Bas.J.Vet.Res.Vol.19, No.2, 2020.

EFFECT OF COMPOSITE EDIBLE COATING ON THE STORAGE OF FRIED CHICKEN PIECES

Najla H. Al-Garory*, Alaa G. AL-Hashimi

Department of food science, college of agriculture, university of Basrah, Basrah, Iraq

(Received ,Accepted 17 May 2020)

Key words: edible coat, starch, deep frying.

Corresponding author: Najla.saper@yahoo.com

ABSTRACT

Food packaging has a great importance to increase the shelf life and safety of food, as well as packaging works as a buffer against the conditions that cause damage, such as light, dust, oxygen, moisture and microbes, Native (NS)and modified (MS) potato starches using stearic acid ,and different concentrations of whey protein (WP)0-50% were used as edible coatings for the chicken pieces then kept at refrigerator (4±1°C) and deep freezing conditions (-18°C) for periods of (2,5,7) days.The effect of coating was studied to determine the moisture loss, oil uptake ,peroxide value and thiobarbituric acid in addition to the sensory evaluation. The results showed that all the composite edible coats improved the chemical characteristic and the best edible coat was MS50% +WP% which provided better results in terms of reduction the moisture loss , oil uptake and the oxidation values and improved the score of colour ,flavor ,texture and general appearance which reflect the sensory evolution.

INTRODUCTION

Deep frying is a cooking method that is widely used in commercial food processing. It is the method of strength flavor, texture and appearance of food products. However, one of the main problems associated with fried foods was consuming a high percentage of oil, which was badly related to the spread of diseases such as sudden rise in blood pressure and cholesterol disturbances such as raising the level of cholesterol that is harmful to the blood resulting in diseases and chronic problems in the heart with low immune capabilities of the body (35). The consumer has become more aware of the effects of eating foods that are high in fat and its effect on health (28). Therefore, the development of food products that have a low fat content by reducing oil absorption is the most important point in deep frying to reduce the incidence of diseases such as obesity, high cholesterol levels, etc (46)

Moreover, oxidation of fats during frying generates various oxidative derivatives, some of which are also associated with many diseases such as premature aging, membranes damage, heart disease and cancer. Thus, fried foods have become a source of concern for health (16).

The modern researches have prompted studies in order to reduce the oil content in the fried food. An aqueous solution forms was commonly known method "edible coating films" on the food to be fried (27) and thus applying the coating is a promising way to reduce oil content (29).

Various packaging materials such as protein, dried breadcrumbs, starch, carrageenan, and their combinations have been used to reduce moisture loss, to extend their shelf life, as well as to reduce oil absorption during frying for meatballs, chicken, and potatoes during deep frying with oil (1,35). The process of packing and packing food and creating edible and biodegradable food packaging. An important process associated with food safety and environmental conservation, proteins and carbohydrates are generally considered good polymers for forming edible films and coating and biodegradation because of the excellent mechanical properties as well as their ability to retain moisture, gas and odor, they also act as a barrier against microorganisms and their ability to carry food additives and improve the appearance of products, which makes them more attractive to the consumer (20).The whey proteins are the by-product of the cheese industry that used as a functional food ingredient as well as for their use to produce new edible and degradable polymeric materials (36).

At the present time, polysaccharides are used in the preparation of edible films as bio-materials which are inexpensive and abundant in nature as well as being renewable and have the ability to form edible films or coating with good mechanical properties to preserve the textures, flavor and extend the life of the food due to its hydrophobic nature, edible films prepared from carbohydrates have good reservation properties of gases, flavor compounds and fatty substances due to their ability to form a cross linking between polymeric chains throw hydrogen bonds that make films have a good reservoir ability of gases while they are weak barriers against water vapor because of their hydrophilic nature (11).

The polysaccharide edible coats are colorless, tasteless, odorless, and non-toxic, as well as their ability to inhibit microbial growth because of the reduced water activity as the researcher showed that starch consists of amylose and amylopectin and presented in grains such as corn, wheat, potatoes. Amylose is responsible for the ability of starch to form the films, as the increase in its quantity increases the elasticity of the film and produces edible film with good reservation properties of fat and oxygen and high solubility of water. Starch films were used in packaging potatoes to prevent oxidation and discoloration after frying(9).

The effect of adding stearic and linoleic fatty acids on starch properties since it was found that adding stearic acid had a greater effect on the adhesive properties of linoleic acid and the addition of saturated fatty acids led to a significant decrease in starch retro gradation as compared to natural starch (48).

Edible film made from proteins or polysaccharide are characterized by appropriate mechanical and reservation properties but are permeable to moisture and their protective properties toward water are weak while fat films (waxes or other fats and oils) have good reservation properties towards water vapor but their mechanical resistance is weak and they have high permeability to oxygen. The properties of these films can be improved by combining these materials together to obtain films with good properties (5).

Therefore, the current study aims to study the efficiency of composite edible coats (native starch and modified starch with stearic acid + whey protein) on the chemical and sensory properties of chilled and frozen chicken pieces.

MATERIAL AND METHODS

Potato starch extraction: 500 g of potato(*Solanum tuberosum*) was washed well, peeled and cut into small slices. The distilled water was added, and the extraction process was done using a centrifuge (Junior – England)at a speed of (4000) rpm for 15 minutes. after that , the samples were filtered using Whatman no. 1(sigma Aldrich), the wet starch was dried at room temperature for 5 hours then crushed into a white .soft, odorless fine powder (3).

Starch–fatty acids complexes preparation: Starch–fatty acids complexes were prepared according to the method of (24). Potato starch suspension was prepared by adding starch to the distilled water (10%, w/w) then heated in water bath (Cotter – Germany) with continuous stirring at (63°C for 30 min), then stearic acid(that were purchased from Sigma-Aldrich (St. Louis, MO). was completely dissolved in ethanol . The combination of starch –fatty acid was heated at (63°C for 30 min). The complex was quickly cooled to room temperature. Excess fatty acids are eliminated by adding ethanol then centrifuged at 1500*g* for 20 min. The complex was washed three times to be surely eliminated free fatty acids in the systems.

Whey proteins Preparation: whey proteins were prepared according to the method used by (12).

Preparation of PS/WP coat: Potato starch (native and modified by stearic acid) and whey protein (PS/WP) mixture were gained from the blending of the following ingredients: solidphase: 60% (starch/whey protein) and liquid phase: 24% glycerol and 16% water. The process of replacing the naive and modified starch with whey proteins was performed from 0% to 50% according to **(7)**.

Sliced chicken packaging: The chicken breast was cut into small pieces (3x7x1cm) then these pieces were divided into three groups by (8) pieces for each group randomly, and immersed in the solution of the composite edible coat (natural and modified starch + whey proteins) , and placed on a mesh tray of stainless steel for 5 to 10 minutes Until the excess solution is removed and all the pieces were dried and then placed in packages. Coated and uncoated samples were stored in the refrigerator (4 ± 1 °C) and in the deep freezer (-18 °C) until analysis (40).

Frying process: The frying process was done according to the method used by (19), three litters of sun oil was heated to (175-180 °C) and the pieces of non-coated and coated samples chicken were dropped into the oil for 1.5 – 2 min and covered with a tight coater. The fried pieces were put in polyethylene bags and stored in refrigerator at (4 ± 1 °C) and the another in freeze at (-18 °C for 7 days). The frying process was carried out for each treatment with triplicates.

Moisture and Fat content determination: Moisture and fat content were estimated based on the method used by (6) and the test was performed with triplicates. Moisture content of coated and non-coated samples stored by refrigerating was estimated by an oven-drying method at (105 °C) until stability of weight was reached. Fat content was estimated by Soxhlet method, which includes continuous evaporation and condensation of petroleum ether solvent passing through 5 g of moisture-free chicken sample. The raw sample was collected, dried and weighed.

The oil uptake (%) was calculated depending on the following equation:

$$oil\ uptake\ \% = \frac{Of - Or}{Or} \times 100$$

of = oil content of fried chicken

or = the oil content of raw chicken.

Determination of peroxide value (PV): The peroxide value of coated and non-coated samples under cooling condition was estimated according to (6). 5g of each chicken samples was homogenized with 30ml of glacial acetic acid and chloroform in a proportion of 3:2. on magnetic stirrer, then 0.5 ml of saturated KI was added, the solution transferred to a dark place for 15 min. Next, 30 -50 ml of distilled water and drops of starch indicator (1%) was mixed with the solution until the purple color appear ,the mixture was titrated with standard 0.1 N sodium thiosulphate till the solution became colorless. All the samples were repeated for three replicates.

The peroxide value was calculated according to the following equation:

$$\text{Peroxide Value (meq/kg)} = \frac{ml\ of\ \text{sodium thiosulphate} \times 1000}{g\ of\ sample}$$

Thiobarbituric acid (TBA): The value of TBA was estimated on the basis of mg malondialdehyde (MDA)/kg chicken according to (32).

Thermo gravimetric analysis (TGA): Thermo gravimetric analysis for whey protein –modified starch based edible coats was performed to study the degradation characteristics of the coats. The thermal stability of the sample was estimated using, Q50V20.13 Build 39 with a heating rate of (10°C/min). Samples were heated from room temperature to (600°C). After drying the samples were milled in powder according to (39).

Sensory evaluation: The sensory evaluation of chicken pieces coated with whey protein –native starch or modified starch by stearic acid and un-coated after being fired in hot oil for 10 minutes was conducted by panelists judgment from the Department of Food Sciences – college of Agriculture, University of Basrah according to the sensory form evaluation originated from proposals of edible coating applications(13).

Statistical analysis: Statistical analysis was done by using SPSS program, and a factorial experiment using complete randomized design was applied. L.S.D. was used to compare among means at 0.05 level. Triplicates were used in the experiments.

RESULTS AND DISCUSSION

Moisture content

Three samples of chicken pieces were used, the first one was the control (un-coated), the second was coated with compound edible coat consisting of native potato starch incorporated with whey protein (NS+WP) with replacement ranged from 0% up to 50%, the third samples was coated with compound edible coat consisting of modified potato starch with stearic acid (18 C) incorporated with whey protein (MS+WP) with replacement range from 0% up to 50%, The coats were thin, homogeneous, transparent, and attached to the surfaces of the chicken pieces, giving them shine and softness.

Table 1 shows the percentage of moisture of chicken pieces which were un-coated and coated with (native starch and modified starch with stearic acid) incorporated with whey protein in different percentage before frying, and storage in refrigerated at (1 ± 4 °C) and freezing at (- 18 °C) for a period of (2, 5, 7) days.

It was observed that the percentage of moisture for non-coated chicken samples was low if it is compared to the coated samples. The percentage of moisture after two days of uncoated chicken pieces storage in cooling and freezing conditions were 30.8, 49.2% and reduced to 25.4, 23.5% and 48.5, 45% on the fifth and seventh days, respectively.

It was noted from the table that the percentage of moisture for chicken samples coated with composite coat (whey - native and modified starch) with different rats of replacement 0% -50 % has maintained the moisture and the highest moisture content was for samples coated with the composite edible coat consisting of native and modified starch with the rate of 50% and whey protein 50% which were (41.2, 40, 32)% and (45.6, 42.5, 40)%, for (2, 5, 5) days respectively when stored in cooling, the higher content of moisture was due to the increasing of the interaction between the starch polymer and whey polymer, therefore the binding of water decreased, as (2) reported, that the non-polar sits and the covalent disulfide bond formed by the denaturation of whey protein which lead to the reduction of moisture adsorption.

The amount of moisture was higher in frozen chicken pieces as compared to those stored in cold, and the higher rate for the samples coated with MS50%+WP50%

which was 72,3% when stored for two days. The statistical analysis for the all the treated samples, storage period (2, 5, 7) days and the kind of storage (cooling and freezing) showed a significant differences.

For the coated samples , it was observed, that as the replacement of potato starches by the whey protein increased the moisture content gradually, the lowest moisture for the coating sample was for the sample coated with (NS100% +WP0%) which was (27.5, 53.1)% when stored in cooling and freezing after seven days .

This result may ascribed to the fact that the amount of moisture evaporates depends on the nutrient content of moisture and the relative moisture prevailing at storage, and the susceptibility of coatings to the permeability of water vapor increases with the increasing the relative moisture of the material to the atmosphere or vice versa, because of its hydrophilic nature, as protein materials contain many polar groups such as hydroxylic groups that are bound to water molecules at high relative humidity and thus cause its spread in the polymer mold and reduce the membrane network cohesion, which leads to an increase in its permeability to water vapor (37).

Chicken pieces coating with starch coat only had the lowest ratio of moisture, this result was due to the high amount of water vapor permeability which was increased because of the high rapprochement of glycerol for starch and its separation between these molecules. The hydrophilic nature of glycerol leads to increase the interaction between starch molecules and build hydrogen bond with the OH group of the two main components of starch amylase and amylopectin (22), whey proteins have the ability bind to water because they contain hydroxyl groups, so moisture can interfere inside the coat (47) the reduction of moisture vapor is because of the polymer matrix which contains the crystalline phase and the water evaporation exist in the amorphous phase of the polymer through the empty space (38).

The high reservation of water for the coated samples used the modified starch (stearic acid) might be due to controlling the evaporation of water and reducing dehydration. The possibility of keeping the moisture of these samples followed the fact that swelling power were reduced because of amylose – mono-glyceride complex formation and form insoluble films on the starch granules surfaces Then delay the transfer of water into the starchy granules (15).Thus, the results was in accordance with (14) and (٤) who indicated the decreasing of the moisture loss when different kinds of coating are used.

.

Table 1: moisture content % of chicken pieces un-coated and coated with (native and modified starch) incorporated with whey protein during storage at (4±1 ℃ and -18 ℃)

Type of coating	Storage Time (days)					
	Cooling 4± 1 °C			Freezing -18 °C		
	2 days	5 days	7 days	2 days	5 days	7 days
CONTROL	30.8	25.4	23.5	49.2	48.5	45
NS50%+WP50%	41.2	40	32	69.7	65.6	63.6
NS60%+WP40%	40.8	35.6	31.1	67.2	65.2	61.8
NS70%+WP30%	39	34	29.4	65.5	63.7	61
NS80%+WP20%	38.9	32.6	29	61.3	60.8	60
NS90%+WP10%	37.5	32	28	60	58.9	57
NS100%+WP0%	36.2	31.2	27.5	58.5	56	53.1
MS50%+WP50%	45.6	42.5	40	72,3	69.5	68.8
MS60%+WP40%	44	41.2	38	71.2	68.5	66.4
MS70%+WP30%	43	39.9	37.1	70.7	67.8	64.1
MS80%+WP20%	41.5	38	35.5	68.6	65.2	63.3
MS90%+WP10%	40	37.5	35.5	65.8	64.4	62.5
MS100%+WP0%	38.8	37	34	64.6	62.7	62

Oil uptake

Table 2 explains the changes in the oil uptake for the chicken pieces coated and non-coated during cooling and freezing storage within seven days. As shown in the table, the coating has an efficient effect on the oil uptake. The oil uptake of the standard pieces (non-coating) was significantly different from the pieces that were coated with (native and modified starch – whey protein). The oil uptake of chicken pieces coated with the compound coat decreased gradually as the concentration of whey protein increased and increased as the storage (cooling or freezing) time increased ranging from 15.1 to 20.8%. The coated chicken pieces using modified starch with stearic acid were less oil uptake than pieces coating with the native potato starch and starches combined with different rates of replacement of whey protein under the fixed conditions of storage and the rate of decreasing was higher in frozen samples as compared to cooled one. It is worth noting that combining the components of starch, whether natural or modified, with whey proteins decreased fat absorption.There were significant differences ($P \leq 0.05$) for all the factors regarding the treatments, kind of storage as well as the storage time.

A new polymer was produced from the interaction between whey protein and the starches which was completely different from the two polymers, this interaction was developed the favorite functional properties and characteristic of these polymers and made them more cohesive (44), the cohesive character of the combined film was formed via many bonds like Vander Waals forces, hydrogen bonding, Covalent bond and disulfide bond, these bonds were formed because of charges of amino acid of the protein which has the feature of polarity and non-polarity and the hydrophilic groups which have the ability to react with the starch is – OH- NH_2 – COOH – and SH and all these factors made the film more strong (31).

The result behind the reduction of oil uptake for coated and non-coated samples depends on the relationship between fat and moisture content which were related to the replacement of water with oil, that depends on the moisture evaporation during frying processing, so the samples coated by potato starch–whey protein prevent water evaporation during frying which avoided the absorption of oil, samples coated with modified starch using stearic acid had the lower fat uptake because of the formation of amylose-stearic acid complexes, the formation of complexes increases by increasing the molecular weight of fatty acids and by increasing the length of the hydrocarbon chain for them and thus creating more stable complexes and more cohesive film (43; 18), These results are consistent with the results presented by (42, 21).

Table 2: Oil uptake % of fried chicken pieces un-coated and coated with (native and modified starch) incorporated with whey protein during storage at (4±1ºC and -18 ºC).

Type of coating	Storage Time (days)					
	Cooling 4± 1 °C			Freezing -18 °C		
	2 days	5 days	7 days	2 days	5 days	7 days
CONTROL	29.50	30.4	31.5	28.1	28.6	29
NS50%+WP50%	16	16.4	16.8	15.3	15.9	16.2
NS60%+WP40%	17.6	17.9	18.2	16.9	17.3	17.8
NS70%+WP30%	18	18.5	18.9	17.3	17.8	18.3
NS80%+WP20%	18.3	18.9	19	18	18.5	18.6
NS90%+WP10%	18.6	19.3	19.8	18.2	18.8	19.3
NS100%+WP0%	20	20.4	20.8	19	19.5	20
MS50%+WP50%	15.1	15.6	15.9	14	14.5	15.6
MS60%+WP40%	15,7	16	16.8	14.9	15.5	15.9
MS70%+WP30%	16.2	16.9	17.1	15.8	16	16.5
MS80%+WP20%	16.6	17	17.5	16.2	16.7	17.3
MS90%+WP10%	16.8	17.5	17.8	16.6	16.8	17.6
MS100%+WP0%	17	17.6	18	16.9	17	17.9

Lipid oxidation

One of the most important feature of the edible coat is its possibility to delay the oxidation and spoilage processes for the food and increase its shelf life. Peroxide value (PV) and thiobarbituric acid (TBA) values are good indicators for detecting damage and degradation of oils and fats in un-coated and coated samples of chicken piece table (3, 4). As shown in the tables there were significant differences between the un coated and coated samples and PV and TBA of un-coated (control) chicken samples were significantly higher than that of coated chicken (native and modified starch + whey protein), as well as the results showed that PV and TBA of all treatments has increased constantly during storage.

The highest values of peroxide and thiobarbituric acid for the control samples after seven days storage in cooling 3.023Meq 0_2/kg, 0.954MDA/kg. As the concentration of whey protein increased in the complex polymer of the edible coat, PV and TBA decreased the lowest amount was for the sample coated with the modified starch 50% incorporated with whey protein 50% which was 0.216Meq 0_2/kg and, 0.111 MDA/kg respectively when storage at freezing (-18 ºC) two days.

The statistical analysis indicated that there is a significant differences ($P \leq 0.05$) for the period and the kind of storage (cooling and freezing) and there is a significant differences between the coating samples except the samples consisting of 70% starches + 30% whey protein and 70% starches + 30% whey protein and 80% starches + 20% whey protein there were no significant ($P \geq 0.05$) between them.

Gas barrier characteristics of edible films for O_2 and CO_2 affected on the breathing or oxidant reactions. polymer types, gas type and temperature are the most important factors affected barrier characteristics (41). Films barrier properties are largely dependent on polymer components and increasing the ratio of whey proteins reduces gas transmission (10).

The possible reason behind the reduction of oil oxidation was the cooking process and exposure of oxygen which are the factors that influence the oxidation of oil in foods (34), therefore edible films prevent the penetration of oxygen into the food material. Our results were in agreement with the results of (26, 17, 25).

Table 3: peroxide value Meq 0_2/kg of fried chicken pieces un-coated and coated with (native and modified starch) incorporated with whey protein during storage at (4±1 ºC and -18 ºC).

Type of coating	Storage Time (days)					
	Cooling 4± 1 °C			Freezing -18 °C		
	2 days	5 days	7 days	2 days	5 days	7 days
CONTROL	2.941	3.12	3.023	2.531	2.860	2.905
NS50%+WP50%	0.772	0.856	0.984	0.701	0.823	0.911
NS60%+WP40%	0.812	0.901	0.993	0.800	0.854	0.890
NS70%+WP30%	0.865	0.932	1.022	0.823	0.911	0.998
NS80%+WP20%	0.891	0.987	1.132	0.858	0.950	1.112
NS90%+WP10%	1.112	1.136	1.1887	0.982	0.987	1.238
NS100%+WP0%	1.128	1.154	1.140	1.021	1.119	1.146
MS50%+WP50%	0.636	0.767	0.896	0.216	0.342	0.543
MS60%+WP40%	0.763	0.790	0.961	0.381	0.436	0.658
MS70%+WP30%	0.871	0.892	0.989	0.409	0.552	0.698
MS80%+WP20%	0.888	0.982	0.998	0.552	0.768	0.736
MS90%+WP10%	0.979	0.975	1.132	0.698	0.887	0.985
MS100%+WP0%	1.054	1.068	1.087	0.824	0.934	1.509

Table 4: TBA value MDA/kg of fried chicken pieces un-coated and coated with (native and modified starch) incorporated with whey protein during storage at (4±1 ºC and -18 ºC).

Type of coating	Storage Time (days)					
	Cooling 4± 1 °C			Freezing -18 °C		
	2 days	5 days	7 days	2 days	5 days	7 days
CONTROL	0.336	0.787	0.954	0.298	0.569	0.686
NS50%+WP50%	0.176	0.382	0.476	0.137	0.259	0.379
NS60%+WP40%	0.197	0.402	0.499	0.166	0.282	0.398
NS70%+WP30%	0.213	0.453	0.518	0.178	0.290	0.433
NS80%+WP20%	0.259	0.470	0.523	0.186	0.397	0.474
NS90%+WP10%	0.272	0.486	0.553	0.189	0.400	0.483
NS100%+WP0%	0.289	0.497	0.590	0.212	0.443	0.493
MS50%+WP50%	0.122	0.272	0.366	0.111	0.222	0.279
MS60%+WP40%	0.135	0.285	0.382	0.123-	0.154	0.286
MS70%+WP30%	0.178	0.291	0.398	0.135	0.188	0.323
MS80%+WP20%	0.192	0.300	0.412	0.152	0.256	0.365
MS90%+WP10%	0.201	0.321	0.433	0.175	0.277	0.379
MS100%+WP0%	0.233	0.352	0.458	0.212	0.443	0.394

Thermogravimetric analysis (TGA)

The technology of gravimetric decomposition is one of the most important techniques for determining the stability of polymers in general and polymeric films and coats in particular towards manufacturing temperatures. Figure (1) shows the thermal decomposition curve of the composite coat consisting of modified starch with stearic acid 50% and whey protein 50%. A weight loss of 3-4% occurs at a temperature between (54-59 °C) due to the loss of free water in the polymer, the initial weight loss was 9-8% at (82.86 °C) due to the bound water, and this result agreed with **(** 45) who indicated that the absorbed or bound water were lost at temperature below (130 **ºC**).

In the second stage, the degradation of the whey protein in addition of the plasticizer in the polymer matrix was occurred at a temperature (269.26 °C). The film loses about 45-46% of its weight and the degradation involves the release of gases from the dissociation of the film, such as CO_2, NH_3, and CO. At the same time it includes the degradation of the bonds C- N, C(O)-NH, C(O)-NH_2, C(O)-OH and NH_2 as mentioned by (23) and this indicated that the compound film had the ability to withstand high temperatures without degradation till (270 °C) which is higher than the boiling point of oil (180°C) or more slightly. The present study was in agreement with the study of (8) whose investigated the thermal stability of composite edible films consisting of carbohydrate as well as different concentration of whey protein, revealed that the thermal degradation of these films higher than (170 °C).

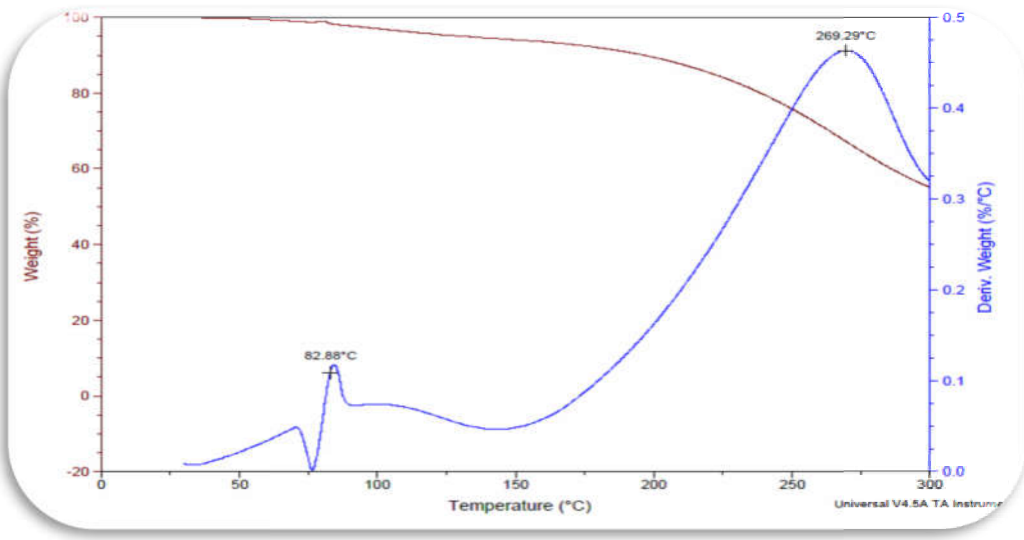

Figure (1) TGA for the edible coat 50% modified starch +50% whey protein

Sensory evaluation

The two coated treatment (NS 50% +wp50%) and (MS 50% + wp50%) were amelioration the mean values of the sensory evaluation for the characteristics of color, flavor, texture, juiciness, and general acceptance of chicken breast comparing to the control. As shown in fig 2, the coated samples showed a clear effect on the color characteristic of coefficients (A and B) with values up to (7.82, 8.99), while the control sample reached (7).

A and B samples were distinguished by an attractive, shiny, brownish appearance due to the presence of starch, whey, and Millard reactions. Consumers pay great attention to the color of fried food products and it is one of the most important criteria used before eating the product (33).

The flavor score which includes test and crispy for the coated samples (A, B) were (8.23, 9.8) respectively which had a significantly higher score ($P \leq 0.05$) than (C) 7.3.

The results of the statistical analysis of juiciness, texture and general appearance indicated that the score of the coated samples (A and B) were significantly ($P \leq 0.05$) higher than non – coated one (control), B sample had the high score for these characteristics which were (9.3, 9, 9.8).

Edible coats have demonstrated their efficiency in improving the sensory characteristics of samples by increasing their tenderness due to their low moisture loss and reduced fat absorption. As the reason for the low moisture loss of food coated with edible coats of a hydrophilic nature prevents the water permeability from food during the frying process (35). Also, coated with different concentrations of proteins reduces the oil content in the fried final product due to the formation of covalent bonds inside the coats during heating (13). The results were consistent with (30) who indicated that the use of methylcellulose for coating the chicken improved the sensory properties.

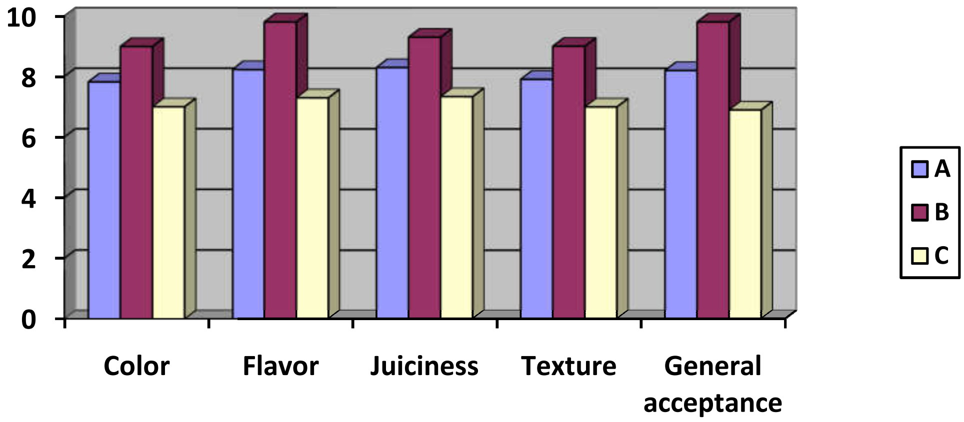

Figure (2): Effect of coating of fried chicken on the sensory evaluation A : Coated with composite edible coat (NS50% +WP50%) B: Coated with composite edible coat (MS50% +WP50%)C: non coated (control).

تأثير الطلاء المركب للأكل على تخزين قطع الدجاج المقلية

نجلاء حسين الجاروري   آلاء غازي الهاشمي

قسم علوم الاغذية, كلية الزراعة, جامعة البصرة, البصره، العراق.

الخلاصة

لتغليف الغذاء أهمية كبيرة على زيادة عمر صلاحية وسلامة الاغذية فضلاً عن أن التغليف يعمل كعازل ضد الظروف المسببة للتلف كالضوء والغبار والاوكسجين والرطوبة والميكروبات. تم استخدام نشأ البطاطا الطبيعي والمحور بحامض الستيريك مع نسب مختلفة من بروتينات الشرش ٠-٥٠% كطلاء قابل للاكل، اذ تم تغلف قطع الدجاج وحفظها في ظروف التبريد بحرارة (٤ ± ١ م□) والتجميد العميق بحرارة (-١٨ م□) وعند مدد (٢، ٥، ٧ أيام) .تمت دراسة تأثير الطلاء لتحديد مقدار فقدان الرطوبة وامتصاص الزيت وقيمة البيروكسيد وحامض الثايوباربيوترك وكذلك التقييم الحسي، إذ أظهرت النتائج إن جميع الأغشية المركبة الصالحة للأكل حسنت من الخواص وأفضلها كان للغشاء المركب (MS50% + WP50%) والتي توفر نتائج أفضل من حيث خفض فقدان الرطوبة وامتصاص الزيت وقيم الأكسدة وزيادة درجات اللون والنكهة والملمس والمظهر العام الذي يعكس التقييم الحسي.

REFERENCE

1-Al-Abdullahb B. M.; Angora M. M.; Al-Ismailb K. M. and Ajoa R. Y., (2011). Reducing fat uptake during deep-frying of minced chicken meat-balls by coating them with different materials, either alone or in combination. Journal of Food Science, 23: 331-337.

2-Allen E. K.; Carpenter E. C. and Walsh M. K., (2007). Influence of protein level and starch type on an extrusion-expanded whey product. *International Journal of Food Science and Technology*, 42: 953-960.

3-Altemimi A. B., (2018). Extraction and Optimization of Potato Starch and Its Application as a Stabilizer in Yogurt Manufacturing. Foods, 7, 2, 14.

4-Angor M.M., (2014). Application of Whey Protein and Whey Protein Isolate as Edible Coating Films on Potato Pellets Chips to Reduce Oil Uptake During Deep Frying. Contemporary Engineering Sciences, Vol. 7, no. 34, 1839 - 1851.

5-Arham R.; Salengke, S.; Metusalach M. and Mulyati M. T., (2018). Optimization of agar and glycerol concentration in the manufacture of edible film. International Food Research Journal 25(5): 1845-1851.

6-Association of Official Analytical Chemists, (2000). Official methods of analysis. 17th ed., Washington. DC: Association of official analytical chemists.

7-Azevedo VM.; Borges SV.; Marconcini JM.; Yoshida MI.; Neto ARS.; Pereira TC. and Pereira CFG., (2017) Effect of replacement of corn starch by whey protein isolate in biodegradable film blends obtained by extrusion. Carbohydr Polym 157:971–980.

8-Chakravartula S.; Soccio M.; Lotti L.; Balestra F.; Marco Dalla R. and Valentina S., (2019). Characterization of Composite Edible Films Based on Pectin/Alginate/Whey Protein Concentrate. Materials**,** *12* (15), 2454. DOI: 10.3390/ma12152454.

9-Claudia, A. R. B.; Bello-Perez, L. A.; Gacia, M. A.; Martino, M. N.; Solorza-Feria, J. and Zaritzky, N. E., (2005). Physicochemical and microstructural characterization of films prepared by thermal and cold gelatinization from non-conventional sources of starches. Carbohyd. Polym.,60(2)235-244.

10-Debeaufort, F.; Voilley, A. E_ect., (1995). of surfactants and drying rate on barrier properties of emulsified edible films. Int. J. Food Sci. Technol, 30, 183–190. [CrossRef]

11-Dhanapal, A.; Sasikala, P.; Rajamani, L.; Kavitha,V.; Yazhini, G. and Banu, M.S., (2012). Edible films from Polysaccharides. Food Science and Quality Management, l 3:9-17.

12-Diaza, O.; Pereirab, C. D.and Cobos, A., (2004). Functional properties of ovine whey protein concentrates produced by membrane technology after clarification of cheese manufacture by-products. Food Hydrocolloids, 18: 601–610.

13-Dogan S.; Sahinand ,S. and Sumnu G., (2005). Effects of batters containing different protein types on the quality of deep-fat-fried chicken nuggets,Eur Food Res Technol,220, 502–508.http://dx.doi.org/10.1007/s00217-004-1099-7.

14-El-Abd, M. and Badawy,W., (2017). Effect of edible coating on oil uptake and shelf life of fried chicken strips. Middle East Journal of Applied Sciences. Vol: 07 Issue :03: 410-420.

15-Eliasson A.-C. and Krog N., (1985). Physical properties of amylose-monoglyceride complexes. Journal of Cereal Science 3:239-248.

16-Falguera, V.; Quintero, J.; Jiménez, A.; Muñoz, J.and Ibarz, A., (2011) Edible films and coatings: Structures, active functions and trends in their use, Trends Food Sci Technol, 22, 292- 303.

17-Fan, W. J.; Chi Y. L. and Zhang S., (2008). The useof a tea polyphenols dip to extend the shelf life of silver carp (Hypophthalmicthys molitrix) during storage in ice. J. Food Chem., 108: 148-153.

18-Fanta, G. F.; Felker, F. C. and Shogren, R. L., (2002). Formation of crystalline aggregates in slowly-cooled starch solutions prepared by steam jet cooking. Carbohydrate Polymers, 48, 161-170.

19-Garmakhany, A. D.; Mirzaei H. O.; Nejad M. K. and Maghsudlo Y., (2008). Study of oil uptake and some quality attributes of potato chips affected by hydrocolloids. Eur. J. Lipid Sci.Tech., 110:1045-1049.

20-Jooyandeh, H., (2011). Whey Protein Films and Coatings: A Review. Pakistan Journal of Nutrition, 10(3): 296-301.

21-Kim, D. N.; Lima J.; Bae I. Y.; Lee H. G. and Lee S., (2011). Effect of hydrocolloid coatings on the heat transfer and oil uptake during frying of potato strips. J. Food Eng., 102: 317–320.

22-Laohakunjit,N. and Noomhorm,A.,(2004). Effect of plasticizers on mechanical and barrier properties of rice starch film.Starch-Stärke, 56(8), 348–356.

23-Limpan, N., (2009). Properties of biodegradable film based on fish myofibrillar protein and poly (vinyl alcohol) blend**.** M. S. thesis science in packaging technology, Songkla university.

24-Liu P.; Sun S.; Hou H. and Dong H., (2016c). Effects of fatty acids with different degree of unsaturation on properties of sweet potato starch-based films. Food Hydrocolloids 61:351-357.

25-Lu, F.; Liu D. H.and Ye X. Q., (2009). Alginate-calcium coating incorporating nisin and EDTA maintains the quality of fresh northern snakehead (Channa argus) fillets stored at 4℃. J. Sci. Food Agric., 89: 848-854.

26-Manju, S.; Jose L.; Srinivasa Gopal T. K.; Ravishankar C. N. and lalitha K. V., (2007). Effects of sodium acetate dip treatment and vacuum-packaging on chemical, microbiological, textural and sensory changes of pearl spot (Etroplus suratensis) during chill storage. J. Food Chem., 102:27-35.

27-Mellema, M., (2003). Mechanism and reduction of fat uptake in deep-fat fried foods. *Trends in Food Science and Technology, 14*(9), 364-373.

28-Ngadi, M.; Dirani, K. and Oluka, S., (2006). Mass transfer characteristics of chicken nuggets. *International Journal of Food Engineering, 2*(3), 1-16.

29-Ngadi, M.; Li, Y., and Oluka, S., (2007). Quality changes in chicken nuggets fried in oils with different degrees of hydrogenation. *LWT-Food Science and Technology, 40*, 1784-1791.

30-Nguyen, B.E., (2009). Effects of methylcellulose on the quality and shelf life of deep fat fried and oven baked chicken nuggets. M.Sc. Thesis, Faculty of Food Science, Texas Tech University, Texas, USA.

31-Opade, P. A.; Hardin, M.; Fitzpatrick, P.; Desmee, H. and Halley, P., (2006). Macromolecular Interactions During Gelatinisation and Retrogradation in Starch-Whey Systems as Studied by Rapid Visco-Analyser. International Journal of Food Engineering,Vol. 2, Iss. 4, Article 7.

32-Oparaku, F. N.; Obialo M. B. and Effiong E. J., (2010). Proximate andorganoleptic characteristics of sun and solar dried fish. AnimalResearch International ,7(2)z 1169 - 1175.

33-Pedreschi F.; Moyano P.; Kaack K. and Granby K., (2004). Color changes and acrylamide formation in fried potato slices. Food Research International, 39(1): 1-9.

34-Pikul, J.; Leszczynski,D.E.; Bechtel, S. and Kummerow,F.,(1984) .Effects of frozen storage and cooking on lipid oxidation in chicken meat. J.Food.Sci.49:838-843.

35-Porta, R.; Mariniello, L.; Di Pierro, P.; Sorrentino, A.; Valeria, C.; Giovanna, G.; Marquez, R. and Esposito, M., (2012). Water barrier edible coatings of fried foods. J. Biotechnol Biomater, 2(7):1-3.

36-Ramos, Ó. L.; Reinas, I.; Silva, S. I.; Fernandes, J. C.; Cerqueira, M. A.; Pereira, R. N.; Vicente, A. A.; Poças, M. F; Pintado, M. E. and Malcata, F. X., (2013). Effect of whey protein purity and glycerol content upon physical properties of edible films manufactured therefrom. Food Hydrocolloids, 30: 110-122.

37-Regalado, C.; Pérez-Pérez, C.; Lara-Cortés, E. and García-Almendarez, B., (2006). Whey protein based edible food packaging films and Coatings. In Advances in Agri. and Food Biotechnol., Editors: Guevara-González, R. G and Torres-Pacheco, I.pp: 237-261.

38-Sarantópoulos C.I.; de Oliveira L. M.; Padula M.; Coltro L.; Alves, R.M.V.**andGarcia,E.E.C.,(2002).**Embalagensplásticasflexíveis:Principaispolímeroseavaliac ̧ãodepropriedades.CETEA/ITAL.

39-Senna, M. M.; El-Shahat, H. A. and El-Naggar, A. M., (2011). Characterization of gamma irradiated plasticized starch/poly (vinyl alcohol) (PLST/PVA) blends and their application as protected edible materials. J. Polym. Res., 18:763–771.

40-Seyhan F.D.; Serpil S. and Gulum S., (2005). Effects of soy and rice flour addition on batter rheology and quality of deep-fat fried chicken nuggets. J. Food Eng ., 71;127-132si.

41-Siracusa, V.; Romani, S.; Gigli, M.; Mannozzi, C.; Cecchini, J.; Tylewicz, U.; Lotti, N., (2018). Characterization of Active Edible Films based on Citral Essential Oil, Alginate and Pectin. Materials, 11, 1980. [CrossRef].

42-Surmei, E. and Usturoi1 M.G., (2012). Considerations regarding quality of poultry meat stored in refrigeration conditions. Lucrari Ştiinţifice–Seria Zootehnie, 58:199-202.

43-Tufvesson, F.; Wahlgren, M. and Eliasson, A.-C., (2003). Formation of amylose-lipid complexes and effects of temperature treatment. Part 1. Monoglycerides. Starch/Starke, 55, 61–71.

44-Turgeon S. and Beaulieu M . , (2001). Improvement and modification of whey protein gel texture using polysaccharides.Food Hydrocolloids 15(4):583-591.

45-Valencia-Sullca, C.; Vargas, M.; Atarés, L.; Chiralt, A., **(2018)**. Thermoplastic cassava starch-chitosan bilayer filmsncontaining essential oils. Food Hydrocol., 75, 107–115. [CrossRef]

46-Varela, P. and Fiszman S., (2011). Hydrocolloids in fried foods: A review. *Food Hydrocolloid, 25*, 1801-1812.

47-Wang N.;Zhang X. ; Han N. and Bai S., (2009). Effect of citricacid and processingontheperformanceofthermoplasticstarch/montmorillonitenanocomposites.CarbohydratePolymers,76(1), 68–73.

48-Zhou Z. ; Robards K. ; Helliwell S. and Blanchard C., (2007). Effect of the addition of fatty acids on rice starch properties. Food Research International 40:209-214.