STABILITY OF GINGER EXTRACT TREATED CARP FISH FINGERS STORED FROZEN UNDER VACUUM

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Abstract

Proximate composition, moisture loss, pH value, TBA value, water holding capacity (WHC), Expressible water (EW), total bacterial count, psychrophilic bacterial count, and sensory evaluation were done in order to study the effect of adding ginger extract (as natural antioxidant), and packaging under vacuum on the stability of fish fingers made from carp fish and stored frozen for 10 months. The data indicated reduction in the moisture content, and (WHC) value, while increase in the (EW), pH, and cooking loss values for the control samples compared to the treated ones. The data showed that the treated samples by ginger extract had the lowest values of TBA, total bacterial count, psychrophilic bacterial count compared with the control ones. In addition, it has the highest evaluation value for overall acceptability compared to the control one.

Key words: *Carp fish fingers, natural antioxidants, vacuum packaging, ginger extract*

INTRODUCTION

Fish is one of the most affordable sources of animal protein and essential nutrients for humans since it is a cheap and major supply of protein, vitamins, and minerals for people living in many underdeveloped countries. Fish is a substantial source of animal protein everywhere, including Egypt [4]. Due to the world's continually expanding population and the fact that more than 60 million people in developing countries depend on fish and its byproducts for income and nutrition [15], the demand for fishing products has skyrocketed. Fish is one of the most economical sources of animal protein and essential nutrients for people living in many underdeveloped countries since it is a cheap and major source of protein, vitamins, and minerals for them. Seventeen percent of the protein consumed worldwide is from fish. Fresh fish is also a staple food and inexpensive source of animal protein in Egypt. Carp fish (*Cyprinus carpio*) are esteemed around the world, not just in Egypt. A total of 188,969 tons of carp fish were produced in Egypt, of which 174185 tons came from farmed carp. Freshwater species including tilapia, carp, and catfish are predicted to make up around 62% of total aquaculture production by 2030, up from 58% in 2016. Several fish species, including the grass carp, common carp, and silver carp, are members of the carp fish family. Because of its omnivorous character, capacity to grow quickly, and resistance to harsh weather circumstances, many nations prefer this species for its flavor and affordability. According to [26] carp is one of the top four fish species in the world and made up 8% of the fish species produced in aquaculture in 2016. Freshwater species including tilapia, carp, and catfish are predicted to make up around 62% of total aquaculture production by 2030, up from 58% in 2016.

Microbial contamination and lipid oxidation are the two factors that cause food to deteriorate and rot. They are thought to be the main reasons why food quality deteriorates and its shelf life shortens. The goal of food manufacturers is to delay lipid oxidation and avoid or reduce bacterial contamination as a result [14]. The texture,

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flavor, and odor of preserved seafood have deteriorated mostly due to oxidation of unsaturated lipids. The quality of meat and seafood is gravely threatened by oxidation. Lipid oxidation causes rancidity, an unpleasant flavor, and the emergence of a number of potentially harmful compounds in meat and fish products. Since oxidation shortens the time that items can be stored, it has an impact on distribution and marketing of both meat and fish products. By degrading both the lipids and the color of red meat and redfish like salmon, oxidation will affect customers' sensory acceptance of these foods. In order to improve the nutritional value, shelf life, and sensory quality of animal products, antioxidants are therefore required [24]. Antioxidant compounds can be added to such products to delay the commencement of lipid oxidation, according to [11]. Due to their exceptional ability to extend the shelf life of food products without sacrificing their nutritional or sensory qualities, antioxidants have emerged as a crucial class of food additives. Due to the potential carcinogenicity and toxicity frequently linked with synthetic chemicals, the demand for natural antioxidants has recently increased. According to [11], antioxidants such as ascorbic acid, sodium erythorbate, -tocopherol, and -carotene are being employed increasingly frequently in the processing of beef. Ginger includes bioactive compounds and antioxidants that can be used to delay or prevent the oxidation of lipids, according to [19]. These substances include gingerol, gingerdiol, and gingerdione, which have anti-inflammatory, anti-diabetic, anti-cancer, chemo-preventive, and chemo-therapeutic activities [5].

In particular for muscle foods during storage, vacuum packing is widely utilized to enhance food quality, extend shelf life, and promote food safety from a microbiological perspective. Since seafood is highly perishable, it must be preserved properly to maintain the highest standards of quality and safety while being stored. The most popular methods for delaying microbiological and biochemical decomposition in newly caught fish during marketing and distribution are mechanical cooling and ice. The ice's tendency to contaminate fish as it melts shortens the fish's shelf life and speeds up degradation. Modified environment packaging has been created as a scientifically sound method to extend the shelf life and reduce losses of fresh seafood products in addition to mechanical refrigeration or ice. Packaging air is replaced with different gas mixes in a modified atmosphere to limit microbial activity and prevent product discoloration [21]. On the other hand, fish is one of the most perishable foods and has a relatively short shelf life. The shelf life of fish can be increased by using preservation procedures including freezing, chilling, salting, smoking, glazing, etc.'

The purpose of the current study was to investigate the combined effects of adding ginger extract (as natural antioxidant) and vacuum packaging treatment on the chemical alterations, some physical, microbiological features, and sensory evaluation of the carp fish fingers stored frozen for 10 months.

MATERIALS AND METHODS

Packaging materials: Two different forms of packaging were used. The initial batch of low density polyethylene (LDPE) bags came from the local market in Minia, Egypt. Laminated PE/Nylon bags from Cryovac Co., USA, were the second.

Preparation of ginger extract: Ginger powder was obtained from local market of Minia, Egypt. Five grams of the powder mixed with 500 ml distilled water, and left over night at room temperature, then, centrifuged at 3000 rpm for 10 minutes. The extract was preserved in brown glass, and stored in refrigerator till use [16].

Making carp fish fingers: Twenty five kg of live Nile carp fish (Cyprinus carpio) were purchased at a local market in El-Minia, Egypt. The fish was gutted, cleaned and painstakingly fashioned into fillet. The fillet was mechanically minced into 4 mm (coarse), and chilled at 4°C until usage. The carp fish fingers product was made using [18] recipe, as given in (Table 1).

Table 1 Formulation of carp fish fingers product

Ingredient	%
Ground carp fish Fillet	89.8
Wheat flour	3.5
Salt	2.5
White pepper powder	1
Onion powder	1
Garlic powder	1
Cumin powder	1
Thyme powder	0.2

After all the ingredients completely blended, two equal portions were made. The first portion was left (as control), while the second portion received ginger extract in the proportion of 1 ml per 10 g of material. Each part was cut into tiny balls weighing 50 g each, and shaped into fingers and placed in a polystyrene (foam) tray with LDPE sheets in between them to prevent sticking during freezing. Each segment was split in half, with the first half was packaged in LDPE bags with no vacuum, while the second half packaged in laminated PE/Nylon bags under vacuum (Figure 1). All of the treatments, were stored at -18°C for 10 months.

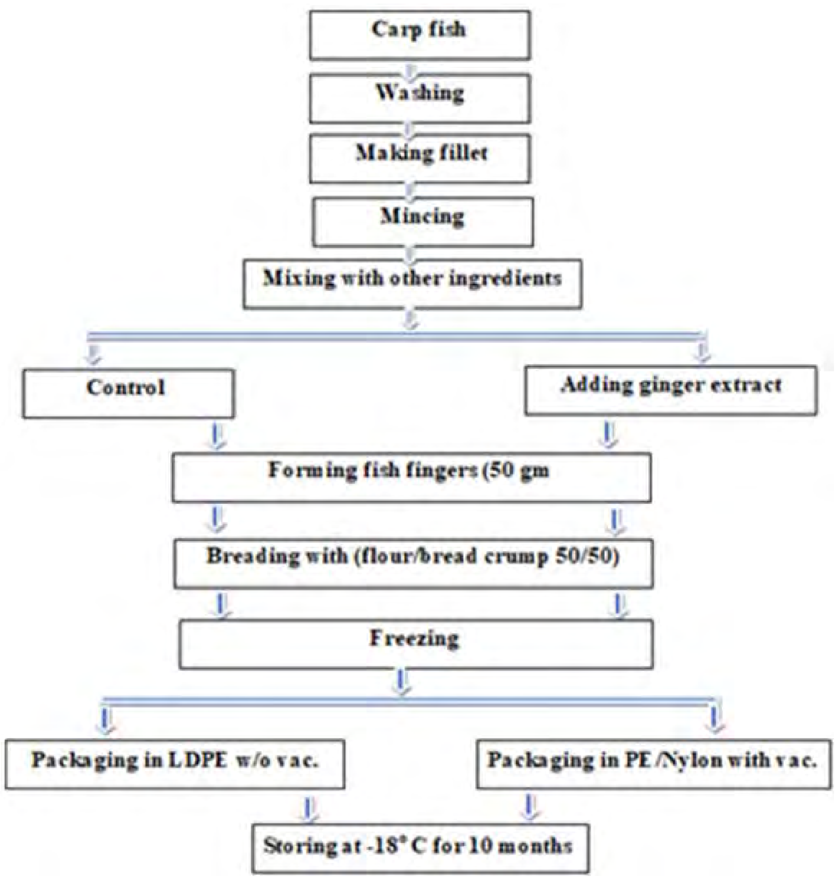


Fig. 1 Flow diagram of carp fish fingers processing

Analytical procedures: Moisture content, crude protein, either extract, ash, pH, and total acidity (mg lactic acid) for minced carp flesh, treated, and untreated carp fish fingers were measured at zero time of storage by procedures described in [8].
Determination of moisture loss: According to the method described in [8], moisture content loss for carp fish fingers that were either vacuum-sealed or not was measured along with the length of time at frozen condition.
Measurement of pH: According to the method described by [23], the pH of the slurry (of 5 g carp fish fingers with 45 ml of distilled water) was measured using the glass-electrode method.
Thiobarbituric acid (TBA) value: The amounts of TBA were independently determined for frozen carp fish fingers packaged with or without vacuum using the method described by [12]. The colorimetric absorbance at 530 nm was measured using a Spectronic 710 Spectrophotometer. Readings were transformed from mg malonaldehyde/1000g product to mg TBA values (mg TBA/1000g chicken meat product).
Measurements of water holding capacity and expressible water: According to the method described by [7] water holding capacity (W.H.C.), and expressible water (EW) for fish fingers was measured. For expressible water, the following computation is used:

EW= (PW - AW) / PW X 100
Where:
PW = "pre-pressed weight," and
AW = "after-pressed weight."
Calculating water holding capacity is done as follows:

WHC % = % Moisture content – EW
Measurements of cooking loss: Following the procedure outlined by [22], cooking loss was calculated for the cooked carp fish fingers as follows:

$$\% \text{ cooking loss} = \frac{WU - WC}{WU} \times 100$$

Where:
WU = Weight uncooked sample
WC = Weight cooked sample
Total and psychrophilic plate count: The total plate count and psychrophilic plate count for the control and treated carp fish fingers, packaged with or without vacuum were made as (CFU/g) using the methods of [9 & 28], and [20].
Sensory evaluation: Overall acceptability of cooked control and ginger extract treated carp fish fingers that were packaged with and without vacuum and kept frozen for 10 months was done in accordance with the guidelines provided by [17].
Statistical analysis: The data were analyzed using the GLM (General Linear Model) program and the statistical analysis system [25]. The Duncan test was used to compare mean values.

RESULTS AND DISCUSSIONS

Fish is one of the most affordable sources of animal protein and essential nutrients for humans since it is a cheap and major supply of protein, vitamins, and minerals for people living in many underdeveloped countries. Fish is a substantial source of animal protein everywhere, including Egypt [4]. Due to the world's continually expanding population and the fact that more than 60 million people in developing countries depend on fish and its byproducts for income and nutrition [15], the demand for fishing products has skyrocketed. In Egypt, fresh fish is both a common food and a low-cost source of animal protein. The industry that is expanding the fastest across the majority of Africa is aquaculture. According to [4], Egypt is the continent of Africa's aquaculture leader. One of Egypt's most significant industries is fishing. Additionally, it is a dependable protein source that meets the dietary demands of Egyptians. Due to the high nutritional content of the proteins, minerals, lipids, and vitamins included in carp fish meat, it is a highly nutrient-dense raw material. Protein levels in carp flesh typically range from 15.9% to 18.5%. Carp flesh has a fat level that ranges from 1.5% to 6.8% and is either lean or moderately fat. Carp flesh is low in fat and high in nutrients [2].

The chemical composition of treated and untreated carp fish fingers, as well as minced carp fish flesh, was displayed in (Table 2). The information revealed that the amount of total acidity (as lactic acid) was 0.45, 0.90, and 0.69 mg%, the pH value was 5.42, 5.85, and 5.85, the amount of ether extract was 4.5%, 4.32, and 4.40%, the amount of ash was 1.21%, 1.71, and 1.67%, and the amount of moisture was 76.87, 70.10, and 72.14% respectively. Adding the materials to make the fish fingers increased the total ash and the pH values while decreased the other contents, as shown in the table.

Table 2 Proximate chemical composition of mincing carp fish, control and treated carp fish fingers (fresh weight)

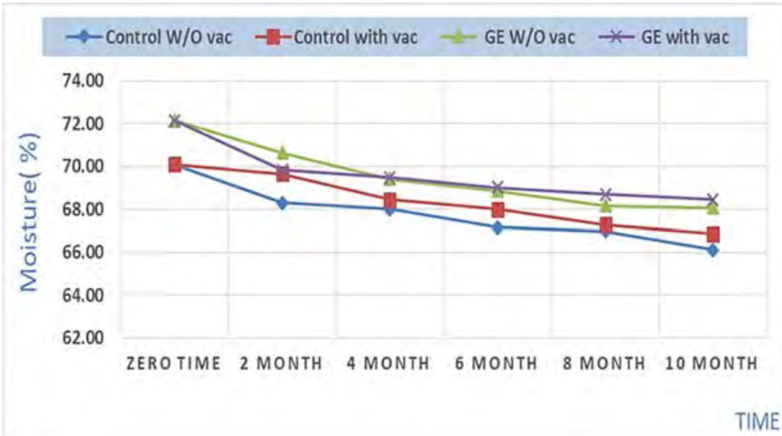
Constituents	M.F	C.F.F	G.T.F.F
Moisture	76.87±0.12	70.10±0.15	72.14±0.22
Crude protein *	17.35±0.08	16.99±0.12	16.92±0.02
Ether extract	4.5±0.10	4.32±0.16	4.30±0.26
Total ash	1.21±0.02	1.71±0.02	1.67±0.09
PH values	5.42±0.12	5.85±0.09	5.85±0.11
Total acidity	0.45±0.02	0.90±0.02	0.69±0.05

**Nx6.25 n=3 ± SD*
M.F = Minced flesh. C.F.F = Control fish fingers. G.T.F.F = Ginger extract treated fish fingers.

Figure (3) illustrates the effect of 10 months period of frozen storage, ginger extract (as natural antioxidant), and different packing strategies on the moisture retention of fish fingers prepared from carp fish. It is evident that the moisture content of all samples reduced as storage times grew longer. The moisture content of the samples containing ginger extract decreased more slowly than the control samples. at the start of the storage period Because fish fingers were given a treatment with ginger extract aqueous solutions, the two moisture content values are different. The moisture content had decreased at the conclusion of the storage period to ranges between 66.11% and 68.08%. This might be because the treated samples maintain moisture longer than the control samples due to ginger extract, a natural antioxidant.

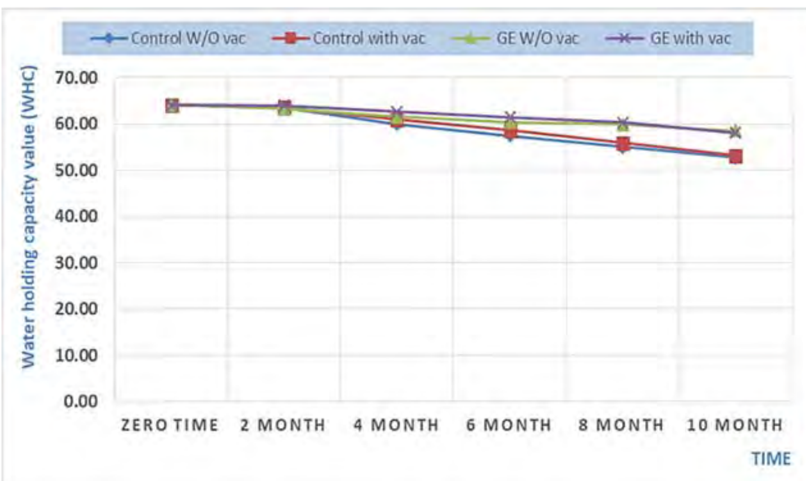
Figure (4) illustrates the effect of packaging treatment and the addition of ginger extract as a natural antioxidant on the water holding capacity (WHC) values of fish fingers prepared from carp fish that were kept frozen for 10 months. The rate of decline was significantly higher in the control samples than it was in the product treated with ginger extract as a natural antioxidant after 10 months of frozen storage. This may be due to the ginger's capacity to draw moisture from the matrix. We were unable to detect any appreciable changes between the obtained values at the end of the storage period because the water vapor transfer rate between the two packaging materials, LDPE and Laminate PE/Nylon, is rather low.

Figure (5) shows the impact of adding ginger extract as a natural antioxidant substance on the% expressible water values of fish fingers made from carp fish, packaged in two different types of packing materials, and kept frozen for ten months. The data demonstrated that the (% EW) values rose with longer storage times for both treated and untreated samples. The rate of increase was greater in the control samples when compared to samples that had been treated with ginger extract. The data derived from the water holding capacity (WHC) values of the same products logically supports past findings. The information gained suggests that adding ginger extract as a natural antioxidant to the ingredients of fish fingers might help keep water in the matrix, which is congruent with what was learned about the water holding capacity. The influence of the freezing process on the product's tissue cells, which rupture and release water, may also cause the expressible water to rise [3].



Control W/O vac. = Control without vacuum. Control with vac. = Control with vacuum
GE W/O vac. = Ginger extract treated without vacuum.
GE with vac. = Ginger extract treated with vacuum.

Fig. 3 Effect of packaging treatment, ginger extract, and time of frozen storage on moisture content % of carp fish fingers



Control W/O vac. = Control without vacuum. Control with vac. = Control with vacuum.
GE W/O vac. = Ginger extract treated without vacuum.
GE with vac. = Ginger extract treated with vacuum.

Fig. 4 Effect of packaging treatment, ginger extract, and time of frozen storage on the water holding capacity (WHC) value of carp fish fingers

Control W/O vac. = Control without vacuum.   Control with vac. = Control with vacuum.
GE W/O vac. = Ginger extract treated without vacuum.
GE with vac. = Ginger extract treated with vacuum.

Fig. 5 Effect of packaging treatment, ginger extract, and time of frozen storage on the expressible water values (EW) of carp fish fingers

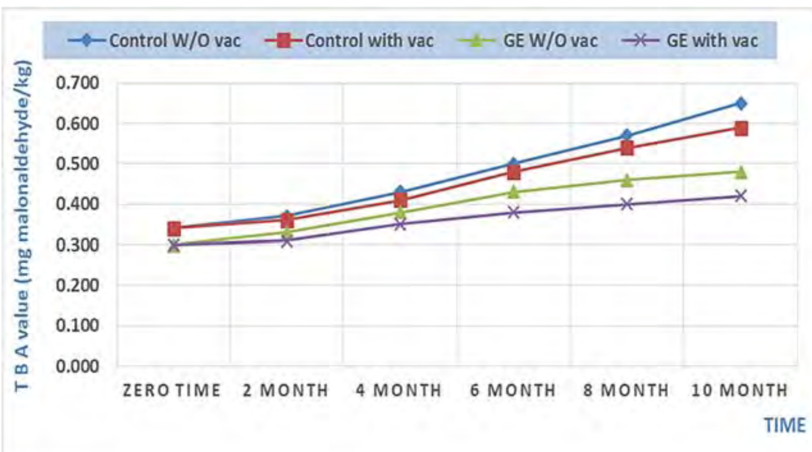
Figure (6) illustrates how the pH levels of carp fish fingers that were frozen and stored for 10 months changed after adding ginger extract (a natural antioxidant) and packing treatment. The information demonstrated that all samples' pH values rose during storage. Compared to the carp fish fingers that had received ginger extract, the rate of escalation was higher in the untreated (control) carp fish fingers. As bacterial metabolism breaks down nitrogen molecules and produces basic chemicals like ammonia and trimethylamine, the findings also demonstrated that the rise in pH levels for fish products during storage indicated deterioration most likely caused by bacterial contamination [27]. The results agree with those of [10].

The lipid oxidation in fish flesh may be influenced by a variety of factors, such as the species, preservation temperature, fat makeup, etc. Figure (7) illustrates the effect of adding ginger extracts, (as natural antioxidant), the packaging treatment, and the length of storage (10 months under freezing conditions) on the TBA (mg malonaldehyde/kg sample) values of the carp fish fingers. The information demonstrated that the TBA values for all samples increased as the storage time increased. The rate of rise was higher for the control sample than it was for the samples that had been given ginger extract treatment. We can conclude from the earlier findings that adding ginger extract (as a natural antioxidant) could minimize and retard the oxidation of carp fish products since such materials have been described as being a good source of natural antioxidants. Due to the inclusion of several antioxidant components, such as flavonoids, ascorbic acid, carotenoids, and phenolics, foods containing fat would have a longer shelf life [6]. One could see that the TBA values for the samples packaged in LDPE bags were greater than those for the samples packaged in laminated PE/Nylon bags by comparing the two packaging materials utilized (LDPE and laminated PE/Nylon). This might be as a result of the fact that LDPE bags have a much higher oxygen permeability than laminated PE/Nylon bags do.

Figure (8) illustrates the impact of packaging modifications, storage for 10 months in a frozen environment, and ginger extract as an antioxidant on the percentage of cooking loss values for the carp fish fingers. According to the findings, cooking loss values rose as storage time under freezing conditions progressed for all treated and untreated samples that were packaged with or without vacuum. The results are logically inferred from the WHC and expressible water values for the tested samples. This is in line with the findings of [1].

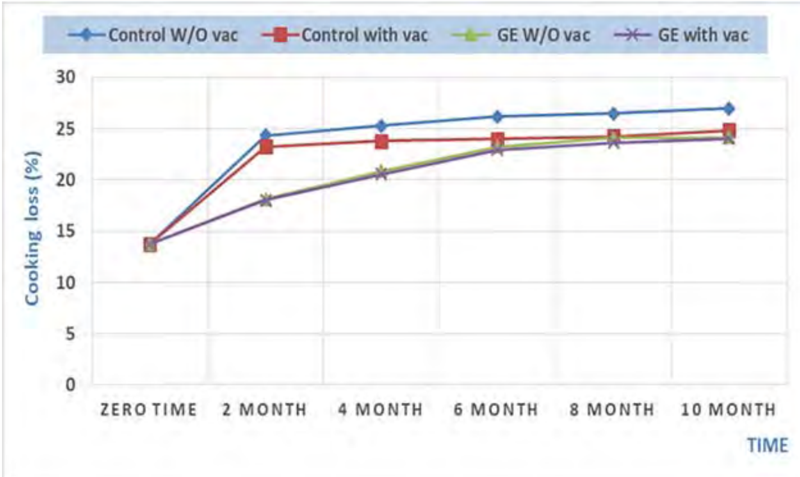
Control W/O vac. = Control without vacuum. Control with vac. = Control with vacuum.
GE W/O vac. = Ginger extract treated without vacuum.
GE with vac. = Ginger extract treated with vacuum.

Fig. 6 Effect of packaging treatment, ginger extract, and time of frozen storage on the pH values of carp fish fingers



Control W/O vac. = Control without vacuum. Control with vac. = Control with vacuum.
GE W/O vac. = Ginger extract treated without vacuum.
GE with vac. = Ginger extract treated with vacuum.

Fig. 7 Effect of packaging treatment, ginger extract, and time of frozen storage on the TBA value (mg malonaldehyde/kg sample) of carp fish fingers



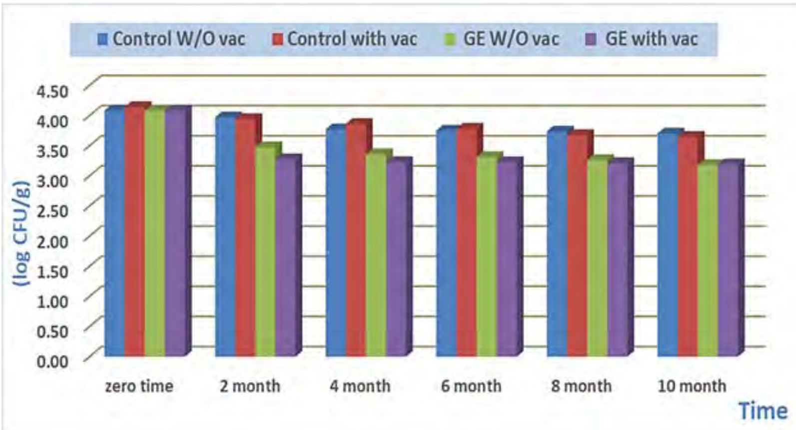
Control W/O vac. = Control without vacuum. Control with vac. = Control with vacuum.
GE W/O vac. = Ginger extract treated without vacuum.
GE with vac. = Ginger extract treated with vacuum.

Fig. 8 Effect of packaging treatment, ginger extract, and time of frozen storage on the % cooking loss of carp fish fingers

The microbiological safety and quality of fish and fish products is essential for processors, retailers, and, of course, consumers. Since inadequate hygiene during handling, processing, and storage can contribute to the development of illnesses, the aerobic bacterial count in fish and fish products can be used as a common indicator of these issues. Figures (9 & 10) show how the total bacterial count and psychrophilic bacterial count of carp fish fingers were affected by a natural antioxidant (ginger extract), packaging methods (LDPE without vacuum and laminated PE/Nylon with vacuum) and storage time (10 months) under freezing conditions. The data showed that in all treated and untreated samples, the total bacterial count (log CFU/g) was less than 6. There was a reduction in the overall bacterial count after each treatment and during storage. The total bacterial count was highest in the control samples when compared to the treated samples. The samples treated with ginger extract as an antioxidant have the lowest bacterial counts when compared to control samples, proving the substance's potency as an antibacterial agent as well. [13] found that the fish muscle becomes dangerous to eat when the total viable count (log CFU/g) exceeds 7.

The findings showed that psychrophilic bacteria log CFU/g levels were lower in the treated samples than in the control samples (which did not contain ginger extract). After the second month of storage, only the control sample had psychrophilic bacteria. This suggests that the number of psychrophilic bacteria was adversely affected by packaging modifications and the addition of ginger extract as a natural antioxidant. This shows that, during storage, the quantity of psychrophilic bacteria decreased and the safety and quality of the carp fish fingers were preserved due to the presence of ginger extract and the absence of oxygen from the atmosphere, respectively.

By assessing a food product's color, flavor, appearance, and texture with the five senses, the quality of the food can be identified. Fish products' sensory quality is typically assessed. The effect of packaging modifications and treatment with a natural antioxidant (ginger extract) on the general acceptability of carp fish fingers that were frozen-stored for ten months is shown in Figures (11). The evaluations showed that the samples had obtained all-around excellent ratings from the panel. According to the data, all of the samples under investigation were given somewhat lower ratings by the panelists after being frozen for 10 months. The reduction in the control samples was bigger than it was in the treated samples. The samples that had been vacuum-packed and treated with ginger extract received the highest ratings for general approval.

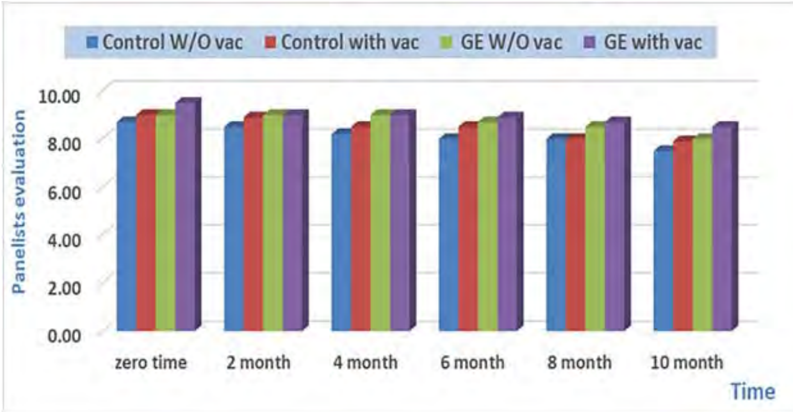


Control W/O vac. = Control without vacuum. Control with vac. = Control with vacuum.
GE W/O vac. = Ginger extract treated without vacuum.
GE with vac. = Ginger extract treated with vacuum.

Fig. 9 The effect of natural antioxidant, packaging treatments, and storage time under frozen condition on the total bacterial count (log CFU/g) of carp fish fingers

Control W/O vac. = Control without vacuum. Control with vac. = Control with vacuum.
GE W/O vac. = Ginger extract treated without vacuum.
GE with vac. = Ginger extract treated with vacuum.

Fig. 10 The effect of natural antioxidant, packaging treatments, and storage time under frozen condition on the psychrophilic bacterial count (log CFU/g) of carp fish fingers



Control W/O vac. = Control without vacuum. Control with vac. = Control with vacuum.
GE W/O vac. = Ginger extract treated without vacuum.
GE with vac. = Ginger extract treated with vacuum.

Fig. 11 The effect of natural antioxidant, packaging treatments, and storage time under frozen condition on the sensory evaluation (overall acceptability) of carp fish fingers

CONCLUSION

In conclusion, the quality and stability of fish fingers manufactured from carp fish and kept frozen for ten months have been improved by the addition of ginger extract (1 ml per 10 g of sample) as a natural antioxidant and by vacuum-sealing the package.

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