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Contributions concerning the quality indices' appreciation in main aquatic organisms, which fall under human consumption

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Abstract. In present work paper, the authors broach a theme of top modernity concerning the fish and other aquatic organisms' quality, in the context of more and more demand from the consumers' side. To put into evidence the meat quality proceeded from fishes and other aquatic organisms, were effected physical-chemical studies to emphasize the value of some parameters and their evolution depending on species, age and body weight. Also, were done comparisons between fish meat quality and other provenance sources respectively meat from farm animals. The obtained results put into evidence superior qualitative values of aquatic organism meat to those terrestrial ones, especially as regard the protein and decreased fat content. The researches emphasized also the fact that meat production indices have an evolution in direct correspondence with body weight and age on the one hand, and on the other one, they are different also depending on species, those predacious ones having superior values in all cases. Other studied aquatic organisms, unless fishes, have emphasized a very reduced content of fats and carbohydrates that reveals the especial biological and chemical value, in conditions of alimentary components' demand to provide a rational alimentation and an alimentary insurance.
Key words: aquatic organisms, nutrients, cholesterol.

Tartalom. A jelenlevő dolgozatban, a szerzők egy nagyon fontos alkalomszerű tételt hoznak fel, amely a hal és más vízi organizmusok minőségét viszgálja, a fogyasztok kérésének egyre nagyobb összefügésével. A hal hús és más vízi organizmusok minőségének kimútatására kémiai és fizikai kutatásokat hajtottak végre, egyes parameterek kimútatására és ezek evolúciójanak, a fajta, kor és testi tömeg fügvényében. Ezentúl, összehasonlítások végzödtek a hal hús és más fajták húsa között, illetve a háziállatokéval. A kutatások kimutatták, hogy a vizi élőlények húsának minősége felsőbb fokú a háziállatokéhoz hasonlitva, föleg a fehérje taralom és az alacsony köverség tartalom miatt (szempontajából). Színtén a kutatások azt is kimútatták hogy a hús termelés mutatoinak evolúciója egyenesen arányos összefűgésben vannak a test tömeggel és a korral, ugyan úgy kiderült hogy ezek a mutatok elkülönülnek a fajták fügvényében is, a ragadozóké minden esetben felsőbb fokú minöséget mútatak. A kutatásban vont más vizi élölények, a hal húson kivül, alacsony szintű kövérség és szénhidrát szintet mútatak ki minden esetben, ami egy kitünő biologiai és kémiai értékre útal, az olyan összetételű élelmiszerek fogyasztásának fügvényében amelyek egy racionális étkezést és élemiszer bisztonságot nyújtsanak.
Kulcsszavak: vizi organizmusok, tápérték, koleszterol.

Rezumat. În prezenta lucrare, autorii abordează o tematică de strictă actualitate privind calitatea peştelui şi a altor organisme acvatice, în contextul cererii tot mai mari din partea consumatorilor. Pentru evidenţierea calităţii cărnii provenite de la peşti şi alte organisme acvatice, au fost efectuate cercetări fizico-chimice care să evidenţieze valoarea unor parametri şi evoluţia acestora în funcţie de specie, vârstă şi greutate corporală. De asemenea, s-au făcut comparaţii între calitatea cărnii de peşte şi alte surse de provenienţă, respectiv carne de la animalele de fermă. Rezultatele obţinute au evidenţiat valori calitative superioare ale cărnii organismelor acvatice faţă de cele terestre, îndeosebi sub raportul proteinei şi a conţinutului scăzut de grăsime. Cercetările au mai evidenţiat şi faptul că indicii producţiei de carne au o evoluţie în corespondenţă directă cu masa corporală şi vârsta, pe de o parte, iar pe de altă parte, aceştia se diferenţiază şi în funcţie de specie, cele răpitoare având în toate cazurile valori superioare. Alte organisme acvatice, în afară de peşti, luate în studiu, au evidenţiat printre altele un consum foarte redus de grăsimi şi glucide, ceea ce relevă valoarea biologică şi chimică deosebită, în condiţiile cererii de componente alimentare care să asigure o alimentaţie raţională şi o securitate alimentară.
Cuvinte cheie: organisme acvatice, nutrienţi, colesterol.

Introduction. The extraction of prime materials from aquatic environment, and especially the fishes, mollusks and crustaceans which constitute special alimentary resources for human (Plates 1 and 2), represents one of the most important preoccupation of XXIst Century, human having in view their especial biological value (Sikorski et al 1996; Kim & Mendis 2006; Blanco et al 2007).

Today, it is known the fact that a high consumption rate of aquatic products has a benefic role on human health through the help that they offer to the organism fortification on one hand and on the other hand minimizing the cardiovascular diseases apparition (Christensen et al 1997; Arts et al 2001) by decreasing the total cholesterol level, by decreasing the triglycerides level and by the fact that they moderate the inflammatory response and improve carbohydrates metabolism.

Keeping in view the above mentioned considerations, today is ascertained an increasing of aquatic organisms' consumption, in aversion to other alimentary components, in a pronounced dynamics and even much more people direct their attention and preferences to these nourishments (see Blanco et al 2007).

Having in view that we mentioned, our researches had as purpose the emphasis of some quality indices in main aquatic organisms, which fall under human alimentation. Also, we want to do a comparative analysis of some chemical features of these organisms, both among them, and also with other farm animal species to emphasize the quality difference. The obtained data were statistically processed and are presented in tables that follow.

Material and Method. The biological material was represented by ten fish species bred in fresh and marine waters, and also by other five aquatic invertebrates, which fall more and more under modern human alimentation. In the species selection we have in view by the one hand the consumer preferences, and by the other one their husbandry in exploitation farms.

We have in view the main indices' determination of meat production, as well the weight establishing of different components at trenching, reported to initial weight.

For the chemical composition determination of the fish meat were collected meat samples from the dorsal muscle region on each five individuals from each studied species.

Having in view that in the majority of aquatic organisms there are no data, but only very rarely and imperfect to emphasize their qualities, we effected chemical analysis in these species, in which we have also in view the establishing of cholesterol quantity expressed in mg at 100 g of product.

The chemical analyses were effected by classical laboratory methods (see Popescu et al 1986; Stănescu 1998; Nicolae 2002; Metaxa 2003), and the data were statistically processed and expressed in percentage in the following tables.

Result and Discussion. After the effected researches and obtained results, as first finding is that among studied species exist significant differences as concerns the slaughter efficiency, with values comprised between 63 and 77.20%.

From the data presented in Table 1, comes out that marine species and common carp have the most reduced slaughter efficiency values, which do not surpass 65%, in return all predacious species, but to which are added also two cyprinid species, the slaughter efficiency is superior to the other mentioned species. These results are relatively alike to those ones obtained by Iurcă (2006), Laslo et al (2008) Rotaru & Mihaiu (2003).

Making a fish species hierarchy depending on slaughter efficiency, on the first place is situated the trout with 77.2%, followed by pikeperch with 72% and African catfish with 69.35% while the most reduced values were registered in common carp, horse mackerel and merllucius of under 65%.

From the data of our researches comes out that one of the most important indices of meat production, which in fact establishes also the commercial value, is the meat weight from the total weight.

In this regard comes out that the trout is situated on first place with a value of 67.10%, followed by pikeperch with 57.40% and European catfish with 53.5%, while in common carp this index is only of 46.60%, and in bream of 48.90%.

Table 1

Main meat production indices in some fish species

*Species***	*Slaughter efficiency (%)*	*Meat (%)*	*Tegument (%)*	*Head (%)*	*Fins (%)*	*Scales (%)*	*Bones *(%)*	*Viscera (%)*	*Cholesterol (g/100 g)*
Common carp (*Cyprinus carpio*)	63.00	46.60	4.20	18.30	3.50	5.20	8.70	13.50	56
European catfish (*Silurus glanis*)	68.60	53.50	5.10	21.70	2.10	-	7.90	9.70	67
Pike perch (*Sander lucioperca*)	72.00	57.40	3.70	15.60	3.10	2.60	7.80	9.80	52
African catfish (*Clarias gariepinus*)	69.35	53.00	6.00	20.80	2.25	-	8.10	9.85	58
Rainbow trout (*Oncorhynchus mykiss*)	77.20	67.10	2.15	13.80	2.15	1,15	5.80	7.85	53
Horse mackerel (*Trachurus mediterraneus*)	64.35	50.25	3.15	24.85	0.95	-	10.00	10.80	54
Merllucius (*Merluccius merluccius*)	64.30	52.50	1.90	17.80	2.40	1.60	7.50	16.30	58
Tench (*Tinca tinca*)	66.50	50.45	3.95	17.80	2.85	3.10	9.25	12.60	52
Pike (*Esox lucius*)	65.80	51.30	3.60	19.75	2.95	2.65	7.95	11.80	54
Bream (*Abramis brama*)	66.70	48.90	3.40	15.00	3.40	4.30	11.00	14.00	51

*Myoseptal bones (false bones) were also included; **Latin names have lesser taxonomic significance here.

These last values are determined by the more increased gastro-intestinal content on the one hand, and by the other one by the much greater length of digestive tube in omnivorous, comparatively to predacious species (see Mireşan 2004).

In conditions in which we analyze the weight of tegument layer, reported to total weight, we observe that this has the highest values in species without scales, respective in African catfish with 6% and in European catfish with 5.1%, while the most reduced values are, as it is normal, in merllucius with 1.9% and trout with 2.15%.

One of the segments that influence significantly the slaughter efficiency is the head, which weight varies in very large limits, depending on species. Thus, the head weight riches to 13.8%, while in horse mackerel the value is significantly superior, of 24.85%. High values are also in the European catfish with 21.70% and in the African catfish with 20.80%, respectively.

Following the weight of fins and scales comes out that the percentage values are more reduced, with mention that also in these cases the differences are significant among species. Thus, the smallest weight of fins, reported to total weight is in trout, with only 0.95%, while the greatest value is registered in carp and bream, with 3.5% and 3.4% respectively.

If we analyze the weight of scales from total weight, comes out that in some species these ones are absent (catfishes), while reduced values are in trout and merllucius of 1.15% and 1.6% respectively, and the largest ones in carp with 5.2% and bream with 4.3%.

The bones are other components, which impress on slaughter efficiency and on carcasses' quality. We must mention that the bones' proportion from the organism structure is in direct correspondence with species, fish size and skeleton development degree. As it can be observed from the obtained data, the highest weight of bones is in bream (11%), in horse mackerel (10%) and in tench (9.25%), and the most decreased in trout (5.8%) and merllucius (7.5%).

The viscera had also a weight relatively high reported to total weight, the registered differences being determined firstly by the body size and the alimentary behavior type, but also by the satiety degree in the capture moment. Thus, according to obtained data the variation limits are relatively great, ranking between 7.85% (in rainbow trout) and 16.30% (in merllucius). The most reduced values are in case of predator species, whose slaughter efficiencies are the most favorable. Besides, in all predacious species the weight of viscera varied between reduced limits, respective 7.85-9.85, values that we appreciate to be very favorable as concerns the efficiency.

Another aspect less observed in the work papers studied during the time was to establish the cholesterol quantity reported to 100 g of product, whose results are very interesting. As can be observed, the cholesterol quantity varied between limits relatively reduced, respectively between 51 g and 67 g that reveal special qualities of fish meat and the importance of this aliment for the human organism health.

To see whether the weight or age have impact on meat production indices, we have analyzed individuals of three species with different weight and ages, whose results are presented in Table 2.

Table 2

Main meat production indices at slaughter depending on species and age category

*Species**	*Average weight (g)*	*Slaughter efficiency (%)*	*Weight of different components from total weight (%)*				
			Fins	Scales	Head	Viscera	Bones
Common carp	500	48.89	3.05	2.21	22.40	10.20	13.25
Common carp	1500	52.68	2.82	3.85	18.90	12.60	9.15
Common carp	3000	59.14	2.63	3.15	15.85	11.43	7.80
Rainbow trout	100	59.68	1.45	1.50	19.25	10.70	7.42
Rainbow trout	200	66.56	1.15	1.18	15.36	8.85	6.90
Rainbow trout	300	70.03	1.02	0.98	13.90	7.65	6.42
Pike	500	59.02	2.88	4.95	18.65	4.50	10.00
Pike	1500	63.58	2.05	4.15	17.12	4.35	8.75
Pike	3000	66.04	1.98	4.00	15.72	4.21	8.05

*For latin names of the species see Table 1.

According to obtained data comes out that age and weight, in case of all the three species, have a favorable evolution on the meat production indices with aging time and increasing of body weight.

In common carp case, the slaughter efficiency increases with 3.79% from the weight of 500 g to that one of 1500 g and with 6.46% between two and three summer age, values that we appreciate to be very favorable, which permit us to recommend the common carp slaughter when the fish has at least two summer age, respectively over 1.5 kg and in no cases carp under 500-800 g.

Following the same aspects, but in predacious species, comes out the same tendency, but with values significantly superior. Thus, in trout of 100 g, the slaughter efficiency is 59.68% that increases in individuals with double weight with 6.88% and then in 300 g weight increases more with 3.47% reaching over 70.03%. If we analyze these aspects in case of pike, comes out that in individuals of 500 g the slaughter efficiency is 59.02%, with an increasing in those ones of 1500 g with 4.56%, and in a weight of 3 kg the slaughter efficiency reaches to 66.04%, with an increasing of 2.46%.

Interesting and, in the same time, important are the data which reveal the weight of different components reported to total weight and which put into evidence the fact

that some of components have a descendant evolution as the body weight increases, while the other ones have ascendant evolutions. In the carp case, the fins' weight decreases from 3.05% to 2.63% in carp of 3 kg, in change the scales' weight increases from 2.21% to 3.85% at 1.5 kg weight and decreases to 3.15% at 3.0 kg weight. The most spectacular decreasing we registered in case of head weight in carp that from a very high value of 22.40% at 500 g weight decreases with 3.50% at 1.5 kg weight and gets to 15.85% at 3.0 kg weight. These data confirm ones again the moment of maximal favorability when is good to be capitalized the carp. Similar aspects we observed also in case of bones' weight, which decrease from 13.25% at the smallest weight to 7.80% at 3.0 kg weight, the decreasing being significant and ensured.

In trout, the most significant decreasing is registered in case of head weight that decreases from 19.25% to 13.90%, respective a decreasing with 5.35%, and the most reduced differences are find for fins level, which do not surpass 0.43%.

In case of the second predator fish (pike), the most significant differences occur also in case of anterior extremity weight - the head - in which from a value of 18.65% at minimal analyzed weight, gets to 15.72%, the difference of 2.93% being significant also in this case.

Analyzing the fish meat chemical composition in all 10 studied species of fresh or marine water, comes out, as it is normal, variability in all determined elements, with differences more or less significant (see Table 3).

Table 3

Chemical composition of fish meat

*Species**	*Water (%)*	*Dry mass (%)*	*Protein (%)*	*Fat (%)*	*Crude energy (MJ/kg)*	*Minerals (%)*
Common carp (*Cyprinus carpio*)	73,22 ± 4,32	26,78 ± 3,45	16,61 ± 2,11	8,97 ± 3,73	6,99 ± 1,00	1,20 ± 0,3
European catfish (*Silurus glanis*)	71,70 ± 3,74	28,30 ± 1,36	16,80 ± 1,15	10,25 ± 1,82	8,12 ± 0,76	1,25 ± 0,2
Pike perch (*Sander lucioperca*)	77,56 ± 3,93	22,44 ± 2,68	18,78 ± 1,96	2,56 ± 1,25	5,40 ± 0,34	1,10 ± 0,2
African catfish (*Clarias gariepinus*)	72,17 ± 3,46	27,83 ± 1,68	17,20 ± 1,07	8,56 ± 1,14	7,98 ± 2,33	2,07 ± 0,1
Rainbow trout (*Oncorhynchus mykiss*)	77,03 ± 3,22	22,97 ± 2,15	18,88 ± 1,63	2,94 ± 0,34	3,67 ± 0,9	1,15 ± 0,1
Horse mackerel (*Trachurus mediterraneus*)	77,46 ± 2,52	22,54 ± 2,11	17,84 ± 1,09	3,25 ± 0,94	4,93 ± 1,07	1,45 ± 0,1
Merllucius (*Merluccius merluccius*)	76,38 ± 2,67	23,62 ± 2,18	18,25 ± 1,34	4,07 ± 1,15	5,25 ± 1,23	1,30 ± 0,2
Tench (*Tinca tinca*)	80,40 ± 2,85	19,60 ± 4,36	15,95 ± 1,23	1,80 ± 0,36	3,76 ± 1,12	1,85 ± 0,2
Pike (*Esox lucius*)	78,62 ± 4,15	21,38 ± 1,52	17,96 ± 1,34	2,34 ± 0,89	4,93 ± 0,28	1,08 ± 0,1
Bream (*Abramis brama*)	78,41 ± 2,85	21,59 ± 1,68	16,48 ± 1,25	2,96 ± 0,77	5,25 ± 1,15	2,15 ± 0,2

*Latin names have lesser taxonomic significance here.

Following the dry substance values comes out that in majority of species, these are situated about 20-22%, excepting the species which have an higher fat content, in which the dry substance gets to 26-28% (common carp and the two catfish species). The smallest quantity of dry mass is found in tench, with only 19.60%, and the greatest, as it is normal, in European catfish, of 28.30%.

The protein, one of the most important nutrients of fish meat, has a weight that varies from species to species, with mention that in majority of cases is greater in predacious fishes, besides priority appreciated by the consumers. We must mention the fact that protein composition from fish meat is generally considered superior to that one derived from other animals, and that difference is based on essential aminoacids' amounts (Banu & Dumitrescu 1978; Banu et al 1999; Rotaru & Mihaiu 2003; Bud et al 2007a,b).

In case of fat, comes out that differences are significant, varying between 1.80% in case of tench and gets maximum of 10.25% in European catfish. Superior values of fat content we found also in African catfish, of 8.56% and respective in common carp with 8.97%. As concerns the caloric fish meat value, this one varies directly proportional with the fat quantity.

Appreciating the chemical composition of fish meat comparatively to that one proceeded from other domestic animal species, comes out that nutrient values are different both between studied species and also comparatively with those one existent in farm animal meat (see Table 4).

Table 4

Chemical composition of fish meat compared to composition of beaf, pork and mutton

*Species**	*Water (%)*	*Dry mass (%)*	*Protein (%)*	*Fat (%)*	*Crude energy MJ/kg*	*Minerals (%)*
Common carp (*Cyprinus carpio*)	73.22 ± 4.32	26.78 ± 3.45	16.61 ± 2.11	8.97 ± 3.73	6.99 ± 1.00	1.20 ± 0.3
Pike perch (*Sander lucioperca*)	77.56 ± 3.93	22.44 ± 2.68	18.78 ± 1.96	2.56 ± 1.25	5.40 ± 0.34	1.10 ± 0.2
European catfish (*Silurus glanis*)	71.70 ± 3.74	28.30 ± 1.36	16,80 ± 1.15	10.25 ± 1.82	8.12 ± 0.76	1.25 ± 0.2
Rainbow trout (*Oncorhynchus mykiss*)	77.03 ± 3.22	22.97 ± 2.15	18.88 ± 1.63	2.94 ± 0.34	3.67 ± 0.9	1.15 ± 0.1
Bovines (*Bos taurus*)	70.55 ± 4.32	29.45 ± 2.31	16.75 ± 1.14	10.35 ± 1.34	8.56 ± 0.77	2.35 ± 0.25
Swine (*Sus scrofa*)	53.49 ± 4.54	46,51 ± 2.38	15.85 ± 1.83	27.80 ± 2.46	19.32 ± 1.26	2.86 ± 0.31
Ovine (*Ovis aries*)	61.03 ± 3.86	38,97 ± 2.46	17.95 ± 1.36	18.65 ± 2.15	14.54 ± 1.38	2.37 ± 0.42

*Latin names have lesser taxonomic significance here.

The most evident differences are registered as concern dry mass and water, these ones being influenced mostly by the fat weight and in a less proportion by the protein and minerals. Also, there are significant differences as regard the crude energy that is superior in farm animals. These values confirm once again the quality and biological value superiority of fish meat comparatively to other meat sources.

Keeping account of spectacular increasing in the human alimentation of some aquatic organisms with especial biological and culinary value (Plate 2), we also had in view a succinct presentation of the chemical composition in main aquatic species demanded on alimentary market (Bura 2002; Table 5).

As comes out from the data presented in table, there exist significant and ensured differences as chemical regard depending on studied species. Thus, can be observed a great variability as concern the protein quantity reported to 100 g that varies from 9.10 g in shell meat and to 23.0 g in red shrimp meat. We mention that irrespective of considered species, the meat of these organisms is extremely poor in lipids, no overdoing 1.8 g at 100 g meat, in change, it is very reach in calcium, going to values of 551 mg in case of crabmeat. Pursuant to decreased content in lipids and carbohydrates, but reach in proteins and mineral salts, the aquatic organisms are more and more asked by the

consumers, their demand on world market doubling in the last 10 years (Bud et al 1989, 2004, 2007a,b; Ladoşi & Ladoşi 2005; Iurcă 2006).

Table 5

Chemical composition of some aquatic species meat

*Species**	*Dry mass (g/100 g)*	*Water (g/100 g)*	*Protein (g/100 g)*	*Fat (g/100 g)*	*Glycogen (g/100 g)*	*Ca (mg/100 g)*	*Cholesterol (mg/100 g)*
Crayfish (*Astacus fluviatilis*) meat	14.7	85.30	10.70	1.30	0.50	222	125
Lobster (*Homarus gammarus*) meat	21.6	78.40	15.20	0.60	0.10	120	93
Crab (*Pachygrapsus marmoratus*) meat	27.6	72.40	22.90	1.80	1.00	551	142
Red shrimp (*Pandalus borealis*) meat	31.9	68.10	23.30	0.80	0.10	61	184
Shell (*Myrtilus edulis*) meat	13.9	86.10	9.10	0.40	1.00	6.7	126

Source: adapted after Bura (2002); *Latin names have lesser taxonomic significance here.

Conclusions and Recommendations. After the effected researches and obtained results come out some conclusions and recommendations, which are succinct presented.

Today, it is observed a significant change of consumers' preferences as concerns the alimentary components, the humans demanding more and more the aquatic products because of their qualities, as comes out from the presented qualitative values.

As regard the meat production indices, comes out that almost all fish species registered superior values to other meat sources, which get into human alimentation.

Among fish species, which were the object of this study, those predacious ones and respectively those marine ones registered values superior to cyprinid species.

The meat production indices' values are significantly improved once with age and body weight increasing, information that must be kept in view in the conditions of some superior economic capitalization.

The fish meat, in general lines, does not differentiate much as chemical regard from other animal species but differentiates significantly as biological value and caloric regard.

Both fish meat and that one proceeded from other aquatic species, in general, is poor in lipids, aspect that confers superiority to other meat sources, to which we can also mention the fact that this fat has an increased content of unsaturated fatty acids, among them being also those of omega 3 type, essential for the human health.

Plate 1. Marine and freshwater aquatic products – marketed all over the world.

Plate 2. All sort of marine and freshwater aquatic products.

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