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The Effects of Various Coating Materials on Chicken Drumsticks Some Quality Parameters

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Abstract: In this study, fat uptake and moisture contents of coated drumsticks coated with edible materials after frying and some physical and chemical changes were investigated during storage. The chicken drumsticks were coated with (three layers of) coating materials. Then, they were stored at -18 °C for 7 months. In the coated meats, a great amount of moisture remained and the frying and juicy structure of the meat was protected. However, in the consuming total mass, moisture level decreased. The pH, TBA and TVB-N values were performed only in coating groups first, second last (re-write). The lowest pH values were in the order of zein, 6.33 and gluten, 6.34 for first coatings; guar gum, 6.32 and xanthan gum, 6.33 for second coatings and they were same for all last coating groups. The lowest TBA values were in the order of guar gum, 0.24 mg kg^{-1} for second coatings and mixture contain 1:2 wheat flour: Corn flour, 0.26 mg kg^{-1} and 2:1 wheat flour: Corn flour, 0.29 mg kg^{-1} for last coatings and these values were same for first coatings. The lowest TVB-N value of secondary coatings is 16.86 mg 100^{-1} for xanthan gum and these values were same for first and last coating groups. Results showed that the most cited materials were those; at the first coating; gluten and caseins, at the second coating; guar gum and xanthan gum, at the last coating; 1:2 and 2:1 wheat flour: Corn flour containing mixture.

Key words: Edible coatings, chicken drumstick, breading, battering, fat intake

INTRODUCTION

Processed chicken meats are products of great economic importance in many countries. The product quality of processed chicken meat may declines as a result of several factors during processing and storage. These factors are lipid oxidation, hydrolysis and protein denaturation or physical and chemical changes during frying or storage. Lipid oxidation and hydrolysis have been shown to occur during chicken frozen storage and become an important factor of chicken meat deterioration, influencing protein denaturation, texture changes and colour development (Stewart and Amerine, 1982; Patsias *et al*., 2006).

Using edible coating the deterioration of the chicken meat can be significantly reduced during long-term storage. Research interest in edible coatings made from proteins, polysaccharides and lipids has intensified in recent years. The coatings can lessen or prevent quality changes in foods such as frozen chicken by acting as barriers to control moisture transfer, oxidation and loss of volatile aromas and flavours (Gennadios *et al*., 1997; Cutter, 2006).

Lipid, polysaccharide and protein based films can be utilized to extend the shelf life of this foods. Lipids such as waxes, fats and gelling or proteins such as gluten, zein, casein, soy protein can be used as a coating. They are located on food surface as thin layers between several parts within the product (Kulp and Loewe, 1990).

Edible film coatings can be made from combination these materials as either bilayers or emulsions. They formed with several compounds may develop to take advantage of complementary functional properties of these different constitutive materials and to overcome their respective drawbacks. These coatings applied on surface of fish, poultry and meat pieces prior to battering, breading and frying could improve the products' nutritional value by reducing oil uptake and moisture loss during frying or oxidation during stored (Guilbert *et al*., 1997; Cutter, 2006).

Maskat *et al*. (2005)' found that edible coatings prepared from Methylcellulose (MC) reduced frying loss and improved cooked yield and moisture retention in poultry products.

According to Hirasa (1991), Casein and Acetylated monoglycerides (myvacet 5-07) emulsions coatings were

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used on frozen silver salmon pieces, which were stored at-10°C and reduced moisture loss when compared to uncoated salmon.

McHugh and Krochta (1994) found that, films from Whey Protein Isolate (WPI) have been shown to be excellent oxygen barriers for food protection.

Therefore, in this study formation with gums, protein based materials, cereal flours and other ingredients were used to coat chicken drumsticks. Detections of chicken meat physical, chemical and biochemical quality during storage and end of the frying process were carried out.

MATERIALS AND METHODS

Materials: Fresh chicken drumsticks were purchased from Köy-Tur Co. that is chicken meat producer in Turkey. Zein, gluten, casein mix, guar gum (3500-4000 cps), xanthan gum (1500-1600 cps), locust bean gum (2500-3000 cps), flour (corn, wheat, grissini), maltodextrin, salt, swelling powders, union and garlic powders were used in coatings. Zein was purchased from Sunar Corn Products Co. (Adana, Turkey), caseins and gums from Dairy Gold Co. (Ireland) gluten, onion powders, garlic powders, maltodextrine from Kurtsan Co. (İstanbul, Turkey). Flours, salt baking powder were obtained from the local food ingredient sellers. Hydrogenated palm olein margarine, as frying medium Paksoy Co. (Adana, Turkey), was used.

Methods: Zein, gluten and casein mix (rennet casein and potassium casein) were used as first coating. Nine hundred and nintyseven gram wheat flour + 1 g gum (guar, xanthan, locust bean) + 2 g swelling powder + 2000 ml water (1600 mL water used in locust been gum contain coating) were used as second coating (battering). % 47.5 pre mix + % 47.5 grissini flour + % 1 onion powder + % 1 garlic powder + % 1 maltodextrine + % 2 salt blend that prepared from 1:1, 1:2, 2:1 wheat flour:corn flour pre mix were used as the last coating (breading).

Chicken drumsticks dipped in second coatings (battering) followed by pre dusted with first coating materials. Then these were coated with last coatings (breading). Pre frying was done at 180°C for 20 sec, cooled at ambient and stored at-18°C. Frying process was conducted at 180°C for 10 min after each storage periods (at 0. day and after 1. 2. 3. 4. 5. 6. 7. month of storage).

Twenty-eight treatments were tested with control. In addition, at these periods, the samples' pH, TBA, TVB-N values before frying and moisture, oil and sensory values after frying were evaluated. pH values of the samples were determined using a pH meter (Hanna Instruments, Italy) (Varlİk *et al*., 1993); Thiobarbituric Acid (TBA) value was determined using a spectrophotometer (Cecil Ce1120, England) and Total Volatile Basic Nitrogen (TVB-N) value was determined with vapour distillation method according to Schormüller (1969). Moisture contents were determined (by oven air method) at 102°C and fat contents were determined by using soxhelet extraction method (AOAC, 2000). Moisture contents coated chicken drumsticks were determined with two different ways to examine the water of capacity of meat without coating and with coating. In the first group, after frying, coatings were removed and the meat was minced in 1st, 3rd, 5 and 7th months. In the second group, coatings were not removed and the fillets with their coating were minced in 2nd, 4th and 6th months.

Five semi trained judges assessed (ranked) the sensory properties using a (9 point) hedonic scale for general appearance, colour, smell, taste-flavour and texture for acceptability. In the scale, 1: Extreme dislike, 2: Important degree dislike, 3: Rather dislike, 4: Few dislike, 5: Neutral, 6: Few like, 7: Like, 8: Very like, 9: Extreme like (Gökalp *et al*., 1999).

The experimental design was completely randomized factorial design (3×3×3) containing three types of the first coating materials, three types of the second coating materials and three types last coating materials with two replications. The data were subjected to analysis of variance and results were expressed as mean ±standard deviation Analysis of Variance (ANOVA) was conducted and mean separation were determined by Duncan's multiple range test using the Statistical Analysis System program (SAS, 1998). The levels of $p<0.01$ and $p<0.05$ were used as the criterion for statistical significance.

RESULTS AND DISCUSSION

The moisture and fat contents of coated chicken drumsticks after frying;

At zero day for first group: the moisture was measured as 75.05% and was different from other storage periods. The highest moisture values were determined as 68.19% in 5th month (Table 1, $p<0.01$). In fresh meat, fat level was 4.18% that increased rapidly at the end of frying. The highest fat levels were 8.78%, in fried meats in the 1st months ($p<0.01$).

Table 2 shows the differences between the moisture and fat contents of the second group minced with the coatings after frying process. In the beginning, the moisture value was 75.05%. However, it decreased rapidly after frying. This decrease was higher than those of the drumsticks minced without coatings the score the characteristics of coating materials.

Table 1: General means of moisture and fat contents of coated chicken drumsticks after frying at different storage periods

Times(month)	n	SWOC moisture (%)	SWOC fat (%)	Times(month)	n	SWC moisture (%)	SWC fat (%)
0	2	75.05±0.19^{a}	4.18±0.10^{d}	0	2	75.05±0.19^{a}	4.18±0.10^{c}
1	56	66.38±0.27^{c}	8.78±0.20^{a}	2	56	51.37±0.58^{c}	15.39±0.35^{ab}
3	56	66.60±0.24^{c}	7.90±0.18^{b}	4	56	51.23±0.60^{c}	15.87±0.35^{a}
5	56	68.19±0.23^{b}	7.49±0.21^{bc}	6	56	54.96±0.42^{b}	14.59±0.28^{b}
7	56	67.68±0.26^{b}	7.03±0.25^{c}	-	-	-	-

SWOC:The samples that minced without coating after frying. SWC: The samples that minced with coating after frying. n: Total samples

Table 2: The effects of coating materials on general means of moisture and fat values in coated chicken drumsticks after frying

Coatings	n	SWOC moisture (%)	SWOC fat (%)	n	SWC moisture (%)	SWC fat (%)
Non coating	10	65.01±1.69	9.62±0.96		68.05±1.65	7.56±0.86
First coatings	-	-	-	-	-	-
Zein	72	66.90±0.22^{b}	8.06±0.19^{a}	54	51.86±0.65^{a}	15.68±0.37^{a}
Gluten	72	67.99±0.16^{a}	7.42±0.15^{b}	54	51.85±0.34^{a}	15.61±0.26^{a}
Casein mix	72	67.27±0.22^{b}	7.57±0.21^{b}	54	52.38±0.42^{a}	15.28±0.25^{a}
Second coatings	-	-	-	-	-	-
Guar gum	72	67.56±0.20^{a}	7.62±0.18^{a}	54	52.42±0.55^{a}	15.39±0.29^{b}
Xhanthum gum	72	67.24±0.23^{a}	7.82±0.20^{a}	54	51.70±0.45^{a}	16.30±0.30^{a}
Locust bean gum	72	67.35±0.20^{a}	7.59±0.19^{a}	54	51.97±0.45^{a}	14.90±0.26^{b}
Last coatings	-	-	-	-	-	-
1:1 W:C	72	67.42±0.20^{a}	7.57±0.17^{a}	54	52.03±0.40^{ab}	15.60±0.28^{a}
1:2 W:C	72	67.40±0.21^{a}	7.83±0.18^{a}	54	51.47±0.51^{b}	15.66±0.31^{a}
2:1 W:C	72	67.34±0.23^{a}	7.46±0.21^{a}	54	52.59±0.53^{a}	15.32±0.30^{a}

SWOC: The samples that minced without coating after frying. SWC: The examples that minced with coating after frying. W: C: Wheat flour: Corn flour, n: Total samples.

In this group, the highest value of moisture was 54.96% in the 6th month ($p<0.01$). In the process of storing, after frying the moisture content decreased In the beginning fat value was 4.18%, but in the other months (2, 4 and 6. months) of the storage, after frying the fat content increased. Fat contents of these examples were higher than those of the other group that minced without the coating. The highest fat levels were determined as 15.39% in the 2nd month and as 15.87% in 4th month, respectively (Table 1, $p<0.01$).

In general, the mean moisture contents of the meat samples without coating or with coating significantly decreased after frying. However, as seen in Table 2, in first group that samples minced without the coatings, after frying the moisture contents were higher than that of the non coated samples (65.01%). It is probably because coatings decreased and prevented moisture loss from meat. The highest moisture content in the first coating group was 67.99% in gluten coatings ($p<0.01$) while in the secondary coating and the last coating groups the values were similar ($p>0.05$).

Fat contents of meats after frying were increased. However, coatings had a limiting effect reducing absorbed fat by the product. In non coated drumsticks, after frying, general mean was 9.62%, in the first covering group the lowest fat value was in gluten as 7.42% and in casein mix as 7.57%, respectively ($p<0.01$). In the secondary group and the last group values were similar ($p>0.05$).

In the samples minced with the coatings after frying, the effects of coating on the loss of moisture after frying was also determined and the results are shown in Table 2. The level of moisture in the non coated fillets was 68.05% after frying. Contrary to the examples minced without coatings, in this group, the score was higher than coated samples. As seen the level of moisture of non-coated, samples was higher than coated examples.

On the samples that minced with coating the moisture content in the first coating group and second coating group were similar ($p>0.05$). In the last group, the highest mean, coated with 2:1 wheat flour: Corn flour was 52.59 ($p<0.01$).

In general the mean fat content in non coated samples was 7.56%. The values were higher in the samples minced with the coatings because of oil holding capacity of the coatings. In the first coating and last coating group means were not statistically significant ($p>0.05$). But, in second coating group, the lowest value as 15.39% and as 14.90% were zein and casein mix, respectively ($p<0.01$).

The moisture of fresh meat was 75.05% that was an agreement with other results given as 74.7 and 75% in the literature (Göğüş and Kolsarıcı, 1992; Öztan, 1999). Moisture level of non coated and coated chicken drumsticks decreased after frying in period of storage. However, the functional characteristics of coating materials became effective on the level after frying. Frying process affected the both edible and nutritional characteristics of drumsticks. Primary coating materials were protein based. Secondary coating materials consisting of polysaccharides (gums and flours) became gelatinous because of gums and starches in flours, so coatings occur on the surface of meat. In that period lose of moisture from chicken drumsticks decrease. Last coating materials are very important to protect the moisture because they present both the characteristics of polysaccharides and proteins (Bravin *et al*., 2006; Cutter, 2006) had the author agreed upon that coating was effective because of the characteristics of CHO and protein system. It is obvious that wheat flour protects the moisture (Kulp and Loewe, 1990). As the quantity of flour increases, the kept moisture level increases because compared to corn flour, wheat flour particles are small, (Kılınççeker *et al.* 2006) and its protein level is high. In meats without coating minced, the results are in agreement with the literature, but in meats minced with coating the results are different. In the coated chicken drumsticks, a great amount of moisture was kept in frying and juicy structure was protected. However, in consuming total mass, level of moisture decreased.

The results of minced meat without coating are in line with the other results. Gennadios *et al*. (1997) referred that Balasubramaniam detected 16.4% decreasing moisture loss in chicken meat during the frying process. Mallikarjunan *et al.* (1997) observed 14.9, 21.9 and 31.1% decrease the moisture loss in fried potatoes coated with various coatings. Moreover, in Williams and Mittal's (1999) study the moisture loss on donuts after frying decreased 30%; by Gennadios *et al*. (1997), moisture loss on coated cow meat decreased greatly during storage. Our study had the similar results. However, in this research the results of meats minced with coating moisture were different due to the very little moisture content of coatings.

The fat level of fresh chicken drumsticks (4.18%) was similar with the values given as 3.1 and 5.5% in literature (Göğüş and Kolsarıcı, 1992; Öztan, 1999). However, in general after frying fat content in all materials increased (Table 2). In the 1st, 3rd, 5 and 7th months, in examples, which were minced after frying without edible coatings, the fat levels were low. In 2nd, 4, 6th months because of mincing the materials with the coatings, the fat levels were higher than those of uncoated. Coating materials produced a film on the meat during frying process and this part of meat prevented the increase in the level of fat. Especially flours used in the last coatings affected the level of fat. In the samples in which the crust was minced with the meat, the level of fat increased (Table 1 and 2). However, it decreased the fat level in the inner parts of meat. So it affected the characteristics and quality of the meat in a good aspect because moisture was retained. High level of fat is not desirable. The final results of minced meats without coating are similar to the results of research in fried potatoes showing 54% decrease in absorbed oil level (Brincic *et al*., 2004) and the results of Mallikarjunan *et al.* (1997) studying on potatoes and showing 59, 61.4 and 83.6% decrease in absorbed oil level with connected coatings. In addition, in Williams and Mittals (1999) results on donuts coated by gums showed 50-91% decrease in oil absorption and Balasubramanian at all stated 33.7% decrease in absorbed oil content than uncoated controls during deep fat frying in peanut oil in meat balls prepared from ground chicken breast and coated hydroxypropyl methylcellulose (Gennadios *et al*., 1997). However, as stated earlier, the decrease in oil level may not ensure great advantageous because the product is consumed with coatings.

The pH, TBA and TVB-N results during storage of coated chicken drumsticks were given in Table 3. pH, TBA and TVB-N results were appeared at Table 3.

At zero day the value of pH was 6.17. The pH increased rapidly compared to fresh meat value. The highest pH mean values were determined as 6.39 in the 1st month ($p<0.01$).

Initial TBA mean value in fresh meat was 0.057 mg kg^{-1}. This value increased during storage and the highest values was determined as 0.42 mg kg^{-1} in the 7th month ($p<0.01$).

The beginning of TVB-N value was 6.34 mg 100 g^{-1}. This value also increased rapidly during storage. The highest levels were determined as 20.26 mg 100 g^{-1} in the 3rd month ($p<0.01$).

Table 3: pH, TBA and TVB-N general means of coated chicken drumsticks during storage

Times (month)	n	pH	TBA (mg kg^{-1})	TVB-N (mg.100 g^{-1})
0	2	6.17±0.01^{e}	0.057±0.01^{e}	6.34±0.05^{d}
1	56	6.39±0.01^{a}	0.37±0.03^{b}	12.03±0.32^{c}
2	56	6.31±0.01^{bc}	0.22±0.02^{d}	16.87±0.42^{b}
3	56	6.30±0.02^{c}	0.29±0.02^{c}	20.26±0.36^{a}
4	56	6.26±0.02^{d}	0.31±0.02^{c}	16.69±0.42^{b}
5	56	6.31±0.01^{bc}	0.31±0.03^{c}	20.22±0.41^{a}
6	56	6.34±0.01^{b}	0.41±0.04^{a}	17.37±0.33^{b}
7	56	6.38±0.01^{a}	0.42±0.03^{a}	17.10±0.37^{b}

Table 4: The effects of coating materials on general means of pH, TBA and TVB-N in coated chicken drumsticks during storage

Coatings	n	pH	TBA (mg kg^{-1})	TVB-N (mg.100 g^{-1})
Non coating	16	6.25±0.04	0.94±0.12	17.65±1.43
Firs coatings	-	-	-	-
Zein	126	6.33±0.01^{b}	0.28±0.02^{a}	17.25±0.35^{a}
Gluten	126	6.34±0.01^{ab}	0.29±0.02^{a}	17.32±0.32^{a}
Casein mix	126	6.36±0.01^{a}	0.29±0.02^{a}	16.87±0.34^{a}
Second coatings	-	-	-	-
Guar gum	126	6.32±0.01^{b}	0.24±0.01^{b}	17.16±0.36^{a}
Xanthan gum	126	6.33±0.01^{ab}	0.30±0.02^{a}	16.86±0.34^{b}
Locust bean gum	126	6.36±0.01^{a}	0.31±0.02^{a}	17.42±0.33^{a}
Last coatings	-	-	-	-
1:1 W:C	126	6.34±0.01^{a}	0.30±0.02^{a}	17.24±0.35^{a}
1:2 W:C	126	6.33±0.01^{a}	0.26±0.02^{b}	17.27±0.37^{a}
2:1 B:C	126	6.35±0.01^{a}	0.29±0.02^{ab}	16.93±0.29^{a}

W: C: Wheat flour: Corn flour

In the non coated materials, the mean pH was 6.25, but in the coated samples, pH increase was determined (Table 4). The lowest pH was in the first group was determined in zein as 6.33 ($p<0.01$). In the secondary group of guar gum, it was 6.32 ($p<0.01$). In the last coating group, all pH values were similar ($p>0.05$). In the fresh meat, the pH value was 6.17 in the coated samples it increased during storage. The highest result was determined in all coated meat samples, compared to the non coated meats. Especially, the rise in the 1st month was because of the heat effects of pre frying, causing increase ammonia and amines so called base characteristic units in the structure of meat (Simeonidou *et al*., 1997). The decrease observed in the later periods was because of the reactions of these nitrogenous materials causing oxidation, products such as aldehydes and ketons. In some periods their amounts decreased and pH dropped. Generally, pH values increased owing to proteolitic bacteria and autolitic enzymes in the meat. In the beginning, because of rigor, the maximum level of lactic acid in the structure, pH decreased. Then, after the activities of autolitic and protolitic enzymes, degradation in nitrogenous materials, pH increased. So, the lower value of pH in fresh meat, increased rapidly. However, in the mean of all coated materials, pH was not higher than limit value of 6-6.5 given by Varlık *et al*. (1993) and Gülyavuz and Ünlüsayın (1999). The result of pH was lower than the values given by Ötleş and Berkay (1999) in the case of squid pane, haddock pane, Alaska Pollack croquet and fish burger products those minimum pH levels were 7.07, 6.82, 6.7 and 6.45, respectively.

In Table 4, it is shown that, TBA value, in non coated chicken drumstick samples, the values (0.94 mg kg^{-1}) was higher than those of the coated materials. There were no significant differences in the first coatings group ($p>0.05$). In the second coatings, the lowest TBA value was 0.24 mg kg^{-1} in guar gum content coatings ($p<0.01$). In the last coating, the lowest TBA as 0.26 mg kg^{-1} was 1:2 wheat flour: Corn flour content coatings ($p<0.01$). The bitterness of meat increases as TBA values increases. It may also result in the change of the colour. Moreover, the sensory characteristics may be affected negatively. In this study, the TBA value in fresh meat (0.057 mg kg^{-1}) increased because of oxidation during storage. The decrease during 2nd month storage may be caused by interactions between malondialdehyde and amines, nucleosides and nucleic acid, amino containing phospholipids, proteins (Simeonidou *et al*., 1997). The coating consisted of polysaccharides and proteins based materials the surface of meat prevents the interaction between air and the surface of meat and the oxidation decreases. Therefore, TBA values become lower. The TBA values of coated chicken drumsticks were lower from the level of consuming that was given by Gökalp *et al*. (1999) e as 1 mg kg^{-1}. Increase in TBA values was similar with the values given by Villea *et al*. (1999) in the case of cooked ham and salted pork meat. The investigators pointed out that the increase caused because of oxidation.

The differences between coating materials on TVB-N were presented at Table 4. General mean of non coated group was 17.65 mg 100 g^{-1}. This value was higher than some of the coated materials. There were no significant differences among the first and last coating groups ($p>0.05$). In the second coatings, the lowest TVB-N value was 16.86 mg 100 g^{-1} in xanthan gum content coating ($p<0.05$). In stored meat products, TVB-N values are nitrogenius materials exist because of proteolitic bacteria. It causes smell in meat and high TVB-N values are not desired. In our study, TVB-N value was 6.34 mg 100 g^{-1} in the beginning. It increased and affected the quality of the meats by time. During storage, mean TVB-N values were similar to those given in the literatureş less than 25 mg 100 g^{-1} for a very good quality product (Varlık *et al*., 1993; Gülyavuz and Ünlüsayın, 1999). Our results were higher than the minimum values obtained by Ötleş and Berkay (1999) in kalamar pane, croquet and burger, as kalamar pane as 8.4 mg 100 g^{-1} and fish burger as 14 mg 100 g^{-1}. However, the results of the present study were lower than those of whiting pane (23.8 mg 100 g^{-1}) and Alaska Pollack croquet (21 mg 100 g^{-1}). Because of deterioration in the structure of proteins during pre frying, total volatile basic nitrogenous compounds increased.

The sensory properties of coated chicken drumsticks: Sensory characteristics of marketing materials are attractive for the consumers. Sensory analyses were done in 2nd, 4th and 6th months to measure consumers' preference of fried chicken drumsticks.

The highest values of all sensory analysis were determined in the 4th month (Table 5). These were 7.01 in general appearance, 7.01 in colour, 7.13 in odour, 6.93 in taste and flavour and 7.19 in structure and texture ($p<0.01$).

In order to determine the general appearance values of coated meats differences, all coating group means were higher than that of non coated meats (Table 6). The values of first coating groups, the highest values (6.94 and 6.96) were in gluten and casein mix coated fillets ($p<0.01$). In secondary group, meats contains guar gum and xanthan gum had the highest value (6.68 and 6.61, $p<0.01$). For last coating group, the highest values were determined in 1:2 and 2:1 wheat flour: Corn flour content coatings (6.39 and 6.52, $p<0.01$). In first coating, especially gluten and casein mix had positive influence because of having small particles and rough surface on the surface of

Table 5: Sensorial analyses general means of coated chicken drumsticks during storage

Times (month)	n	General appearance	Colour	Odour	Tasteand flavour	Structure and texture
2	56	6.24±0.16[b]	6.60±0.14[b]	6.21±0.11[c]	6.60±0.13[b]	6.85±0.10[b]
4	56	7.01±0.17[a]	7.01±0.18[a]	7.13±0.99[a]	6.93±0.11[a]	7.19±0.10[a]
6	56	6.12±0.14[b]	6.30±0.13[c]	6.82±0.10[b]	6.23±0.15[c]	6.48±0.15[c]

Table 6: The effects of coating materials on general means of sensorial analyses in coated chicken drumsticks during storage

Coatings	n	General appearance	Colour	Odour	Taste and flavour	Structure and texture
Non coated	6	5.27±0.44	4.33±0.37	6.42±020	7.25±0.45	7.82±0.22
First coatings		-	-	-	-	-
Zein	54	5.60±0.14[b]	6.27±0.15[b]	6.47±0.13[b]	6.34±0.12[b]	6.75±0.11[a]
Gluten	54	6.94±0.16[a]	6.89±0.16[a]	6.79±0.10[a]	6.67±0.13[a]	6.88±0.11[a]
Casein mix	54	6.96±0.13[a]	7.06±0.12[a]	6.94±0.10[a]	6.69±0.16[a]	6.79±0.15[a]
Second coatings	-	-	-	-	-	-
Guar gum	54	6.68±0.13[a]	6.91±0.12[a]	6.83±0.01[a]	6.70±0.13[a]	6.90±0.10[a]
Xanthan gum	54	6.61±0.20[a]	6.92±0.18[a]	6.75±0.15[a]	6.44±0.17[a]	6.90±0.15[a]
Locust bean gum	54	6.22±0.14[b]	6.39±0.14[b]	6.62±0.10[ab]	6.55±0.11[a]	6.62±0.11[a]
Last coatings	-	-	-	-	-	-
1:1 W:C	54	5.59±0.14[b]	6.94±0.12[a]	6.63±0.12[ab]	6.25±0.15[c]	6.41±0.14[c]
1:2 W:C	54	6.39±0.19[a]	6.50±0.19[b]	6.82±0.10[a]	6.88±0.12[a]	7.20±0.10[a]
2:1 W:C	54	6.52±0.15[a]	6.78±0.14[a]	6.76±0.13[a]	6.55±0.13[b]	6.80±0.11[b]

W:C: Wheat flour: Corn flour

meat, made easy to keep the next coatings creating exact surfaces. In the gum contained coatings, in guar gum and xanthan gum concentrated coatings looked better because it had more homogeneous solutions; therefore, there were fewer cracks on coatings.

The colour values (Table 6), at first, in the coated samples' means, all the values were higher than that of the non coated fillets (4.33). In the first coating materials, the highest were (6.89 and 7.06) in gluten and casein mix coated samples ($p<0.01$). In secondary coatings, the means of samples coated guar gum and xanthan gum were the highest (6.91 and 6.92, $p<0.05$). In the last coatings, the highest values were determined (6.94 and 6.78) in 1:1 wheat flour: Corn flour and 2:1 wheat flour: Corn flour contained coatings ($p<0.05$). In the colour values, there were no negative results in the ranks of coating materials. Although in the analysis guar gum was evaluated high in scoring, because of their transparent structures, it may assume that, all gums had similar effects. In the last coatings 1:1 and 2:1 wheat flour: Corn flour contained coatings resulted in high score. Generally flour contained coatings were preferred because of the colour obtained after frying process.

In non coated fillets, odour value was 6.42, but in the coated materials, it was higher (Table 6). In the first coating group, materials coated by using gluten and casein mix were different from the other and the highest values were 6.79 and 6.94, respectively ($p<0.01$). In the secondary coating group and in the last coating group, there was no significant difference ($p>0.05$). In the terms of odour scores, storage period means of the samples were satisfying even in the last months. Gluten and casein mix had fewer odours than the zein coatings samples. Gums had no smell, so they had no influence on odour. Except for the fried meat smell, slight odour of coatings was acceptable. In some practices, this affected the preference of consumer.

The mean taste and flavour value of non coated meat was 7.25 (Table 6). In coated examples, the mean value decreased. In the first coating group, the highest values were 6.67 and 6.69 in the samples coated by gluten and casein mixture ($p<0.01$). In the secondary coating group, all materials were not statistically different from each other ($p>0.05$). In the last coating group, the highest value was 6.88 for drumsticks samples coated with 1:2 wheat flour: Corn flour contained materials ($p<0.01$). The coated meats gained consumers' satisfaction. In the results, casein mixture and gluten, owing to their characteristics of not having strong taste like zein, obtained higher scores. Gums had no influence on taste. In the last coating group, especially corn flour affected taste and flavour positively in drumsticks.

The results of structure and texture values were appeared at Table 6. The mean of non coated materials were 7.82. In the coated examples the values were lower. There were no significant differences in the primary and secondary coating group ($p>0.05$). In last coating group, the value of coated fillet group produced by using 1:2 wheat flour: Corn flour was different and had the highest score (7.20). In the structure and texture analyses made on coated fillets had satisfying scores ($p<0.01$).

In the coated chicken drumsticks, there were desired surfaces with blister and no cracks. Smell was developed and desired golden-red colour existed. The results of sensory analysis were similar to the scores given in literature related to protein and polysaccharide or their mixture based coating materials (Kulp and Loewe, 1990; Gennadios *et al*., 1997; Guilbert *et al*., 1997).

CONCLUSION

Gluten and casein mixture in the first coating group, guar gum and xanthan gum containing coating materials in the secondary coating group, mixture of 1:2 and 2:1 wheat flour:corn flour in the last coating group are the materials having desired results. Therefore, in the edible coating practices, usage of these materials is more advantageous than the other combinations (include the other combinations) for the quality parameters investigated in this study.

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