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Effect of Pretreatment on Quality Characteristics of Green Chillies during Storage

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ABSTRACT

The effect of edible coatings (viz. Liquid paraffin and Aloe-Vera gel) on different quality characteristics of fresh green chillies were studied. Two varieties of green chilli viz. tropica and crumpy were used for the study. The samples were stored for 6 weeks at refrigerated conditions (7°C) during the study. Changes in various quality characteristics of chillies were analyzed during storage viz. moisture content, chlorophyll content, capsaicin content, vitamin-C content and β-carotene. No significant differences between coated and uncoated chillies were noticed with respect to the hue angle and chromaticity that shows a stable color during the study. Changes in moisture content, chlorophyll content, capsaicin content, vitamin-C content and β-carotene content were lower in coated samples than that of uncoated chillies. Study showed that paraffin wax coating results better in terms of retention of parameters as compared to aloe vera gel.

Keywords: *edible coatings, green chillies, chlorophyll content, capsaicin content, vitamin-C content and β-carotene, paraffin wax, aloe vera gel.*

INTRODUCTION

Chilli (*Capsicum annuum* L.) is one of the most important spice crops of India and valued around the world for its color, flavor, spice, and nutritional value. India is not only the leading producer and exporter of chillies followed by China, Indonesia, Korea, Pakistan, Turkey, Sri Lanka, Nigeria, Ghana, Tunisia, Egypt, Mexico, the US, Yugoslavia, Spain, Romania, Bulgaria, Italy, Hungary, Argentina, Peru and Brazil but also the largest consumer of chillies in the world. The production and area under cultivation of chillies in India during 2012-2013 was 13.04 million metric tonnes and 0.794 metric hectares, respectively (National Horticulture Database, NHB). Fresh chillies are highly perishable and are preferentially consumed in fresh; in consequence, the fruit quality and shelf life are important factors in its commercial value. Chillies are highly perishable under ambient storage atmosphere and temperatures (Lowands et al., 1994). The shelf life of freshly harvested chillies is estimated to be 2–3 days. Fresh chilli loses water very quickly after harvest and begins to shrivel and turn color within a few days.

Edible coatings are applied on the horticulture produces to replace the natural waxy coating that is lost during handling. (Gol, 2013 and Dhall, 2013). Edible coatings provide a partial barrier to the movement of moisture on the surface of fresh produce minimizing moisture loss during postharvest storage. Coatings also work as a gas barrier establishing a modified atmosphere around the product, which slows down respiration, senescence and enzymatic oxidation and preserves colour and texture. Coatings help to retain natural aroma of produce and restrict foreign odours. Structural integrity is maintained in fresh produce and protection against mechanical damages is offered by coatings (Dhall, 2013; Ghasemnezhad, 2013; Mohebbi, 2012). Various edible coatings have been applied to reduce the moisture loss from the fresh commodities which in-turn increases the shelf life of the produce. Liquid paraffin and Aloe-Vera gel are effective edible coatings for shelf life extension of horticulture commodities.

This study was aimed to extend the shelf life of fresh green chillies using Liquid paraffin and Aloe-vera gel coatings as pretreatment and to study the changes in various quality parameters.

MATERIALS AND METHODS

The freshly harvested and mature field-grown green chillies of Tropica & Crumpy varieties were procured from Manoli co-operative fruit and vegetable producers & marketing society ltd., Village Manoli, Sonepat. Aloe-Vera gel and Liquid Paraffin procured from market were used as coating material.

Sample Preparation

Freshly harvested Chillies were graded to remove pest affected, over matured and damaged ones. Selected chillies were washed with chlorinated water to remove the adhering dust and dirt. The excess water was removed by spreading the washed chilies. The coatings were applied by dipping method as a uniform coating could be obtained by this method. Chillies were directly dipped into the coating solution and then excess coating was drained putting the chillies on a perforated vessel. Coated samples were stored under refrigerated condition (7ºC). Control sample (without any coating) was also kept along with the coated samples.

Physiochemical analysis of samples

Freshly harvested chilli samples and the samples under storage were tested for various physico-chemical quality parameters. The stored samples were analyzed weekly upto 06 weeks of storage period. The parameters analyzed are as follows:

Surface Colour Measurement

Surface color changes were measured using two objective tests. The surface color of chilli samples was measured using a Hand held Hunter colorimeter and the results were given on the basis of L, a and b values. These values were used to calculate chroma and hue angle values. Hue angle measurements aid in color description: 0° is purple color; 90° is yellow color; 180° is blue-green color; and 270° is blue color. Chroma values describe color intensity; vivid colors have high chroma values, while dull colors have low chroma values.

$$Chroma = \sqrt{(a^*)^2 + (b^*)^2}$$

$$Hue\ angle = \tan^{-1}(\frac{b^*}{a^*})$$

Chlorophyll and β- carotene Estimation

Chlorophyll and β- carotene were analyzed by the spectrohotometric method given by Katoch (2011). Chlorophyll and carotene were extracted in 80% acetone and the absorbance was taken at 663 nm, 645 nm and 450 nm in a spectrophotometer against the solvent (80% acetone) blank. Using the absorption coefficients, the amount of chlorophyll was calculated. Chlorophyll mg/g and β- Carotene µg fresh weight were calculated by the formula given below:

$$mg\ Chlorophyll\ {}^{a}/_{g}\ tissue, C_a = 12.7\ (A_{663}) - 2.69\ (A_{645}) \times \frac{V}{1000 \times W}$$

$$mg\ Chlorophyll\ {}^{b}/_{g}\ tissue, C_b = 22.9\ (A_{645}) - 4.68\ (A_{663}) \times \frac{V}{1000 \times W}$$

$$mg\ total\ chlorophyll = 20.2\ (A_{645}) + 8.02\ (A_{663}) \times \frac{V}{1000 \times W}$$

$$\mu g\ \beta - Carotene = 4.1\ (A_{450}) - 0.0435(C_a) - 0.367\ C_b$$

Where,

A663 = Absorbance at 663 nm

A645 = Absorbance at 645 nm

A450 = Absorbance at 450 nm

V = Final volume of chlorophyll extract in 80% acetone

W = Weight of sample taken

Moisture Content

The *moisture content* of chillies is measured by hot air oven method given by Vijayalakshmi and Rajarathnam (2011). The method is based on measuring the mass of food before and after the water is removed by evaporation. The calculation was done by using the following formula:

$$Moisture\ (\%) = \frac{M_1 - M_2}{M_1 - M} \times 100$$

Where, M = weight in gram of empty plate

M_1= weight in gram of plate with material before drying

M_2= weight in gram of plate with material after drying

Capsaicin Content

The *capsaicin content* was estimated by using the colorimetric method given by Katoch (2011). The principle involves that the phenolic

group in capsaicin reduces phosphomolybdic acid to lower acids of molybdenum. The resulting component is blue in color and is read at 650nm. The color intensity is directly proportional to the concentration of capsaicin.

Ascorbic Acid Content

The *ascorbic acid content* was measured by using the direct colorimetric method given by Ranganna (2011). This method is based on measurement of the extent to which a 2, 6-dichlorophenol-indophenol solution is decolorized by ascorbic acid in sample extracts and in standard ascorbic acid solutions as interfering substances reduce the dye slowly so rapid determination would be measuring mainly the ascorbic acid. The amount of ascorbic acid present was calculated by the following formula:

$$mg\ of\ ascorbic\ acid\ per\ 100\ gm\ of\ sample = \frac{ascorbic\ \ acid\ \ content\ \ \times volume\ \ made\ \ up\ \times 100}{ml\ \ of\ \ solution\ \ \ taken\ \ for\ \ estimation\ \ \times 1000\ \times volume\ \ \ of\ \ sample\ \ \ tak\ en}$$

Statistical Analysis

Analysis of variance (ANOVA) was applied using the Microsoft Excel 2010 to determine if any changes between treatment groups or changes during the storage period occurred. Comparison of means was performed by using least significant difference values (LSD) to evaluate significant differences at P = 0.05.

Results & Discussion

Change in Moisture Content

The most obvious difference between treated and untreated samples was observed in *moisture content* due to which weight loss occurs during storage. All treatments exhibited significant moisture loss during storage ($p<0.05$) in both the varieties of chilli (Figure-1 & 2). Uncoated control chillies were found to losing greater amounts of moisture significantly ($p<0.05$) during storage than any of the coated groups. The increased loss observed in uncoated samples emphasized the protective nature of the applied coatings. The loss in weight may be due to low relative humidity levels that may have increased the rate of water loss, and therefore accelerated deterioration. As none of the coated chillies differed significantly ($p>0.05$) in weight loss, it can be said that both the coating were effectively protective against weight loss regardless the material of coating.

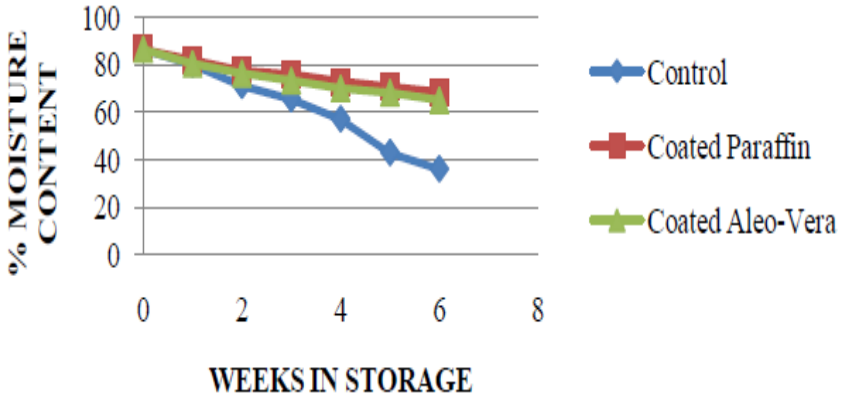

Figure1. *Change in moisture content of Crumpy Variety chillies during storage.*

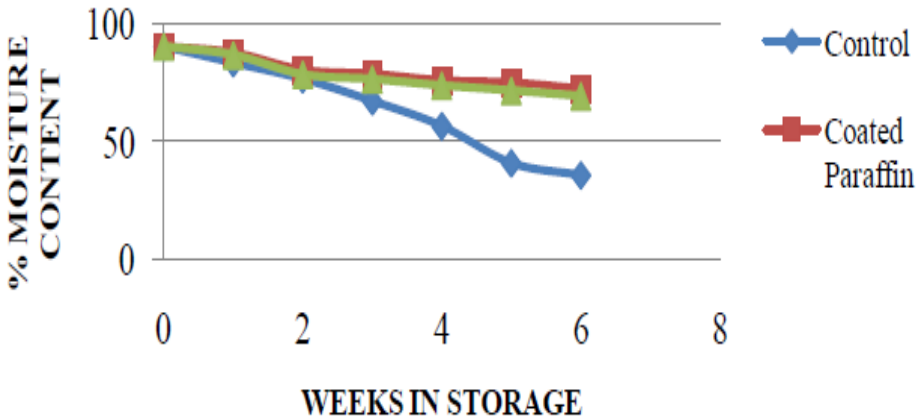

Figure2. *Change in moisture content of tropica variety chillies during storage.*

Change in Surface Colour

The colour change was given in terms of hue angle and chromaticity. Average hue angles for each treatment during the storage period are given in Table 1. Hue angle values for the control chillies did not differ significantly from coated chillies values ($p>0.05$) on any given week of the study. In addition, hue angles did not change significantly ($p>0.05$) from week to week during the study (Table 2). The lack of color differences after every experimental week indicates chillies color was stable throughout the study. Average weekly chromaticity values for both coated and uncoated chillies during study are listed in Table 3. No significant difference ($p>0.05$) in chroma value in different samples was seen during the storage period. The lack of change in vividness of color in the control group indicated that the color intensity did not diminish during storage. Weekly average chromaticity values for each sample are presented in Table 4.7. In general, treatments differed significantly in their chroma values ($p<0.05$), however there were no significant differences ($p>0.05$) between uncoated control chillies and coated chillies. Paraffin coated samples were found to have higher chromaticity than others.

Table1. *Average hue angle for coated and control green chillies stored for six weeks.*

Treatment	Tropica Variety	Crumpy Variety
Control	123.6443	121.4129
Paraffin Coated	123.9129	123.6371
Aloe-Vera Coated	122.9957	119.7571

** Treatments did not differ ($p>0.05$) in hue angle values.*

Table2. *Average weekly hue angle for coated and uncoated green chillies stored for six weeks.*

Weeks	Tropica Variety	Crumpy Variety
0	127.58	125.26
1	126.88	122.4133
2	124.60	121.3633
3	129.7	122.3067
4	125.19	120.75
5	126.59	117.4633
6	124.06	121.66

** Weeks did not differ significantly ($p>0.05$) in hue angle values.*

Table3. *Average chroma value for coated and control green chillies stored for six weeks.*

Treatments	Tropica Variety	Crumpy Variety
Control	24.76714	25.44
Paraffin coated	25.57714	26.96
Aloe-Vera coated	24.33571	25.73

**Treatments values did not differ significantly ($p>0.05$).*

Table4. *Average weekly chroma value for coated and control green chillies stored for six weeks.*

Weeks	Tropica Variety	Crumpy Variety
0	24.62	28.18
1	25.87	27.51
2	23.24	26.56
3	23.14	28.63
4	24.30	29.19
5	25.30	26.51
6	23.76	27.07

** Weeks did not differ significantly ($p>0.05$) in Chroma* values.

Table5. *ANOVA for variation of Tropica variety chilli during storage at refrigerated conditions*

	Source of Variation	SS	df	MS	F	P-value	F crit
Moisture Content	Rows	1017.64	2	508.819	7.390053	0.008095	3.885294
	Columns	2408.852	6	401.475	5.83099	0.004748	2.99612
	Error	826.224	12	68.852			
	Total	4252.716	20				
Hue Angle	Rows	33.4325	2	16.7162	1.110724	0.360931	3.885294
	Columns	278.6016	6	46.4336	3.085316	0.045778	2.99612
	Error	180.5984	12	15.0498			
	Total	492.6326	20				
Croma	Rows	5.56121	2	2.78060	0.133844	0.876014	3.885294
	Columns	413.0257	6	68.8376	3.31349	0.036708	2.99612
	Error	249.2995	12	20.7749			
	Total	667.8865	20				
Chlorophyll Content	Rows	0.014129	2	0.00706	16.75592	7.77E-05	3.554557
	Columns	0.253604	9	0.02817	66.83554	5.45E-12	2.456281
	Error	0.007589	18	0.00042			
	Total	0.275322	29				

Vitamin-C Content	Rows	1933.579	2	966.789	10.14673	0.002633	3.885294
	Columns	29080.97	6	4846.82	50.86884	7.68E-08	2.99612
	Error	1143.371	12	95.2808			
	Total	32157.92	20				
B-Carotent Content	Rows	1.162061	2	0.58103	17.60913	0.000269	3.885294
	Columns	7.865323	6	1.31088	39.72871	3.12E-07	2.99612
	Error	0.395952	12	0.03299			
	Total	9.423336	20				
Capsaicin Content	Rows	0.174617	2	0.08730	14.20939	0.000685	3.885294
	Columns	0.874306	6	0.14571	23.71541	5.4E-06	2.99612
	Error	0.073733	12	0.00614			
	Total	1.122656	20				

**Rows: Control, Paraffin Coated & Aloe-vera Coated, Column: Storage Weeks*

Table6. *ANOVA for variation of Crumpy variety chilli during storage at refrigerated conditions*

	Source of Variation	SS	Df	MS	F	P-value	F crit
Moisture Content	Rows	741.8782	2	370.9391	7.512493	0.007665	3.885294
	Columns	2070.972	6	345.162	6.99044	0.002225	2.99612
	Error	592.5156	12	49.3763			
	Total	3405.366	20				
Hue Angle	Rows	53.06755	2	26.53378	3.244752	0.074737	3.885294
	Columns	97.35171	6	16.22529	1.984152	0.147157	2.99612
	Error	98.12931	12	8.177443			
	Total	248.5486	20				
Croma	Rows	79.4918	2	39.7459	1.959647	0.183461	3.885294
	Columns	190.6342	6	31.77237	1.566517	0.239032	2.99612
	Error	243.3861	12	20.28217			
	Total	513.5121	20				
Chlorophyll Content	Rows	0.034209	2	0.017104	26.51756	3.95E-05	3.885294
	Columns	0.190449	6	0.031742	49.21008	9.28E-08	2.99612
	Error	0.00774	12	0.000645			
	Total	0.232398	20				
Vitamin-C Content	Rows	1990.829	2	995.4144	18.83333	0.000199	3.885294
	Columns	36538.97	6	6089.829	115.2201	6.71E-10	2.99612
	Error	634.2464	12	52.85387			
	Total	39164.05	20				
B-Carotent Content	Rows	1.057151	2	0.528575	16.95981	0.000318	3.885294
	Columns	13.34932	6	2.224886	71.38744	1.09E-08	2.99612
	Error	0.373996	12	0.031166			
	Total	14.78046	20				
Capsaicin Content	Rows	0.029055	2	0.014528	8.867741	0.00432	3.885294
	Columns	0.478734	6	0.079789	48.70328	9.85E-08	2.99612
	Error	0.019659	12	0.001638			
	Total	0.527449	20				

**Rows: Control, Paraffin Coated & Aloe-vera Coated, Column: Storage Weeks*

Change in Chlorophyll Content

Average *chlorophyll content* for all the samples showed a significant linear trend ($p<0.05$) during the study (Figure 3 & 4). Results showed higher chlorophyll amounts at the beginning which decreased linearly during the study. Chlorophyll was found to be appreciably reduced 15-20% during the storage in treated while in untreated it is reduced to 40-45%. Due to decreased chlorophyll content in the later weeks of storage, chillies appeared to become more yellow, which suggests chlorophyll degradation. Uncoated control chillies differ significantly ($p<0.05$) in chlorophyll content from coated groups on any given week during

storage at refrigerated conditions 7ºC. Analysis of changes in individual treatments over the six-week period showed there was a significant positive linear ($p<0.05$) relationship between chlorophyll content of the paraffin coated chillies and week of the study. The results also showed that the paraffin coating retained higher amount of chlorophyll content than the aloe-vera coating.

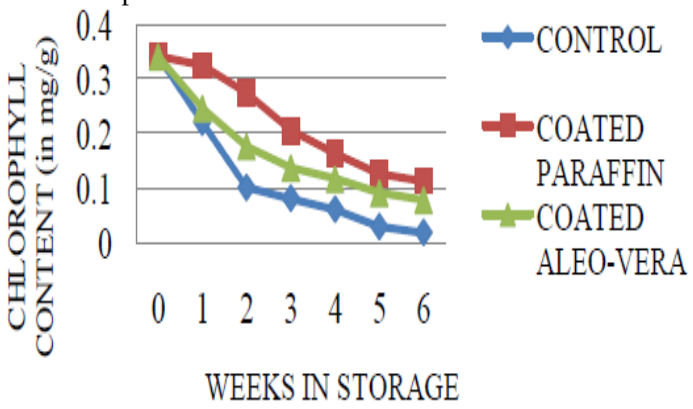

Figure3. *Change in Chlorophyll Content Tropica variety Chillies during storage*

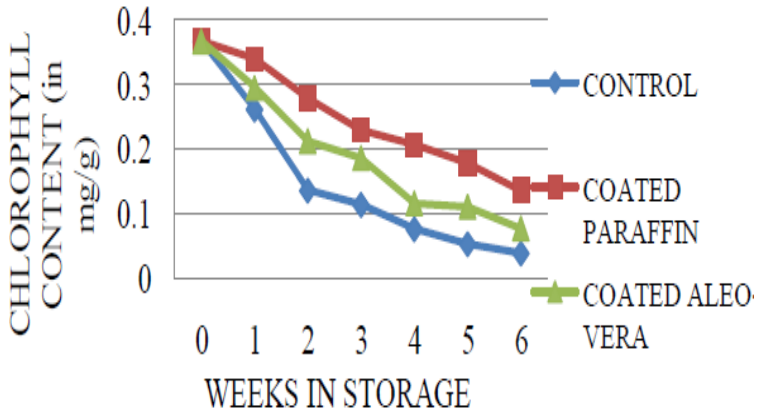

Figure4. *Change in Chlorophyll Content Crumpy variety Chilies during storage.*

Change in Ascorbic Acid Content

Ascorbic acid content in chilli samples decreased during the study. Uncoated chilies differed significantly from coated challis during any week of the study ($p<0.05$). A significant decreasing linear trend over weeks in ascorbic acid content for all treatments was seen ($p<0.01$) (Figure 5 & 6). Individual coated samples exhibited linear trends for both paraffin coated chilies ($p<0.05$) and aloe-vera coated chilies ($p<0.05$). Ascorbic acid is oxidized and converted into de-hydro ascorbic acid with reacts with oxygen. The application of coatings protected the oxidation of ascorbic acid as it prevents the interaction of oxygen. Paraffin coated chilli samples showed minimum changes in ascorbic acid content as compared to aloe vera coated ones.

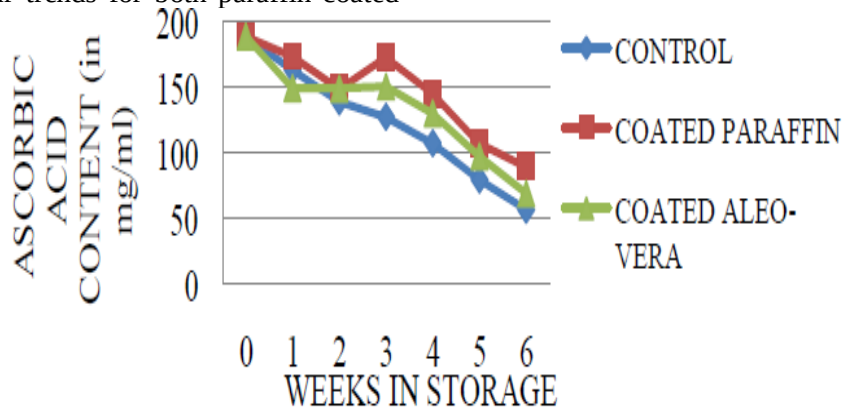

Figure5. *Change in Ascorbic Acid Content of Tropica variety Chillies during storage.*

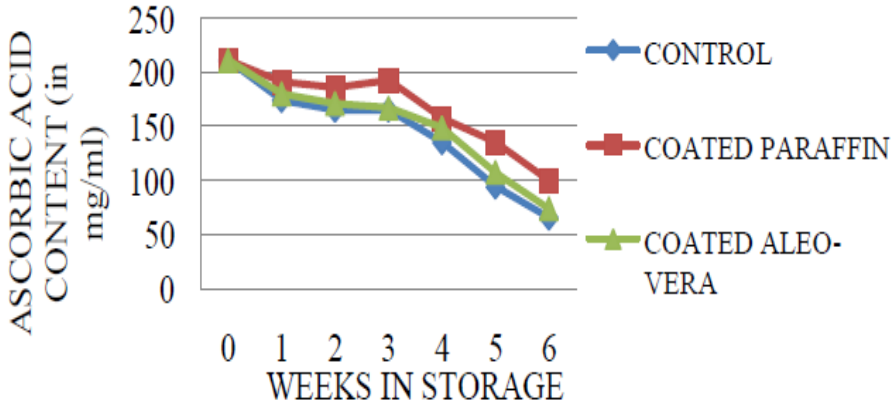

Figure5. *Change in Ascorbic Acid Content of Crumpy variety Chillies during storage*

Changes in β-carotene Content

The *β-carotene content* in chilli samples showed a decreasing trend during the study. There were significant differences (P<0.05) in *β-carotene* concentration between coated chillies and uncoated chillies during storage (Figure 7 & 8). Chilli samples coated with paraffin and aloe-vera showed small loss in *β-carotene* content than uncoated chillies during storage. In addition, there was significant difference (P < 0.05) between coated chillies during storage. Liquid paraffin coated chillies retained higher amount of β-carotene as compared to Aloe Vera gel coated samples.

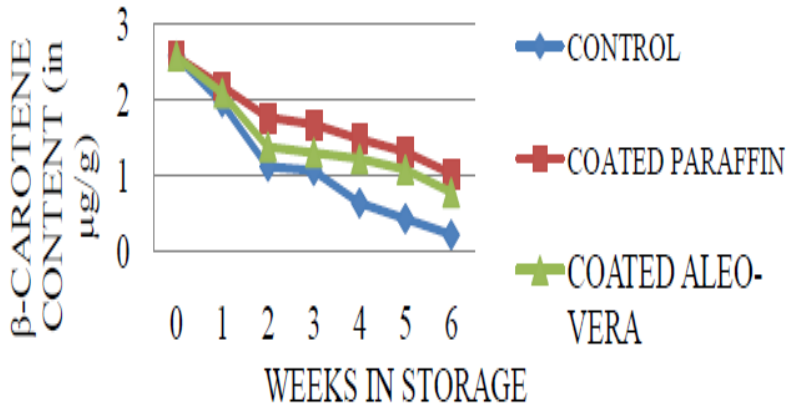

Figure6. *Change in β-Carotene Content of Tropica variety green chillies during storage.*

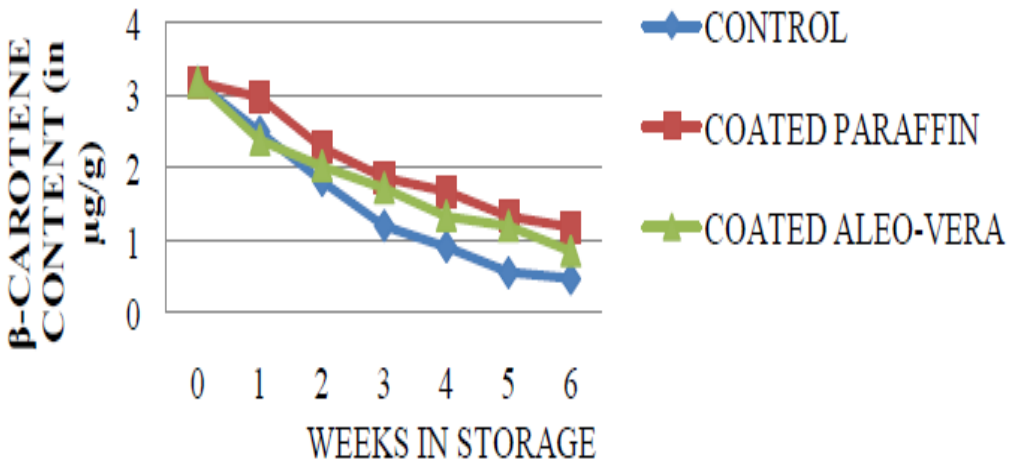

Figure7. *Change in β-Carotene Content of Crumpy variety green chillies during storage.*

Change in Capsaicin Content

Total capsaicinoids comprising of capsaicin and dihydrocapsaicin was measured in green chillies during storage at 7°C after. There were significant differences (P<0.05) in capsaicinoid concentration between coated chillies and uncoated chillies

(Figure 9 & 10). Total capsaicinoid concentrations decreased in chillies during storage. Coated chillies showed small loss in capsaicinoid content than uncoated chillies during storage. In addition, there was significant difference ($P < 0.05$) between coated chillies during storage. Paraffin coating retained maximum amount of capsaicin content during storage than the Aloe-Vera and uncoated samples.

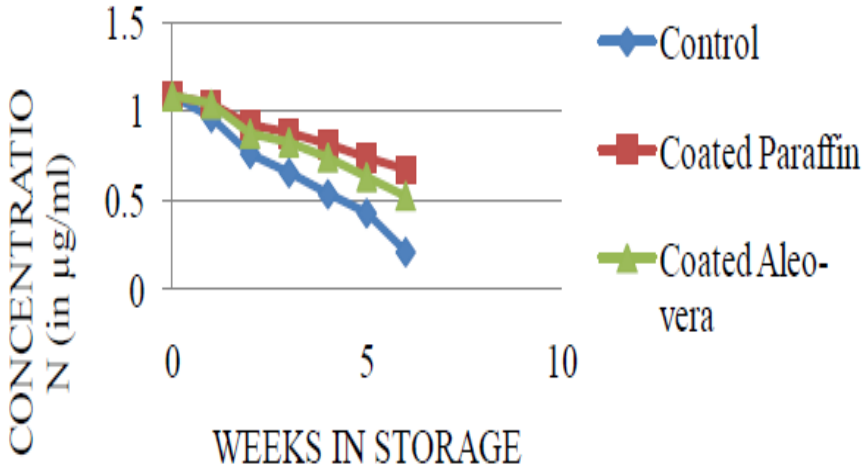

Figure8. *Change in Capsaicin content of Tropica variety chillies during storage.*

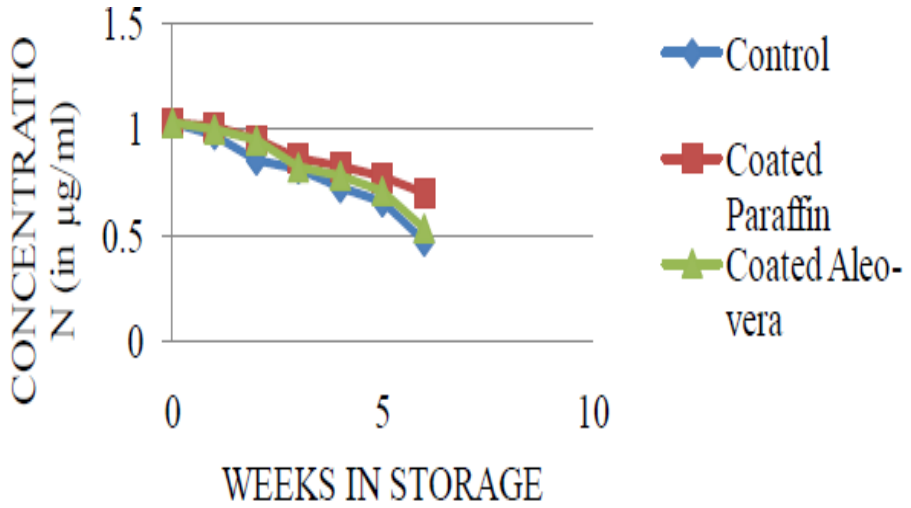

Figure9. *Change in Capsaicin content of Crumpy variety chillies during storage*

CONCLUSION

The study concludes that the application of edible coatings viz. Liquid Paraffin and Aloe-Vera gel could be used to enhance the shelf life of green chillies and to prevent the changes in various quality characteristics. The samples coated with these edible coatings and stored under refrigerated condition were found acceptable in terms of the appearance and texture. Not only the sensory quality but the nutritive quality of the coated samples in terms of ascorbic acid content, capsaicin content, carotene content, was also found better than the control one. Ascorbic acid content and carotene content decreased to 20-25% & 15-20% respectively in treated chillies during the study indicating that vitamin loss. Also, capsaicin content of chillies decreases to 15-20% during the study indicating the loss in phytochemical properties. Variety of chilli has no effect on quality parameters. Both the varieties studied, exhibited the same pattern during storage. Paraffin coating was found better in retention of these quality parameters as compared to aloe-vera coating during storage of chillies at refrigerated conditions (7ºC).

Figure11. *Chilies in the last week of storage at refrigerated conditions (7ºC)*

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