Journal of Spices and Aromatic Crops
Vol. 23 (1) : 98–101 (2014)
www.indianspicesociety.in/josac/index.php/josac

Indian Society for Spices

Wax coating affects postharvest shelf-life of non-cooled sweet pepper

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Received 19 July 2013; Revised 13 September 2013; Accepted 27 September 2013

Abstract

Investigations were carried out to determine the effect of wax coating on physical and quality parameters in sweet pepper (*Capsicum annuum*) cv. Indra under ambient storage (25±5 °C). Wax coating with carnauba wax at 2% produced the lowest physiological loss of weight (PLW), and increased shelf-life, total soluble solids (TSS), total sugar content and ascorbic acid. Wax concentration of > 2% coating had little or no effect, on physical and biochemical characters. This suggested that 2% wax coating increased the shelf life, while concentration of > 2% did not enhance its shelf life.

Sweet pepper (*Capsicum annuum* L. var. *grossum* Srndt.) is a high value crop but short shelf-life restricts its availability and increases cost. Cold storage technique (7-9°C) is the only known economically feasible technique for short-term storage of sweet pepper. In India, the tropical climate and lack of adequate cold storage facilities shorten shelf-life of sweet pepper to only 6-8 days at ambient temperature (27±4°C). Hence, there is a need to extend shelf-life of sweet pepper at ambient temperatures in order to extend its availability and to reach distant markets (Jagadeesh *et al.* 2004). Sweet peppers are normally classified as nonclimacteric fruit that show no dramatic changes other than color from green to red during ripening (Biale 1964). Physiology of fruit growth and maturity of sweet pepper was discussed earlier in detail (Biles *et al*. 1993; Serrano *et al*. 1995; Tadesse 1997). Sweet pepper fruit, like other aerial plant parts, are covered with a cuticle, composed of biopolymer cutin and embedded wax with epicuticular waxes on the outer surface, which serves as the major barrier to moisture loss. Banaras *et al*. (1988) reported that fruits with greatest amount of epicuticular wax had the lowest rate of water loss. Though attempts have been made in the recent past to standardize cold storage techniques, India lacks the protocol of postharvest management for ambient storage. The present study was, therefore, undertaken to study the effects of wax coating on postharvest shelf life of sweet pepper under ambient storage.

Studies on enhancing shelf-life of sweet pepper,

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cv. Indra, were conducted in the Department of Vegetable crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore (11º02'N latitude and 77º03' E longitude at an altitude of 426.72 m MSL). The experiment was carried out from November 2003 to February 2004 and arranged in a completely randomized block design with 5 replications. Fruits were harvested from plants treated with $CaCl_2$ spray @ 400 ppm at 50% flowering and then followed by precooling. The harvested fruits were treated with different wax concentrations of 2%, 4% and 6%. The treatment also included a no wax control.

Initial weight of fresh fruit was recorded and subsequent weights determined daily. Fruit firmness was measured using a penetrometer. Fruits were cut and the pericarp thickness measured at the calyx end using a screw gauge. To determine shelf-life, 15 mature green fruits were selected at random from each treatment. The fruits were kept at room temperature (25±3°C). The fruits were scored on visual appearance using a chart which included the grades 1 to 5 for color (mature green, turning to yellow red, change to light red, light red and dark red), appearance (glossy green, dull glossy, good appearance, acceptable and not acceptable) and shrinkage (no shrinkage, little shrinkage, moderate shrinkage, maximum shrinkage and not acceptable). Based on the scores, shelf-life was calculated. A cumulative total score of color, appearance and shrinkage of six was the maximum to terminate shelf-ife. The ascorbic acid content was determined by 2, 6-dichlorophenol indophenol dye titration method (Freed 1966). Total sugar content was accessed using anthrone reagent method and values were expressed in percentage. Reducing sugar content was accessed using Nelson-Somoyogi method. Total chlorophyll content was estimated using 80% acetone and color intensity read at 652 nm. The epicuticular wax content was estimated using $K_2Cr_2O_7$ reagent (Ebercon *et al.* 1977). Data were analyzed with procedures of Panse & Sukhatme (1985). Differences between means were determined with standard error and critical difference.

The PLW differed during storage (Table 1) and 2% wax treatment had the lowest PLW, while the control had the highest PLW at 12th day of storage (DS). Fruit weight decreased as storage time increased. Moisture loss through transpiration reduces weight and eventually the material becomes unusable as a result of wilting and shrinking. In general, gases diffuse through pores in the skin of the fruit, while water moves preferentially through a liquid aqueous phase in the cuticle as observed in banana (Ben 1986). A similar trend was observed in this study. Ascorbic acid is a predominant vitamin in sweet pepper and tends to decrease during ripening of fruit. Low content in the control (Table 2) might be due to the effect of ethylene evolved by fruit during the process of ripening which would have destroyed the ascorbic acid.

Among wax coating treatments, fruits treated with 2% wax had the highest shelf-life

Table 1. Effect of wax coating treatments on physiological loss of weight (PLW; %) in sweet pepper, cv. Indra

Wax treatment	1st DS[a]	3rd DS	5th DS	7th DS	9th DS	11th DS	12th DS
2%	1.66	4.91	6.9	9.78	12.88	16.44	17.880
4%	1.81	5.24	7.18	10.2	15.98	19.86	22.440
6%	1.83	5.42	7.24	10.1	16.13	19.98	22.880
0%	1.95	5.56	7.48	11.44	16.94	21.23	23.450
SEm±	0.0467	0.1386	0.1877	0.2707	0.4063	0.5072	0.5666
CD (P<0.05)	0.0991**	0.2937**	0.3979*	0.5739**	0.8613**	1.0753**	1.2012**

*,** significant at P<0.05 or P<0.01; [a] DS=Days of storage

Table 2. Effect of wax coating treatments on ascorbic acid content (mg $100g^{-1}$) of sweet pepper, cv. Indra

Wax treatment	3rd DS [a]	6th DS	9th DS	12th DS
2%	158.21	138.21	130.12	117.02
4%	146.54	134.34	117.02	109.76
6%	150.41	130.15	117.02	107.76
Control	146.34	130.15	113.82	97.50
Mean	150.375	133.213	119.495	108.01
SEm±	1.5045	1.3325	1.1964	1.0823
CD (P<0.05)	3.1894**	2.8249**	2.5363**	2.2944**

** significant at P<0.01; [a] DS=Days of storage

(Table 3). Wax coating extended shelf-life of fruit by reducing PLW, ethylene synthesis and respiration, retarding color change and delaying biochemical changes and extending ripening and senescence of fruit (Amarante & Banks 2001). Wax coating restricted permeation of gases resulting in low level of O_2 and increased CO_2 concentration resulting in modified atmosphere around the fruit. Hence, rate of respiration was reduced, which prolonged the shelf-life of fruit. Treatment with 2% wax had the highest firmness and control had the lowest firmness over time (Table 4). Fruit treated with 2% wax had the highest firmness. Loss of firmness in wax coated fruit was slow. This was probably due to low rate of water loss from waxed fruit. Pericarp thickness varied during storage. Differences were found on the 6th, 9th and 12th DS. Fruit treated with 2% wax had the highest pericarp thickness. Wax depositions on fruit surface prevented loss of moisture extending firmness as reported by Potjewijd *et al.* (1995). Pericarp thickness was found to be related with respiration. Epicuticular wax content differed on 6th, 9th and 12th DS. However, 2% wax treatment had the highest epicuticular wax content on the 3rd, 6th, 9th and 12th DS. However,

Table 3. Effect of wax coating on epicuticular wax content and shelf-life of sweet pepper, cv. Indra

Wax treatment	Epicuticular wax content (μg cm^{-2} area)				Shelf life
	3rd DS	6th DS	9th DS	12th DS	(days)
2%	20.68	16.48	14.88	12.51	11.7
4%	19.88	14.98	13.82	10.43	9.8
6%	19.96	14.82	13.42	9.98	9.6
Control	19.84	14.54	12.71	9.31	9.2
Mean	20.0900	15.205	13.7075	10.5575	10.075
SEm±	0.5237	0.3966	0.3576	0.2781	0.7298
CD(P<0.05)	NS	0.8407**	0.758**	0.5896**	1.5472*

NS= Non significant; *,** significant at P<0.05 or P<0.01; DS=Days of storage

Table 4. Effect of wax coating on firmness (N) and pericarp thickness (mm) of sweet pepper, cv. Indra

Wax treatment	Firmness (N)				Pericarp thickness (mm)			
	3rd DS	6th DS	9th DS	12th DS	3rd DS	6th DS	9th DS	12th DS
2%	23.82	20.87	14.66	10.88	6.15	5.90	5.50	4.65
4%	22.42	17.88	12.12	8.47	6.10	5.65	5.05	4.00
6%	22.54	17.91	12.42	8.92	6.10	5.60	5.00	3.95
Control	21.74	16.42	11.64	7.84	6.00	5.55	4.90	3.70
Mean	22.6300	18.2700	12.7100	9.0275	6.0875	5.675	5.1125	4.075
SEm±	1.6328	1.3226	0.9204	0.6561	0.0609	0.0568	0.0512	0.0409
CD (P<0.05)	NS	2.8039*	1.9511*	1.3909**	NS	0.1203**	0.1085**	0.0867**

NS= Non significant; *** significant at P<0.05 or P<0.01; DS=Days of storage

the control had the lowest epicuticular wax content on 3rd, 6th, 9th and 12th DS. The findings suggested that 2% wax coating increased the shelf life and the concentration of > 2% did not enhance shelf life.

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