Study of Meat Physical-Chemical Composition of Three Trout Breeds Farmed in Salmonid Exploitations from Moldova

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Abstract
For all trout breeds, especially regarding brown trout, data from local and foreign literature consulted are less conclusive and sometimes controversial in terms of physical-chemical composition of different trout breeds meat, so our research represents a novelty for Romanian literature and aims to bring new information to enrich it.
Our research aimed to evaluate the physical-chemical composition of the meat gathered from brook, rainbow and brown trout breed, by analyzing 50 individuals, 10 individuals in each batch (F_1, F_2, C_1 C_2 and I_1), from two trout farms from Moldova, being determine the pH of meat, dry matter, content in proteins, lipids, ash and water/protein ratio for all three trout breeds. The obtained values for pH at warm ranged between 6.91 at batch F_1, and 7.09 for batch I_1. As regarding the pH at cold, this one had and descendant evolution ranging between: 6.78 for trout from batch F_1 respectively a value of 6.88 for individuals from batch I_1. The obtained values were between 23.95 and 27.12 for dry matter. Content in proteins recorded the best values (19.21%) at individuals from batch F_2, and content in lipids oscillated between 4.14% and 5.62%. The obtained values regarding physical-chemical composition highlighted that all trout breeds have a good nutritional value.

Keywords: nutritional value, physical-chemical composition, trout

1. Introduction

One of the current problems of human nutrition, debated and studied in wide circles of contemporary scientific society is the problem of protein nutrition and, in particular, the current deficiency in providing the human body with protein, due to ever-increasing growth of the global human population and territorial inhomogeneous distribution of food [1, 2].
During human evolution, fish meat contributed to a considerable extent at assuring the needs for animal protein. Together with other animal origin products represents a very important food source with a high nutritional value, much used in human nutrition. Trout meat is a very nutritive food due to its rich content in proteins of high quality [3-7].
Knowing the physical-chemical composition of fish meat has a great importance, because on its basis could be made appreciations on general physiological state of fishes and also on the efficiency of feed capitalization [6].
Physical-chemical composition is the main element based on which we could evaluate the nutritive value of fish meat [8].
Aim of the present research consisted in determination and comparison in terms of physical-chemical composition of brook, rainbow and brown trout meat reared in similar environmental conditions in North-Eastern part of Romania.
For all trout breeds, especially regarding brown trout, data from local and foreign literature consulted are less conclusive and sometimes

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controversial in terms of physical-chemical composition of different trout breeds meat, so our research represents a novelty for Romanian literature and aims to bring new information to enrich it.

2. Materials and methods

Biological material was represented by 50 individuals of brook, rainbow and brown trout of both sexes, reared in two trout farms from Neamț and Suceava County. To achieve the proposed goals, from the biological material which was studied during 2012-2013, were made up five experimental batches, each of 10 individuals per batch, for the three studied breeds.

To determine the physical-chemical composition of trout meat were gathered samples from side musculature of fishes from all five batches.

Establishing the pH of trout meat at warm and cold (after 24 hours) was performed by potentiometric methods (electrometric), according to SR ISO 2917:2007 [9] working with extract prepared from the muscular tissues provided from the trout individuals from experimental batches.

Determination of dry matter was realised through the method of drying in oven, which is the most used indirect method and suppose the drying of sample in oven at +105°C, till reaching a constant weight, in according to SR ISO 1442:2010 [10].

Proteins were identified by using the Kjeldahl method, described by SR ISO 937:2007 [11].

Determination of lipids content was realised using Soxhlet method, which consists in fat extraction from the analysed sample using petrol ether (SR ISO 1443:2008) [12].

The ash was determined by calcinations at a temperature of 550ºC in calcinations oven according to SR ISO 936:2009 [13].

The software used for statistical analysis was SPSS. We calculated the average, standard deviation, coefficient of variation and statistical significance of differences between samples.

3. Results and discussion

Physical-chemical composition of trout meat, in addition to the genetic factors, is also influenced by environmental factors such as water quality, its pH and temperature, oxygen content, technological factors, feeding, type of food used, season of the year, age and size of the fish [14-18].

Fish meat, through its structure and composition is classified as white meat and dietary.

In terms of composition, fish meat closely resembles with most butchery animals; water varies relatively high according to breed, consistently exceeding 70%.

Concerning the quality of water, during our research the physical-chemical parameters of water were maintain in the optimal limits for trout exploitation. Rearing conditions, the quality of the administrated fodders and the distribution way of the fodders were evaluated by analysing the main physical-chemical parameters of trout meat: pH, raw proteins, lipids, moisture content and ash, the results being presented in the current paper.

Acidity influences meat quality in relation to sensory, hygienic and technological. It determines and reflects the state of chemical components of meat and is closely related to color features. Acidity has direct and indirect links with other sensory features (tenderness, consistency, aroma and taste) and affects water retention capacity and shelf life of meat [19].

Stress before trout slaughter lead to an accelerated decline in pH due to the production of increased amounts of lactic acid in the muscle tissue [20-23]. pH level from fillet, was determined on fresh meat and, respectively, at 24 hours after slaughter (Table 1), observing that the values obtained from the two tests, fall within the limits from the literature [19, 24].

Table 1. pH value of fillet gathered from analysed trout

Breed	Batch	After slaughter		At 24 hours	
		$\bar{X} \pm s_{\bar{x}}$	V%	$\bar{X} \pm s_{\bar{x}}$	V%
Brook trout	F_1	6.97±0.06	1.86	6.83±0.09	1.96
	F_2	6.99±0.03	1.84	6.85±0.09	1.47
Rainbow trout	C_1	6.91±0.09	1.57	6.78±0.06	1.79
	C_2	6.96±0.02	1.68	6.81±0.10	1.84
Brown trout	I_1	7.09±0.09	1.75	6.88±0.08	1.63

Water content of muscle tissue. Due to the high proportion of participation in the chemical composition and the multiple roles performed, water is the main component of all living organisms, with importance in their organization and functioning.

Water content of fillet (side muscles) obtained from the studied trout breeds had close values (Table 2 and 3) ranking between 72.89% at batch F_2 and 76.05% at batch I_1, values which fall with in the limits from the literature [8, 14, 16, 18, 25-34].

Table 2. Chemical composition of fillet obtained from brook, rainbow and brown trout

Specification		Brook trout F_1	Brook trout F_2	Rainbow trout C_1	Rainbow trout C_2	Brown trout I_1
Water (%)	$\bar{X} \pm s_{\bar{X}}$	73.56±0.23	72.89±0.48	74.25±0.34	75.21±0.50	76.05±0.27
	V %	1.01	2.08	1.47	2.12	1.14
Fisher Test		10.8078 (F)>F(0.001) (4 ; 45) 5,70 *** highly significant				
DM (%)	$\bar{X} \pm s_{\bar{X}}$	26.44±0.23	27.12±0.48	25.75±0.34	24.79±0.50	23.95±0.27
	V %	2.84	5.61	4.25	6.45	3.63
Fisher Test		10.8107 (F)>F(0.001) (4 ; 45) 5,70 *** highly significant				
Protein (%)	$\bar{X} \pm s_{\bar{X}}$	18.3±0.20	19.21±0.34	17.87±0.16	17.45±0.22	17.27±0.24
	V %	3.49	5.69	2.86	4.05	4.53
Fisher Test		10.0172 (F)>F(0.001) (4 ; 45) 5,70 *** highly significant				
Fat (%)	$\bar{X} \pm s_{\bar{X}}$	5.62±0.14	5.43±0.32	5.02±0.22	4.53±0.14	4.14±0.21
	V %	7.98	18.80	14.29	10.27	16.61
Fisher Test		7.7619 (F)>F(0.001) (4 ; 45) 5,70 *** highly significant				
Ash (%)	$\bar{X} \pm s_{\bar{X}}$	1.17±0.003	1.19±0.01	1.11±0.01	1.09±0.009	1.09±0.007
	V %	0.85	3.18	4.02	2.66	2.18
Fisher Test		23.2387 (F)>F(0.001) (4 ; 45) 5,70 *** highly significant				

Table 3. Tukey test Chemical composition of fillet obtained from brook, rainbow and brown trout with statistical differences between batches

Specification	Brook trout F_1		Brook trout F_2	Rainbow trout C_1	Rainbow trout C_2	Brown trout I_1
	Indicators		Means' difference	Significance		Significance level
Water	WC_2	WF_1	1.65	significant		p<0.05
	WC_2	WF_2	2.32	distinctly significant		p<0.01
	WC_2	WI_2	1.80	significant		p<0.05
	WF_2	WI_1	3.16	distinctly significant		p<0.01
	WF_1	WI_1	2.49	distinctly significant		p<0.01
	Indicators		Means' difference	Significance		Significance level
Dry matter	DMC_2	DMF_1	1.65	significant		p<0.05
	DMC_2	DMF_2	2.32	distinctly significant		p<0.01
	DMC_1	DMI_1	1.80	significant		p<0.05
	DMF_2	DMI_1	3.17	distinctly significant		p<0.01
	DMF_1	DMI_1	2.49	distinctly significant		p<0.01
	Indicators		Means' difference	Significance		Significance level
Protein	PC_2	PF_2	1.75	distinctly significant		p<0.01
	PC_1	PF_2	1.33	distinctly significant		p<0.01
	PF_2	PI_1	1.94	distinctly significant		p<0.01
	PF_1	PI_1	1.03	significant		p<0.05
	Indicators		Means' difference	Significance		Significance level
Fat	FC_2	FI_1	0.39	distinctly significant		p<0.01
	FC_2	FF_2	0.91	significant		p<0.05
	FF_2	FI_1	1.30	distinctly significant		p<0.01
	FF_1	FI_1	1.48	distinctly significant		p<0.01
	Indicators		Means' difference	Significance		Significance level
Ash	AC_2	AF_1	0.08	distinctly significant		p<0.01
	AC_2	AF_2	0.10	distinctly significant		p<0.01
	AC_1	AF_1	0.06	distinctly significant		p<0.01
	AC_1	AF_2	0.08	distinctly significant		p<0.01
	AF_2	AI_1	0.11	distinctly significant		p<0.01
	AF_1	AI_1	0.08	distinctly significant		p<0.01

* rest of the difference were insignificantly (p>0.05)

Relatively high water content of fish as well as trout breeds, in case of our determinations ranged between 70-80%, which indicates that this content favors the growth of most micro-organisms, which makes the period of storage by refrigeration to be considerably diminished, recommending consumption as freshly is possible [2, 16].

Muscle protein. Within chemical composition of muscle tissue after water, proteins are the major constituents of animal bodies; proteins perform functions extremely varied, reflecting a high degree of structural organization and specialization.

Proteins are the basic substances that offer products their nutritional value. Therefore, the quality of food is assessed primarily by their content of protein [19].

The protein content of trout breeds fillet from the experimental batches ranged between 17.27% for brown trout, and 19.21% for brook trout, values similar to the specialty literature [8, 14, 16, 18 and 25-34]. Also, there are highly significant statistical differences in the protein content for the three trout breeds.

Lipids from fish meat vary within wide limits, 0.1-28.0% [35], and in case of trout meat speciality literature provides information regarding the fat content ranging between 1.7% and 9% [8, 14, 16, 18 and 25-34].

The amount of fat and its distribution depend on fish breed, age, nutrition, storage location, climatic factors, state of fish fattening and it's physiological state [36].

The degree of fish fat assimilation is very high in relation to other fats, 94-97%, which is explained primarily by nature of fatty acids from fish fats, predominantly polyunsaturated (linoleic, linolenic, arahidonic, eicosapentaenoic, docosapentaenoic, docosahexaenoic acids) [34-36].

The fat content of the analyzed trout's fillet ranged between 4.14%, in case of brown trout and 5.62% for brook trout, values that places them in the category of fish medium lipid content (4–8%). And this time data obtained were within the limits of specialty literature consulted [14, 16, 18, 26, 29-31, 34].

Water/protein ratio (a/p) is an appreciation criterion for the nutritional value of fish meat, according to which, fish are divided in 5 classes(categories): 1st class–fish with highly nutritional value (a/p–2.5–3.5); 2nd class-fish with good nutritional value (a/p–3.5–4.2); 3rd class-fish with mediocre nutritional value (a/p–4.2-4.7); 4th class-fish with reduced nutritional value (a/p–4.7–5.2); 5th class–fish with advanced state of starvation (a/p higher than 5.2). Water/protein ratio is an insufficient criterion for establishing the nutritional value of fish and therefore must be taken into consideration the fat content of fish meat. At fish, protein represents 12.3–28.0% from total mass, being a direct correlation between water and protein content [36].

In case of the first four experimental batches (Table 4) the water/proteins ratio of fillet indicates that the analysed breeds frames in the second class–fish with a good nutritional value, water/proteins ratio ranging between 3.79 at batch F_2 and 4.15 at batch C_1, while in case of brown trout the water/protein ratio of fillet (4.40) indicates that breed frames in third class, fish with average nutritional value towards mediocre.

Table 4. Water/proteins ratio of fillet from brook, rainbow and brown trout

Specification	Water/protein ratio
Salvelinus fontinalis F_1	4.01
Salvelinus fontinalis F_2	3.79
Oncorhynchus mykiss C_1	4.15
Oncorhynchus mykiss C_2	4.11
Salmo trutta fario I_1	4.40

After processing the major statistical indicators on the chemical composition of the meat for the three trout breeds, performed for total studied individuals (Table 5), were revealed strong positive correlations between meat content in the dry matter and protein content, fat and organic matter and strong negative correlation between dry matter, fat, protein, ash and humidity content.

Table 5. Correlations coefficients between constituents of chemical composition

	Correlations	DM	W	A	P	F	SEN	SO
DM	Pearson Correlation	1	-1.000**	.511**	.671**	.833**	.213	.981**
	Sig. (2-tailed)		.000	.000	.000	.000	.137	.000
	N	50	50	50	50	50	50	50
W	Pearson Correlation	-1.000**	1	-.511**	-.671**	-.833**	-.214	-.981**
	Sig. (2-tailed)	.000		.000	.000	.000	.137	.000
	N	50	50	50	50	50	50	50
A	Pearson Correlation	.511**	-.511**	1	.615**	.503**	.156	.431**
	Sig. (2-tailed)	.000	.000		.000	.000	.278	.002
	N	50	50	50	50	50	50	50
P	Pearson Correlation	.671**	-.671**	.615**	1	.481**	.190	.600**
	Sig. (2-tailed)	.000	.000	.000		.000	.186	.000
	N	50	50	50	50	50	50	50
F	Pearson Correlation	.833**	-.833**	.503**	.481**	1	.080	.804**
	Sig. (2-tailed)	.000	.000	.000	.000		.581	.000
	N	50	50	50	50	50	50	50
SEN	Pearson Correlation	.213	-.214	.156	.190	.080	1	.198
	Sig. (2-tailed)	.137	.137	.278	.186	.581		.167
	N	50	50	50	50	50	50	50
SO	Pearson Correlation	.981**	-.981**	.431**	.600**	.804**	.198	1
	Sig. (2-tailed)	.000	.000	.002	.000	.000	.167	
	N	50	50	50	50	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

4. Conclusions

The values obtained after physical-chemical determinations enlightened the fact that rainbow trout individuals from the experimental batches fall into the limits cited in the literature.

The obtained values regarding physical-chemical composition highlighted that all trout breeds have a good nutritional value.

After evaluation of physical-chemical composition of trout meat, was observed that brook trout individuals from both experimental batches presented a superior quality, reflected by a higher content in dry matter and protein.

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