GIDA (2014) 39 (2): 63-70
doi: 10.5505/gida.79188

Research / Araştırma

DETERMINATION of SOME QUALITY PROPERTIES and NUTRITIONAL COMPOSITION of TURKISH RAW MEAT BALL PRODUCED WITH MARINATED ATLANTIC BONITO

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Received / Geliş tarihi: 04.11.2013
Received in revised form / Düzeltilerek Geliş tarihi: 03.12.2013
Accepted / Kabul tarihi: 07.12.2013

Abstract

This study was carried out to determine sensory, chemical, microbiological quality properties and nutritional composition of the raw meat ball produced with marinated Atlantic bonito. The raw meat ball samples were separated into three groups: Group A-Atlantic bonito:bulgur (1:1), Group B- Atlantic bonito:bulgur (2:1) and the control group-without Atlantic bonito. It was determined that B, A and K groups were spoiled in terms of sensory characteristics during storage period of 8 days at 4 °C; at days 4, 6 and 8, respectively. When microbiological analysis and TVB-N values stayed within acceptability limit values during storage, TBA values exceeded acceptability limit values at day 2 of the storage in the A and B groups (P<0.05). The highest mean crude protein, crude lipid, moisture and crude ash contents were found in the B group, when the highest energy value was found in the A group.

Keywords: Turkish raw meat ball (cig kofte), marinated atlantic bonito, nutritional composition

MARİNE EDİLMİŞ PALAMUT ile YAPILAN ÇİĞ KÖFTENİN BAZI KALİTE ÖZELLİKLERİ ve BESİN KOMPOZİSYONUNUN BELİRLENMESİ

Özet

Bu çalışmada, marine edilmiş palamut ile yapılan çiğ köftenin duyusal, kimyasal, mikrobiyolojik özellikleri ile besin kompozisyonu belirlenmeye çalışılmıştır. Yalnızca bulgur ve katkı maddeleri içeren (palamut ilavesiz) grup (K), 1:1 palamut:bulgur oranı içeren grup (A) ve 2:1 palamut:bulgur oranı içeren grup (B) olmak üzere 3 grup oluşturulmuştur. 4 °C'de 8 günlük depolama süresince B grubunun 4. günde, A grubunun 6. günde ve K grubunun 8. günde duyusal açıdan bozulduğu tespit edilmiştir. Depolama süresince mikrobiyolojik analiz değerleri ile TVB-N değeri tüketilebilirlik sınır değerleri içerisinde kalırken, TBA değerleri A ve B gruplarında depolamanın 2. günü tüketilebilirlik sınır değerlerini aşmıştır (P<0.05). En yüksek ortalama protein, yağ, nem ve kül değerleri B grubunda, enerji değeri ise A grubunda belirlenmiştir.

Anahtar kelimeler: Çiğ köfte, marine palamut, besin kompozisyonu

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INTRODUCTION

Raw meat ball (cig kofte) is a traditional food that is consumed in Turkey and particularly in Eastern and Southeastern Anatolia. In general, the raw meat ball is produced by kneading finely ground lean mutton or beef, with a mixture of bulgur, tomato or red pepper paste, chili pepper, black pepper, onion, parsley, salt and cinnamon, cumin, mint, garlic (depending on consumer demand) with water or ice (1). Main component of the raw meat ball is minced raw meat. The mixture is minced, and its consistency is adjusted with the addition of water. This mixture is manually formed into meat balls, and meatballs are served with vegetables such as lettuce. In general, the raw meat ball is produced and consumed daily in traditional restaurants and houses. In our country, there is no specific standard for the composition and ingredients of raw meat ball (2). Depending on consumer demand, amount and kind of the ingredients and also the rates of minced meat and bulgur may differ. The raw meat ball contains microorganisms that contaminate through air, employees, the food additives and water or through the equipment that is used for production and it also contains some microorganisms in the minced meat and bulgur (3, 4). This case causes the fact that the raw meat ball has a short shelf life because of high microbial load at production (5). It is suggested that, raw meat ball should be consumed within a few hours after preparation. However, it is stated that commercially produced raw meat ball is kept for a longer time and it may be served in market shelves or several point of sales after storage in a refrigerator for 24 h (6). Quality of the raw meat ball is closely related with quality properties of used minced meat and other ingredients (3). In particular, the minced meat considerably affects microorganism flora of the raw meat ball (7).

Almost all present studies related with raw meat ball are to investigate microbiological quality of the raw meat ball (4, 7-11). In addition, there is just one study related with raw meat ball made from fish meat. Yet, in that study fish meat was used after cooking (12).

Preparing raw meat ball from marinated Atlantic bonito (*Sarda sarda*, Bloch 1793) instead of raw minced meat was investigated for the first-time with this study. The aims of this research were to determine sensory, chemical, microbiological quality properties and nutritional composition of the raw meat balls produced with marinated Atlantic bonito.

MATERIALS AND METHODS

Raw Material

Fresh Atlantic bonito (Sarda sarda, Bloch 1793) were purchased from a fisherman in Sinop. They were transferred to the laboratory in a polystyrene box with crushed ice within 30 min. In total, 8.5 kg of Atlantic bonito with an average length of 38.42±0.45 cm and average weight of 617.36±23.02 g were used.

Marination and Preparation of Raw Meat Ball

Atlantic bonito were headed, gutted, sliced (thickness 3-4 cm), washed and waited in ice water for 1 h. Atlantic bonito were taken out from the ice water and immersed into marination solution containing salt and acetic acid (10 g salt:4 mL glacial acetic acid to 100 mL water). The rate of Atlantic bonito:solution was 1:1.5 and it was marinated for 12 days at 4±1 °C. Optimum ripening level of the fish for making raw meat ball was determined by sensory analyses that were done on certain days. Also, pH values of the fish meat and temperature of the solution were monitored.

The raw meat ball samples were separated into three groups: Group A- Atlantic bonito:bulgur (1:1), Group B- Atlantic bonito:bulgur (2:1) and the control group-without Atlantic bonito. Formulation for making the control group (K) raw meat ball was determined as following: 54.05% bulgur, 23.78% water, 4.86% onion, 3.78% raw meat ball mix (Bagdat Traditional Cig Kofte Mix, irradiated), 3.57% chili pepper (irradiated), 3.89% hot pepper paste, 2.59% tomato paste, 1.73% red pepper (irradiated), 1.2% sunflower oil and 0.54% salt. All ingredients were kneaded by hand in a large case for 40 min. The marinated Atlantic bonito (for 12 days) were drained, skinned and separated into small pieces by hand. 27.02% bulgur+27.02% marinated Atlantic bonito and 18.01% bulgur+36.04% marinated Atlantic bonito were used for the A and B groups raw meat

balls, respectively. Other ingredients and spices were used at the same rate with the control group (K). The A and B groups raw meat balls were kneaded by hand in large case for 40 min, too. Small pieces were taken apart from raw meat ball mix and given typical raw meat ball shape by hand. Sterile latex gloves were used in all stages that were made by hand such as separating into pieces, kneading and giving shape.

Packaging and Storage

The K, A and B groups raw meat balls were placed into polystyrene plates (MOD-16A, Polystyrene, White, AB.10037, 20x30 cm) and wrapped in stretch film (Sera stretch film, 33 m, 06291-01). These raw meat balls were as 10-12 pieces, approximately 225-235 g weight and were taken to the store at 4±1 °C. All analyses were carried out in triplicate. For each sampling day, two random packages from each group were analyzed.

Analyses

Biochemical Composition

Crude protein, crude lipid and crude ash analyses were carried out according to AOAC methods (13). Moisture content was determined by the method of Ludorf and Meyer (14). The carbohydrate value was calculated by [Carbohydrate value = 100 - (Moisture + Protein + Lipid + Ash] formula and then, the energy value was calculated according to Atwater method:

[Energy (kcal/100 g) = (Lipid * 9) + (Protein * 4) + (Carbohydrate * 4)] (15).

Total Volatile Basic Nitrogen (TVB-N) Value

Total volatile basic nitrogen (TVB-N) was determined according to method of Lucke and Geidel modified by Antonacopoulas (16).

Thiobarbituric Acid (TBA) Value

Thiobarbituric acid (TBA) was determined according to Tarladgis et al. (17).

pH Value

pH analysis was carried out with the instrument Werkstatten 82362 Weilheim, Germany, according to Curran et al. (18).

Microbiological Analysis

Microbiological analyses were made according to Baumgart (19). 10 g of fish sample was taken, transferred into 90 mL sterile Physiological Saline Solution (0.85%) and then homogenized in a homogenizer (IKA Yellow Line DI 25 Basic). From the 10-1 dilution, other decimal dilutions were prepared and inoculated. Plate Count Agar was used as medium for total mesophilic aerobic bacteria and psychrophilic bacteria counts, petri dish were incubated at 28 °C for 3 days and 4±1 °C for 10 days, respectively. For total yeast-mold count, Potato Dextrose Agar was used as medium and petri dish were incubated at 28 °C for 3 days. To count coliform bacteria, Violet Red Bile Agar was used as medium and petri dish were incubated at 35 °C for 24 h.

Sensory Analysis

Trained panelists (six men and four women) attended to sensory analysis. Samples were served to the panelists for evaluation of flavor, odor, general appearance, texture and color. Scoring was made by using scores between 0-10 according to 'hedonic scale'. In this evaluation, scores between 10 and 8 were accepted as 'very good' , 8 and 6 were accepted as 'good', 6 and 5 were accepted as 'middle' and the scores lower than 5 were accepted as 'spoiled' samples (20).

Statistical Analysis

The Minitab 15 (Minitab Inc. USA) program was used to search for significant differences among mean values of different results. Differences between means were analyzed by one-way analysis of variance (ANOVA). The results are presented as mean±SE. The P value (P<0.05) was used to determine significant differences.

RESULTS and DISCUSSION

Biochemical Analysis

Nutritional compositions of raw, marinated Atlantic bonito and raw meat balls are presented in Table 1. Protein, lipid, moisture, ash, carbohydrate and energy values of the fresh Atlantic bonito was found as 24.26%, 6.80%, 68.04%, 1.35%, 0.9% and 161.86 kcal/100 g, respectively. These values were observed as 23.93%, 9.34%, 60.35%, 5.02%, 6.39% and 205.3 kcal/100 g after the marination process, respectively. When differences between the protein and

Table 1. Chemical analysis results of the raw meat ball produced with marinated Atlantic bonito.

Days				0	2	4	6	8
pH/Temperature (°C)	R	5.62±0.04[a] 25.1 °C	K	5.58±0.01[a] 23.6 °C	5.48±0.03[a] 22.8 °C	5.55±0.01[a] 23.7 °C	5.58±0.01[a] 23.5 °C	5.51±0.01[a] 23.2 °C
	M	3.84±0.02[b] 23.4 °C	A	4.27±0.00[b] 23.2 °C	4.30±0.02[b] 22.3 °C	4.30±0.01[b] 22.3 °C	4.28±0.00[b] 22.9 °C	4.27±0.01[b] 23.7 °C
			B	4.12±0.03[c] 23.6 °C	4.21±0.05[b] 22.3 °C	4.19±0.02[c] 23.1 °C	4.19±0.01[c] 23.5 °C	4.15±0.01[c] 23.2 °C
TVB-N (mg/100 g)	R	16.08±1.74[a]	K	13.63±0.21[a]	13.87±0.00[a]	13.09±0.77[a]	9.78±0.02[a]	13.96±0.02[a]
	M	8.37±1.12[a]	A	15.91±0.70[a]	18.71±0.57[b]	19.58±0.00[b]	17.40±0.47[b]	17.77±1.28[a]
			B	16.24±1.22[a]	16.92±0.64[a]	14.98±1.62[a]	16.68±0.06[b]	12.33±5.47[a]
TBA (mg MA/kg)	R	1.57±0.04[a]	K	0.52±0.03[a]	0.43±0.00[a]	0.65±0.15[a]	0.43±0.01[a]	0.37±0.01[a]
	M	2.84±0.77[a]	A	1.01±0.00[b]	9.50±0.13[b]	11.97±0.20[b]	19.22±0.23[b]	25.99±5.21[b]
			B	0.93±0.01[b]	18.58±0.01[c]	22.78±0.36[c]	23.07±0.03[c]	24.84±0.39[b]

Values are shown as mean ± standard error of triplicates.
a,b… (↓) The difference between the groups with different letters is important (P<0.05).
R: Raw; M: Marinated; K: Control group (without Atlantic bonito); A: Atlantic bonito/bulgur (1:1); B: Atlantic bonito /bulgur (2:1).

carbohydrate values of the raw and marinated Atlantic bonito were not found significant (P>0.05), differences among the fat, moisture, ash and energy values were found significant (P<0.05).

Decrease in protein rate of the raw meat ball was a proportional decrease arising from the fish amount and the addition of other ingredients. The highest crude protein values were determined in the B, A and K groups, respectively. Similar changes were also seen in lipid rates for the same reasons (Table 1). The moisture content of the raw meat ball increased when the used fish amount increased. The highest and lowest energy values were found in the A and B groups, respectively. It might be thought that the energy value of marinated Atlantic bonito as 205.3 kcal/100 g arising from proportional increase occurred in carbohydrate amount depending on water loss. Yildirim et al. (21) reported that in their study crude protein and crude lipid values of raw meat ball were 7.44 g/100 g and 2.62 g/100 g, respectively. These results are similar to our findings. In one study made by Durmaz et al. (11) moisture content of raw meat ball was detected between 54-62%. Sagun and Alisarli (23) reported that initial moisture value of raw meat ball was 58% and these values were 54%, 51% and 45% at the end of the storage at 10 °C, 21-23 °C and 30 °C, respectively.

Mean crude ash values of the K, A and B groups raw meat balls were determined as 2.29, 4.31 ve 4.62, respectively. There haven't been any studies so far related with the investigation of crude ash and energy values of raw meat ball.

Chemical Analysis

Chemical analysis results of the raw meat balls are given in Table 2. According to the table, the lowest and highest pH values of the raw meat ball produced with marinated Atlantic bonito were 4.12 and 4.30, respectively. These values were observed as 5.48-5.58 in the control group.

Although the raw meat ball is a product produced with raw minced meat, it is mostly consumed as meat free nowadays. Uzunlu and Yildirim (8) stated that the ingredients that are used to make raw meat ball do not decrease the pH value of meat to the values that can prevent bacteria growth (4.5 and lower values). It is shown in the present study that the above-mentioned decrease in the value can be provided by using marinated fish. It was thought that used acetic acid in the marination process was responsible for this case. In the previous studies, irradiated raw meat balls (purchased from a local restaurant) at 0, 2, 4 and 7 kGy, pH values were detected as 4.37, 4.41, 4.41 and 4.40, respectively (21). In our study, the pH values of the raw meat ball produced with marinated Atlantic bonito were found lower in comparison to the values of irradiated raw meat balls.

TVB-N values of the control group were almost constant, when compared to the values of the A and B groups during storage. TVB-N value of the marinated Atlantic bonito was determined as 8.37 mg/100 g, when the value was 16.08 mg/100 g for the fresh fish. TVB-N values of the A and B groups raw meat balls showed significant differences (P<0.05) just at days 2 and 3 of the storage, not for other days (P>0.05).

Table 2. Biochemical composition of the raw meat ball produced with marinated Atlantic bonito.

Days				0	2	4	6	8
Crude Protein (%)	R	24.26±0.35[a]	K	8.99±0.56[a]	9.86±0.14[a]	8.56±0.16[a]	9.20±0.01[a]	9.53±0.57[a]
	M	23.93±3.07[a]	A	14.61±0.54[b]	15.01±0.18[a]	15.23±0.27[b]	15.93±0.58[b]	15.87±0.01[b]
			B	16.75±0.14[c]	14.03±1.81[a]	16.74±0.42[c]	17.29±0.56[b]	17.04±0.42[b]
Crude lipid (%)	R	6.80±0.12[a]	K	2.89±0.02[a]	3.09±0.07[a]	3.60±0.82[a]	4.31±0.09[a]	3.88±0.22[a]
	M	9.34±0.18[b]	A	7.55±0.27[b]	7.03±0.02[b]	7.24±0.17[b]	8.53±0.12[b]	7.94±0.78[b]
			B	8.63±0.12[c]	9.08±0.35[c]	8.46±0.33[b]	9.98±0.33[c]	9.57±0.38[b]
Moisture (%)	R	68.04±0.11[b]	K	48.53±0.41[a]	48.15±0.12[a]	48.67±0.26[a]	47.23±0.39[a]	47.03±0.67[a]
	M	60.35±0.54[a]	A	48.74±0.39[a]	47.63±0.26[a]	47.70±0.09[b]	46.36±1.65[a]	47.95±0.53[a]
			B	51.56±0.22[b]	52.42±0.11[b]	52.06±0.17[c]	52.58±0.28[b]	50.92±0.13[b]
Crude ash (%)	R	1.35±0.02[a]	K	2.37±0.04[a]	1.56±0.06[a]	1.66±0.03[a]	2.53±0.05[a]	2.29±0.01[a]
	M	5.02±0.08[b]	A	4.56±0.07[b]	4.59±0.02[b]	4.60±0.06[b]	3.90±0.06[b]	3.92±0.02[b]
			B	4.94±0.09[c]	4.67±0.02[b]	4.95±0.11[c]	4.25±0.15[b]	4.30±0.03[c]
Carbohydrate (g/100 g)	R	0.90±0.34[a]	K	39.60±0.17[a]	38.91±0.10[a]	39.18±0.41[a]	39.26±0.49[a]	39.56±1.56[a]
	M	6.39±2.36[a]	A	29.11±1.20[b]	30.52±0.23[b]	29.84±0.53[b]	29.48±2.39[b]	28.25±0.24[b]
			B	23.07±0.25[c]	24.48±1.57[c]	22.75±0.25[c]	20.16±0.61[c]	22.48±0.92[c]
Energy (kcal/100 g)	R	161.86±0.56[a]	K	220.31±1.72[a]	222.87±0.81[a]	223.34±5.12[a]	232.63±1.11[a]	231.28±1.58[a]
	M	205.3±1.27[b]	A	242.77±0.24[b]	244.65±0.92[b]	245.40±0.49[b]	257.19±7.18[b]	247.88±6.00[a]
			B	236.89±1.46[c]	235.70±2.17[c]	234.08±2.31b[a]	239.60±2.75[c]	244.17±1.38[a]

Values are shown as mean ± standard error of triplicates.
a,b... (↓) The difference between the groups with different letters is important (P<0.05).
R: Raw; M: Marinated; K: Control group (without Atlantic bonito); A: Atlantic bonito /bulgur (1:1); B: Atlantic bonito /bulgur (2:1).

There haven't been any studies investigating TVB-N value of the raw meat ball in the literature. However, it was reported that TVB-N analyses did not give a direct result in marinade type products, results of the analysis found quite lower than the limit values and also the changes were not stabile. As a main reason for this case; it was shown that acidic structure of environment stopped several enzymatic and microbiological activities that were responsible for product spoilage (22). Our findings in the analyses support these statements.

TBA values of the A and B groups and of the control group, changed between 0.37-0.65, 1.01-25.99 and 0.93-24.84 mg MA/kg during storage, respectively.

TBA values of the fresh and marinated Atlantic bonito were found as 1.57 and 2.84 mg MA/kg, respectively. It was observed that these values increased considerably in the A and B groups raw meat balls during storage. Yildirim et al. (21) reported that TBA values of raw meat balls that were irradiated at 0, 2, 4 and 7 kGy were 0.43, 0.44, 0.53 and 0.60 mg MA/kg, respectively. These values were quite lower than the TBA values in the present study. In our study, it might be thought that several potential chemical reactions arising from combination of the marinated fish with used ingredients and extreme hot spices were responsible for high TBA values. However, when initial TBA value (2.84 mg MA/kg) of the marinated fish was considered, it might be said that used salt in the marination contributed to the increase in the TBA values.

Microbiological Analysis

Changes in microbiological count of the samples are given in Table 3. Considering microbiological analysis results, it was observed that acceptability limit value was not exceeded in all the groups.

It was seen that marination process decreased microbiological load significantly (P<0.05) (Table 3). In psychrophilic bacteria count, a significant increase (P<0.05) was observed for the marinated Atlantic bonito that were stored at 4 °C during marination. It might be said that this increase resulted from suitable environment conditions for psychrophilic bacteria growth depending on storage in refrigeration conditions. At the end of the storage, total mesophilic and psychrophilic bacteria counts of the raw meat balls were the lowest, while total yeast-mold count was the highest in the B group containing more fish. Moisture content increased because of using higher amount of the marinated fish, so suitable environment conditions were provided for yeast-mold growth.

Table 3. Microbiological analysis results of the raw meat ball produced with marinated Atlantic bonito (log cfu/g).

Days				0	2	4	6	8
Total Mesophilic Bacteria	R	4.08±0.06[a]	K	3.02±0.04[a]	3.24±0.04[a]	3.56±0.08[a]	3.67±0.12[a]	3.74±0.07[a]
	M	3.25±0.05[b]	A	2.87±0.08[a]	3.01±0.04[a]	3.95±0.05[a]	3.95±0.03[a]	4.21±0.09[b]
			B	2.78±0.07[a]	2.87±0.10[a]	3.75±0.58[a]	3.84±0.05[a]	4.10±0.07b[a]
Total Psychrophilic Bacteria	R	1.81±0.04[a]	K	1.44±0.05[a]	1.62±0.08[a]	2.58±0.34[a]	2.76±0.28[a]	3.23±0.38[a]
	M	2.27±0.03[b]	A	1.48±0.18[a]	1.86±0.02[a]	1.91±0.01[a]	2.15±0.15[a]	2.93±0.01[a]
			B	1.72±0.13[a]	1.73±0.23[a]	2.12±0.02[a]	2.25±0.04[a]	2.28±0.04[a]
Total Coliform Bacteria	R	2.67±0.01	K	<1	<1	<1	<2	<2
	M	<1	A	<1	<1	<1	<2	<2
			B	<1	<1	<1	<2	<2
Total Yeast and Mold	R	3.15±0.00[a]	K	2.79±0.21[a]	2.98±0.01[a]	3.54±0.15[a]	3.48±0.03[a]	3.60±0.01[a]
	M	2.37±0.13[b]	A	2.77±0.03[a]	3.64±0.31[a]	3.73±0.25[a]	4.11±0.19[b]	3.82±0.16[a]
			B	2.70±0.07[a]	3.34±0.00[a]	3.93±0.00[a]	4.14±0.06[b]	4.75±0.06[b]

Values are shown as mean ± standard error of triplicates.
a,b... (↓) The difference between the groups with different letters is important (P<0.05).
R: Raw; M: Marinated; K: Control group (without Atlantic bonito); A: Atlantic bonito /bulgur (1:1); B: Atlantic bonito /bulgur (2:1).

Baygar et al. (12) reported that the raw meat balls with cooked fish in the modified atmosphere packed groups and in the control group spoiled microbiologically at day 7 and 11, respectively.

Microbiological qualities of raw meat balls largely depended on microflora of raw minced meat. Additionally, several ingredients such as spices, salt, bulgur, onion, paste, garlic and parsley used for obtaining raw meat ball were an important contamination source (3). Vural et al. (9) stated that total mesophilic aerobic bacteria count was 6.32 log cfu/g for control group, when it was 5.47, 4.60, 3.21 log cfu/g irradiated at 1, 2 and 3 kGy raw meat balls. In the same study, total yeast-mold counts were 4.77, 3.42 and 2.38 log cfu/g in the control group, irradiated at 1 kGy and 2 kGy samples, respectively. Also it was stated that any yeast-mold were not encountered in the samples irradiated at 3 kGy. Coliform count that was initially 3.13 log cfu/g increased to 2.36 log cfu/g after irradiation at 1 kGy and there was not any growth for the 2 and 3 kGy ones. Uzunlu and Yildirim (8) reported that total mesophilic aerobic bacteria and yeast - mold counts changed between 6.54-6.95 log cfu/g and 3.53-4.45 log cfu/g during 24 h storage of raw meat ball, respectively. Sancak and Isleyici (4) determined that mean total mesophilic aerobic bacteria, coliform group microorganisms, yeast-mold counts were 6.40, 4.17 and 4.44 log cfu/g for raw meat ball purchased from costers in Van province, respectively. Another study investigating microbiological qualities of raw meat balls reported that hygienic qualities of them were low and an adequate assurance was not provided in terms of public health (24). It was stated that even if the raw materials were chosen carefully and they were produced and stored hygienically, the risks arising from the potential contamination of raw meat and spices were not eliminated totally, so a long shelf life was not provided for the product (5).

In the present study, earlier spoilage of the B group containing the higher amount of marinated fish might because of the fact that fish is one of the most perishable food products. Although the TBA value exceeded acceptability limit value at day 2 in the A and B groups, this increase was not detected in terms of sensory properties.

Sensory Analysis

According to sensory analysis results of the raw meat ball produced with marinated Atlantic bonito, shelf life of the B, A and K groups were determined as 4, 6 and 8 days, respectively. Effect of storage time on flavor, odor, general appearance, color and texture scores was found significant (P<0.05) (Table 4).

Some researchers (26, 27) reported several relations between TBA and sensory evaluation; but some other researchers did not find any correlation (28). Hence, interpretation of TBA values in the sensory quality measurements was necessary (29). It was thought that combination of typical extreme hot flavor of the raw meat ball with sourish flavor of the marinated fish concealed undesirable odor and flavor characteristics due to aldehydic secondary reaction products.

Table 4. Sensory evaluation of the raw meat ball produced with marinated Atlantic bonito.

Days				0	2	4	6	8
Flavor	R	*	K	9.2± 0.37[a]	8.4±0.68[a]	7.0±0.00[a]	6.4±0.24[a]	5.2±0.20
	M	10±0.00	A	9.4±0.24[a]	9.2±0.37[a]	7.2±0.58[a]	4.8±0.20[b]	*
			B	9.2±0.37[a]	9.2±0.49[a]	4.2±0.20[b]	*	*
Odor	R	9.8±0.20a	K	9.6±0.24[a]	8.6±0.51[a]	7.2±0.20[a]	6.0±0.00[a]	3.8±0.73
	M	9.6±0.24a	A	9.2±0.20[a]	9.6±0.24[a]	7.8±0.58[a]	5.2±0.20[b]	*
			B	9.8±0.20[a]	8.4±0.24[a]	3.2±0.37[b]	*	*
Appearance	R	10±0.00a	K	9.4±0.40[a]	8.8±0.58[a]	7.0±0.00[a]	5.2±0.20[a]	3.8±0.73
	M	10±0.00a	A	9.8±0.20[a]	9.2±0.37[a]	8.2±0.37[b]	3.8±0.20[b]	*
			B	9.8±0.20[a]	9.2±0.20[a]	3.6±0.24[c]	*	*
Texture	R	10±0.00a	K	9.2±0.37[a]	8.4±0.51[a]	6.4±0.24[a]	6.4±0.24[a]	4±0.84
	M	10±0.00a	A	9.6±0.24[a]	9.6±0.24[b]	7.2±0.58[a]	3.6±0.24[b]	*
			B	9.6±0.24[a]	9.6±0.24[b]	2.6±0.24[b]	*	*
Color	R	10±0.00a	K	9.2±0.37[a]	8.4±0.68[a]	7.0±0.32[a]	6.0±0.32[a]	4.0±0.84
	M	10±0.00a	A	10±0.00[b]	9.8±0.20[a]	7.6±0.51[a]	3.4±0.24[b]	*
			B	10±0.00[b]	9.4±0.24[a]	3.6±0.24[b]	*	*

Values are shown as mean ± standard error of triplicates.
a,b... (↓) The difference between the groups with different letters is important (P<0.05).
R: Raw; M: Marinated; K: Control group (without Atlantic bonito); A: Atlantic bonito /bulgur (1:1); B: Atlantic bonito /bulgur (2:1); * not analyzed.

Comprehensive sensory analyses were not encountered in any of the studies related with raw meat ball. However, Baygar et al. (12) packaged raw meat ball produced with cooked trout with two different modified atmospheres and investigated their shelf life. Accordingly, it was stated that control group and other two groups were spoiled after day 5 and 9 in terms of sensory properties, respectively. It might be thought that, difference was arising from used fish species, applied processes and packaging methods in our study. In another study, irradiated raw meat balls were evaluated in terms of odor and color (25).

CONCLUSION

It was seen that, the marinated Atlantic bonito might be a raw material of for raw meat ball that is consumed with or without meat in Turkey. With the usage of marinated Atlantic bonito instead of raw minced meat (red meat) to produce the raw meat ball, an extended shelf life was obtained in terms of sensory and microbiological properties. If fish is used to obtain the raw meat ball, it might be said that the ratio of Atlantic bonito:bulgur (1:1) is the most suitable one in terms of the shelf life. In addition, control group which didn't contain any fish had the longest shelf life.

REFERENCES

1. Ocal MH. 1997. Properties and Beauty of our Raw Meat ball. Ozlem Bookstore, Sanliurfa. p 158.

2. Cetin O, Dumen E, Bingol EB. 2008. Raw meat ball and some quality properties. *Academic Food,* 6 (3): 49-53.

3. Sagun E, Sancak YC, Durmaz H, Akkaya L. 1997. A research on hygienic qualities of raw meat balls marketed in Van province. *Yuzuncu Yil Univ J Health Sci,* 3: 64.

4. Sancak YC, Isleyici O. 2006. A research on microbiological quality of raw meat balls. *Yuzuncu Yil Univ J Vet Fac,* 17 (1-2): 81-86.

5. Gezgin Z, Gunes G. 2004. Providing microbial safety of raw meat ball with irradiation method. Traditional Food Symposium, 16-17 September, Van, Turkey.

6. Uzunlu S. 2002. Microbiological quality of raw meat ball and investigation of microbial variation at the different storage time and temperature. Ph.D. Dissertation, Akdeniz University, Turkey, 64 p.

7. Vural A, Yesilmen S. 2003. A study on microbiological quality of raw meat ball sold in Diyarbakir. *J Turk Microbiol Assoc,* 33: 350-355.

8. Uzunlu S, Yildirim I. 2003. Microbiological quality of raw meat ball and investigation of microbial variation at different storage time and temperature. *Food*, 28(5): 553-558.

9. Vural A, Aksu H, Erkan ME. 2006. Low dose irradiation as a measure to improve microbiological quality of Turkish raw meat ball (cig kofte). *Int J Food Sci Technol*; 41: 1105-1107.

10. Dogan M, Cankurt H, Toker OS, Yetim H, Sagdic O. 2012. Effect of yoghurt or yoghurt serum on microbial quality of cig kofte. *J Food Sci Technol*. DOI 10.1007/s13197-012-0649-4.

11. Durmaz H, Sagun E, Sancak H, Sagdic O. 2007. The fate of two *Listeria monocytogenes* serotypes in 'cig kofte' at different storage temperatures. *Meat Sci*; 76: 123-127.

12. Baygar T, Erkan N, Mol S, Ozden O, Ucok D, Yildirim Y. 2008. Determination of the shelf life of trout (*Oncorhynchus mykiss*) raw meatball that packed under modified atmosphere. *Pak J Nutr*, 7(3): 412-417.

13. AOAC. 1980. Official methods of analysis. 13th Edition, Washington, DC, USA.

14. Ludorf W, Meyer V. 1973. Fishe und fisherzeuge. Z.Auflage. Verlag Paul Parey In Berlin und Hamburg, pp. 209-210.

15. Falch E, Overrien I, Solberg C, Slizyte R. 2010. Composition and calories. In: Seafood and Seafood Product Analysis, Toldrá F and Nollet LML (eds), Part III, CRC Press, pp. 257-288.

16. Hall GM. 1992. Fish Processing Technology. Blackie Academic Professional, NY, USA.

17. Tarladgis BG, Watts BM, Younathan MT, Dugan L. 1960. A distillation method for the quantitative determination of malonaldehyde in rancid foods. *J Am Oil Chem Soc*, 37: 44-48.

18. Curran CA, Nicoladies L, Poulter RG, Pors J. 1980. Splipidage of fish from Hong Kong at different storage temperatures. *Trop Sci*, 22: 367-382.

19. Baumgart J. 1986. Microbiologische untersuchung von lebensmittel. Behr's verlag. B.Behr's GmbH. Co., Hamburg, 76 p.

20. Amerina MA, Angborn RB, Roessler EB. 1965. Principles of Sensory Evaluation of Food. Academic Press, NY, USA.

21. Yildirim I, Uzunlu S, Topuz A. 2005. Effect of gamma irradiation on some principle microbiological and chemical quality parameters of raw Turkish meat ball. *Food Control*, 16: 363-367.

22. Ozden O, Baygar T. 2003. The effect of different packaging methods on some quality criteria of marinated fishes. *Turk J Vet Anim Sci*, 27(4): 899-906.

23. Sagun E, Alisarlı M, Durmaz H. 2003. Effect of different temperatures storage on *Staphylococcus aureus* growth and enterotoxin production in raw meat ball. *Turk J Vet Anim Sci*, 27: 839-845.

24. Arslan A, Guven A, Saltan S, Patir B. 1992. The microbiological quality of raw meat balls in Elazig. *J Firat Univ Health Sci*, 6: 6-13.

25. Gezgin Z, Gunes G. 2007. Influence of gamma irradiation on growth and survival of *Escherichia coli* O157:H7 and quality of cig kofte, a traditional raw meat product. *Int J Food Sci Technol*, 42: 1067-1072.

26. Hoyland DV, Taylor AJ. 1991. A review of the methodology of the 2-thiobarbituric acid test. *Food Chem*, 40: 271-291.

27. Raharjo S, Sofos JN, Schmidt GR. 1993. Solid phase acid extraction improves thiobarbituric acid method to determine lipid oxidation. *J Food Sci*, 58: 921-924, 932.

28. Boyd LC, Green DP, Giesbrecht FB, King MF. 1993. Inhibition of oxidative rancidity in frozen cooked fish flakes by tert-butylhydroquinone and rosemary extract. *J Sci Food Agri*, 61: 87-93.

29. Huss HH. 1995. Quality and Quality Changes in Fresh Fish. FAO Fishery Technic, Roma, Italy, 195 p.