SEASONAL IMPACT OF HARVESTING ON THE FRESHNESS AND QUALITY OF EUROPEAN SEABASS MEAT (*Dicentrarchus labrax* Linnaeus, 1758)

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Summary

The main goal and task of this research is to determine the most suitable and effective method of stunning fish during harvesting which affects the maintenance of freshness and quality of fresh market size seabass meat, and also to determine in which season during storage seabass maintains better quality and freshness of meat. Fish harvesting and stunning were performed twice on the fish farm in the Bay of Neum, during summer and winter period. The fish were stunned using two methods, stunning in ice/sea water mixture (group I) and stunning with anaesthetic (group II). Values of temperature and pH of fish meat and lactate in the blood were also recorded during the fieldwork, then each fish was transported to Sarajevo for further analysis. In the laboratory were conducted the following methods and analysis: measured length and weight for each fish; the chemical composition of fish meat was determined; physico-chemical characteristics of meat; values of the Quality Index Method (QIM) were determined. The results of temperature and pH of meat and content of lactate in the blood don't show statistically significant differences between two groups. QIM results don't show statistically significant differences between two groups within one season, but QIM results show statistically significant differences when comparing summer and winter period, and on the basis of these results it is concluded that seabass during winter storage maintains a longer period of time better quality and freshness than in summer period.

Key words**:** *Seabass, Harvesting, Stunning, Quality, Freshness*

INTRODUCTION

Perch-like fishes (lat. Perciformes) have a first-rate importance in world marine fisheries. About 75% of the species of this order live along the sea coastline, and other species in the open waters and freshwaters (Bogut *et al.*, 2006). Order Perciformes contains 20 suborders, 160 families, about 1539 genera, and about 10033 species (Nelson, 2006). European seabass – *Dicentrarchus labrax* (Linnaeus, 1758) belongs to the family Moronidae (temperate basses). This is a marine fish, which also enters freshwaters (Vuković, 1977). It is distributed in the Mediterranean Sea and the

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eastern Atlantic, from Morocco to the southern coasts of Sweden and Norway, and around the British Isles (Treer *et al.*, 1995). In the Adriatic Sea, it is quite common in the coastal area, from where it enters the lower courses of most of its tributaries. In Bosnia and Herzegovina, European seabass is rarely found in the lower course of the Neretva river (Sofradžija, 2009). The meat of this species is highly valued. It has exceptional economic importance. In many countries this species is very successfully farmed in mariculture (Glamuzina *et al.*, 2013).

The body of the European seabass is elongated, slightly flattened laterally, covered with cycloid scales. The head is large, elongated, with a large mouth. Numerous sharp teeth are located on the jaws and on the tongue. The eyes are proportionately large. European seabass has two dorsal fins. The first dorsal fin is composed of 8 to 11 strong, sharp, unbranched spines, clearly separated from the second dorsal fin, which is composed of one hard spine and 12-16 soft rays. There are 3 hard spines and 8 to 11 soft rays in the anal fin. Caudal fin is shallowly incised. The pelvic fins are located a little behind the pectoral fins and have one hard spine. On the lower part of the preopercle bone there are 4-6 hard spines, which are facing forward. There are 2 hard spines and one dark spot on the upper corner (rim) of the gill covers; in young individuals there are 4-6 spots in this place. A serration can be seen on the back part of the gill cover. All fins are light colored and transparent. Dorsal side is usually lead-gray in color. The flanks are lighter, grey-silver, and the belly is silvery-white. There are sometimes irregularly scattered black spots on the body (Bogut *et al.*, 2006; Sofradžija, 2009; Glamuzina *et al.*, 2013).

European seabass is a typical carnivorous species. They feed mainly on small fish that live in schools, juvenile fish, worms, crustaceans and molluscs (cephalopods). They usually grow from 40 to 70 cm, rarely up to 100 cm and reaches a weight of up to 14 kg (Bogut *et al.*, 2006). Males become sexually mature during the second, and females during the third year of life (Bogut *et al.*, 2006). They spawn at the end of autumn and until the beginning of winter, in the river mouths (brackish waters). In the North Sea they spawn from May to August. Females lay, depending on the size, 400000-800000 eggs and the egg diameter is about 2 mm. The eggs are pelagic and embryonic development lasts 2-4 days (Sofradžija, 2009). There is a large fat globule in the eggs (Bogut *et al.*, 2006).

In the beginning, this species was mainly farmed in coastal lagoons before the race for mass production of European seabass fry began in the late 1960s. During these years, France and Italy competed to develop the most reliable technique for mass production of European seabass fry, and by the late 1970s, these techniques were sufficiently well developed in most Mediterranean countries as well. European seabass was the first marine non-salmonid fish to be commercially farmed in Europe, and is currently the most important commercial fish farmed in the Mediterranean area. Greece, Turkey, Italy, Spain, Croatia and Egypt are the largest producers of this species (FAO Yearbook, 2008). Total European seabass world production in 2019 was an estimation of 236215 tonnes. Turkey is the biggest producer accounting 52.21% (137419 tonnes) of world European Seabass production. Followed by Greece accounting for 15.67% (41237 tonnes) of production, and Egypt with 11.52% (30313 tonnes) of production (FAO Yearbook, 2021).

One of the most important characteristics in terms of fish quality is the freshness of the fish. Fresh fish is a highly perishable product (Ashie *et al.*, 1996; Gram and Husse, 1996). The loss of fish quality largely depends on the fish species, but also on the conditions of preservation and storage (Whittle *et al.*, 1990). Biochemical, microbiological and sensory changes affect the quality of fish during storage and preservation (Ehira and Uchiyama, 1986). The characteristic odor of fish during spoilage is attributed to trimethylamine (TMA), and this odor is more prevalent in large fish compared to small fish (Hamilton *et al.*, 1994; Özogul *et al.*, 2005). Also, a low pH level in meat (6.13) can lead to a shorter shelf life compared to the optimal pH value (Fletcher, 2002).

MATERIALS AND METHODS

Sampling of European seabass was carried out at the fish farm in the Bay of Neum on two occasions, during the summer period and sampling during the winter period. On both occasions, 50 individuals of this species, of consumption size (250-350 grams), were taken as a sample. Each individual of sampled fish is marked with a special stamp. During sampling, a basic analysis of the samples was performed (measuring the meat temperature of each individual, pH of meat and lactate level in the blood) as well as measurements of the basic physico-chemical characteristics of the water (water temperature, water pH value and dissolved oxygen level in the water). The sampled fish were divided into two groups. Fish from group I (n=25) were stunned in a solution of sea water and ice. Fish from group II (n=25) were stunned in a solution of sea water and anesthetic.

After the field measurements, fish from both groups were placed in ice boxes, then placed in plastic bags, and transported to Sarajevo, more precisely to the laboratory of the Center for Aquaculture and Fisheries at the Faculty of Agriculture and Food Sciences in Sarajevo. The samples were stored and preserved in a cold and dark room, with a controlled microclimate. Laboratory analyses included the following parameters: measurement of basic morphometric characteristics for each individual (standard body length and total weight), condition factor, meat temperature, meat pH, sensory analysis – the Quality Index Method (QIM) and determination of moisture, fat and protein content in European seabass meat.

RESULTS AND DISCUSSION

Day after sampling the fish, the basic morphometric characteristics of the individuals for both examined groups were measured. Two basic morphometric characteristics were measured, weight (body mass) and standard length of the fish. Based on the obtained average values of these measures, the condition factor was calculated using the following formula:

$K = W \cdot L^{-3} \cdot 100$,

where W is the weight of the fish in grams, and L is the standard length of the fish in centimeters.

Table 1 shows the average values for weight and standard body length, as well as values of the condition factor for the two examined groups of fish in two seasons (summer and winter).

Table 1. The average values ± SD of morphometric characteristics and condition factor by season

Parameter	**Season**			
	Summer (n=50)		**Winter (n=50)**	
	Group I	**Group II**	**Group I**	**Group II**
Weight (g)	326.8 ± 115.9	311.0 ± 103.1	322.6 ± 58.8	309.8 ± 86.8
	319.1 ± 108.9		316.2 ± 73.7	
Standard length (cm)	29.2 ± 3.2	28.2 ± 2.7	27.4 ± 1.5	26.6 ± 2.2
	28.7 ± 3.0		27.0 ± 1.9	
Condition factor	1.35		1.61	

Based on the obtained results, it can be concluded that the values of the mentioned measures for the two examined seasons were approximate and that it is a uniform population without statistically significant differences ($P>0.05$). The condition factor of the fish in the summer period for both examined groups was 1.35, while in the winter period it was 1.61 for the same groups.

Table 2 shows the average values of the chemical composition of European seabass meat – the average percentage of protein, fat and moisture in the meat of fish harvested during the summer and winter period.

Table 2. The average percentage ± SEM of protein, fat and moisture in European seabass meat

Parameter	**Season**	
	Summer	**Winter**
Protein (%)	18.4 ± 0.4	20.4 ± 0.3
Fat (%)	1.5 ± 0.2	1.1 ± 0.1
Moisture (%)	77.7 ± 0.6	74.7 ± 0.5

The meat of European seabass harvested during the summer period contained an average of 18.4% protein, 1.5% fat and 77.7% moisture, while the meat of European seabass harvested during the winter period contained an average of 20.4% protein, 1.1%

fat and 74.7% moisture. The data from this table indicate that the average percentage values of moisture and fat were higher in fish harvested in the summer period, while the average percentage values of protein in European seabass meat were higher in fish harvested during the winter period. The obtained results show that there is no statistically significant difference between fish harvested in two different seasons (P>0.05).
Table 3 shows the average values of basic physico-chemical parameters of fish meat harvested in summer and winter, measured after stunning.

Table 3. The average values ± SEM of basic physico-chemical parameters of European seabass meat

Parameter	Season			
	Summer		Winter	
	Group I	Group II	Group I	Group II
Temperature of meat (°C)	10.8 ± 0.5	21.0 ± 0.5	2.9 ± 0.2	13.2 ± 0.03
pH of meat	7.06 ± 0.1	7.09 ± 0.2	7.16 ± 0.04	7.20 ± 0.1
Lactate level (mmol/l)	2.7 ± 0.4	3.4 ± 0.4	2.2 ± 0.3	2.8 ± 0.3

The obtained results of the average value of meat pH and lactate level in the blood do not show a statistically significant difference between these two examined groups (P>0.05). For fish harvested during the summer period, the average pH values of the meat were 7.06 for group I and 7.09 for group II, while these values for fish harvested in the winter period were 7.16 for group I and 7.20 for group II. The concentration of lactate in the blood of European seabass was also similar between these two examined groups and amounted to 2.7 mmol/l (group I) and 3.4 mmol/l (group II) for fish harvested in summer, while the average values of lactate for fish harvested during the winter period amounted to 2.2 mmol/l for group I and 2.8 mmol/l for group II (see Figure 1).

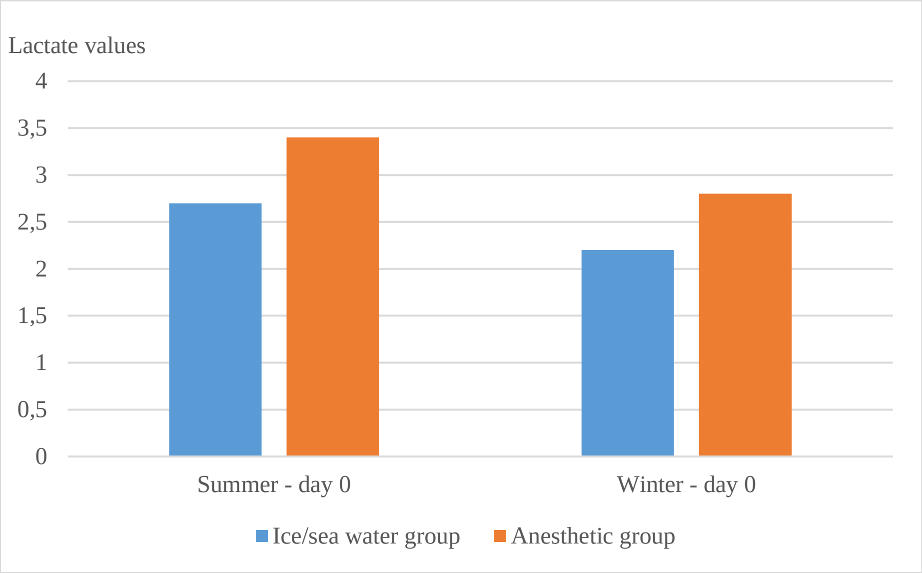

Figure 1. The average values of lactate in the blood of European seabass

The average pH values of the meat between examined groups during storage were approximately the same on day zero and also during all other days of storage in ice. The results of mean pH values of European seabass meat do not show a statistically significant difference between group I and group II ($P>0.05$).

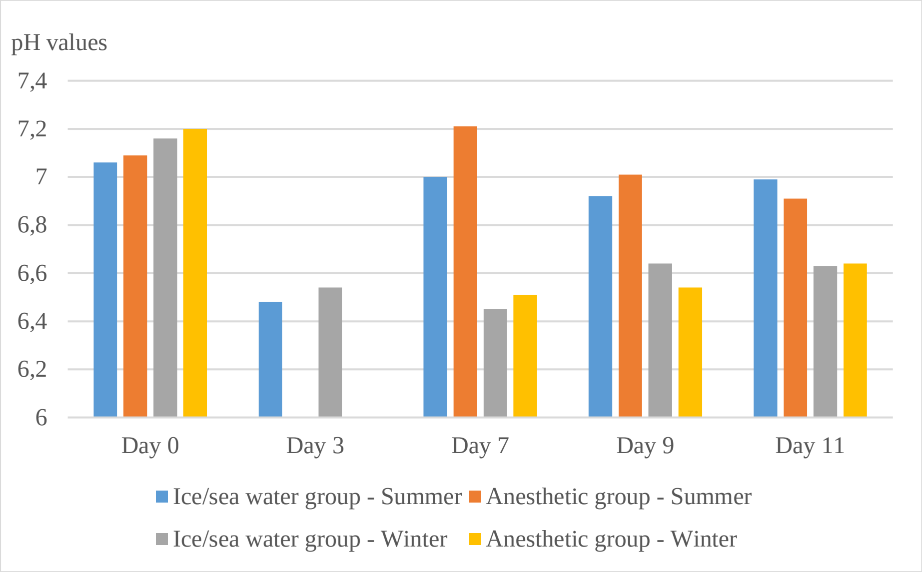

Figure 2. The average pH values of European seabass meat during storage

Table 4 shows the average values of the Quality Index Method for both groups of fish harvested during the summer and winter period, and these values were obtained during the analysis in storage days.

Table 4. Values of the Quality Index Method for European seabass harvested in summer and winter period

Quality parameter		Day 3.	Day 4.	Day 7.		Day 9.		Day 11.	
		Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II
		Summer							
Skin	Colour	0	0	0	0	0	0.2	1.6	1.5
	Odour	0	0.2	1.0	1.0	1.2	1.2	1.8	1.8
	Texture	0	0.7	1.0	1.0	1.0	1.0	1.3	1.4
Eyes	Pupils	0	0.3	0.2	0.4	1.2	1.0	1.6	1.4
	Form	0	0.2	0.6	1.0	1.1	1.0	1.1	1.2
Gills	Colour	0	0.2	0.7	0.9	0.9	1.1	1.3	1.6
	Mucus	0	0.5	1.0	0.8	1.4	1.7	1.6	1.7
	Odour	0.1	0.8	1.0	0.7	1.5	1.9	2.0	1.8
Viscera	Solution	0	0.1	0.8	0.5	0.9	0.8	1.0	0.8
Quality Index		**0.1**	**3.0**	**6.3**	**6.3**	**9.2**	**9.9**	**13.3**	**13.2**
		Winter							
Skin	Colour	0	0	0	0	1.5	1.5	1.6	1.6
	Odour	0	0	0	0	1.5	1.5	1.6	1.6
	Texture	0.1	0	1.0	1.0	1.0	1.0	1.2	1.2
Eyes	Pupils	0	0	0	0	2.0	2.0	1.6	1.6
	Form	0	0	0	0	1.0	1.0	0.8	0.8
Gills	Colour	0.05	0.1	0	0	0.6	0.8	0.6	1.2
	Mucus	0.05	0.2	0.5	0.5	0.6	0.8	0.6	1.2
	Odour	0.05	0.05	0	0	0.6	0.8	1.1	1.4
Viscera	Solution	0	0	0.4	0.4	0.8	0.6	0.4	0.6
Quality Index		**0.25**	**0.35**	**1.9**	**1.9**	**9.6**	**10.0**	**9.5**	**11.2**

The obtained results of the average QIM values between the examined groups, harvested in the summer period, do not show a statistically significant difference ($P>0.05$). During the 3rd day of storage, the analysis was performed on 10 fish (all from the group I) and the average value was 0.1. On the 4th day of storage, the analysis was performed on 10 fish (all from the group II) and the average value was 3. During the other days of storage, the analysis was performed on 10 fish (5 from group I and 5 from group II). On the 7th day of storage, the average value for both, group I and group II, was 6.3. On the 9th day of storage, the values were 9.2 (group I) and 9.9 (group II), while on the 11th (last) day of storage and analysis, the values were 13.3 for group I and 13.2 for group II.

The obtained results of the average QIM values between the examined groups, harvested in the winter period, do not show a statistically significant difference (P>0.05). During the 3rd day of storage, the analysis was performed on 10 fish from group I and the average value was 0.25, while on the 4th day the analysis was performed on 10 fish from group II and the average value was 0.35. During the other days of storage, the analysis was also performed on 10 fish (5 from the group I and 5 from the group II). On the 7th day of storage, the average value for both, group I and group II, was identical and amounted to 1.9. On the 9th day, the average values of the Quality Index Method were 9.6 for group I and 10 for group II, and on the 11th day they were 9.5 (group I) and 11.2 (group II).

Figure 3 shows the average QIM values for fish from group I (summer-winter).

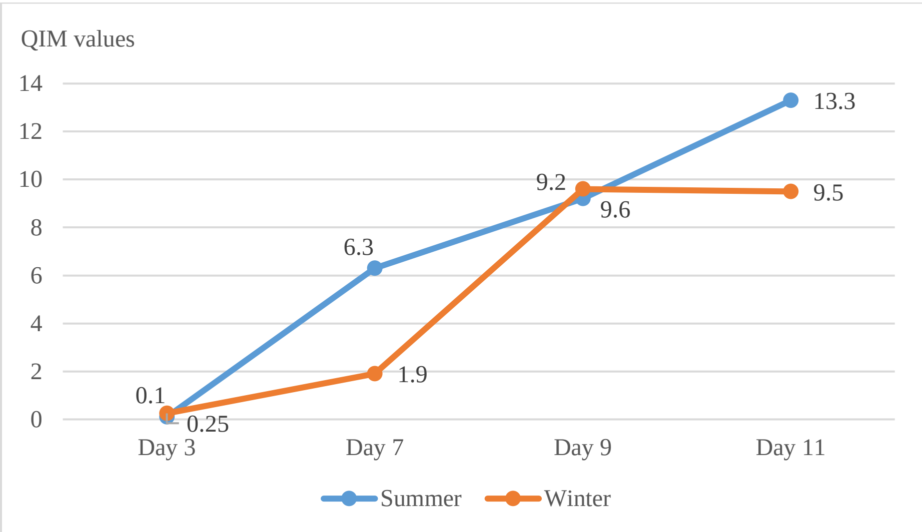

Figure 3. The average values of the Quality Index Method for group I (summer-winter)

The average QIM values were generally lower during the winter period, which is understandable since the temperature values are significantly lower during the winter period, which favor better preservation of fish meat from spoilage. The QIM values during the summer period began to increase sharply after the 3rd day of storage, while in the winter period after the 7th day. For fish harvested in summer, the values ranged from 0.1 (day 3) to 13.3 (day 11), while for fish harvested in winter they ranged from 0.25 (day 3) to 9.5 (day 11). The biggest value differences were on the 7th and 11th day.

Figure 4 shows the average QIM values for fish from group II (summer-winter).

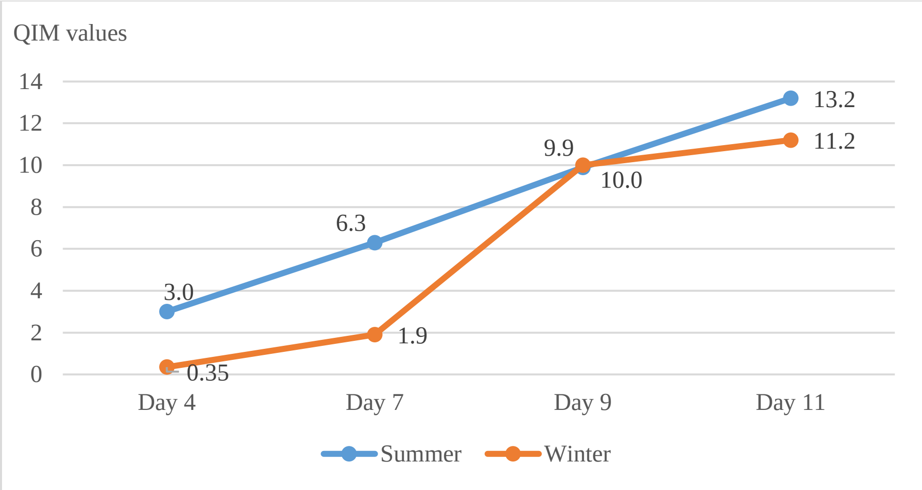

Figure 4. The average values of the Quality Index Method for group II (summer-winter)

The average QIM values for fish from group II were also lower during the winter period. The Quality Index Method values during the summer period showed a constant increase after the 4th day of storage, while in the winter period they increased after the 7th day of storage. For fish harvested in the summer period, the values ranged from 3 (day 4) to 13.2 (day 11), while for fish harvested in winter they ranged from 0.35 (day 4) to 11.2 (day 11). The biggest value differences were on the 4th, 7th and 11th day.

CONCLUSION

The obtained research results about impact of stunning methods on the freshness and quality of European seabass meat (condition factor, chemical composition of the meat, meat pH, lactate level in the blood and Quality Index Method) showed that there is no statistically significant difference between group I (stunned in a mixture of sea water and ice) and group II (stunned in a mixture of sea water and anesthetic) within the season in which the individuals were harvested. Only the temperature values of European seabass meat, which were measured on the day zero immediately after fish harvesting and stunning, showed a statistically significant difference between the examined groups ($P<0.05$), which is understandable since the fish from group I were stunned using ice, and the fish from group II were stunned using anesthetic. However, temperature values of European seabass meat, measured during the storage days, did not show statistically significant differences between these two groups. The obtained research results about mentioned parameters of freshness and quality of European seabass meat, apart from the sensory analysis (the Quality Index Method), also showed that there is no statistically significant difference between seasons of fish harvesting. Parameter values of freshness and meat quality of fish harvested during the summer period did not differ statistically significantly from the results obtained after harvesting in the winter period. Only total results of the Quality Index Method values, between these two seasons, show a statistically significant difference ($P<0.05$).

REFERENCES

Ashie, I. N. A., Smith, J. P., Simpson, B. K. (1996). Spoilage and shelf-life extension of fresh fish and shellfish. Crit Rev Food Sci Nutr 36(1/2):87-121.

Bogut, I., Novoselić, D., Pavličević, J. (2006). Biologija riba. Sveučilište J. J. Strossmayera u Osijeku, Sveučilište u Mostaru.

Ehira, S., Uchiyama, H. (1986). Determination of fish freshness using the k value and comments on same other biochemical changes in relation to freshness. In: Kramer, D. E., Liston, J. (Eds.), seafood Quality Determination. Elsavier Science, B.V, Amsterdam, pp. 185-207.

FAO Yearbook. (2008). Fishery and Aquaculture Statistics. Statistiques des pêches et de l'aquaculture. Estadísticas de pesca y acuicultura 2006. Food and Agriculture Organization of the United Nations Rome.

FAO Yearbook. (2021). Fishery and Aquaculture Statistics. Statistiques des pêches et de l'aquaculture. Estadísticas de pesca y acuicultura 2019. Food and Agriculture Organization of the United Nations Rome.

Fletcher, G. C., Summers, G., Corrigan, V., Cumarasamy, S., Dufour, J. P. (2002). Spoilage of king salmon (*Oncorhynchus tshawytscha*) fillets stored under different atmospheres. J Food Sci 67(6):236–74.

Glamuzina, B., Pavličević, J., Tutman, P., Glamuzina, L., Bogut, I., Dulčić, J. (2013). Ribe Neretve. Udruga CEAV - Centar za zaštitu i promicanje endemskih i autohtonih ribljih vrsta, Mostar, Bosna i Hercegovina; Modrozelena - Zadruga branitelja, Metković, Republika Hrvatska.

Gram, L., Husse, H. H. (1996). Microbiological spoilage of fish and fish products. Int J. Food Microbiol 33:121-37.

Hamilton, R. J. In: Allen, J. C., Hamilton, R. C., editors. (1994). Rancidity in foods. 3rd ed. London. U.K.: Champan and Hall. p.p. 1-22.

Nelson, J. S. (2006). Fishes of the World. 4th Edition, John Wiley & Sons Inc., Hoboken, New Jersey.

Özogul, Y., Özyurt, G., Özogul, F., Kuley, E., Polat, A. (2005). Freshness assessment of Europian eel (*Anguilla anguilla*) by sensory, chemical and microbiological methods. Food Chem 92:745-51.

Sofradžija, A. (2009). Slatkovodne ribe Bosne i Hercegovine. Vijeće Kongresa bošnjačkih intelektualaca. Sarajevo.

Treer, T., Safner, R., Aničić, I., Lovrinov, M. (1995). Ribarstvo, Nakladni zavod Globus, Zagreb.

Vuković, T. (1977). Ribe Bosne i Hercegovine. IGKRO „Svjetlost“ – OOUR Zavod za udžbenike. Sarajevo.

Whittle, K., Hardy, R., Hoobs, G. (1990). Chilled fish and fishery products, In: Gormley, T. Editors. Chilled food. The state of the art. New York: Elsavier Appiled Science. p.p. 87-116.

SEZONALNI UTJECAJ IZLOVLJAVANJA NA SVJEŽINU I KVALITET MESA LUBINA (*Dicentrarchus labrax* Linnaeus, 1758)

Rezime

Osnovni cilj i zadatak ovog istraživanja je utvrđivanje najučinkovitije i najpovoljnije metode omamljivanja riba tokom izlova koja utiče na održavanje svježine i kvaliteta mesa konzumnog lubina, a također i utvrditi u kojem godišnjem dobu tokom skladištenja lubin održava bolji kvalitet i svježinu mesa. Izlov i omamljivanje je obavljeno u dva navrata u Neumskom zaljevu, tokom ljetnog i zimskog perioda. Ribe su omamljivane na dva načina i to u mješavini leda i morske vode (grupa I), te korištenjem anestetika (grupa II). Na terenu su također zabilježene vrijednosti temperature i pH ribljeg mesa, te vrijednosti laktata u krvi, a zatim su ribe transportovane za Sarajevo na daljnja analiziranja. U laboratoriji je izvršeno mjerenje dužine i težine svake ribe, utvrđen je hemijski sastav ribljeg mesa, fizičko-hemijski parametri mesa, a obavljena je i metoda indeksa kvaliteta (QIM). Dobijeni rezultati temperature i pH mesa, te sadržaja laktata u krvi ne pokazuju statistički značajne razlike između dvije grupe. Rezultati metode indeksa kvaliteta ne pokazuju statistički značajne razlike između grupa unutar jednog godišnjeg doba, ali pokazuju statistički značajne razlike kada se upoređuje ljetni i zimski period, te se na osnovu ovih rezultata zaključuje da je lubin tokom zimskog skladištenja održao duži vremenski period bolji kvalitet i svježinu nego u ljetnom periodu.

Ključne riječi: *lubin, izlov, omamljivanje, kvalitet, svježina*