Scientific Papers. Series D. Animal Science. Vol. LXIII, No. 2, 2020
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

MEAT QUALITY OF TRADITIONALLY SMOKED TROUT FROM TRECĂTOAREA URSULUI SALMONID FARM, BRAȘOV COUNTY

Alexandru SAVA, Paul UIUIU, Camelia RADUCU, Daniel COCAN, Radu CONSTANTINESCU, Călin LAȚIU, Aurelia COROIAN, Andrada IHUȚ, Vioara MIREȘAN

[1]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Animal Science and Biotechnologies, 3-5 Mănăştur Street, 400372, Cluj-Napoca, Romania

Corresponding author email: vmiresan@yahoo.com

Abstract

The consumption of fish meat in Romania is on an upward trend, due to the establishment of salmonid units on the territory of the country. The trout`s commercialization is mainly in fresh or chilled form, but for the diversification of the products offered to the market, it is also sold in preserved form, either by salting or by smoking. The analyses performed on the chemical composition of trout meat were as follows: water content, dry matter, fat content, protein content, non-nitrogenous extractive substances and minerals The chemical analysis was made in all phases of the technological flow of conservation by smoking: fresh meat, salted meat, desalted meat and smoked meat throughout the technological flow for the Rainbow and Brook trout species, reared in the fish farm. Therefore, the chemical analyses of the meat pointed out that the highest percentage of water content is found in the Rainbow trout comparative to Brook trout in all stages of the technological flow. On the contrary, the dry matter content was higher in the Brook than in Rainbow trout. As for the fat content we noticed that the Brook trout registered higher values than the Rainbow trout. For the protein content, the obtained values were quite close to both species of salmonids. Both Rainbow trout and Brook trout traditionally smoked meat registered values that are within the limits cited in the scientific literature.

Key words*: quality, salmonid, smoked trout, traditionally.*

INTRODUCTION

Among the products of animal origin, fish meat is a special food source, for which the preferences and tastes of consumers have been and are constantly growing. Due to its high biological, fat and mineral protein content, which can be added to the special dietary properties and the suitability for a wide variety of culinary preparations, fish meat is highly appreciated (Iurca and Răducu, 2005).
To obtain a proper fish meat production at efficient technical-economic parameters, this requires a correct appreciation technique and a better knowledge of the biochemical processes that characterize the fish meat (Petrea et al., 2012).
According to the official statistics (Ministry of Agriculture and Rural Development - MARD), the consumption of fish meat in Romania is on an upward trend, due to the establishment of salmonid units in the territory of the country with European funds (Petrea et al., 2012).
The trout's capitalization for selling purposes is mainly in fresh or chilled form, but for the diversification of the products offered to the market, it is also sold in preserved form, either by salting or by smoking procedures. The quality of fish meat depends on the farm production capacity, the quantity and quality of the administered feed, the environmental conditions, the technologies of exploitation and not lastly, the biological material (Cocan and Mireşan, 2011). Fish meat quality can be maxim if optimal environmental conditions are taken into account (Cinemre et al., 2006; Fornshell, 2002; Uiuiu et al., 2019).
The productive capacity and the economic efficiency also depend on the anatomic-morphological characteristics of the exploited species, as well as on some physiological and microstructural features (Topuz et al., 2017; (Cocan and Mireșan, 2018).
In Romania, aquaculture production is carried out almost exclusively in classic landscaping, such as ponds and pools, where extensive and semi-intensive breeding technologies are applied. The bio productive potential of these types of arrangements is limited, which is why it is necessary to implement new fish breeding

technologies, super intensive systems, to ensure both quantity and quality for the consumer requirements of fish meat. Having certain limits of variation, determined by factors such as species, age of fish, harvest season, geographical area, environmental conditions and operating systems, as well as the feed used (Ihuț et al., 2018), fish meat has special organoleptic qualities and high nutritional value.

MATERIALS AND METHODS

The biological material used in this study was sampled from Trecătoare Ursului trout farm, Râșnov, Brașov County and it was represented by Rainbow trout (*Oncorhynchus mykiss*) and Brook trout (*Salvelinus fontinalis*) species.
The experiment took place in July 2019. In each stage of the technological flow of the traditional smoking process, 10 specimens from each species were analysed in each stage of the smoking process per lot (100 fishes/lot), with a body weight of approximately 250 grams per individual, resulting a total of 80 analysed individuals.
The traditional smoking of the specimens was done following the following technological flow: harvesting (with the help of fishing nets), stunning (mechanical stunning percussion in the dorsal-aboral region of the head), evisceration (the extraction of organs together with the peritoneum of the general cavity and the formed blood clots), washing (removal of mucositides and impurities adhering to the fish surface, elimination of blood and viscera), salting (the salting time is at least 16 hours, under refrigeration conditions, 2–4ºC) and desalting (in desalination (washing), the amount of salt remaining on products is max. 3%), drying (the salted fish is washed and left to dry, an interval between 2 and 4 hours), smoking (the fuel used for smoking is made of beech and cherry wood, stifled when necessary, with nettle and fir satin. It is used a cold smoke for one and a half hour, after a warm smoke at 65-70ºC and then hot smoking at 70-85ºC for a maximum of 2 hours) and packaging and storage (it is made in cold spaces, under refrigeration conditions, to ensure the 45 days validity of the product).
The specimens used in the experiment were clinically healthy, in order to not interfere with the determination of chemical composition of the trout meat throughout the technological flow related to traditional smoking conservation procedures. For this, specimens of each species were sacrificed, and the meat was separated manually from fins, skin, bones and viscera. The separated meat was macerated well using pestle and used for further analyses.
The analyses determined were: water (Water%), dry matter (SU%), fat (Gb%), protein (Pb%), non-nitrogenous extractive substances (SEN%) and mineral substances (Ash%).
The determination of the water content (Water%) was done by drying the samples in the oven at 103ºC (mandatory in case of litigation). The dry matter content (SU%) was determined by the percentage difference of the mass of the sample to be analysed and the water content, determined by drying the sample in the oven.
The determination of the crude protein (Pb%) was done by the Kjeldahl method. The total nitrogen in the sample to be analysed was converted into ammonium ions under the catalytic action of copper sulphate in sulfuric acid and potassium sulphate. After alkalization, ammonia was introduced with water vapor, which was captured in a hydrochloric acid solution, subsequently titrated with 10n sodium hydroxide.
The determination of fat was done by extraction with organic solvent (petroleum ether) using the Soxhlet apparatus. After extraction it fallowed the solvent removal, drying and weighing of the extracted fat. The determination of non-nitrogenous extractive substances was done by mathematical calculation and the determination of mineral substances (Ash%) was done by calcining the samples to be analyzed at a temperature of 600ºC, for 5 hours. All the chemical analyses of the fish meat were carried out by well-established methods used to determine these parameters (Iurca & Răducu, 2006), and the results have been statistically processed and are presented in the following section.

RESULTS AND DISCUSSIONS

In order to determine the chemical composition of traditionally smoked trout meat, samples were taken from 10 specimens from each lot of fish prepared for smoking.
The analyses determined were made throughout the entire technological flow related to

traditional smoking conservation procedures (fresh, salted, desalted and smoked meat).
The chemical analyses of the fresh meat from the two species of salmonids exploited within the Trecătoare Ursului trout farm, showed that the highest percentage of water is found in the Rainbow trout 74.18±0.083%, followed by the Brook trout with a water content of 72.88±0.112% (Tabel 1).

Table 1. The chemical composition of fresh trout meat (n=10)

Species	Specification	X ± sx	V%	s
O. mykiss	Water (%)	74.18±0.083	1.12	0.834
	Dry matter (%)	25.82±0.083	3.23	0.834
	Fat (%)	4.25±0.083	19.58	0.832
	Protein (%)	16.72±0.058	3.46	0.579
	SEN (%)	0.27±0.005	16.70	0.046
	Ash (%)	4.58±0.041	8.87	0.406
S. fontinalis	Water (%)	72.88±0.112	1.54	1.121
	Dry matter (%)	27.12±0.112	4.13	1.121
	Fat (%)	5.20±0.023	4.40	0.229
	Protein (%)	16.16±0.071	4.40	0.711
	SEN (%)	0.21±0.008	38.72	0.081
	Ash (%)	5.54±0.031	5.51	0.305

* X ± sx – Mean ± Standard error of mean; V% - coefficient of variability; s – standard deviation; n – number of samples from every lot.

The dry matter content, which is inversely proportional to the water content, was higher in Brook trout (27.12±0.112%) than in the Rainbow trout (25.82±0.083%). The fat content showed the highest value in the Brook trout (5.20±0.023%) and in the rainbow trout (4.25 ± 0.083%). Regarding the content in crude protein, the obtained values were quite close to both species of salmonids, however with a maximum value recorded in the case Rainbow trout (16.72±0.058%) and the Brook trout (16.16±0.071%). The non-nitrogenous extractive substances were in the Rainbow trout 0.27±0.005%, and in the case of the Brook trout, 0.21±0.008%. The minerals obtained after the calcination, presented the following values: Brook trout - 5.54±0.031%; and Rainbow trout - 4.58±0.041%.
Noteworthy is the coefficient of variability reduced for all species, for the determinations. These low values of the coefficients of variability do nothing but certify the accuracy of the determinations made, even if the number of samples has been reduced.
The chemical analyses of the salted meat from the two species of salmonids exploited within the Trecătoare Ursului trout farm are shown in Tabel 2.
Analysing the data regarding the chemical composition of the meat subjected to salting process, it is possible to observe a decrease in the water content, compared to the fresh meat, regardless of the species. Thus, the lowest water content was recorded in the Brook trout - 69.54±0.092%, the Rainbow trout - 71.12±0.076%.

Table 2. The chemical composition of salted trout meat (n=10)

Species	Specification	X ± sx	V%	s
O. mykiss	Water (%)	71.12±0.076	1.07	0.761
	Dry matter (%)	28.88±0.076	2.64	0.761
	Fat (%)	3.16±0.016	5.16	0.163
	Protein (%)	15.06±0.075	4.95	0.746
	SEN (%)	0.27±0.007	24.34	0.065
	Ash (%)	10.39±0.043	4.11	0.427
S. fontinalis	Water (%)	69.54±0.092	1.32	0.921
	Dry matter (%)	30.46±0.092	3.02	0.921
	Fat (%)	4.33±0.062	14.22	0.616
	Protein (%)	16.98±0.149	8.78	1.492
	SEN (%)	0.32±0.008	25.65	0.082
	Ash (%)	8.82±0.062	7.01	0.619

* X ± sx – Mean ± Standard error of mean; V% - coefficient of variability; s – standard deviation; n – number of samples from every lot

Due to the fact that the dry matter content is inversely proportional to the water content, it was higher than compared to the fresh meat data values. After salting, the highest value was obtained in the case of the Brook trout (30.46±0.092%), the rainbow trout (28.88±0.076%).
As a result of the salting process, the percentage of fat was reduced, by about one percent, regardless of the species. Thus, in the case of the Brook trout, the fat content of the salted meat was 4.33±0.062%, and for the Rainbow trout it was of 3.16±0.016%. Throughout salting process, the following values were obtained regarding the level of the protein according to the species, Brook trout - 16.98±0.149%, respectively Rainbow trout - 15.06 ± 0.075%.

The non-nitrogenous extractive substances (SEN%) had a weight of 0.32 ± 0.008% in the case of the Brook trout and 0.27 ± 0.007% in the case of the Rainbow trout and the mineral substances (ash) had a very significant weight following the salting of the meat, resulting for the Rainbow trout a weight of 10.39±0.043%, for the Brook trout 8.82±0.062%. The coefficient of variability was low for all species, aspect which show us the accuracy of the determinations made.

For future stage of smoking, the trout were washed and desalted, respecting the technological flow. The results of the analyses for the desalted trout can be seen in Table 3.

Table 3. The chemical composition of desalted trout meat (n=10)

Species	Specification	X ± sx	V%	s
O. mykiss	Water (%)	73.81±0.099	1.34	0.989
	Dry matter (%)	26.19±0.099	3.78	0.989
	Fat (%)	3.05±0.032	10.44	0.318
	Protein (%)	15.57±0.104	6.69	1.042
	SEN (%)	0.21±0.005	25.03	0.051
	Ash (%)	7.36±0.035	4.73	0.348
S. fontinalis	Water (%)	71.23±0.094	1.32	0.942
	Dry matter (%)	28.78±0.094	3.27	0.942
	Fat (%)	4.59±0.04	8.71	0.400
	Protein (%)	16.99±0.128	7.56	1.285
	SEN (%)	0.51±0.011	20.63	0.106
	Ash (%)	6.68±0.058	8.63	0.576

* X ± sx – Mean ± Standard error of mean; V% - coefficient of variability; s – standard deviation; n – number of samples from every lot

Following the desalting process, as an important stage of the technological flow for obtaining the traditional smoked trout, changes in the chemical composition of the meat have appeared again in the two species of salmonids exploited within the Trecătoarea Ursului trout farm.

Therefore, the water content increased slightly due to carcass washing and easy assimilation through osmosis processes. In this case, the rainbow trout presented the highest water content - 73.81±0.099% and Brook trout - 71.23±0.094%.

As we expected, with the slight increase in the water content, the weight of the dry matter (SU%) was reduced, the Rainbow trout having a lower value (26.19±0.099%), compared to the Brook trout (28.78±0.094%).

The fat content (Gb%) does not show major changes compared to the previous stage of the technological flow, the highest value being obtained in the Brook trout, 4.59±0.04% and in the Rainbow trout 3.05±0.032%. As in the case of salted meat, the content of protein (Pb%) is situated around 16%. The content of non-nitrogenous extractive substances (SEN%) presented for the Rainbow trout an average value which is almost half when it's compared to the Brook trout (Rainbow trout - SEN% = 0.21 ± 0.005; Brook trout - SEN% = 0.51 ± 0.011. The highest weight of minerals was recorded in the case of meat subjected to desalinisation for the rainbow trout (Ash% = 7.36 ± 0.035).

Going through all stages in chronological order to the technological flow for obtaining traditionally smoked trout in Table 4 is shown the chemical compositions of smoked meat.

Table 4. The chemical composition of traditionally smoked trout meat (n=10)

Species	Specification	X ± sx	V%	s
O. mykiss	Water (%)	66.14±0.045	0.68	0.451
	Dry matter (%)	33.86±0.045	1.33	0.451
	Fat (%)	4.10±0.062	15.19	0.623
	Protein (%)	20.97±0.042	2.02	0.424
	SEN (%)	5.91±0.029	4.86	0.288
	Ash (%)	2.86±0.017	5.86	0.167
S. fontinalis	Water (%)	64.25±0.14	2.18	1.400
	Dry matter (%)	35.75±0.14	3.92	1.400
	Fat (%)	5.66±0.053	9.41	0.533
	Protein (%)	21.86±0.064	2.91	0.636
	SEN (%)	5.19±0.085	16.33	0.848
	Ash (%)	3.04±0.029	9.65	0.293

X ± sx – Mean ± Standard error of mean; V% - coefficient of variability; s – standard deviation; n – number of samples from every lot

The finished product, the traditional smoked trout, after drying, baking and smoking at high temperature, lost its water content, as follows: the rainbow trout has the highest content (66.14 ±0.045%) followed by the Brook fountain (64.25 ±0.140%).

As expected, the percentage of dry matter (SU%) regardless of the analysed species, increased as a result of the smoking and baking process. Therefore, the highest value recorded,

we found in the Brook trout, 35.75±0.140%, and in the Rainbow trout it was 33.86±0.045%.
The content of fat (Gb%) recorded after smoking had the following percentages: Rainbow trout 4.10 ± 0.062% and Brook trout 5.66 ± 0.053%. There is a significant increase in the content of protein in traditionally smoked trout. Therefore, the crude protein (Pb%) showed an increase to 20.97±0.042% for the Rainbow trout and in the case of the Brook trout to 21.86±0.064%.
The content of non-nitrogenous extractive substances (SEN%) presented the following values for smoked trout meat (finished product): Rainbow trout - 5.91±0.029% and Brook trout - 5.19±0.085% and regarding the mineral content of traditionally trout smoked meat, it is 2.86 ± 0.017% in the Rainbow trout and 3.04 ± 0.029% in the Brook trout.
When we analysed the obtain data per the entire technological flow, we noticed that chemical parameters had significant changes during the stages. We can notice that in comparation with the fresh meat, after the salting process occurs, the water content decreased, fact that is primarily due to the osmosis processes. The dry matter content increased, because is inversely proportional to the water content.
As a result of the salting process, the percentage of fat was reduced, by approximately one percentage, regardless of the species and the mineral substances (ash) had a significant weight following this process.
After the salting stage, according to the technological flow discussed in the Material and Method's Section, the trout carcasses were desalted (washed with water and left to dry), therefore, the water content increased slightly due to carcass washing and easy assimilation through osmosis processes. Also, the dry matter content decreased comparative with the salting process. As a result of the desalting, the chemical constituents did not present values different from the other situations, except for the water content which increased by about 1%.
The finished product, the traditional smoked trout, after drying, baking and smoking at high temperature, has lost a high quantity of its water content, with the increase of the dry matter. Also, there is a significant increase in the protein content in smoked trout in comparation with the fresh, salted and desalted meat. This is primarily due to the change of the aminoacidic structure which is in relationship with the heat release during the smoking process.
Both rainbow trout and Brook trout traditionally smoked meat registered values are within the limits cited in the scientific literature (Alçiçek, 2011; Cardinal et al., 2001; Duedahl-Olesen et al., 2010; Arvanitoyannis and Kotsanopoulos, 2011; Tóth & Potthast, 1984; Jittinandana et al., 2002; Popescu et al., 2019) and present no risk for human consumption.

CONCLUSIONS

Chemical analyses of the traditionally smoked trout meat from the Trecătoarea Ursului trout farm were made for two species of salmonids exploited within the farm, in the entire technological flow.
Therefore, the chemical analyses of the meat pointed out that the highest percentage of water content is found in the Rainbow trout comparative to Brook trout in all stages of the technological flow. On the contrary, the dry matter content, which is inversely proportional to the water content, was higher in the Brook trout than in Rainbow trout.
As for the fat content we noticed that the Brook trout registered in all cases higher values than the Rainbow trout. Regarding the protein content, the obtained values were quite close to both species of salmonids, however with a maximum value recorded in the case of Brook trout. The content of non-nitrogenous extractive substances (SEN%) and the minerals content was also higher in the case of Brook trout.
We recommend and propose at the same time the continuation of studies in this field, especially regarding the composition of the smoke and its influence on the quality of the finished products (wood essences, aromatic hydrocarbons, etc.) with direct implications on the food safety for human consumption.

ACKNOWLEDGEMENTS

We are grateful to the technical staff of Trecătoarea Ursului trout farm, Valea Glejăriei, Râșnov, Brașov County for the opportunity to collect data from the farm and also to work and learn at the same time about the beautiful process of traditional preservation of trout meat with the help of smoke.

REFERENCES

Alçiçek, Z. (2011). The effects of thyme (*Thymus vulgaris* L.) oil concentration on liquid-smoked vacuum-packed rainbow trout (*Oncorhynchus mykiss* Walbaum, 1792) fillets during chilled storage. *Food Chemestry* (128), 683-688.

Arvanitoyannis, I. S., Kotsanopoulos, K. V. (2011). Smoking of Fish and Seafood: History, Methods and Effects on Physical, Nutritional and Microbiological Properties. *Food and Bioprocess Technology*, 5(3), 831-853.

Cardinal, M., Knockaert, C., Torrissen, O., Sigurgisladottir, S., Mørkøre, T., Thomassen, M., & Luc Vallet, J. (2001). Relation of smoking parameters to the yield, colour and sensory quality of smoked Atlantic salmon (Salmo salar). *Food Research International*, 34(6), 537–550.

Cinemre, H. A., Ceyhan, V., Bozoglu, M., Demiryurek, K., Kilic, O. (2006). The cost efficiency of trout farms in the Black Sea Region, Turkey. *Aquaculture*, 251(2-4), 324-332.

Cocan, D., Mireșan, V. (2011). The influence of the farming system technology on the chemical composition of rainbow trout *(Oncorhynchus mykiss)* meat. *CASEE Conference*, *Bulletin of Szent Istvan University*, Godollo-Hungary, p.199.

Cocan, D. I., Mireșan, V. (2018). *Ihtiologie Volumul I: Sistematica și morfologia peștilor.* Cluj-Napoca, RO: Colorama Publishing House.

Duedahl-Olesen, L., Christensen, J. H., Højgård, A., Granby, K., Timm-Heinrich, M. (2010). Influence of smoking parameters on the concentration of polycyclic aromatic hydrocarbons (PAHs) in Danish smoked fish. *Food Additives & Contaminants*: *Part A*, 27(9), 1294-1305.

Fornshell, G. (2002). Rainbow Trout — Challenges and Solutions. *Reviews in Fisheries Sciences*, 10(3-4), 545-557.

Ihuț, A., Răducu, C., Lațiu, C., Cocan, D., Uiuiu, P., Mireșan, V. (2018). Meat quality of Rainbow trout (*Oncorhynchus mykiss*) from the Bistrișorii Valley trout farm, Alba County. *Bulletin UASVM Animal Science and Biotechnologies*, 75(1), 46-48.

Iurca, I., Răducu, C. (2005). *Tehnologia industrializării produselor animale*. Cluj-Napoca, RO: AcademicPress Publishing House.

Jittinandana, S., Kenney, P. B., Slider, S. D., Kiser, R. A. (2002). Effect of brine concentration and brining time on quality of smoked Rainbow trout fillets. *Journal of Food Science*, 67(6), 2095-2099.

Ministry of Agriculture and Rural Development – MARD, Retrieved Aprilie 25, 2020, from *https://www.madr.ro/en/european-fisheries-fund eff.html*

Petrea, S. M., Kurtoglu, I. Z., Kayis, S., Cristea, V., Metaxa, I., Coadă, M. T., Ion, S. (2012). Economic situation of fish farming in southeastern coast of the Black Sea. *Scientific Papers: Animal Science and Biotechnologies*, 45 (2), 78-87.

Popescu, A., Vlase, G., Nicolae, C. G., Păun, C., Nenciu, M. I. (2019). Fish meat contamination with heavy metals – a real concern for the food consumption. *Scientific Papers. Series D. Animal Science*, LXII (2), 254-258.

Rasmussen, R. S. (2001). Quality of farmed salmonids with emphasis on proximate composition, yield and sensory characteristics. *Aquaculture Research*, 32(10), 767-786.

Topuz, O. K., Yerlikaya, P., Yatmaz H. A., Kaya, A., Alp, A. C. (2017). Polyunsaturated fatty acid (PUFA) contents of meat and egg of Rainbow trout fish (Oncorhynchus mykiss). *Scientific Papers. Series D. Animal Science*, LX (1), 312-315.

Tóth, L., Potthast, K. (1984). Chemical Aspects of the Smoking of Meat and Meat Products. *Advances in Food Research*, 87-158.

Uiuiu, P., Cocan, D., Constantinesc,u R., Lațiu, C., Popescu, F., El Mahdy, C., Ihuț, A., Sava, A., Răducu, C., Mireșan, V. (2019). Body thermal response to environment temperature in Rainbow trout (Oncorhynchus mykiss) during the summer season. *Scientific Papers. Series D. Animal Science*, LXII (1), 431-438.