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RESEARCH ARTICLE

Rosemary (*Rosmarinus officinalis*) as a preservative agent in canned bonito (*Sarda sarda*)

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ABSTRACT

This study was conducted to determine the shelf life and quality of traditional canned fish made from bonito (*Sarda sarda*) fish. The effect of the rosemary plant on some quality parameters and storage time of bonito fish with tomato sauce stored for 510 days at room temperature was determined by sensory, physical, chemical and microbiological freshness control methods. Nutrient composition analyses were performed in bonito fish before the canning process. Crude protein, crude oil, moisture and crude ash values were found to be, 23.125±1.062%, 2.783±0.339%, 72.717±0.652% and 1.150±0.212%, respectively. The amount of carbohydrates was determined as 0.275 g/100 g, the amount of energy was determined as 157.43 kcal/100 g. During storage, the total amount of volatile basic nitrogen (TVB-N), the number of thiobarbituric acid (TBA), pH, water activity (aw), the total number of aerobic mesophilic bacteria (TAMB), the total number of yeast and mold (TYM) were calculated. When TBA, pH, aw and microbiological analyzes were evaluated, both groups did not exceed the consumption limit values during the storage period. But in the research, the antioxidant effect of rosemary was clearly seen.

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Introduction

Nutrition, which is one of the basic requirements of life, is an important factor affecting all age groups and their quality of life, from the health of the unborn baby to the health of the elderly (Talak et al., 2010). Fish is healthy food and is the main player in human nutrition, ensuing about 20% of protein consumption to a third of the world's population which is more obvious in developing countries (Béné et al., 2007). Currently, chilling, freezing, salting, canning, drying and smoking, are the

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most frequently used techniques used for efficient safekeeping (Kumolu-Johnson et al., 2010). Bonito is the most abundant fish species in the Black Sea of Turkey and this species is consumed fresh domestically or exported as frozen (Caglak et al., 2012). Changing eating habits over time and increasing the number of working people necessitates the development of ready-to-eat foods. For this reason, antimicrobial or antibacterial agents are added to foods for protection purposes (Altuğ, 2001). Canning is a well-established and traditional way of providing food products with a long shelf life at constant ambient temperatures and is suitable for worldwide distribution (Bratt, 2010). Rosemary extract, whose antioxidant activity is well known (*Rosmarinus officinalis*) (Erkan et al., 2008, Bousbia et al., 2009), is the most tested active natural agent in both food simulation systems and real foods (Akhtar et al., 1998, Serdaroglu & Felekoğlu, 2005). Among the plants reported to have antioxidative activity, rosemary in its ground form or as an extract is commonly used in many food applications. The high antioxidant capacity of rosemary is due, substantially, to the phenolic diterpenes, carnosic acid, carnosol and rosmarinic acid (Sáenz-López et al., 2002). It has been reported that rosemary extract has antioxidant properties, it is a natural source of antioxidants compared to BHA and BHT in this regard (Tewari & Virmani, 1987).

The effects of rosemary extract on the quality of fish have been reported by several authors (Kenar, 2009; Ozogul et al., 2011; Kvangarsnes et al., 2021; Fouad et al., 2021). However, the effects of dry rosemary on the quality of canned bonito with tomatoes have not been reported so far.

This study was conducted in order to determine the quality of fresh bonito fish, which are loved and consumed in Turkey, canned rosemary with tomatoes and tomatoes were made by traditional methods.

Materials and Methods

Material

In this study, dry rosemary (*Rosmarinus officinalis*), purchased ready-made from the spicer, was used. To boil in tomato sauce, 200 g of dry rosemary were wrapped in a clean cloth. 150 bonito (*Sarda sarda*) fish with an average length of 28.91±2.85 cm and an average weight of 273.44±14.51 g, caught in Sinop in October, were used as fish material. 60 kg of tomatoes were obtained from the local market of Sinop, after being peeled, they were cut into 2 equal parts with a food processor. One group was boiled with the addition of rosemary and salt, the other group was boiled with the addition of salt only. An average of 5 liters of sunflower oil was used to add to each jar.

Methods

The fish purchased from the fishing stalls were cleaned after removing the head and internal organs and cooked in the oven at 180°C for 25 min without adding any salt and spices. The fish, the skin and the bones of which are extracted are placed in 370 ml jars with 150 g of fish meat. Fish meat is placed in jars in such a way that there is ahead, abdomen and tail. On average, 200 g of dried rosemary was added to 15 l of tomato juice. Jars with 200 ml of tomato sauce and 20 ml of sunflower oil added to them were autoclaved at 121°C for 30 minutes after closing the lids. The jars removed from the autoclave were turned over on a clean cloth for sealing control and allowed to cool. Sensory, chemical, physical and microbiological quality parameters were evaluated 15 days decently. The research continued for 510 days.

The methods of total crude protein Kjeldahl (AOAC, 1990), crude oil analysis (Bling & Dyer, 1959), crude ash analysis (AOAC, 1984), moisture analysis (Ludorf & Meyer, 1973) were used in nutrient composition analysis. Carbohydrate and energy amounts were calculated according to Merril & Watt (1973). The analysis of the nutritional composition of fresh bonito fish was carried out in two repetitions, three in parallel. During the storage period; the total volatile basic nitrogen (TVBN) (Antonacopoulos & Vyncke, 1989), the thiobarbituric acid level (TBA) [Erkan & Özden (2008) and Tarladgis et al. (1960) the methods were used together], the pH (Curran et al., 1980). An automatic water activity machine, the Novasina LabSwift-Aw meter, was used to determine the water activity (aw), the total aerobic mesophilic bacteria count (TAMB) and the total yeast and mold (TYM) count (Baumgart, 1986; Kılınç & Çaklı, 2005) and sensory analysis (Anonymous, 1988), of the canned bonitos in both groups were determined. In sensory analysis, it was taken according to 6 panelists. According to General Principles of Canned Fish Canned Fish (Anonymous, 1988), quality ranking of canned fish, first quality products get 15 points, second quality products get 14.9-13.0, third quality products get 12.9-11.0 and fourth quality products gets 10.9-6.

Results

The quality of the raw fish is the basic factor that governs the final product quality. This applies as much to canned fish as to any other food product. Estimation of the quality parameters is possible using both organoleptic and analytical methods in

the laboratory and chemical and microbiological testing are have been done in this research. Crude protein, crude oil, crude ash and moisture values were determined as 23.125±1.062%, 2.783±0.339%, 1.150±0.212% and 72.717±0.652%, respectively (Figure 1). Carbohydrate (Figure 1, column right) and energy (Figure 1, column left) amounts were determined as 0.275 g/100 g and 157.43 kcal/100 g, respectively.

The pH value, which was determined as 5.47±0.01 in the group R at the beginning of the storage and as 5.39±0.008 in the control group, was determined as 5.73±0.06 and 6.03±0.01 on the 510th day, the last day of storage, respectively (Figure 2). As a result of analysis of variance and Tukey test, the difference between groups was found to be significant ($p<0.05$).

When the TVB-N results were examined, the average values of groups R and C on the first day were determined as 14.3±0.56 mg/100 g, 15.33±1.12 mg/100 g, respectively (Figure 3). The amount of TVB-N increased in both groups during the storage period. The amount of TVB-N was determined as 35.49±2.75 mg/100 g, exceeding the consumable limit value in the C group on the 450th day, and 28.02±2.75 mg/100 g in the R group on the 2nd day. And it has been determined that it does not exceed the consumable limit value. As a result of the variance analysis and Tukey test, the effect of storage time and groups on the amount of TVB-N was found to be significant ($p<0.05$).

In the study, the TBA value of groups R and C was determined as 0.88±0.02 mg malonaldehyde/kg and 0.67±0.101 mg malonaldehyde/kg, respectively, on the first day. An increase due to storage was observed in both groups. TBA values of groups R and C were determined as 4.95±0.12 mg malondialdehyde/kg and 7.18±0.22 mg malondialdehyde/kg, respectively, on day 510 (last day of storage) (Figure 4). As a result of the variance analysis and Tukey test, the effect of storage time and groups on the amount of TBA was found to be significant ($p<0.05$).

Water activity (aw) values were found to be 0.982±0.001, 0.98±0.001 in the R and C groups, respectively, on the first day of storage. On the 510th day, which is the last day of storage, it was determined as 0.96±0.002 and 0.959±0.097 in groups R and C, respectively (Figure 5). The variance analysis and Tukey test performed showed that the server storage time and the effect of the groups were significant ($p<0.05$).

Preparation of raw materials for canning, processing issues from the fresh product to the finished product, from the intestinal microflora of the fish to cross-contamination should be considered. Comprehensive planning of canned products in the production environment should be done, it is important to avoid contact between the beginning and the end of production. Microorganisms that can cause fish spoilage include yeasts, molds, bacterial cells and spores (Bratt, 2010). The results of the total number of mesophilic aerobic bacteria (TMAB) were determined as 2.13±0.04 log cfu/g in group R and 2.10±0.06 log cfu/g in group C on the first day (Figure 6). Considering the changes in the number of TMAB in the study, there was an increase due to storage in both groups, and on the 510th day, the last day of the last storage, the number of TMAB in R and C groups was 0.20 log cfu/g and 5.98±0.09 log cfu/g, respectively. As a result of analysis of variance and Tukey test, the effect of storage time and groups on the amount of TMAB was found to be significant ($p<0.05$).

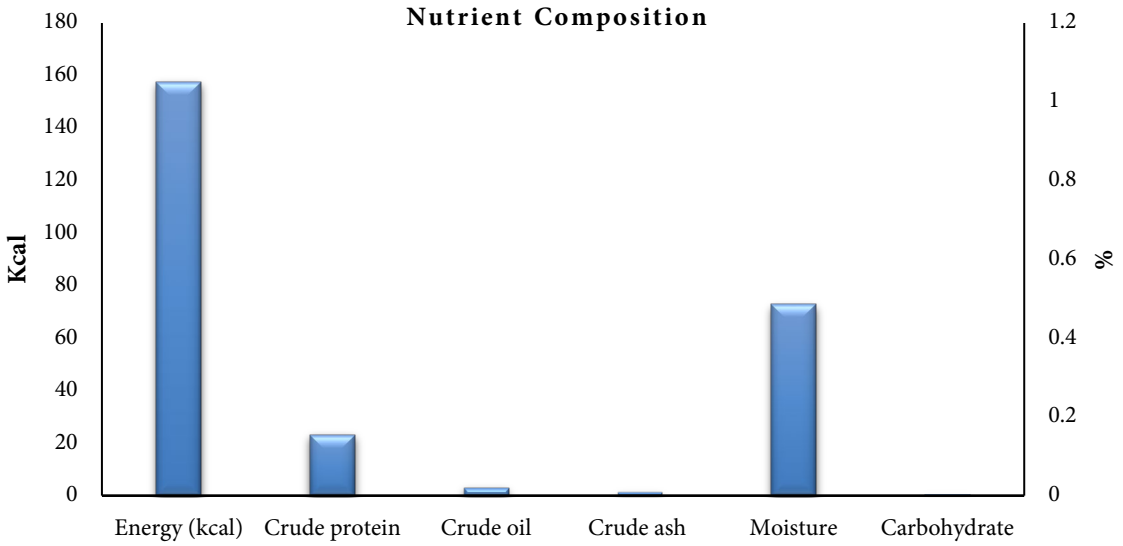

Figure 1. Nutrient composition of bonito

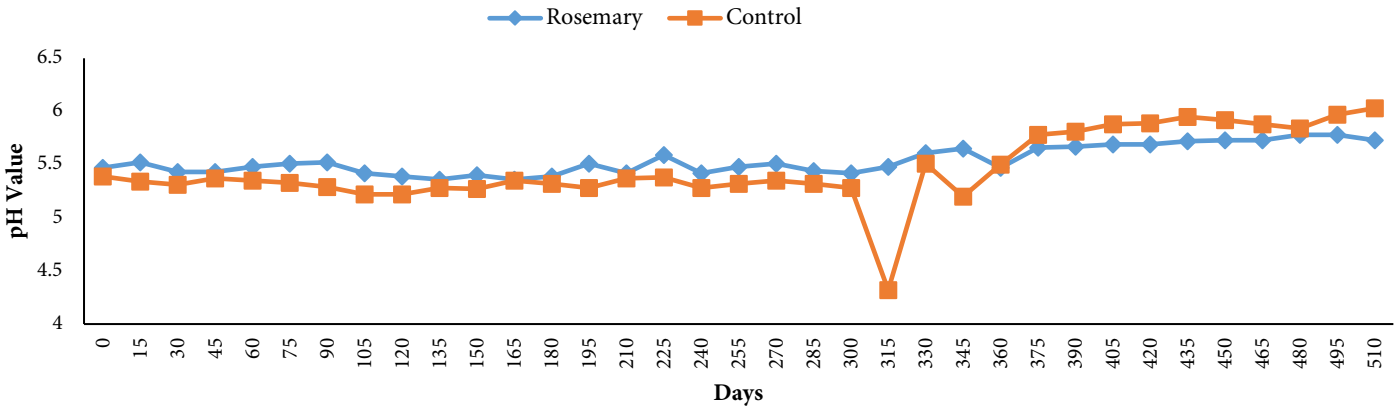

Figure 2. pH change during storage

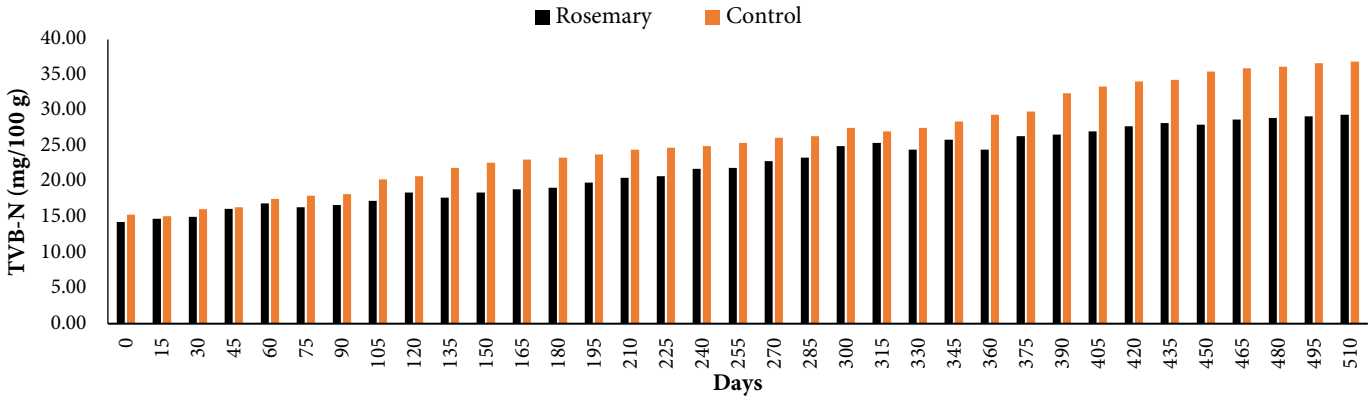

Figure 3. TVB-N change during storage

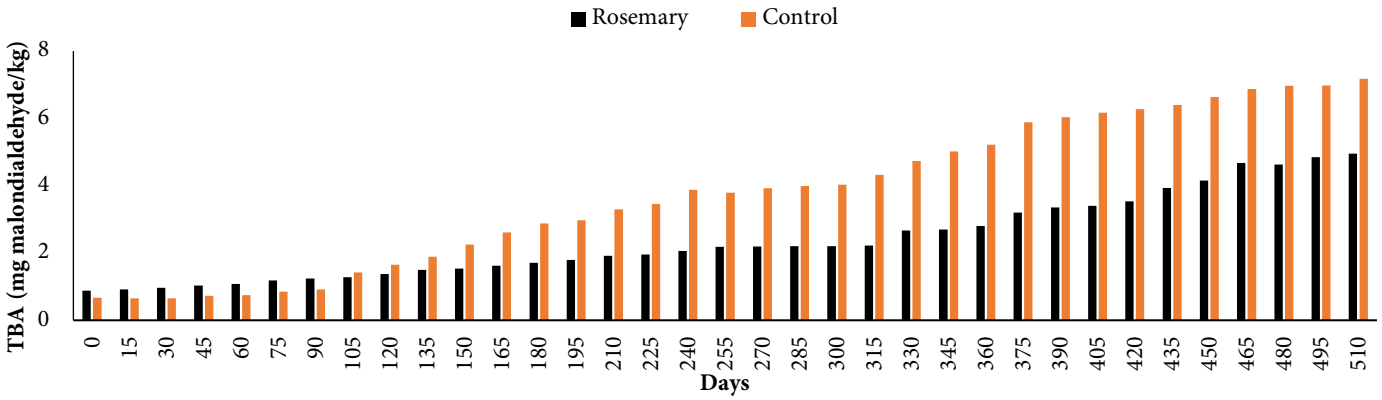

Figure 4. TBA change during storage

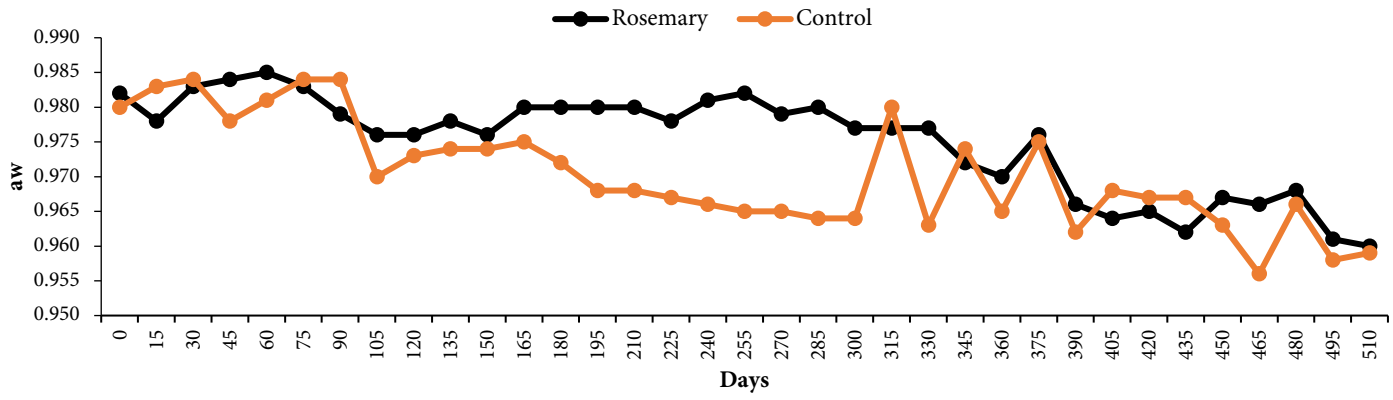

Figure 5. Water activity (aw) values

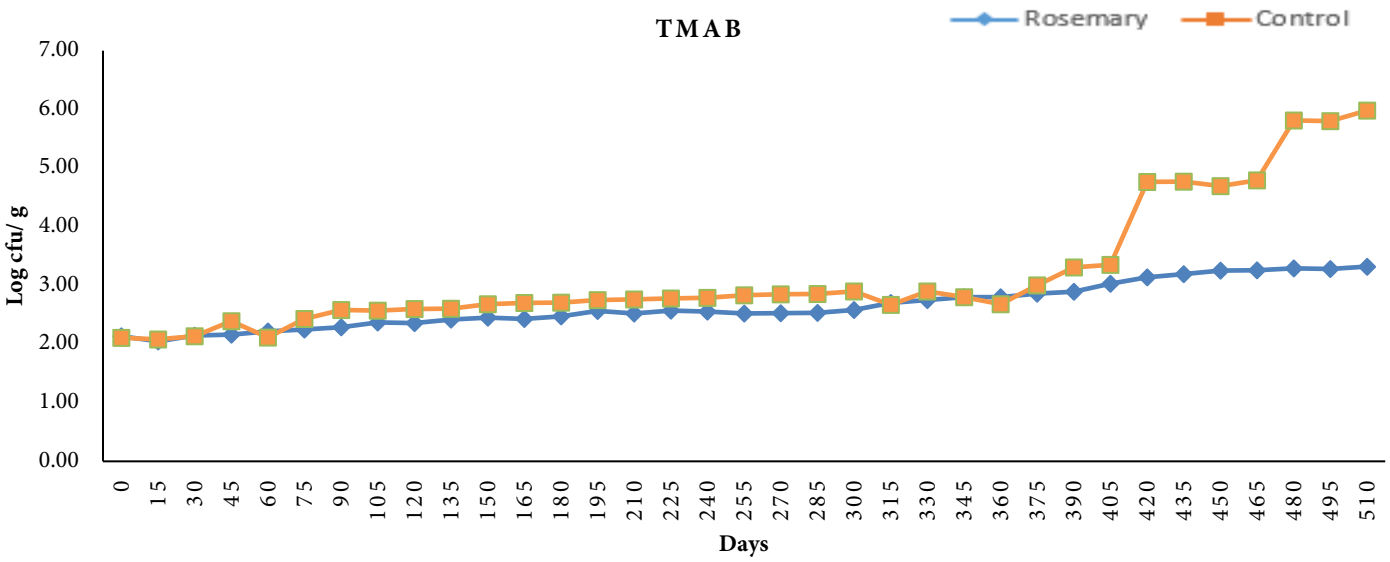

Figure 6. TMAB change during storage

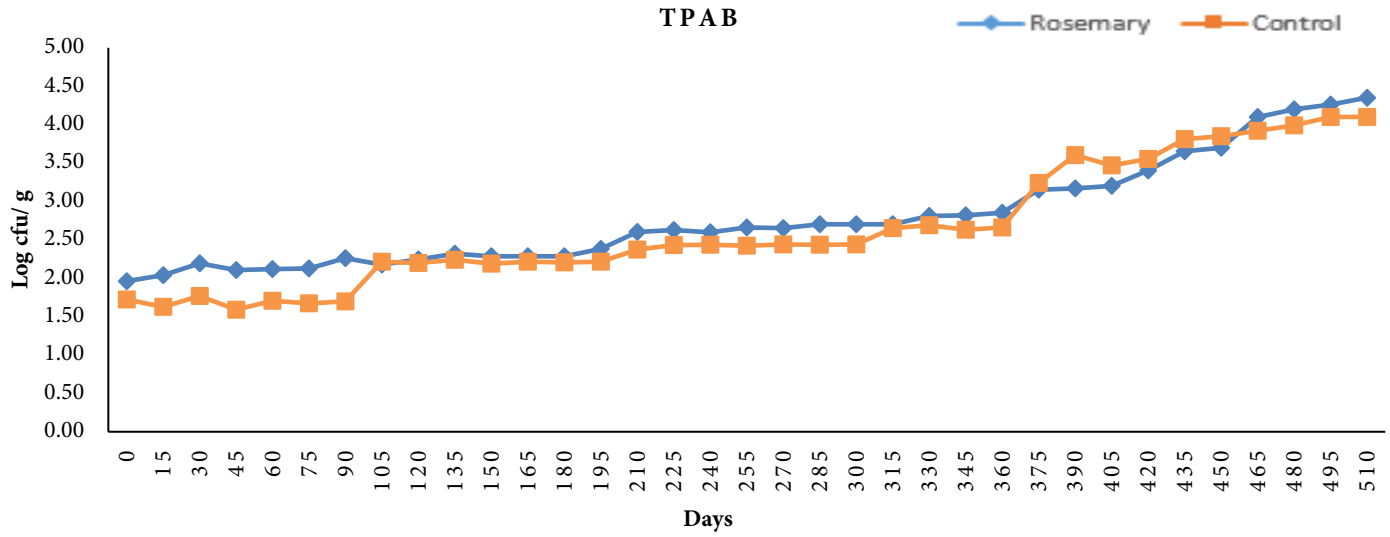

Figure 7. TPAB change during storage

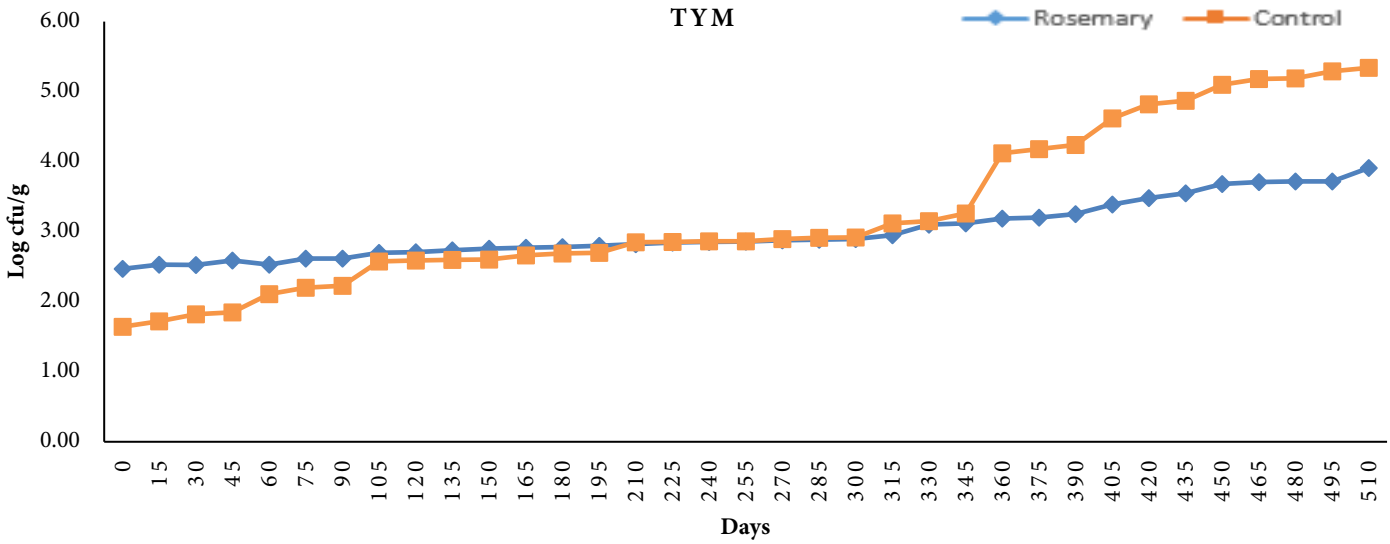

Figure 8. TYM change during storage

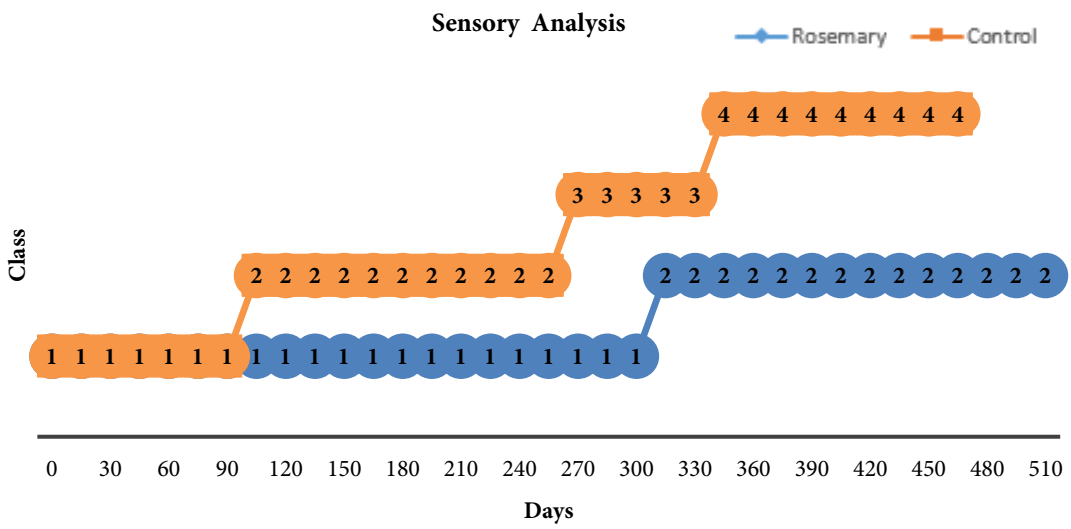

Figure 9. Sensory analysis during storage

The first-day results of the total psychrophilic aerobic bacteria (TPAB) count of groups R and C were determined as 1.96±0.03 log cfu/g and 1.72±0.12 log cfu/g, respectively (Figure 7). There was a steady increase in both groups during storage. On the 510th day, the last day of storage, TPAB results were 4.35±0.30 log cfu/g and 4.10±0.04 log cfu/g in groups R and C, respectively. As a result of analysis of variance and Tukey test, the effect of storage time and groups on the amount of TPAB was found to be significant ($p<0.05$).

Total yeast and mold (TYM) counts on the first day of storage in groups R and C were determined as 2.46±0.02 log cfu/g and 1.64±0.12 log cfu/g, respectively, and an increase was observed in both groups depending on the storage period. On the 510th day, which is the last day of storage, yeast and mold numbers of groups R and C were determined as 3.91±0.3 log cfu/g and 5.34±0.09 log cfu/g, respectively (Figure 8). As a result of analysis of variance and Tukey test, the effect of storage time and groups on TYM amount was found to be significant ($p<0.05$).

In order to determine their quality, sensory analysis was performed in both groups for 510 days and it was calculated which quality class of canned food products they were. The panelists generally accepted the rosemary-added group with appreciation according to the control groups in terms of appearance, taste, smell and consistency. It has been determined that from the first day of storage to the 300th day, it is a R group 1st class product, and from the 310th day to the 510th day, which is the last day of storage, it is a 2nd class product. In the C group, the canned goods that were 1st class until the 105th day were determined as 2nd class until the 270th day, 3rd class until the 330th day, 4th class until the 480th day, and then they were declared as "non-consumable" by the panelists (Figure 9). As a result of variance analysis and Tukey test, 105% of the storage was performed. the effect of storage time and groups from day to day was found to be significant ($p<0.05$).

Discussion

Recently, studies on obtaining natural antioxidants from different sources have increased. For this purpose, new natural antioxidants have been discovered as a result of studies on plant and spice species (sage, green tea leaves, pomegranate peel, grape seeds, nettle, basil, thyme, rosemary, etc.) (Vareltzis et al., 1997; Serdaroğlu & Felekoğlu, 2005; Da Silva Afonso & Sant'ana 2008; Al-Bandak et al., 2009; Turhan et al., 2009). Investigating the nutritional components of red and white muscles in bonito fish, Öksüz et al. (2008), Duyar et al. (2016) and Kınay et al. (2020) showed parallelism with the results of the study.

When nutritional composition examined, crude protein, crude oil, crude ash and moisture values were determined as 23.125±1.062%, 2.783±0.339%, 1.150±0.212% and 72.717±0.652%, respectively. Kınay et al. (2020) calculated crude protein, crude oil, crude ash and moisture values as 23.88±0.575%, 360±0.051%, 70.61±0.675%, 0.97±0.010%, respectively. Duyar et al. (2016) investigated the effect of coating and vacuum packaging the nutritional composition of bonito fish and reported that crude protein was 25.78±0.62%, crude oil was 3.66±0.38%, moisture was 69.57±0.61%, and raw ash was 0.98±0.10%. The results show parallelism with these studies.

The pH value, which was determined as 5.47±0.01 in the group R at the beginning of the storage and as 5.39±0.008 in the

control group, was determined as 5.73±0.06 and 6.03±0.01 on the 510th day, the last day of storage, respectively. Many canned fish products contain ingredients with a pH above 4.6 and a water activity above 0.85. Thus, canned fish products are considered low acid canned foods. Regulatory requirements for the production of low acid canned fish products take into account target organisms that must be controlled to produce commercially sterile products (Bratt, 2010). The pH data are in parallel with the values set in the corresponding book.

In quality classification according to TVB-N values, samples containing 25 mg/100 g TVB-N are very good, samples containing 30 mg/100 g TVB-N are good, samples containing 30-35 mg/100 g TVB-N are marketable, 35 mg/100 g TVB-N Samples containing more than 100 g of TVB-N are considered degraded (Varlık et al., 1993). The amount of TVB-N increased in both groups during the storage period. On the 450th day, when C group exceeded the consumable limit value and was determined as 35.49±2.75 mg/100 g, R group was determined as 28.02±2.75 mg/100 g. It was determined that group R did not exceed the TVB-N value and the consumption limit value until the end of storage (510 days). In his study examining the sensory, chemical and microbiological effects of natural antioxidants obtained from aromatic plants on fish fillets, Kenar (2009) reported that the TVB-N value increased during the storage period, and the TVB-N values of rosemary extract with sardine fillets were lower than the control group. The results show parallelism with the study.

Oily fish contain high levels of unsaturated fatty acids. For this reason, it is attacked by atmospheric oxygen and causes bitterness. This is why some oily fish, such as sardines and mackerel, have a shorter shelf life than lean fish, even when frozen (Slabjy & True, 1978). TBA value, which is one of the most important criteria of spoilage in meat, emerges as a result of fat oxidation and is considered as one of the most important criteria of quality criteria (Günlü, 2007). TBA change amounts of rosemary and control groups were determined as 0.88±0.02 mg malonaldehyde/kg, 0.67±0.101 mg malonaldehyde/kg on the first day, respectively. A steady increase was observed in both groups during storage. Yerlikaya & Gokoglu (2010), Kenar (2009), Yasin & Abou-Taleb (2007), and Duman et al. (2012) reported that oxidation occurred more in the control groups in terms of TBA amount in their study where they used plants (rosemary, sage tea, marjoram, thyme) as natural antioxidants. The results show parallelism with the present study.

It has been reported that canned foods are included in the high moisture content foods group with aw values above 0.90. It has been stated that such foods carry the risk of bacterial spoilage, and at aw values below 0.90, deterioration related to fermentation and mold growth due to yeasts may begin (Özay et al., 1993). They determined aw values in various foods (canned foods, soft drinks, meat, milk and flour products, confectionery, honey and jams, shelled and dried fruits, cereals, legumes, spices, instant soups, etc.). In their studies in which some cans were examined in terms of aw, it was reported that aw values were in the range of 0.994-0.998 (Özay et al., 1993) and the results show parallelism.

Gökoğlu (1993) examined the sensory characteristics such as color, taste, texture and smell in canned sardine according to the 1-9 evaluation system and they found average values between 6 and 6.5 in fish. Erüstün (1984) reported that in the sensory evaluation of canned sardines produced by five different companies, after 9 months of storage, the products of four companies were of first quality and the products of the other company were of second quality. It has been determined that from the first day of storage to the 300th day, it is a R group 1st class product, and from the 310th day to the 510th day, which is the last day of storage, it is a 2nd class product. In the C group, the canned goods that were 1st class until the 105th day were determined as 2nd class until the 270th day, 3rd class until the 330th day, 4th class until the 480th day, and then they were declared as "non-consumable" by the panelists. The results show parallelism with the study.

In the production of canned fish products, as with most foods, the microbiological content of the raw material is essential for the effective preservation or stability of the end product. After harvesting, microbial growth on and in the raw fish must be minimized (Bratt, 2010). It has been reported that the number of microorganisms in nutrients is an important criterion in terms of both human health and quality (Karaçam, 1998), and the microbial flora in fresh fish is 6 log cfu/g (Huss, 1988). Gargacı (2010), Kenar (2009), and Aysel (2008) reported that the control groups had a higher antimicrobial load in their studies with aromatic plants. Kobya et al. (2021), noticed that, plant extracts have the potential to be used as an antioxidant agent in processing technology. In general, considering the microbial flora detected in our study, it is thought that there is a microbial load because rosemary is taken from herbalists and is not in compliance with the standards and is not treated with radiation. Therefore, in our study, the antimicrobial properties of rosemary as TMAB and TPAB were not found. Duman et al. (2012) found that rosemary and thyme essential oils, waters and extracts showed antifungal effects at different rates on molds in studies conducted in culture media. Elgayyar et al. (2001), examining the effects of essential oils obtained from plants

against selected pathogens and saprophytic microorganisms, it was reported that rosemary and thyme essential oils, juices and extracts showed antifungal effects at different rates on molds. The results show parallelism with all studies with the antioxidant effect of rosemary.

Conclusion

In our study, in which the effect of rosemary plant used in canned bonito fish prepared with the traditional method was investigated, it was determined that rosemary provides both sensory and antioxidant properties. The most important positive changes in our study were TVB-N, TBA and sensory aspects. It has been determined that rosemary increases the sensory and chemical consumability and reliability of the product after canning bonito fish. The preservation of fishery products, which is one of the foods whose storage and preservation is problematic, with different methods and technologies should be investigated in more detail.

Compliance With Ethical Standards

Authors' Contributions

Author HAD designed the study and AGK performed and managed statistical and chemical analyses. Both authors read and approved the final manuscript.

Conflict of Interest

The author confirms that no conflicts of interest exist and the funders had no role in study design, data collection, analysis, and decisions.

Ethical Approval

For this type of study, formal consent is not required.

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