.*, 2017) [5].

Table 1. Effect of different packaging materials on rehydration ratio of dried coriander greens during storage

Varieties (V)	Packaging materials (P)																			
	Days of storage																			
	Initial day					30 days					60 days					90 days				
	P1	P2	P3	P4	Mean	P1	P2	P3	P4	Mean	P1	P2	P3	P4	Mean	P1	P2	P3	P4	Mean
V1	3.85	3.97	3.89	3.94	3.91	3.74	3.91	3.79	3.85	3.82	3.58	3.85	3.69	3.78	3.73	3.46	3.79	3.61	3.71	3.65
V2	3.74	3.89	3.80	3.85	3.82	3.61	3.82	3.68	3.76	3.72	3.49	3.74	3.59	3.65	3.62	3.38	3.67	3.51	3.58	3.54
Mean	3.79	3.93	3.84	3.86	3.87	3.68	3.87	3.74	3.80	3.77	3.54	3.80	3.64	3.72	3.68	3.42	3.73	3.56	3.65	3.60
Factors		S.Em ±		CD at 5%			S.Em ±		CD at 5%			S.Em ±		CD at 5 %			S.Em ±		CD at 5%	
(V)		0.028		0.085			0.025		0.076			0.022		0.065			0.024		0.074	
(P)		0.040		NS			0.036		0.108			0.031		0.092			0.035		0.104	
(V)x(P)		0.056		NS			0.050		NS			0.043		NS			0.049		NS	

Varieties (V): V1: Sudha V2: Suguna
Packaging materials: P1: LDPE 200 gauge pouches P2: PET containers P3: Polythene lined paper covers P4: Aluminium pouches

Chlorophyll (mg g^{-1})
Table 2 shows the changes in the chlorophyll content (mg g-1) of dried coriander greens packed in different packaging materials during 3 months storage. There was a decrease in the chlorophyll content in both varieties irrespective of packaging materials as the days of storage increased. The chlorophyll content was higher in dried greens of Sudha variety when compared to Suguna variety. Among packaging materials, dried coriander greens packed in aluminium pouches (P4) showed maximum retention of chlorophyll while least chlorophyll content was observed in LDPE 200 gauge pouches (P1). This difference might be due to the level of prevention of chlorophyllase activity and conversion of chlorophyll to pheophytin (Singh and Sagar, 2010) [6].

Ascorbic acid (mg 100 g^{-1}): The details pertaining to ascorbic acid content (mg 100 g-1) of dried coriander greens packed in different packaging under ambient conditions is presented in table 3. The ascorbic acid was found to decrease from initial to final day of storage. This might be due to the residual oxygen in packaging material prior to packaging which catalyse the oxidation of ascorbic acid during storage (Seevaratnam *et al.*, 2012) [8]. Among packaging materials, PET bottles (P2) showed better retention of ascorbic acid throughout the 90 days storage period while LDPE 200 gauge pouches (P1) showed lowest retention of ascorbic acid. This may be attributed to the strong barrier properties of PET bottles against oxygen while LDPE is a poor barrier against oxygen (Seevaratnam *et al.*, 2012; Singh and Sagar, 2010) [8, 6].

Table 2: Effect of different packaging materials on chlorophyll content (mg g^{-1}) of dried coriander greens during storage

Varieties	Packaging materials (P)																			
	Days of storage																			
	Initial day					30 days					60 days					90 days				
	P1	P2	P3	P4	Mean	P1	P2	P3	P4	Mean	P1	P2	P3	P4	Mean	P1	P2	P3	P4	Mean
V1	2.69	2.74	2.81	2.86	2.77	2.57	2.65	2.72	2.78	2.68	2.49	2.58	2.66	2.71	2.61	2.42	2.51	2.58	2.66	2.54
V2	2.47	2.54	2.60	2.66	2.57	2.39	2.46	2.52	2.58	2.49	2.31	2.38	2.45	2.52	2.41	2.24	2.30	2.38	2.45	2.35
Mean	2.58	2.64	2.71	2.76	2.67	2.48	2.55	2.62	2.68	2.59	2.40	2.48	2.55	2.62	2.51	2.33	2.41	2.48	2.56	2.45
Factors		S.Em ±		CD at 5 %			S.Em ±		CD at 5 %			S.Em ±		CD at 5 %			S.Em ±		CD at 5 %	
(V)		0.041		0.123			0.030		0.091			0.030		0.091			0.031		0.095	
(P)		0.058		NS			0.043		0.129			0.042		0.128			0.044		0.134	
(V)x(P)		0.081		NS			0.060		0.239			0.060		0.240			0.063		0.245	

Varieties (V): V1: Sudha V2: Suguna
Packaging materials (P): P1: LDPE 200 gauge pouches P2: PET containers P3: Polythene lined paper covers P4: Aluminium pouches

Table 3: Effect of different packaging materials on ascorbic acid content (mg 100 g-1) of dried coriander greens during storage

Varieties (V)	Packaging materials (P)																			
	Days of storage																			
	Initial day					30 days					60 days					90 days				
	P1	P2	P3	P4	Mean	P1	P2	P3	P4	Mean	P1	P2	P3	P4	Mean	P1	P2	P3	P4	Mean
V1	48.92	49.16	48.99	49.09	49.04	46.46	47.01	46.54	46.70	46.68	45.57	45.98	45.66	45.75	45.74	43.73	44.42	43.95	44.13	44.06
V2	47.71	47.96	47.79	47.87	47.83	45.01	45.56	45.18	45.25	45.25	44.03	44.37	44.11	44.18	44.17	41.77	42.82	41.92	42.20	42.18
Mean	48.32	48.56	48.39	48.48	48.44	45.74	46.28	45.86	45.96	45.97	44.80	45.18	44.88	44.97	44.96	42.75	43.62	42.93	43.17	43.12
Factors	S.Em ±		CD at 5 %			S.Em ±		CD at 5 %			S.Em ±		CD at 5 %			S.Em ±		CD at 5 %		
(V)	0.044		0.132			0.046		0.140			0.041		0.124			0.042		0.126		
(P)	0.062		NS			0.065		0.198			0.058		0.175			0.059		0.179		
(V)x(P)	0.087		NS			0.092		NS			0.082		0.248			0.084		0.252		

Varieties (V): V1: Sudha V2: Suguna
Packaging materials (P): P1: LDPE 200 gauge pouches P2: PET containers P3: Polythene lined paper covers P4: Aluminium pouches

Conclusion

Among varieties, dried coriander greens prepared from Sudha variety showed superior quality in terms of rehydration ratio, chlorophyll and ascorbic acid content. PET containers are found to be a suitable packaging material for storage of dried coriander greens. However, dried greens packed in aluminium pouches were found to be better in terms of colour retention.

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