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Color properties of gilthead sea bream (*Sparus aurata*) fillets coated with shrimp chitosan

Aygül KÜÇÜKGÜLMEZ Yasemen YANAR Serap GELIBOLU Çiğdem DIKEL Mehmet GÖKÇIN
Cukurova University, Faculty of Fisheries, Department of Fishing and Fish Processing Technology, Adana, Turkey

Corresponding Author
E-mail: akucukgulmez@cu.edu.tr

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Abstract

In this study, the effects of chitosan extracted from *Metapenaeus stebbingi* shells on color properties of gilthead sea bream (*Sparus aurata*) during refrigerated storage (4±1ºC) were examined. The control and treated fillet samples were analyzed periodically for color (*L**, *a**, *b**) analysis. Accordingly, it was determined that chitosan has a positive effect on *L** and *a** values of gilthead sea bream ($p<0.05$), while it displayed no effect on *b** value ($p>0.05$). Any significant difference was not detected between chroma and hue values of groups ($p>0.05$).
Keywords: Chitosan; *Metapenaeus stebbingi*; gilthead sea bream; color changes

INTRODUCTION

Gilthead sea bream is the second most cultured sea fish species in Turkey, and its production is 28.157 tons/year [1]. Its fresh consumption is quite common in Turkey, and it is also exported to European Countries. However, there are some problems experienced in the storage of this highly demanded species. Among these problems, lipid oxidation and microbial development can be regarded as the leading problems. Additionally, physical changes also appear during storage. Color change is quite important among these physical changes and it directly affects the product quality, and therefore, the color is demanded to remain unchanged during storage, which can be achieved by addition of various preservative substances. In this regard, the application of chitosan as preservative is gradually increasing.

Chitosan (poly-β-1.4-2-amino-2-deoxy-β–D-glucopyranose), mainly manufactured from crustacean shells (crabs, shrimps, crayfishes etc.), is derived by deacetylation of chitin [2, 3]. Due to its biodegradability, biocompatibility, non toxic and wound healing properties as well as its haemostatic activity; chitosan has received increased attention as one of the promising renewable polymeric materials [2]. It is widely used in many sectors including chemistry, biotechnology, agriculture, veterinary, cosmetics, medicine, dentistry, environmental protection, textile, packaging, etc. [4]. Apart from these, chitosan also has a wide application area in food industry due to its antimicrobial and antioxidant properties [5, 6]. Therefore the objective of this study was to evaluate the effect of chitosan extracted from *M. stebbingi* shells on color properties of gilthead sea bream fillets during refrigerated storage.

MATERIALS AND METHODS

Materials

In the study, chitosan extracted from shrimp (*Metapenaeus stebbingi*) shells, using a chemical method of Chang et al. [7]. Deproteinization and demineralization steps were carried out with 2.5 N NaOH at 65ºC for 6 h and 1.7 N HCl at 25ºC for 6 h, respectively. The chitin residue was treated with nine volumes of hydrogen peroxide and dried at 90ºC for 2 h. Chitosan was prepared by alkali treatment of chitin using 50% (w/v) NaOH in distiled water at 120ºC. The reactants were filtered, washed with deionized water to neutral pH and dried at 90ºC for 2 h. Deacetylation degree of the chitosan was determined as 92.19%, while its molecular weight and apparent viscosity were 3.52 kDa and 46.14 cp, respectively. Water and fat binding capacities of chitosan were 712.99% and 531.15%.

The cultured gilthead sea bream (*Sparus aurata*) (average weight and length: 27.50±0.62 g and 370.91±20.71 cm, respectively) were purchased from a local fish market. They were stored in ice in an insulated box and transferred to the laboratory. The head and viscera were removed from each fish, and two fillets were obtained from the carcass.

Preparation and chitosan treatment of fish samples

Chitosan was dissolved in acetic acid (1%) at two concentrations (0.5% and 1.0%). Gilthead sea bream fillets were cut into pieces of approximately 7.5×1.5 cm and these pieces were immersed into the following solutions at different treatments for 5 min: control containing only acetic acid (1%), 0.5% and 1% (w/v) chitosan. Then, samples were removed from the treatment solution, placed in sterile bags (Baglight, 20x25 cm, 400 ml, Interscience). Samples were stored in the refrigerator (approximately 1ºC) for 27 days. All analyses were performed in triplicate on days 0, 3, 6, 9, 12, 18, 21, 24 and 27.

Color measurements

Colorimetric measurements were taken according to the Calder [8] method. Sample color was measured using a portable Hunter Lab color analyzer (Hunter Associates Laboratory, Inc., Reston, VA, USA). Sensor was standardized with white and black tiles for the analysis. *L**, *a** and *b** values were recorded. The *L** variable represents lightness (*L**=0 for black, *L**=100 for white), *a** scale represents the red/green, +*a** intensity in red and -*a** intensity in green. *b** scale represents the yellow/blue, +*b** intensity in yellow and -*b** intensity in blue. Color was measured in three different parts of the fillet pieces, and then chroma and hue values were calculated.

Statistical analysis

The SPSS (SPSS Inc., Chicago, IL, USA) software was used for the statistical analysis. Comparisons among groups were made using one-way analysis of variance (ANOVA), and significant differences were determined by Duncan's multiple range tests at 5% confidence level.

RESULTS AND DISCUSSION

The color values as *L** (lightness/darkness), *a** (redness/greenness) and *b** (yellowness/blueness) of gilthead sea bream fillets treated with chitosan are shown in Table 1.

In the comparison of groups considering *L** value, indicating the brightness of fish fillets, *L** value of 1% chitosan added group was found significantly higher than those of other 2 groups except for the 6th day of storage ($p<0.05$). *L** value of 1% chitosan added gilthead sea bream fillets increased during storage, which verified the positive effect of chitosan obtained from shrimp shells on the color brightness of gilthead sea bream fillets. Contrary to the findings of this study, López-Caballero et al. [9] reported no significant difference ($p > 0.05$) in the lightness values between the fish sausages containing chitosan and the control sausages during the storage. the comparison of *a** values, no significant difference was observed among the groups during the initial days of storage; however, in the last 2 days of analysis (24th and 27th days), *a** value was found lower in 1% chitosan added group. In fact, the increase in *a** value in during cold storage indicated the progressing color and decreasing acceptability; for this reason, this value is demanded to be low in terms of freshness criteria [10]. As a result, the lowest *a** value was determined in 1% chitosan added group during storage, which was followed by 0.5% chitosan added group, and this clearly demonstrated the positive effect of chitosan on *a** value. Similar results were also obtained with meat samples containing chitosan [11].

During storage, *b** value was observed to increase in all groups and no significant difference was detected among groups in this regard ($p>0.05$). In a similar study, there was no significant difference ($p > 0.05$) in the *a** and *b** values of Atlantic salmon fillets among treatments on any day during the frozen storage [12]. In another study, there was no significant ($p > 0.05$) effect of chitosan coating on *a** and *b** values for cooked pink salmon fillets after 3 month frozen storage [13].

Chroma and hue values are given in Table 2. No significant difference was detected between the groups containing chitosan and control group considering these values ($p > 0.05$). Chroma and hue values increased in all groups during storage, except the group of control for hue value. No previous study was encountered about the chroma and hue value changes of gilthead sea bream fillets containing chitosan during refrigerated storage.

CONCLUSIONS

There is an increasing interest in food additives nowadays. Chitosan draws attention as a preservative substance in food industry due to its antioxidant and antimicrobial properties. This study investigated the effects of chitosan extracted from shrimp shells discarded in Turkey on color properties of gilthead sea bream, a highly perishable food, during refrigerated storage. These findings can be well utilized by researchers as well as manufacturers in the long-term storage of fish and fish products.

Table 1. *L**, *a** and *b** changes of gilthead sea bream fillets treated with chitosan during refrigerated storage

Days / Groups	1% Chitosan	0.5 % Chitosan	Control
L*			
0	56.84±2.55^{b}	56.10±4.16^{ab}	52.51±0.83^{a}
3	57.46±0.82^{c}	54.35±0.54^{b}	51.43±2.63^{a}
6	59.50±2.30^{a}	58.99±0.64^{a}	57.50±5.38^{a}
9	59.17±2.52^{b}	55.87±1.30^{a}	54.76±0.92^{a}
12	62.52±3.31^{b}	55.14±2.51^{a}	53.79±3.09^{a}
15	60.90±5.96^{b}	57.88±2.70^{ab}	54.21±1.58^{a}
18	61.43±3.78^{b}	55.37±1.39^{a}	52.77±2.43^{a}
21	67.17±4.73^{b}	56.59±1.58^{a}	56.14±1.97^{a}
24	66.72±4.45^{b}	57.43±2.10^{a}	56.03±1.76^{a}
27	64.73±2.85^{b}	54.53±3.75^{a}	52.92±2.53^{a}
a*			
0	-0.31±2.24^{a}	0.08±1.72^{a}	-0.40±2.74^{a}
3	-2.11±0.45^{a}	-1.10±0.85^{a}	-1.01±1.64^{a}
6	-0.67±2.33^{a}	-0.14±1.23^{a}	0.13±0.13^{a}
9	-0.63±1.57^{a}	-0.23±1.90^{a}	-0.55±1.52^{a}
12	-0.70±2.11^{a}	-0.23±1.48^{a}	0.61±1.94^{a}
15	-0.95±1.85^{a}	-0.84±0.84^{a}	1.15±2.38^{a}
18	0.71±0.97^{a}	1.10±2.44^{a}	2.07±0.34^{a}
21	-0.43±1.04^{a}	0.97±1.92^{a}	1.57±2.41^{a}
24	0.35±0.94^{a}	1.37±0.90^{ab}	2.52±1.84^{b}
27	0.53±1.52^{a}	2.78±0.56^{b}	3.06±1.29^{b}
b*			
0	7.49±1.63^{a}	5.97±0.80^{a}	5.94±1.51^{a}
3	5.84±0.11^{a}	6.19±0.79^{a}	7.62±0.73^{b}
6	8.16±2.05^{a}	9.89±0.51^{a}	8.30±2.67^{a}
9	8.54±1.92^{a}	8.63±2.50^{a}	9.08±2.33^{a}
12	9.80±2.49^{a}	8.93±1.97^{a}	8.85±1.13^{a}
15	8.80±2.17^{a}	7.51±1.16^{a}	9.94±2.29^{a}
18	12.00±0.97^{a}	10.43±2.76^{a}	11.74±1.86^{a}
21	10.72±1.47^{a}	10.73±2.05^{a}	11.07±2.59^{a}
24	11.87±2.07^{a}	12.21±0.89^{a}	11.94±0.78^{a}
27	12.71±1.53^{a}	12.49±2.02^{a}	12.40±2.48^{a}

Data are expressed as means ± standard deviation. Different letters within the row denote significant differences ($p < 0.05$).

Table 2. Chroma and hue values of gilthead sea bream fillets treated with chitosan during refrigerated storage

Days / Groups	1% Chitosan	0.5% Chitosan	Control
Chroma			
0	7.76±1.60[a]	6.16±0.83[a]	6.50±1.18[a]
3	6.22±0.24[a]	6.35±0.67[a]	7.83±0.72[b]
6	8.47±1.94[a]	9.95±0.47[a]	8.30±2.67[a]
9	8.67±1.93[a]	8.77±2.61[a]	9.19±2.35[a]
12	10.03±233[a]	9.04±1.87[a]	9.02±1.31[a]
15	9.03±2.03[a]	7.61±1.06[a]	10.16±2.66[a]
18	12.04±1.04[a]	10.65±3.05[a]	11.92±1.86[a]
21	10.78±1.42[a]	10.89±2.13[a]	11.33±2.88[a]
24	11.91±2.07[a]	12.31±0.93[a]	12.31±0.92[a]
27	12.79±1.57[a]	12.95±2.40[a]	13.02±2.98[a]
Hue			
0	-0.22±1.43[a]	-0.32±1.47[a]	0.42±1.25[a]
3	-1.22±0.06[a]	-1.38±0.15[a]	-0.18±1.52[a]
6	-0.21±1.43[a]	-0.29±1.60[a]	0.92±1.39[a]
9	-0.22±1.57[a]	-0.87±1.23[a]	-0.85±1.27[a]
12	-0.19±1.52[a]	0.36±1.56[a]	-0.36±1.53[a]
15	-0.79±1.22[ab]	-1.44±1.30[a]	0.23±1.58[b]
18	1.51±0.07[a]	0.24±1.54[a]	1.39±0.02[a]
21	-0.26±1.64[a]	0.24±1.55[a]	0.20±1.57[a]
24	0.92±1.32[a]	0.83±1.33[a]	0.73±1.26[a]
27	0.28±1.60[a]	1.37±0.17[a]	0.11±1.48[a]

Data are expressed as means ± standard deviation. Different letters within the row denote significant differences ($p < 0.05$).

REFERENCES

[1]Anonymous 2010. Fisheries Statistics. Aquaculture Production. State Institute of Statistics Prime Ministry Republic of Turkey.

[2]Knorr D. 1984. Use of chitinous polymers in food. Food Technology. 38(1): 85-97.

[3]Sandford PA. 2003. Commercial sources of chitin and chitosan and their utilization, in *Advances in Chitin Sciences*, Vårum, K.M., Domard, A., Smidsrød, O., Eds., NTNU Trondheim. 6: 35.

[4]Duman SS, Şenel S. 2004. Kitosan ve Veteriner Alandaki Uygulamaları. Veteriner Cerrahi Dergisi. 10(3-4): 62-72.

[5]Tsai GJ, Su WH, Chen HC, Pan CL. 2002. Antimicrobial Activity of Shrimp Chitin and Chitosan from Different Treatments and Applications of Fish Preservation. Fisheries Science 68: 170-177.

[6]Bostan K, Aldemir T, Aydın A. 2007. Kitosan ve Antimikrobiyal Aktivitesi. Türk Mikrobiyoloji Cemiyeti Dergisi. 37(2): 118-127.

[7]Chang KLB, Tsai G, Lee J, Fu W-R. 1997. Heterogenous *N*-deacetylation of Chitin in Alkaline Solution. Carbohydrate Research. 303: 327-332.

[8]Calder BL. 2003. The use of polyphosphates to maintain yield and quality of whole cooked, cryogenically frozen lobster (*Homarus americanus*) and the use of sorbitol and tocopherol to maintain quality of whole cooked, cryogenically frozen crab (*Cancer irroratus*). PhD Thesis, The University of Maine. USA.

[9]López-Caballero ME, Gómez-Guillén MC, Pérez-Mateos M, Montero P. 2005. A functional chitosan-enriched fish sousages induced by high pressure. Journal of Food Science. 70(3): 166–171.

[10]Schubring R, Meyer C. 2006. Ice Storage of Fish, New Aspects: Comparison Between Flake Ice and Stream Ice – Part I: Sardine (*Sardine pilchardus*). Deutsche Lebensmittel-Rundschau. 102(9): 405-415.

[11]Darmadji P, Izumimoto M. 1994. Effect of Chitosan in Meat Preservation. Meat Science. 38: 243-254.

[12]Hammond MD. 2004. The use of chitosan to preserve and extend Atlantic salmon quality. Master of Science in Food Science and Human Nutrition, The Graduate School, The University of Maine.

[13]Sathivel S. Himelbloom BH. 2005. Effects of chitosan on the quality of fish filet and fish oil. IFT Annual meeting, July 15-20-New Orleans. Louisiana.