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SHELF-LIFE OF LEMON FRUITS AS FUNCTION OF VARIOUS PACKAGING MATERIALS

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Abstract

Packaging materials are used to create a modified atmospheric condition around the fruits and develop a low oxygen zone for shelf-life extension during storage. Among different packaging materials, LDPE (low density polyethylene), HDPE (high density polyethylene), Cling film and Shrink film are widely used as packaging materials. LDPE (low density polyethylene) is characterized by high permeability to carbon di-oxide and other gases, HDPE (high density polyethylene) has high tensile strength, Shrink film packaging materials can reduce shrinkage and mechanical damage to fruits while Cling film is plastic stretch film which protects the fruits from loss of moisture and severely restrict the ventilation.
***Keywords*:** Cling film, high density polyethylene, lemon, low density polyethylene, shrink film.

Introduction

Lemon (*Citrus limon*) belongs to family Rutaceae which includes *Citrus medica*, pummelo, mandarins and papeda as real species while other known species have formed through artificial or natural hybridization (Hynniewta *et al.*, 2014). According to study of genetics lemon reported to be hybrid between bitter orange and citron (Mabberley, 1997). Lemon contains 40-60 mg of vitamin C per 100g of fruit (Bender, 2016). Lemons have copper, phosphorous, niacin, calcium, thiamine and magnesium in significant amount. Sore throat, cancer, heart disease, kidney stone formation and scurvy can be prevented with lemon (Kumar and Dwivedi, 2018a; Kumar *et al.*, 2018b; Kumar *et al.*, 2018c; Kumar and Dwivedi, 2018d; Kumar *et al.*, 2018e; Kumar and Pathak, 2019f; Kumar *et al.*, 2019g). Lemon can be cold stored at 10-13^{0}C and 85-90% relative humidity for 9-13 weeks. Freshly harvested fruits of lemon contain 65-95% water but because of respiration and transpiration it suffers a loss of 5-10 percent in fresh weight. Postharvest losses start from farm and goes up to market and consumers. Poor storage and postharvest facilities affect shelf life and quality of fruit (Siddique *et al.*, 2018h; Siddique *et al.*, 2018i; Pathak *et al.,* 2017j; Prakash *et al.,* 2014L; Kumar *et al.,* 2014m.; Kumar *et al.,* 2013o; Kumar *et al.*, 2014q). Modified atmosphere packaging develops a micro-atmosphere which is a low-oxygen atmosphere around the fruits and enable extension of shelf-life (Church and Parsons, 1995). While selecting packaging films for fruits, the main characteristics to be considered are gas permeability, water vapour transmission rate, mechanical properties, transparency, type of packaging material and sealing reliability (Jouki and Khazaei, 2014). The most commonly used packaging materials are LDPE (low density polyethylene), PVC (polyvinyl chloride), EVA (ethylene-vinyl acetate), paper, aluminium foil, Cellulose film (coated), Polythene, Rubber, Cellulose acetate, Vinylidene chloride etc. (Hicks, 2002; Ferrar *et al.*, 1988). These packaging materials are having wider scope in shelf-life extension of fruits and vegetables to ensure distribution of such materials to distant markets. However, the packaging materials used are also having certain limitations in terms of cost-effectiveness and eco-friendly claim. Thus, there is need to evaluate cost effective method of packaging for enhancing shelf-life and sustaining quality of fruits. The present study is centered towards the objective to evaluate the effect of different packaging films on shelf life of lemon fruits (Kumar, 2014r; Kumar *et al.*, 2012t; Kumar *et al.,* 2011u; Kumar *et al.,* 2011v; Kumar *et al.*, 2018y; Kumar *et al.*, 2018z; Kumar *et al.*, 2018aa.; Kumar *et al.*, 2018bb; Kumar *et al.*, 2018cc).

Material and methods

Packaging films for lemon

Six packaging materials viz. LDPE of 25 micron (A_2), Cellophane film of 30 micron (A_3), Cling film of 10 micron (A_4), Shrink film of 125 micron (A_5), Shrink film of 25 micron (A_6) and Control as unwrapped fruit (A_1) with three replications each were used. After packaging, fruits were stored under ambient condition at 21^{o}C to 22^{o}C and 45-48% RH and observations were taken at interval of 5 days (B_1), 10 days (B_2), 15 days (B_3), 20 days (B_4) and 25 days (B_5). The observations were recorded for fruit spoilage, physiological loss in weight (PLW) and various chemical properties. Physiological loss in weight was measured as reduction in weight of fruits at different interval of observation recorded. Spoilage percentage was calculated by counting the fruits which showed signs of spoilage and was expressed in percentage.

Results and Discussion

Spoilage percentage of fruits

Spoilage of fruits was not reported till 5th day of storage (B_1). At 10 days of storage (B_2), A_2, A_3 and A_6 packaging materials have retained better fruit quality without any spoilage; however, in A_1, A_4 and A_5 20% of spoilage was observed (Fig. 1). The fruits provided with A3 (Cellophane film of 30 micron) packaging have kept better fruit quality over all packaging materials and no spoilage was reported. However, 20 days onward the fruit spoilage was more than 50% in all packaging materials and was not supposed to be fit for storage. Thus, the little damage to fruit was also found in cellophane. That damage was less than other damages of different packaging films. At 25^{0}C spoilage was at fast rate but at 5 ^{0}C cellophane showed decrease in spoilage of Iranian

Dates (Salari *et al.*, 2008). Barmore *et al.* (1983) revealed that HDPE film reduced fruit spoilage by individual wrapping of citrus fruits. Ladaniya *et al.* (1997) observed less decay in individual wrapped nagpur mandarin (*Citrus reticulata*) with poly ethylene and cryovac heat shrinkable films as compared to tray-wrapped at ambient temperature (30-35^{0}C and 25-30% RH) or refrigeration (6-7^{0}C and 90-95% RH).

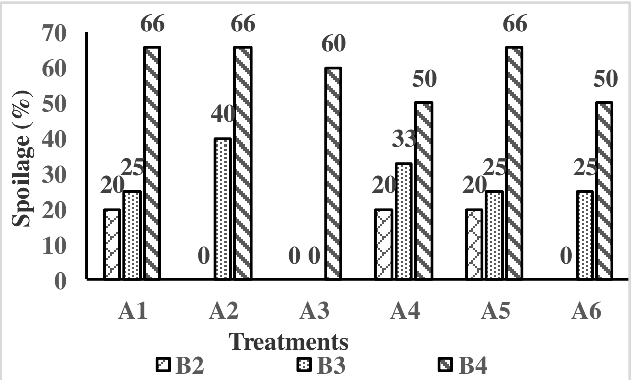

Fig. 1: Spoilage of fruits under different treatments during storage

[A-Package materials, A_1-Control, A_2-LDPE of 25 micron, A_3-Cellophane film of 30 micron, A_4-Cling film of 10 micron, A_5-Shrink film of 125 micron and A_6-Shrink film of 25 micron, B-Number of days of storage, B_1-At 5 days of storage, B_2-At 10 days of storage, B_3-At 15 days of storage, B_4-At 20 days of storage, B_5-At 25 days of storage]

Moisture content (%) and weight loss (%)

On the basis of single fruit weight loss highest weight loss was in control i.e. 8.93 g and minimum weight loss was noticed in cellophane i.e. was 2.6g on 5th day (Table 1 & 2). Overall highest weight loss was occurred in control during experiment from packaging to 25th day. Minimum weight loss was noticed in cellophane of 30 micron during all days of experiment which ranged between 2.06 - 2.6g followed by LDPE of 25 micron (2.53-4.05g). The minimum loss of fruit weight maybe due to minimum moisture loss which is attributed with the fruits stored with cellophane packaging. Garg *et al.* (1971) packed Dushehari mango in 200-gauge polythene bags having 0.65 perforation followed by storage at room temperature showed lower weight loss. Golomb *et al.* (1984) observed that sealing individually "Marsh Seedless" grape fruit in 0.015 mm thick HDPE sheet greatly reduced fruits weight loss under uncontrolled room conditions. Gilfillian (1985) compared unwaxed Valencia oranges wrapped in HDPE or LDPE with those of conventionally waxed and tissue paper wrapped fruits and observed minimum weight loss of film wrapped fruits with conventionally waxed fruits. Gorini and Testoni (1988) reported very positive result by packaging Italian oranges and lemons with HDPE of 15 micron and D950 of 15 micron and reduction in weight loss was obtained with films.

[A-Package materials, A_1-Control, A_2-LDPE of 25 micron, A_3-Cellophane film of 30 micron, A_4-Cling film of 10 micron, A_5-Shrink film of 125 micron and A_6-Shrink film of 25 micron, B-Number of days of storage, B_1-At 5 days of storage, B_2-At 10 days of storage, B_3-At 15 days of storage, B_4-At 20 days of storage, B_5-At 25 days of storage]

Table 1: Moisture content (%) inside packaging materials at different days of storage

Treat ments	B_0	B_1	B_2	B_3	B_4	B_5	Mean A
A_1	32.19	37.507	29.677	28.073	28.287	29.233	30.828
A_2	37.82	29.573	28.683	32.663	29.213	28.877	31.138
A_3	31.18	27.610	30.463	26.397	29.423	26.560	28.606
A_4	31.83	32.740	37.337	34.837	32.630	32.897	33.712
A_5	27.41	32.703	36.457	31.773	27.177	31.713	31.206
A_6	22.52	30.807	36.920	31.277	26.213	30.740	29.746
Mean B	30.49	31.823	33.256	30.837	28.824	30.003	
Factors	C.D.		SE(d)		SE(m)±		
Factor (A)	1.199		0.60		0.424		
Factor (B)	1.199		0.60		0.424		
Factor (A X B)	2.937		1.47		1.039		

Table 2: Weight loss of fruits inside packaging materials at different days of storage

Treat ments	B_1	B_2	B_3	B_4	B_5	Mean A
A_1	8.933	4.050	2.600	5.133	8.333	5.810
A_2	6.233	8.067	3.200	2.600	4.667	4.953
A_3	7.933	6.000	7.200	2.867	2.467	5.293
A_4	3.600	6.200	4.067	6.600	2.867	4.667
A_5	2.467	3.467	6.200	3.933	6.067	4.427
A_6	2.533	2.067	2.733	5.733	2.733	3.160
Mean B	5.283	4.975	4.333	4.478	4.522	
Factors	C.D.		SE(d)		SE(m)	
Factor (A)	0.177		0.088		0.062	
Factor (B)	0.162		0.081		0.057	
Factor (A X B)	0.396		0.197		0.14	

[A-Package materials, A_1-Control, A_2-LDPE of 25 micron, A_3-Cellophane film of 30 micron, A_4-Cling film of 10 micron, A_5-Shrink film of 125 micron and A_6-Shrink film of 25 micron, B-Number of days of storage, B_1-At 5 days of storage, B_2-At 10 days of storage, B_3-At 15 days of storage, B_4-At 20 days of storage, B_5-At 25 days of storage]

Conclusion

The present investigation confirms that cellophane 30-micron packaging is an economical and efficient method to increase shelf life of lemon up to 20 days with good quality.

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