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THE ROLE OF PACKAGING AND PRE-PACKAGING TREATMENTS ON ORGANOLEPTIC AND QUALITY ATTRIBUTES OF FRESH-CUT CABBAGE LEAVES DURING COLD STORAGE

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ABSTRACT

The demand for fresh cut, ready-to-use fruits and vegetables is increasing worldwide, however, fresh cuts have a short shelf life because of their inherent sensitivity. Fresh cut cabbage leaves can be used for making stuffed cabbage rolls (Mahshi) and or eaten raw along with green salads. Different pre-packaging treatments and local packaging materials were used in order to preserve cabbage leaves quality for longer time. The dipping treatments were: ascorbic acid (0.2%), potassium permanganate (0.02%), and water (control). After dipping, drained samples were then packaged in two polypropylene (PP) pouches (12 × 20 cm) of different thickness (22, and 30 μ) and in polystyrene (PS) trays over-wrapped with a clear stretch PVdC film. Packaged cabbage leaves were kept refrigerated at 4±0.5 °C and 85±3 % R.H.

Water loss of packaged cabbage leaves, was minimal for samples packaged in PP-22 and PP-30 pouches, whereas those packaged in PS trays showed the greatest weight loss. The water treated samples showed the least shelf life. Other treated samples showed lower microbial counts initially and continued lower during storage. Samples treated with ascorbic acid were the best followed by those treated with potassium permanganate. Deterioration in color (browning edges) was fast notable for the water dipped samples, whereas ascorbic acid treated samples had higher panelists' scores for color during storage. Packaged cabbage leaves showed about 9 days shelf life. PP materials available at the local market are not recommended for packaging fresh cut unless perforated to allow for the respiration of fresh cut vegetables and to avoid anaerobic bacterial growth and anaerobic respiration development. PS-tray covered with stretch PVdC over wrap was the most appropriate package.

INTRODUCTION

Consumption of fresh cut, ready-to-use fruits and vegetables is increasing worldwide. This is related to increasing health awareness, changes in life style, and seeking convenience in meal preparation and consumption. Fresh cuts have short shelf life because of their inherent sensitivity for quick deterioration and they require special care and protection. The demand for minimally processed vegetables has promoted an increase in the quality and variety of the products. Temperatures between 0ºC and 3ºC can extend the shelf life of minimally processed vegetables from 5 to 18 days, since the quality degradation is retarded by the lower temperature causing a reduction in the respiratory rate Scoot (1989).

Minimally processed, "fresh-cut" fruits or vegetables are defined as those that maintain their fresh state regardless having suffered physical alterations. They go through a sorting process, washing, peeling and cutting in order to produce a packaged, 100% usable products which offer to the consumers freshness, convenience and nutritional quality. The quality of the fresh cut products is related to the maintenance of their sensorial characteristics and control of the contaminating microbial similar the quality of the intact produce (Vilas Boas and Kader, 2001).

Cabbage usually appear in the fall season. The consumption of cabbage may reduce the risk of some forms of cancer including colorectal cancer. Cabbage is also high in beta-carotene (anti-oxidants), Vitamin C and fiber [Evelyn (2007)]. Leafy vegetables can be pick up microbial contamination during growing, irrigating, pick-up, handling, transporting, processing and retail-market displaying. Odumeru *et a*l., (1997) evaluated the presence of pathogenic microbes in some commercial ready-to-use (RTU) vegetable samples. The increase in number of some of these pathogens were associated with temperature abuse.

Potassium permanganate has been used for decontamination of leafy salads from the metacercariae; human fascioliasis at 24 mg/L (El-Sayad *et al.,* 1997) and by To *et al.,* (1999) at 0.2% to extend the shelf life of dragon fruit (*Hylocerus undatus*) to up to 40 days. Also, Soriano *et al.,* (2000) found that when using sodium hypochlorite or potassium permanganate solutions in washing leafy vegetables such as lettuce serviced at 16 university restaurants, the aerobic microorganisms were reduced by more than two log units, and the total coliforms by at least one log.

Byeong and Andreas (1999) minimally processed Chinese cabbage (*Brassica campestris* L pekinensis group) using best preparation techniques and storage at 0 and 5°C with and without dips in either citric acid, calcium chloride or ascorbic acid, all at 10 g litre-1. Citric acid inhibited the development of black speck (spots) and extended storage life from 10 days of the control to 14 days at 5°C. At 0°C the storage life was not extended by any dip, but citric acid improved quality by reducing black speck. Minimally processed Chinese cabbage treated with citric acid showed only a slight reduction of pH from 6·3 of the control to 6·1 ($P \leq 0{\cdot}05$) and taste was not significantly affected ($P > 0{\cdot}05$). Microbial spoilage was not apparent during storage at 0°C for 35 days and 5°C for 21 days under any treatment.

The effect of different dip treatments and storage period on quality of minimal processed Indian cabbage was studied by Charanjit and Kapoor (2007). A gradual decrease in total antioxidant activity was observed during storage at 6°C with no detectable activity at the end of 9 days in all the dip treatments, except in treatments containing combination of ascorbic acid and citric acid, and ascorbic acid alone (10 g/L each). Incorporation of ascorbic acid and citric acid in the dip water improved the overall appearance and retained the maximum antioxidant activity, ascorbic acid and total carotenoids. Based on the overall quality and appearance score, a shelf-life of 9 days was achieved.

Pirovani, *et al.* (1997) studied the effects of packaging and storage at 3°C in a refrigerated case on quality changes of minimally processed cabbage. Shredded cabbage samples were packaged in three forms: bags of monooriented polypropylene film (OPP bags) and polyethylene trays overwrapped with a multilayer polyolefin (RD106-PE tray) or with a plasticized PVC film (PVC-PE tray). All types of package effectively controlled the weight loss. The modified atmosphere in PVC-and RD106- PE trays did not change more than 3% as compared with normal atmosphere levels. However, in OPP bags, O_2 reached 2% and CO_2 increased to approximately 13% after 3 days. The microbiological quality during the storage period for all types of packaging was satisfactory. OPP samples were significantly better ($p < 0.05$) in general appearance, wilting and browning but developed an off-odor. No off-odor was detected in samples packaged in PVC and RD106-PE trays. Shelf life for the three packaging forms was estimated [Pirovani, *et al.* (1997)].

Gómez-López, *et al.* (2007) studied the effect of neutral electrolyzed oxidizing water (NEW) as a novel decontamination method on microbial counts and overall visual quality (OVQ) of minimally processed cabbage and lettuce. From the microbial groups, only psychrotrophic counts decreased significantly ($P < 0.05$) due to the effect of NEW, but the counts in treated samples and control were similar after 3 days of storage at 4 °C and 7 °C. Packaging configurations kept O_2 concentration around 5% and prevented CO_2 accumulation. pH increased from 6.1–6.2 to 6.4 during the shelf-life. No microbial parameter reached unacceptable counts after 14 days at 4 °C and 8 days of storage at 7 °C. The shelf-life of controls stored at 4 °C was limited to 9 days by OVQ, while samples treated with NEW remained acceptable during the 14 days of the experiment. [Gómez-López, *et al*.(2007)].

Rinaldi, *et al.,*(2008) evaluated the respiration rate and ethylene production of whole and minimally processed cabbage as well as the shelf life of minimally processed cabbage stored under controlled atmosphere. The respiration rates of whole and minimally processed cabbage, stored at 5 ºC, were significantly lower than that at 10 ºC, and for both temperatures, the minimally processed cabbage presented higher respiration rates than the whole cabbage. Ethylene production was not detected by the method of analysis which was used. Controlled atmosphere did not prolong the shelf life of minimally processed cabbage kept in the concentrations ranging from 2% to 10% of oxygen and 3% to 10% of carbon dioxide.

Gaseous ClO_2 was evaluated by Gbmez, *et al.* (2008) for its effectiveness in prolonging the shelf-life of minimally processed (MP) lettuce and MP cabbage, previously immersed in a cysteine solution in order to inhibit browning occurring during ClO_2 treatment. Although an initial microbiological reduction was observed due to ClO_2 gas treatment, aerobic plate counts and psychrotrophic counts reached in the samples treated with ClO_2 higher levels than in those non-treated with ClO_2 before the third day of the shelf-life study. All samples of MP lettuce were sensorial unacceptable due to bad overall visual quality after 4 days, while treated and untreated MP cabbage remained sensorial acceptable during the 9 days of the study. Gaseous ClO_2 failed to prolong the shelf-life of MP lettuce and MP cabbage, the reason for the enhanced growth of microorganisms in decontaminated samples demands further investigation [Gbmez, *et al.* (2008)].

The aim of the present study was prolonging the shelf life and preserving the quality of fresh cauliflower flowerets and cabbage leaves by utilizing the available, simple and appropriate techniques for post-harvest treatment and packaging. In addition, these developed simple techniques will extend the shelf life, increase the marketing value and profitability and reduce contamination opportunities of consumed minimally processed fresh cabbage leaves.

MATERIALS AND METHODS

Materials:

Samples Source: Fresh cabbage (*Brassica oleracea* L. var. Capitata) heads of Balady variety were obtained from Horticultural Research Institute, Agriculture Research Center, Giza, Egypt, season 2006 .

Package materials: Pouches (150x200 mm) were made of bi-axial oriented polypropylene (BOPP) of 22µ thickness (PP_22) and 30µ thickness (PP_30), and polystyrene trays (PS) covered with PVdC stretch over wrap. The trays and the wrap were bought from the local market, whereas the BOPP materials were donated by Egy. Wrap a local manufacturer of polypropylene film, 6 October city, Giza, Egypt**.**

Chemicals: All chemicals materials used were food grade and were bought from the local market.

Methods:

Sample preparation: Prior to dipping, head were chopped into small cabbage leaves (5x7 cm) pieces. The good sound clean healthy pieces were selected, divided into groups. Groups were randomly assigned to each of the treatment-combinations..

Dipping and packaging treatments:

Chopped cabbage leaves were dipped for 2 min in: 1. Ascorbic acid (As) solution (0.2%), 2. Potassium permanganate (P) (0.02%), and 3. water (W)(control). After dipping, excess solutions were left to drain for 5 min. One hundred gram of drained samples from each dip treatment was packaged in PP_30 and PP_22 pouches and PS trays covered with stretch film over wrap. Packaged samples were stored refrigerated at 4°C and 85% R.H. Random samples were withdrawn regularly during storage for inspection and to run weight- loss , TSS, pH , microbial and sensory evaluations.

Loss in Weight (L.W.): Changes in weight of packaged cabbage samples were monitored during storage, and calculated (average of three replicates) according to the following equation:

% L.W = (Initial weight - weight of sample at sampling date) X 100/ Initial weight of sample.

pH of cabbage leaves: The pH of the sap-expelled by pressing of sample tissues was measured by the use bench top pH-meter.

Total soluble solids: The percentage of total soluble solids (TSS) of cabbage leaves sap was measured by a hand refractometer.

Microbial enumeration:

The microbial contents of packaged cabbage leaves samples were determined according to the methods described in the DIFCO manual (DIFCO, 1984). Acidified potato dextrose agar and nutrient agar were used to enumerate yeast & Mold and total microbial counts, respectively. Other total count plates were incubated under anaerobic conditions in order to enumerate anaerobic bacteria. Duplicated plates of these cultures were enumerated and expressed as colony forming units (CFU/ g sample) .

Sensory evaluation: Samples were evaluated by a group of trained panelists recruited from the Food Technology Research Institute. Color, juiciness, smell, texture, and wiltness attributes were evaluated for the degree of likeness and given a point from 5 on an opened scale. Where 1 is unlike most, and 5 is extremely liked.

Statistical analysis.: Statistical analysis was conducted using the SPSS Statistical Software Package (v.11.5). Comparisons among the main treatment means were made using L.S.D test at (***P*** = 0.05).

RESULTS AND DISCUSSION

The results of the analyses of variance for weight loss, total soluble solids and pH values of packaged cabbage leaves during cold storage are summarized in table (1), whereas the mean values for these attributes are presented in table (2) and depicted in Figure (1).

Changes in weight loss, TSS and pH of minimally processed packaged cabbage leaves during storage at 4°C.

Generally, weight loss of the packaged cabbage leaves increased as storage duration was increased. It can be noticed from table (1) that the effects of the main factors; packaging materials (PKG), dipping solutions (TRT), and storage duration (DAYS) on weight loss of cabbage leaves were highly significant ($P \geq 0.01$), whereas the two two-way interactions; PKGxTRT and TRTxDAYS, and the three way interaction were not significant at P =0.05. This indicated that the effect of any of the main factors acts independently on weight loss. In this respect, samples packaged in trays lost significantly more weight during storage than those packaged in the other two packages.

Table (1): Analysis of variance mean squares estimates for weight loss, total soluble solids (TSS), and pH value of packaged fresh-cut cabbage during storage at 4°C.

Source of variance	Weight loss		TSS		pH value	
	d.f	Mean squares	d.f	Mean squares	d.f	Mean squares
Packaging materials (PKG)	2	231.438**	2	0.112*	2	2.513**
Dipping solutions (TRT)	2	341.399**	2	0.039NS	2	0.143NS
Storage duration (DAYS[1])	4	243.779**	2	0.023NS	2	0.751**
PKG * TRT	4	62.834NS	4	0.209**	4	0.165NS
PKG * DAYS	8	5.605NS	4	0.028NS	4	0.165NS
TRT * DAYS	8	24.555NS	4	0.020NS	4	0.215NS
PKG * TRT * DAYS	16	9.426NS	8	0.046NS	8	0.059NS
Error	52	28.120	27	0.024	27	0.137

[1] Days factor (storage durations) for weight loss has one degree of freedom (d.f) less because data at zero time were all zeros and were excluded from the analysis

***,** Denote significant at P level 0.05 and 0.01; respectively.**

NS = not significant at P level 0. 05

Table (2): Mean values of weight loss (%), Total soluble solids (TSS B) and pH value of packaged fresh-cut cabbage leaves during cold storage at 4° C and 85 % R.H.

Treatments / Characteristics		Packaging materials								
		PP_30			PP_22			TRAY		
		Dipping treatments								
		As	Pr	W	As	Pr	W	As	Pr	W
Storage duration (day)										
Weight loss (%)										
	0	0.00			0.00			0.00		
	3	0.32	3.65	1.53	0.55	2.45	2.89	3.63	7.72	2.87
	6	1.25	5.09	4.23	1.47	6.78	4.31	7.64	10.14	4.74
	9	1.59	8.51	5.73	2.76	9.47	7.51	11.66	12.36	6.76
$LSD_{0.05}$ = 2.243										
Total soluble solids (°B)										
	0	1.72			1.72			1.72		
	3	1.50	2.00	1.80	2.00	1.70	1.55	1.45	1.40	1.90
	6	1.50	2.00	1.70	1.55	1.55	1.60	1.55	1.50	1.85
	9	1.75	1.95	1.55	1.50	1.55	1.60	1.65	1.50	1.65
$LSD_{0.05}$ = 0.106										
pH value										
	0	5.85			5.85			5.85		
	3	5.81	6.04	5.85	5.55	6.05	5.90	6.26	6.17	6.31
	6	5.63	6.28	5.66	5.30	5.50	5.31	6.17	6.29	6.18
	9	6.15	5.94	6.21	5.75	5.85	5.77	6.69	6.37	6.72
$LSD_{0.05}$ = 0.253										

Packaging materials: PP_30, PP_22 = Polypropylene pouches 30 μ and 22 μ, respectively, and TRAY= Polystyrene tray with stretch film over wrap.
Dipping solutions: As= Ascorbic acid (0.2%), Pr= Potassium permanganate (0.02%), and W = Water (Control).

This can be attributed to the higher permeability (for water vapor, CO_2 and O_2 gases) of the stretch film used with tray. In contrast, polypropylene pouches holds inside more of the CO_2 produced by the respiring fresh produce and do not permit enough O_2 to get in replacing that consumed by the packaged produce. Thereby, an internal modified atmosphere is gradually created inside that suppresses metabolic activity, transpiration and respiration of the packaged produce and thereby reduces weight losses. Using ascorbic acid as dipping solution for disinfection of cabbage leaves before packaging, results in significant reduction in weight losses (P = 0.05) in comparison with samples treated with water or potassium permanganate particularly when PP_L and PP_T pouches were the package (Fig. 1). Differences among dipping treatments were not noticeable for samples packaged in PS trays. Potassium permanganate treated samples significantly lost weight (P = 0.05) compared with those treated with water or ascorbic acid.These results are in agreement with those of [Artés, *et al.* (2007)]..

Treatment means for TSS (Table 2) indicate fluctuation within a narrow range of 1.4 to 2.0 during the cold storage. Data in table (1) for the analysis of variance show a significant effect of package material on TSS ($P \geq 0.05$).

Such an effect is dependent on the type of dipping solution because of the significant two-way interaction (PKG * TRT) between these two main factors ($P \geq 0.01$). Cabbage leaves treated with different dipping solutions showed similar TSS values during storage when PP-20 was the package.

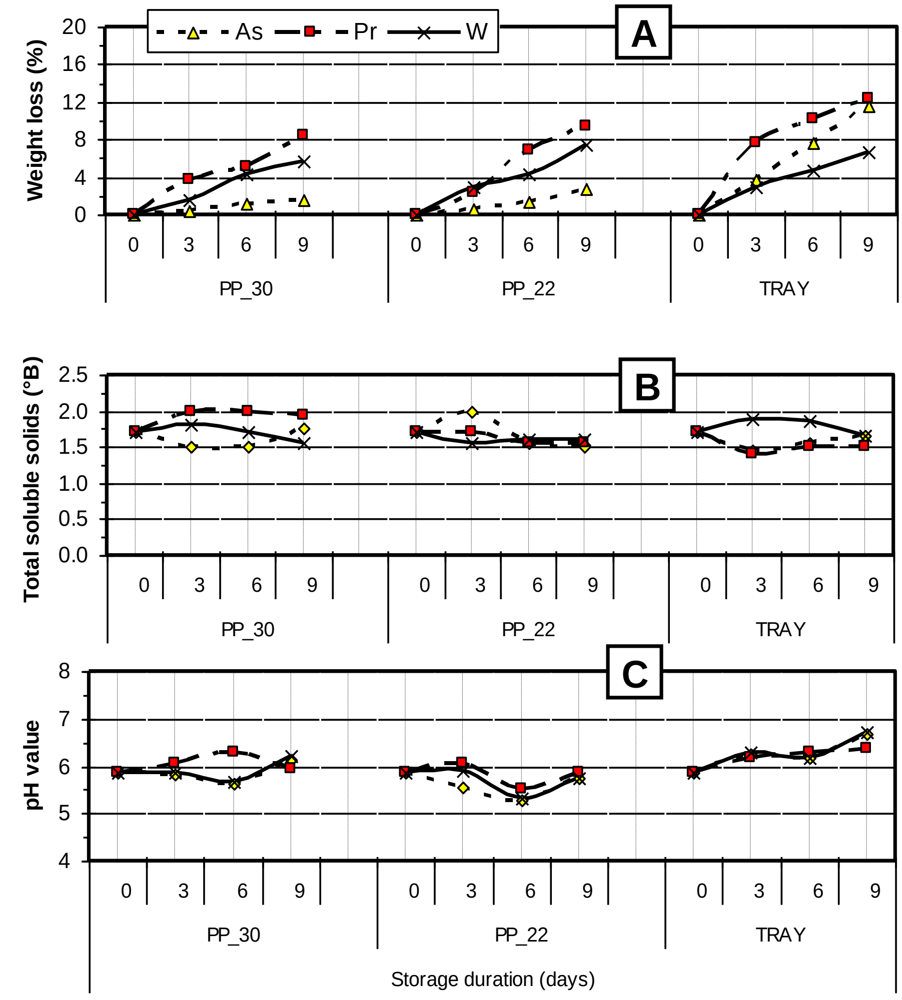

Figure (1). Changes in weight loss (A), total soluble solids (B), and pH value (C) of packaged fresh cut cabbage leaves during cold storage at 4 °C and 85% R.H.

Packaging materials: PP_30, PP_22 = Polypropylene pouches 30 µ and 22 µ, respectively, and TRAY= Polystyrene tray with stretch film over wrap.

Dipping solutions: As = Ascorbic acid (0.2%), Pr = Potassium permanganate (0.02%), and W = Water (Control).

When PP-30 was the package, potassium permanganate treated samples showed higher TSS than those treated with ascorbic acid, whereas, when trays were the package, samples treated with water showed higher TSS values during storage compared with potassium permanganate treated samples (Fig. 1). These results are in agreement with those of (Charanjit and Kapoor, 2007). Data in table (1) show significant effects of package material and storage duration on pH values of cabbage leaves ($P \geq 0.01$). Neither the effect of dipping solutions nor any of the interactions showed a significant effect. It can be seen in Figure (1) that pH values of samples packaged in trays showed steep but continuous increase during storage. Those samples packaged in PP-20 showed slight decline in pH values at the first storage periods followed by a continuous increase, whereas samples packaged in PP-30 showed mixed trends (Fig (1).

Comparison among the overall means of the main treatments showed that samples packaged in PP-30 to have lower pH values than those packaged in trays whereas those packaged in PP-20 had the least pH values. The overall means of pH values at the end of storage were significantly higher than those at the middle of storage. Changes in the pH values may be attributed to the metabolic activity of the packaged fresh produce and to in micro flora within the package. These results are in agreement with those of Byeong and Andreas (1999).

Table (3): Analysis of variance mean squares estimates for total count (TC), yeast and mold count (Y_M), and anaerobes count (AN) of fresh cut cabbage leaves during storage at 4°C and 85% R.H.

Source of variance	d.f	Mean squares		
		TC	Y_M	AN
Packaging materials (PKG)	2	2860.750**	186.815**	8.259NS
Dipping solutions (TRT)	2	434.250**	61.676**	7.843NS
Storage duration (DAYS)	2	592.444**	57.898**	2.843NS
PKG * TRT	4	224.667**	21.231**	11.898NS
PKG * DAYS	4	91.944*	14.537**	8.315NS
TRT * DAYS	4	31.528NS	19.398**	6.273NS
PKG * TRT * DAYS	8	10.653NS	3.370NS	5.100NS
Error	81	35.543	3.679	5.769

***,** Denote significant at *P* level 0.05 and 0.01; respectively. NS = not significant at *P* level 0.05.**

Changes in microbial counts of minimally processed packaged cabbage leaves during storage at 4°C.

The analyses of variance for total microbial (plate) count, yeast and mold count, and anaerobes counts are presented in table (3), whereas the mean values are summarized in table (4) and depicted in Figure (2).

Data in table (3) show the significant effects ($P \geq 0.01$) of the three main factors on total microbial count (TC). In addition, the two-way interactions PKG * TRT and PKG * DAYS were also significant at $P \geq 0.01$ and 0.05, respectively. A significant interaction between two factors indicates that the effect of any of them depends on the level of the other factor. This can be noticed in Figure (2), samples packaged in PP-22 showed continuous increase in TC with the ascorbic acid treated samples showing higher values than those of the other two dipping treatments.

Samples packaged in trays or PP-30 showed a decrease in TC at the beginning of storage followed by a continuous increase and that increase was larger for samples packaged in PP-30 than in those packaged in trays. Comparison among the overall means of the main factors, showed significant variation among the three storage durations (9 > 6 > 3 days of storage), and among the three packaging materials (PP-22 > PP-30 > Trays). In this respect, the ascorbic acid treated samples showed higher overall mean for TC than the other those of other two package materials. These results are in agreement with those of Gómez-López, *et al*.(2007) and Berrang *et al*. (1990) who demonstrated that, these microorganisms continued growing in asparagus.

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By the end of storage total count ranged from (3.25x 10^3) CFU/g sample for the sample treated with Water (Control) and packaged in Polystyrene tray with stretch film over wrap (TRAY) to (31.25x 10^3) CFU/g sample treated with ascorbic acid (0.2%), and packaged in polypropylene pouches 22 μ (PP_22) (Table 4).

All the main factors and their two-way interactions showed significant effect on values of mold and yeast counts (table 3). Values of mold and yeast showed similar trends to that previously discussed for total plate counts (Figure 2). This indicated that the internal package atmosphere conditions that controls the growth of microorganisms has the same effects on both types of counts. This may reflect that the major micro flora measured in total counts are similarly aerobic as the case for mold and yeast microbes.

By the end of storage mold and yeast counts ranged from (1.75x 10^3) CFU/g sample for the sample treated with Water (Control) and packaged in polystyrene tray with stretch film over wrap (TRAY) to (9.75x 10^3) CFU/g sample treated with ascorbic acid (0.2%), and packaged in polypropylene pouches 30 μ (PP_30) (Table 4).

Data in table (3) show insignificant effects of the main factors and their interactions on anaerobes counot of packaged fresh cut cabbage leaves during cold storage. A narrow range of anaerobes count was noticed (Table 4).

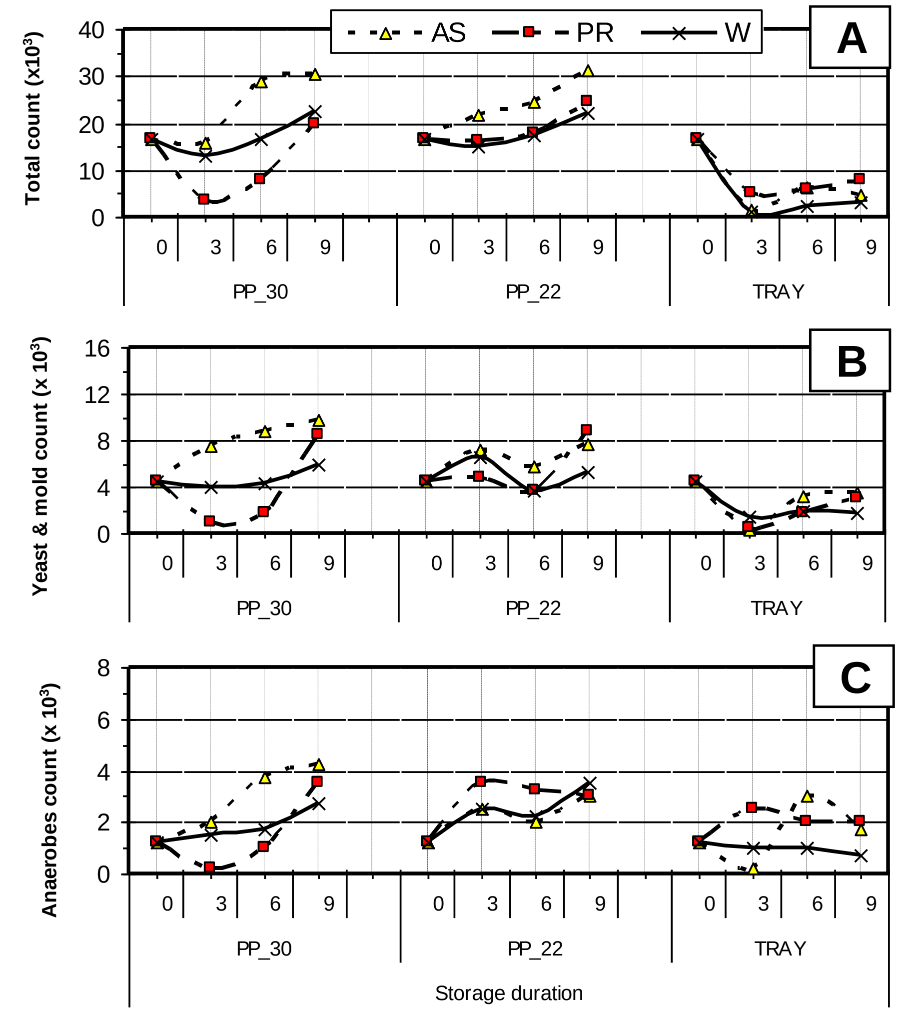

Figure (2). Total microbial (A), yeast and mold (B) and anaerobes (C) counts of fresh cut cabbage leaves during cold storage at 4 C and 85% R.H.

Dip treatments: As = Ascorbic acid (0.2%), Pr = Potassium permanganate (0.02%), and W = water (Control).

Package materials: PP_30, PP_22 = Polypropylene pouches (30 µ and 22 µ; respectively), and TRAY= Polystyrene tray with stretch film overwrap.

By the end of storage anaerobes counts ranged from (0.75x 10^3) CFU/g sample for the sample treated with water (Control) and packaged in polystyrene tray with stretch film over wrap (TRAY) to (4.25x 10^3) CFU/g sample treated with ascorbic acid (0.2%), and packaged in polypropylene pouches 30 µ (PP_30) (Table 4).

The French legislations proposed the limit of mesophilic aerobic population as $5.0x10^7$ CFU/g to end of the consumption stage for fresh cut produce (Pirovani, *et al.* 1997). According to these authors, the shelf life can be defined as the time of refrigerated storage at which the microbiological counts exceeded such limits and/or for the sensory attributes to reach unacceptable limit (Pirovani, *et al.* 1997). None of the samples presented in table (5) exceeded such limit, thereby, the limiting factor determining the shelf life of the samples under investigation will be the panelists scores for rejection (less than 3) according to the evaluated visual sensory attributes.

Table (4): Mean values of total microbial, yeast and mold, and anaerobes counts of packaged fresh-cut cabbage leaves during cold storage at 4 C and 85 % R.H.

Treatments / Characteristics		Packaging materials								
		PP_30			PP_22			TRAY		
		Dipping treatments								
		As	Pr	W	As	Pr	W	As	Pr	W
Storage duration(day)										
Total count (x 10^3)										
	0	16.50			16.50			16.50		
	3	15.75	3.75	13.25	21.75	16.25	15.00	1.50	5.00	1.25
	6	28.75	8.00	16.50	24.75	18.00	17.50	6.50	6.00	2.50
	9	30.50	19.75	22.50	31.25	24.50	22.00	4.75	8.00	3.25
$LSD_{0.05}$ = 2.80										
Yeast and mold (x 10^3)										
	0	4.5			4.5			4.5		
	3	7.50	1.00	4.00	7.25	4.75	6.50	0.25	0.50	1.50
	6	8.75	1.75	4.25	5.75	3.75	3.75	3.25	1.75	2.00
	9	9.75	8.50	6.00	7.75	8.75	5.25	3.50	3.00	1.75
$LSD_{0.05}$ = 0.90										
Anaerobes count (x 10^3)										
	0	1.25			1.25			1.25		
	3	2.00	0.25	1.50	2.50	3.50	2.50	0.25	2.50	1.00
	6	3.75	1.00	1.75	2.00	3.25	2.25	3.00	2.00	1.00
	9	4.25	3.50	2.75	3.00	3.00	3.50	1.75	2.00	0.75
$LSD_{0.05}$ = 1.13										

Changes Sensory attributes of minimally processed packaged cabbage leaves during storage at 4°C.

During storage, samples were evaluated organoleptically for color, juiciness, smell (odor), texture, wiltness and attribute. The analysis of variance of panelists' scores for these attributes were summarized in table (5) and their mean values are presented in table (6) and depicted in Figure (3).

Data in table (5) show significant effects ($P \geq 0.01$) of the main factors on panelists' scores for color attribute, whereas their interactions showed insignificant effects. In general, panelists' scores for color decrease continuously during storage.

Comparison among the overall means for the three main factors showed that : samples packaged in trays had significantly better panelists scores for color than the other two types of packaging, particularly when water was not the dipping solution. The ascorbic acid treated samples showed significantly better panelists scores for color than the other two dipping treatments. The 9th day of storage showed significantly lower scores for color than the 3d and 6th day of storage.

Table (5): Analysis of variance mean squares estimates for sensory attributes of packaged fresh-cut for cabbage during storage at 4°C.

Source of variance	d.f	Mean squares				
		Color	Juiciness	Smell	Texture	Wiltness
Packaging materials (PKG)	2	3.160**	7.049**	8.975**	3.494**	7.444**
Dipping solutions (TRT)	2	2.605**	2.975**	5.049**	2.383**	6.370**
Storage duration (DAYS[1])	2	3.049**	0.642NS	6.309**	4.531**	1.444*
PKG * TRT	4	0.401NS	0.198NS	0.253NS	0.198NS	0.259NS
PKG * DAYS	4	0.179NS	0.531NS	0.735NS	0.123NS	1.111*
TRT * DAYS	4	0.679NS	0.235NS	0.031NS	0.179NS	0.315NS
PKG * TRT * DAYS	8	0.142NS	0.373NS	0.123NS	0.216NS	0.620NS
Error	54	0.506	0.605	0.469	0.432	0.395

[1] Days factor (storage durations) for weight loss has one degree of freedom (d.f) less because data at zero time were all fives and were excluded from the analysis.
***,** denote Significant at *P* level 0.05 and 0.01; respectively. NS = not significant at *P* level 0.05.**

Data in table (5) showed significant effects of the main factors packaging materials and dipping treatments ($P \geq 0.01$). The effects of storage duration on panelists' scores for this attribute was not significant at ($P = 0.05$). Samples packaged in trays showed better scores for juiciness compared with that of samples of packages, whereas water treatment (control) showed the least scores for this attribute compared with samples treated with other dipping solutions.

Deterioration of cabbage leaves by internal or external factors can be better judged by the odor of the opened packaged. Generally, panelists' scores for smell (odor) decreased continuously during storage (Fig. 3). Data in table (5) show significant effects ($P \geq 0.01$) of the main factors on panelists' scores for odor attribute, whereas their interactions showed insignificant effects. Samples packaged in PS trays showed significantly better than those packaged in PP-22 while those packaged in PP-30 had the least scores. Pirovani, *et al.* (1997) also reported that shredded cabbage samples packaged in OPP packages developed an off-odor, whereas no off-odor was detected in samples packaged in PVC and RD106-PE trays.

Samples treated with ascorbic acid or potassium permanganate showed similar panelists' scores that were better than those treated with water (control). There were no significant differences between Panelists' scores for odor at the 3d and the 6th days of storage. The 9th day of storage recorded lower panelists' scores than the other two storage durations.

According to the analysis of variance (Table 5), panelists' scores for texture of cabbage leaves were significantly affected by package materials, dipping treatments and storage duration. Changes in panelists scores for texture attribute showed similar trend to that of the smell attribute. In that ascorbic acid treated samples had the higher scores compared with the other dipping treatments. The PP-30 packaged samples showed lower scores compared with the other two types of packaging (Table 6). These results are in agreement with those of (Pirovani, *et al..;* 1997). Panelists' scores for texture decreased by increasing storage duration (Figure 3).

Figure (3): Changes in panelists' scores of sensory attributes of packaged fresh cut cabbage leaves during cold storage at 4 °C and 85% R.H.

Packaging materials: PP_30, PP_22 = Polypropylene pouches 30 μ and 22 μ, respectively, and TRAY= Polystyrene tray with stretch film over wrap.

Dipping solutions: As= Ascorbic acid (0.2%), Pr = Potassium permanganate (0.02%), and W = Water (Control).

Table(6): Mean values of panelists' scores for sensory attributes of packaged fresh-cut cabbage leaves during cold storage at 4 C and 85 % R.H

Treatments / Characteristics		Packaging materials								
		PP_30			PP_22			TRAY		
		Dipping treatments								
		As	Pr	W	As	Pr	W	As	Pr	W
Storage duration (day)										
Color										
	3	4.50	3.50	4.00	4.00	3.70	3.67	4.33	4.67	3.67
	6	3.60	3.00	3.00	3.67	3.33	3.00	4.33	4.00	3.33
	9	2.67	2.67	2.50	3.33	2.67	2.33	4.00	3.67	3.00
$LSD_{0.05}$ = 0.338										
Juiciness										
	3	3.33	3.33	3.00	3.33	3.33	3.00	3.67	4.22	3.33
	6	3.00	2.67	2.67	3.00	2.67	2.33	3.67	4.00	3.33
	9	3.00	2.40	2.33	2.67	2.67	2.33	3.50	3.71	3.00
$LSD_{0.05}$ = 0.424										
Smell										
	3	3.67	3.67	3.33	3.67	3.33	2.67	4.67	4.33	3.33
	6	3.40	3.33	3.33	3.33	3.00	2.33	4.00	4.00	3.33
	9	3.00	2.33	2.00	2.33	2.00	1.67	4.00	4.00	3.00
$LSD_{0.05}$ = 0.374										
Texture										
	3	4.00	3.67	4.00	3.67	3.33	3.00	4.67	4.33	3.67
	6	4.00	3.33	3.67	3.33	3.00	3.00	3.67	4.00	3.33
	9	3.67	3.00	2.33	3.00	2.67	2.33	3.67	3.33	3.00
$LSD_{0.05}$ = 0.359										
Wiltness										
	3	3.67	3.33	3.67	3.33	3.00	2.67	4.60	3.33	3.00
	6	3.67	3.00	3.00	3.33	2.80	2.67	4.10	3.20	3.00
	9	3.33	2.51	2.00	2.67	2.33	1.67	3.20	3.00	2.60
$LSD_{0.05}$ = 0.343										

Table (5) showed significant effects of the main factors on panelists' scores of wiltness attribute (***P*** $\geq$ 0.01). In addition, the PKGxDAYS interaction was significant at (***P*** $\geq$ 0.05). This indicated that the effect of packaging on this attributes depends on which day the evaluation took place. Similarly, the effect of storage duration (DAYS) on panelists' scored for this attribute depends on the type of package. It can be seen in Figure (3) that panelists' scores for this attributes decreased continuously during storage for samples packaged in PP-30, while those packaged in trays or PP-22 showed fast decrease in panelists' scores at the beginning of storage then the scored did not show noticeable changes at the middle of storage followed by continuous decrease during the last days of storage. (Figure 3).

It can be concluded from the sensory evaluation that the ascorbic acid was better preserver for the evaluated sensory attributes, followed by potassium permanganate, whereas the water treated samples recorded the least panelists acceptance. Similar results were reported for minimally processed Indian cabbage by Charanjit and Kapoor (2007). Samples packaged in trays showed better scores compared with those packaged in PP-22, whereas those packaged in PP-30 showed the least scores.

Conclusion and Recommendation

From the previous results, it could concluded that polystyrene trays (PS) covered with stretch PVdC over wrap was the best tested packaging for cabbage leaves during storage followed by the 22 μ polypropylene pouches. Concerning the dipping treatments, the ascorbic acid (0.2%) was the best dipping treatment for cabbage leaves followed by those treated with potassium permanganate(0.02%).

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دور العبوة ومعاملات ما قبل التعبئـة علـى الصفات الحسية وصفات الجودة لأوراق الكرنب محدود التجهيز أثناء التخزين المبرد

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يـزداد الطلـب علـى مسـتوى العـالم للفواكـه والخضـروات الطازجـة محـدودة التجهيـز , والتـي نظـرا لحساسيتها للتلف والفساد فان فترة حفظها تكون عادة قصيرة . حفظ الكرنب الطـازج محدود التجهيز مهم جدا حيث أنه لا يضيف قيمـة تسويقية للمنتج فقط ولكن يجعل الكرنب ملائم وسـهل الاستخدام بالنسبة للمستهلكين حيث يستخدم في عمل المحشى ويستخدم في السلطات .

تـم دراسـة تـأثير المعاملـة بمحاليـل غمـر وهـى حـامض الاسـكوربيك بتركيـز ٠,٢% و برمنجانـات البوتاسـيوم بتركيـز ٠,٠٢% و المـاء (كنتـرول) و ثلاثـة أنـواع مـن مـواد التعبئـة والتغليـف وهـى: حـوافظ pouches من مادة البولي بروبلين polypropylene (١٢ x ٢٠ سنتيمتر) بسمك مختلف ٣٠ ميكرون و٢٢ ميكرون ، وكـذلك أطبـاق مـن البـولي اسـتيارين polystyrene (PS) trays مغطـاة over-wrapped بأغشية stretch film من مادة الكلوريد عديد الفنليدين PVdC علـى صفات الجودة للكرنب الطـازج محـدود التجهيـز للصـنف البلـدي. تـم غمـر أوراق الكرنـب فـي محاليـل الغمـر المـذكورة وتعبئتهـا فـي العبـوات تحـت الدراسـة والتخـزين علـى درجـة ٤± ٠,٥ درجـة مئويـة ورطوبـة نسـبية ٨٥±٣ % وتـم سـحب عينات على فترات زمنية لتقدير صفات الجودة لأوراق الكرنب و هي الفقد في الوزن , المواد الصلبة الكلية, pH ، الحمل الميكروبي , والصفات الحسية.

أظهرت النتائج أن الفقد في الوزن بالنسبة لأوراق الكرنب والمعبأ في عبوات بولي بـروبلين بسمك ٣٠ ميكرون و٢٢ ميكرون كان اقل من تلك العينات في بـاقي العبوات تحت الدراسـة.بينما أعطت العينـات المعبـأة في عبوات البولي استيرين أعلى فقد في الوزن. و أعطت المعاملة بالمـاء (كنترول) أقل فترة حفظ للعينات بينما أعطت باقي المعاملات تحت الدراسة أقل حمل ميكروبي أثناء التخزين. وأوضحت الدراسة أن المعاملـة بحـامض الاسكوربيك بتركيـز ٠,٢% كانت الأفضـل يليهـا المعاملـة ببرمنجانـات البوتاسيوم بتركيـز ٠,٠٢%, ولوحظ تدهور اللون مع العينات المعاملة بالماء , بينما العينات المعاملة بحامض الاسكوربيك أعطت أعلى قيم للتقييم الحسي إثناء التخزين.

قام بتحكيم البحث

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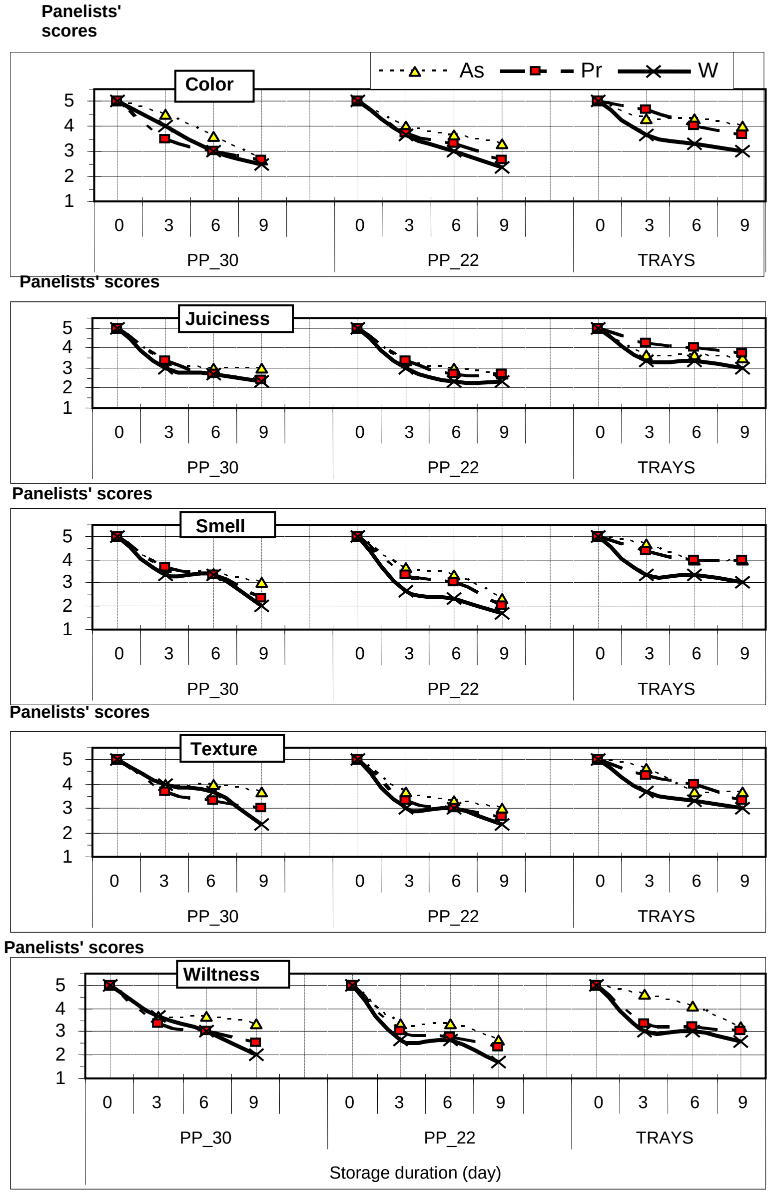
Panelists' scores
As
Pr
W
Color
Juiciness
Smell
Texture
Wiltness
0 3 6 9
PP_30
PP_22
TRAYS
Storage duration (day)