E.Ü. Su Ürünleri Dergisi 2008
E.U. Journal of Fisheries & Aquatic Sciences 2008
Cilt/Volume 25, Sayı/Issue (2): 101–104


ISSN 1300 - 1590
http://jfas.ege.edu.tr/

# Quality Changes of Salted Red Mullet (*Mullus barbatus* L., 1758) During Vacuum Packaged Stored at +4ºC*

*Bahar Gümüş, Ramazan İkiz, Mustafa Ünlüsayin, Hayri Gülyavuz

*Akdeniz University, Faculty of Fisheries, Dumlupınar Bulvarı, 07058, Antalya, Turkey*
**E mail: baharg@akdeniz.edu.tr*

Özet: ***Tuzlanmış barbun balığı (***Mullus barbatus ***L., 1758)'nın vakum paketlenerek +4ºC'de depolanması sırasında oluşan kalite değişimleri.*** Bu çalışmada, taze ve %20'lik tuz çözeltisi ile tuzlanmış barbun balığı (*Mullus barbatus* L., 1758) vakum paketlenerek +4±0,5 ºC'de depolanmış ve depolama sırasında meydana gelen kimyasal ve mikrobiyal değişimleri incelenmiştir. Depolama süresince toplam uçucu bazik azot (TVB-N), tiyobarbiturik asit sayısı (TBA), pH, toplam mezofilik aerob bakteri sayımı, koliform bakteri sayımı ve maya-küf analizleri yapılmıştır. Taze ve tuzlanmış örneklerde depolama sırasında pH, TBA ve TVB-N değerlerindeki farklılıklar istatistiki olarak önemli ($p<0.05$) bulunmuştur. Her iki örnekte de TVB-N değerinde, toplam mezofilik aerob bakteri sayısı ve koliform bakteri sayısında depolama süresince önemli ($p<0.05$) artışlar belirlenmiştir. Depolama süresince taze ve tuzlanmış örneklerin her ikisinde de maya-küf tespit edilememiştir. Mikrobiyal analiz sonuçlarına göre, tuzlama yöntemi sonrası mikrobiyal yükte bir azalma belirlenmesine rağmen bu değerin depolama sırasında önemli ($p<0.05$) bir şekilde arttığı saptanmıştır. Tuzlanmış örneklerde raf ömrü yaklaşık olarak 11 gün olmasına karşın taze örneklerde bu sürenin 7 gün olduğu belirlenmiştir.

Anahtar Kelimeler: Barbun, tuzlama, raf ömrü, kalite, depolama.

Abstract: In the present study, the chemical and microbiological quality changes in vacuum packaged fresh and salted (20% salt concentration) red mullet were carried out during storage at +4±0.5ºC. Total volatile basic nitrogen (TVB-N), thiobarbituric acid (TBA) and pH were analysed to determine chemical quality and total mesophilic aerob count (TMAC), total coliform count (TCC) and yeast-mould were measured to determine microbial quality during the storage. Increasing in TVB-N, TMAC and TCC were found statistically significant ($p<0.05$) in the fresh and salted red mullet throughout storage. No yeast and mould were detected for the period of storage fresh and salted red mullet. Microbial analysis demonstrated that the salted techniques reduced the microbial counts of the red mullet whereas it didn't retard the microbial growth during the storage period. Based on the data, the optimal shelf life was found 7 days for fresh red mullet and 11 days for salted red mullet.

Key Words: Red mullet, salted, shelf-life, quality, storage.

**This work has been supported by Akdeniz University Scientific Research Projects Commission (AÜBAP–2006.02.0121.006).*

## Introduction

Salting of fish has long worldwide traditions as means to preserve and increase the shelf life. In addition, it is a preliminary operation in some smoking, drying and marinating processes (Ismail and Wootton 1992) that have been mostly empirically developed and has remained unchanged for millennia.

The preservative effect of salt has been recognised according to a decrease in water activity, less availability to microbial attack, and enhancement of functional properties, leading to an increase of the shelf-life time (Aubourg and Ugliano 2002). Salt inhibits the growth of spoilage-causing microorganisms by drawing water out of tissue through osmosis (Horner 1997). Length of salting period as well as salt concentration depends on the expected final product (Bellagha et al 2007).

Red mullet (*Mullus barbatus* L. 1758) living in the Mediterranean and Black seas is a benthic species, like the other mullets. They prefer sandy and muddy bottoms of the continental shelf, at depths between 20 and 300 m. They show a distribution from the east Atlantic to the coast of Senegal (Whitehead et al 1986). Total amount of red mullet caught in Turkey was 2825 tons in 2005 and 863 tons of caught red mullet were harvested in Mediterranean Sea (Turkish Statistical Institute 2005). Usually, red mullet is consumed fresh (Turkish Statistical Institute 2005). The bulk of this species is marketed as whole fish, packed on ice.

The aim of the this work was to investigate the effect of salting and vacuum packaging on the chemical and microbial quality changes of red mullet during storage at 4ºC.

## Materials and Methods

Red mullet (*Mullus barbatus* L. 1758) was obtained from a local fisherman in Boğazkent, (Serik-Antalya,Turkey) and then transported to our laboratory in polystyrene boxes in crushed ice. The mean weight of individual fish was 89.4±22.8 g with total length of about 18.4±1.5 cm. After gutted and washed, the fish were divided into two lots; one was kept as fresh fish (control) and other was kept in a 20% (w/v) salt solution (fish/brine solution ratio: 1:1) at 16°C for 20 min. The fish were then removed from the brine solution. Fresh and salted red mullet were vacuum packed and stored at 4°C.

pH was measured with a digital electronic pH meter with a glass electrode (WTW Mark 320). TBA value was determined as described by Varlık et al (1993). TVB-N values were estimated using the method described by Lucke-Geidel, as modified by Antonacopoulas and reported by Inal (1992). For microbiological analysis, preparation of the samples was carried out according to Refai (1979) and Varlık et al (1993). Total mesophilic aerob count (TMAC) was determined using plate count agar (Merck 5463) after incubation at 30±1°C for 72 h (Refai 1979, Varlık et al 1993, Çolakoğlu 2004). Total coliform count (TCC) was determined with violet red bile agar (Merck 1406) after incubation at 30±1°C for 24 h (Anonymous 1994, Arslan et al 1997). Mould and yeast were determined in potato dextrosa agar (Merck 0130) after 5 days of incubation at 22±1°C (Varlık et al 1993). All colonies were counted and the data were reported as colony forming units (CFU) per gram.

All measurements were performed in triplicate and the values expressed as the mean±SD. Statistical analyses were performed using SPSS 9.0 for Windows. Analysis of variance (ANOVA) was used and statistical significance was set at $p< 0.05$.

## Results

pH, thiobarbituric acid (TBA), and total volatile basic nitrogen (TVB-N) values of all samples are given in Table 1. The initial TVB-N value of fresh red mullet was 15.83±0.07 g/100g. The change in the TVB-N value of fresh and salted red mullet were found to be significant ($p<0.05$) during the time of storage and the TVB-N value both of samples increased significantly at the end of the storage time. The increase in the TBA values of both fresh and salted samples were found to be significant during the time of storage ($p<0.05$). The TBA value was 0.59±0.05 mg malonaldehyde/kg at the beginning of the storage and increased to 0.68±0.05 mg MA/kg after salting. The initial pH values of fresh and salted red mullet were determined as 6.67 and 6.51, respectively.

Different superscript letters in the same row indicate significant differences among days ($p<0.05$).

Microbiological findings for fresh and salted red mullet stored at 4°C are presented in the Table 2. There were increases in total mesophilic aerob count and total coliform count over the period of storage. The total mesophilic aerob count was 3.16±0.04 log cfu/g at the beginning of the storage and decreased to 2.84±0.05 log cfu/g after salting.

Table 1. Changes in TVB-N, TBA, and pH values of fresh and salted red mullet during storage (at 4°C) (mean±SD).

| Days | TVB-N (mg/100g) | | TBA (mg MA/kg) | | pH | |
|---|---|---|---|---|---|---|
| | Fresh | Salted | Fresh | Salted | Fresh | Salted |
| 1 | 15.83±0.07$^{a}$ | 17.08±0.07$^{a}$ | 0.59±0.05$^{a}$ | 0.68±0.05$^{a}$ | 6.67±0.00$^{b}$ | 6.51±0.02$^{a}$ |
| 3 | 22.32±0.17$^{b}$ | 23.60±0.20$^{b}$ | 0.92±0.04$^{b}$ | 1.07±0.07$^{c}$ | 6.49±0.07$^{a}$ | 6.61±0.06$^{bc}$ |
| 5 | 28.94±0.06$^{c}$ | 25.70±0.32$^{c}$ | 1.35±0.08$^{d}$ | 1.44±0.04$^{e}$ | 6.60±0.09$^{b}$ | 6.64±0.06$^{c}$ |
| 7 | 33.92±0.06$^{d}$ | 29.58±0.27$^{d}$ | 1.07±0.04$^{c}$ | 0.83±0.01$^{b}$ | 6.65±0.03$^{b}$ | 6.59±0.02$^{abc}$ |
| 9 | 39.54±0.39$^{e}$ | 32.36±0.21$^{e}$ | 1.39±0.04$^{e}$ | 1.32±0.04$^{d}$ | 6.87±0.04$^{c}$ | 6.54±0.02$^{ab}$ |
| 11 | 47.74±0.11$^{f}$ | 36.36±0.19$^{f}$ | 1.48±0.04$^{f}$ | 1.59±0.01$^{f}$ | 6.60±0.03$^{b}$ | 6.59±0.02$^{abc}$ |

Table 2. The microbial flora of fresh and salted red mullet during storage (at 4°C) (log cfu/g) (mean±SD).

| Days | TMAC | | TCC | | Yeast-Mould | |
|---|---|---|---|---|---|---|
| | Fresh | Salted | Fresh | Salted | Fresh | Salted |
| 1 | 3.16±0.04$^{a}$ | 2.84±0.05$^{a}$ | 2.73±0.01$^{a}$ | 2.43±0.02$^{a}$ | ▪ | ▪ |
| 3 | 3.75±0.04$^{b}$ | 3.22±0.06$^{b}$ | 3.19±0.04$^{b}$ | 2.85±0.02$^{b}$ | ▪ | ▪ |
| 5 | 5.05±0.03$^{c}$ | 3.84±0.09$^{c}$ | 3.68±0.14$^{c}$ | 2.99±0.04$^{c}$ | ▪ | ▪ |
| 7 | 6.20±0.01$^{d}$ | 4.87±0.03$^{d}$ | 4.76±0.07$^{d}$ | 3.23±0.04$^{d}$ | ▪ | ▪ |
| 9 | 7.77±0.04$^{e}$ | 4.93±0.01$^{e}$ | 4.93±0.01$^{e}$ | 3.59±0.01$^{e}$ | ▪ | ▪ |
| 11 | 8.84±0.05$^{f}$ | 5.70±0.02$^{f}$ | 5.98±0.05$^{f}$ | 4.24±0.04$^{f}$ | ▪ | ▪ |

*Different superscript letters in the same row indicate significant differences among days ($p<0.05$). (▪) Not detected*

## Discussion

The TVB-N value increased after the salting process in this study. As expected, a significant increase ($p<0.05$) in TVB-N values was observed in both the samples during storage. The increase in TVB-N was caused by a combination of microbiological and autolytic deamination of amino acids and the complete microbial reduction of TMAO to TMA (Truelstrup et al 1996). A comparable pattern of the increase in TVB-N has been reported in brined chub mackerel (Goulas and Kontominas 2005), and brined anchovies (Karaçam et al 2002) during refrigerated storage. Conversely, a much higher TVB-N level (60.5 mg/100 g) was reported by day 42 in vacuum-packaged, salted sea bream stored under refrigeration at 4ºC (Chouliara et al 2004).

The initial TBA value of fresh red mullet was 0.59±0.05 mg MA/kg (Table 1). This value increased to 0.68±0.05 mg MA/kg after salting process. A statistically significant ($p<0.05$) but disorderly increase was observed in the TBA values of the fresh and salted samples during storage (Table 1). Brine is a protective barrier against atmospheric oxygen during brining and, thus, the oxidative process did not proceed as rapidly as

was expected. In strongly salted products, the oxidation speed is accelerated because salt increases oxidase enzyme activity (Gülyavuz and Ünlüsayın 1999). Therefore, the TBA value increased as a result of fat oxidation in salted products. Final TBA value was 1.48±0.04 mg MA/kg for fresh fish and 1.59±0.01 mg MA/kg for salted fish. These values didn't exceed the limit beyond which fish will normally develop an objectionable odour and flavour (Connell 1995). In agreement with the results reported previously (Aubourg and Ugliano 2002, Guillen and Ruiz 2004, Ruiz-Capillas and Moral 2001). As it can be seen from Table 1 there were fluctuations at the TBA levels with samples stored at 4 ºC. Therefore, although the TBA test is commonly used in the determination of rancidity in fish products, it can be concluded that it may not be a reliable quality criterion for salted red mullet. Chouliara et al (2004) reported that the decrease in TBA values after day 28 of storage may represent the breakdown of malonaldehyde to tertiary degradation products. Jeevanandam et al (2001) reported that the TBA value of non-irradiated, salted threadfin bream increased to a maximum value during storage up to 12th day and then decreased. The present result indicated that oxidative rancidity in both samples remained relatively low throughout the entire period of vacuum-packaged storage at 4 ºC and its level was within the acceptability limits for fish consumption. The initial pH values of fresh and salted red mullet were determined as 6.67 and 6.51, respectively. The pH value of the fish samples decreased slightly after salting at the begin of the storage period (Table 1). There were no significant differences ($p>0.05$) in mean pH levels (between the 7th and 11th day of storage) for salted red mullet. Similar results were reported with salted fish in the some researches (Gökoğlu et al 1994).

As expected, salted significantly ($p<0.05$) reduced (1st day) the total mesophilic aerob count and total coliform count (TCC) values (Table 2). It is clear that used of salting resulted in mesophilic aerobic and coliform bacteria counts that were lower than those of the fresh samples (non-salted). In the present study, the total mesophilic aerob count and the total coliform count (TCC) showed statistically significant ($P<0.05$) increases in the fresh and salted red mullet during storage at 4 °C. In this work $10^6$ CFU/g of mesophilic bacteria was used as the limit for the evaluation of microbial spoilage. When aerobic plate counts reach $10^6$ CFU/g, the food product was assumed to be at or near spoilage (Pascual and Calderón 2000, Arashisar et al 2004, Özoğul et al 2004). In this study, the fresh samples showed high levels of this microorganism, exceeding 6 log CFU/g at 7 days storage. Microbial growth was lower in salted samples and didn't reach $10^6$ CFU/g. However, by the end of storage, growth was well over $10^5$ CFU/g and reflected product that was close to spoilage. In general, fresh red mullet showed the highest microbial growth. These results agree with Özoğul et al (2004) and Sivertsvik et al (2002). No yeast or mould was detected in our fresh and salted samples.

The present study concluded that red mullet 20% salt solution could retard the microbial growth, delay the chemical changes, and extend the shelf life of the product during refrigerated storage; therefore, salt solutions can be used as a safe method for preservation of fish. Based on the presented data, the optimal shelf life was found 7 days for fresh and 11 days for salted red mullet.

## References


Anonymous. 1994. Merck Microbiology Manual, Published by Merck, Germany, 347 p.

Arashisar, S., O. Hisar, M. Kaya, and T. Yanik. 2004. Effects of modified atmosphere and vacuum packaging on microbiological and chemical properties of rainbow trout (*Oncorynchus mykiss*) fillets. International Journal of Food Microbiology 97: 209-214.

Arık Çolakoğlu, F. 2004. The effects of processing techniques on microflora of roach (*Rutilus rutilus)* and whitefish (*Coregenus sp.*) (In Turkish). Turkish Journal of Veterinary and Animal Sciences 28: 239-247.

Arslan, A., C. Çelik, G. Gönülalan-Ateş, A. Kök, and A. Kaya. 1997. Analysis of Microbiological and Chemical Qualities of Vacuumed and Unvacuumed Mirror carp (*Cyprinus carpino* L.) Pastrami (In Turkish). Turkish Journal of Veterinary and Animal Sciences 21: 23-29.

Aubourg, S.P., and M. Ugliano. 2002. Effect of brine pretreatment on lipid stability of frozen horse mackerel (*Trachurus trachurus*). European Food Research and Technology 215: 91-95.

Bellagha, S., A. Sahli, A. Farhat, N. Kechaou, and A. Glenza. 2007. Studies on salting and drying of sardine (*Sardinella aurita*): Experimental kinetics and modelling. Journal of Food Engineering 78: 947-952.

Chouliara, I., I.N. Savvaidis, N. Panagiotakis, and M.G. Kontominas. 2004. Preservation of salted, vacuum-packaged, refrigerated sea bream (*Sparus aurata*) fillets by irradiation: microbiological, chemical and sensory attributes. Food Microbiology 21: 351-359.

Connell, J. 1995. Methods of assessing and selecting for quality. In: Control of Fish Quality. 4th edn. Oxford: Fishing News Books. 135-164.

Goulas, A.E., and M.G. Kontominas. 2005. Effect of salting and smoking method on the keeping quality of chub mackerel (*Scomber japonicus*): biochemical and sensory attributes. Food Chemistry 93: 511-520.

Gökoğlu, N., H. Gün, and C. Varlık. 1994. Determination of the preservation time of salted trout *Oncorhynchus mykiss* (Walbaum, 1792) (In Turkish). Istanbul University, Journal of Fisheries and Aquatic Sciences 1-2: 174-180.

Guillen, M.D., and A. Ruiz. 2004. Study of the oxidative stability of salted and unsalted salmon fillets by 1H nuclear magnetic resonance. Food Chemistry 86: 297-304.

Gülyavuz, H., M. Ünlüsayın. 1999. Seafood Processing Technology (In Turkish). Şahin press, Ankara, 364 s.

Horner, W.F.A. 1997. Salting. In: Fish Processing Technology Preservation of Fish by Curing (edited by G.M. Hall). Chapman &Hall Publishers, UK. Pp:32-72.

Inal, T. 1992. Food Hygiene. Health control of animal foods (in Turkish). İstanbul. 783s.

Ismail, N., and M. Wootton. 1992. Fish salting and drying: a review. Asean Food Journal 7: 175-183.

Jeevanandam, K., A. Kakatkar, S.N. Doke, D.R. Bongiwar, and V. Venugopal. 2001. Influence of salting and gamma irradiation on the shelf-life extension of threadfin bream in ice. Food Research International 34: 739-746.

Karaçam, H., S. Kutlu, and S. Köse. 2002. Effect of salt concentrations and temperature on the quality and shelf life of brined anchovies. International Journal of Food Science and Technology 37: 19-28.

Özogul, F., A. Polat, and Y. Özogul. 2004. The effects of modified atmosphere packaging and vacuum packaging on chemical, sensory and microbiological changes of sardines (Sardina pilchardus). Food Chemistry 85: 49-57.

Pascual, M., V. Calderón. 2000. Recuento de microorganismos aerobios mesófilos revivificables. In: Díaz de Santos (Ed.), Microbiología Alimentaria, Madrid, pp. 13-15.

Refai, M.K. 1979. Manual of Food Quality Control, 4. Microbiology Analysis.

Food and Agriculture Organization of the United Nations, Rome.

Ruiz-Capillas, C., and A. Moral. 2001. Residual effect of $CO_2$ on hake (*Merluccius merluccius*) stored in modified and controlled atmospheres. European Food Research and Technology 212: 413-420.

Sivertsvik, M., W.K. Jeksrud, and J.T. Rosnes. 2002. A review of modified atmosphere packaging of fish and fishery products-significance of microbial growth, activities and safety. International Journal of Food Science and Technology 37: 107-127.

Truelstrup, L., T. Gill, and H. Huss. 1995. Effect of salt and storage temperature on chemical, microbiological activity on quality of cold-smoked salmon. Food Research International 28: 123-130.

Turkish Statistical Instute (Turkstat). 2005. Fishery Statistics. Ministry of Agriculture and Rural Affair. Ankara, Turkey.

Varlık, C., M. Uğur, N. Gökoğlu, and H. Gün. 1993. Principle and Methods of Quality Control in Sea Products (In Turkish). Gıda Teknolojisi Dergisi Yayın No:17, İstanbul, 174.

Whitehead, P.L.P., M.L. Bauchot, and J.C. Hureau. 1986. Fishes of the North-eastern Atlantic and the Mediterranean. Volume II, UNESCO, Rome, Italy. pp. 877-882.