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EFFECT OF PACKAGING MATERIALS AND MODIFIED ATMOSPHERE PACKAGING ON SHELF-LIFE OF GREEN PEAS

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ABSTRACT

Peas are one of the most important vegetable crops in Egypt. The shelf life of fresh peas is shorter than processed ones, so the use of modified atmosphere packaging (MAP) can play an important role in extending their shelf-life. Studies were carried out on modified atmosphere packaging of peas for variety Master B. The peas were packaged in lowdensity polyethylene (LDPE) and polyproplyene (PP) of 50 and 55 mμ thickness respectively. These packages were stored at 0, 5, 15C° and room temperature and evaluated for quality at different storage periods. The treatments comprised modified atmosphere packaging (MAP) 3% O_2 + 7% CO_2 + 90% N_2 headspace and normal air (control). The shelf life of peas packaged in (LDPE) and (PP) under MAP was 38, 20, 9 & 5 days and 33, 17, 8 & 5 when stored at 0, 5, 15C° and room temperature, respectively. The quality indices like total soluble solids, moisture conten, pH value, microbiological analysis, weight loss and decay were determined . The shelf life of peas was 20 and 17 days when packaged in (LDPE) and (PP) with (MAP) at 5C°, but it was 17, 15 days with normal air (control) at the same temperature. Statistical analysis showed significant effect of temperature and storage period on total soluble solids, moisture content, pH value, microbiological analysis, weight loss and decay of peas.

INTRODUCTION

Peas are one of the most popular winter season vegetables and pulse crops of Egypt. Peas have a high respiration rate and susceptibility to deterioration by organisms. The ability of modified atmosphere packaging (MAP) to extend the shelf life of fruits and vegetables has been recognized for many years by inhibiting the normal microbiological and biochemical deterioration of food.

The different package parameters like weight of the commodity, volume of the headspace, variety, water vapour transmission rate and gaseous transmission rate of the film play very important role in maintaining the desired environment of package. Polymer films are widely used in MAP to affect required gas exchanges between the package and its surrounding environment. Different films have different CO_2 and O_2 permeability characteristics. Research on modified atmosphere packaging of different types of fruits and vegetables has been reported by [Beaudry et al., 1992; Cameron et al. 1994; Roy et al., 1995; Kumar, 1998; Kalra et al., 1986 and Singh, 1999]

The respiration rate can be affected by several intrinsic and environmental factors. Peas have a high respiration rate (260 ml CO_2 kg-1 h-1 at 5C°) because they are harvested at an immature stage. Decreasing of temperature causes a decrease of respiration rate of potatoes however, the

conversion from starch to sugar increases significantly, and being undesirable in potatoes. In contrast, decreasing of temperature gives reduction in respiration rate and metabolism. However, not all metabolic reactions have the same patterns (Wills et al., 1982 and Kays, 1991).

The normal composition of air is 78% nitrogen and 21% oxygen, with the balance made up of carbon dioxide 0.035%, other gases and water vapour. An increase in the proportion of carbon dioxide and/or a reduction in the proportion of oxygen within specified limits maintains the original product quality and extends the product shelf life. The respiration rate depends on product type (fruit or vegetable), variety and stage of maturity. A reduction in the concentration of oxygen and/or an increase in carbon dioxide concentration of the storage atmosphere surrounding the food reduces rate of respiration of fresh fruits and vegetables and also inhibits microbial and insect growth (Church, 1994; Church and Parsons, 1995).

MAP has been successful in the marketing of fresh produce by working together with low temperatures in order to maintain freshness, ensure safety and extend the shelf-life. Changes in the composition of the gaseous atmosphere of the commodity can result in significant changes in the respiratory process. Low oxygen and high carbon dioxide concentrations have an effect on the respiratory pathways. The respiration rate is decreased by low O_2 due to a reduction in the activity of polyphenol oxidase, ascorbic acid oxidase and glycolic acid oxidase. The respiration rate of fresh vegetables in an atmosphere with 3 % O_2 was proportionally reduced between 10 -46 % at 0C° and 20-60 % at 10 or 20C° (Wills et al., 1982; Kader, 1986; Lebermann 1968 and Kays, 1991).

CO_2 inhibits microbial activity in two ways: It dissolves in water of the food to form mild carbonic acid and thus lowers the pH value of the product; and it has negative effects on enzymic and biochemical activities in cells of both foods and micro-organisms. The effects of CO_2 on microbial growth are discussed by (Dixon and Kell , 1989 and Farber 1991).

The common microflora of vegetables such as bacteria, yeasts and molds contribute to the decline of commodity quality, however MAP in combination with low storage temperature is an effective way to reduce the growth of spoilage microflora and foodborne pathogens due to increasing the solubility of CO_2 in the liquid phase surrounding the food. In addition, the effect of CO_2 is influenced by the microorganism type. Gram negative bacteria are more sensitive than gram positive, where pseudomonas are inhibited with 10-20% CO_2, the growth of lactic acid bacteria can be enhanced by CO_2 content. Conversely, molds are strictly aerobic microorganisms and their growth is inhibited by CO_2 concentrations as low as 10%, however yeast growth is more resistant to CO_2 concentration. An appropriate level of O_2 content can also reduce the growth of spoilage microorganisms (aerobic bacteria) and inhibit the growth of strictly anaerobic bacteria such as clostridium botulinum (Farber, 1991; Church & Parson, 1995; Jay, 1996; FDA/CFSAN, 2001 and Al-Ati and Hotchkiss, 2002).

Sandhya and Singh (2004) studied modified atmosphere packaging of peas for variety Pb-87. The peas were packaged in lowdensity polyethylene bags of 25 mμ thickness and stored at 11, 5, 15C° and room

temperature and evaluated for quality at different storage periods. Considering the quality indices like total soluble solids, total soluble sugars, protein, physiological weight loss and decay. They found that the shelf life of shelled peas packaged in low-density polyethylene bags was 45, 17, 7 and 4 days at 11, 5, 15C° and room temperature, respectively. Also, they indicated that the shelf life of peas was 20 days when packaged in low-density polyethylene bags with 5% CO_2 at 5C°, and there is significant effect of temperature and storage period on total water soluble sugar, weight loss and decay of peas.

Therefore, the aim of the present study was to extend the shelf life of fresh peas packaged in lowdensity polyethylene (LDPE) and polyproplyene (PP) bags under modified atmosphere then stored at different temperatures.

MATERIALS AND METHODS

Materials:

- Fresh peas:

The variety of fresh peas (Master B) was selected for the study and obtained from the Horticultural Research Institute, Giza, Egypt. The geometric mean diameter of peas used in the test was 9.41 ± 0.68 mm and varied from 8.98 to 9.85 mm. The average number of peas seed per pod used in the test was 7.53 ± 1.67.

- Packaging materials: The plastic samples used were of low density polyethylene (LDPE) and polypropylene (PP).

They were obtained from identical Egyptian manufacturing batches as follows: Polypropylene film was obtained from the Islamic Company for packages in 6th October city, Giza, Egypt. Whereas, LDPE were obtained from Arabic medical packaging company (Flexpack), Cairo, Egypt. The sealed package size was 18 cm x 28 cm. Relative permeability of packaging materials was shown in Table (1). Thickness of the two tested packaging materials were 50 µm and 55µm for (LDPE) and (PP), respectively. This thickness was taken on the basis of results of various research (Kumar, 1998).

Table (1): Relative permeability of two packaging materials

Packaging materials	Thickness µm	Water vapor, g/m^2 d	O_2 permeability CC/m^2 d	CO_2 permeability CC/m^2 d
LDPE	50	2.7	2130	4000
PP	55	1.3	961	2200

- Modified atmosphere packaging of peas (MAP)

The experiments were carried out on modified atmosphere packaging of fresh peas to enhance their shelf life. The (MAP) used in thise study were (3% O_2 + 7% CO_2 + 90% N_2 headspace) and normal air (control). The peas were cleaned and sorted and the weighed quantity (200 g) of peas was packaged in two tested packaging materials.

Various quality indices along with subjective evaluation were determined during storage period up to 40 days at 0, 5, 15C° and at room

temperature for the study. These temperatures were selected as they can easily be maintained under the laboratory conditions. Incubators were used to maintain the temperature of 5 and 15C^{o}. The variation in the temperature of the incubator was observed as ± 0.5C^{o}. However, the temperature of 0C^{o} was maintained using freezer where variation was observed as ± 2.0C^{o} may be due to the location of peas samples kept in freezer. The temperature was recorded using digital temperature meter. All treatments were made in triplicate.

Methods:

Moisture content, total soluble solids (T.S.S.)and pH value of grain peas were determined according to the A.O.A.C.(2000).

- Weight loss

The weight loss was calculated from the difference between the initial and final weight at each specific time during the storage period and expressed as a percentage of the initial weight.

- Decay percentage

decay was determined as after inspection of the samples.

- Microbiological Analysis

Total microbial count as well as yeasts and moulds were determined according to Marshal (1992).

- **Determination of carbon dioxied and oxygen permeability for Packaging materials**

Permeability was defined according to the ASTM (Stands of American Society for Testing Materials) E-96 method as the volume as milliliter, per 100 in 2 per 24 hr at 1 atm pressure and 75 F°, passing through a film 1 mL (0.001 in) thick.Oxygen and carbon dioxied transmission through the packaging method were described by Eustace, (1981).

- Statistical analysis

The obtained data were statistically analyzed using the ANOVA procedure of the SPSS statistical package(SPSS,1990).

RESULTS AND DISCUSSIONS

The physicochemical and microbiological properties of peas that have great effect on its overall quality and include moisture contents, total soluble solids, weight loss, pH value, decay, total count , yeast and mold count have been evaluated. The results of the analysis of variance and mean squares for data are presented in table (2). The obtained results are as follows:

- Effect of packaging material and modified atmosphere (MAP) on moisture content of peas stored under different conditions:

The results of the analysis of variance and mean squares for moisture content are shown in table (2). The statistical analysis indicate that the main factors; e.g modified atmosphere (MAP), storage time and storage temperature had high significant effects, but there are no significant different with the packaging type.

The two-way interactions of package x MAP and package x temperature were not significant, which indicates that the effect of package, MAP and temperature were independent. Whereas, the two-way interactions of MAP x temperature was significant. This reflects that the effect of MAP was dependent upon temperature of storage and vise versa. Also, the three-way interactions package x MAP x temperature, package x MAP x storage were not significant. Whereas, the three-way interactions of MAP x temperature x storage was significant.

Table (2): Summary of the analysis of variance (Mean square error and its significance) of physicochemical and microbiological data of peas

Source of variance	d.f	Moisture content%	Total soluble solids%	Mass loss%	pH value	Decay%	Total count	Yeast and mold count
Packge (p)	**1**	52.6 **N.S**	3.68 **N.S**	1.93 *	0.43 **N.S**	0.242 **N.S**	0.006 **N.S**	2.639 **
MAP (M)	**1**	695 **	25.1 **	0.1 **N.S**	4.76 **	23.22 **	0.014 **N.S**	1.656 **
Tempr (T)	**3**	6102 **	198 **	7.26 **	43.01 **	201.53 **	3.75 **	1.216 **
Storage(S)	**4**	1277 **	431.5 **	16.3 **	90.02 **	238.36 **	19.29 **	6.377 **
p* M	**1**	69.3 **N.S**	2.07**N.S**	0.33 **N.S**	0.48 **N.S**	0.15 **N.S**	0.239 **N.S**	0.01 **N.S**
p * T	**3**	71.2 **N.S**	2.12 **N.S**	0.13 **N.S**	0.49 **N.S**	0.202 **N.S**	0.235 **N.S**	0.577 *
M * T	**3**	261 *	7.874 *	1.090 *	1.875 *	21.81 **	0.971 **	0.642 *
p * M * T	**3**	70 **N.S**	2.12 **N.S**	0.20 **N.S**	0.49 **N.S**	0.138 **N.S**	0.196 **N.S**	0.22**N.S**
p * M* S	**8**	69.9 **N.S**	2.22 **N.S**	0.39 **N.S**	0.48 **N.S**	0.167 **N.S**	0.217 **N.S**	0.29 **N.S**
M*T *S	**24**	1205 **	38.53 **	4.82 *	8.57 **	125.9 **	4.799 **	1.891 **
Error	**24**	70.9	2.164	0.25	0.485	0.160	0.227	0.189

*** ,** Significant and N.S non - significant at *p* level 0.01**

Mean values of moisture content of peas packaged in [lowdensity polyethylene (LDPE) and polypropylene (PP)] and modified atmosphere packaging (MAP) during storage at different storage temperature are shown in Table (3). The moisture content for the fresh-peas was 77.00%. It decreased with increasing the storage period and temperature with control and MAP when packaged in two tested packaging materials (Table 3).

The change in moisture content of peas packaged using LDPE was 77.00 to 74.11% at room temperature for 4 days of storage with the control. While, in case of MAP (3% O_2 + 7% CO_2 + 90% N_2 headspace) moisture content decreased slowly with the increase in storage period and temperature. The change in moisture content was 77.00 to 75.05% at room temperature for 4 days of storage period for peas packaged in PP. While, in case of MAP, moisture content decreased slowly with the increase in storage period and temperature.

The reduction in moisture content (3.75 and 3.12%) was maximum at room temperature after 4 days of storage period for peas packaged in LDPE and PP under normal air, respectivly, and minimum (2.48 and 1.48%) at 0C^o after 30 days for peas packaged in LDPE and PP under MAP. Moisture content of peas packaged in LDPE was lower than that packaged in PP. Packaging under normal air (control) showed lower moisture content of peas than that packaged under MAP.

Table (3): Effect of packaging material and modified atmosphere (MAP) on moisture content of peas during storage at different storage temperature.

	LDPE									PP							
Storag period (days) / Temperature (C^0)	Control					MAP				Control				MAP			
	0	4	7	15	30	4	7	15	30	4	7	15	30	4	7	15	30
0	77.0	76.03	75.45	75.12	--	76.32	76.17	76.05	75.09	76.48	76.03	75.94	--	76.74	76.56	76.45	75.86
5	77.0	75.7	75.28	75	--	76.30	76.08	75.96	---	76.11	75.87	75.42	--	76.57	76.32	76.00	--
15	77.0	75	74.86	--	--	76.00	75.44	---	----	76.00	--	--	--	76.25	76.22	--	--
R.T	77.0	74.11	----	--	--	74.6	---	----	----	75.05	--	--	--	75.22	--	--	--

(RT : room temperature)

Therefore, it can be concluded that moisture content of peas decreased with time of strage, temperature and some significant differences were found between peas packaged in different packaging materials. Such differences depended on the type of MAP for packaging. These results agree with Sandhya and Singh (2004) who found that, the peas packaged in low density polyethylene bags of 25 µm thickness and stored at 11, 5, 15Co and room temperature with 5% CO2, the reduction in moisture content (3.02%) was the maximum at room temperature after 4 days of storage and the minimum (1.65%) at 11Co after 45 days. The reduction in moisture content was 2.23% at 5Co after 17 days and 2.0% at 15Co after 7 days of storage.

- Effect of packaging material and modified atmosphere (MAP) on total Soluble Solids (TSS) of peas:

The results of the analysis of variance and mean squares for total soluble solids (%) are shown in table (2). The statistical analysis indicated that the main factors; e.g modified atmosphere (MAP), storage time and storage temperature had high significant effects, but there are no significant different with package type. The two-way interactions of package x MAP and package x temperature were not significant, which indicates that the effect of package, MAP and temperature were independent. Whereas, the two-way interactions of MAP x temperature was significant. This reflects that, the effect of MAP was dependent on temperature of storage and vise versa. Also, the three-way interactions package x MAP x temperature, package x MAP x storage were not significant. Whereas, the three-way interactions of MAP x temperature x storage was significant.

Mean values of total soluble solids of peas packaged in (LDPE) and (PP) during storage at different storage temperature are listed in Table (4). The total soluble solids for the fresh-peas was 14.20%. It decreased with the increase in storage period and temperature with control and MAP when packaged in two tested packaging materials (Table 4).

The change in total soluble solids of peas packaged in LDPE and PP was from 14.20% to 13.48 and 13.25% at room temperature for 4 days of storage period with control, respectivly. While, in case of MAP total soluble solids decreased slowly with the increase in storage period and temperature. The change in total soluble solids was from 14.20 to 13.85% and 13.70% at

room temperature for 4 days of storage for peas packaged in LDPE and PP, respectivly. It was observed that the decrease in total soluble solids was minimum at 0C^{o} as compared to other temperatures. At 0C^{o} it was 13.61% and 13.52% for 30 days of storage for peas packaged in LDPE and PP under MAP respectively.

Table (4): Effect of package material and modified atmosphere (MAP) on total soluble solids (%) of peas during storage at different storage temperature

	LDPE							PP									
Storag period (days) / Temperature (C^{0})	Control				MAP			Control						MAP			
	0	4	7	15	30	4	7	15	30	4	7	15	30	4	7	15	30
0	14.20	14.00	13.77	13.70		14.00	13.82	13.72	13.61	13.80	13.65	13.44		13.90	13.75	13.60	13.52
5	14.20	13.90	13.67	13.17		14.00	13.97	13.91		13.61	13.42	13.00		13.80	13.55	13.43	
15	14.20	13.65	13.24			13.87	13.80			13.40				13.74	13.41		
R.T	14.20	13.48				13.85				13.25				13.70			

(RT) room temperature

The average value of TSS for peas packaged in LDPE under MAP was 13.91, 13.97 and 14.00% for 15, 7 and 4 days of storage period at 5C^{o}, respectively. While, average value of total soluble solids was13.43, 13.55 and 13.88% for 15, 7 and 4 days of storage at the same temperature for peas packaged in PP under MAP. The reduction in total soluble solids (6.69 %) was the maximum at room temperature after 4 days of storage for peas packaged in PP under normal air but, it was minimum (4.1%) at 0C^{o} after 30 days for peas packaged in LDPE under MAP. Total soluble solids of peas packaged using PP was lower than that packaged in LDPE. Packaging under normal air (control) showed lower total soluble solids of peas than that packaged under MAP. These results agree with Sandhya and Singh (2004) who found that, the average value of TSS for peas packaged in low density polyethylene bags and stored at different temperature with 5% CO^2 was 13.8%, thus, registering a decrease of 2.82 % for 17 days of storage period at 5C^{o}.

Therefore, it can be concluded that, the total soluble solids of peas decreased with increasing time of strage and temperature. As well as, some significant differences were found between peas packaged in different package materials. Such differences depended on the type of MAP for packaging.

- Effect of packaging material and modified atmosphere (MAP) on weight loss (%) of peas:

The results of the analysis of variance and mean squares for weight loss are presented in Table (2). The statistical analysis indicated that the main factors; e.g packaging type have significant effects, meanwhile the storage time and storage temperature have high significant effects. But no significant differences existed with modified atmosphere (MAP). The two-way interactions of package x MAP and package x temperature were no

significantly different, the matter which indicates that the effect of package, MAP and temperature were independent. Whereas, the two-way interactions of MAP x temperature had significant differences. This reflects that the effect of MAP depending on temperature of storage and vise versa. Also, the three-way interactions package x MAP x temperature, package x MAP x storage had no significant effects. Whereas, the three-way interactions of MAP x temperature x storage was significant.

The mean values of weight loss of peas packaged in LDPE and PP during storage at different storage temperature are shown in Table (5). The mean values of weight loss was lowest at 0C° with a tendency to increase as the storage time, storage temperature increased for peas packaged in LDPE and PP with MAP and control.

Table (5): Effect of packaging material and modified atmosphere (MAP) on weight loss (%) of peas during storage period at different storage temperature

	LDPE									PP							
Storag period (days) Temperature(C^0)	0	Control				MAP				Control				MAP			
		4	7	15	30	4	7	15	30	4	7	15	30	4	7	15	30
0	0	1.98	2.87	4.13		1.30	2.11	3.80	4.70	1.44	2.23	3.95		1.05	1.34	2.70	4.15
5	0	2.28	3.40	5.48		1.82	2.40	4.20		1.96	2.85	4.93		1.60	2.14	3.81	
15	0	2.87	4.35			2.00	3.22			2.45				1.80	2.85		
R.T	0	5.20	--			3.12				4.00	--			2.57			

(RT : room temperature)

The highest in weight loss was observed at room temperature for all treatments. The mean values of weight loss for peas packaged using LDPE was 1.98, 2.28, 2.87 and 5.20 % at 0, 5, 15C^o and room temperature respectively, for 4 days of storage period with the control. While, in case of MAP, the mean values of weight loss inecreased slowly with the increase in storage period and temperature. These values were 1.30, 1.82, 2.00 and 3.12% at 0, 5, 15C^o and room temperature for 4 days of storage period. Meanwhile, the mean values of weight loss of peas packaged using PP were1.44, 1.96, 2.45 and 4.00 % at 0, 5, 15C^o and room temperature, respectively for 4 days of storage with the control. While, in case of MAP, the mean values of weight loss increased slowly with increasing in storage period and temperature (1.05 1.60, 1.80 and 2.57 % at 0, 5, 15C^o and room temperature respectively), for 4 days of storage. It was observed that, the mean values of weight loss inecreased at 0C^o as compared to other temperatures (4.70% and 4.15% with LDPE and PP under MAP, respectively for 30 days of storage period). The different packaging materials were effective in reducing weight loss when compared to peas stored in LDPE and PP at different storage temperature. The most effective observed with PP in 0C°. LDPE has different permeability to gases O_2, CO_2 and water vapor transmission of PP, so its weight loss was high. This result agree with Trail et al. (1992), who indicated that snap bean pods had a maximum mass loss of

2.6% after16 days of storage at 10C° due to the polylefilm packaging materials.

The results of the analysis of variance and mean squares for pH value are found in table (2). The statistical analysis indicated that the main factors; e.g, modified atmosphere (MAP) storage time and storage temperature showed high significant difference effects ($p \leq 0.05$), respectively, but there are no significant differences with packaging type. The two-way interactions of package x MAP and package x temperature were not significant, which indicates that the effect of package, MAP and temperature were independent. Whereas, the two-way interactions of MAP x temperature was significant. This reflects that, the effect of MAP depends on temperature of storage and vise versa. Also, the three-way interactions package x MAP x temperature, package x MAP x storage were not significant. Whereas, the three-way interactions of MAP x temperature x storage was significant.

Table (6): Effect of package material and modified atmosphere (MAP) on pH value of peas during storage period at different storage temperature

	LDPE									PP							
Storag period (days) / Temperature(C0)	0	Control				MAP				Control				MAP			
		4	7	15	30	4	7	15	30	4	7	15	30	4	7	15	30
0	6.45	6.42	6.40	6.38		6.43	6.43	6.42	6.37	6.43	6.43	6.40		6.43	6.44	6.43	6.40
5	6.45	6.41	6.34	6.30		6.43	6.40	6.33		6.42	6.38	6.34		6.43	6.42	6.38	
15	6.45	6.40	6.22			6.41	6.35			6.42				6.42	6.36		
R.T	6.45	6.38				6.40				6.40				6.40			

(RT : room temperature

The mean values of pH for peas packaged in lowdensity polyethylene and polypropylene under modified atmosphere packaging during storage at different storage temperature are listed in Table (6). The mean values of pH for the fresh peas was 6.45. It decreased with the increase in storage period and temperature with control and MAP when packaged in two tested packaging materials (Table 6).

The change in pH value of peas packaged in LDPE was from 6.45 to 6.42 at 0C°, 6.41 at 5C°, 6.40 at 15C° and 6.38 at room temperature for 4 days of storage with the control. While, in case of MAP pH decreased slowly with the increase in storage period and temperature. The change in pH value of peas packaged in PP was from 6.45 to 6.43 at 0C°, 6.42 at 5C°, 6.42 at 15C° and 6.40 at room temperature for 4 days of storage with the control. In the same time, in case of MAP, the mean values of pH value decreased slowly with the increase in storage period and temperature. The change in pH value was from 6.45 to 6.43 at 0C°, 6.43 at 5C°, 6.42 at 15C° and 6.40 room temperature for 4 days of storage period. It was observed that, the decrease in pH value was minimum at 0C° as compared to other temperatures. At 0C°. The mean values of pH value were 6.37 and 6.40 for 30 days of storage for peas packaged in LDPE and PP under MAP, respectively. The pH values of peas packaged in LDPE during the storage at different temperature varied between 6.43 to 6.30 at 5C° after 15 days, while varied between 6.43 to 6.34

at 5C° during the storage period. The pH value of all the three treatments remained within the range of the pH of freshly harvested common peas.

- Effect of packaging material and modified atmosphere (MAP) on decay of peas:

The results of the analysis of variance and mean squares for decay are listed in table (2). The statistical analysis indicated that the main factors, modified atmosphere (MAP), storage time and storage temperature had high significant effects, but there are no significant differences with the packaging type. The two-way interactions of package x MAP and package x temperature were not significant, which indicates that the effect of package, MAP and temperature were independent. Whereas, the two-way interactions of MAP x temperature was significant. This reflects that the effect of MAP depends on temperature of storage and vise versa. The three-way interactions package x MAP x temperature, package x MAP x storage were not significant. Whereas, the three-way interactions of MAP x temperature x storage was significant.

The mean values of decay of peas packaged in LDPE and PP during storage period at different storage temperature are presented in Table(7). The decay was lowest at 0C° with a tendency to increase as the storage time, storage temperature increased for peas packaged in LDPE and PP with MAP and control. However, the highest decay rate was observed at room temperature for all treatments.

The mean values of decay for peas packaged in LDPE were 0.0% at 0C°, 0.53% at 5Co, 1.59% at 15C° respectively and 43.63% at room temperature for 4 days of storage period with the control. While, in case of MAP the mean values of decay inecreased slowly with the increase in storage period and temperature (0.0% at 0C°, 0.34% at 5C°, 0.78% at 15C° and 22.62%) at room temperature for 4 days of storage.

Table (7):Effect of packaging material and modified atmosphere (MAP) on decay (%) of peas during storage period at different storage temperature

	LDPE									PP							
torag period (days) / Temperature (C^0)	0	Control				MAP				Control				MAP			
		4	7	15	30	4	7	15	30	4	7	15	30	4	7	15	30
0	0	0	0.13	0.22		0	0	0	0.45	0	0.18	0.40		0	0	0	0.86
5	0	0.53	0.85	2.12		0.34	0.60	1.38		0.56	1.25	2.63		0.44	0.87	1.82	
15	0	1.59	2.46			0.78	2.11			1.68				1.20	2.66		
R.T	0	43.6				22.62				45.33				24.32			

(RT) : room temperature

However, the mean values of decay of peas packaged using PP were 0.0% at 0C°, 0.56% at 5C°, 1.68% at 15C° and 45.33% at room temperature for 4 days of storage period with control. While, in case of MAP, the mean values of decay inecreased slowly with the increase in storage period and temperature (0.0% at 0C°, 0.44% at 5C°, 1.20 % at 15C° and 24.32% at room temperature for 4 days of storage.

It was observed that, the increase in mean values of decay was the minimum at 0C° as compared to other temperatures. At 0C°, it was 0.45% and 0.86% for 30 days of storage for peas packaged in LDPE and PP under MAP, respectively. The different packaging materials were effective in reducing decay. The most effective was LDPE at 0C°. PP has different pemability to gases O_2, CO_2 and water vapor transmission of LDPE, so its decay was high.

- Effect of packaging material and modified atmosphere (MAP) on total count :

The results of the analysis of variance and mean squares for total count are listed in table (2). The statistical analysis indicate that, the packaging type, modified atmosphere (MAP), storage time and storage temperature had high significant effects. As well as, the two-way interactions of package x MAP, package x temperature and MAP x temperature were highly significant. This reflects that the effect of packaging depends on MAP, temperature of storage and vise versa. Also, the three-way interactions package x MAP x temperature and package x MAP x storage were significant. Whereas, the three-way interactions of MAP x temperature x storage were highly significant

Table (8): Effect of packaging material and modified atmosphere (MAP) on total count (x 10^3) of peas during storage period at different storage temperature

	LDPE									PP							
Storag period (days) / Temperature(C^0)	0	Control				MAP				Control				MAP			
		4	7	15	30	4	7	15	30	4	7	15	30	4	7	15	30
0	0.32	1.18	2.34	3.64	---	1.44	2..26	2.58	3.45	1.36	2.55	3.78	---	1.55	2..58	2.78	3.65
5	0.32	2.24	3.10	4.85		1.86	2.48	3.23		2.54	3.43	4.96		2.00	2.77	3.81	
15	0.32	3.38	4.00			2.62	3.11			3.84				2.84	3.41		
R.T	0.32	5.22				4.21				5.66				4.48			

(RT : room temperature)

Data presented in table (8) show that, the mean values of total count (T.C) increased with increasing the temperature and time of storge and the rate was higher for peas under air than those samples packaged under MAP. Variations among T.C of peas packaged under air were greater than of those packaged under MAP, particulary, after 4 days of storage at room temperature. The mean values of T.C of peas packaged in PP were higher than the LDPE, when air and MAP were used after 15 days of storage (Table 8). This may be explained by the fact that, the LDPE is more permeable to moisture vapor than PP and thereby allowed the needed water for microbial growth.

As mentioned before, the mean values of T.C in different packaging materials under normal air or MAP for peas showed that the peas packaged in LDPE had the lowest values with air or MAP while, peas packaged in PP had the highest values. Generally, the packaging peas under air showed mean values of T.C higher than packaging peas under MAP. Difference

among samples may be attributed to variation in moisture content of the peas, which is indirectly related to permeability of the package to water vapor.

- Effect of packaging material and modified atmosphere (MAP) on yeast and mold count:

The results of the analysis of variance and mean squares for yeast and mold count are shown in table (2). The F-test indicates that, the packaging type, modified atmosphere (MAP), storage time and storage temperature had high significant effects. The two-way interactions of package x MAP, package x temperature and MAP x temperature were significant. This reflects that the effect of package depends on MAP, temperature of storage and this depends also on temperature of storage and vise versa. Also, the three-way interactions package x MAP x temperature and package x MAP x storage were significant. Whereas, the three-way interactions of MAP x temperature x storage were highly significant.

The data presented in Table (9) show that, the yeast and mold count (Y&M) increased with increasing temperature and time of storge. As well as, the rat was higher for peas packaged under air than those samples packaged under MAP. Variations among (Y&M) of peas packaged under air were highest but those packaged under MAP were the lowest, particulary, after 4 days of storage at room temperature. The data In Table (9) show that, the values fo Y&M of peas packaged in LDPE was higher than that of peas packaged in PP, with normal air or MAP after 15 days of storage. This may be explained by the fact that, the LDPE is more permeable to moisture vapor than the PP and thereby allowed the water needed for microbial growth.

Comparison between the mean values of Y&M for peas packaged in different packaging materials under normal air and MAP, peas packaged in LDPE showed less values of Y&M with air or MAP while the peas packaged in PP under air showed generally, higher values of Y&M. In general, the packaged peas under air showed higher values of Y&M than under the MAP. Difference among samples may be attributed to variation in moisture content of the peas, which is indirectly related to permeability of the packaging materials to water vapor.

Table (9): Effect of packaging material and modified atmosphere (MAP) on yeast and mold count (x 10^3) of peas during storage period at different storage temperature

	LDPE									PP							
Storag period (days) / Temperature(C^0)	0	Control				MAP				Control				MAP			
		4	7	15	30	4	7	15	30	4	7	15	30	4	7	15	30
0	0.12	0.58	1.00	1.27	---	0.14	0.33	1.00	2.03	0.96	1.76	2.83	---	0.38	0.96	1.77	2.88
5	0.12	1.36	1.65	2.16		0.37	0.59	1.43		2.59	3.27	3.96		124	1.79	2.31	
15	0.12	2.20	2.74			1.01	1.23			2.93				1.49	2.34		
R.T	0.12	3.35				1.62				4.45				2.17			

(RT : room temperature

- Quality of peas stored at 5C° in differant packaging materials with modified atmosphere (7% CO_2 , 3% O_2 and 90% N_2) during storage period:

The LDPE package with modified atmosphere (7% CO_2, 3% O_2 and 90% N_2) showed best results in retaining quality parameters and extend shelf life of peas (Table 10).

Table (10): Quality of peas stored at 5C° in low-density polyethylene (LDPE) and polypropylene (PP) packages with modified atmosphere (7% CO_2, 3% O_2 and 90% N_2) during storage period

Storage Period (Days)	Quality Indices	LDPE	PP
0	Moisture content %	77.00	77.00
	Total soluble solids %	14.20	14.20
	Weight loss %	0.00	0.00
	Decay %	0.00	0.00
	pH value	6.45	6.45
	total count	0.32×10^3	0.32×10^3
	yeast and mold count:	0.12×10^3	0.12×10^3
4	Moisture content%	76.30	76.57
	Total soluble solids%	14.00	13.80
	Weight loss%	1.82	1.60
	Decay%	0.34	0.44
	pH value	6.43	6.43
	total count	1.86×10^3	2.00×10^3
	yeast and mold count:	0.37×10^3	1.24×10^3
7	Moisture content%	76.08	76.32
	Total soluble solids%	13.97	13.55
	Weight loss%	2.40	2.14
	Decay%	0.60	0.87
	pH value	6.40	6.42
	total count	2.48×10^3	2.77×10^3
	yeast and mold count:	0.59×10^3	1.79×10^3
15	Moisture content%	75.96	76.00
	Total soluble solids%	13.91	13.43
	Weight loss%	4.20	3.81
	Decay%	1.38	1.82
	pH value	6.33	6.38
	total count	3.23×10^3	3.81×10^3
	yeast and mold count:	1.43×10^3	2.31×10^3

The moisture content decreased from 77 to 75.96% and 76.00%, weight loss were 4.20 and 3.81%, decay were 1.38 and 1.82% for LDPE and PP package respectively, with MAP on 15 days of storage at 5Co. Total soluble solids dcreased from 14.20 to 13.91% and 13.43% for LDPE and PP packaging materials, respectively, with MAP on 15 days of storage. The quality parameters like total soluble solids, pH value, moisture content were found to decrease slightly but weight loss, decay and total count increased with the storage period of peas samples.

- Shelf life of peas kept in different packaging materials under modified atmosphere (MAP) during storage period at different storage temperatures:

Data in Table (11) illustrate the shelf life of peas packaged in different packaging materials under normal air (control) and modified atmosphere

(MAP) during storage at different storage temperature. Evaluation of the peas continued over 38 days and the shelf life was terminated when the peas looked unsafe. Packaged peas showed variable shelf life ranging from 4 to 38 days.

Table (11): The shelf life of peas (days) packaged in different packaging materials under modified atmosphere (MAP) during storage period at different storage temperatures .

	Control		MAP	
Packaging materials / Temperature (C^0)	LDPE	PP	LDPE	PP
0	26	22	38	33
5	17	15	20	17
15	8	6	9	8
R.T	4	4	5	5

Regarding the type of package, peas packaged in LDPE recorded the higher values for shelf life periods, compared with those packaged in PP. The shelf life was extended even more when air was replaced by CO_2 and N_2. Modified atmosphere showed the best preservative effect on packaged peas at all tested storage temperature (shelf life of peas were 38 and 33 days, respectively when using LDPE and PP packaging materials respectively, compared with 26 and 22 days when the samples were packaged in the same package materials without modified atmosphere (control) at $0C^0$.

CONCLUSIONS

1- The shelf life of fresh peas packaged in lowdensity polyethylene (LDPE) and polypropylene (PP) packaging materials stored at 0Co, 5C°, 15C° and room temperature was 26, 17, 8 and 4 days for LDPE and 22, 15, 6and 4 days for PP respectively, considering various quality indices.

2- The shelf life can be extended up to 20 and 17 days for peas packaged in LDPE and PP with MAP (3% O_2 + 7% CO_2 + 90% N_2 headspace) as compared to 17 and 15 days for LDPE and PP without MAP (normal air) at 5C°.

3- The loss in quality was minimum for peas packaged in LDPE package stored at 0C°.

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تـأثير مـواد التعبئـة والتغليـف والجـو المعدل مـن الغـازات علـى مـدة حفـظ البسـلة الخضراء

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تعتبر البسلة من أهم محاصيل الخضر في مصر ويفضل معظم المستهلكين استخدامها طازجة ونظرا لقصر فترة حفظ البسلة الطازجة بالمقارنة بالبسلة المصنعة والجافة, لذلك كان الهدف من البحث هو إطالة فترة التخزين للبسلة الطازجة وذلك عن طريق استخدام نوعين من مواد التعبئة والتغليف البلاستيكية وهما البولى اثيلين منخفض الكثافة (LDPE) وبولي بروبلين (PP) والتعبئة في وجود جو هوائي معدل بنسب ٣% أوكسجين + ٧% ثاني أكسيد الكربون + ٩٠% نتروجين (تم تغير نسب الغازان في الهواء العادي حيث تم خفض نسبة الأوكسجين وزيادة نسبة ثاني أكسيد الكربون والنتروجين وذلك لان البسلة من المحاصيل العالية في معدل التنفس) وتم التخزين على درجات حرارة صفر , ٥ , ١٥ درجة مئوي وعلى درجة حرارة الغرفة وتم تقيم بعض صفات الجودة مثل تقدير المحتوى الرطوبى للبسلة, المواد الصلبة الكلية, نسبة الفقد في الوزن , نسبة الفساد والتلف , الـ pH , بالإضافة إلى تقدير الحمل الميكروبي للبسلة وذلك على فترات تخزين مختلفة ٤, ٧, ١٥, ٣٠ يوم . وتم عمل تحليل إحصائي للنتائج المتحصل عليها باستخدام الانوفا. أظهرت النتائج أن فترة حفظ البسلة المعبأة في وجود الجو الهوائي المعدل كانت ٣٨, ٢٠, ٩ أيام على درجات حرارة صفر , ٥ , ١٥ درجة مئوي بالترتيب و٥ أيام على درجة حرارة الغرفة وذلك بالنسبة لمادة التعبئة البولى اثيلين (LDPE) , أما بالنسبة لعبوة البولى بروبلين (PP) كانت فترة الحفظ ٣٣, ١٧, ٨, ٥ أيام على نفس درجات الحرارة . وأوضحت النتائج أن استخدام الجو المعدل أدى إلى زيادة فترة حفظ البسلة مع كل من العبوات المستخدمة وذلك بالمقارنة بالتعبئة في الجو الهوائي العادي, أيضا أوضحت النتائج أن العبوة البولي اثيلين كانت أفضل من العبوة البولى بروبلين. وبالتحليل الاحصائى للنتائج أظهرت وجود فروق عالية المعنوية لكل من درجات الحرارة المستخدمة وكذلك لفترات التخزين.