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Determining Shelf Life in Refrigerator Conditions of Marinated Meat ball Produced with Smoked Bonito (*Sarda sarda,* Bloch 1793)

Nilgün KABA[a,1] (nilguneri1@hotmail.com)
Bengünur ÇORAPCI[a] (bsoyleyen@sinop.edu.tr)
Şennan YÜCEL[a] (sennanyücel@hotmail.com)
Kübra ERYAŞAR[a] (eryasarkubra@hotmail.com)

[a]*Sinop University, Faculty of Fisheries, Fish Processing Technology Department, 57000 Akliman-Sinop, Turkey*

Abstract - In this study, fish meat ball produced with smoked bonito was marinated after frying and it was aimed determination of shelf life in refrigeration conditions (4ºC). Analyses were performed at 15 day intervals in samples. Total mesophilic aerobic bacteria (TMAB), yeast-mold (YM) counts of meat balls increased from 4.08 log cfu/g, 3.85 log cfu/g to 5.08 log cfu/g, 4.98 log cfu/g and coliform bacteria (CB) count of meat balls decreased from 2.48 log cfu/g to 1.3 log cfu/g on day 150, respectively. Total volatile basic nitrogen (TVB-N), thiobarbituric acid (TBA), trimethyl-amine nitrogen (TMA-N) values and pH values of meat balls were 7.8 mg/100 g, 0.57 mg MA/kg, 2.02 mg/100 g and 4.8 at the beginning and 14.00 mg/100 g, 2.82 mg MA/kg, 5.02 mg/100 g and 3.85 at the end of the storage period (at day 150), respectively. According to sensory analysis results of the shelf life of meat balls was determined to be 135 days in refrigerated conditions. Effect of storage on values of TMAB, TYM, TCB, TVB-N, TBA, TMA-N, pH and sensory scores was found significant ($p<0.05$).

Keywords *- Bonito, Meat ball, Smoked, Marinated, Shelf life*

1. Introduction

Nowadays, due to advancing technology sea products are being ready to consume by processing and packaging in various ways like other foodstuff. This situation both offers innovation to taste and provides consumption of delicious and nutritive foodstuff by less time and energy (Varlik et al. 2000). In seafood processing technology with a fine planning are improving reliable, economic and suitable to expectation of consumers products (Berik

[1]***Corresponding Author***

and Kahraman, 2010). Especially, smoking, marination and frying are common among the seafood processing techniques (Colakoglu, 2004). In smoking technology the objective was long-term preservation of products anciently, but nowadays is improving of sensory characteristics of products by utilizing of smoke aroma and color.

Main principle in smoking technology is removing a part of water content of fish and inhibition growing of microorganisms by providing transition of bactericid substance in smoke to fish (Gulyavuz and Unlusayın, 1999, Kaba et al. 2009). Marinades are products that are obtained by ripening in acetic acid and salt solution of fish without heat treatment application. They are packaged in glass bottles and plastic cases after addition of sugar, spices, brine, sauce and vegetables for obtaining different flavors (McLay, 1972). Besides, fresh and frozen fish or parts of fish by frying in oil are coated with brine or sauces (Meyer, 1965, Kilinc and Cakli, 2004). Flesh of fish may be served in tables in various types. Proceessed fish products are being desired especially in hotels and restaurants due to their different aromas and alternatives. Fish meat ball is one of the these products (Oksuztepe et al. 2010). In fish meat ball producing are preferred using of fleshy, big and less bony fish species and the most important criteria is freshness of fish (Taneri, 1963; Gokoglu, 1994). The aim of this research was to determine sensory, chemical and microbiological quality properties of the marinated fish meat ball produced with smoked bonito (*Sarda sarda*, Bloch 1793).

2. Materials and Methods

2.1. Materials

In this study, 10 bonito with an average weight of 700±100 g were used as material. Fish were headed, gutted and washed.

2.2. Brine

Fish were waited in 10% salt solution for 1.5 h. The rate of fish: brine was 1: 2.

2.3. Smoking

Fish were placed into smoking oven. Fish were dried in oven at 30ºC, while holes of oven were at half open position for 30 min. The temperature was set up to 80ºC after 30 min and continued to smoking process of fish, while the holes of oven were at closed position during 50 min.

2.4. Preparation of fish meat ball

Bones picked out of fish and flesh of fish minced in a blender after smoking process. The fish mince was kneaded after addition of 0.34% crumb, 0.78% egg, 0.22% parsley, 0.17%

garlic, 1% onion, 0.14% salt, 0.05% black pepper, 0.07% cummin, 0.07% red pepper, 0.08% thyme, 0.07% ginger. Then, they were shaped as meat ball by hand and fried in a deep fryer (Fakir Gala 1.5 lt, Germany) at 180 °C.

2.5. Process of marination

Fried meat balls were preserved in glass jars with marination solution containing salt (7%) and acetic acid (1.5%). The glass jar lids were closed after addition of some dill, parsley, garlic, mustard seed, ginger and white pepper into marination solution. And then they were stored at 4ºC.

2.6. Chemical analyses

Total volatile basic nitrogen (TVB-N) was determined according to method of Lucke and Geidel modified by Antonacopoulas (Hall, 1992). Thiobarbituric acid (TBA) was determined according to Tarladgis et al. (1960). Trimethyl-amine nitrogen (TMA-N) was determined according to Dyer developed by Bysted et al. (Boland and Paige, 1971). pH analysis was carried out with the instrument Werkstatten 82362 Weilheim, Germany, according to Curran et al. (1980).

2.7. Microbiological analysis

For all microbiological counts, dehydrated ready mediums of Merck were used. 10 g of sample was taken, transferred into 90 mL 0.85% sterile serum physiologic and then homogenized in a homogenizer (IKA Yellow Line DI 25 Basic). Total mesophilic aerobic bacteria, psychrophilic bacteria, yeast-mold and coliform bacteria counts were determined by using the pour plate method. Plate Count Agar and Potato Dextrose Agar were used as medium for total mesophilic aerobic bacteria and yeast-mold count, respectively. The plates were incubated at 28°C for 3 days. To count coliform bacteria, Violet Red Bile Agar (Merck) was used as medium and plates were incubated at 35°C for 24 h. Results were given as log colony forming units/g (Gokalp et al. 1999).

2.8. Sensory Evaluation

Trained panelists (five men and four women) attented to sensory evaluation. The meat balls were served to the panelists for evaluation of sensory attributes (appearance, odor, flavor, texture). According to a scoring table, a total score of 20 for sensory attributes were accepted excellent quality. In this evaluation, scores between 18.2 and 19.9 were accepted as‘‘very good’’ 15.2 and 18.1 were accepted as ‘‘good’’ and 11.2 and 15.1 were accepted as ‘‘middle’’. Scores between 7.2 and 11.1 were accepted limit of acceptibility and scores between 4.0 and 7.1 were accepted spoiled samples (Neuman et al. 1983).

2.9. 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.

3. Results and Discussion

3.1. Chemical analyses

pH value, TVB-N, TBA and TMA contents of fresh bonito were determined as 6.09, 7 mg/100 g, 1.2 mg malonaldehyde/ kg and 2.5 mg/100 g, respectively (Figure 3.1.1). Duyar and Eke (2009) reported that the TVB-N value of fresh bonito as 7.47 mg/100 g. This result is very similar to our findings. Koral et al. (2010) reported that the TVB-N, TBA and TMA values of fresh bonito as 11.58 mg/100 g, 0.365 mg malonaldehyde/ kg and 2.35 mg/100 g, respectively. In the same study, TVB-N, TBA and TMA values of smoked bonito were reported as 13.13 mg/100 g, 0.385 mg malonaldehyde/ kg and 2.90 mg/100 g, respectively. In our study, TVB-N value of fresh bonito was found less than finding of Koral et al. (2010) as 7 mg/100 g. Besides, TBA and TMA values in our study were found higher than Koral et al. (2010) as 1.2 mg malonaldehyde/ kg and 2.5 mg/100 g, respectively. It is known that, species of fish, hunting season, nutrition condition, sex and age factors have effect on TVB-N value (Oehlenschlager, 1989; Eke, 2007).

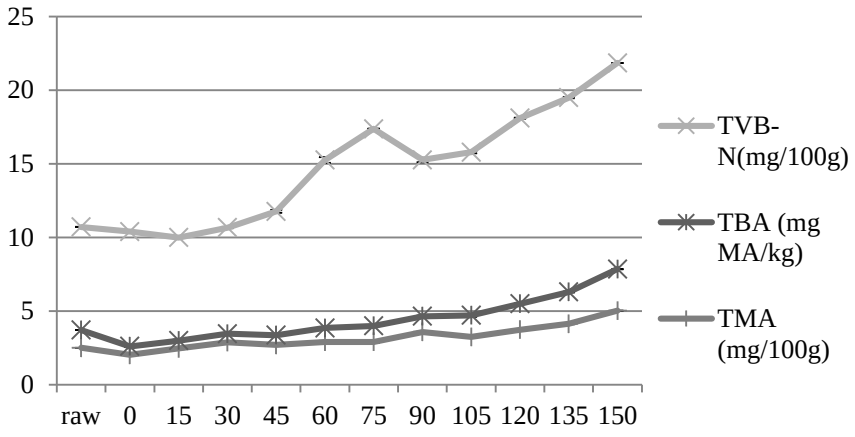

Figure 3.1.1. Values of marinated meat ball produced with smoked bonito Total volatile basic nitrogen (TVB-N), Thiobarbituric acid (TBA), Trimethyl-amin (TMA). n = 3. Markers are shown as mean ± standard error of triplicates.

Analysis results of marinated meat ball produced with smoked bonito during preservation in refrigeration conditions are shown in Figure 3.1.1. Initial pH value, TVB-N, TBA and TMA content of marinated meat ball produced with smoked bonito were 4.8, 7.8 mg/100 g, 0.57 mg malonaldehyde/ kg and 2.02 mg/100 g, respectively. At the end of the storage period of 150 days, these values were determined as 3.85, 14 mg/100 g, 2.82 mg malonaldehyde/ kg

and 5.02 mg/100 g, respectively. However, these values did not exceeded acceptability limit values, this product had inconsumable quality character in terms of sensory quality criterias. Effect of storage time on values of pH, TVB-N, TBA and TMA was found as significant ($p<0.05$).

Unal (1995) stated that TVB-N content of smoked products may be changed according to raw material quality, storage conditions, brine concentration, control of conditions in smoking oven, packaging material and shape of product. Duyar et al. (2008), have been smoked according to hot smoked method to bonito by using different sawdust types. They have been smoked first group with mixed (oak, beech, poplar) sawdust and second group with apple sawdust. While initial pH, TVB-N, TBA and TMA values were determined as 5.60, 11.67 mg/100 g, 0.64 mg malonaldehyde/ kg and 0.88 mg/100 g in first group, respectively; initial pH, TVB-N, TBA and TMA values were determined as 5.59, 11.96 mg/100 g, 0.70 mg malonaldehyde/ kg, 0.85 mg/100 g in second group, respectively. In this study that was made by using different sawdust types, shelf life of smoked bonito was stated as 55 days. Kaya et al. (2006) were determined in bonito stored (4ºC) after hot smoking, pH value was 5.71, TVB-N value was 11.21 mg/100 g and TMA value was 1.19 mg/100 g. These values of it were 5.97, 36.33 mg/100 g and 18.71 mg/100 g at the end of storage period of 15 days, respectively.

3.2. Microbiological analysis

The microbiological analysis results of marinated meat ball produced with smoked bonito are shown in Figure 3.1.2. Initial counts of total mesophilic aerobic bacteria, mold-yeast and coliform bacteria were 4.08 log cfu/g, 3.85 log cfu/g and 2.48 log cfu/g, respectively. At the end of the storage period of 150 days, counts of total mesophilic aerobic bacteria, yeast-mold and coliform bacteria counts were 5.08 log cfu/g, 4.98 log cfu/g, 1.30 log cfu/g, respectively. According to these results, while an increasing was determined in counts of total mesophilic bacteria and yeast-mold, count of coliform bacteria decreased significantly during storage time ($p<0.05$).

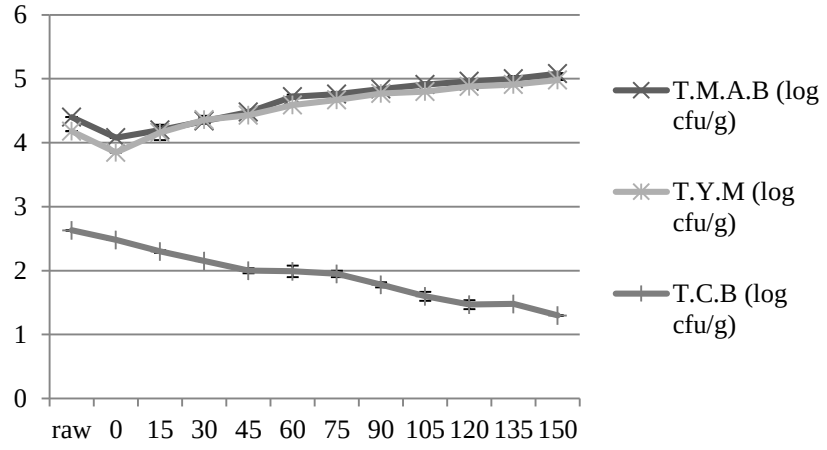

Figure 3.1.2. Values of marinated meat ball produced with smoked bonito Total mesophilic aerobic bacteria (T.M.A.B), Total yeast and mold (T.Y.M), Total coliform bacteria (T.C.B). n = 3. Markers are shown as mean ± standard error of triplicates.

Akkus et al. (2004) reported that, initial count of total mesophilic bacteria was 4.3 log cfu/g in a study related with meat balls produced with boiled anchovy that stored at 4ºC. This value increased to 8.4 log cfu/g at the end of the storage period of 18 days. Also stated that, value of 6 log cfu/g that is acceptability limit value in processed seafood for mesophilic aerobic bacteria was exceed at day 9. Patır and Duman (2006) investigated physicochemical and microbiological changes during preservation of smoked mirror carp. It was determined that brine of process was applied on fresh fillet caused to decrease in coliform bacteria count, however it caused to increase in counts of total mesophilic bacteria, total psychrotrophic bacteria, total yeast and mold, *Staphylococcus* and *Micrococcus*. In addition, it was stated that smoking process of application decreased in microorganism count for all groups significantly. The count of coliform bacteria was remained stable as 1.00 log cfu/g in all groups, in analyses that were performed in defined days. Kaya et al. (2006) reported that counts of total mesophilic bacteria, yeast-mold and total phychrotrophic were determined as $3.8x10^3$ cfu/g, $3.5x10^3$ cfu/g, $2.1x10^2$ cfu/g and $<10^1$ cfu/g, respectively in microbiological analyses that were performed at the end of the storage period of 15 days of bonito that were stored in refrigeration conditions (4ºC) after hot smoking process.

It was stated that microbiological spoilage begins after have been exceeded the value of 10^6 cfu/g in smoked fish (ICMSF 1986). In another report, it was stated that there wasn't seen any sensory changes, despite arrived this value but might be encountered prominent sensory spoilage in existence of microflora dominantly by enterobacter (Varlık et al., 2004). It was known that smoking of process caused to increasing in microflora of fish depending on applied processes (Colakoglu, 2004). In our study, it was thought that usage of smoked fish flesh could be effective in decreasing of microbial load of product, nevertheless the additives were used of meat ball preparation and potential contamination from ambient conditions could increase microbial load. Generally, it can be said that differences between our study and other studies resulted from different ambient conditions, processing techniques and differences among raw materials.

3.3. Sensory Evaluation

The results of sensory analysis are one of the most important quality criteria used for determination of shelf life of seafood. Table 3.3.1. shows the findings of sensory quality and overall acceptability of marinated meat ball produced with smoked bonito. According to the sensory analysis results the shelf life of marinated meat ball produced with smoked bonito were determined as 150 days. Effect of storage time on sensory scores was found significant ($p<0.05$)

Varlik et al. (2000), reported that marinated fish meat ball was ‘very good’ up to day 60, ‘good’ between 60-105 days, ‘marketable’ at 120 day and ‘spoiled’ after 120 days according to sensory analysis results. Gokoglu (1994) stated that, sensory shelf life of fish meat ball stored at 4ºC as 10 days. Boran and Kose (2007) obtained whiting burgers with 3 different mincing methods and investigated shelf life at 4ºC after frying. They reported that sensory shelf life in refrigeration conditions of the burgers produced with fish mince, surimi and pre-cooked mince product were determined as 9 days, 10 days and 1 day, respectively.

Table 3.3.1. Sensory analysis results of marinated meat ball produced with smoked bonito during storage (4ºC)

	Storage time (Days)										
Marinated bonito ball	0	15	30	45	60	75	90	105	120	135	150
Appearance	5 $\pm0.00^{a}$	5 $\pm0.00^{a}$	4.8 $\pm0.20^{ab}$	4.6 $\pm0.24^{ab}$	4.4 $\pm0.24^{bc}$	4.6 $\pm0.24^{ba}$	4 $\pm0.00^{cd}$	3.8 $\pm0.20^{de}$	3.4 $\pm0.24^{ef}$	3.2 $\pm0.20^{f}$	2.2 $\pm0.20^{g}$
Texture	5 $\pm0.00^{a}$	4.8 $\pm0.20^{a}$	4.6 $\pm0.24^{ab}$	4.2 $\pm0.20^{bc}$	4.2 $\pm0.20^{bc}$	4 $\pm0.00^{cd}$	3.6 $\pm0.24^{de}$	3.2 $\pm0.20^{ef}$	3.2 $\pm0.20^{ef}$	2.6 $\pm0.24^{f}$	1.6 $\pm0.24^{g}$
Odor	5 $\pm0.00^{a}$	5 $\pm0.00^{a}$	4.4 $\pm0.24^{b}$	4.4 $\pm0.24^{b}$	4.2 $\pm0.20^{b}$	4.2 $\pm0.20^{b}$	4 $\pm0.00^{bc}$	3.6 $\pm0.24^{cd}$	3.2 $\pm0.20^{de}$	2.8 $\pm0.20^{e}$	2.0 $\pm0.20^{f}$
Flavor	5 $\pm0.00^{a}$	5 $\pm0.00^{a}$	4.8 $\pm0.20^{a}$	4.6 $\pm0.24^{ab}$	4.2 $\pm0.20^{bc}$	4 $\pm0.00^{cd}$	3.8 $\pm0.20^{cd}$	3.6 $\pm0.24^{cd}$	3.2 $\pm0.20^{d}$	2.4 $\pm0.24^{e}$	1 $\pm0.00^{f}$
Overall acceptability	20 $\pm0.00^{a}$	19.8 $\pm0.20^{a}$	18.6 $\pm0.88^{b}$	17.8 $\pm0.92^{bc}$	17 $\pm0.84^{c}$	16.6 $\pm0.44^{c}$	15.4 $\pm0.44^{d}$	14.2 $\pm0.88^{e}$	13 $\pm0.84^{e}$	11 $\pm0.88^{f}$	6.8 $\pm0.64^{g}$
Quality	Very good	Very good	Very Good	Good	Good	Good	Good	Middle	Middle	Accep-tability	Spoiled

n=3

Values are shown as mean ± standard error of triplicates.

Within the rows values with different letters are significantly different ($p<0.05$)

4. Conclusion

In this study, fish meat balls produced with smoked bonito were marinated after frying and stored at 4ºC. The applied techniques to fresh bonito fish were smoking, preparing of fish meat ball from smoked bonito, frying and marination, respectively. In conclusion, it was seen that applied processing techniques contributed to extend the shelf life of marinated meat ball produced with smoked bonito.

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