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Improving The Quality Attributes and Storability of Garlic Minimally Processed Edible Coating as A Carrier of Essential Oil

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THIS research was aimed to study the effect of using edible coating as a carrier of essential oils (as natural antioxidant and antibacterial agent) on the quality of full garlic cloves (*Allium sativum* L.*)* and minimally processed garlic (minced garlic cubes) at cold storage (10ºC) and at relative humidity of 90%during 2016 and 2017 harvest seasons. The coating of full cloves and minced garlic cubes with cellulose or gelatin edible coating incorporated with/without garlic oilresults in reducing the weight loss %, and keeping excellent appearance until 56 days of cold storage.Results indicated that incorporation of garlic essential oil into cellulose and gelatin coatingenhance the storability of minimally processed garlic, since treatments coated with cellulose or gelatin coating incorporated with garlic were had lower total microbial, mould and yeast counts as compared to control.Other chemical properties were studied e.g. Soluble solids content, color, Phenol compound, flavonoids and total Phenols contents. Results indicated that garlic essential oil on cellulose and gelatin are the best treatment for preserving garlic minimally processed.

Keywords: Edible coating,Garlic essential oil,Garlic minimally processed, Microbial count and mould & yeast, Cellulose and gelatin

Introduction

Edible coatings may contribute to prolong minimally processed food shelf life; working as barrier to gases, water vapor, solutes and guaranteeing microbiological safety, since spoilage and pathogenic microorganisms usually grow on food surfaces. The incorporation of antimicrobial agents into packaging flexible films (by coatings) is used to control this problem. In addition, the potential of edible coatings for aroma retention and as an oxygen barrier makes them of interest for food and packaging technologies (Geraldine et al.,2008).

Polysaccharides which used forpreparation of edible films or coatings include cellulose, starch derivatives, pectin derivatives, seaweed extracts, exudates gums, microbial fermentation gums and chitosan are generally very hydrophilic resulting in poor water vapor and gas barrier properties (Bourtoom,2008). Cellulose based edible films are very good barriers to aroma, oxygen and oil transfer like other hydrophilic films (Turhan,2011).

Gelatin is readily soluble in water at temperatures above 40ºC, forming a viscous solution of random-coiled linear polypeptide chains. On cooling a gelatin solution around 20ºC, collagen like helices are formed, albeit not very long ones and including only part of the material, this is form a gel. The properties and film forming ability of gelatin are directly related to the molecular weight, i.e., the higher the average molecular weight, the better the quality of the film(Skurtys et al., 2010).

Edible coatings and films incorporated with essential oils can reduce antimicrobial diffusion into the product since the essential oils form part

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of the chemical structure of the coating /film. Antimicrobial release from the edible coating/ film depends on many factors, including electrostatic interactions between the antimicrobial agent and the polymer chains, osmosis, structural changes induced by the presence of antimicrobial and environmental conditions. Compared with direct application, smaller amounts of antimicrobial agents would be needed when edible films are used in order to achieve a specific shelf life due to a gradual release on food surfaces Avila-Sosa et al., 2012). Essential oil fractions of oregano and pimento are efficientagainst various food borne bacteria such as *Salmonella, E. coli O157:H7*. Spice extracts fromoregano, sage, rosemary, garlic, thyme and pimento arealso reported to possess antioxidant and antimicrobial properties (Dorman and Deans, 2006).

Garlic (*Allium sativum* L.) is a remarkable plant, which has multiple beneficial effects such as antimicrobial, antithrombotic, hypolipidemic, antiarthritic, hypoglycemic and antitumor activity. It is used universally as a flavoring agent, traditional medicine and a functional food to enhance physical and mental health (Eghdami et al., 2011).

Therefore, the objective of this investigation was to evaluate the effects of different edible coatings (cellulose or gelatin coatings) with or without incorporation ofgarlic oil on quality attributes and storability of full cloves and minced garlic cubes during refrigerated storage.

Materials and Methods

Materials

Fresh organic Garlic fruits (*Allium sativum* L.) were obtained in seasons 2016and 2017from a private orchard in (Elkalubia Governorate, Egypt). Fruits were harvested on mid-march when fully matured as followed in the commercial practice, and transported to the postharvest handling lab. At Central Lab of Organic Agriculture and Food Tech. Res. Institute, Giza, Egypt to study the effect of different postharvest treatments on quality of full cloves garlic and minimally processed garlic (minced garlic cubes). Fruits were stored till used at 10 ºC.

Cellulose sulfate (CS) was obtained from Jenapharm, Germany, Gelatin was obtained from Chemicals Company, UK, Citric acid was obtained from ADWIC, Company, Egypt, Glycerol , calcium hypochlorides obtained from AL-Gomhoria Company, Egypt while Oleicacid andGarlic essential oils were obtained fromAcross Organics, Belgium.

Methods

Technological methods

Preparation of cellulose sulfate film

Cellulose Sulfate Film was prepared with or without garlic essential oil (0.1% v/v) by using 2 g cellulose sulfate (CS), 0.3 g glycerol, and 0.1goleic acid as follows: 2 g CS and 0.3 g glycerol were dispersed in 100 mL distilled water, then oleic acid was incorporated and the mixture was homogenized at 6,000 rpm for 2min. under vacuum (Chen et al., 2015).

Preparation of gelatin protein film

Gelatin protein filmwas preparedwith or without garlic essential oil (0.1% v/v) by mixing 8.75 g gelatin and 3.35 g glycerolin 100 ml distilled water.The mixture pH was adjusted to 7 and heated to 85ºC for 15 min. using a heating magnetic stirrer (Lim et al., 1990).

Preparation of full cloves garlic (FCG)

Garlic fruits were prepared by cutting the garlic heads,remove the outer shell and wash them gently with disinfectant solution (calcium hypochlorite 0.25g / L distilled waterfor 10 sec), then air dried and immersed in the pre-prepared solution.

Preparation of minced garlic cubes (MGC)

Garlic fruits were chopped by the kitchen machine and shaped into cubes by packing inplastic cubes form.

Preparation of the deferent treatments

Both fruits and prepared minced garlic cubes were divided into five groups, one group used as control, two groups were coated with cellulose sulfate film with or without garlic essential oil and two groups were coated with gelatin film with or without garlic essential oil (ten groups). The different coated groups were dipped for one minute in the edible film mixture. Coated fruits and minced garlic cubes were drained after dipping and packaged in plastic trays with approximately 250 g. After that, all boxes were cold stored at 4°C and 90-95% RH for 56 days.

Analytical Methods

Physical properties

*Weight loss:*Weight loss percentage was estimated according to Han et al. (2004) by using the following equation:

$$\text{Weight loss \%} = \frac{\text{initial fruit weight} - \text{fruit weight at sampling date}}{\text{initial fruit weight}} \times 100$$

*General appearance:*General appearance was determined by submitting samples to 5 member panel experienced in judging sensory analysis of fruit. Samples were identified with random numbers and arranged on individual plates. Each sample was rated using score system as follows: 9 = excellent, 7 = good, 5 = fair, 3 = poor and 1 = unsalable as described by Mercado et al. (1998) This scale describes fresh appearance, color and taste. In the current study, a score of 5 or below was considered to be unsalable.

*Color measurement:*Internal color measurements L and values of garlic fruits and minced garlic cubes were measured by using Minolta Chroma Meter, Model CR – 200. Calibration was done by a white plate before use. Color changes were quantified for L value which refers to the lightness, and a value which refers to yellow tonality (Barbagallo et al. 2012).

*Total Soluble solids (TSS %):*Total Soluble solidswere determined in juice according to (A.O.A.C. 1990).

Chemical properties

Determination of total phenols content: Total Phenols content were extracted using the method of Kahkonen, et al. (1999) and determined using the method of Ivanova et al. (2010) while fractionation and identification of phenolic compounds and Flavonoids were determined by HPLC according to the method of Goupy et al.(1999).

Microbial analysis

Total microbial count, mold and yeast counts were determined according to Marchall (1992).

Statistical analysis

The obtained data were subjected to the proper statistical analysis using the MSTAT statistical software. The mean values were compared using LSD method at 5% level. The data were tabulated and statistically analyzed using factorial analyses according to the completely randomized design (Snedecor and Cochran 1989).

Results and Discussion

Weight loss percentage

Table 1 shows the coating of full cloves garlic and minced cubes garlic with cellulose and gelatin prolonged the shelf life of garlic minimally processed in cold storage as compared with control. At the same time gelatin coating was more effective with full cloves garlic and minced cubes garlic than cellulose coating.

The full cloves garlic treatments were indicated a higher weight loss than minced cubes garlic which may be due to the direct contact with garlic water and formation of hydrophilic and cross-linking ties with the coating as reported by Albert and Mittal(2002).

The weight loss of minced garlic cubes control was higher than that of full cloves garlic which was 5.90 and 6.85% after 21 days of cold storage respectively at the first season while it was 6.44 and 6.99 % after 21 days at the second season. The same trend was observed with the coated treatments since at the end of the storage period. The weight loss of coated minced garlic cubes ranged between 7.23 and 8.65% while the weight loss of full cloves garlic was ranged between 8.2 and 9.65% in the first season while the weight loss of coated minced garlic cubes ranged between 7.85 and 9.10 % while the weight loss of full cloves garlic was ranged between 9.13 and 10.20 % in the season.In this respect that the weight loss of all treatments is increased as the cold storage period increased. Control treatments indicated a higher weight loss than the edible coated treatments. Edible coating application results in reducing the weight loss because its has semi-permeable properties which led to extend shelf life by reducing moisture and solute migration, respiration and oxidative reaction rates, as well as suppress physiological disorders on fresh-cut fruits as reported by Rojas-Grau et al. (2007) and Bonilla et al. (2012).

General appearance

Table 2 reveals a gradual decrease in general appearance values with increasing the refrigerated storage time. General appearance values of both coated full cloves garlic and mincedgarlic cubes were higher than that of control treatments which spoiled in early time (21 days for full cloves garlic and 28 days for mincedgarlic cubes) when compared to coated treatments which still acceptable until the end of storage period (56 days) for both full cloves and minced garlic cubes.

TABLE 1. Effect of edible coating ongarlicweight loss (full cloves and minced cubes) during refrigerated storage period.

Storage period (days)	Full cloves Garlic						Minced cubes Garlic					
	Control	Cellulose		Gelatin		Mean	control	Cellulose		Gelatin		Mean
		With oil	Without oil	With oil	Without oil			With oil	Without oil	With oil	Without oil	
Season 2016												
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
7	2,60	1,50	2,10	1,75	2,35	1,93	2,35	1,45	1,85	1,55	1,90	1,69
14	3,40	2,15	3,35	2,35	3,90	2,94	4,29	1,90	2,45	2,10	2,65	2,28
21	5,90	3,65	4,55	3,90	4,89	4,25	6,85	2,08	3,60	2,85	3,89	3,11
28	-	4,90	5,65	5,20	5,95	5,43	8,40	3,60	4,22	4,10	4,60	4,13
35	-	5,80	6,85	5,69	6,99	6,33	-	4,85	5,40	5,25	5,86	5,34
42	-	6,86	7,75	6,95	7,88	7,36	-	5,28	6,25	6,20	6,85	6,15
49	-	7,60	8,80	7,90	8,95	8,31	-	6,80	7,88	7,10	8,10	7,47
56	-	8,20	9,27	8,75	9,65	8,97	-	7,23	8,65	7,75	8,90	8,13
Mean	2,98	4,52	5,37	4,72	5,62	5,06	4,38	3,69	4,48	4,10	4,75	4,25
L.S.D.	S = 1.6932		T = 1.4893		S&T = 0.194		S = 1.5294		T = 1.4845		S&T = 0.1967	
Season 2017												
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
7	2,95	1,68	2,35	1,95	2,45	2,11	2,55	1,52	1,97	1,75	1,99	1,81
14	4,70	2,46	3,73	2,80	4,10	3,27	4,96	1,95	2,65	2,80	2,96	2,59
21	6,40	3,77	4,99	4,25	5,25	4,57	6,99	2,10	3,79	3,40	4,10	3,35
28	-	5,00	5,95	5,70	6,35	5,75	8,75	3,89	4,65	4,30	5,25	4,52
35	-	6,20	7,10	6,25	7,40	6,74	-	4,99	5,80	5,39	6,70	5,72
42	-	7,15	8,19	7,30	8,25	7,72	-	5,68	6,66	6,70	7,30	6,59
49	-	8,20	9,10	8,70	9,95	8,99	-	6,95	7,95	7,80	8,29	7,75
56	-	9,13	9,65	9,95	10,20	9,73	-	7,85	8,89	9,10	9,10	8,74
Mean	3,51	4,84	5,67	5,21	5,99	5,43	4,65	3,88	4,71	4,58	5,08	4,56
L.S.D.	S = 1.8154		T = 1.609		S&T = 0.194		S =1.613		T = 1.5619		S&T = 0.1967	

(-)a spoiled reject samples
LSD Treatments = T LSD Storage period = S LSD (Storage period* Treatments) = T * S
Means within a column showing the same letters are not significantly different (P≥ 0.05).

Full garlic cloves control treatment indicates nearly similar general appearance with minced garlic cubes control at 21 days of cold storage. The same trend with also observed with coated full cloves garlic and minced cubes garlic. The general appearance values of coated treatments still acceptable till 56 days of cold storage. The results in agreement with (Wang.,1998)

Color changes

Data in Table 3 indicate continuous decreasing in L value with continuous increasing in a value duringrefrigerated storage (10 ºC) forboth full cloves and minced garlic cubestreatments.There was a markedincrease in colorchange valuesof control cloves compared to the other treatments, for both damaged and non-damaged surfaces(Color differences determined on damaged and non-damaged clove surfaces compared to the white standard.). Color variation on damaged surfaces was, however, considerably higher than that of non-damaged ones. The color difference among cloves with different coatings was not significant ($p < 0.05$) and remained statistically unaltered throughout the storage period for non-damaged surfaces. Control cloves showed a significant increase in color change during 3 days after processing. Color change of cloves treated with different films was also non-significant for damaged surfaces; however, it increased rapidly

with time. The greatest color alteration was found on damaged surfaces of the control treatmentwhich similar to the findings of Geraldine et al., 2008. Similar results were obtained by Aguayo et al. (2003) since they reported that there were non significant differences found after comparing whiteness index (WI) in non-coated fruit fresh-cut and coated with edible coatingimmediately. However, significant changes in this parameter were observed when essential oils and their active compounds were added. Higher concentrations of essential oils result in more whiteness of fruit fresh-cut than lower concentrations.

Total soluble solids (TSS)

From the results in Table 4, it could be noticed that the total soluble solids (TSS) of minimally processed garlic with edible coating is gradually decreased with increasing the refrigerated storage period for both full garlic cloves and minced garlic cubes. Control treatments indicated lower total soluble solids than coated treatments.

TSS decreasing rate of both full garlic cloves and minced cubes was 3.1% and 2.5% respectively after 21and 28 days ofrefrigerated storage. However, refrigerated stored coated samples greatly showed great decrease in both

TABLE 2. Effect of edible coating ongarlicgeneral appearance garlic (full cloves and minced cubes) during storage period.

Storage period (days)	control	Full cloves Garlic				Mean	control	Minced cubes Garlic				Mean
		Cellulose		Gelatin				Cellulose		Gelatin		
		With oil	Without oil	With oil	Without oil			With oil	Without oil	With oil	Without oil	
Season 2016												
0	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00
7	7,00	9,00	8,85	9,00	8,85	8,93	7,50	9,00	8,85	9,00	8,85	8,93
14	6,00	8,40	8,25	8,20	8,10	8,24	6,40	8,50	8,35	8,40	8,25	8,38
21	5,60	8,00	7,80	7,80	7,50	7,78	5,80	8,15	8,00	8,08	7,85	8,02
28	-	7,50	7,30	7,50	7,10	7,35	5,00	7,86	7,55	7,66	7,22	7,57
35	-	7,30	7,10	7,00	6,75	7,04	-	7,35	7,20	7,10	7,10	7,19
42	-	6,50	6,50	6,20	6,20	6,35	-	6,80	6,60	6,55	6,30	6,56
49	-	6,00	6,00	5,85	5,50	5,84	-	6,20	6,15	6,00	5,85	6,05
56	-	5,50	5,10	5,20	5,00	5,20	-	5,85	5,30	5,50	5,11	5,44
Mean	6,90	7,47	7,32	7,31	7,11	7,30	6,74	7,63	7,44	7,48	7,28	7,46
L.S.D.	S = 1.4789		T = 1.0663		S&T = 0.1641		S = 1.3376		T = 1.0404		S&T = 0.1661	
Season 2017												
0	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00	9,00
7	7,00	9,00	8,85	9,00	8,85	8,93	7,00	9,00	8,85	9,00	8,85	8,93
14	6,00	8,50	8,20	8,00	8,00	8,18	6,00	8,20	8,10	8,30	8,10	8,18
21	5,70	8,10	7,70	7,50	7,40	7,68	5,70	8,00	7,90	7,80	7,65	7,84
28	-	7,55	7,20	7,20	7,00	7,24	5,00	7,65	7,50	7,50	7,20	7,46
35	-	7,20	7,00	6,85	6,60	6,91	-	7,00	7,00	7,00	7,00	7,00
42	-	6,40	6,20	6,35	6,20	6,29	-	6,50	6,85	6,50	6,20	6,51
49	-	5,80	5,80	5,70	5,85	5,79	-	6,00	6,50	5,85	5,50	5,96
56	-	5,40	5,50	5,20	5,10	5,30	-	5,50	5,00	5,40	5,20	5,28
Mean	6,93	7,44	7,27	7,20	7,11	7,26	6,54	7,43	7,41	7,37	7,19	7,35
L.S.D.	S = 1.4631		T = 1.065		S&T = 0.1641		S = 1.3217		T =1.0299		S&T = 0.1661	

Score:9=excellent, 7= good ,5=Fair , 3 = unsalable(-)a spoiled reject samples
LSD Treatments = T LSD Storage period = S LSD (Storage period* Treatments) = T * S
Means within a column showing the same letters are not significantly different (P≥ 0.05).

TABLE 3. Effect of edible coating on color change (Minolta Chroma) garlic during refrigeratedstorage period.

Storage period (days)	Full cloves Garlic						Minced cubes Garlic					
	control	Cellulose		Gelatin		Mean	control	Cellulose		Gelatin		Mean
		With oil	Without oil	With oil	Without oil			With oil	Without oil	With oil	Without oil	
Season 2016												
0	61,50	61,50	61,50	61,50	61,50	61,50	61,50	61,50	61,50	61,50	61,50	61,50
7	57,00	59,20	58,33	58,20	57,10	58,21	56,20	58,65	58,20	58,30	58,00	58,29
14	54,68	57,85	56,66	56,86	55,00	56,59	54,00	56,85	55,33	56,20	54,10	55,62
21	-	56,26	54,39	54,20	52,36	54,30	50,25	54,60	53,25	54,00	52,20	53,51
28	-	54,85	52,00	53,75	50,10	52,68	44,33	52,45	51,50	51,50	50,00	51,36
35	-	52,35	50,10	51,10	48,80	50,59	-	49,20	48,80	48,55	48,60	48,79
42	-	50,66	49,82	49,40	46,25	49,03	-	48,50	47,16	47,35	46,00	47,25
49	-	48,88	47,00	46,10	45,85	46,96	-	47,00	46,84	46,10	45,55	46,37
56	-	46,90	45,26	45,00	45,20	45,59	-	46,80	45,20	45,65	44,95	45,65
Mean	57,73	54,27	52,78	52,90	51,35	52,83	53,26	52,84	51,98	52,13	51,21	52,04
L.S.D.	S = 12.238		T = 7.1422		S&T = 1.1058		S = 9.4374		T = 7.0792		S&T = 1.1339	
Season 2017												
0	60,30	60,30	60,30	60,30	60,30	60,30	60,30	60,30	60,30	60,30	60,30	60,30
7	55,68	60,10	60,25	59,20	58,80	59,59	56,10	59,55	58,25	58,90	57,00	58,43
14	52,90	59,30	58,39	58,35	56,45	58,12	53,65	58,10	57,43	57,65	56,39	57,39
21	48,10	56,86	57,44	54,10	53,20	55,40	50,00	56,66	55,20	56,00	55,65	55,88
28	-	54,30	53,10	52,36	50,35	52,53	44,00	54,20	52,44	53,25	52,10	53,00
35	-	51,80	49,20	50,25	49,10	50,09	-	53,30	50,10	51,36	50,30	51,27
42	-	48,30	47,25	47,35	46,36	47,32	-	52,00	49,00	50,00	49,25	50,06
49	-	46,43	45,36	45,85	44,77	45,60	-	50,55	48,75	49,59	48,00	49,22
56	-	45,20	44,88	44,80	43,60	44,62	-	48,00	47,25	48,00	47,10	47,59
Mean	54,25	53,62	52,91	52,51	51,44	52,62	52,81	54,74	53,19	53,89	52,90	53,68
L.S.D.	S = 10.804		T = 7.2327		S&T = 1.1199		S = 9.9763		T = 6.8522		S&T = 1.1339	

(-)a spoiled reject samples
LSD Treatments = T LSD Storage period = S LSD (Storage period* Treatments) = T * S
Means within a column showing the same letters are not significantly different (P≥ 0.05).

full garlic cloves and minced cubes garlic regarding TSS which reached to 2.3% and 2.1% after 56 days respectively. In general the TSS content of all treatment in 2017 season was higher than that of 2016 season.TSS decreasing with increased storage may be due to the higher rate of sugar loss through respiration than the water loss through transpiration .Omar., H.A(2008) (Wills et al.,1981) and (Wang.,2003).

Total phenolic content

Data in Table 5 show the effect of using edible coating as a carrier of essential oils on total phenolic compounds content of full garlic cloves and minced cubes during refrigerated storage. The results in Table 5 indicate thattotal phenolic compounds contentwas decreased with increasing the refrigeratedstorage period for both full cloves and mincedcubestreatments.Control treatments results inlower total phenolic content than coatedtreatments. The amount of total phenolic varied widely in plant materials and ranged from 0.05 to 0.98 mg /g.The decreases of total phenolic and flavonoids contents are most probably caused by the increase in sulfur compounds and terpenoids present in the essential oil of mature garlic bulbs (Bozin et al., 2008).

Identification and quantification of phenolic compounds in garlic

Garlic essential oilcontains different phytochemicals which have various protective and therapeutic effects such aspreventing diseases and maintain state of well-being. Table 6 shows the phenolic compounds extracted from full garlic cloves and minced garlic cubes. The results show that 25 phenolic compounds were identified of which , 4-amino, caffeic, catechin was the dominant

compoundfollowed by E.vanillic,Pyrogalol, Oleuropein,Salysilic acid.The results described that the,vanillic, chlorogenic recorded the lowest proportion of compounds to follow the compound Epicatechin,and POH Benzoic. Similar results were obtained by Aksoylu and Karakaya (2013) and Vlase et al., (2013) who found that the identified polyphenolic compounds in garlic are p-coumaric acid,ferulic acid,sinapic acid,isoquercitrinrutoside,quercitrin,quercetol,luteolin,kaempferol,apigenin,caftaric acid, gentisic acid,caffeic acid, chlorogenic acid, cichoric acid, hyperoside, isoquercitrin. The major phenolic constituentsarecaffeinc derivatives and flavonoids (Sroka, et al., 2005).

Garlic oil is mainly composed of sulfur-containing compound such as allicin, diallyl disulfide and diallyltrisulfide that possess antimicrobial activity Pranoto et al. (2005).

Identification and quantification ofgarlic flavonoids

The flavonoid extract was subjected to analyses HPLC Agilent(series 1100 equipped with autosamplling injector,solvent degasser, ultraviolet detector phenols)according to the method described by Bimakr ,et al (2011) The obtained results in Table 7 fraction showed 25 peak of which Apigenin-6-arabinose-

TABLE 4. Effect of edible coating on garlictotal soluble solids during refrigeratedstorage period.

Storage period (days)	Full cloves Garlic						Minced cubes Garlic					
	control	Cellulose		Gelatin		Mean	control	Cellulose		Gelatin		Mean
		With oil	Without oil	With oil	Without oil			With oil	Without oil	With oil	Without oil	
Season 2016												
0	9,30	9,30	9,30	9,30	9,30	9,30	9,30	9,30	9,30	9,30	9,30	9,30
7	7,60	8,75	8,45	8,30	7,85	8,34	7,80	8,85	8,80	8,60	8,40	8,66
14	7,45	8,52	8,05	8,12	7,90	8,15	7,55	8,55	8,40	8,25	8,15	8,34
21	6,20	8,20	7,90	7,40	7,75	7,81	7,15	8,41	8,15	8,10	8,00	8,17
28	-	8,00	7,75	7,20	7,60	7,64	6,80	8,10	8,00	7,80	7,80	7,93
35	-	7,80	7,40	7,00	7,35	7,39	-	7,85	7,75	7,55	7,50	7,66
42	-	7,30	7,10	6,85	7,10	7,09	-	7,50	7,40	7,40	7,18	7,37
49	-	7,10	7,00	6,70	6,80	6,90	-	7,35	7,30	7,20	7,10	7,24
56	-	7,00	6,85	6,60	6,55	6,75	-	7,20	7,00	6,85	6,80	6,96
Mean	7,64	8,00	7,76	7,50	7,58	7,71	7,72	8,12	8,01	7,89	7,80	7,96
L.S.D.	S = 1.6167		T = 1.0224		S&T = 0.1639		S = 1.475		T =1.016		S&T = 0.166	
Season 2017												
0	9,50	9,50	9,50	9,50	9,50	9,50	9,50	9,50	9,50	9,50	9,50	9,50
7	7,55	8,80	8,60	8,95	7,80	8,54	7,85	8,90	8,95	8,70	8,40	8,74
14	6,35	8,60	8,09	8,80	7,65	8,29	7,45	8,80	8,50	8,40	8,10	8,45
21	6,35	8,15	7,85	8,45	7,40	7,96	7,05	8,60	8,20	8,10	8,00	8,23
28	-	8,00	7,60	8,15	7,15	7,73	6,85	8,40	8,05	8,00	7,85	8,08
35	-	7,85	7,45	8,00	7,00	7,58	-	8,00	7,80	7,70	7,65	7,79
42	-	7,10	7,10	7,85	6,75	7,20	-	7,85	7,45	7,40	7,40	7,53
49	-	7,00	6,90	7,60	6,45	6,99	-	7,55	7,20	7,30	7,10	7,29
56	-	6,90	6,85	7,08	6,10	6,73	-	7,10	7,00	7,10	6,85	7,01
Mean	7,44	7,99	7,77	8,26	7,31	7,83	7,74	8,30	8,07	8,02	7,87	8,07
L.S.D.	S = 1.6609		T = 1.0163		S&T = 0.1639		S = 1.4996		T = 1.0259		S&T = 0.166	

(-)a spoiled reject samples

LSD Treatments = T LSD Storage period = S LSD (Storage period* Treatments) = T * S

Means within a column showing the same letters are not significantly different (P≥ 0.05).

8-glucose, saffraral, Lutedin-7-glucose, Apigenin-6-arabinose-8-glactose followed by, Acacetin, Kampferol, Rhamneticwhile, the compounds were less, Rutin, Apigonin-7-0-neohes, Kaerpferol-3-7-diramoside, Qurectrin, Rosmarinic and Qurectrin. Similar results were obtained by Bozin,et al (2008), Hackman,et al (2008).The importance of these compounds in the conservation of nutritiongarlic has been reported to have biological functions including antioxidant and antifungal activities. Garlic has been widely used as a foodstuff for centuries and shown to have applications as antimicrobial, antithrombotic, antitumor, hypolipidemic, antiasthmatic, antiarthritic, and hypoglycemic agents. The health benefits from garlic depend on its bioactive compounds and antioxidant activities Hye-Jin Park and In-Sook Kim.,(2011)**.**

Microbial evaluation of garlic minimally processed

Total bacterial counts

The use of edible films incorporated with natural essential oils which have antimicrobial activity is a form of the active packaging techniques that could be extend the shelf-life of the food products and provides microbial safety for consumers, sinceit acts to reduce, inhibit or retard the growth of pathogen microorganisms in packed foods and packaging materials (Avila-Sosa et al., 2012).

Table 8 shows the changes in total bacterial counts of full cloves garlic and minced cubes coated with cellulose or gelatin coatings incorporated with/ without garlic essential oil during storage periods at 4ºC.The data indicates that total bacterial counts gradually increased with increasing the cold storage period in both full garlic cloves garlicand minced cubes.Control treatments indicate higher bacterial counts than coated ones. The bacterial counts reached to 10.5 and 11.5 × 10^{-2} CFU/g forcellulosecoated full cloves with and without garlic oil respectively, while bacterial counts ofgelatin coated full cloves recorded 11.8and 11.8×10^{-2} CFU/g with and without garlic oil,respectively after 56 days of cold storage as compared to the initial counts (1.5×10^{-2}CFU/g). While total bacterial counts of cellulose coated minced garlic cubes reached to10.2 and 11.0×10^{-2} CFU/g for with and without garlic oilrespectively, on the other hand gelatin coatedminced garlic cubes exhibited higher total bacterial counts 11.5 and 11.3 ×10^{-2} CFU/g with and without garlic oil respectively.

It was found that there are a clear significant difference between control and all other treatments. There was a significant difference between control treatments and other treatments from garlic minced cubesand full cloves. Similar results were obtained by Péreza et al., (2011) reported that an antibacterial alginate edible film incorporated with garlic oil has good potential in many food applications.

TABLE 5. Effect of edible coating on total phenol contents (mg/g) of garlic duringrefrigerated storage period.

Storage period (days)	Full cloves Garlic						Minced cubes Garlic					
	control	Cellulose		Gelatin		Mean	control	Cellulose		Gelatin		Mean
		With oil	Without oil	With oil	Without oil			With oil	Without oil	With oil	Without oil	
Season 2016												
0	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81
7	0,52	0,73	0,63	0,63	0,62	0,63	0,51	0,75	0,7	0,64	0,62	0,64
28	-	0,44	0,42	0,42	0,41	0,42	0,39	0,42	0,41	0,41	0,41	0,41
56	-	0,18	0,07	0,15	0,11	0,12	-	0,07	0,03	0,07	0,04	0,05
Mean	0,67	0,54	0,48	0,5	0,49	0,5	0,57	0,51	0,49	0,48	0,47	0,48
L.S.D.	S =0.1893		T = 0.2583		S&T =0.4489		S =0.1889		T =0.2556		S&T =0.4491	
Season 2017												
0	0,77	0,77	0,77	0,77	0,77	0,77	0,77	0,77	0,77	0,77	0,77	0,77
7	0,58	0,75	0,64	0,72	0,63	0,67	0,46	0,75	0,64	0,75	0,62	0,64
28	-	0,47	0,52	0,57	0,46	0,5	0,35	0,56	0,45	0,57	0,42	0,45
56	-	0,23	0,19	0,21	0,20	0,21	-	0,21	0,20	0,22	0,13	0,19
Mean	0,67	0,56	0,53	0,57	0,51	0,57	0,53	0,57	0,52	0,58	0,49	0,51
L.S.D.	S =0.19		T =0.2457		S&T = 0.4333		S = 0.1799		T = 0.2414		S&T = 0.4359	

TABLE 6. Effect of edible coating on Phenol compound of garlic duringrefrigerated storage period (mg/g).

Phenol compound	Minced cubes Garlic					Full cloves Garlic				
	Cellulose		Gelatin		control	Cellulose		Gelatin		control
	With oil	Without oil	With oil	Without oil		With oil	Without oil	With oil	Without oil	
Pyrogalol	0.4157	0.2172	1.3615	0.2628	0.021202	1.19537	1.49089	1.63559	0.15347	0.04350
Gallic	66.476	71.169	38.792	73.432	26.4066	62.7876	40.49973	77.0810	50.7252	24.2121
(A)	41.881	35.001	32.737	50.200	29.6138	47.1081	47.1336	34.4083	69.9923	16.8750
(B)	0.0084	0.0103	0.0043	0.0702	0.00326	0.01537	0.05073	0.03057	0.12542	0.08451
Catechin	20.640	37.379	30.549	12.647	18.0650	5.88393	23.2657	22.0017	17.2373	3.58379
catechol	0.0856	0.0436	0.1068	0.2951	0.01668	0.23095	0.24920	0.20059	0.18705	0.32543
Epicatechin	0.0295	0.0168	0.0195	0.0495	0.02159	0.04587	0.05693	0.02096	0.07094	0.05482
(C)	0.0062	0.0101	0.0248	0.0128	0.00325	0.01367	0.07968	0.06560	0.05723	0.07807
caffeine	0.0156	0.0044	0.0111	0.0185	0.00465	0.02186	0.05941	0.02769	0.03936	0.04275
chlorogenic	0.0269	0.0241	0.0241	0.0485	0.00845	0.02537	0.03067	0.12332	0.05895	0.03396
vanillic	0.0179	0.0178	0.0096	0.0311	0.00545	0.02983	0.01368	0.02807	0.03938	0.05164
caffeic	28.527	19.260	65.859	11.728	15.3113	97.9327	13.9250	42.2368	87.1402	11.6525
P coumaric	0.0883	0.0362	0.0353	0.0347	0.02824	0.08063	0.08155	0.28519	0.26643	0.47755
ferrulic	0.0052	0.0325	0.0271	0.0192	0.00698	0.04592	0.14542	0.04473	0.108138	0.04401
Isoferulic	0.0233	0.0031	0.0078	0.0110	0.00757	0.00486	0.00534	0.00379	0.00607	0.00503
E. vanillic	26.957	1.0411	1.5837	1.3210	0.28753	36.4624	1.31709	1.78241	1.65081	0.62427
Resveralrol	0.0716	0.0802	0.0947	0.1514	0.04978	0.09835	0.022632	0.118337	0.067417	0.14837
Oleuropein	0.1220	0.1288	0.1810	0.2577	0.01158	0.17296	0.3146	0.18028	0.10844	0.06277
α coumaric	0.0364	0.0259	0.0655	0.0259	0.02124	0.01443	0.01142	0.01502	0.01068	0.01753
Benzoic	0.0298	0.0560	0.0371	0.0862	0.01167	0.02811	0.02024	0.04389	0.03609	0.07437
Ellagic	0.0150	0.0327	0.1064	0.0487	0.03551	0.00401	0.01340	0.02884	0.02382	0.02175
(D)	0.0155	0.0384	0.0367	0.0582	0.01529	0.01092	0.04599	0.05613	0.02181	0.06629
Coumarin	0.0127	0.0155	0.0263	0.0217	0.02076	0.02027	0.01128	0.05323	0.06065	0.02508
Cinamic	0.0331	0.0349	0.0072	0.0136	0.00249	0.03130	0.00492	0.00808	0.01219	0.02870
Salysilic	0.4672	0.4903	0.4438	0.1033	0.02971	0.26793	0.49734	0.42842	0.44262	0.02133

(A) 4.aminobenzoic **(B)** Protocatechouic**(C)** P OH Benzoic **(D)** 3.4.5 methoxycinamic

TABLE 7. Effect of edible coating on Flavonoids of garlic duringrefrigerated storage period (mg/g).

Flavonoids	Minced cubes Garlic					Full cloves Garlic				
	Cellulose		Gelatin		control	Cellulose		Gelatin		control
	With oil	Without oil	With oil	Without oil		With oil	Without oil	With oil	Without oil	
A	0.2428	0.9893	1.4908	2.9523	0.9956	1.0509	2.1006	1.6028	2.606	0.108
B	0.0016	0.0054	0.0042	0.0101	0.0037	0.0098	0.0182	0.0145	0.028	0.027
C	73.294	15.070	27.814	19.021	12.488	43.821	72.684	21.145	19.43	4.985
D	172.73	201.18	32.231	58.841	162.27	23.467	40.392	58.990	122.6	5.603
E	0.0016	0.0045	0.0025	0.0038	0.0008	0.0019	0.0614	0.003	0.0016	0.005
Lutedin-7-glucose	93.670	68.850	60.216	103.67	19.113	26.736	35.665	48.462	143.51	8.582
Naringin	0.0117	0.0014	0.0024	0.0009	0.0016	0.002011	0.0232	0.009	0.0054	0.003
Hespordin	0.2901	0.5709	0.3812	0.7922	0.8978	1.1936	1.7750	1.124	1.5497	0.059
Quercetin-3-0-glucose	0.0150	0.0151	0.0056	0.0287	0.0197	0.0067	0.0524	0.048	0.0234	0.031
Rutin	0.0031	0.0006	0.0005	0.0002	0.0003	0.0011	0.0082	0.003	0.0012	0.002
Apigonin-7-0-neohes	0.0015	0.0035	0.0052	0.0050	0.0022	0.0032	0.0045	0.006	0.0015	0.006
Kaerpferol-3-7-diramoside	0.0061	0.0065	0.0142	0.0185	0.0052	0.0012	0.0152	0.011	0.0011	0.002
Qurectrin	0.003	0.0015	0.0107	0.0098	0.0010	0.0006	0.0008	0.009	0.0017	0.004
Rosmarinic	0.0027	0.0052	0.0085	0.0262	0.0030	0.0055	0.0091	0.021	0.0103	0.016
Qurestin	0.0021	0.0021	0.0003	0.0001	0.0031	0.0061	0.0031	0.004	0.0003	0.008
Narengenin	0.0131	0.0009	0.0009	0.0015	0.00087	0.0008	0.0017	0.006	0.0004	0.006
AcacetinN.o	0.0434	0.0158	0.0143	0.0256	0.0124	0.0082	0.0208	0.015	0.0125	0.014
Kaempfero,l 3-2-p	0.0142	0.0170	0.0139	0.0087	0.0083	0.0078	0.0139	0.013	0.0141	0.008
Hespertin	0.0040	0.0116	0.0063	0.0130	0.0042	0.00658	0.0055	0.006	0.0089	0.005
Kampferol	4.3642	1.0868	0.8922	1.6702	1.1979	4.4229	2.3425	2.725	1.1990	1.572
Rhamnetic	1.3702	0.5770	1.7199	0.2482	0.1300	1.2267	2.1232	1.720	1.4342	0.310
Apigenin	0.5263	0.3477	1.5522	1.4860	1.5184	1.4500	2.3107	1.691	2.2267	1.618
Apigenin-7-glucose	1.4225	4.6387	3.8354	2.3747	1.5637	5.1360	2.5655	4.921	7.2284	0.934
Saffraral	94.775	57.652	48.121	37.033	6.616	90.734	48.276	40.73	12.134	4.169
Acacetin	01125	2.7260	2.9013	2.8169	0.5074	11.762	1.8112	2.461	2.0929	0.961

(A)Luleolin-6-arabinose-8-glucose (B)Luteolin-6-glucose-8-arabinose (C)Apigenin-6-arabinose-8glactose
(D) Apigenin-6-arabinose-8-glucose(E)Apigenin-6- glucose-8-rhmnose

TABLE 8. Effect of edible coating on total count(CFU x 10^{-2}/ g) of garlic during refrigeratedstorage period.

Storage period (days)	Full cloves Garlic						Minced cubes Garlic					
	control	Cellulose		Gelatin		Mean	control	Cellulose		Gelatin		Mean
		With oil	Without oil	With oil	Without oil			With oil	Without oil	With oil	Without oil	
						Season 2016						
0	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50
7	7,30	2,00	2,50	4,00	6,00	3,63	6,50	3,80	4,50	4,00	4,80	4,28
14	9,50	4,20	5,80	5,30	6,40	5,43	9,40	4,00	6,00	7,20	8,50	6,43
21	11,91	4,70	6,20	6,40	7,20	6,13	10,40	4,80	6,40	7,80	8,80	6,95
28	-	5,50	6,50	7,20	8,50	6,93	11,51	5,20	6,80	8,40	9,50	7,48
35	-	5,90	7,80	9,20	10,50	8,35	-	5,80	7,50	8,80	10,00	8,03
42	-	8,30	8,90	9,90	11,00	9,53	-	6,50	8,60	9,50	10,60	8,80
49	-	9,50	9,70	10,70	11,40	10,33	-	8,20	9,50	10,40	11,00	9,78
56	-	10,50	11,50	11,80	11,80	11,40	-	10,20	11,00	11,50	11,30	11,00
Mean	7,55	5,79	6,71	7,33	8,26	7,02	7,86	5,56	6,87	7,68	8,44	7,14
L.S.D.	S = 2.3576		T = 1.8855		S&T = 0.2172		S = 2.163		T = 1.7937		S&T = 0.2199	
						Season 2017						
0	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30	1,30
7	5,50	2,30	2,80	2,50	2,90	2,63	4,20	4,40	4,80	4,60	4,90	4,68
14	7,90	2,90	3,50	3,00	3,70	3,28	6,60	4,70	5,10	4,90	5,30	5,00
21	10,90	3,50	4,20	3,70	4,40	3,95	8,90	4,90	5,50	5,30	5,80	5,38
28	-	3,90	4,80	4,00	4,90	4,40	10,23	5,20	5,90	5,70	6,00	5,70
35	-	4,40	5,10	4,60	5,40	4,88	-	5,80	6,30	5,90	6,60	6,15
42	-	4,70	5,80	4,90	5,90	5,33	-	6,40	6,80	6,60	6,90	6,68
49	-	5,90	6,00	6,00	6,20	6,03	-	6,90	7,20	7,00	7,50	7,15
56	-	6,10	6,90	6,30	7,20	6,63	-	7,30	7,80	7,60	7,90	7,65
Mean	6,40	3,89	4,49	4,03	4,66	4,27	6,25	5,21	5,63	5,43	5,80	5,52
L.S.D.	S = 1.5323		T = 1.2482		S&T = 0.2172		S (=1.5161		T = 1.2944		S&T = 0.2199	

(-)a spoiled reject samples

LSD Treatments = T LSD Storage period = S LSD (Storage period* Treatments) = T * S

Means within a column showing the same letters are not significantly different (P≥ 0.05).

Mould and yeast counts

Table 9 shows the changes in mould and yeast counts of minced garlic cubesand full garlic cloves coated with cellulose or gelatin edible films incorporated with/without garlic oil during cold storage. The obtained results indicate that the mouldand yeast counts gradually increased with increasing the cold storage period in both minced garlic cubesand full cloves garlictreatments.The mold and yeast counts reached to 3.5 and 4.9 × 10^{-2} CFU/g for gelatin coated full garlic cloves treatments with and without garlic oilrespectively while it reached to 2.2 and 3.2 ×10^{-2} CFU/g forcellulose coated full garlic cloves with and without garlic oilrespectively.

On the other hand mould and yeast counts reached to 2.8 and 3.7×10^{-2} CFU/g forgelatin coatedminced cubeswith and without garlic oilrespectively,whileit reached to 3.2 and 3.5 × 10^{-2} CFU/g forcellulose coatedminced cubes with and without garlic oilrespectivelyafter 56 days of storage for samples packaged, as compared to the initial counts (0.50×10^{-2} CFU/g). Similar results were reported by Rojas-Graüet al. (2007) who indicated that edible coatings with essential oils were effectives to control bacterial and fungi growth in fresh fruit andvegetable.

TABLE 9. Effect of edible coating on mold and yeast counts (CFU x 10^{-2}/ g) of garlic during refrigeratedstorage period.

Storage period (days)	Full cloves Garlic						Minced cubes Garlic					
	control	Cellulose		Gelatin		Mean	control	Cellulose		Gelatin		Mean
		With oil	Without oil	With oil	Without oil			With oil	Without oil	With oil	Without oil	
Season 2016												
0	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
7	1,80	1,20	1,50	1,00	1,30	1,25	1,50	0,20	0,80	0,40	0,90	0,58
14	3,60	1,40	1,70	0,90	1,80	1,45	2,80	0,40	1,00	0,70	1,30	0,85
21	5,70	1,70	2,00	1,20	2,50	1,85	3,40	0,70	1,30	0,90	1,80	1,18
28	-	1,90	2,40	1,50	2,90	2,18	4,90	0,90	1,60	1,30	2,00	1,45
35	-	2,20	2,90	1,90	3,80	2,70	-	1,20	1,90	1,70	2,50	1,83
42	-	2,70	3,00	2,50	4,00	3,05	-	1,40	2,40	2,00	3,00	2,20
49	-	2,90	3,20	2,90	4,50	3,38	-	1,80	2,90	2,40	3,40	2,63
56	-	3,20	3,50	3,50	4,90	3,78	-	2,20	3,20	2,80	3,70	2,98
Mean	2,90	1,97	2,30	1,77	2,91	2,24	2,62	1,03	1,73	1,41	2,12	1,58
L.S.D.	S = 0.8854		T = 0.7041		S&T = 0.0953		S = 0.7347		T = 0.5989		S&T = 0.0965	
Season 2017												
0	0,55	0,55	0,55	0,55	0,55	0,55	0,55	0,55	0,55	0,55	0,55	0,55
7	2,00	1,40	1,70	1,60	1,80	1,63	1,80	0,30	0,90	0,50	1,20	0,73
14	2,60	1,70	2,30	1,90	2,40	2,08	2,30	0,50	1,30	0,90	1,60	1,08
21	5,50	2,00	2,80	2,20	3,70	2,68	2,70	0,70	1,70	1,40	1,90	1,43
28	-	2,40	3,00	2,70	4,30	3,10	5,30	0,80	2,00	1,90	2,20	1,73
35	-	2,90	3,50	3,00	4,80	3,55	-	1,10	2,60	2,30	2,80	2,20
42	-	3,50	3,90	3,70	5,00	4,03	-	1,50	2,90	2,80	3,20	2,60
49	-	3,90	4,10	4,10	5,30	4,35	-	2,00	3,40	3,40	3,80	3,15
56	-	4,20	4,50	4,40	5,50	4,65	-	2,50	3,90	4,20	5,20	3,95
Mean	2,66	2,51	2,93	2,68	3,71	2,96	2,53	1,11	2,14	1,99	2,49	1,93
L.S.D.	S = 0.9981		T = 0.7776		S&T = 0.0953		S = 0.8321		T = 0.6905		S&T = 0.0965	

(-)a spoiled reject samples

LSD Treatments = T LSD Storage period = S LSD (Storage period* Treatments) = T * S

Means within a column showing the same letters are not significantly different (P≥ 0.05).

Conclusion

It could be concluded that edible coatings incorporated with garlic essential can improve quality attributes and storability of minimally processed garlic, since it protect thephysical, chemical and microbiological quality attributes of full garlic cloves and minced garlic cubes during cold storage**.**

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تحسين صفات الجوده والقدرة التخزينية لثمار الثوم محدود التجهيز بإستخدام الأغشية الغذائية الحاملة للزيوت العضوية

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يهدف هذا البحث إلى دراسة تأثير إستخدام الأغشية الغذائية الطبيعية الحاملة للزيوت العطرية كعامل مضاد للأكسدة والميكروبات على جودة الثوم محدود التجهيز من فصوص ومكعبات والمبردة على ٤ْم ورطوبة نسبية ٩٥٪ خلال موسم الحصاد ٢٠١٦ / ٢٠١٧. حيث أخذتعيناتعلىفتراتمنتظمةللتحليلووجد أن الأغشية الغذائية السليلوزوالجيلاتين الحاملة زيت الثوم العطري والمغطى بها فصوص الثوم أو المخلوطة مع مفروم الثوم المكعبات أدت إلى تقليل الفقد فى الوزن والحفاظ على المظهر العام لمدة تتراوح ٥٦ يوم من التخزين المبرد كما اشارت النتائج إلى أن تحميل الزيوت العطرية للثوم علىالسليلوزوالجيلاتين تعزز قابلية التخزين للثوم محدود سواء كانت فصوص او مكعبات للحفظ أيضا وجد أنهذة المعاملات تحد وتخفض من نمو الميكروبات البكتيريا والفطريات والخمائر بالمقارنة بالكنترول كماأظهرت نتائج الدراسة أن المعاملة بالأغشية الطبيعية سواء بالسليلوز أو الجيلأتين مع زيت الثوم كانت أفضل من حيث الجودة فى كل التقديرات وأيدت ذلك كلا من لتحليل الحصائى ونتائج محتوى الموادالصلبة الكلية واللون ومركبات الفينول والفلافونويداتومحتويات الفينولات الكلية والحمل الميكروبى حيث أحتفظت بأطول فترة ممكنة من التخزين . وأشارت النتائج إلى أن المعاملة بزيت الثوم المحمل على السليلوزوالجيلاتين هما الأفضل لحفظ الثوم المحدود التجهيزمع الأحتفاظ بالصفات الطبيعية والكيماوية ولذلك نوصى باستخدام الأغشية الطبيية حيث أنها تحافظ على القيمة الغذائية للمنتج وتشجيع الأقبال على تناول منتج طازج محدود التجهيز وتوفيرة فى صورة جيدة سهلة الأستخدام والتداول .