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ANALYSIS OF MEAT QUALITY AND PRODUCTIVITY INDICES IN FISH SPECIES WITH DIFFERENT NUTRITIONAL SPECTRUM

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Abstract

Nutritional behavior and feed intake contribute to fish growth dynamics, productive indices, and meat quality. In this study, productive indices and meat quality were analyzed in three fish species with different nutritional spectrums: a predatory species, the rainbow trout (Oncorhynchus mykiss), an omnivorous species, the wild Danube carp (Cyprinus carpio), and a planktivorous-detritivorous species, the Golden grey mullet (Chelon auratus). A phenotypic characterization of the species was performed (measurements) and body size indices were calculated [Fulton condition factor (K), profile index (Pi), thickness index (Ti), Kiselev quality index (KQi), and fleshiness indices (Ci1-Ci2)], slaughter yields and organs weight ratio and body segments, as well as meat quality. The results show us higher protein values in fish meat from natural environments (Danube carp and Golden grey mullet) due to the more varied nutritional spectrum. Slaughter yields were also better for wild species.

Key words*: body indices, fish meat, nutritional value, slaughter yield.*

INTRODUCTION

Fish meat is an important source of nutritional components, being recommended for daily consumption (Chen et al., 2022). The chemical composition of fish meat differs from one species to another, depending on season, food source, sex, age, and environment (Rasul et al., 2021; Imtiaz et al., 2022; Sandu et al., 2023). The same fish species can have different chemical compositions of the meat depending on muscle segments (epaxial, hypaxial, dorsal, abdominal-intercostal, or caudal peduncle) (Sava et al., 2022). It is important to study the chemical and nutritional composition due to the following aspects: fish is a cheap and easily accessible protein source for the entire world population (Nicolae et al., 2016); polyunsaturated fatty acids have an important role in maintaining human health and in the treatment of some diseases (Ristić-Medić et al., 2013; Carr et al., 2023); and the content of minerals and vitamins is specific to each fish species and differs according to the season.

Statistics show that a cooked portion of 100 g of most types of fish is equivalent to 18-20 g of protein, or a third of the recommended average daily protein intake (Bissih, 2021). Fish protein is of high quality, contains many essential amino acids, and is highly digestible by people of all ages. In fish, there are three main groups of proteins: myofibrillar, sarcoplasmic, and stromal proteins, which constitute 70-80%, 20-30%, and 3%, respectively, of the total proteins in the muscles.

Fish-specific lipids can be divided into two main groups: phospholipids and triglycerides. Phospholipids constitute the integral structure of unit membranes present in cells, being also called structural lipids. Triglycerides have the role of storing energy in fat deposits, being known as storage fats. The latter have unsaturated and saturated monocarboxylic fatty acids in their chemical composition. From the series of saturated fatty acids in fish meat triglycerides, the most representative are considered to be palmitic acid, myristic acid, and stearic acid (Shramko et al., 2020).

The content of minerals and vitamins is specific to each fish species and differs according to season. Fish is an important source of phosphorus, calcium, iron, copper, and selenium. A high iodine content is found in saltwater fish (Sprague et al., 2022). Vitamin B is considered to be one of the most important sources typical of fish meat, and in the case of fatty species, the most common vitamins are A and D (Merdhzanova & Dobreva, 2020).

The purpose of our research was to determine the meat quality (chemical composition) and productive indices of three fish species (rainbow trout - *Oncorhynchus mykiss*; wild Danube carp - *Cyprinus carpio*; mullet - *Chelon auratus*), taking into account their nutritional spectrums: a predatory species, an omnivorous species, and a herbivorous species. Related to the proposed goal, we established the following research objectives: their phenotypic characterization based on somatic measurements; calculation of body size indices [Fulton K index, profile index (Pi), thickness index (Ti), Kiselev quality index (KQi), fleshiness indices 1 and 2 (Ci1 and Ci2)]; meat quality analysis (water %, dry matter %, crude protein %, crude fat %, ash %); the statistical interpretation of the results obtained and the statement of the conclusions and recommendations).

MATERIALS AND METHODS

This study was organized based on the data regarding the quality of the meat and productive indices from the specialized literature that mentions differences between predatory, omnivorous, and herbivorous fish species. Thus, representative and relatively common species were studied, respecting their spectrum and feeding behaviour.

The phenotypic characterization of the samples studied was based on somatic measurements and weighing: body mass (Bw), total length (Tl), standard length (Sl), commercial length (Cl), maximum height (H), minimum height (h), body depth (Bd), large perimeter (P), small perimeter (p), head length (Hl) and caudal peduncle length (CPl).

Based on the somatic measurements performed, and following the weighing of fish specimens from the three species, body size indices were calculated. These indices provide indications on the productive performance of fish and carcasses (Cocan and Mireşan, 2015). The calculation formulas are as follows:

Fulton condition factor (K)

K = (Bw · 100) / Tl3, where Bw – body mass; Tl – total length;

Profile Index (Pi)

Pi = Sl / H, where Sl – standard length; H – large perimeter;

Thickness Index (Ti)

Ti = (Bd · 100) / Sl, where Bd – body depth; Sl – standard length;

Kiselev Quality Index (KQi)

KQi = Sl / P, where Sl – standard length; P – large perimeter;

Fleshiness index 1 (Ci1)

Ci1 = (Hl · 100) / Sl, where Hl – head length; Sl – standard length;

Fleshiness index 2 (Ci2)

Ci2 = (CPl · 100) / Sl, where CPl – the length of the caudal peduncle; Sl – standard length.

The analyses regarding the chemical composition of the meat consisted of the determination of water content (moisture), dry matter (DM), crude fat (Cf%), crude protein (Cp%), and the determination of mineral substances (ash%). To perform the analyses, the meat from the three species of fish was separated from the bones and the rest of the organs and was mixed (individually each specimen). The dry substance content (DM%) was determined by the percentage difference of the mass of the sample to be analyzed and the water content (moisture%), determined by drying the sample in an oven. Crude protein (Cp%) was determined by the Kjeldahl method. Crude fat (Cf%) was determined by extraction with an organic solvent (petroleum ether) using a Soxhlet apparatus. The determination of mineral substances (Ash%), was done by calcining the samples to be analyzed at a temperature of 600°C for 5 hours.

RESULTS AND DISCUSSIONS

Following the somatic measurements and weighing, we obtained the results presented in Table 1. The average body weight of the rainbow trout was 236.94±3.37 g, with a minimum value of 197 g and a maximum value of 282.80 g. The average value of the total length was 26.6±0.049 cm, the smallest specimen having 26 cm, and the largest 27.2 cm. Regarding the standard length, its average value was 24.24±0.043 cm, the minimum value was 23.50 cm, and the maximum value was 24.60 cm. The commercial length showed an average value of 18.56±0.066 cm, the minimum being 18 cm and the maximum 19.50 cm. The maximum height, measured in the most developed part of the body, showed an average value of 7.16±0.059 cm, the minimum being 6.5 cm and the maximum 8 cm.

Table 1. Average, minimum and maximum values regarding somatic measurements and body mass of the fish species studied

Parameters	Bw	Tl	Sl	Cl	H	h	P	p	Bd	Hl	CPl
Rainbow trout (*Oncorhynchus mykiss*)											
X±sx	236.94± 3.37	26.6± 0.049	24.24± 0.043	18.56± 0.066	7.16± 0.059	2.78± 0.023	14.78± 0.09	6.7± 0.067	3± 0.031	5.4± 0.053	4.32± 0.033
Min.	197.00	26.00	23.50	18.00	6.50	2.50	13.50	6.00	2.50	4.60	4.00
Max.	282.80	27.20	24.60	19.50	8.00	3.00	16.00	7.50	3.30	6.00	4.70
V%	14.22	1.86	1.79	3.55	8.30	8.20	6.12	10.01	10.27	9.89	7.57
s	33.702	0.495	0.434	0.658	0.594	0.228	0.904	0.671	0.308	0.534	0.327
Common carp (*Cyprinus carpio*)											
X±sx	2810± 79.718	53.18± 0.451	45.72± 0.419	33.7± 0.247	19.12± 0.189	6.64± 0.063	40.02± 0.417	14.6± 0.154	7.88± 0.116	11.74± 0.11	9.2± 0.148
Min.	1700.00	47.10	40.00	29.50	15.80	5.70	34.50	12.40	6.40	10.10	7.50
Max.	3700.00	58.50	50.00	35.50	20.40	7.30	45.30	16.50	9.60	13.10	11.40
V%	28.37	8.47	9.17	7.33	9.89	9.50	10.42	10.57	14.78	9.34	16.14
s	797.183	4.507	4.194	2.469	1.891	0.631	4.170	1.543	1.165	1.097	1.485
Golden grey mullet (*Chelon auratus*)											
X±sx	330.92± 3.876	34.3± 0.164	29.06± 0.113	20.74± 0.184	6.68± 0.054	2.96± 0.022	15.38± 0.08	7.22± 0.03	4.06± 0.039	7.78± 0.018	6.86± 0.074
Min.	273.20	31.50	27.10	18.40	5.90	2.70	14.50	6.90	3.60	7.50	5.70
Max.	368.00	35.60	29.90	23.50	7.20	3.30	16.20	7.50	4.60	7.90	7.70
V%	11.71	4.80	3.90	8.88	8.16	7.40	5.23	4.20	9.63	2.30	10.79
s	38.761	1.645	1.133	1.842	0.545	0.219	0.804	0.303	0.391	0.179	0.740

[1]**Bw** – body weight; **Tl** – total length; **Sl** – standard length; **Cl** – commercial length; **H** – maximum height; **h** – minimum height; **P** – great perimeter; **p** – small perimeter; **Bd** – body depth; **Hl** – head length; **CPl** – caudal peduncle length

The depth of the body presented an average value of 3±0.031 cm, the minimum value obtained being 2.50 cm, and the maximum 3.30 cm. The length of the head (Lcap) and the length of the caudal peduncle (Lped) are not particularly important from a commercial point of view. The average value of the head length was 5.4±0.053 cm, and that of the caudal peduncle was 4.32±0.032 cm.

The average body weight of common carp was 2810±79.718 g, with a minimum value of 1700 g and a maximum value of 3700 g. The average value of the total length was 53.18±0.451 cm, with the smallest specimen at 47.10 cm, and the largest at 58.50 cm. Regarding the standard length, its average value was 45.72±0.419 cm, the minimum value was 40 cm, and the maximum value was 50 cm. The commercial length presented an average value of 33.70±0.247 cm, the minimum being 29.50 cm and the maximum 35.50 cm. The maximum height, measured in the most developed part of the body, presented an average value of 19.12±0.189 cm, the minimum being 15.80 cm and the maximum 20.40 cm. Regarding the minimum height, it presented an average value of 6.64±0.063 cm, a minimum value of 5.70 cm and a maximum value of 7.30 cm. An equally important parameter in terms of fish productivity is the large perimeter. It presented an average value of 40.02±0.417 cm, the minimum value being 34.50 cm and the maximum 45.30 cm. The small perimeter showed an average value of 14.6±0.154 cm, a minimum value of 12.40 cm, and a maximum value of 16.50 cm. The body depth presented a calculated average value of 7.88±0.116 cm, the minimum value obtained being 6.40 cm, and the maximum 9.60 cm. The average value of the head length was 11.47±0.11 cm, and that of the caudal peduncle was 9.20±0.148 cm.

The average body weight of the mullet specimens was 330.92±3.876 g, with a minimum value of 273.20 g and a maximum value of 368.00 g. The average value of the total length was 34.3±0.164 cm, the smallest specimen being 31.50 cm, and the largest 35.60 cm. Regarding the standard length, its average value was 29.06±0.113 cm, the minimum value was 27.10 cm, and the maximum value was 29.90 cm. The commercial length showed an average value of 20.74±0.184 cm, the minimum being 18.40 cm and the maximum 23.50 cm. The maximum height, measured in the most developed part of the body, showed an average value of 6.68±0.054 cm, the minimum being 5.90 cm and the maximum 7.20 cm. Regarding the minimum height, it presented an average value of 2.96±0.022 cm, a minimum value of 2.70 cm and a maximum value of 3.30 cm. The large perimeter presented an average value of 15.38±0.08 cm, the minimum value being 14.50 cm and the maximum 16.20 cm. The small perimeter showed an average value of 7.22±0.03 cm, a minimum value of 6.90 cm and a maximum value of 7.50 cm. The body depth presented a calculated average value of 4.06±0.039 cm, the minimum value obtained being 3.60 cm, and the maximum 4.60 cm. The average value of the head length was 7.78±0.018 cm, and that of the caudal peduncle was 6.86±0.074 cm.

The Fulton condition factor (K) reflects the maintenance status of the fish (Mireșan et al., 2010). The higher the value of this index, the better the maintenance status of the fish. In the case of rainbow trout, it had a value of 1.25 ± 0.012 (V% = 9.39). In the case of common carp, it had a value of 1.82 ± 0.011 (V% = 6.22), and in the case of mullet specimens, it had an average value of 0.89 ± 0.013 (V% = 14.31) (Table 2).

The thickness index (Ig) expresses the width of the musculature (the depth of the body Ac in the most developed region of the body) in relation to the standard length of the fish (Ls). Expressed as a percentage ratio between the depth of the body (Ac) and the standard length of the fish (Ls), the higher value of this index will reflect a better development of the lateral musculature of the fish. The value of the thickness index for rainbow trout was 12.59 ± 0.15 (V% = 11.93), in the case of common carp 17.19 ± 0.14 (V% = 8.12), and in the case of mullet it was 14.00 ± 0.157 (V% = 11.19).

Table 2. Average values and dispersion indices of body size indices for the three fish species studied

Parameters	K	Pi	Ti	KQi	Ci1	Ci2
Rainbow trout (*Oncorhynchus mykiss*)						
X±sx	1.25±0.012	3.4±0.029	12.59±0.15	1.65±0.012	22.28±0.224	17.82±0.12
Min.	1.08	3.04	10.16	1.52	18.93	16.33
Max.	1.41	3.78	14.04	1.82	24.49	19.11
V%	9.39	8.43	11.93	7.09	10.05	6.74
s	0.118	0.287	1.502	0.117	2.239	1.201
Common carp (*Cyprinus carpio*)						
X±sx	1.82±0.011	2.4±0.013	17.19±0.14	1.14±0.004	25.69±0.097	20.04±0.16
Min.	1.63	2.21	16.00	1.09	24.40	18.75
Max.	1.93	2.53	19.51	1.18	26.68	22.80
V%	6.22	5.35	8.12	3.40	3.77	8.00
s	0.113	0.129	1.396	0.039	0.969	1.602
Golden grey mullet (*Chelon auratus*)						
X±sx	0.89±0.013	4.36±0.022	14±0.157	1.89±0.006	26.79±0.064	23.56±0.172
Min.	0.78	4.11	12.16	1.84	26.01	21.03
Max.	1.10	4.59	15.87	1.99	27.68	25.75
V%	14.31	4.97	11.19	3.35	2.41	7.30
s	0.127	0.217	1.567	0.063	0.644	1.721

[1]**K** - Fulton condition factor; **Pi** - profile index; **Ti** - thickness index; **KQi** - Kiselev quality index; **Ci1** - fleshiness index 1; **Ci2** - fleshiness index 2

The profile index (Ip) highlights the body size of the fish and allows individuals of a population to be classified in a certain type of profile (Cocan & Mireșan, 2015). A low-profile index reflects a pronounced convexity of the upper body line, the fish have a chubby appearance, and a chubby spine is correlated with a rich muscle mass in the trunk region. From our evaluations, we obtained a profile index for rainbow trout of 3.4 ± 0.029 (V% = 11.93), 2.4 ± 0.013 (V% = 5.35) for common carp and 4.36 ± 0.022 (V% = 4.97) for mullet.

The quality index (Ica) gives information on the quality of the fish, just by knowing the values of the large body perimeter and the standard length. Specimens with a quality index as low as possible will be retained following the selection processes by breeders, but also in the case of fish destined for slaughter, because specimens with a circumference as large as possible in relation to length are desirable, denoting a rich muscle mass. The value of the quality index for rainbow trout was 1.65 ± 0.012, for common carp 1.14 ± 0.004, and for mullet 1.89 ± 0.006.

The values of the fleshiness indices in the case of rainbow trout were as follows: Ic1 = 22.28 ± 0.224 (V% = 10.05); Ic2 = 17.82 ± 0.17 (V% =

6.74). The values of the fleshiness indices in the case of common carp were as follows: Ic1 = 25.69 ± 0.097 (V% = 3.77); Ic2 = 20.04 ± 0.16 (V% = 8.00), and in the case of mullet Ic1 = 26.79 ± 0.064 (V% = 2.41); Ic2 = 23.56 ± 0.172 (V% = 7.30).

The production of fish meat depends on the production capacity, the quantity, and quality of the administered feed (Nielsen et al., 2002), the environmental conditions (Honcharova et al., 2021; Wang and Mendes, 2022), on the exploitation technologies, and not lastly, on the biological material. Fish meat production can be maximized if optimal environmental conditions are considered. The productive capacity and the economic yield also depend on the anatomical and morphological characteristics of the exploited species, as well as on some physiological peculiarities (Figure 1).

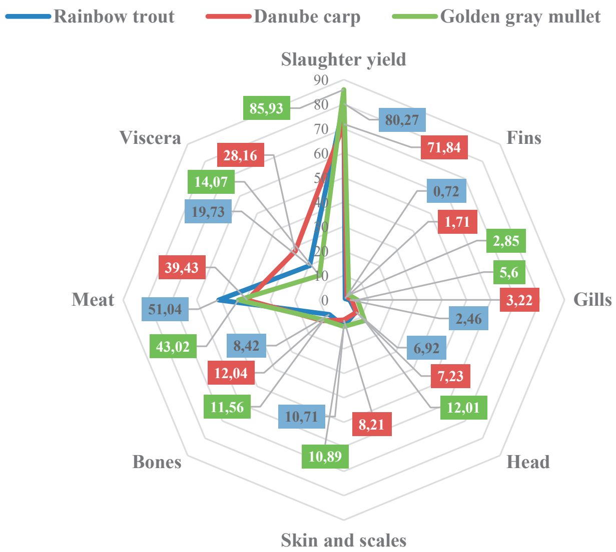

Figure 1. Slaughter yield and weight of viscera, respectively of body segments in the three species studied

To determine the slaughter yield and the weight of the anatomical segments in rainbow trout, 5 specimens with an average body weight of 236.94±3.37 gr were sacrificed. After removing the viscera, the average weight of the carcasses was 200.98 ± 2.58 g and had a slaughter yield of 80.27 ± 0.05%. The viscera weighed 46.75 ± 0.19 g, representing 19.73 ± 0.05% of the initial body weight. The trout head weighed 16.4 ± 0.21 g, representing 6.92 ± 0.04% of the initial body weight. The percentage weight of the fins was only 0.72 ± 0.01% of the initial weight (1.71 ± 0.06 g), while the bones represented 8.42 ± 0.01% (19.95 ± 0.32 g). The skin and scales represented 10.71 ± 0.01% of the initial weight (25.38 ± 0.85 g). The largest percentage share of the initial weight was the somatic musculature (meat), representing 51.04 ± 0.11% of the initial weight (120.93 ± 1.36 g), resulting in a very good yield at slaughter, both in terms of the species of fish, but also compared to other farm animals.

To determine the slaughter yield and the weight of the anatomical segments in common carp, 5 specimens with an average body weight of 2810.80 ± 79.718 g were slaughtered. After removing the viscera, the average weight of the carcasses was 2406.42 ± 68.271 g, with a slaughter yield of 71.84 ± 0.05%. The viscera weighed 791.5 ± 0.19 g, representing 28.16 ± 0.05% of the initial body weight. The carp head weighed 203.12 ± 5.761 g, representing 7.23 ± 0.04% of the initial body weight. The percentage weight of the fins was only 1.71 ± 0.01% of the initial weight (47.98 ± 1.362 g), while the bones represented 12.04 ± 0.01% (338.36 ± 0.32 g). The skin and scales represented 8.21 ± 0.01% of the initial weight

(230.74 ± 6.545 g). The largest percentage of the initial weight was the somatic musculature (meat), representing 39.43 ± 0.11% of the initial weight (1108.5 ± 31.133 g), resulting in a relatively low yield at slaughter, both in terms of the species of fish but also compared to other farm animals.

To determine the yield at slaughter and the weight of the anatomical segments in the mullet, 5 specimens with an average body mass of 330.92±3.876 g were sacrificed. After removing the viscera, the average weight of the carcasses was 299.44 ± 3.26 g, with a slaughter yield of 85.93 ± 0.05%. The viscera weighed 46.56 ± 0.19 g, representing 14.07 ± 0.04% of the initial body weight. The head of the mullets weighed 39.76 ± 0.461 g, representing 12.01 ± 0.06% of the initial body weight. The percentage weight of the fins was only 2.85 ± 0.01% of the initial weight (9.42 ± 0.119 g), while the bones represented 11.56 ± 0.01% (38.26 ± 0.548 g). The skin and scales represented 10.89 ± 0.01% of the initial weight (36.04 ± 1.352 g). The largest percentage of the initial weight was the somatic musculature (meat), representing 43.02 ± 0.12% of the initial weight (142.36 ± 1.306 g), resulting in a relatively good yield, both in terms of fish species and compared to other farm animals.

To determine the chemical composition of rainbow trout meat, 5 specimens of each species were sacrificed. After slaughter, evisceration, decapitation, skinning, and boning, the meat of each specimen was mixed and homogenized using a blender. The following parameters were determined: moisture (moisture), dry matter (DM), crude protein (Cp), crude fat (Cf%), and mineral substances (ash%).

Trout meat is one of the most appreciated varieties of fish meat, basically due to its chemical characteristics, organoleptic and even curative properties. All these aspects derive from the high biological value (content in amino acids and fatty acids), but also from the fact that the growing technology is very well developed and extremely modernized, a fact that leads to the permanent availability of this assortment in specialty stores, in any time of the year.

The results of our study demonstrated an average water content in rainbow trout meat of 76.27 ± 0.14%, with minimum values of 74.02% and a maximum of 77.71%. The average value of the dry matter, calculated by difference, was 23.71 ± 0.142%. Surprisingly, the protein content obtained was slightly below the usual values. Thus, we obtained an average crude protein value of 15.73 ± 0.192%, with a minimum of 14.53% and a maximum value of 19.10%. Normally, the protein level of trout meat is in the range of 17-20%. This fact may be due to the feeds used recently in feeding trout, which contain higher values of lipids, a fact also reflected in the average value of the crude fat obtained (Gb% = 6.92 ± 0.083%). The intake of minerals from rainbow trout meat presented a value of 1.08 ± 0.005%.

Carp is the representative species in terms of cypriniculture (Nicolae et al., 2018). In the case of this species, it should be mentioned that recently, this branch of fish farming is in decline in Romania, the reasons being of an economic nature (the growth period is longer compared to salmonids, large areas of clear water are needed for exploitation, the selling price is relatively low and there is also unfair competition in terms of carp imports, which are found at very low prices due to the subsidies practiced by other countries). In our study, we analyzed the quality of Danube carp meat, a fish caught from the natural environment, and not from aquaculture.

The water content of the carp meat had an average value of 74.44 ± 0.031%, with a minimum of 73.95% and a maximum of 74.72%, the homogeneity (V% = 0.41) resulting precisely from the fact that the fish had the same food resources and the same environmental conditions. The average value of the dry matter was 25.56 ± 0.031%, with a minimum of 25.28% and a maximum value of 26.05%. It is known that the Danube carp has a higher level of protein in the meat than the cultured varieties and breeds. This fact is also demonstrated in this study, the protein level of the meat being 16.06 ± 0.192%, with a minimum of 13.86% and a maximum of 18.80%. Normally, the protein level in aquaculture carp varieties is in the range of 12-15% Pb. The increased level of protein in Danube carp meat is due to the very diverse food supply of the species from natural environments, to the low stress compared to

specimens from intensive farms, but also to the adaptations that appeared during the phylogeny.
Regarding the level of lipids in carp meat, there is a distinction between cultured varieties that present consistent deposits of subcutaneous fat, which usually depreciate the organoleptic properties of the meat, and wild varieties (such as the Danube carp) that present a marbled arrangement of fat between muscle fibers, similar to beef. Usually, in carp from aquaculture, the fat level in the meat is in the range of 10-12% Gb. In this study, the average value of fat in carp meat was 8.54 ± 0.199%, with a minimum value of 5.47% and a maximum of 10.58%. The minerals in the Danube carp meat presented an average value of 0.96 ± 0.006%.

Table 3. The chemical composition of the meat of the three species of fish studied

Parameters	Moisture %	Dry Matter %	Crude Protein %	Crude Fat %	Ash %
Rainbow trout (*Oncorhynchus mykiss*)					
X±sx	76.27±0.14	23.71±0.142	15.73±0.192	6.92±0.083	1.08±0.005
Min.	74.02	22.21	14.53	5.88	1.00
Max.	77.71	25.98	19.10	8.16	1.13
V%	1.84	6.00	12.21	12.01	4.50
s	1.402	1.422	1.921	0.831	0.049
Common carp (*Cyprinus carpio*)					
X±sx	74.44±0.031	25.56±0.031	16.06±0.192	8.54±0.199	0.96±0.006
Min.	73.95	25.28	13.86	5.47	0.90
Max.	74.72	26.05	18.80	10.58	1.04
V%	0.41	1.20	11.98	23.33	6.59
s	0.306	0.306	1.925	1.992	0.063
Golden grey mullet (*Chelon auratus*)					
X±sx	75.3±0.233	24.62±0.229	21.05±0.219	2.57±0.077	1.09±0.007
Min.	72.67	21.14	18.63	1.60	1.01
Max.	78.74	27.32	24.19	3.56	1.18
V%	3.09	9.29	10.39	30.15	6.33
s	2.330	2.288	2.187	0.774	0.069

The mullet is widespread in the European and African coasts of the Atlantic Ocean, in the Mediterranean Sea, the Black Sea and the Sea of Azov, but also in their lagoons. In Romania, it is found along the coast, and in the past, it was also found in coastal lakes. Today, attempts are being made to implement technologies for breeding the species in captivity (Niță et al., 2018). It feeds in the sea on algae, benthic, and phytoplanktonic invertebrates, and in the lagoons, it feeds mainly on vegetable detritus.
In our study, we obtained an average water content value of 75.3±0.233%, with a minimum of 72.67% and a maximum of 78.74%. The average value of the dry substance was 24.62±0.229%, with a minimum of 21.14% and a maximum of 27.32%.
There was a very high level of crude protein in the meat, with an average value of 21.05±0.219%, with a minimum of 18.63% and a maximum of 24.19%. These values are clearly higher than those obtained in the case of rainbow trout and common carp, being demonstrated once again that the biological and nutritional value of oceanic and marine fish meat are higher compared to the meat of freshwater fish, respectively those obtained in aquaculture.
Also, the low level of crude fat obtained from mullet meat showed an average value of 2.57±0.077%, with a minimum of 1.60% and a maximum of 3.56%. The importance of fats in fish meat is known. Even if in the case of mullet it had low values, specialized studies mention the high intake of unsaturated fatty acids (monounsaturated MUFA and polyunsaturated PUFA), type Ω3, Ω6, Ω9 and Ω12 (Hedayatifard & Yousefian, 2010). The intake of minerals from the obtained mullet meat was 1.09±0.007%.
Related to our study, it can be observed that the highest average value of water content was obtained for rainbow trout (76.27%), followed by mullet (75.30%), and Danube carp (74.44%). Antagonistically, the content in dry matter presented the following situation in a decreasing manner: Danube carp SU = 25.56%; SU mullet = 24.62%; rainbow trout SU = 23.71%.
The dry matter with the highest possible value is of great importance, being later responsible for the intake of nutrients (proteins, lipids, carbohydrates, minerals). Moreover, a very

high water content in meat is not desirable, as the presence of water favours the degradation of the meat and its perishability.

The lowest average value of crude protein was obtained in rainbow trout (Pb% = 15.73%), followed by Danube carp (Pb% = 16.06%) and mullet (Pb% = 21.05). This ranking clearly demonstrates that in terms of nutritional value, mullet is clearly superior to the other two species. Of course, a more complex analysis would require the determination of essential and non-essential amino acid structures, but even so, a substantial protein intake in fish meat is desirable.

Regarding the fats and their average values, Danube carp (Gb% = 8.54%) was in first place, followed by rainbow trout (Gb% = 6.92%), and mullet (Gb% = 2.57%). As mentioned in the case of proteins, it is desirable to have as much fat as possible in fish meat. Similarly to proteins, in the case of fats, research on the structure of saturated and unsaturated fatty acids must be continued (Ljubojevic et al., 2013). Saturated fatty acids are not desirable in very high quantities, but the proportion of monounsaturated fatty acids and especially polyunsaturated ones is particularly important. The latter are involved in various physiological processes, starting from the supply of energy and permeability of membranes to curative and even therapeutic effects (prevention of diseases of the cardiovascular system, liver diseases, prevention and even treatment of various types of cancer, such as rectal or breast cancer) (Salin et al., 2021; Cocan et al., 2010).

In general, minerals in meat are not particularly important, but it must be taken into account that they are involved in numerous physiological processes (Mishra, 2020), and the lack of minerals can lead to various pathological conditions.

CONCLUSIONS

This study demonstrates that there are major differences in terms of meat quality and productive indices between fish species with different nutritional spectrums (herbivores, omnivores and predators). Even under these conditions, it is difficult to make recommendations regarding the consumption of one or other species, because if some species have a high protein content, it is possible, as we have obtained in this study, to have a lower fat content. From a nutritional point of view, a balanced intake of proteins, fats and minerals is recommended. That is why we recommend constant consumption of fish meat and if possible, to diversify the species consumed. Of course, these studies must be continued, because many factors influence the productivity of fish species and the quality of the meat.

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