

Original Research Article

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Effect of Minimal Processing and Packaging on Physico Chemical Composition of Carrots (*Daucus carota*)

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ABSTRACT

Food market continuously generates novel products by following trends of consumers whose preferences are increasing towards ready-to-use foods. Among these minimally processed vegetables are at top as 'quick' and convenient products that preserve their nutritional value and texture and contain fewer additives. Further edible coatings can extend the shelf life and improve the quality of vegetables by creating a modified atmosphere inside the vegetable due to their barrier properties to gases and moisture. Sliced carrots were coated with edible coating of carboxy methyl cellulose (CMC- 1, 2 and 3 per cent) and sucrose (1, 2 and 3 per cent) and packed (200g) in polypropylene bags and shrink wrap film and analysis was carried out at 7 days interval. The physiological loss in weight and rotting index in both packaging showed an increasing trend during 21 days of storage and treatment T₃ (2% CMC) recorded the lowest physiological loss and rotting index after 21 days storage. Storage period also significantly influenced the TSS and titratable acidity of minimally processed carrots and it increased with the advancement in storage period. The treatment T₄ (3% CMC) recorded the highest value of 11.93°Brix in shrink wrap and 11.17°Brix in polypropylene bags. On the basis of sensory scores, treatment T₃ (2% CMC) was rated best amongst all treatments for overall acceptability scores. Therefore, minimally processed with 2 per cent edible coating (CMC) is an effective treatment for extending shelf life of carrots with retention of physical, nutritional and sensory characteristics.

Keywords

Carrot, Minimal processing, Carboxy methyl cellulose, Sucrose, Sensory scores

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Introduction

The fresh cut fruits and vegetables industry is constantly growing mainly due to the consumer's tendency of health consciousness and their increasing interest in the role of food for maintaining and improving human well-being (Omus-Oliu *et al.*, 2010). Minimally processed products have been defined as any fruit or vegetables or any combination thereof,

which has been physically altered from its original but has remained in its fresh condition (IFPA, 2000).

Minimally processed vegetables (fresh cut vegetables) are highly perishable because of exposed internal tissue, lack of skin, a cuticle for protection and activated metabolism. The main changes in the products are increased metabolic activity, enzymatic browning and

presence of micro organisms and pathogens in the plant tissues that have been processed.

In the fresh produce industry especially with fruits and vegetables, edible coatings have been used in an attempt to preserve fresh cut products because the coatings act as barriers to water loss and gas exchange, creating a micro modified atmosphere around products. Edible films are thin films prepared from edible material that act as a barrier to external elements (factors such as moisture, oils, gases and vapors) and thus protect the product, extend its shelf life and improve its quality (Krochta and Mulder-Johnston, 1997). The need is basically emphasized based on the increasing demand for high quality minimal processed food and storage technologies.

Minimal processed carrots (*Daucus carota* L.) are ready to eat products with a limited shelf life due to physiological disorder called “white blush”. Formation of whitish appearance on the surface of the peeled carrots has been attributed to dehydration and possible formation of lignin in response to peeling (Baldwin *et al.*, 1995). Therefore, some dipping treatments and edible coatings or acidic environment can be used to inactivate the lignification process which is enzyme mediated. Also, losses of carotene have been reported in fresh cut carrots and with application of edible coatings, about 50 per cent retention can be obtained. Therefore, in this study suitability of edible coatings along with chlorine dip combined with packaging was investigated to prevent the quality loss during storage of fresh cut minimally processed carrot.

Materials and Methods

Procurement of raw materials

Good quality fresh carrot vegetables were purchased from the local market. Two

packaging materials viz. polypropylene bags of 0.02mm thickness and polystyrene trays with shrink wrap covering were used for packaging of minimally processed carrots in 250 gm packaging. The edible coatings viz. carboxy methyl cellulose (CMC) and sucrose were used for coatings of minimally processed carrots. Prior to coating, the carrots were given chlorine dip, ascorbic acid dip and finally benzoic acid dip.

Preparation of minimally processed carrots

The whole carrots were peeled and the head and tail were removed. The prepared carrots were washed thoroughly and given chlorine dip (0.1%) for 3 minutes followed by benzoic acid dip (1%) for 2 minutes and drained properly. After dip, the minimally processed carrots (MPC) were sliced into slices (1cm thick) and given ascorbic acid (1%) dip for 3 minutes then subjected to below mentioned treatments and The edible coated carrots were packed in polypropylene bags and polystyrene trays covered with shrink wrap film in 250 gm packing stored under refrigerated conditions.

T₁ = Control

T₂ = Minimally processed carrots + 1% carboxy methyl cellulose.

T₃ = Minimally processed carrots + 2% carboxy methyl cellulose.

T₄ = Minimally processed carrots + 3% carboxy methyl cellulose.

T₅ = Minimally processed carrots + 1% sucrose solution

T₆ = Minimally processed carrots + 2% sucrose solution

T₇ = Minimally processed carrots + 3% sucrose solution

Physico-chemical analysis

Colour values (L*, a* and b*)

Color analysis of the minimally processed carrots was done by using Hunter Lab colorimeter using method of Vargas *et al.*, (2009).

Rotting index

Rotting index was calculated based on number of carrot discs showing symptoms of decay (D) to the total no of carrot discs per bag (TC) at the end of 21 days of storage (Ngure *et al.*, 2009).

$$ID (\%) = [(D/TC) * 100]$$

Total soluble solids, titratable acidity and reducing sugars

Total soluble solids (TSS), Titratable acidity and Reducing Sugars were measured by using standard procedure as given by (Ranganna, 2006).

pH

The pH was determined by using pH meter calibrated with a standard buffer solution of pH as described by AOAC (2002).

Total plate count

Total plate count of micro-organisms present in toffees was estimated as per Palczar and Chan (1991). Firstly 1: 10 dilution was prepared by mixing the 1 g in 9 mL buffered peptone water and homogenize for 1 min, followed by serial dilution. An amount of 15 mL cooled media was poured aseptically into pre-sterilized Petri-dishes. The plates were incubated in inverted positions for 24 h at 35°C. Then colonies were counted after 24 to 36 h.

Overall acceptability scores

Sensory evaluation depends upon the responses given by different sense organs. The samples were evaluated for overall acceptability by semi-trained panel of 7-8 judges by using 9 point hedonic scale assigning scores 9- like extremely to 1- dislike extremely. A score of 5.5 and above was considered acceptable (Amerine *et al.*, 1965).

Statistical analysis

All the experiments were conducted in factorial completely randomized design with each treatment replicated three times. The data was analyzed to test statistical significance as per Panse and Sukhatme (1967).

Results and Discussion

Colour values

There was a significant increase in L* values (Table 1a) of minimally processed carrot with the advancement in storage period. The treatment T₁ (control) recorded the highest L* value of 53.11 in polypropylene bags and 53.18 in shrink wrap after 7 days of storage. However, after 21 days of storage treatment, T₇ (3% sucrose) recorded the lowest value of 52.82 in polypropylene bags and 52.91 in shrink wrap.

In case of a* values (Table 1b), the highest value of 43.47 in polypropylene bags and 43.59 in shrink wrap were recorded in T₄ (3% CMC) and the lowest values of 38.68 in polypropylene bags and 38.81 in shrink wrap were recorded in T₁ (control). As the storage period advanced, a decrease in a* values was observed. A significant decrease in b* values (Table 1c) was noticed during storage and the mean values decreased from 26.70 to 25.40 in polypropylene bags and 26.70 to 25.58 in shrink wrap packaged minimally processed

carrots. Karande *et al.*, (2014) also reported increase in L^* of minimally processed carrots during low temperature storage in PP and LDPE bags. Spokowski (2010) and Djioua *et al.*, (2009) also reported similar findings during refrigerated storage of broccoli, cauliflower and carrots and minimally processed mangoes. Increase in L^* values and decrease in a^* and b^* values in minimally processed pumpkin coated with xanthan gum, chitosan and glycerol have been reported by Cortez-Vega (2014) and Incedayi *et al.*, (2009) and this was due to reduced impairment of the visual aspect of pumpkin cubes after use of edible coatings.

Rotting index

Rotting index (Table 2) showed an increasing trend during storage period. T_1 (control) recorded the maximum rotting index of 4.80 per cent in polypropylene bags and 4.58 per cent in shrink wrap after 14 days of refrigerated storage, however, the minimum rotting index content of 1.55 per cent in polypropylene bags and 1.40 per cent in shrink wrap were noticed in T_5 (1% sucrose).

After 21 days of storage, highest rotting index content of 9.39 per cent in polypropylene bags and 9.11 per cent in shrink wrap were recorded by T_1 (control) where as a minimum of 3.76 per cent in polypropylene bags and 3.64 per cent in shrink wrap were observed in treatment T_3 (2% CMC). Ngure *et al.*, (2009) reported that storage and packaging affected quality of okra pods because packaging might have improved moisture retention and reduced exposure to micro-organisms and contaminants. Mastromatteo (2012) demonstrated that coating fresh cut carrots with sodium alginate followed by packaging into perforated polypropylene film prevents dehydration and microbial proliferation, delays respiratory activity and enhances quality of product stored at 4°C.

Total soluble solids

Storage period and packaging also significantly influenced the TSS content (Table 3) of minimally processed carrots. The treatment T_7 (3% CMC) recorded the highest TSS content of 11.80 °Brix in polypropylene bags and 11.93 °Brix in shrink wrap at 7 days of storage. However, after 21 days of storage treatment T_1 (control) recorded the lowest value of 11.80 °Brix in polypropylene bags and 12.02 °Brix in shrink wrap packed minimal processed carrots Opoku *et al.*, (2009) also reported increase in TSS content of refrigerated stored carrots.

Rashidi and Bahri *et al.*, (2009) also reported increase in TSS content during storage of carrots. Increase of TSS is caused through starch hydrolysis by α - amylase enzyme during storage (Wills *et al.*, 2007). Manoj *et al.*, (2016) and Marpudi (2011) also gave similar findings in edible coated bell pepper and papaya during storage.

Titrateable acidity

The titrateable acidity (Table 4) increased during refrigerated storage of minimally processed carrots and after 7 days of storage period, the highest titrateable acidity of 0.23 per cent in polypropylene bags and 0.22 per cent in shrink wrap were recorded by treatment T_5 (1% sucrose), whereas, T_4 (3% CMC) recorded the lowest titrateable acidity of 0.17 per cent in polypropylene bags and 0.16 per cent in shrink wrap packaged minimally processed carrots. The mean titrateable acidity increased from 0.18 to 0.23 per cent in polypropylene bags and from 0.18 to 0.22 per cent in shrink wrap packed carrots during 21 days storage. Geeta (2015) and Cortez-Vega *et al.*, (2014) also reported increase in acidity of minimally processed carrots and pumpkin cubes during storage. This was due to increase in organic acids.

Table.1 (a) Effect of edible coatings and packaging on L* values in minimally processed carrots during refrigerated storage

Treatments	Packaging									
	Polypropylene					Shrink wrap				
	Storage (days)					Storage (days)				
	0	7	14	21	Mean	0	7	14	21	Mean
T ₁ (Control)	52.84	53.11	53.58	53.87	53.35	52.84	53.18	53.67	54.0	53.42
T ₂ (1% CMC)	52.48	52.70	52.99	53.32	52.87	52.48	52.86	53.19	53.72	53.06
T ₃ (2% CMC)	51.80	52.23	52.43	53.07	52.38	51.80	52.40	52.89	53.34	52.61
T ₄ (3% CMC)	51.53	51.90	52.36	52.96	52.19	51.53	52.16	52.71	53.10	52.38
T ₅ (1% Sucrose)	52.32	52.58	52.84	53.24	52.75	52.32	52.72	52.98	53.65	52.92
T ₆ (2% Sucrose)	51.75	52.18	52.31	53.00	52.31	51.75	52.36	52.90	53.23	52.56
T ₇ (3% Sucrose)	51.30	51.76	52.13	52.82	52.00	51.30	51.82	52.43	52.91	52.12
Mean	52.00	52.35	52.66	53.18		52.00	52.50	52.97	53.42	
CD (P = 0.05)										
Packaging (A)	=	0.01	A×B	=	0.02					
Storage (B)	=	0.02	A×C	=	N/S					
Treatments (c)	=	0.02	B×C	=	0.05					
			A×B×C	=	0.07					

Table.1 (b) Effect of edible coatings and packaging on a* values in minimally processed carrots during refrigerated storage

Treatments	Packaging									
	Polypropylene					Shrink wrap				
	Storage (days)					Storage (days)				
	0	7	14	21	Mean	0	7	14	21	Mean
T ₁ (Control)	39.47	38.68	38.29	37.10	38.39	39.47	38.81	38.40	37.86	38.64
T ₂ (1% CMC)	41.15	39.35	39.06	37.98	39.39	41.15	39.50	39.89	38.22	39.69
T ₃ (2% CMC)	42.70	42.22	41.89	41.43	42.06	42.70	42.42	42.03	41.95	42.28
T ₄ (3% CMC)	43.91	43.47	43.01	42.71	43.28	43.91	43.59	43.13	42.82	43.36
T ₅ (1% Sucrose)	39.81	39.20	38.69	38.02	38.93	39.81	39.29	38.88	38.17	39.04
T ₆ (2% Sucrose)	42.31	42.05	41.63	41.10	41.77	42.31	42.17	41.78	41.19	41.86
T ₇ (3% Sucrose)	43.58	43.00	42.56	42.08	42.81	43.58	43.22	42.92	42.47	43.05
Mean	41.85	41.14	40.73	40.06		41.85	41.29	41.00	40.38	
CD (P = 0.05)										
Packaging (A)	=	0.01	A×B	=	0.02					
Storage (B)	=	0.02	A×C	=	0.03					
Treatments (c)	=	0.02	B×C	=	0.04					
			A×B×C	=	0.05					

Table.3 Effect of edible coatings and packaging on TSS (⁰B) in minimally processed carrots during refrigerated storage

Treatments	Packaging									
	Polypropylene					Shrink wrap				
	Storage (days)					Storage (days)				
	0	7	14	21	Mean	0	7	14	21	Mean
T ₁ (Control)	10.69	11.17	11.54	11.80	11.30	10.69	11.30	11.58	12.02	11.40
T ₂ (1% CMC)	10.83	11.26	11.68	11.90	11.42	10.83	11.35	11.70	11.99	11.47
T ₃ (2% CMC)	10.88	11.32	11.71	11.95	11.47	10.88	11.51	11.72	12.17	11.57
T ₄ (3% CMC)	11.06	11.55	11.92	12.27	11.70	11.06	11.67	11.96	12.40	11.77
T ₅ (1% Sucrose)	11.10	11.45	11.94	12.09	11.65	11.10	11.59	11.97	12.15	11.70
T ₆ (2% Sucrose)	11.16	11.73	12.03	12.18	11.78	11.16	11.80	12.05	12.29	11.83
T ₇ (3% Sucrose)	11.30	11.80	12.19	12.45	11.94	11.30	11.93	12.23	12.57	12.01
Mean	11.00	11.47	11.86	12.09		11.00	11.59	11.89	12.23	
CD (P = 0.05) Packaging (A) = 0.01 A×B = 0.02 Storage (B) = 0.01 A×C = 0.02 Treatments (c) = 0.02 B×C = 0.03 A×B×C = 0.05										

Table.4 Effect of edible coatings and packaging on titrable acidity (%) in minimally processed carrots during refrigerated storage

Treatments	Packaging									
	Polypropylene					Shrink wrap				
	Storage (days)					Storage (days)				
	0	7	14	21	Mean	0	7	14	21	Mean
T ₁ (Control)	0.21	0.22	0.22	0.25	0.23	0.21	0.21	0.22	0.23	0.22
T ₂ (1% CMC)	0.18	0.20	0.21	0.23	0.21	0.18	0.19	0.20	0.22	0.20
T ₃ (2% CMC)	0.16	0.18	0.20	0.22	0.19	0.16	0.17	0.19	0.20	0.18
T ₄ (3% CMC)	0.15	0.17	0.19	0.21	0.18	0.15	0.16	0.18	0.20	0.18
T ₅ (1% Sucrose)	0.21	0.23	0.23	0.26	0.22	0.21	0.22	0.22	0.24	0.22
T ₆ (2% Sucrose)	0.18	0.21	0.21	0.24	0.21	0.18	0.18	0.20	0.22	0.20
T ₇ (3% Sucrose)	0.17	0.19	0.19	0.23	0.19	0.17	0.17	0.19	0.20	0.18
Mean	0.18	0.19	0.20	0.23		0.18	0.18	0.20	0.22	
CD (P = 0.05) Packaging (A) = N/S A×B = N/S Storage (B) = 0.01 A×C = N/S Treatments (c) = 0.02 B×C = N/S A×B×C = N/S										

Table.7 Effect of edible coatings and packaging on overall acceptability in minimally processed carrots during refrigerated storage

Treatments	Packaging									
	Polypropylene					Shrink wrap				
	Storage (days)					Storage (days)				
	0	7	14	21	Mean	0	7	14	21	Mean
T₁ (Control)	7.97	6.99	6.52	5.59	6.77	7.97	7.05	6.58	5.70	6.83
T₂ (1% CMC)	7.91	7.71	7.53	7.04	7.55	7.91	7.77	7.50	7.13	7.58
T₃ (2% CMC)	8.06	7.85	7.70	7.35	7.74	8.06	7.94	7.65	7.42	7.77
T₄ (3% CMC)	7.93	7.71	7.63	7.12	7.60	7.93	7.79	7.52	7.18	7.61
T₅ (1% Sucrose)	7.80	7.56	7.34	6.81	7.38	7.80	7.62	7.31	6.89	7.41
T₆ (2% Sucrose)	7.93	7.70	7.47	7.14	7.56	7.93	7.78	7.45	7.26	7.61
T₇ (3% Sucrose)	7.84	7.55	7.37	6.86	7.41	7.84	7.67	7.36	7.01	7.47
Mean	7.92	7.58	7.37	6.84		7.92	7.66	7.34	6.94	
CD_(P = 0.05)										
Packaging (A)		= 0.01			A×B		= 0.02			
Storage (B)		= 0.02			A×C		= N/S			
Treatments (c)		= 0.02			B×C		= 0.05			
					A×B×C		= N/S			

Dong *et al.*, (2004) and Hayat *et al.*, (2005) were more of the opinion that titratable acidity was higher in control samples because coatings and packaging created microenvironment coupled with less oxidative reactions and lesser decline in degradation of acids thus maintaining the integrity of the cells.

pH

Storage period significantly influenced the pH value (Table 5) of minimally processed carrot during refrigerated storage. There was a significant increase in pH value of minimally processed carrot with the advancement in storage period. The treatment T₄ (3% CMC) recorded highest pH value of 6.32 in polypropylene bags and 6.30 in shrink wrap after 7 days of storage.

However, after 21 days of storage treatment T₁ (control) recorded the lowest value of 6.27 in polypropylene bags and 6.24 in shrink wrap. Anjum *et al.*, (2006) and Pilon *et al.*, 2006 also reported increase in pH of minimally processed carrot and CMC coated mangoes during refrigerated storage and related it to lower organic acid values found. Menezes and Athmaselvi (2016) also reported significant increase in pH of coated sapota during storage at 4°C.

Total plate count

A significant increase in total plate count (Table 6) was noticed during refrigerated storage of minimally processed carrots and the mean count increased from 3.02 to 3.23 x 10⁴ CFU/g in polypropylene bags and 2.65 to 2.94 x 10⁴ CFU/g in shrink wrap. After 14 days of storage the lowest mean total plate count of 1.41 x 10⁴ CFU/g in polypropylene bags and 1.28 x 10⁴ CFU/g in shrink wrap were recorded by treatment T₃ (2% CMC). Microbial growth on minimally processed

carrots is favoured by high moisture and numerous cut surfaces. Pilon *et al.*, (2006) reported that refrigeration temperature below 7°C extends the shelf life of minimally processed carrot by slowing down the growth rate of microorganisms Conte *et al.*, (2009) also reported prolonged shelf life and delayed microbial growth of minimally processed *Lampascioni Muscari Comosum* with Sodium alginate coating. Also, Benzoic acid dip based coating reduced microorganisms proliferation in minimally processed carrot. Similar findings of aloe vera coating in papaya (Marpudi *et al.*, 2011) and aloe vera gel coating in sweet cherries (Abirami 2009).

Overall acceptability

A general decrease in overall acceptability scores (Table 7) was observed with the advancement of storage period. After 7 days of storage, the maximum scores were recorded in T₃ (2% CMC), whereas the minimum scores were observed in T₁ (control) in both packaging. After 21 days of storage, the highest scores of 7.35 in polypropylene bags and 7.42 in shrink wrap for overall acceptability of minimally processed carrots were recorded in T₃ (2 % carboxy methyl cellulose). Porta *et al.*, (2013) reported that carrots coated with sodium alginate followed by packaging into a micro perforated polypropylene film were acceptable for about two weeks. The results are in agreement with the findings of Mahendran (2015) and Aythan *et al.*, (2008) for refrigerated storage of carrots. On the basis of the evaluation of range of quality parameters, it is concluded that minimally processed carrots after giving chlorine (0.1%) and benzoic acid dip (1%) followed by ascorbic acid dip (1%) and finally application of edible coating with 2 per cent carboxy methyl cellulose retained fresh like characteristics up to 21 days of storage under refrigerated condition in shrink wrap packaging.

References

- Abirami, L. S. S. 2009. *Efficacy of chitosan and natural plant extracts on the growth of selected fungal pathogens and control of anthracnose disease of papaya*. M.Sc thesis, Sri Sathya Sai University, Prashanthi Nilayam, India.
- Anjum, N., Masud, T. and Latif, A. 2006. Effect of various coating materials on keeping stored at low temperature. *American Journal of Food Technology*, 1: 52-58
- AOAC. 2002. *Official Methods of Analysis*, (17th Edn), Association of Official analytical Chemists, Washington D. C., New York, USA.
- Aythan, Z., Esturk, O. and Tas, E. 2008. Modified atmosphere packaging on the quality and shelf life of minimally processed carrot. *Turkey Journal Agriculture and Forestry*, 32: 57-67.
- Baldwin, E.A., Nisperos-Carriedo, M. O. and Baker, R.A. 1995. Use of edible coatings to preserve quality of lightly (and slightly) processed products. *CRC Critical Reviews in Food Science and Nutrition*, 35: 509-524.
- Conte, A., Scrocco, C., Brescia, I., Del Nobile, M. A. 2009. Packaging strategies to prolong the shelf life of minimally processed lampascioni (*Muscari comosum*). *Journal of Food Engineering*, 90: 199–206.
- Cortez, V. W., Piotrowicz, I. B. B., Prentice, C. and Borges, D. C. 2014. Influence of different edible coatings in minimally processed pumpkin. *International Food Research Journal*, 21(5): 2017-2023.
- Djioua, T., Charles, F., Lopez-Lauri, F., Filgueiras, H., Coudret, A., Jr, M. F., Ducamp Collin, M. N. and Sallanon, H. 2009. Improving the storage of minimally processed mangoes (*Mangifera indica* L) by hot water treatments. *Postharvest Biology and Technology*, 52: 221-226.
- Dong, H., Cheng, L., Tan, J. Zheng, K. and Jiang, Y. 2004. Effects of chitisan coating on quality and shelf life of peeled Litchi fruit. *Journal of Food Engineering*, 64: 355-358.
- Geetha, P. 2015. Effect of pre -treatments and Packaging on Shelf life of Minimally Processed Carrots. *Madras Journal of Agriculture*, 102: 268-272.
- Hayat, I., Masud, T. and Rathore, H. A. 2005. Effect of coating and wrapping materials on the shelf life of apple (*Malus domestic acv. Borkh*). *International Journal of Food Safety*, 5: 24-34.
- Incedayi, B., Tamer, C. E., Yonel, S. P. and Çopur, O. U. 2009. A research on the dessert produced from modified atmosphere packaged pumpkins. *International Journal Food Agriculture and Environment*, 7: 149-154.
- International Fresh-cut Produce Association. IFPA. 2000. *Fresh cut produce: get the facts*. www.freshcuts.org.
- Karande, D., Sonkar, C. and Kuthe, G. 2014. Shelf life study of minimally processed carrot through modified atmospheric packaging. *International Journal of Research in Engineering and Advanced Technology*, 2: 2320-8791.
- Krochta, J. M. and Mulder-Johnston, D. C. 1997. Edible and biodegradable polymer films: challenges and opportunities. *Food Technology*, 51(2): 61–74.
- Mahendran, T. 2015. Quality and shelf life of minimally processed shredded carrots in modified atmosphere packaging. *International Research Conference, KDU*, 8: 108-113.
- Manoj, H. G., Sreenivas, K. N., Shankarappa, T. H. and Krishna, H. C. 2016. Studies on chitosan and aloe vera gel coatings on biochemical parameters and

- microbial population of bell pepper under ambient condition. *International Journal of Current Microbiology and Applied Sciences*, 5(1): 399-405.
- Marpudi, S. L., Abirami, L. S. S., Pushkala, R. and Srividya, N. 2011. Enhancement of storage life and quality maintenance of papaya fruits using aloe vera based antimicrobial coating. *Indian Journal of Biotechnology*, 10: 83-89.
- Mastromatteo, M., Conte, A and Del Nobile, M. A. 2012. Packaging strategies to prolong the shelf life of fresh carrots (*Daucus carota* L.). *Innovations in Food Science and Emerging Technology*, 13: 215-220.
- Menezes, J. and Athmaselvi, K. 2016. Study on effect of pectin based edible coating on the shelf life of sapota fruits. *Food Science and Biotechnology Research Asia*, 13(2): 1195-1199.
- Ngure, J. W, Aguyoh, J. N. and Gaoquiong, L. 2009. Interactive effects of packaging and storage temperatures on the shelf-life of okra. *ARPN Journal of Agricultural and Biological Science*, 4(3): 44-49.
- Omus-Oliu, G., Rojas-Grau, M. A., Gonzalez, L. A., Varela, P., Soliva-Fortuny, R., Hernando, M.I.H., Munuera, I. P., Fiszman, S. and Martin-Belloso, O. 2010. Recent approaches using chemical treatments to preserve quality of fresh cut fruit - A review. *Post-Harvest Biology and Technology*, 57: 139-148.
- Opoku, A., Meda, V. and Wahab, J. 2009. Effects of storage methods on quality characteristics of carrots grown under organic and conventional management. *Prince Edward Island*, 702: 1-17.
- Palczar, M. J. and Chan, E.C.S.1991. *Laboratory Exercise in Microbiology*. Black Dot Inc., New York.
- Pilon, L., Oetterer, M., Gallo, C.R. and Spoto, M. H. F. 2006. Shelf life of minimally processed carrot and green pepper. *Ciência e Tecnologia de Alimentos campina*, 26(1): 150-158.
- Porta, R., Marquez, G. R, Mariniello, L., Sorrentino, A., Giosafatto, C. V. L., Esposito, M. and Pierro, P. D. 2013. Edible coating as packaging strategy to extend the shelf life of fresh cut fruits and vegetables. *Journal of Biotechnology and Biomater*, 3: 1-3.
- Ranganna, S. 2006. *Manual of Analysis of Fruits and Vegetables Products*. Tata McGraw Hill Publishing Company Ltd. New Delhi.
- Spokowski, A. 2010. *Vacuum effect of refrigerated storage on shelf life of comingled broccoli, cauliflower and carrots*. M.Sc. thesis, Clemson University.
- Vargas, M., Chiralt, A., Albors, A. and Gonzalez-Martinez, C. 2009. Effect of chitosan-based edible coatings applied by vacuum impregnation on quality preservation of fresh cut carrot. *Postharvest Biology and Technology*, 51: 263- 271.
- Wills, R. B. H., W. B. McGlasson, D. G. and Joyce, D. C. 2007. *Postharvest*. Oxfordshire: UNSW Press.

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