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Influence of Modified Atmosphere Packaging to Prolong Shelf Life of Chicken Patties

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ABSTRACT

This study was performed to determine the effect of two types of modified atmosphere packaging (MAP) materials, polyamide/polyethylene (PA/PE), polyamide/polyethylene/ paper/aluminum foil (PA/PE/P/AL) and modified atmosphere conditions on the shelf-life of chicken patties. Where, the samples of chicken patties were packaged in PA/PE under air (A1), modified atmosphere condition 100% CO_2 (B1) and 50% CO_2+ 50% N_2 (C1); or packaged in PA/PE/P/AL under air (A2), modified atmosphere condition 100% CO_2 (B2) and 50% CO_2+ 50% N_2 (C2). The samples were stored at 4±1°C for 30 days and evaluated for various physio-chemical, microbial and sensory changes. Rapid degradation in chemical and physical composition was occurred in preserved chicken patties under air condition either in PA/PE or PA/PE/P/AL at 4±1°C during 10 days. There were significantly decrease in microbial load in samples B1, B2, C1and C2 compared with samples A1 and A2 at 10th day of storage. Chicken patties samples in PA/PE or PA/PE/P/AL with 50% CO_2+ 50% N_2 had the highest values in all sensory attributes. It could be established that the MAP conditions of 50 % CO_2 + 50 % N_2 (C1 and C2) were the most suitable conditions for preserving the chicken patties for up to 30 days at 4±1°C compared with control samples A1 and A2 which acceptable for less than 10 days.

Keywords: chicken patties, shelf-life, modified atmosphere packaging, polyamide, polyethylene, paper and aluminum foil

INTRODUCTION

The method of preservation is defined by changing the atmospheric environment around a perishable food by replacing it with a single protective gas or a gas mixture with modified atmosphere packaging (MAP), and MAP implements the primary objective of packaging which is to protect foodstuffs from microbiological contamination and changes in physical chemical properties as well as sensory qualities. MAP products stored at low temperatures demonstrate an effective method of preservation to extend shelf life and maintain fresh quality such as red meat, poultry, fish and fish products (Velu *et al*., 2013). The rate of degradation during food product storage depends on the biochemical compositions of the substrates and metabolites in the tissues, bacterial contamination and storage conditions. However, the short shelf life is a limiting factor for these perishable products as chicken is sold in many forms as whole chicken and chilled chicken fillets which are more susceptible to microbial spoilage due to the removal of the skin and the slicing method, especially if they are frozen for long periods. Therefore, it was necessary to search for new technologies to preserve chilled chicken for as long as possible. (Abdou *et al*., 2018), Given the fact that poultry belongs to perishable foods, the main concern of industries is to extend the shelf life of poultry products (Ibrahim *et al*., 2020). Over the past years modified atmosphere packaging (MAP) has received increasing attention as a method of food preservation (Lee, 2010; Masniyom, 2011). It was the fastest growing method for packing meat, including poultry, the Modified

Atmospheric packaging (MAP) system. On the other hand, the correct selection of gases (usually a mixture of O2, CO2 and N2) is an effective limiting factor for the development of microorganisms responsible for spoilage of meat. (Chmiel *et al*., 2018).

The choice of gas composition in MAP depends largely on the food product to be packaged as single gases or groups of gases contribute to the prolongation of the shelf life depending on the acceptable number of microbes and organoleptic characteristics in terms of color, odor and feel of the food perceived in the smell and feel course and visual examination. MAP includes the common gases of oxygen, nitrogen and carbon dioxide (Masniyom, 2011). The three main gases used in MAP are CO2, O2, and N2, either singly or in combination. First, carbon dioxide (CO2) is the most important gas in MAP foods due to its antibacterial and antifungal properties and it is also particularly effective against aerobic spoilage bacteria, such as *Pseudomonas species* where the solubility of carbon dioxide increases with decreasing temperature and thus the activity The antimicrobial CO2 is significantly greater at lower temperatures and therefore has significant effects on the MAP of the food. The high CO2 solubility of high moisture/high fat foods such as meat, poultry and seafood leads to the collapse of the packages due to the reduction of volume velocity. Head Also High levels of carbon dioxide can lead to increased drip or secretions

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from meaty foods and the addition of absorbent pads at the base of the package is used to compensate for this. Second, gaseous oxygen (O2) promotes several types of degradative reactions in foods including lipid oxidation and most common spoilage bacteria and fungi require O2 for growth. For these reasons, O2 is either excluded or the level is set as low as possible. And third, nitrogen gas (N2) is an inert gas without odor or taste and has low solubility in water and other food components, which makes it a useful filler gas in MAP to counteract the packaging breakdown caused by the dissolution of carbon dioxide in food. Nitrogen indirectly affects the microorganisms in perishable foods by inhibiting the growth of aerobic spoilage microbes, according to Kaleemullah. (2002).

Poultry meat is a food with high nutritional value and is higher in protein content compared to the mentioned red meat as depleted chicken meat contains 70% moisture, 23% protein, 3.5% fat and 1.21% ash. These proteins are classified within the first class category because they contain all acids Essential amino in balanced proportions (Ganguly *et al*., 2014). Low-fat chicken meat provides all the essential fatty acids. These fatty acids form the cell wall, mitochondria and cell components. Due to its low energy value, chicken meat is a good food for weight control systems. Chicken meat contains more phosphorous fats and cholesterol than other meats, which reduces the risk of Diabetes and Heart Disease. Due to its high biological value and ease of digestion, it is a food choice for the elderly as well as children. It has the ability to alleviate nutritional stress conditions in humans (Para and Ganguly, 2015; Nath *et al.,* 2016).

Chicken products (chicken kofta, sausages and chicken sandwiches) from consumed chicken meat, their storage stability and their public health importance. Two different packaging materials of low-density polyethylene (LDPE) and aluminum foil strips at different storage temperatures were studied and samples were analyzed in terms of pH and value of 2- thiobarbituric acid (TBA), tyrosine value, moisture content, microbial contaminants such as standard platelet count (SPC), total psychological number (TPSC) and organoleptic characteristics at different storage periods during refrigerated and frozen storage where pH, TBA value, tyrosine value, SPC and TPSC for all products increased with progression Storage period. Moisture content, appearance, flavor, taste, and general product acceptability also showed a downward trend until the end of the storage period and two types of packaging did not significantly affect product quality as the shelf life of meat kofta at refrigerated temperature was extended by an additional week and doubled In storage under air packing conditions, aluminum foil showed a marginal advantage over polyethylene in the case of chicken frankfurter and Shelf life of chicken frankfurter was 20 days based on TBA value and flavor and chicken sandwiches were acceptable until the 14th day of refrigerated storage. (Biswas *et al.,* 2017).

Therefore, this work aims to study the effect of two types of modified atmosphere films on the quality and shelf life characteristics of chicken patties during cold storage (4 ± 1 °C).

MATERIALS AND METHODS

Materials

Chicken meat breast: White Chicken meat breast which used in manufacture of patties was collected from local market, Giza, Egypt without bones and skin in the same day of experiment.

Spices: Spices (black pepper, dried onion, dried garlic, coriander and cumin), starch and salt (sodium chloride) were purchased from local market, Giza, Egypt.

Polyamide/Polyethylene and Polyamide/Polyethylene/Paper/Aluminum foil: These packages were obtained from Tecno-plast Company, Borg El-Arab city, Alexandria Governorate, Egypt.

Chemicals and microbial media were obtained from El- Goumhouria Company for trading chemicals and microbial appliances, Tanta city, EL. Gharbia Governorate, Egypt.

Methods Preparation of chicken patties

Chicken patties were prepared according to the method of Aleson-Carbonell *et al*., (2005).

Since a simple traditional formulation was used to obtain a base batter as follows: -

The breasts were washed by running water, drained in colander, and minced in meat grinder (Moulinex, ME 205, made in France). About 90% of minced breasts mixed with 5% starch and spices as shown in Table (1). The final mixture was shaped using commercial burger machine (Italmans type: made in Italy) 9 cm internal diameter to obtain patties of approximately 70 gm and 1 cm thickness.

Chicken patties were packaged in modified atmosphere as follows:

A1: Packed in PA/PE with air (control)

B1: Packed in PA/PE with 100% CO_2

C1: Packed in PA/PE with internal gas mixing (50% CO_2 /50% N_2)

A2: Packed in PA/PE/P/AL with air (control)

B2: Packed in PA/PE/P/AL with 100% CO_2

C2: Packed in PA/PE/P/AL with internal gas mixing (50% CO_2 /50% N_2)

All samples after packing were kept in the refrigerator at 4 ± 1 °C. This experiment was conducted at the Department of Food and Packaging Engineering, Institute, Agricultural Research Center, Giza, Egypt

Cooking of chicken patties

Chicken patties samples were grilled in a grill machine, (x- 800 mad in turkey) for 10 minutes. Both sides of patties were kept flipped for few minutes until a well done cooked patties obtained (Dreeling *et al*., 2000).

Table 1. The formula of chicken patties.

Ingredients	Percentage%
Chicken meat	90
Starch	5
Dried onion	1
Dried garlic	1
Salt	2
Coriander	0,25
Cumin	0,25
Black pepper	0.50

Gas measurements

The process of mixing the composition of the two types of gases, CO_2 and N_2 were studied under a modified gaseous atmosphere with rates ranging from two types of packages, which are modified atmosphere packaged PA/PE and PA/PE/P/A, And the mixing process of the two gases in a tank, and the injection was carried out on a device of model and type a gas analyzer. The modified atmosphere-packed chicken patties were closed by the Sagueny group that was stored at 4 ± 10 °C Witt Oxybaby headspace Gas anlyzer (CO2 and N2). The air-packed group was used as a control. Analyzes were performed on air and modified atmospheric-packed chicken patties using separate packages. WITT is certified in accordance with0 ISO 22000. This International Standard defines a food safety system. (Victor *et al.*, 2007).

Leakage test

The leakage test of the injected gases in the containers under study into which the chicken patties product was packed was carried out on a type and model device by wittgas (Sagueny Group) offers high quality certified leak detection systems for all types of product packaging. For sample leak detection test systems or continuous checks - based on carbon dioxide, oxygen, nitrogen oxide or as a bubble test.

Chemical composition of chicken patties: Moisture, crude protein, ether extract and ash contents were determined according to the methods described by A.O.A.C. (2010).

Determination of Total Volatile Basic Nitrogen: The value of TVN was estimated by performing semi-fine distillation according to the methods described by (AMC, 1979; Kirk and Sawyer, 1991). The bases are steam distilled to a standard acid and back titrated with a standard alkali. Determination of Thiobarbituric Acid (TBA): The thiobarbituric acid value of chicken patty samples was determined colorimetrically using the method published by (Kirk and Sawyer, 1991). **Microbial examination:** The total number of bacteria (TBC) was determined according to Marshall (1992) in duplicate using laminar counting agar medium. The plates were incubated at 37 °C for 48 hours. The glycophilic bacteria were incubated at 4°C for 5 days and quantified using plate number agar medium. The number of molds and yeast was determined using methods described by the American Public Health Association (A.P.H.A, 1976) using malt extract agar medium, and the plates were incubated at 25 °C for 5 days. *Salmonella* was determined according to the method described by the Food and Agriculture Organization (1979). Total *coliforms* were made according to (FDA, 2000 and ISO, 2001).

These analyses were performed in laboratories of the Food Engineering and Packaging Department, Institute, Agricultural Research Center, Giza, Egypt and Food Science and Technology Department, Faculty of Home Economic , AL-Azhar University, Tanta, Egypt.

Sensory evaluation: Chicken patties were sensually evaluated for taste, color, texture and over all palatability. Sensory characters were evaluated by 10 panelists belonging to Food Science and Technology Dept. Faculty of Home Economic, Al- Azhar Univ, using a hedonic scale from 1-10 points according to (Yetim and Kesmen, 2009).

Statistical analysis: The data were subjected to appropriate statistical analysis using the statistical program MSTAT. The results were statistically analyzed by means of analysis of variances by SPSS (1997). Significant differences between individual means were analyzed by Duncan's multiple range test (Duncan, 1955). Statistical analysis was carried out using factorial analyzes according to a completely random design (Snedecor and Cochran, 1989).

RESULTS AND DISCUSSION

Gas measurements

Gases were measured during storage period at (4±1ºC) in chicken patties packages either in normal atmosphere or modified atmosphere. Results in the Table (2) noticed that gas in samples in normal atmosphere (A1 and A2) were slightly changes during 10 days of storage period. The percentage of gases in sample A1 was 0.9% CO_2, 78.6% N_2 and 19.5% O_2, respectively at zero time, after 10 days became 0.7% CO_2, 68.2% N_2 and 20.72% O_2, respectively. Also sample A2 at the same trend, the gases in packages were slightly changes during 10 days of storage period. The percentage of gases in modified atmosphere packages (MAP) showed noticeable changes. CO_2 decreased by 16.6 and 19.3% in B1and B2 samples which packed in PA/PE and PA/PE/P/AL during the storage period, respectively. On the other hand, it was decreased by 26.8 and 27.6% in C1 and C2 samples which packed in PA/PE and PA/PE/P/AL, respectively. Nitrogen in B1 and B2 samples was 6.4 and 6.12% at zero time and increase to reach 11.1 and 11.32%, respectively, almost doubled after 30 days of storage period. Oxygen in B1 and B2 samples was 1.03 and 1.3% at zero time and reached to 5.34 and 5.56%, respectively, it increased approximately five times after 30 days of storage period. Nitrogen in C1 and C2 samples was decreased during storage period. It was decreased by 33.3% in both C1 and C2 samples which packed in PA/PE and PA/PE/P/AL, respectively. Oxygen in C1 and C2 samples was 0.5 and 0.04% at zero time and reached to 5.58 and 6.56%, respectively, after 30 days of storage period at (4±1ºC). From these results, it could be concluded that, the best treatment B1 and B2 in terms of reduction the percentage modified atmosphere packaging loss followed by treatment C1 and C2 until 30 days of storage , as compared with control samples A1 and A2 until 10 days of storage. These results are agreement with (Aboul-Anean *et al*., 2018), who decided that the reduction in gases may be due to an obvious and invisible leakage process.

In enclosed foodstuffs, biochemical reactions and slow-moving gases in and out of the packaging materials may lead to changes in the gaseous atmosphere throughout the storage period that can affect the expected shelf life (Velu *et al*., 2013).

Table 2. Gas composition of internal modified atmosphere packaging of chicken patties during storage at (4±1°C)

Storage period, days	(PA/PE)								
	A1			B1			C1		
	CO_2%	N_2%	O_2%	CO_2%	N_2%	O_2%	CO_2%	N_2%	O_2%
0	0.9	78.6	19.50	92.20	6.40	1.03	46.34	47.67	0.50
5	0.8	70.4	20.63	89.00	7.60	2.70	44.25	44.98	1.63
10	0.7	68.2	20.72	86.12	8.23	2.53	40.56	40.16	2.72
15		_		82.56	9.10	3.13	38.56	37.89	3.56
20		_		80.90	9.68	4.45	36.56	34.90	4.21
25		_		78.78	10.23	5.06	34.78	32.56	4.90
30		_		76.87	11.10	5.34	33.90	31.80	5.58
	(PA/PE/P/AL)								
	A2			B2			C2		
0	0.82	69.5	19.45	92.68	6.12	1.30	47.30	48.70	0.04
5	0.72	70.2	20.66	90.20	7.86	1.79	45.73	46.60	2.28
10	0.60	68.0	20.70	85.34	8.89	2.76	44.94	43.00	2.90
15		_		83.45	9.98	3.24	42.34	40.80	3.68
20		_		79.69	10.12	4.43	38.78	38.87	4.88
25		_		76.34	10.89	5.25	36.00	35.45	5.56
30		_		74.80	11.32	5.56	34.23	32.45	6.56

A1: Packed in PA/PE with air (control), B1: Packed in PA/PE with 100% CO_2, C1: Packed in PA/PE with internal gas mixing (50% CO_2/50% N_2), A2: Packed in PA/PE/P/AL with air (control) , B2: Packed in PA/PE/P/AL with 100% CO_2 C2: Packed in PA/PE/P/AL with internal gas mixing (50% CO_2/50% N_2) PA: Polyamide, PE: Polyethylene, P: Paper, AL: Aluminum foil

Leakage test

No gas leakage or bubbles were detected from the analysis of the tested parameters of the packaging materials used in this study either (PA/PE) or (PA/PE/P/AL). however, with longer storage period, slight leakage may occur. In general, it is recommended to pack chicken patties under modified climatic conditions in such containers due to their quality compared to ordinary packaging materials.

Chemical composition of chicken patties

The effect of modified atmosphere packaging on chemical composition of chicken patties during cold storage period at 4±1°C for 30 days was given in Table (3).

Moisture content

The results in Table (3) revealed that, the moisture content values of chicken patties were gradually decreased with increasing the storage period at cold temperature. The chicken patties samples A1 and A2 in PA/PE or in PA/PE/P/AL had lower moisture content than other samples in MAP at zero time. After 10 days of storage period at 4°C, the percentage of moisture loss in A1 and A2 samples was 2.19 and 1.43%, respectively. However, the chicken patties samples in PA/PE/P/AL were related and retained its appearance and good quality chicken patties up to 30 days of cold storage. Moisture contents in samples B1 and C1 reached to 68.15 and 69.18% after 30 days of storage period, with maximum loss 4.97 and 4.68%, respectively. Meanwhile, Moisture contents in samples B2 and C2 reached to 68.71 and 69.53% after 30 days of storage period, with maximum loss 3.41 and 3.37%, respectively. There were significant differences between all treated samples in moisture content during 30 days of storage period. These results are in agreement with (Biswas *et al*., 2017) who found that moisture of chicken frankfurter and chicken kofta decreased during cold storage at (4±1°C) for 21 days. Also, (Chmiel *et al.*,2019) and (Abdou *et al.*, 2018) decided that moisture was decreased as the storage time increased in the range 73-74 % for chicken fillets stored at (4±1°C).

Protein

From the same Table, it was noticed that the protein of chicken patties was significantly decreased with increasing the storage period at cold temperature for all samples. The treated samples in PA/PE bags had higher loss in protein content than treated samples in PA/PE/P/AL. The lower protein values causing the occurrence of changes in the physical and chemical characteristics with a loss of most of the vital properties such as their activity as enzymes and hormones, followed by a significant decrease in their solubility. The decrement of protein during cold storage could be due to partially break down by proteolytic enzyme which is not completely inactivated during cold storage as well as loss of the nitrogenous compounds (Morsi, 1988) as observed that protein breakdown consequently as reflect the degree of hydrolysis in protein due to enzyme activity and bacterial decomposition. There were no significant differences in protein content between samples B2 and C2 after 30 days of storage at (4±1ºC). these results are agreement with those reported by (Boschetti *et al.*, 2016 ; Chmiel *et al.*, 2019 and Abdou *et al.*, 2018).

Ether extract

The changes in ether extract of chicken patties were determined during storage period at cold temperature for samples kept packaged in both PA/PE and PA/PE/P/AL. From Table (3), it could be observed that ether extract of all chicken patties samples was slightly decreased with increasing of storage period. This result may be due to The most important gas in MAP foods due to its high solubility in carbon dioxide in high-moisture/high-fat foods such as meat, poultry and seafood can lead to package collapse due to reduced head size and frequency, According to (Kaleemullah, 2002).

Ash

Ash contents of chicken patties samples were determined during storage period at cold temperature (4±1ºC). (Table 3). The results indicated that, the ash increased significantly with increasing of storage period in chicken patties kept in both PA/PE and PA/PE/P/AL bags.

The rate of ash increases in patties samples kept in PA/PE was less than the samples in PA/PE/P/AL. The chicken patties samples A1 and A2 in PA/PE and in PA/PE/P/AL had 1.28 and 1.3% ash at zero time, respectively. After 10 days of storage period at (4±1ºC), the ash content increased to reach 1.58 and 1.69%, respectively in the same samples. On the other hand, the initial ash contents in samples B1, C1, B2 and C2 were 1.25, 1.32, 126 and 1.35%, respectively with no significant differences between them. After 30 days of storage period at (4±1ºC), ash contents reached to 1.75, 1.82, 1.96 and 1.90% in the same samples, respectively (Table 3). The increase of ash contents during storage period may be due to decrease of moisture. These results are in agreement with (Heba, 2019) who found that ash in chicken fillets increased with increasing time at cold temperature.

It was observed that, the samples C1 and C2 were related good quality and best treatment to contains 100% CO_2 due to the most important gas in the MAP of foods because of its the high solubility of CO_2 in high moisture / high fat foods such as meat, poultry and seafood can result in package collapse owing to the reduction of headspace volume (Kaleemullah, 2002).

Table 3. Effect of different packaging method on chemical composition of chicken patties during storage period at 4±1°C

Storage period (days)	PA/PE			PA/PE/P/AL		
	A1	**B1**	**C1**	**A2**	**B2**	**C2**
			Moisture, %			
0	70.67^{Af}	71.72^{Ad}	72.58^{Aa}	70.73^{Ae}	71.78^{Ac}	71.96^{Ab}
5	70.45^{Be}	70.61^{Bd}	71.40^{Bb}	70.67^{Bc}	71.60^{Ba}	71.63^{Ba}
10	69.12^{Ce}	70.49^{Cc}	71.37^{Bb}	69.72^{Cd}	71.41^{Cb}	71.49^{Ca}
15	-	70.38^{Dd}	70.97^{Cc}	-	71.18^{Db}	71.36^{Da}
20	-	69.27^{Ec}	70.21^{Db}	-	69.19^{Ed}	70.75^{Ea}
25	-	68.34$^{Fd\ n}$	69.35^{Eb}	-	68.80^{Fc}	70.38^{Fa}
30	-	68.15^{Gd}	69.18^{Fb}		68.71^{Gc}	69.53^{Ga}
			Protein, %			
0	20.53^{Af}	21.82^{Ad}	22.34^{Ab}	20.85^{Ae}	21.91^{Ac}	22.85^{Aa}
5	20.25Bf	21.68^{Bd}	22.06^{Bb}	20.46^{Be}	21.80^{Bc}	22.61^{Ba}
10	18.64^{Cf}	20.78^{Cd}	21.86^{Cb}	19.65^{Ce}	21.47^{Cc}	22.48^{Ca}
15	-	20.59^{Dd}	21.63^{Db}	-	21.36^{Dc}	21.77^{Da}
20	-	20.43^{Ed}	20.53^{Ec}	-	20.74^{Eb}	21.45^{Ea}
25	-	20.35^{Fc}	20.30^{Fc}	-	20.60^{Fb}	20.77^{Fa}
30	-	20.19^{Gc}	20.30^{Fb}	-	20.48^{Ga}	20.51^{Ga}
			Ether extract, %			
0	2.43^{Af}	2.62^{Ad}	2.68^{Ac}	2.49^{Ae}	2.85^{Ab}	2.92^{Aa}
5	2.13^{Be}	2.53^{Bc}	2.58^{Bc}	2.25^{Bd}	2.75^{Bb}	2.81^{Ba}
10	2.10^{Bc}	2.44^{Cb}	2.46^{Cb}	2.15^{Cc}	2.65^{Ca}	2.50^{Cb}
15	-	2.30^{Dd}	2.40^{Dc}	-	2.53^{Da}	2.46^{Cb}
20	-	2.20^{Ec}	2.29^{Eb}	-	2.46^{Ea}	2.20^{Dc}
25	-	2.09^{Fb}	2.12^{Fb}	-	2.22^{Fa}	2.15^{Db}
30	-	2.00^{Ga}	2.04^{Ga}	-	2.01^{Ga}	2.08^{Ea}
			Ash, %			
0	1.28^{Ca}	1.25^{Ga}	1.32^{Ga}	1.30^{Ca}	1.26^{Ea}	1.35^{Fa}
5	1.37^{Ba}	1.30^{Fb}	1.46^{Fa}	1.42^{Ba}	1.44^{Da}	1.43^{Ea}
10	1.58^{Ab}	1.43^{Ec}	1.52^{Eb}	1.69^{Aa}	1.63^{Cb}	1.55^{Db}
15	-	1.50^{Dc}	1.59^{Db}	-	1.79^{Ba}	1.59^{Db}
20	-	1.59^{Cc}	1.70^{Cb}	-	1.88^{Aa}	1.70^{Cb}
25	-	1.68^{Bd}	1.76^{Bc}	-	1.93^{Aa}	1.82^{Bb}
30	-	1.75^{Ad}	1.82^{Ac}	-	1.96^{Aa}	1.90^{Ab}

A1: Packed in PA/PE with air (control), B1: Packed in PA/PE with 100% CO_2, C1: Packed in PA/PE with internal gas mixing (50% CO_2 /50% N_2), A2: Packed in PA/PE/P/AL with air (control) , B2: Packed in PA/PE/P/AL with 100% CO_2 C2: Packed in PA/PE/P/AL with internal gas mixing (50% CO_2 /50% N_2) PA: Polyamide, PE: Polyethylene, P: Paper, AL: Aluminum foil means with different lower case letters (a,b,….) in the same row are significantly different ($p<0.05$).

means with different upper case letters (A,B,….) in the same column are significantly different ($p<0.05$)

Chemical quality attributes of chicken patties

Quality attributes of chicken patties included of peroxide value, TBA, TVN and acid value under the influence of modified atmosphere packaging during cold storage period at (4±1°C) were illustrated in Table (4).

Peroxide value of chicken patties

The changes in peroxide value of treated chicken patties samples in two types of packages were determined during storage period at cold temperature (4±1ºC). Data on Table 4 observed that, the peroxide value was increased with increasing of storage period for all chicken patties samples. The peroxide values of chicken patties samples A1 and A2 were 1.15 and 1.09 meqo_2/kg, respectively at zero time and reached to 1.96 and 1.78 meqO_2/kg, respectively for the same samples after 10 days of storage period. Peroxide values of chicken patties samples treated with 100% CO_2 or 50% CO_2 +50% N_2 in both two types of packages were significantly increased with increasing of storage period at 4°C. Peroxide values were 1.0, 1.25, 1.17 and 1.28 meqO_2/kg for samples B1, C1, B2 and C2, respectively and reached to 2.01, 2.04, 2.06 and 2.07 meqO_2/kg for the same samples after 30 days of storage at (4±1ºC).

Thiobarbituric acid (TBA) of chicken patties

Table 4 illustrated the changes in TBA of chicken patties samples during storage period at cold temperature. It could be observed that there were significant differences between chicken patties samples packed in air and chicken patties samples packed in MAP at zero time. Otherwise, there were no significant differences in TBA between chicken patties samples kept in MAP for two types of packages during 30 days of storage period. These results were in agreement with (Chmiel *et al.*, 2018*)* who stated that the values of the TBA index were increased by increasing the amount of oxygen slightly in modified atmosphere. According to (Abdel-Hamied *et al.*, 2009), aldehydes are rancid flavor compounds which accelerate the rate of lipid oxidation.

Total volatile nitrogen (TVN) of chicken patties

From Table (4), it could be observed that there were significant differences in TVN between all chicken patties samples at zero time. TVN values in samples A1 and A2 was 12.90 and 12.53 mg/100g at zero time and clearly increased after 10 days of storage period at (4±1ºC). Approximately the same increase of TVN occurs after 30 days of storage at (4±1ºC) for samples B1, C1, B2 and C2. Results showed significant differences in TVN for all samples at different storage times.

Total volatile nitrogen of all treatments was progressively increased as the time of cold storage increased according to (Abdou *et al.*, 2018). Fennema and Tannenbaum (1996) and (Aboul-Anean *et al*., 2018) found that after storage, the TVN increased by increasing refrigerator storage period. Since, total volatile nitrogen TVN consider an excellent indicator for protein breakdown consequently they reflect the degree of hydrolysis in protein due to enzyme activity and bacterial decomposition. These results are in agreement with Emam and Mohamed (2004) who found that TVN of chicken sausage increased during frozen storage. One the same line, (Lin *et al.*, 2003) indicated that TVN increased during frozen storage due to photolytic bacteria growth and chemical changes during storage due to amino acids decarboxylase activity produced by microorganisms. These results were in agreement with (Egyptian Organization Standardization, 2005) which resulted that TVN was not more than 20 (mg/100g) in refrigerated chicken. (Blacha *et al.*, 2014) found that the TVN values ranged between 27.04 mg/100g of meat (day1) and 28.20mg/100gof meat (day 12) of turkey breast muscles were packaged in vacuum and in different modified atmosphere mixtures.

Acid value of chicken patties

At the same trend of TVN values, Acid values in samples A1 and A2 which was 0.51 and 0.45 mg/100g at zero time and clearly increased to reach 1.05 and 1.02 mg/100g, respectively after 10 days of storage period at (4±1ºC). Approximately the same increase of acid values occurs after 30 days of storage at (4±1ºC) for samples B1, C1, B2 and C2. Results showed significant differences in acid values for all samples at different storage times. The increment of acid value during storage may be due to partial hydrolysis of fat or protein by the action hydrolysis enzymes such as lipase (Goston, 1995) .

Table 4. Effect of different packaging method on chemical quality attributes of chicken patties during storage period at 4±1°C

Storage period (days)	PA/PE			PA/PE/P/AL		
	A1	B1	C1	A2	B2	C2
	Peroxide value(meqO_2/kg)					
0	1.15^{Cb}	1.00^{Gd}	1.25^{Fa}	1.09^{Cc}	1.17^{Gb}	1.28^{Fa}
5	1.56^{Ba}	1.20^{Fd}	1.45^{Eb}	1.35^{Bc}	1.30^{Fc}	1.39^{Ec}
10	1.96^{Aa}	1.40^{Ee}	1.65^{Dc}	1.78^{Ab}	1.51^{Ed}	1.50^{Dd}
15	-	1.50^{Dc}	1.79^{Ca}	-	1.62^{Db}	1.78^{Ca}
20	-	1.75^{Cc}	1.94^{Ba}	-	1.83^{Cb}	1.92^{Ba}
25	-	1.93^{Bb}	2.01^{Aa}	-	2.00^{Ba}	2.02^{Aa}
30	-	2.01^{Aa}	2.04^{Aa}	-	2.06^{Aa}	2.07^{Aa}
	TBA (mg/kg)					
0	0.33^{Aa}	0.17^{Bb}	0.19^{Ab}	0.30^{Aa}	0.19^{Ab}	0.18^{Ab}
5	0.34^{Aa}	0.19^{Bb}	0.22^{Ab}	0.34^{Aa}	0.20^{Ab}	0.18^{Ab}
10	0.36^{Aa}	0.19^{Bb}	0.22^{Ab}	0.35^{Aa}	0.22^{Ab}	0.19^{Ab}
15	-	0.20^{Ba}	0.23^{Aa}	-	0.22^{Aa}	0.19^{Aa}
20	-	0.21^{Aa}	0.24^{Aa}	-	0.25^{Aa}	0.21^{Aa}
25	-	0.24^{Aa}	0.25^{Aa}	-	0.25^{Aa}	0.22^{Aa}
30	-	0.26^{Aa}	0.26^{Aa}	-	0.25^{Aa}	0.22^{Aa}
	TVN (mg/100g)					
0	12.90^{Ca}	10.66^{Gc}	10.40^{Gd}	12.53^{Cb}	10.37^{Gd}	9.88^{Ge}
5	20.52^{Ba}	12.45^{Fc}	12.15^{Fe}	19.88^{Bb}	12.26^{Fd}	12.09^{Ff}
10	27.77^{Aa}	15.92^{Ec}	14.60^{Ed}	25.19^{Ab}	14.43^{Ee}	13.93^{Ef}
15	-	17.22^{Da}	16.44^{Db}	-	16.13^{Dc}	15.58^{Dd}
20	-	19.45^{Ca}	18.63^{Cc}	-	18.67^{Cc}	18.80^{Cb}
25	-	21.18^{Ba}	20.34^{Bc}	-	20.53^{Bb}	19.16^{Bd}
30	-	23.12^{Aa}	22.14^{Ad}	-	23.02^{Ab}	22.29^{Ac}
	Acid value (mg/100g)					
0	0.51^{Ca}	0.16^{Gd}	0.22^{Gc}	0.45^{Cb}	0.11^{Fd}	0.23^{Gc}
5	0.88^{Bb}	0.25^{Fd}	0.28^{Fd}	0.94^{Ba}	0.23^{Ed}	0.35^{Fc}
10	1.05^{Aa}	0.44^{Eb}	0.44^{Eb}	1.02^{Aa}	0.35^{Dc}	0.45^{Eb}
15	-	0.56^{Db}	0.67^{Da}	-	0.55^{Cb}	0.68^{Da}
20	-	0.87^{Ca}	0.78^{Cb}	-	0.73^{Bb}	0.88^{Ca}
25	-	0.97^{Ba}	0.86^{Bb}	-	0.98^{Aa}	0.93^{Ba}
30	-	1.04^{Aa}	0.98^{Aa}	-	1.01^{Aa}	1.00^{Aa}

A1: Packed in PA/PE with air (control), B1: Packed in PA/PE with 100% CO_2, C1: Packed in PA/PE with internal gas mixing (50% CO_2 /50% N_2), A2: Packed in PA/PE/P/AL with air (control) , B2: Packed in PA/PE/P/AL with 100% CO_2 C2: Packed in PA/PE/P/AL with internal gas mixing (50% CO_2 /50% N_2) PA: Polyamide, PE: Polyethylene, P: Paper, AL: Aluminum foil

means with different lower case letters (a,b,….) in the same row are significantly different (p<0.05). means with different upper case letters (A,B,..) in the same column are significantly different (p<0.05)

Microbial evaluation of chicken patties samples during storage at cold temperature (4±1ºC)**.**

The microbiological analysis such as total bacterial count, psychrophilic bacteria, molds and yeasts count, *salmonella* and *coliform* of chicken patties samples during storage at cold temperature were determined and tabulated in Table (5).

Total bacterial count (TBC).

Initial TBC counts of chicken patties samples were average of 2.34 log cfu/g, which showed significant increases (P < 0.05) during storage time in all samples (Table 5). During 10 days of storage period at (4±1ºC), the colony of bacteria increased sharply in A1 and A2 samples which kept in air packaging and reached to 9.69 and 8.87 log cfu/g, respectively. These counts exceeded the maximum onset of spoilage (>7 log cfu/g) indicated for fresh meat by ICMSF, the International Commission on Microbiological Specifications for Foods (ICMSF,2002). Similar results were also reported by Guo *et al.* (2018) who studied the effect of normal and modified atmosphere packaging on shelf life of roast chicken meat. TBC were increased gradually during storage period at (4±1ºC) in MAP samples B1, C1, B2 and C2 which reached to 9.69, 9.50, 8.40 and 8.33 log cfu/g, respectively, (Table 5).

The results indicated that MAP could reduce the rate of growth of bacteria in chicken patties, compared with air packaging. In addition, CO2 had a significant effect in inhibiting microbial growth. These results were in agreement with (Chouliara *et al*., 2007) and (Guo *et al*., 2018) who stated that carbon dioxide atmosphere packaging method could effectively inhibit the growth of molds and yeasts in roast chicken meat, and with the increase of carbon dioxide content in the package, bacteria grew slower. Other research found that, TBC of the samples packed in air and treatment of modified atmosphere packaging reached to 6 log cfu/g, which is considered as the upper acceptability limit for poultry meat as defined by International Commission on Microbiological Specifications for Foods (ICMSF, 2002; Vongsawasdi *et al*., 2008) on days 30 and 65 of storage, respectively. Also, (Blacha *et al*., 2014) observed that total viable counts of turkey breast samples packaging in vacuum and in different modified atmosphere mixtures increased by extend storage period.

Psychrophilic bacterial count

Increasing rate of Psychrophilic count in A1 and A2 samples was high during the first 10 days at (4±1ºC) and went from 1.25 and 1.30 log cfu/g to 5.90 and 5.20 log cfu/g, respectively. Psychrophilic counts were increased slightly in B1, C1, B2 and C2 during 30 days of storage at 4°C. These results are due to present of CO_2 and N_2 in two types of tested films (Table 5). These results were agreement with (Aboul-Anean *et al*., 2018) who stated that, Psychrophilic bacteria counts of control chicken patties treatments gradually increased with the storage period (30 days) at cold temperature (4±1°C). At the same trend (Biswas *et al*., 2017) found that Psychrophilic bacteria counts of chicken frankfurter and chicken kofta increased during cold storage at (4±1°C) for 21 days. (Byrd *et al*., 2011) reported that the treatments evaluated, CO_2 allowed the least growth of Psychrophilic. (Fraqueza and Barreto, 2009) studied the effect on turkey meat shelf life of modified atmosphere packaging and found that Psychrophilic bacteria counts increased as the period of storage increased up to 25 days.

Molds and yeast count

The counts of yeasts and molds increased sharply from 0.58 and 0.52 log cfu/g to 4.52 and 4.35 log cfu/g on day 10 in A1 and A2 samples, respectively, whereas the counts were increased slightly significantly in MAP (B1, C1, B2 and C2) throughout the 30 days of storage period (Table 5). The yeast and molds of B2 and C2 samples were the lowest ($p < 0.05$) among the whole samples and went from0.52 and 0.53 log cfu/g to4.67 and 4.64 log cfu/g by day 30 of storage at (4±1ºC). Similar results were also report by (Patsias *et al.*, 2006) and (Guo *et al.*, 2018) who studied the effect of air and MAP on yeasts and molds of chilled precooked chicken and roasted chicken meat products, respectively. This result showed that type of package and MAP packaging method could effectively inhibit the growth of molds and yeasts in chicken patties, and with the diminished of carbon dioxide content in the package, molds and yeasts grew faster Poultry meat spoilage depends on a combination of microbial growth and complex biochemical activities. Therefore, product shelf life depends on many factors of which packaging and storage temperature both of two are equally important (Das *et al.*, 2015).(Thippareddi and Phebus, 2002) and(Kumar *et al.*, 2015) shows that yeast and mold counts increased with the increasing storage period sample for all treatments chicken patties throughout the storage period. There are significantly variations in all chicken patties samples treated with modified atmosphere packaging in molds and yeast during storage period.

Table 5. Effect of different packaging method on microbial count ($x10^2$cfu/g) of chicken patties during storage period at 4±1°C

Storage period(days)	PA/PE			PA/PE/P/AL		
	A1	B1	C1	A2	B2	C2
			Total bacterial count (TBC)			
0	2.37Ca	2.35Ga	2.32^{Ga}	2.34^{Ca}	2.33^{Ga}	2.31^{Ga}
5	6.78Ba	4.68Fc	4.33^{Fd}	6.49^{Bb}	4.19^{Fe}	3.69^{Ff}
10	9.69Aa	6.49Ec	6.00^{Ed}	8.87^{Ab}	5.58^{Ee}	4.28^{Ef}
15	-	6.76^{Da}	6.69^{Db}	-	6.38^{Dc}	6.21^{Dd}
20	-	7.39^{Cb}	7.57^{Ca}	-	6.96^{Cc}	6.82^{Cd}
25	-	8.24^{Bb}	8.59^{Ba}	-	7.67^{Bc}	7.50^{Bd}
30	-	9.69^{Aa}	9.50^{Ab}	-	8.40^{Ac}	8.33^{Ad}
			psychrophilic bacterial count			
0	1.25^{Ca}	1.20^{Ga}	1.28^{Ga}	1.30^{Ca}	1.20^{Ga}	1.22^{Ga}
5	3.40^{Ba}	2.30^{Fb}	1.95^{Fd}	3.35^{Ba}	2.10^{Fc}	1.70^{Fe}
10	5.90^{Aa}	3.00^{Ec}	2.46^{Ee}	5.20^{Ab}	2.75^{Ed}	2.10^{Ef}
15	-	3.85^{Da}	3.00^{Dc}	-	3.40^{Db}	2.80^{Dd}
20	-	4.00^{Ca}	3.20^{Cc}	-	3.70^{Cb}	3.10^{Cd}
25	-	4.50^{Ba}	3.60^{Bc}	-	4.35^{Bb}	3.35^{Bd}
30	-	5.12^{Aa}	4.10^{Ac}	-	4.70^{Ab}	3.70^{Ad}
			Molds and yeast			
0	0.58^{Ca}	0.57^{Ga}	0.58^{Ga}	0.52^{Ca}	0.52^{Ga}	0.53^{Ga}
5	2.56^{Ba}	2.28^{Fc}	1.56^{Fe}	2.45^{Bb}	2.14^{Fd}	1.42^{Ff}
10	4.52^{Aa}	3.71^{Ec}	2.73^{Ee}	4.35^{Ab}	3.25^{Ed}	2.18^{Ef}
15	-	4.10^{Da}	3.33^{Db}	-	4.00^{Da}	3.12^{Dc}
20	-	4.33^{Ca}	4.26^{Cb}	-	4.20^{Cb}	4.21^{Cb}
25	-	4.58^{Ba}	4.60^{Ba}	-	4.45^{Bc}	4.52^{Bb}
30	-	4.95^{Aa}	4.80^{Ab}	-	4.67^{Ac}	4.64Ac

A1: Packed in PA/PE with air (control), B1: Packed in PA/PE with 100% CO_2, C1: Packed in PA/PE with internal gas mixing (50% CO_2 /50% N_2), A2: Packed in PA/PE/P/AL with air (control) , B2: Packed in PA/PE/P/AL with 100% CO_2 C2: Packed in PA/PE/P/AL with internal gas mixing (50% CO_2 /50% N_2) PA: Polyamide , PE: Polyethylene , P: Paper, AL: Aluminum foil

means with different lower case letters (a,b,….) in the same row are significantly different ($p<0.05$). means with different upper case letters (A,B,..) in the same column are significantly different ($p<0.05$)

Pathogenic bacteria

Salmonella spp. and *Coliform* group were not detected in all samples in both MAP either in 100% CO_2 or in 50% CO_2 + 50% N_2. It was reported that *Salmonella* spp. and Coliform group could not be isolated in all patties chicken samples during storage period at 4°C. These results are agreement with (Vongsawasdi *et al*., 2008) and (Aboul-Anean *et al*., 2018) who reported that pathogenic microorganisms (coliform group) were not detected, which may be due to the good sanitation practices in production of chicken breast meat. The results concerning the microbiological examination are in the same line with those recommended by Egyptian Organization of Standardization (2005) for chilled poultry and rabbits. Also, (Byrd *et al*., 2011) reported that *salmonella* was not detected in the study of growth allowed by either O_2 or modified atmosphere

Organoleptic evaluation of chicken patties samples kept in different types of bags with MAP during storage at 4±1ºC

Sensory properties of chicken patties samples in modified atmosphere packaging during cold storage were illustrated in Table (6). Mean scores of sensory properties (taste, color, texture and overall palatability) of chicken patties showed significant differences between tested two bags and storage period. Taste of chicken patties was gradually decreased with increasing the storage period at cold temperature. Mean score of taste ranged between 9.8 for A2 sample and 9.4 for B2 samples at zero time. Taste scores were decreased significantly during 30 days of cold storage for all tested samples. A1 and A2 samples were undesirable at 10th day for all sensory parameters. Taste scores reached to 5.8 for C1 samples and 5.7 for other samples after 30 days of cold storage. It is noticeable that packaging the chicken patties in MAP, either in PA/PE or PA/PE/P/AL, led to increase its storage period. These results are agreement with (Biswas *et al*., 2017) who found that taste of chicken frankfurter and chicken kofta decreased as the cold storage time extended at (4±1°C) for 21 days. Also, with (Biswas *et al*., 2014) who reported that taste value of chicken patties decreased during storage.

Likewise, color at the same line, B2 and C2 samples had higher score than B1 and C1 samples while, texture, C2 sample hade the highest score between all chicken patties samples after 30 days of storage at 4±1°C. This means that packaging chicken patties in PA/PE/P/AL was better than in PA/PE. Also MAP with 50% CO2 + 50% N2 Lead to the preservation of chicken patties and prolong the preservation period (Table 6). (Victor *et al*., 2007).

Also, data presented in Table (6) revealed that slightly significant differences in overall palatability of chicken patties samples in PA/PE or PA/PE/P/AL after 30 days of storage period at 4±1oC. Generally, the mean scores of sensory properties of chicken patties samples were high acceptance at the first 5 days and decreased gradually up to 30 days at 4±1oC. According to (Aboul anean *et al*., 2018), Average scores for sensory characteristics (appearance, taste, texture, and overall palatability) of chicken patties were high palatability to panelists and they had generally high acceptability on the first day. The observed effect of atmospheric packaging and edible films on the quality of carp patties was also observed.

Ozoğul and Ozoğul (2006) found that the statistical significance between values of appearance, smell, flavor and texture was higher than in other months in vacuum samples and gas mixtures (70% CO2/30% N2, 50% CO2/50% N2) anchovies soaked, respectively. The high level of carbon dioxide may lead to negative effects on other aspects of the product, especially on the sensory aspects. The efficacy of carbon dioxide as an antimicrobial mediator is not complete and depends on the characteristics of the food product and the presence of microbial flora. (Velu *et al*., 2013).

Table 6. Effect of different packaging method on sensory evaluation of chicken patties during storage period at 4±1°C

Storage	PA/PE			PA/PE/P/AL		
period (day)	A1	B1	C1	A2	B2	C2
			Taste			
0	9.7^{Ab}	9.5^{Ad}	9.5^{Ad}	9.8^{Aa}	9.4^{Ae}	9.6^{Ac}
5	7.1^{Bf}	8.3^{Bd}	8.5^{Bb}	7.6^{Be}	8.7^{Ba}	8.4^{Bc}
10	5.8^{Ce}	7.4^{Cd}	7.6^{Cc}	5.8^{Ce}	7.8^{Cb}	7.9^{Ca}
15	-	7.0^{Dc}	6.9^{Dd}	-	7.3^{Da}	7.2^{Db}
20	-	6.6^{Ec}	6.5^{Ed}	-	6.8^{Ea}	6.7^{Eb}
25	-	6.1^{Fb}	6.1^{Fb}	-	6.0^{Fc}	6.3^{Fa}
30	-	5.7^{Gb}	5.8^{Ga}	-	5.7^{Gb}	5.7^{Gb}
			Color			
0	9.6^{Ac}	9.4^{Ae}	9.5^{Ad}	9.8^{Aa}	9.7^{Ab}	9.6^{Ac}
5	7.9^{Bf}	8.7^{Bd}	9.0^{Bb}	8.00^{Be}	8.9^{Bc}	9.1^{Ba}
10	5.7^{Ce}	8.2^{Cc}	8.6^{Ca}	6.3^{Cd}	8.4^{Cb}	8.4^{Cb}
15	-	7.7^{Dc}	8.2^{Da}	-	7.5^{Dd}	8.1^{Db}
20	-	6.8^{Ed}	7.4^{Eb}	-	6.9^{Ec}	7.6^{Ea}
25	-	6.3^{Fc}	6.3^{Fc}	-	6.4^{Fb}	6.9^{Fa}
30	-	5.3^{Gd}	5.4^{Gc}	-	5.8^{Gb}	6.2^{Ga}
			Texture			
0	9.2^{Ab}	9.2^{Ab}	9.2^{Ab}	9.3^{Aa}	9.2^{Ab}	9.2^{Ab}
5	8.5^{Ba}	8.3^{Bb}	8.2^{Bc}	8.2^{Bc}	8.2^{Bc}	8.2^{Bc}
10	6.1^{Cf}	7.6^{Cc}	7.9^{Cb}	6.3^{Ce}	7.4^{Cd}	8.0^{Ca}
15	-	7.2^{Dc}	7.7^{Da}	-	7.0^{Dd}	7.3^{Db}
20	-	6.3^{Ed}	6.5^{Ec}	-	6.7^{Eb}	6.8^{Ea}
25	-	6.0^{Fd}	6.1^{Fc}	-	6.3^{Fb}	6.6^{Fa}
30	-	5.6^{Gc}	5.8^{Gb}	-	5.8^{Gb}	6.0^{Ga}
			Overall palatability			
0	9.5^{Ab}	9.4^{Ac}	9.4^{Ac}	9.7^{Aa}	9.4^{Ac}	9.5^{Ab}
5	8.1^{Bd}	8.4^{Bc}	8.6^{Ba}	8.4^{Bc}	8.5^{Bb}	8.6^{Ba}
10	6.1^{Cd}	7.8^{Cb}	8.0^{Ca}	6.2^{Cc}	7.8^{Cb}	8.0^{Ca}
15	-	7.4^{Dc}	7.6^{Da}	-	7.3^{Dd}	7.5^{Db}
20	-	6.8^{Eb}	6.8^{Eb}	-	6.8^{Eb}	7.0^{Ea}
25	-	6.4^{Fc}	6.4^{Fc}	-	6.5^{Fb}	6.6^{Fa}
30	-	6.0^{Gb}	6.1^{Ga}	-	6.1^{Ga}	6.0^{Gb}

A1: Packed in PA/PE with air (control), B1: Packed in PA/PE with 100% CO_2, C1: Packed in PA/PE with internal gas mixing (50% CO_2 /50% N_2), A2: Packed in PA/PE/P/AL with air (control) , B2: Packed in PA/PE/P/AL with 100% CO_2 C2: Packed in PA/PE/P/AL with internal gas mixing (50% CO_2 /50% N_2) PA: Polyamide , PE: Polyethylene , P: Paper, AL: Aluminum foil

means with different lower case letters (a,b,….) in the same row are significantly different (p<0.05). means with different upper case letters (A,B,..) in the same column are significantly different (p<0.05)

CONCLUSION

Modified atmosphere packaging generally maintained chemical and microbial and sensory quality attributes during storage at 4±1ºC for 30 days of chicken patties and the quality parameters. The best treatment C1 and C2 in terms of reduction the percentage modified atmosphere packaging loss followed by treatment B1 and B2 until 30 days of storage, as compared with control samples A2 and A1 until 10 days of storage. It is clear that the PA/PE and PA/PE/P/AL of the MAP have kept the quality of chicken patties up to 30 days of storage.

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تأثير التعبئة تحت جو معدل لآطالة فترة صلاحية باتية الدجاج

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أجريت هذه الدراسة لتقييم تأثير نوعين من عبوات التعبئة فى الجو المعدل وهما (بولى ايثيلين/ بولى أميد(و) بولى أميد/ بولى ايثيلين/ ورق/ ألومنيوم فويل (وظروف الغلاف الجوي المعدل على فترة صلاحية باتية الدجاج. حيث تم تعبئة عينات باتية الدجاج داخل الغلاف (بولى ايثيلين/ بولى أميد(فى جو هوائى عادى) A1(، وداخل جو هوائى معدل بنسبة 100٪ ثانى أكسيد الكربون (B1) أو 50٪ ثانى أكسيد الكربون+ 50% نيتروجين (C1) ؛ أو معبأة داخل الغلاف) بولى أميد/ بولى ايثيلين/ ورق/ ألومنيوم فويل(فى جو هوائى عادى) A2(، وداخل جو هوائى معدل بنسبة 100٪ ثانى أكسيد الكربون (B2) أو 50٪ ثانى أكسيد الكربون + 50% نيتروجين)C2). وقد تم تخزين العينات على درجة حرارة) 4 ± 1مْ (لمدة ثلاثون يومًا مع ملاحظة التغيرات الفيزيوكيميائية والميكروبية والحسية .وأوضحت النتائج حدوث تدهور سريع فى التركيب الكيميائى والفيزيائى فى عينات باتيه الدجاج المعبأة فى الجو الهوائى العادى داخل النوعين من الأغلفة (بولى ايثيلين/ بولى أميد(و) بولى أميد/ بولى ايثيلين/ ورق/ ألومنيوم فويل(أثناء التخزين المبرد)4 ± 1مْ(لمدة عشرة أيام . وقد كان هناك انخفاض معنوي في الحمل الميكروبي في العينات B1 و B2 و C1 و C2 مقارنة مع العينات A1 و A2 فى اليوم العاشر من التخزين. عينات باتية الدجاج المعبأة في الغلافين مع جو هوائى معدل اكتسبت أعلى القيم في جميع الصفات الحسية. وقد أثبتت النتائج أن التعبئة فى جو معدل بتركيز 50% ثانى أكسيد الكربون + 50% نيتروجين) C1 و C2(كانت أكثر الظروف ملاءمة لحفظ باتية الدجاج لمدة تصل إلى ثلاثين يومًا عند(4 ± 1م)ْمقارنة بعينات الكنترول A1 و A2 والتي تكون مقبولة عند أقل من عشرة أيام.