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CHEMICAL COMPOSITION AND ENERGY VALUE IN THE MEAT OF THE MACEDONIAN AND OHRID TROUT

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Abstract: *The aim of this research is to conduct a comparative analysis and to verify the quality properties of meat of the Macedonian trout (Salmo macedonicus) and the Ohrid trout (Salmo letnica), from aquaculture production, bred on a fish farm under controlled conditions. In order to determine the quality of meat of the Macedonian and Ohrid trout, analyses of the chemical composition have been conducted: the amount of proteins, fat, water, minerals, as well as a determination of the energy value of the meat. The analyses have been made on samples from Macedonian and Ohrid trout, with size of consumption between 200g and 300g. By these analyses, it has been confirmed that in the meat of the Macedonian trout, the amount of water is 77.122%, 17.800% proteins, 3.333% fat and 1.667% minerals, whereas in the meat of the Ohrid trout 75.923% water, 16.783% proteins, 5.403% fat and 1.080% minerals. Though the established difference in the amount of water and fat is not significant, the differences determined in the contents of proteins and minerals are significant on a level p>0,05. The energy value of Macedonian trout meat is 435.29 KJ/100gm, i.e. and 498.49 KJ/100gm in the Ohrid trout meat.*

Keywords: Salmo macedonicus, Salmo letnica, quality, aqua cultural production

1. Introduction

The Republic of Macedonia has excellent conditions for the development of fishery such as the climatic conditions, the tradition of fishing and the abundance of water areas. At the beginning the Macedonia fishery was present in freshwater lakes, but after the Second World War, there was a fast development of the aquaculture [1]. In the waters of Macedonia representatives of different types of fish can be found such as: *Salmonidae* (trout), *Esocidae*, *Cyprinidae*, *Cobitidinae*, *Siluridae*, *Anguillidae* (eels), *Percidae*, *Blennidae*, *Poeciliidae*. The family *Salmonidae* includes nine different genera, with forty types of fish. In the lakes in our state, there are four genera with a large number of types and subtypes. The Macedonian trout – *Salmomacedonicus* (Karaman, 1924) is an indigenous and endemic type of fish, characteristic of the Macedonian lakes, whereas the Ohrid trout – *Salmoletnica* (Karaman, 1924) is an endemic type that lives only in the Ohrid lake and at the same time it is being bred in aquaculture, under controlled conditions on fish farms.

The protein composition of fish from aquaculture production has a very high quality and large biological and nutritive value, and speaking from an ecological point of view their breeding ranks among the cleanest and most natural breeding of animals [2].

The annual consumption of fish in Macedonia is very small, around 3.5 kg per person (together with the imported and processed fish), which is far from the annual world`s average of 15-20 kg fish per person. The main reason for small consumption and processing of fish is thought to be the insufficient domestic production, the small assortment of fish, little knowledge of the nutritive value and quality of the meat, a lack of habit for regular consumption of fish meat by the population and most often the consumption is connected with fasting religious holidays. Therefore, there is a need of informing people about the benefits for their health by consuming fish, as well as the advantages that fish meat has when compared with different types of meat: easy digestion, small amount of fat, high percent of omega-3 unsaturated fatty acids that reduce the cholesterol levels in the blood and so on [1].

The nutritive and health significance of fish and fish products in the human diet is the reason for continued higher demand on the market, especially for fish from aquaculture conditions [14, 22]. Fish meat is the most valuable and useful food product of animal origin used in human nutrition [27].

The high nutritious value of fish is manifested through the favorable content and proportion of proteins, fat, carbohydrates and minerals [3, 4]. From the components that are present in fish meat, the human organism on average uses 95-96% of proteins and up to 91% of fat.

Fish that are bred in aquaculture show slight, predictable variations in the chemical content. The controlled conditions of breeding, the content of the food such as the amount of proteins and fat, the environmental conditions, the size of the fish and the genetic potential are all factors that have influence on the content as well as on the quality of the fish bred in aquaculture [5]. The amount of nutrients in fish meat varies in accordance with the type of fish, diet, age, external conditions, season, etc. [7].

The nutritional characteristics, quality and biological value of fish meat, apart from the other factors, also depend on its chemical composition and is characterized by easy digestion, nutritious-physiologically nutritionally-physiological favorable relationship of amino acids and great amount of vitamins and minerals. Speaking from a nutritious point of view, fish is an important source of substances such as proteins which are a necessary component for human life and development [6]. Proteins are the most important content in fish meat, which combined with fats and carbohydrates form the base of healthy diet. The proteins from fish meat are equally as valuable as proteins from other kinds of meat. The amount of proteins in fish meat is 12% to 24%, which is reduced during spawning because the roe is rich in proteins, while the fish loses about 25% of its weight [8, 9]. The main characteristic of proteins is easy digestion (on average between 2 and 3 hours), better usage, favorable amino acid relation that is connected with the presence of the essential amino acids such as: methionine, lysine, tryptophan, arginine, histidine.

The amount of fat in fish varies between 0.7% and 20% and depends on the diet, type, gender, age of the fish and season [10]. According to the amount of fat, fish is classified in: lean fish that has less than 0.5% fat, medium-fat fish which has 5-10% fat and fatty fish with more than 10% fat [12]. The fat in fish usually consists of triglycerides, i.e. complex substance which

is a mix of glycerol and higher fatty acids. The amount of fat in fish is not constant and varies during the year, usually being inversely proportional with the content of water [13]. The percent of fat in fish, which can be reabsorbed in the gastrointestinal tract, is known as the coefficient of digestibility of fat in fresh, frozen and smoked [5].

The average chemical content in low fat fish is: 77-82% water, 18-19% proteins, 0.1% -1.0% fat, 1.0% - 2.0% minerals whereas in high fat fish the content is as follows: 55-79% water, 14.5-21.5% proteins, 1.1 -2.9% fat and 1.0-2.0% minerals. [16] Depending on the type of fish differences of water and fat content in the meat occur [17, 18].

Analyses have been made in order to determine the influence of the season on the chemical content of meat from different types of carp. In the examined samples the amount of proteins varied between 13.0 – 21.9%, fat 0.3 – 23.9%, water 59.8 – 84.2% and minerals from 0 to 16% [20]. The results show that the season has no big influence on the chemical content of the carp (proteins, water, fat and minerals) [21].

Fish is very important for the human diet, due to the presence of minerals which range from 1.0% to 1.5%. Mineral matters in fish meat have been identified such as salts of potassium, sodium, calcium, magnesium and phosphorus, but also small amounts of iron, copper, iodine, chromium, zinc and fluorine. The large amount of fluorine and iodine in fish meat increases its biological value, whereas the small amount of sodium makes it preferable as a dietary food [23, 24].

The presence of carbohydrates in fish meat changes between 0.5 and 0.8%. However, the small amount of carbohydrates in fish does not make them less significant [26]. The amount of carbohydrates in fish meat is relatively low as compared to other types of meat [13, 25]. The most common carbohydrate is glycogen [10]. The amount of carbohydrates in fish meat depends on: fatigue, stress and diet. If the fish is well fed, rested and has not been subjected to stress, it contains a great amount of glycogen [23].

In the meat of the California trout the average value of its contents is 20% proteins, 2% fat and 1.2% minerals. Due to its ideal content this fish has been recommended to children, old people and people with certain health issues [19]. With the conducted analyses on the chemical composition of the meat of California trout, it has been determined that its average content is: proteins 18.8 – 19.3%, water 73.8 – 78.0% and minerals 1.2% [5]. With the examinations and analyses of the meat of California trout it has been determined that it contains: 77.2% water, 13.7% proteins, 5.5% fat and 2.0% minerals [15]. With different examinations in the meat of the California trout, the following chemical content has been determined: 75% water, 20% fat, 3.8% fat, 1.2% minerals [12].

2. Materials and methods

In this research as a material for work, we used samples of the Macedonian trout (*Salmo macedonicus)* and the Ohrid trout (*Salmoletnica)* with size of consumption between 200g and 300g. The trout has been bred in a fish farm with spring water from the spring of the river Beleshnica, which is situated near the village Belica in the region Poreche in Macedonia, and at the same time the fishpond is the reproduction center for Ohrid trout. The average temperature of the water in the fishpond depends on the weather conditions and season, and usually varies between 7-12^{o}C. Both types of fish are fed with the same complete food for trout.

In order to determine the quality of the meat of the trout, the following analyses have been made:

Analyses of the chemical composition of the fish meat

The amount of water is determined by drying the material at a temperature of 105^0C until a constant weight is reached. The amount of proteins has been determined according to the Kjeldahl method, whereas the amount of fat has been determined with the method of extraction according to Soxhlet. The presence of minerals has been confirmed by using the method of burning the material at a temperature of 500^oC. The appearance of phosphorus (P) in the meat was determined by using atomic emission spectrometry with inductively coupled plasma (ICP – AEC). The quantity of potassium (K) was verified by burning the material with concentrated H_2SO_4 and its determination with flame photometer. The energy value of the meat of both the Macedonian and Ohrid trout was determined through the already confirmed quantity of proteins and fat. By multiplying the amount of proteins (%) by the factor 17.16 and multiplying the amount of fat (%) by the factor 38.96 and then calculating the sum of the two already calculated values, we reckon the energy value of the fish meat expressed in KJ/100g [11].

3. Results and discussion

The results from our examination of the chemical content in the meat of both the Macedonian and Ohrid trout are shown in Table 1.

Table 1.

Comparison of the chemical content in the meat of the two types of trout

type of fish	water % $\bar{x} \pm S\bar{x}$	proteins % $\bar{x} \pm S\bar{x}$	Fat % $\bar{x} \pm S\bar{x}$	minerals % $\bar{x} \pm S\bar{x}$
Macedonian trout	77.122 ± 0.61	17.800 ± 0.17	3.333 ± 0.44	1.667 ± 0.06
Ohrid trout	75.923 ± 0.60	16.783 ± 0.22	5.403 ± 0.93	1.080 ± 0.09

With the results shown in Table 1, we conclude that the average content of water in the Macedonian trout is 77.122 ± 0.61% i.e. 75.923 ±0.60% in the Ohrid trout. The amount of proteins in the Macedonian trout is 17.800 ± 0.17%, whereas in the Ohrid trout, proteins are present with 16.783 ±0.22%. The amount of fat in the Macedonian trout is 3.333 ± 0.44% and is lower than in the Ohrid trout where fat is present with 5.403 ± 0.93%. There are 1.667 ± 0.06% minerals in the meat of the Macedonian trout, whereas in the Ohrid trout the amount of minerals is smaller and is determined to be 1.080 ± 0.09% (Fig. 1). The verified differences in the amount of water and fat in the two types of trout have no statistical significance. However, a significant difference is determined in the content of proteins and minerals in the two types of trout ($p>0.05$).

The amount of potassium (K) and phosphorus (P) in the meat of the Macedonian and Ohrid trout is shown in Table 2.

Table 2.

Content of K and P in the meat of the Macedonian and Ohrid trout

type of fish	Parameters (%)	
	potassium (K) $\bar{x} \pm S\bar{x}$	phosphorus (P) $\bar{x} \pm S\bar{x}$
Macedonian trout	1.413 ± 0.02	1.888 ± 0.03
Ohrid trout	1.012 ± 0.06	1.540 ± 0.02

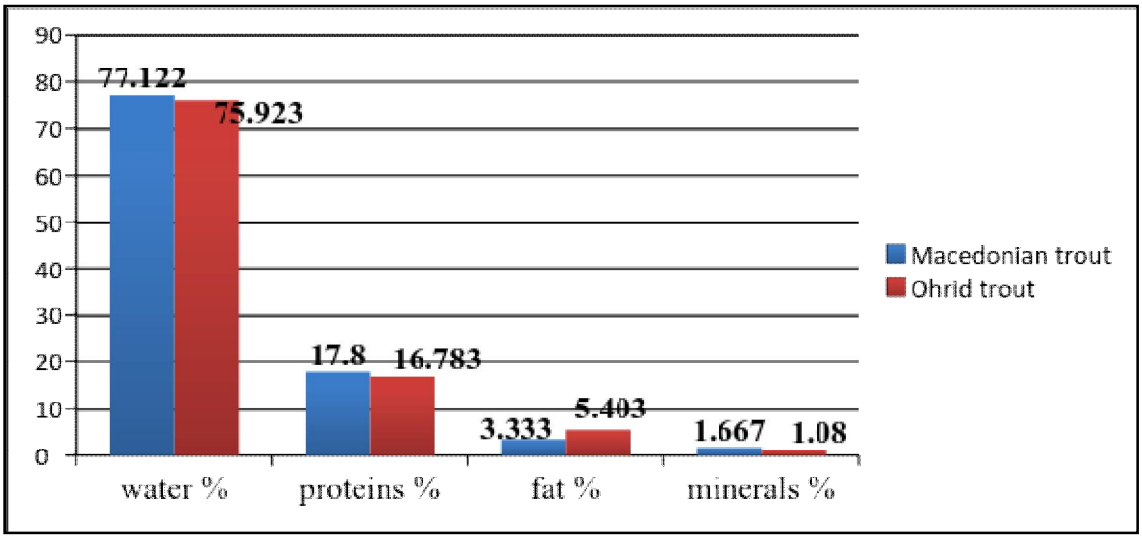

Fig. 1. Comparison of the chemical content in the meat of the Macedonian and Ohrid trout

The amount of potassium in the meat of the Macedonian trout is 1.413 ±0.02%, whereas in the Ohrid trout potassium is 1.012 ±0.06%. On the other hand, there is 1.888 ± 0.03% phosphorus in the meat of the Macedonian trout, whereas there is 1.540 ±0.02% phosphorus in the Ohrid trout (Fig. 2). The determined differences in the amount of phosphorus and potassium in the meat of the Macedonian and Ohrid trout are significant ($p>0.5$).

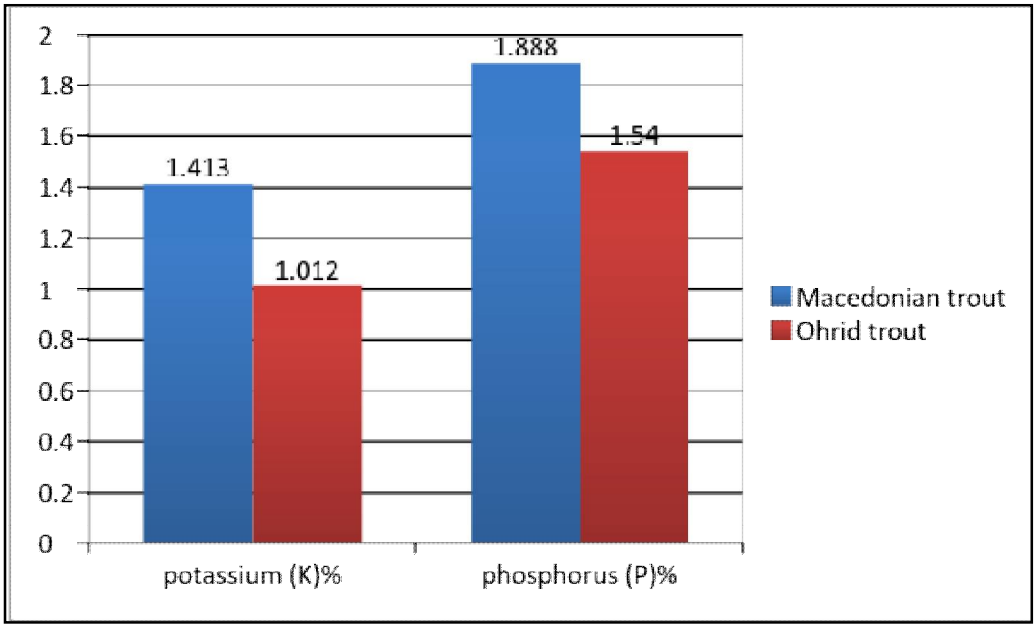

Fig. 2. Comparison of the amount of phosphorus and potassium in the meat of the Macedonian and Ohrid trout

The energy value of the meat of the Macedonian and Ohrid trout is shown in Fig. 3. The energy value of the meat of the Macedonian trout is 435.29 KJ/100g, i.e. 498.49KJ/100g of the meat of the Ohrid trout.

Higher energy value is determined in the meat of the Ohrid trout as a result of the higher amount of fat. The energy value of the meat of the Ohrid trout is significantly higher (p>0.05) in comparison with the meat of the Macedonian trout.

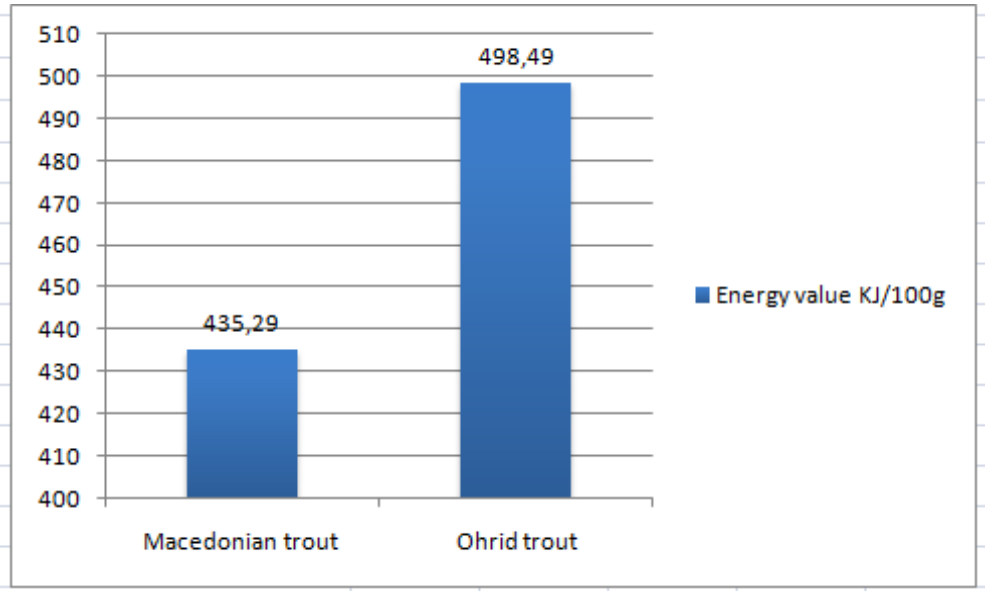

Fig. 3. Energy value in the meat of Macedonian and Ohrid trout

4. Conclusions

No significant differences were determined about the amount of water in the meat of the trout (in the Macedonian trout 77.122 ±0.61% and 75.923 ± 0.60% in the Ohrid trout), as well as in the amount of fat in the trout (in the Macedonian trout 3.333 ±0.44% and 5.403 ± 0.93% in the Ohrid trout). A significant difference (p>0.05) was determined in the amount of proteins (17.800 ±0,17% in the Macedonian trout and 16.783 ±0.22% in the Ohrid trout). A significant difference (p>0.5), as well, was determined in the amount of minerals (1.667 ± 0.06% in the Macedonian trout and 1.080 ± 0.09% in the Ohrid trout). In the amount of phosphorus and potassium a significant difference was determined in the two types of trout (p>0.05). The energy value of the meat of the Ohrid trout is 498.49 KJ/100g and it is significantly higher (p>0.05) when compared with the energy value of the meat of the Macedonian trout 435.29 KJ/100g, explained by the higher amount of fat in the Ohrid trout. Due to the favorable chemical content, i.e. the significant content of proteins and the small amount of fat, both the Macedonian and the Ohrid trout are one of the most nutritionally valuable products of animal origin, which should often be a part of the human diet, because of the nutritive and health benefits for its consumers.

5. References

[1]. HRISTOVSKI M., STOJANOVSKI S., Biology and fish diseases, National forum for animal protection in Macedonia,7-16; 39-46; 126-134; 156-163, Skopje, (2005).
[2]. STEVANOVSKI V., HRISTOVA K. V., Technology for processing and canning fish, Faculty of Biotechnological Sciences, 43-70; 263-271, Bitola, (2010).
[3]. CONOR W. E., Importance of n-3 fatty acids in health and desease. *American Journal of Clinical Nutrition 71S*, 171–175, (2000)
[4]. SIDHU K. S., Health benefits and potential risks related to consumption of fish or fish oil, *Regulatory Toxicology and Pharmacology*, 38 (3): 336–344, (2003).
[5]. VRANIĆ D., BALTIĆ Z. M., The Californian trout Oncorhynchus mykiss): chemical composition, cholesterol content and fatty acid

composition of the fillets, *Meat technology*, 53(1): 26–35, (2012).
[6]. MAROSEVIĆ D., Freshwater fisheries, Fish as a foodstuff, 553, (1982).
[7]. HAMIĆ A., Aquaculture in BiH, Coron's, Sarajevo, (2003).
[8]. ŠOŠA B., Hygiene and technology of processing sea fish, Zagreb, Schoolbook, (1989).
[9]. KIESSLING A., PICKOVA J., Changes in fatty acid composition in muscle and adipose tissue of farmed rainbow trout (Oncorhynchus mykiss) in relation to ration and age, *Food Chem.*, 73: 271–284, (2001).
[10]. INGEMANSSON T., Lipids in light and dark muscle of farmer rainbow trout (Oncorhynchus mikiss). *J. Sci. Food. Agric.*, 57: 443-447, (1991).
[11]. VITCHENKO A., KOPILOV Â., Fisihing, 175, Moskva, (1981).
[12]. GRUJIĆ R., The science of nutrition, Banja Luka, Faculty of Technology, Atlantik, (2000)
[13] ZHLENDER, B., Sea fish vs freshwater fish, 42-43, (2000)
[14]. BURGER J., GOCHFELD M., Perceptions of the risks and benefits of fish consumption: Individual choices to reduce risk and increase health benefits, *Environmental Research*, 109: 343–349, (2009).
[15]. PHILIPS A.M., BROCKWAY D.R., The nutrition of trout II, Protein and Carbohydrate, progr, *Fish-Cult*, 19(4), (1956).
[16]. TADEJEVIĆ V., Merchandising with the basics of technology and science of nutrition, Zagreb, Schoolbook, 310–316, (1971).
[17]. RASOARAHO J. R. E., BARNATHAN G., Influence of season on the lipid content and fatty acid profiles of three tilapia species (Oreochromisni loticus, O. macrochir and Tilapia rendalli) Madagascar: *Food Chemistry*, 91(4): 683–694, (2005).
[18]. ĆELIK M., DILER A., KUCUKGULMEZ A., A comparison of the proximate compositions and fatty acid profi les ofzander (Sander lucioperca) from two different regionsand climatic conditions, *Food Chemistry*, 92(4): 637–641, (2005).
[19]. ĆIRKOVIĆ M., JOVANOVIĆ, B., MALETIN S., Fisheries, Faculty of Agriculture, Novi Sad, (2002).
[20]. MILINKOVIĆ R., The effect of steroids and nutrition on reproductive and productive traits of rainbow trout at different growing conditions. The business community in the production, processing and marketing of livestock, livestock products and animal feed, Beograd, (1988).
[21]. STOLYWHO A., KOLODZIJESKA I., SIKOROSKI Y. E., Long chain polyunsaturated fatty acid in smoked Atlantic mackerel and Baltic sprats, 94: 585–595, *Food Chemistry*, (2006).
[22]. SVEINSDOTTIR K., MARTINDOTTIR E., Sensory characteristics of different cod products related to consumer preferences and attitudes, *Food Quality and Preference*, 20: 120–132, (2009).
[23]. ANON., Nutritional aspects of fish, Bord Iascaigh Mhara, Co. Dublin: www.bim.ie, (2003).
[24]. BOGUT I., OPAĆAK A., STEVIĆ S., Nutritional and protective value of fish with emphasis on omega-3 fatty acids, *Fisheries*, 54(1): 21-38, (1996).
[25]. KONOSU S., YAMAGUĆI K., MARTINETA L R. E., The flavor components in fishandshellfish In: Chemistryandbiochemistry of marine food products, 367-404, Connecticut: AVI Publishing Co, (1982).
[26]. STRIPKOVIĆ F., Changes properties of sardines (hunting areas Korcula pool) during the year and their impact on the production of "sardines in oil", Master's thesis: Faculty of Food Technology, University of Zagreb, (1982).
[27]. NISTOR E. C., PAGU I. B., Study of Meat Physical-Chemical Composition of Three Trout Breeds Farmed in Salmonid Exploitations from Moldova. *Animal Science and Biotechnologies*, 47(2): 190–195, (2014).

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