Meat quality of eight common commercial fish species found on the Romanian market

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Abstract. Fish meat is an important source of nutrients, having organoleptic and dietary properties, especially important for human nutrition, in the form of essential and non-essential amino acids, and unsaturated fatty acids such as Omega 3, Omega 6, Omega 9 and Omega 12. They are essential for preventing and treating cardiovascular disease or various forms of cancer, like colorectal cancer. In the present study, characteristics and chemical properties of the meat were analyzed in eight different fish species: rainbow trout (*Oncorhynchus mykiss*), common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), European sea bass (*Dicentrarchus labrax*), golden grey mullet (*Liza aurata*), mackerel (*Scomber scombrus*), sea bream (*Sparus aurata*) and prussian carp (*Carassius gibelio*). The characteristics and chemical properties of the meat were analyzed, taking into account the anatomical muscle segments (epaxial muscles, hypaxial muscles and caudal peduncle muscles). The analyses of the chemical composition of the meat consisted of: water content (%), dry matter (%), crude protein (Pb%), crude fat (Gb%) and mineral content (Min.%). The proximate analysis results are influenced by many factors, such as the sex of fish, the age of fish, the catch season, the farming system used, the geographical region of catch, the time from harvest to analysis, the conservation method, and many others. The results offer important information regarding the structure and composition of fish meat available on the market.
Key Words: chemical analysis, fish species, meat composition.

Introduction. Fish meat has become a consumed food among the population and is also a food that should be often found in the diet. Both qualitatively and quantitatively, fish meat is influenced by several factors, both internal and external, such as species, line, variety (internal factors), but also by the feed used, water source, breeding technique, degree of riverbed anthropization (external factors) (Espe 2008, Lațiu et al 2022, Uiuiu et al 2021). Fish can be classified into fat and lean fish. There are some fat fish who have a higher fat intake and others who have a higher protein intake. Lean fish are valuable for their high protein content. In the composition of fish meat there are many vitamins, such as vitamin A, with a role in bone development, vitamin B-complex, for the proper functioning of the nervous system, vitamin D, helping the correct assimilation of calcium and phosphorus, vitamin K, potent in prevention of internal bleeding, but also helping proper blood coagulation (Higashi 2012). In addition, fish have valuable minerals, such as calcium, magnesium, zinc, iodine, selenium and others (Tilami & Sampels 2017). By 2030, it is estimated that 90% of the fish production will be used as food, 8% will be used for fish oil and meal and the remaining 2% will be used for non-food products (FAO 2018).

17% of the animal protein consumed by humans globally comes from fish. The percentage is higher in less developed countries than in developed ones. Nowadays, fish products are heavily marketed. Since 2002, China has been the main exporter and producer of fish products. It seems that the Northwest Pacific is the most productive area in terms of fishing and catches, where catches of 22.4 million tons were recorded in 2016. Total maritime catches are fluctuating, with 81.2 million tons produced in 2015, and 79.3 million tons in 2016 (FAO 2018).

It is considered beneficial for human health to eat fish meat at least once a week or even twice. This is related to the level of omega-3 found in the human body, because the regular consumption of fish can satisfy the required level of the human body. Pelagic species, such as sardines, are recommended, but more common species, such as carp, can also be consumed. In addition to omega-3 intake, fish meat can also provide some micronutrients, including iodine, selenium, potassium, vitamin A, and vitamin D. Vitamin D can be easily obtained from fat marine fish, because they are rich in oil, which has a beneficial effect on bone health. It also has a role in calcium intake that helps the human bone system (Weichselbaum et al 2013).

Fish meat has a high nutritional value comprised of the content rich in lipids, carbohydrates and proteins, but also vitamins and mineral salts. These components found in the structure of the chemical composition of fish meat vary according to age, species, sex, food, season, weight, and other factors. There is the possibility of variations even within the same population. In addition, the water content can reach over 80% in the fish fillet (Akpambang 2015). Table 1 presents some proximate compositions of different species of freshwater fish, as determined by Bud (1999).

Table 1

Proximate analysis of some freshwater fish species (Bud 1999)

Species	*Water content %*	*Dry matter %*	*Crude protein %*	*Crude fat %*	*Ash %*	*Minerals %*
Cyprinus carpio	70.96	29.05	15.96	6.56	4.7	1.81
Ctenopharyngodon idella	79.18	20.82	13.7	1.84	3.9	1.35
Hypophthalmichthys molitrix	79.85	20.15	13.25	2.16	3.2	1.59
Ictiobus cyprinellus	78.6	21.4	15.16	2.31	2.4	1.54
Silurus glanis	79.5	20.5	17.45	1.12	1.9	-
Esox lucius	78.6	21.4	18.4	0.85	2.2	-
Oncorhynchus mykiss	75.31	24.69	19.52	2.7	2.5	-
Sander lucioperca	77.9	22.1	19	0.79	2.3	-

However, there are variations in the proximate composition of the meat of the same fish, depending on the body region (El Masry & Wold 2008). The aim of this study is to determine the proximate analysis of some fish species found on the market depending on body region, but also to present some other characteristics of these economically important fish.

Material and Method. The fish were purchased from local stores from Cluj, Romania, having a normal commercial weight. 5 specimens of each species were selected. The species studied are: rainbow trout (*Oncorhynchus mykiss*) (A), common carp (*Cyprinus carpio*) (B), silver carp (*Hypophthalmichthys molitrix*) (C), European sea bass (*Dicentrarchus labrax*) (D), golden grey mullet (*Liza aurata*) (E), mackerel (*Scomber scombrus*) (F), sea bream (*Sparus aurata*) (G) and Prussian carp (*Carassius gibelio*) (H) (Figure 1).

Chemical analyses of the meat were performed on different body segments (EM - epaxial musculature, HM – hypaxial musculature, MPC - caudal peduncle musculature) (Figure 2). The proximate analysis was performed for the 3 segments of each species (water content, dry matter, crude fat, crude protein, minerals). The results obtained were interpreted statistically using descriptive statistics and represented graphically with the help of the Microsoft Office package (Excel, Word).

Figure 1. Studied fish species.

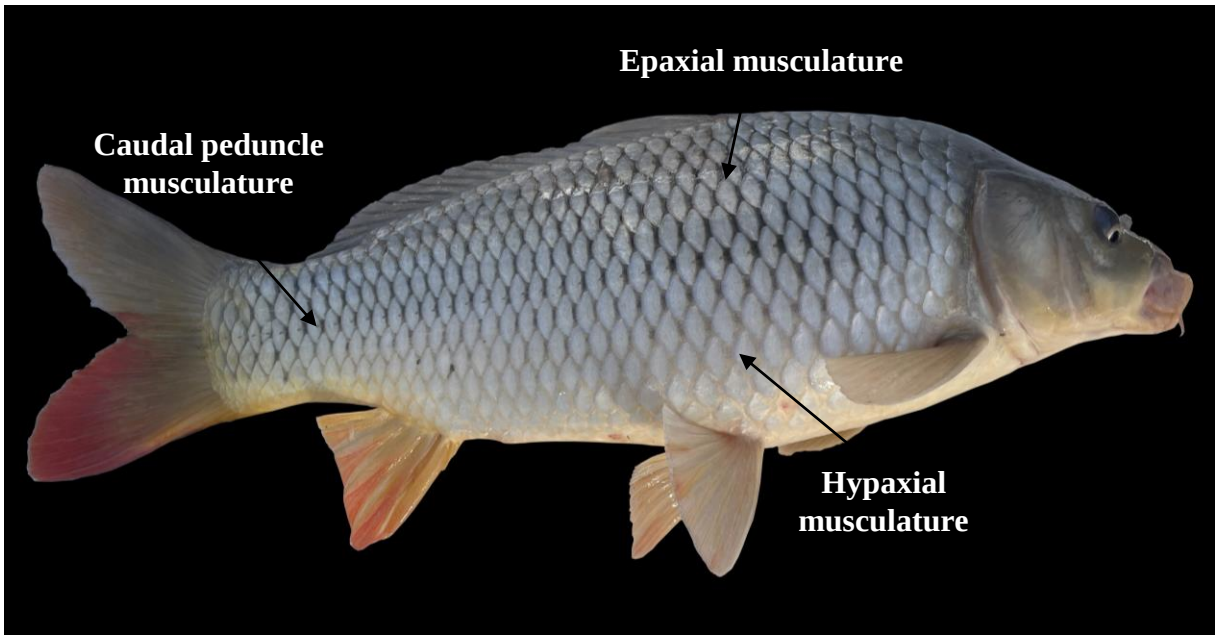

Figure 2. Sampling different body regions for the proximate analysis of the muscle.

Proximate analyses. The analyses of the chemical composition of the meat consisted in the determination of water content (%), dry matter (%), crude protein (%), crude fat (%) and mineral content (Min. %) (AOAC 2005). The fish meat analyzed was collected from three anatomical segments: the epaxial musculature, the hypaxial musculature and the caudal peduncle musculature.

All analyses were carried out in the Laboratory of Animal Physiology, TIPA (Animal Products Technology and Hygiene) Laboratory and Animal Nutrition Laboratory of the Faculty of Animal Sciences and Biotechnologies, UASVM Cluj-Napoca. Descriptive statistics were performed for the obtained results, and the data was processed using the Microsoft Office package (Excel, Word).

Results and Discussion

Epaxial musculature composition. The species with the highest water content in the epaxial musculature was sea bream, with 59.90±0.52%, the lowest value being 82.11±0.16% in the Prussian carp (Table 2). The dry matter (DM) content was highest in sea bream, with 40.10±0.52%, and the lowest was 17.89±0.18%, for Prussian carp. The fat content, not surprisingly, had the highest value in the case of mackerel, with 19.29±0.29%, mackerel being rich in fat. The lowest fat content was in the case of sea bass, with a value of 2.42 ±0.15%. For protein, the highest value was in sea bream, 36.22±0.59% and the lowest was in mackerel, with 16.46±0.49%. The mineral substances had a low content, the highest value being 1.31±0.03% for sea bream and the lowest was 0.94±0.06 for silver carp.

Table 2

Mean values of the proximate analysis results for epaxial musculature of the studied fish (n=5)

No	*Species*	*Water %*		*DM%*		*Crude fat %*		*Crude protein %*		*Minerals %*	
		X±sx	*V%*	*X±sx*	*V%*	*X±sx*	*V%*	*X±sx*	*V%*	*X±sx*	*V%*
1	Carp	75.24± 0.41	1.22	24.76± 0.41	3.69	6.52± 0.19	6.39	17.17± 0.24	3.09	1.07± 0.03	6.75
2	Rainbow trout	73.90± 0.38	1.16	26.10± 0.38	3.30	5.22± 0.06	2.78	19.80± 0.35	3.94	1.08± 0.03	6.26
3	Mackerel	62.56± 0.50	1.79	36.77± 0.75	4.54	19.29± 0.29	3.38	16.46± 0.49	6.68	1.02± 0.04	8.01
4	Sea bream	59.90± 0.52	1.96	40.10± 0.52	2.92	18.57± 0.12	10.61	36.22± 0.59	3.62	1.31± 0.03	5.84
5	Silver carp	80.84± 0.43	1.19	19.56± 0.43	4.91	11.13± 0.03	6.79	17.48± 0.37	4.76	0.94± 0.06	12.95
6	Prussian carp	82.11± 016	1.44	17.89± 0.18	2.07	3.23± 0.02	14.68	16.71± 0.16	2.10	0.97± 0.03	6.6
7	Sea bass	75.12± 0.35	1.05	24.82± 0.35	3.19	2.42± 0.15	13.80	21.31± 0.27	2.83	1.09± 0.05	9.68
8	Mullet	79.70± 0.37	1.02	20.30± 0.37	4.2	14.32± 0.01	8.04	18.86± 0.33	3.92	1.12± 0.05	8.99

Note: DM - dry matter; X - average; sx - standard deviation; V% - variability coefficient.

Hypaxial musculature composition. Table 3 shows the proximate analysis results of the hypaxial musculature of the studied fish. The species with the highest water content was the Prussian carp, with 81.58±0.4%, while the lowest value, 47.94±0.23%, was observed for mackerel. The content of DM had the highest value in mackerel, with 52.060±0.23%, and the lowest in the Prussian carp, 18.42±0.4%. The fat content with the highest value was found in mackerel, 22.18±0.29%, and the lowest in Prussian carp, with 4.40±0.02%. For protein, the highest value was found in the silver carp, 21.35±0.19% and the lowest in mackerel, with 11.04±0.11%. The mineral substances had a low content, the highest value being 1.05±0.03% for silver carp and the lowest, 0.84±0.05%, for mackerel.

Table 3

Mean values of the proximate analysis results for hypaxial musculature of the studied fish (n=5)

No	Species	Water %		DM%		Crude fat %		Crude protein %		Minerals %	
		X±sx	V%	X±sx	V%	X±sx	V%	X±sx	V%	X±sx	V%
1	Carp	53.59± 0.26	1.09	46.61± 0.26	1.25	11.85± 0.15	2.07	13.82± 0.14	2.23	0.93± 0.03	7.21
2	Rainbow trout	70.23± 0.28	0.97	29.77± 0.28	2.13	10.73± 0.28	5.85	18.03± 0.17	2.13	1.01± 0.03	7.49
3	Mackerel	47.94± 0.23	1.87	52.06± 0.23	1.05	22.18± 0.29	2.60	11.04± 0.11	2.26	0.84± 0.05	11.09
4	Sea bream	66.62± 0.31	1.23	33.38± 0.31	2.06	20.33± 0.2	2.86	17.01± 0.20	2.65	1.04± 0.05	9.95
5	Silver carp	68.29± 0.26	1.15	31.71± 0.26	1.86	12.30± 0.29	6.98	21.35± 0.19	2.15	1.05± 0.03	6.86
6	Prussian carp	81.58± 0.4	1.10	18.42± 0.4	4.86	4.40± 0.02	8.86	17.08± 0.38	4.94	0.94± 0.04	8.84
7	Sea bass	52.94± 0.27	1.14	47.06± 0.27	1.29	8.02± 0.28	2.27	18.03± 0.35	4.28	1.01± 0.01	2.83
8	Mullet	77.05± 0.37	1.08	22.95± 0.37	3.62	17.34± 0.05	7.66	20.60± 0.33	3.62	1.02± 0.04	9.46

Note: DM - dry matter; X - average; sx - standard deviation; V% - variability coefficient.

Caudal peduncle musculature composition. Table 4 presents the chemical composition of the musculature from the caudal peduncle region for the studied fish. The species with the maximum water content was the Prussian carp, with 80.24±0.42%, while the minimum value was 71.07±0.33% in the mackerel. The DM content had the highest value in mackerel, with 28.93±0.32%, the lowest value being 19.76±0.41%, recorded for the Prussian carp. The fat content with the highest value was in mullet, with 13.37±0.01%, while the lowest content was in the Prussian carp, with a value of 2.39±0.01%. For protein, the highest value was in mackerel, with a content of 22.11±0.13%, while the lowest was in carp, with 17.12±0.27%. Mineral substances had a lower content, the highest value being 1.16±0.02% in sea bream and the lowest in carp, 0.86±0.03%.

Table 4

Mean values of the proximate analysis results for caudal peduncle musculature of the studied fish (n=5)

No	Species	Water %		DM%		Crude fat %		Crude protein %		Minerals %	
		X±sx	V%	X±sx	V%	X±sx	V%	X±sx	V%	X±sx	V%
1	Carp	77.62± 0.36	1.02	22.38± 0.36	3.55	4.39± 0.16	8.05	17.12± 0.27	3.55	0.86± 0.03	7.40
2	Rainbow trout	77.80± 0.48	1.38	22.20± 0.48	4.85	3.02± 0.07	5.12	18.18± 0.39	4.75	1.01± 0.04	8.84
3	Mackerel	71.07± 0.33	1.05	28.93± 0.32	2.59	5.86± 0.22	8.32	22.11± 0.13	1.28	0.96± 0.04	10.09
4	Sea bream	72.64± 0.39	1.19	27.36± 0.39	3.15	8.64± 0.19	9.18	21.56± 0.25	2.63	1.16± 0.02	3.77
5	Silver carp	76.81± 0.36	1.04	23.19± 0.35	3.44	7.84± 0.07	8.95	20.37± 0.28	3.09	0.97± 0.04	8.41
6	Prussian carp	80.24± 0.42	1.17	19.76± 0.41	4.75	2.39± 0.01	4.91	18.31± 0.41	4.98	1.05± 0.03	6.86
7	Sea bass	72.11± 0.38	1.19	27.89± 0.38	3.08	4.26± 0.25	8.99	20.55± 0.33	3.60	1.09± 0.03	6.26
8	Mullet	77.29± 0.38	1.11	22.71± 0.38	3.76	12.37± 0.01	8.68	21.22± 0.35	3.64	1.12± 0.04	7.52

Note: DM - dry matter; X - average; sx - standard deviation; V% - variability coefficient.

The proximate analysis results are influenced by many factors, such as the sex of fish, the age of fish, the catch season, the farming system used, the geographical region of

catch, the time from harvest to analysis, the conservation method, and many others. However, our results are in line with the results of other studies.

Ogbe & Omada (2020) obtained similar results in the case of mackerel meat proximate analysis, with a protein content of 24.3%, moisture content of 68.68%, and fat content of 6.42%. Sea bream and sea bass proximate compositions are similar in other studies (Erkan & Ozden 2007). Protein content was 20.35% and 19.81% in the case of sea bass and sea bream, respectively, while fat content was 6.10% and 15.11%, respectively. The golden mullet has a protein content between 21.52-24-75%, and a fat content between 3.7-4.83% (Norouzi & Bagheri 2015). Carp is a common fish on the market, especially in Eastern Europe. It is usually farmed in extensive or semi-intensive systems, in large earthen ponds. The common carp has a lower protein content then the saltwater species studied. Abdulrahman et al (2019) determined a protein content for carp between 13 and 16.8%, while the fat content was between 6.33 and 10.18%. Silver carp is usually farmed in polyculture with the common carp. It has a higher protein content then the common carp, between 18-20%, and a fat content between 7-9% (Ullah et al 2014). The Prussian carp is also a fish easily farmed in polyculture with the common carp and the silver carp, with a protein content between 19-20% and a fat content between 3-4% (Ozyilmaz et al 2016). Salmonid farming is one of the biggest freshwater aquaculture sectors in the world, due to the organoleptic properties of fish from the family Salmonidae. Its main farmed freshwater species is the rainbow trout, which is one of the fastest growing salmonids, and a fish with a great farming tradition and history, not just in North America, but also in Europe, spreading throughout the world. Rainbow trout usually has a protein content over 23% (Chaiyapechar & Liu 2003), with a low-fat content, being a lean fish. Thus, rainbow trout can compete with saltwater species in terms of consumer preference.

Conclusions. When choosing a fish species for consumption, the consumers should take into consideration the quantitative and qualitative aspects. Marine species (especially predatory species) provide a greater supply of proteins and fats beneficial to human nutrition. Herbivorous and omnivorous species present advantages in the quantitative context, but are less favorable from a qualitative point of view.

Conflict of Interest. The authors declare that there is no conflict of interest.

References

Abdulrahman N. M., Rasool B. A., Parug S., 2019 Comparison study of proximate analysis of common carp (*Cyprinus carpio* L.) fish meat reared in earthen ponds in Ranya (north of Iraq). Iraqi Journal of Science and Technology 10(1):80-88.

Akpambang V. O. E., 2015 Proximate composition of some tropical fish species. Der Chimica Sinica 6(4):125-129.

Alomar C., Sanz-Martin M., Compa M., Rios-Fuster B., Alvarez E., Ripolles V., Valencia J. M., Deudero S., 2021 Microplastic ingestion in reared aquaculture fish: Biological responses to low-density polyethylene-controlled diets in *Sparus aurata*. Environmental Pollution 280:116960.

Chaiyapechar S., Liu K. K. M., 2003 Proximate composition, lipid oxidation, and sensory characteristics of fillets from rainbow trout *Oncorhynchus mykiss* fed diets containing 10% to 30% lipid. Journal of the World Aquaculture Society 34(3):266-277.

Cocan D., Popescu F., Lațiu C., Coșier V., Coroian A., Negrea O., Ihuț A., Mireșan V., 2015 Meristic and morphometric characteristics of spirlin, *Alburnoides bipunctatus* Bloch 1782 (Actinopterygii: Cyprinidae) of the Letca area - Someș river. Bulletin UASVM Animal Science and Biotechnologies 72(2):252-254.

Costa A. M. O., Gordo L., Martins M. M., 2017 Growth and distribution of mackerel *Scomber scombrus* Linnaeus, 1758 from the west coast of Portugal. Cahiers de Biologie Marine 58(4):409-421.

El Masry G., Wold J. P., 2008 High-speed assessment of fat and water content distribution in fish fillets using online imaging spectroscopy. Journal of Agricultural and Food Chemistry 56:7672-7677.
Erkan N., Ozden O., 2007 Proximate composition and mineral contents in aqua cultured sea bass (*Dicentrarchus labrax*), sea bream (*Sparus aurata*) analyzed by ICP-MS. Food Chemistry 102:721-725.
Espe M., 2008 Understanding factors affecting flesh quality in farmed fish. In: Improving farmed fish quality and safety. Woodhead Publishing Series in Food Science, Technology and Nutrition, pp. 241-264.
Higashi H., 2012 Vitamins in fish - with special reference to edible parts. In: Fish as food V1: Production, bichemistry, and microbiology. Borgstrom G. (ed), Elsevier, pp. 411-486.
Kırankaya S. G., 2013 Life-history traits of the invasive population of Prussian carp, *Carassius gibelio* (Actinopterigi: Cypriniformes: Cyprinidae), from Gelingüllü Reservoir, Yozgat, Turkey. Acta Ichthyologica Et Piscatoria 43(1):31-40.
Laiz-Carrion R., Sangiao-Alvarellos S., Guzman J. M., Martin del Rio M. P., Soengas J. L., Mancera J. M., 2005 Growth performance of gilthead sea bream *Sparus aurata* in different osmotic conditions: Implications for osmoregulation and energy metabolism. Aquaculture 250(3-4):849-861.
Laţiu C, Papuc T, Muntean G, Uiuiu P, Constantinescu R, Matei-Laţiu M-C, Nicula A-S, Craioveanu C, Mireșan V and Cocan D (2022) Fish Species Diversity From Someșul Cald River: 50 Years After Cascade Dam Constructions. Front. Environ. Sci. 10:918745
Norouzi M., Bagheri M., 2015 The chemical composition of golden grey mullet *Liza aurata* in southern Caspian Sea during sexual rest and sexual ripeness. AACL Bioflux 8(4):517-525.
Ogbe K. U., Omada O. I., 2020 Comparative studies on the proximate composition of the various body part of *Clarias gariepinus* and *Scomber scrombus*. Journal of Applied Sciences and Environmental Management 24(4):615-618.
Ozyilmaz A., Erguden S. A., Erguden D., Ozeren A., Semerci R. S. N., 2016 The proximate compositions, carbohydrate contents and energy values of three freshwater fish from Seyhan River in Adana/Turkey. Journal of Entomology and Zoology Studies 4(4):1153-1155.
Stavrescu-Bedivan M. M., Vasile Scăeţeanu G., Madjar R. M., Matei P. B., Tobă G. F., 2015 Comparative study of length-weight relationship, size structure and Fulton's condition factor for Prussian carp from different romanian aquatic ecosystems. AgroLife Scientific Journal 4(2):132-139.
Tilami S. K., Sampels S., 2017 Nutritional value of fish: Lipids, proteins, vitamins, and minerals. Reviews in Fisheries Science & Aquaculture 26(2):243-253.
Uiuiu, P.; Latiu, C.; Papuc, T.; Craioveanu, C.; Ihut, A.; Sava, A.; Raducu, C.; Sonea, C.; Constantinescu, R.; Cocan, D.; Miresan, V. Multi-Approach Assessment for Stress Evaluation in Rainbow Trout Females, Oncorhynchus mykiss (Walbaum, 1792) from Three Different Farms during the Summer Season. Animals 2021, 11, 1810. https://doi.org/10.3390/ani11061810
Ullah S., Hasan Z., Zuberi A., Younus N., Rauf S., 2014 Comparative study on body composition of two Chinese carps, common carp (*Cyprinus carpio*) and silver sarp (*Hypophthalmichthys molitrix*). Acta Veterinaria 13(5):867-876.
Weichselbaum E., Coe S., Buttriss J., Stanner S., 2013 Fish in the diet: A review. Nutrition Bulletin 38(2):128-177.
*** AOAC, 2005 Official method of analysis. 18th Edition. Association of Officiating Analytical Chemists, Washington DC.
*** Bud I., 1999 [Aquaculture course]. Faculty of Animal Sciences and Biotechnologies, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania. [In Romanian].
*** FAO 2018 The state of the world fiseries and aquaculture 2018 - Meeting the sustainable development goals. Rome, 227 p.

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