STABILITY OF VACUUM PACKAGED LOW FAT CHICKEN BURGER EXTENDED BY QUINOA POWDER

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Abstract

Proximate composition, moisture loss, total acidity, pH value, physical examination (cooking loss, shrinkage value, texture coefficient indices, and Feder value), microbial examination, and sensory evaluation were done in order to study the effect of extending chicken wings meat by 15% germinated quinoa seeds flour to produce low fat chicken burger, packaged in two different packing materials and stored frozen for nine months. The data indicated reduction in the moisture content, crude either extract, and increase in the ash content, pH value, and total acidity for the samples extended by quinoa flour compared with the control one. The data showed that the extended samples with quinoa flour had the lowest values of TBA, cooking loss, and shrinkage value compared with the control ones. The data also revealed that, the sample contained quinoa flour had total bacterial count and psychrophilic bacterial count lower than the control sample. In addition, it has higher evaluation values for overall acceptability than the control one.

Key words: *chicken wings, low fat chicken burger, quinoa flour, vacuum packaging*

INTRODUCTION

Meat is considered as one of the highest and easily spoiled foods. This is because of its chemical composition which make it vulnerable to lipid oxidation and microbiological contamination that lead it to deterioration and become unaccepted by the consumers (Feng et al. 2010). Some properties of meat are responsible of determining its shelf life such as color, lipid stability and microbial quality.

With the occurrence and increasing of the metabolic diseases, consumers became highly concerned about what they eat. Selecting of proper and healthy foods play an important role in avoiding such health problems. Therefore, many studies have been done to choose and control the healthiest components and processing methods (Abdolghafour et al. 2014). Nowadays, because of the bad effects of the animal fat, the saturated fatty acids, and the cholesterol on health, consumers changed their nutrition habits and avoid or reduced the consumption of meat and meat products especially the red meat (Decker, et al. 2010).

Recently, enthusiasm in high nutritious and healthy foods as bird meat has been increased. Globally, the consumption of poultry meat and its products is rapidly increased (Kokoszyński et al 2013). Increasing the consumers demand for processed and ready-to- eat chicken meat products required a capability to develop and add new value poultry products (Maradini et al 2017).

Consumption of fast foods increased rapidly as the social patterns changed, increased movability, less family gathering, and increased the number of workers. Therefore, good handling and processing is highly required (Majabadi et al 2016).

In addition to enhancing the quality of chicken meat products, addition of non-meat components has been applied to reduce the cost and to offer beneficial health effects for consumers (Abdolghafour, 2014).

Enhancement of chicken meat products with some other ingredients from vegetable source compounds have been examined as a good way to develop useful meat products have been studied recently. Addition of quinoa,

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which is one of the most valuable vegetable sources, has been involved in the new products. The results showed that quinoa can be considered as a very important ingredient to improve the nutritional value, and the quality of the product (Wang et al. 2016).

Quinoa seeds are considered as a highly nutritious food. It has good source of fiber, protein and vitamin C (three times the daily requirement). Quinoa seeds germination led to increase its content from iron, calcium, zinc, vitamin C and carotenoids, and decreased the anti-nutritional factors saponin, phytic acid and tannins. The biological assessment showed that fortification with 10% germinated quinoa can be suggested as the best treatment to improve body weight, organs weights, serum profile, and blood cell counts. Food safety is in great concern due to the eruption and the spreading of the food-borne disease resulted from the pathogens. The new situation increases the tendency of using chemical preservatives, antioxidants, and antimicrobial agents to prevent or at least retard the deterioration caused by microbes and/or lipid oxidation. Oxidation of lipids and microbial contamination are the main factors that interfere with food quality and food safety. Therefore, preventing or at least delaying lipid oxidation and blocking bacterial cross-contamination are highly significant to food processors (Kenawi et al 2016).

Natural antioxidants from some plants or their extracts can be considered as an excellent additives that can improve the shelf life and quality of chicken meat and its products mainly by retarding lipid oxidation and microbial growth.

Moringa Oleifera Lam. leaves have been described to be an excellent source of natural antioxidants and, thus, increase the shelf life of foods containing fat for the presence of many different types of antioxidant components such as flavonoids, ascorbic acid, carotenoids and phenolics (Al-Juhaimi et al. 2015).

Since extending the shelf life of meat and poultry products is one of the technology requirements to fulfil the consumer's interest. Therefore, using of packaging techniques is crucial to meet that needs. Vacuum Packaging is a form of packaging in which air is removed from the inside of the primary package. The main objective is to remove oxygen from the package which lead to the extension of product's shelf life. Therefor the overall intention of vacuum packaging is to eliminate some or all oxygen which mainly responsible of chemical and or microbial degradation depending on the type of products being wrapped (Perdue, 2009).

The objective of the present study was to investigate the combined effects of germinated quinoa flour, moringa oleifera leaves powder and vacuum packaging on the stability of low fat chicken burger made from chicken wing and stored for 9 months at frozen condition.

MATERIALS AND METHODS

Moringa oleifera powder: The Moringa oleifera plant was obtained from Minia University farm, Egypt. The leaves were taken out, cleaned and dried in the air for two days, then powdered to 60 mesh by Moulinex mill (TYPE 2282-00, France).

Quinoa seeds: Quinoa seeds were obtained from the department of agronomy, Minia University, Egypt. The seeds were cleaned, washed several times with tap water to remove saponin, and soaked for 3 hrs. in tap water at room temperature, then allowed to germinate for 24 hrs., the germinated seeds were oven dried at 50°C and ground to obtain powder 60 mesh.

Chicken meat: Chicken wings (30 kg.) were purchased from the local market of Minia city, Egypt. The wings were washed, deboned and the excess fat was manually trimmed, then the meat were minced by meat mincer (SAP Meat Mincer TC 22, Italy) through an 8mm grinder plate and kept in refrigerator till formulated into burger.

Spices blend: Spices (white pepper, cardamom, garlic powder), salt, and fresh onion were purchased from the local market of Minia city, Egypt.

Packaging materials: Two different packaging materials were used in this study. The first one is low density poly ethylene bags LDPE were purchased from the local market of Minia city, Egypt. The second one was laminated PE/Nylon bags from Cryovac Co., USA.

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Preparation of chicken meat burger: Chicken meat burger was made according to the formula of (Amira et al 2016) as shown in table (1).

Table 1 chicken burger formula

Ingredients	Treatment	
	Control	15% Quinoa flour
Minced chicken wings meat	81.4%	66.4%
Moringa oleifera powder	1%	1%
Fresh onion	15%	15%
Quinoa flour	-----	15%
Cardamom powder	0.2%	0.2%
Garlic powder	0.2%	0.2%
White pepper powder	0.2%	0.2%
Salt	2%	2%
Total	100%	100%

Figure 1, illustrates the flow diagram of the low fat chicken meat burger made from chicken wings with 1% moringa leaves powder, with or without 15% of germinated quinoa seeds powder. All the ingredients were mixed for 5 min. in a Classic Chef KM 353 Kenwood meat mixer (Kenwood Ltd., Havant, UK), and formed in a burger like shaped (50 g weight, 10 cm diameter, and 0.5 cm thickness) by a hand presses (Italman, Italy), then packaged in two packaging materials: (low density poly ethylene bags without vacuum and laminated Poly ester/Nylon bags with vacuum). All the packages frozen at -18°C and stored frozen for 9 months at -18°C. Preliminary tests were done to study the best addition percentage of the germinated quinoa flour to the mixture in order to produce chicken burger with good acceptability by the panelists until reaching the 15% ratio, then it applied in the investigation.

Analytical methods: Moisture, crude protein, ether extract, and ash were determined according to the methods described by (AOAC 1995).

Determination of moisture loss: Moisture content for the control and the germinated quinoa flour replaced chicken wings burger (packaged without or with vacuum) was measured along with the frozen storage period according to the method of the (AOAC 1995).

Determination of total acidity: The total acidity for frozen low fat chicken meat products that packaged with two methods was determined by titration according to the method described by (Keeton et al 1978).

pH measurement: A slurry was prepared by blending 5 gm. of the meat product in 45 ml distilled water. The pH of the slurry was measured by using the glass-electrode method according to (Ramadhan et al 2021).

Thiobarbituric acid (TBA) value: The Thiobarbituric acid (TBA) values for frozen low fat chicken meat products that packaged with and without vacuum were determined separately. TBA-reactive substances were measured using the method described by (Fung 2010). Colorimetric absorbance at 530 nm was measured using a Spectronic 710 Spectrophotometer. Readings were converted to mg malonaldehyde /1000g product and reported as TBA values (mg TBA/1000g chicken meat product).

Physical examination:

Cooking loss: Cooking loss of the frozen low fat chicken meat products that packaged with and without vacuum were determined according to the method of (Dreeling et al 2000) by using the following equation:

$$\% \text{ cooking loss} = \frac{RSW - CSW}{RSW} \times 100$$

Where;
RSW = Raw sample weight
CSW = Cooked sample weight

Shrinkage value: Shrinkage values of cooked low fat chicken meat products that packaged with and without vacuum samples were determined according to the method of (Fung 2010) as follows:-

$$\text{Shrinkage value} = \frac{(R.T - C.T) + (R.D - C.D)}{(R.T + R.D)} \times 100$$

Where:
R.T = raw sample thickness C.T = cooked sample thickness.
R.D = raw sample diameter C.D = cooked sample diameter.

Texture coefficient indices: Texture coefficient indices (protein water coefficient PWC, and protein water fat coefficient

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PWFC), for the low fat chicken meat products that packaged with and without vacuum were calculated according to the methods described by (Tsoladze, 1972) as follows:-

$$PWC = \frac{\%\ Protein}{\%\ Moisture}$$

$$PWFC = \frac{\%\ Protein}{\%\ Moisture + \%\ Fat}$$

Feder value: Feder values for the low fat chicken meat products that packaged with and without vacuum were calculated according to the method of [24] as follows:-

$$\text{Feder value} = \frac{\%\ \text{Moisture content}}{\%\ \text{Organic non-fat content}}$$

Where: % organic non-fat content = 100 – (%fat + % ash + % moisture).

Microbiological test: Total plate count: Total plate count for the low fat chicken meat products that packaged with and without vacuum were made as (CFU/g) according to the methods described by in the standard methods of (APHA 1985) & Vanderzant et al. 1992).

Psychrophilic bacterial count: Psychrophilic counts for the low fat chicken meat products that packaged with and without vacuum and stored frozen for 9 months were determined in a similar method to that of total plate count except that plates were incubated at 7ºC for 10 days according to the methods of (Cousin et al 1992).

Sensory evaluation: Sensory evaluation for overall acceptability for the cooked low fat chicken meat products that packaged with and without vacuum and stored frozen for 9 months were carried out in order to determine the consumer acceptability for the product according to the methods described by (Larmond et al. 1977). Ten judges were participated in this test. A numerical hedonic scale ranged between 1 and 10 (1 for very bad, and 10 for excellent) was used for the evaluation.

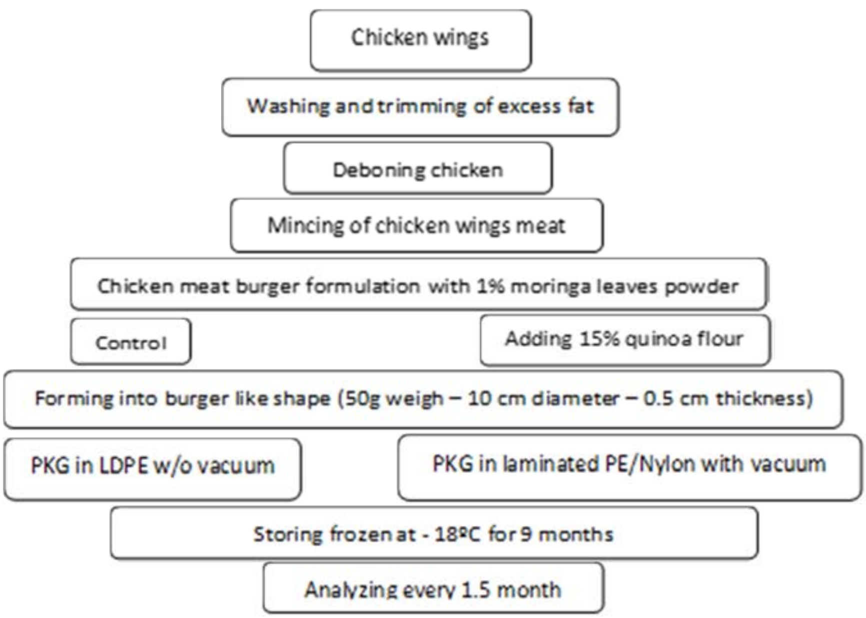

Fig. 1 Flow diagram of low fat chicken meat burger

Statistical analysis: Data were analyzed by analysis of variance (ANOVA) by using the SPSS statistical package program, and differences between means by Duncan's Multiple Range test (SPSS 2007).

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RESULTS AND DISCUSSION

Chicken meat is considered as one of the most decomposable foods. Because of its physical and chemical characteristics that made it vulnerable to microbial spoilage and growth, which lead to deterioration of chicken meat and its products (Fung, 2010). Human health have become increasingly important with the advents of rise of metabolic disease. Food can play a stronger role in disease treatment and prevention and so, more spotlight has been conducted toward the development of the healthiest components in our food products. The extension of non- meat components improve the quality of the meat products, and cut down the cost and have good health effects on consumers (Abdolghafour et al. 2014). Quinoa (Chenopodium quinoa Willd.) is a plant that has some healthy benefits and good sources of protein, dietary fiber, minerals and essential amino acids (Ramos et al 2015). Also, the quinoa seed contains antioxidant compounds such as carotenoids and flavonoids (Dini et al. 2010 & (Maradini et al 2017).

Chemical composition, pH, and TBA values (mg malonaldehyde/kg) of germinated quinoa flour and fat trimmed chicken wings meat (% fresh weight) are illustrated in table (2). The data showed that the moisture content in the chicken wings meat is more than 6 fold of the quinoa flour, in addition the crude either extract content in the trimmed chicken wings meat was more than 50% extra in the quinoa flour and mainly saturated fats as well.

Table 2 Chemical composition and pH values of germinated quinoa flour and fat trimmed chicken wings meat (%fresh weight)

Parameters	Germinated quinoa flour	Fat trimmed chicken wings meat
Moisture %	11.71±0.02	72.12±0.01
Crude protein* %	14.03±0.01	19.20±0.05
Crude either extract %	3.66±0.03	5.50±0.01
Ash %	3.09±0.01	1.08±0.06
pH	5.70±0.05	5.92±0.01
TBA (mg malonaldehyde/kg sample)	0.24±0.01	0.31±0.00

Means of 3 replicates ±SD * NX6.25

Table (3), illustrates the proximate composition, total acidity, pH, and TBA (mg malonaldehyde/kg) values of chicken burger treatments (% fresh weight) at the zero time of storage. The data showed that the addition of 15% germinated quinoa flour to the formula reduced the moisture content, the crude protein content, the crude either extract, and the pH value, while increased the total acidity (expressed as lactic acid), whereas, there was no change in the TBA value for all low fat chicken burger formulations and treatments. The data also revealed that the packaging treatments (without or with vacuum in two different packaging materials LDPE and laminated PE/Nylon bags) have no effect on the examined treatments values at zero time of storage. The reduction in the moisture, the crude protein, the crude either extract contents is related to the differences in the chemical contents and structure of the raw materials (germinated quinoa flour and chicken wings meat).

Table 3 proximate composition, total acidity, pH, and TBA (mg malonaldehyde/kg) values of chicken burger treatments (% fresh weight)

Parameters	Without quinoa (control)		With 15% quinoa flour	
	PKG w/o Vac.	PKG with Vac.	PKG w/o Vac.	PKG with Vac.
Moisture %	71.86	71.86	64.85	64.85
Crude protein* %	19.01	19.01	18.51	18.50
Crude either extract %	5.41	5.40	4.71	4.70
Ash %	1.40	1.38	1.95	1.90
pH	5.98	5.97	5.94	5.93
Total acidity	0.78	0.77	0.90	0.89
TBA (mg malonaldehyde/kg sample)	0.63	0.63	0.61	0.61

Means of 3 replicates ±SD * NX6.25

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Figure (2) illustrates the effect of germinated quinoa flour replacement and packaging treatments on the moisture retention of chicken burger during the frozen storage for nine months. It is clearly noticed that, the progressing of the storage time was accompanied by the loss of the moisture content for all samples. The reduction was much higher in the samples packaged in LDPE without vacuum, and in the control samples than the ones extended with quinoa flour. That means the quinoa flour extended samples have the ability to pound water much higher than the control samples.

Figure (4) illustrated the effect of storage time, and packaging treatments on the total acidity of control and chicken meat burgers extended by germinated quinoa flour. The data showed an increase in the total acidity values for all samples along with the storage period under freezing condition. The samples extended with germinated quinoa flour had the higher total acidity than the control ones. This change went parallel with the changes in the pH values for the studied treatments. Some investigators explained that, the changes in the total acidity of meat products when extended by some plant source mainly, depends upon the pH of the added materials and generally, plant-derived components, that had acidic pH, when integrated in meat products reduced pH of products as the level of incorporation increased (Aleson-Carbonell et al 2004). They also mentioned that, during the storage period of the burger samples, the total acidity values insignificantly increased and were shown a similar trend in both control and plant extended samples.

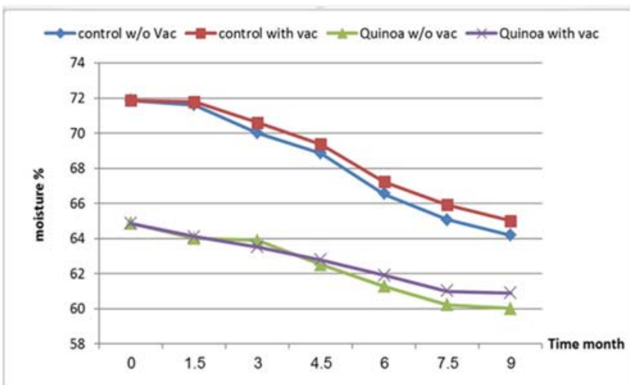

Figure 2 Effect of germinated quinoa flour replacement and packaging treatments on the moisture retention of chicken burger during frozen storage

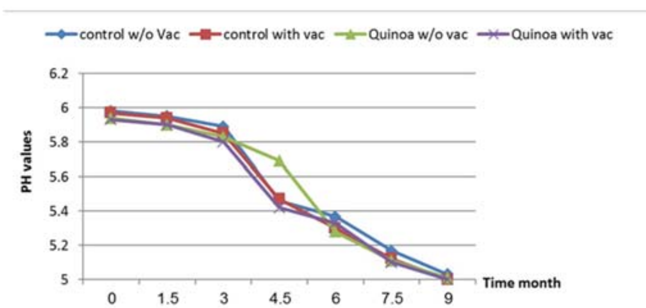

Figure 3 Effect of germinated quinoa flour replacement and packaging treatments on the pH values of chicken burger during frozen storage

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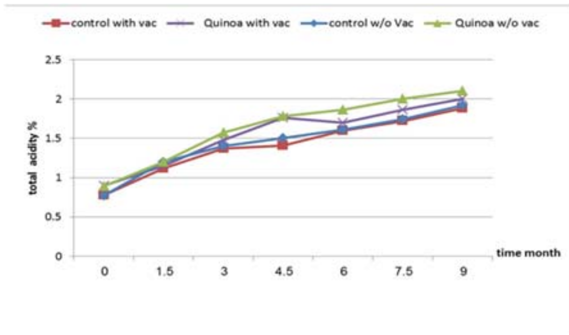

Figure 4 Effect of germinated quinoa flour replacement and packaging treatments on the total acidity of chicken burger during frozen storage

The effect of storage time, and packaging treatments on the TBA (mg malonaldehyde/kg sample) values of control and chicken meat burgers extended by germinated quinoa flour is shown in fig. (5). The data showed an increase in the TBA values with progressing of the storage time for all treatments. The TBA values for the control samples were higher than for the quinoa flour extended samples which showed the inhibitory effect of quinoa on the formation of the oxidative compounds. The data also revealed that the vacuum treated samples had lower TBA values compared with the samples packaged without vacuum. This is could be due to the high oxygen permeability through the LDPE materials compared with the laminated PE/Nylon materials which increased the rate of lipid oxidation. The differences in the TBA values were limited between treatments at zero time, but the control samples had values little higher than the samples extended with the germinated quinoa flour along with the storage period. In the meantime the vacuum treatment had negative effect on the TBA values (decreased the values compared to the non-vacuum packaging). Previous studies reported that quinoa has impressive and greater antioxidant activity than some cereals because of its phenolic and flavonoid content and it can be used as a source of free radical scavenging agents (James et al 2009).

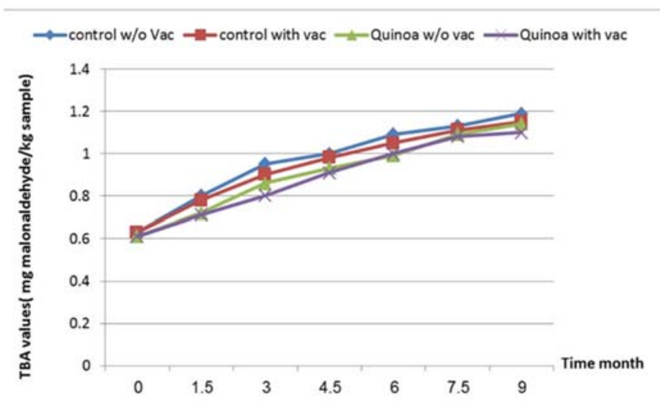

Figure 5 Effect of germinated quinoa flour replacement and packaging treatments on the TBA (mg malonaldehyde/kg sample) values of chicken burger during frozen storage

Figures (6&7) illustrated the effect of storage time and packaging treatments on the cooking loss and shrinkage values of chicken meat burgers with or without quinoa flour extension. The data showed that the samples that extended by 15% germinated quinoa flour

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had the lowest values of cooking loss compared to the control samples without quinoa flour. The loss is highly correlated with the moisture and fat contents. This means that the addition of quinoa flour led to bind the moisture content to the matrix. The results comes in agreement with (James et al 2009), who found that quinoa flour has high water and oil holding capacity. The samples packaged with vacuum had the lowest cooking loss values compared to the other ones. All the samples experienced cooking loss along with the storage period.

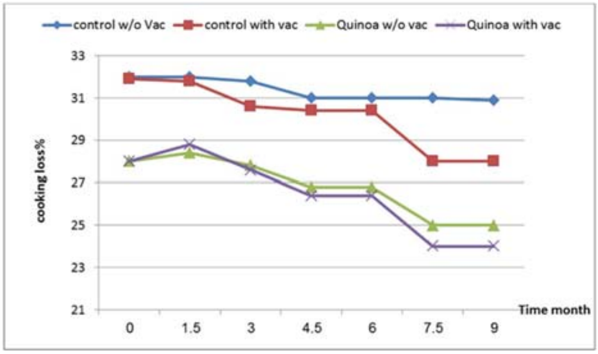

Figure 6 Effect of germinated quinoa flour replacement and packaging treatments on the cooking loss values of chicken burger during frozen storage

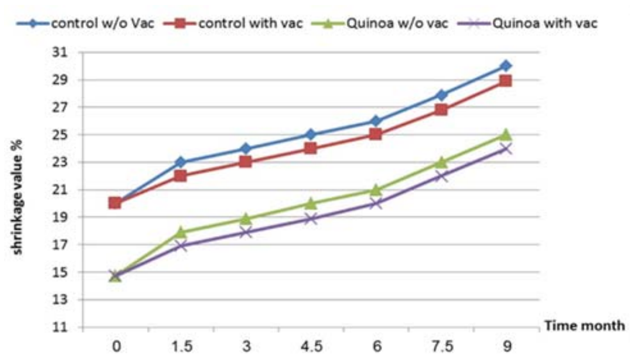

Figure 7 Effect of germinated quinoa flour replacement and packaging treatments on the shrinkage values of chicken burger during frozen storage

The data also revealed that, all the treatment samples suffered from an increase in the shrinkage values along with the progressing in the storage period. The shrinkage values were higher in the control samples compared with the germinated quinoa flour extended ones at any time of the storage period. That means the use of quinoa flour in burger showed a significant effect on all cooking properties values. This improvement on cooking criterion could be linked to the functional properties of quinoa flour.

Figures (8&9), represent the effect of packaging treatment and frozen storage condition on the protein water coefficient (P.W.C), and protein water fat coefficient (P.W.F.C) of low fat chicken burger (fresh weight). The data revealed that, the samples contain 15% germinated quinoa flour had the highest values of (P.W.C) and (P.W.F.C) compared with control ones. Extending of the storage period of the samples under frozen condition, increased the (P.W.C) and (P.W.F.C) values, but the increment values for the control samples was lower than the values

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in the quinoa flour extended samples. This means that, the meat extenders have positive effects on the protein water coefficient (P.W.C), and the protein water fat coefficient (P.W.F.C) of the products (Kenawi et al 2009). It is well known that the protein water coefficient (P.W.C), and protein water fat coefficient (P.W.F.C) are two items among the factors that play an important role in the tenderness of meat products. Therefore, one could say that the addition of germinated quinoa flour to chicken wings burger, resulted in better cooking yield.

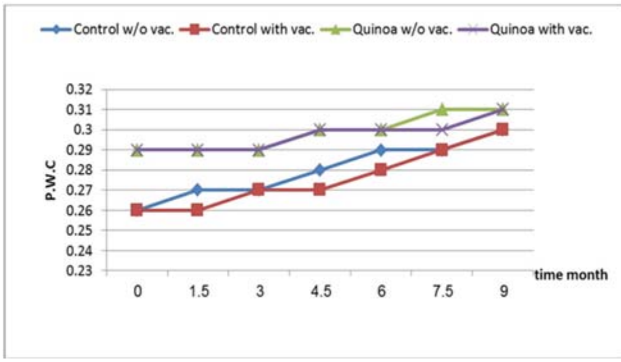

Figure 8 Effect of germinated quinoa flour replacement and packaging treatments on the protein water coefficient (P.W.C) values of chicken burger during frozen storage

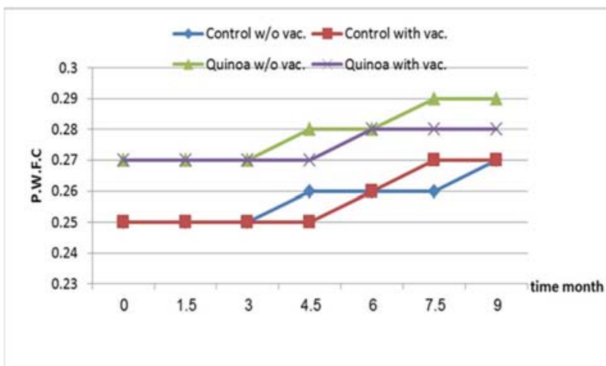

Figure 9 Effect of germinated quinoa flour replacement and packaging treatments on the protein water fat coefficient (P.W.F.C) values of chicken burger during frozen storage

Feder value is considered as one of the tests used for assessing the quality of meat products. The effect of packaging treatment, and storage condition on the Feder values of low fat chicken burger (fresh weight) are illustrated in fig. (10). The data showed decrease in the Feder values with progressing in the storage time. The Feder values for all samples were less than 4.0 which means that all samples had good quality. The addition of 15% germinated quinoa flour improves the product's quality and this is realized from the low Feder values. This improved that the addition of quinoa flour as meat extender increase the tenderness of the product. Many researchers reported that quinoa flour has high water and oil holding capacity, emulsifying and foaming capacity, gelation properties, so it bind water and fat which reflects the more tenderness of the products (Kenawi et al 2009).

The effect of packaging treatment and frozen storage condition on the total bacterial count (log CFU/g) of control and low fat chicken burger (packaged in LDPE without vacuum and in laminated PE/Nylon bags under vacuum) is illustrated in fig. (11). There

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was a reduction in the total bacterial count with all treatments along with storage time. The data showed a slight increase in the total bacterial count after the first 45 days of storage, then started to decline after four months of storage. The reduction was much higher in the samples packaged under vacuum which means that, the vacuum condition negatively affect the surviving of the aerobic microorganisms. It is also noticed that the samples contained 15% germinated quinoa flour had low bacterial populations compared with the control samples (without quinoa flour).

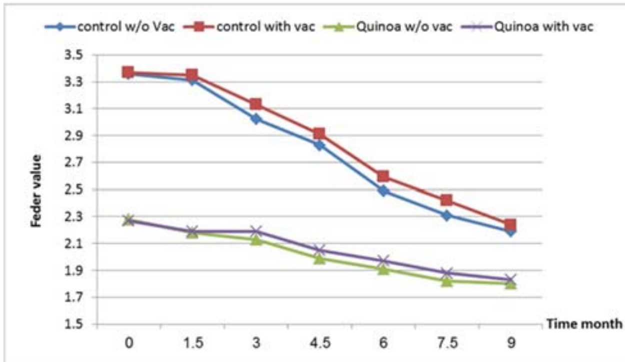

Figure 10 Effect of germinated quinoa flour replacement and packaging treatments on the Feder values of chicken burger during frozen storage

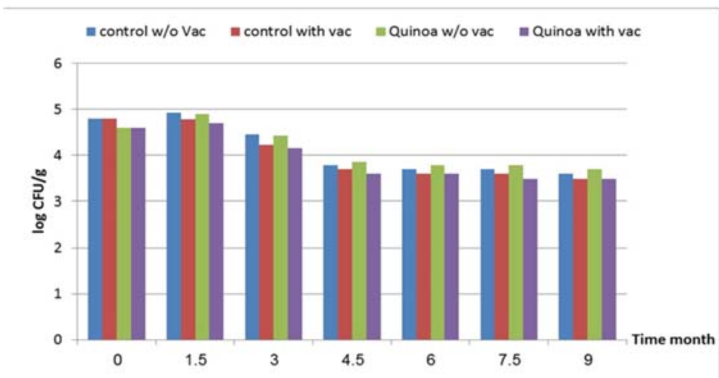

Figure 11 Effect of packaging treatment and frozen storage condition on the total bacterial count (log CFU/g) of control and low fat chicken burger

Figure (12) represents the effect of packaging treatment and frozen storage condition on the Psychrophilic bacterial count (log CFU/g) of the control and the chicken burgers extended by 15% germinated quinoa flour (packaged in LDPE without vacuum and in laminated PE/Nylon bags under vacuum). The data showed an increase in the Psychrophilic bacterial count (log CFU/g) in the beginning (the first 45 days of storage) followed by reduction in the count for all treatments along with the storage period. The number of colonies in the control samples was higher than the samples extended by quinoa flour. Vacuum packaging slightly negatively affected the Psychrophilic bacterial count (log CFU/g) along with the storage time.

The effect of packaging treatment and frozen storage condition on the sensory evaluation (overall acceptability) of control and low fat chicken burger is illustrated in fig. (13). The data showed a reduction for the overall acceptability values with progressing the storage time. Samples contain 15%

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germinated quinoa flour had higher values than the control samples. Limited changes were observed between the two packaging treatments. From the data obtained one could say that the addition of 15% germinated quinoa flour to the formula improved the quality of the chicken meat wings according to the panelist's responses.

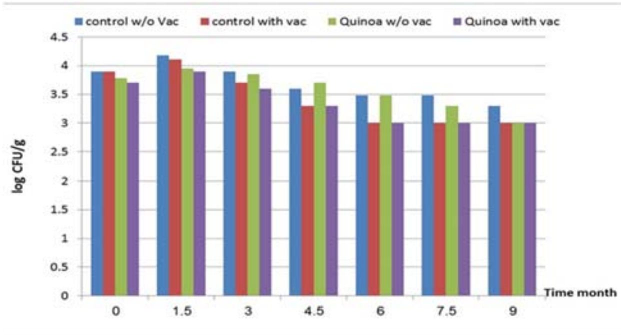

Figure 12 Effect of packaging treatment and frozen storage condition on the Psychrophilic bacterial count (log CFU/g) of control and low fat chicken burger

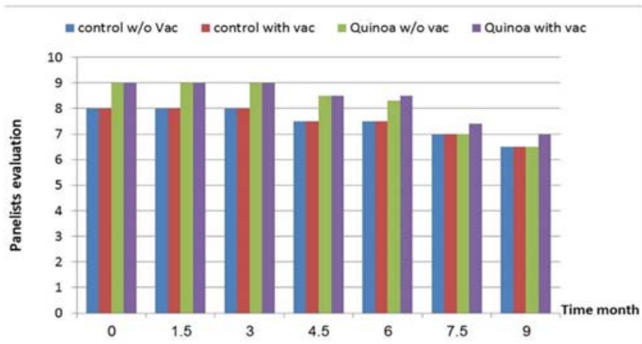

Figure 13 Effect of packaging treatment and storage condition on the sensory evaluation (overall acceptability) of control and low fat chicken burger

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