

Effect of packaging materials and methods on quality characteristics of dehydrated fenugreek (*Trigonella foenum graecum* L.) leaves during storage

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Abstract

The fresh fenugreek leaves were dried in axial flow convective tray dryer at 60°C air temperature, packed in 200 gauge LDPE and HDPE polyethylene pouches using hot sealing and vacuum packaging machine. The samples were kept at room temperature (25-38°C) for six months for conducting storage study. The rehydration ratio (RR) and water activity (aw) was found to decrease and increase, respectively with advancement of storage period irrespective of packaging materials and methods but rate of reduction and increment was observed higher in LDPE pouches than that of HDPE. The colour value (L*, a, & b) of samples packed in HDPE were observed higher than that of LDPE samples irrespective of packaging methods. Mean organoleptic score for taste and overall acceptability was found to decrease with increase in storage period but rate of decrease was higher in LDPE samples than that of HDPE. After 180 days of storage, the quality attributes viz. rehydration ratio, water activity and colour values (L*, 'a', 'b') of vacuum packed HDPE samples were found as 2.80, 0.687, and 57.45, -18.84 & -27.24, respectively. The samples of vacuum packaging method were found better in quality when compared to the quality of hot sealed.

Key words : Colour, drying, fenugreek leaves, rehydration ratio, storage, water activity.

Introduction

Green leafy vegetables represent an excellent component of the habitual diet in the tropical and temperate countries. Fenugreek (*Trigonella foenum graecum* L.) is one of the popular green leafy vegetable in India. Fenugreek is highly seasonal and usually available in plenty at a particular part of the year. Fenugreek leaves contain 89% water, 6% carbohydrates, 4% protein and provide energy of 49 kcal per 100 g (Gopalan *et al.*, 1989). Fenugreek are extensively used in various cooked and processed form. It is gaining importance, mainly because of being good source of vitamins, minerals and dietary (Karva, 2008, Kalaskar *et al.*, 2012). Green fenugreek is highly seasonable and perishable. Augmenting utilization and avoiding wastage calls for employing suitable preservation techniques that are user friendly and sustainable at the household levels. Drying is simple and economical methods of preservation green leafy vegetables (Lakshmi and Vimala 2000, Doymaz *et al.*, 2004; Makobo, 2010). Drying of leafy vegetables creates an avenue for marketing of the produce by reducing the volume and bulk, easy to transport, and adds value in terms of nutritional benefit and economic advantage. In addition to increasing variety in the menu, dehydration of leafy vegetables reduces

wastage, labour and storage space (Rajeswari, *et al.*, 2013).

Dehydrated fenugreek leaves are simple to use and have longer shelf life than green leaves. In order to augment the availability of green fenugreek leaves during lean season very few works could be pointed out on the shelf life study of dehydrated green fenugreek leaves. Therefore, this storage study was carried out to evaluate the effect of different packaging materials and methods on quality characteristics of dehydrated fenugreek leaves.

Material and methods

Sample preparation

Fenugreek plants were procured from the local fruits and vegetables market. Good quality fresh fenugreek leaves were picked manually and washed to remove the adhering dirt/dust prior to dehydration. The moisture content of the fresh and dehydrated fenugreek leaves were determined as described by AOAC, 2000. Green fenugreek leaves were dried in convective tray dryer (Model no: 12TD, Lab line Gujarat) at 60°C air temperature and 1m/s air velocity till the moisture content reached constant (Anonymous, 2016). The samples for conducting storage study were prepared by packing 15g dehydrated fenugreek leaves in 200 gauge LDPE (Low density polyethylene) pouches and

200 gauge HDPE (High density polyethylene) pouches. The pouches thus prepared were sealed using hot sealing machine (Maxpack, Pack-Seal, Pune) and vacuum packaging machine (Q5400VMG-MC, Sevana's, India).

Storage study of dried fenugreek leaves

Dehydrated samples (Fig. 1) of dried fenugreek leaves were stored at room temperature (25-38°C) for conducting storage study for 6 months. Quality parameters viz., rehydration ratio (RR), water activity (a_w), colour values (L^* , a^* , b^*) of stored samples were evaluated during storage study at every 15 days interval. Similarly, organoleptic properties of dehydrated samples viz., taste and overall acceptability was also evaluated.

Dehydrated fenugreek leaves (5g) were put into glass beaker and 200 ml warm water (40°C) was added. After 1 hour, the excess water was drained off through filter paper (Whatman No. 4) and drained weight of dehydrated materials was taken for determination of rehydration ratio (Ranganna, 2000). Rehydrated samples of fenugreek leaves at 90th day of storage have been shown in Fig. 2. Water activity (a_w) was measured by using digital water activity meter (Model- hygrolab-3). Colour value was measured in three-dimensional scale L^* , a^* and b^* using Hunter Lab Colorimeter, model-NCFLX/DIFF, CFLX-45 (Anantheswaran *et al.*, 1986). Organoleptic properties like taste and overall acceptability of dehydrated fenugreek were evaluated by panel of 10 judges. Score sheets describing the quality score (80-100 for excellent, 60-79

for good, 40-59 for fair, 20-39 for poor and 0-19 for very poor) were provided to mark the product according to liking (BIS-6273).

Results and discussion

The effect of packaging materials and methods on the rehydration ratio, water activity and colour values during 180 days of storage have been presented in Table 1-3. The score of organoleptic evaluation for taste and overall acceptability of dried fenugreek leaves has been described in Table 4. Initial moisture content of fresh fenugreek leaves and moisture content after drying was observed to be 668.64 per cent (db) and 6.00 per cent (db), respectively.

Effect of packaging materials and methods on rehydration ratio

The rehydration ratio of dried fenugreek leaves samples was found to decrease gradually with the increase in storage period for both packaging materials and methods. The rate of reduction in RR was observed higher in LDPE pouches than that of HDPE irrespective of packaging methods (Table 1& Fig 2.).

It is clearly shows that from Table 1 that the RR of hot sealed samples decreased from 3.42 to 2.57 and 3.42 to 2.74 for LDPE and HDPE packaging materials, respectively during 180 days of storage. Similarly, the RR of the vacuum-packed samples decreased from 3.42 to 2.63 and 3.42 to 2.80 for LDPE and HDPE packaging materials, respectively. The maximum RR of 2.80, among



Hot Sealed LDPE



Vacuum Packed LDPE



Hot Sealed HDPE



Vacuum Packed HDPE

Fig. 1 Dehydrated samples of fenugreek leaves for storage study

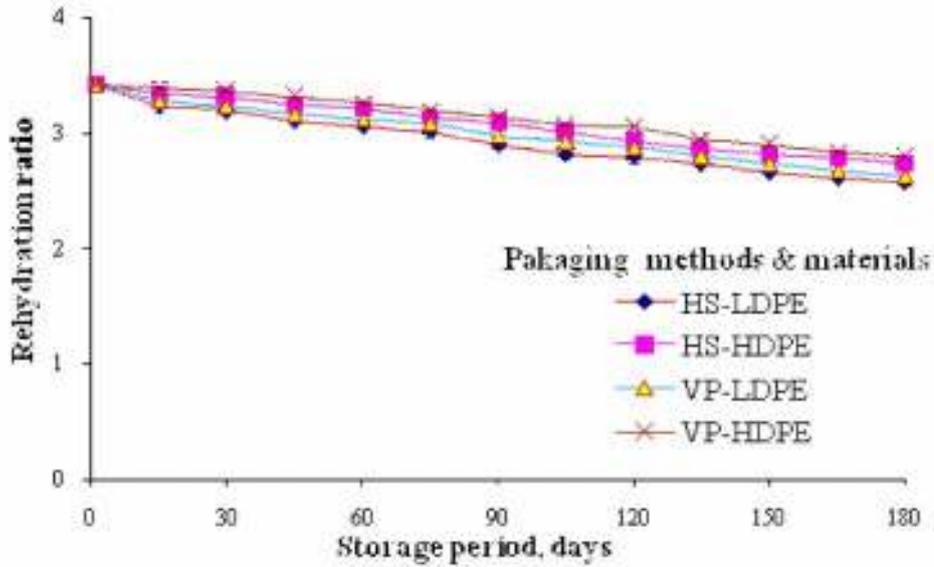


Fig 2. Variation in rehydration ratio of dehydrated fenugreek

Table 1. Rehydration ratio of dried fenugreek leaves during storage study

Storage period (Days)	Hot sealing		Vacuum packaging	
	LDPE	HDPE	LDPE	HDPE
1	3.42	3.42	3.42	3.42
15	3.23	3.34	3.28	3.39
30	3.19	3.30	3.23	3.35
45	3.10	3.25	3.16	3.30
60	3.05	3.21	3.12	3.26
75	3.01	3.13	3.08	3.20
90	2.9	3.08	2.98	3.14
105	2.81	3.00	2.92	3.07
120	2.78	2.92	2.87	3.05
135	2.73	2.86	2.79	2.94
150	2.66	2.82	2.73	2.89
165	2.61	2.78	2.67	2.83
180	2.57	2.74	2.63	2.80



Hot Sealed (LDPE) Hot Sealed (HDPE) Vacuum Packed (LDPE) Vacuum Packed (HDPE)

Fig. 3. Rehydrated samples of fenugreek leaves at 90th day of storage

the all samples of different treatment on 180th day of storage, was found in vacuum packed HDPE pouches. The lowest RR (2.57) was found in hot sealed and LDPE pouches. It may be due to the moisture migration which leads to decrease in RR. Findings are in confirmation with the Singh and Sagar (2010) for storage of dehydrated curry and drumstick leaves and Khatoniar *et al.*, 2016 for waterleaf.

Effect of packaging materials and methods on water activity

The water activity of the dried fenugreek leaves samples was found to be increased gradually with the increase in storage period for both packaging materials and methods. The rate of increment in a_w was observed higher in the LDPE samples than that of HDPE irrespective of packaging methods (Table 2& Fig 4.).

It can be seen from Table 2 that the a_w found to increase from 0.412 to 0.805 and 0.412 to 0.752 for hot sealed sample LDPE and HDPE pouches, respectively. Whereas for vacuum-packed samples, the increase in a_w was found from 0.412 to 0.776 and 0.412 to 0.687 for LDPE and HDPE packaging materials, respectively. After 180th day of storage, the lowest a_w (0.687) was found in vacuum packed HDPE pouches. It may be due to higher rate of moisture migration through LDPE packaging materials than that of HDPE which leads to increase in a_w . These findings are in confirmation with the Kaur and Singh (2014). The a_w of dried fenugreek leaves was observed to exceed more than 0.80 after 4 months of storage which leads to enzymatic browning for sample packed in LDPE.

Effect of packaging materials and methods on colour value

Table 3 shows that the L* value of the hot sealed dried fenugreek leaves samples was found to decrease from 65.12 to 51.26 and 65.12 to 55.00 for LDPE and HDPE packaging materials, respectively. Similarly, the L* value of the vacuum-packed samples was found to decrease from 65.12 to 54.14 and 65.12 to 57.45 for LDPE and HDPE packaging materials, respectively. Similar results have been reported by Sharma *et al.*, 2013 for Anardana. The ‘a’ value of the hot sealed samples increased from -34.11 to -16.50 and -34.11 to -18.02 for LDPE and HDPE packaging materials, respectively during 180 days of storage. The ‘a’ value of the vacuum-packed samples also shown similar pattern of increase in a value from -34.11 to -16.86 and -34.11 to -18.84 for LDPE and HDPE packaging materials, respectively. The ‘b’ value of the hot sealed samples was found to increase from -37.58 to -18.15 and -37.58 to -26.84 for LDPE and HDPE packaging materials, respectively during 180 days of storage. Similarly, the ‘b’ value of the vacuum-packed samples was found to increase from -37.58 to -20.50 and -37.58 to -27.24 for LDPE and HDPE packaging materials, respectively. Table 3 clearly shows that the L*, a, & b values of sample packed in HDPE pouches are on higher side than that of samples packed in LDPE irrespective of packaging methods. These research findings of colour value are in confirmation with the Sharma *et al.*, 2013 for Anardana.

Table 2. Variation in water activity dried fenugreek leaves during storage study

Storage period (Days)	Hot sealing		Vacuum packaging	
	LDPE	HDPE	LDPE	HDPE
1	0.412	0.412	0.412	0.412
15	0.450	0.420	0.440	0.414
30	0.461	0.429	0.455	0.421
45	0.483	0.438	0.470	0.428
60	0.511	0.455	0.490	0.439
75	0.579	0.473	0.532	0.451
90	0.627	0.524	0.556	0.472
105	0.664	0.582	0.613	0.567
120	0.704	0.625	0.656	0.586
135	0.762	0.668	0.713	0.599
150	0.783	0.702	0.737	0.638
165	0.794	0.736	0.764	0.667
180	0.805	0.752	0.776	0.687

Table 3. Colour value (L*, a & b) of dried green fenugreek during storage study

Storage period (Days)	Hot sealing						Vacuum packaging					
	LDPE			HDPE			LDPE			HDPE		
	L*	a	b	L*	a	b	L*	a	b	L*	a	b
1	65.12	-34.11	-37.58	65.12	-34.11	-37.58	65.12	-34.11	-37.58	65.12	-34.11	-37.58
15	63.16	-28.22	-32.09	64.94	-34.41	-41.17	64.3	-31.27	-36.19	66.24	-37.52	-44.16
30	62.96	-27.3	-31.02	63.9	-30.08	-37.14	63.27	-29.43	-35.08	65.2	-33.37	-40.85
45	61.16	-24.65	-30.19	62.84	-29.4	-36.2	62.12	-27.29	-32.8	64.24	-32.51	-40.42
60	60.96	-21.94	-29.12	61.9	-27.87	-33.87	61.43	-26.15	-31.8	63.65	-30.36	-36.9
75	58.37	-19.56	-26.89	61.04	-25.26	-32.89	60.95	-24.53	-30.13	62.67	-28.92	-35.84
90	57.17	-18.7	-24.01	60.14	-24.62	-31.2	59.14	-22.89	-28.14	61.51	-26.62	-33.34
105	56.39	-18.04	-21.15	59.23	-21.94	-29.85	58.75	-19.57	-27.29	60.87	-24.78	-31.81
120	54.22	-17.30	-20.17	58.3	-20.45	-29.03	57.18	-18.42	-24.16	60.34	-22.34	-31.27
135	53.59	-17.02	-19.50	57.38	-19.97	-28.14	56.74	-17.92	-23.01	59.20	-21.74	-30.08
150	53.14	-16.87	-18.98	56.88	-19.86	-27.79	55.35	-17.37	-22.34	58.30	-20.17	-29.42
165	52.37	-16.64	-18.74	55.67	-19.01	-27.16	54.76	-16.99	-21.17	57.90	-19.55	-28.12
180	51.26	-16.50	-18.15	55.00	-18.02	-26.84	54.14	-16.86	-20.50	57.45	-18.84	-27.24

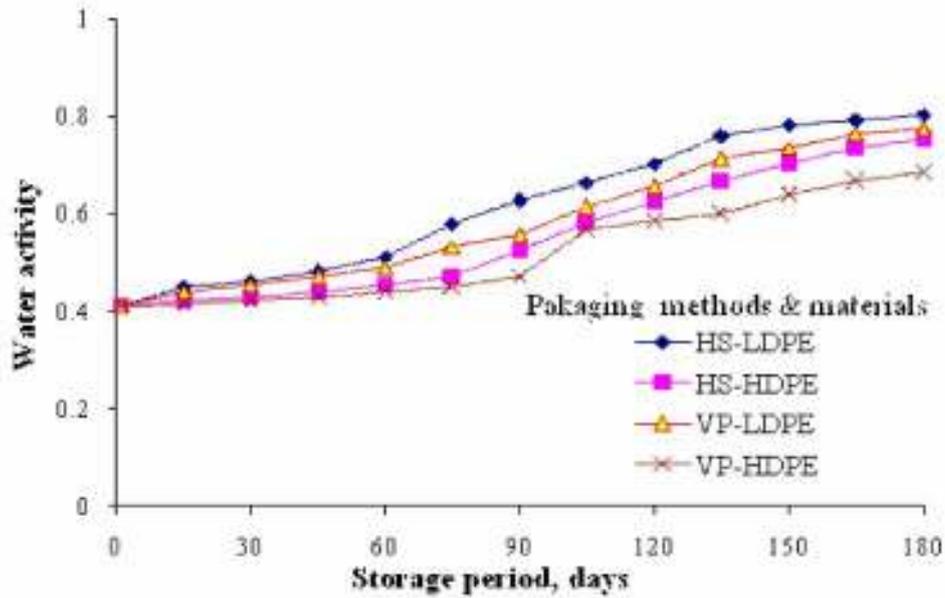


Fig 4. Variation in water activity of dehydrated fenugreek

Table 4. Mean sensory score for dried green fenugreek during storage study

Character	Storage period (Days)	Hot sealing		Vacuum packaging	
		LDPE	HDPE	LDPE	HDPE
Taste and Overall acceptability	1	89	89	89	89
	15	84	86	85	88
	30	81	84	83	85
	45	79	82	80	83
	60	76	78	77	79
	75	75	77	76	78
	90	73	75	74	76
	105	69	71	70	73
	120	67	70	68	71
	135	65	68	66	69
	150	64	66	65	68
	165	63	65	64	66
	180	62	64	63	65
	1	87	87	87	87
	15	81	84	83	85
	30	78	83	80	84
	45	75	78	77	82
	60	73	77	76	79
	75	71	75	74	76
	90	70	72	70	74
	105	68	70	68	71
	120	65	68	66	70
	135	64	66	65	67
	150	62	64	63	65
165	61	63	61	64	
180	60	62	61	63	

Sensory Analysis

It can be observed from Table 4 that the mean organoleptic score for taste and overall acceptability of the dried fenugreek leaves was found to decrease gradually with increase in storage period for both packaging materials and methods. The rate of decrease was observed higher in LDPE samples than that of HDPE, irrespective of packaging methods. At 180th day of storage, the mean organoleptic score for taste and overall acceptability was 62, 60; 63, 61 and 65, 64; 66, 65 for hot sealed and vacuum-packed LDPE and HDPE samples, respectively. Vacuum packed HDPE samples were observed to have higher shelf-life as compared to other samples. Findings are in confirmation with the Singh and Sagar (2010) for storage of dehydrated curry leaves and drumstick leaves in HDPE and followed by other packaging materials.

Conclusions

The rehydration ratio (RR) and water activity (a_w) was found to decrease and increase, respectively with advancement of storage period irrespective of packaging materials and methods but rate of reduction and increment was observed higher in LDPE pouches than that of HDPE. The colour value (L^* , a , & b) of samples packed in HDPE were observed higher than that of LDPE samples irrespective of packaging methods. Mean organoleptic score for taste and overall acceptability was found to decrease with increase in storage period but rate of decrease was higher in LDPE samples than that of HDPE. After 180 days of storage, the quality attributes viz. rehydration ratio, water activity and colour values (L^* , 'a', 'b') of vacuum packed HDPE samples were found as 2.80, 0.687, and 57.45, -18.84 & -27.24, respectively. The mean score of organoleptic properties i.e. taste and overall acceptability were evaluated as 65 and 63, respectively for vacuum packed HDPE samples after 180 days of storage.

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