TECHNOLOGICAL FEATURES OF MEAT GATHERED FROM THREE TROUT BREED

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Abstract

Research were carried out on a number of 30 individuals of brown, brook and rainbow trout, 10 individuals for each batch; selected individuals been collected from an salmonid exploitation in Suceava County. The studied trout's were slaughtered and then were gathered samples (side muscles), which were evaluated for collagen content, histological studies and rate of losses at different processing types (frying and frying preceded by flouring). For collagen content, the obtained values were between 3.82 and 4.17%. Histological studies for side muscles gathered from rainbow, brook and brown trout, revealed a mean diameter of muscle fibre of 58.11±3.84μ in the case of rainbow trout specimens, 89.94±4.32 for brook trout specimens and 97.21±5.30 μ at brown trout specimens. Between the two processing types applied to trout meat, the highest losses were recorded at frying – in average 33.36% and the lowest ones were observed at frying preceded by flouring – in average 30.45%.

Key words: technological features, trout, collagen, tissues, losses by processing

INTRODUCTION

Trout meat it's a highly nutritive food with a high biological value, due to significant protein content, slightly digestible, which doesn't produce adverse side effects on human health, also constitutes a source of raw materials for various economical sectors [2], [3], [8], [10], [18].

Technological features of fish meat are determinate by morph-structural features (rate between muscular tissue, conjunctive and fatty; meat structure determined by thermal state, maturation degree and utilisation of proteolytic enzymes) [1], [2], [17], [18] and also by physical-chemical features (meat pH value, content in miofibrilla proteins, conjunctive proteins and fat). Technological features represent those properties which meat must have, to be able for processing [1], [2], [3], [8], [12], [13], [17], [18].

The range of muscle fibre diameters influences both the amount of connective tissue matrix and the passive mechanical properties of the actomyosin component of the muscle in mammals [9], [13]. Although collagen fibres contribute to the texture of raw fish flesh [13], [14], [15], they are thought to be relatively unimportant after cooking [5]. Following cooking the muscle fibres they probably provide the main resistance to mastication [4]. Several inter-specific comparisons have shown significant correlations between average muscle fibre diameter and the "firmness" of the flesh [6], [7].

Meat technological features refers to: water retaining capacity, meat hydration capacity, retaining or releasing capacity of juice, losses rate by maturation and storage, losses rate by boiling or frying, meat resistance, those ones being influenced by physical-chemical and morph-structural proprieties [1], [2], [3], [8], [12], [17], [18].

MATERIAL AND METHODS

In connection with meat technological features, in our research were determined: collagen content, diameter and number of muscular fibre and losses by frying the meat (side muscles) gathered from three trout breed.

The current study was carried out on a number of 30 individuals of brown, brook and rainbow trout, selected individuals been collected from a salmonid exploitation in Suceava County.

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For determination of collagen content from trout meat was utilised a Food-Check meat automatic analyser composed from a compact unit with keyboard, display and a drawer for samples' placing. Display is placed at the upper part being the interface for integrated software, displayed menu and obtained results. Meat samples (side muscles), fine chopped, placed on a glass tray were putted into the apparatus for analysing. The obtained results were posted on the display [10], [17].

For the histological studies, muscle strips from lateral muscle of 10 mm long and 7-10 mm thick, were put into labelled containers in a formalin solution. Muscle was systematically sampled and differentiated by breed and the results were statistically analyzed and interpreted by using Tukey test.

Muscle fibre diameter was determined by inclusion technique in paraffin and staining with haematoxylin-eosin [10], [11], [17]. Histological examination and interpretation of data was performed using Leica DM 750 microscope equipped with Leica Las Software Version V4.2 2012, equipped with microphotography system.

In this way, were made measurements regarding great and small diameter of muscular fibre, and also the area of their transversal section. The obtained data served at calculation of mean thick, using the formula:

$$D\bar{x} = \frac{D_M + D_m}{2}, (\mu)$$

in which:

$D\bar{x}$ = mean diameter (μ);

DM = great diameter (μ);

Dm = small diameter (μ).

This information served for obtaining a general image on muscular ultra-structure elements, being also calculated the existent ratio between the two diameters (great and small), data which was used to enlightened the predominant shape of profile on transversal sections of the analysed samples.

For concretion of muscular fibres density (nr. fibre/mm^2 muscles) these ones were precisely counted, at the level of each FM I (Nr. f.m.); for concretion of transversal square area of FM I (S. FM I) and after that placing it into formula:

$$\textbf{Fibre density} = \frac{N\ f.m \times 1.000.000}{S\ FM\ I}$$

Rate of losses resulted by frying is a feature of meat for losing a certain amount of its own weight, representing a criteria for water retain capacity of processed or prepared meat.

Losses resulted by frying (with and without flouring) are recorded on the basis of water, fat and juice content, and are provoked also by the structural of muscular tissue particularities (thick muscular fibres record a higher losses rate than the thin ones and also the fibres with large width of striation stripes in muscles, generate a lower losses rate by frying) [1], [10], [12], [13] [17]. Losses rate by frying (with and without flouring), directly influences the mode of meat capitalization in gastronomy.

Flouring is a previous operation to fish frying which assure realisation of the followings objectives [1], [10], [17]:

- ✓ protection of muscular tissue against high dehydration in frying process;
- ✓ protection of muscular tissue against darkness and apparition of bitter taste;
- ✓ formation of taste and flavour.

Meat samples gathered from studied trout, after flouring were left at rest for 3-5 minutes for flour soaking with the water on the meat surface. Through this processing procedure of fish meat aimed:

- ✓ obtaining of products with specific aspect, taste and smell;
- ✓ inactivation of muscular tissue own enzymes;
- ✓ destroying of micro-organisms on the skin surface;
- ✓ increasing fish meat consistency through elimination of excess water.

The main experimental data were statistically processed using ANOVA Single Factor algorithm, which is included in Microsoft Excel software kit, calculating: arithmetic mean, variance, standard deviation of mean, variability coefficient [16].

RESULTS AND DISCUSSIONS

Collagen is the most resistant and abundant protein in conjunctive tissue with influence on meat technological features, conferring resistance for organism and contributes at maintaining the structural integrity of tissues. Chemically, collagen is an incomplete protein, with a low biological value [1], [4], [5], [6], [9], [15], [17], [18].

Fraction of collagen proteins, unbalanced in essential amino acids content, is situated for the majority of fish breeds between 3 and 10%, while in the warm blood animals' meat, could reach the level of 17% from total protein content [8], [17], [18].

For the analysed trout breed, the collagen percentage in studied muscles (coastal epaxial muscles, coastal hipaxial muscles) had the following values (table 1):

- ✓ at rainbow trout, 3.82 – 4.08%;
- ✓ at brook trout, 3.85 –4.09%;
- ✓ at brown trout, 3.92 – 4.17%.

It was observed that the highest collagen percentage is in costal hipaxial muscles with values between 4.08% for rainbow trout and 4.17 for brown trout.

Mean values of collagen percentage of 3.95% for rainbow trout, 3.97% for brook trout and 4.01% for brown trout, confirm the data from literature regarding the low proportion of collagen in fish meat, fact which makes that this one to be easier to be cooked [1] [8], [17], [18].

Table 1 Collagen content of the studied muscles gathered from the studied trout

Breed	n	Analysed muscles	Collagen %	
			$\bar{X} \pm s_{\bar{x}}$	V%
Rainbow trout	10	EC	3.82±0.54	2.87
	10	HC	4.08±0.69	3.31
Brook trout	10	EC	3.85±0.45	3.75
	10	HC	4.09±0.14	3.78
Brown trout	10	EC	3.92±0.30	3.16
	10	HC	4.17±0.47	2.98

Note: EC – costal epaxial muscle; HC – costal hipaxial muscle

Many physical and chemical features of trout meat are influenced by histological structure, which is influenced at her turn by breed, age and even by individual.

Histological structure of meat is illustrated by a series of specific indicators such as: great diameter (DM), small diameter (Dm), mean diameter, rate between diameters (DM/Dm), format index of muscular fibres, density of muscular fibre and also square area per transversal section. The obtained values are presented in table 2.

Table 2 Thickness of the muscular fibre in side muscles from rainbow, brook and brown trout

Breed	Large diameter (μ)	Small diameter (μ)	Mean diameter (μ)	Ratio DM/Dm (x/1)	Square area per transversal section of muscular fibre (μ^2)	Density of muscular fibre (f.m./mm^2)
Rainbow trout	69.01±3.75	47.21±4.55	58.11±3.84	1.46/1	2487.10±6.23	187.27±3.65
Brook trout	105.27±5.66	74.61±3.65	89.94±4.32	1.41/1	5533.49±8.66	162.43±4.15
Brown trout	117.49±6.09	76.93±4.94	97.21±5.30	1.65/1	8305.14±5.76	153.34±6.18

Note: n=10 individuals for each batch

These results showed us that texture is more consistent for brook and brown trout meat in comparison with rainbow trout meat, and we consider that these result mainly appear due to the higher degree of genetic improvement in this direction of rainbow trout.

Losses resulted by frying

Regarding losses resulted by frying, could be remarked that at meat gathered from brown trout specimens was a losses percentage rate of 36.67%, with 4.54–5.38% higher face to values determined for other breeds (table 3). Variance testing for recorded losses by frying enlightened significant statistical differences between the losses percentage recorded for brown trout samples and of the other two breeds. Between rainbow and brook trout frying samples, statistical differences were insignificant.

Homogeneity of the analysed batches was very good, calculated values for variability coefficient (V %) ranking between 2.82 and 4.12.

Table 3 Losses recorded by frying the trout's meat

Specification				Brown trout	Brook trout	Rainbow trout
Initial weight of samples (g)	$\bar{X} \pm s_{\bar{x}}$			252.11±3.18	230.24±3.54	237.91±2.86
	V%			5.42	6.97	5.58
Final weight of samples (g)	$\bar{X} \pm s_{\bar{x}}$			159.65±1.21	158.19±1.94	161.46±1.71
	V%			4.12	5.76	3.12
Losses (g)	$\bar{X} \pm s_{\bar{x}}$			92.46±1.15	72.05±2.74	76.45±1.24
	V%			2.23	3.87	3.36
Losses (%)	$\bar{X} \pm s_{\bar{x}}$			36.67±2.35	31.29±2.92	32.13±0.57
	V%			4.12	3.72	2.82
Fisher Test	3,5673 (F) > F 0.05 (3;16) 3,24* *significant differences*					
Tukey Test W1 = 2,55 W2 = 3,27	Indicators		Means' difference	Significance	Significance level	
	Pi	*Pc*	4.91	significant	p<0.05	
	Pi	*Pf*	4.45	significant	p<0.05	
	Pf	*Pc*	0.46	insignificant	p>0.5	

Losses resulted by frying preceded by flouring

Through flouring and frying of trout meat were recorded mean losses of 30.45%. Also this time too, the highest losses were observed at brown trout samples, those ones being with 3.56–4.47% higher than the average calculated for all studied breeds.

Table 4 Losses recorded by frying the trout's flouring meat

Specification				Brown trout	Brook trout	Rainbow trout
Initial weight of the floured samples (g)	$\bar{X} \pm s_{\bar{x}}$			265.27±3.69	224.75±4.32	235.26±3.76
	V%			5.41	4.63	3.81
Flower consumption (g)	$\bar{X} \pm s_{\bar{x}}$			6.56±0.28	5.12±0.73	5.95±0.65
Final weight of samples (g)	$\bar{X} \pm s_{\bar{x}}$			177.38±1.75	158.29±3.26	167.83±1.86
	V%			2.53	2.97	3.24
Losses (g)	$\bar{X} \pm s_{\bar{x}}$			87.89±0.86	66.46±1.27	67.43±1.69
	V%			3.85	3.87	2.68
Losses (%)	$\bar{X} \pm s_{\bar{x}}$			33.13±0.85	29.57±0.95	28.66±0.74
	V%			2.92	1.89	1.91
Fisher Test	3,4057 (F) > F 0.05 (3;16) 3,24* *significant differences*					
Tukey Test W1 = 3,26 W2 = 4,17	Indicators		Means' difference	Significance	Significance level	
	Pi	*Pc*	4.47	significant	p<0.05	
	Pi	*Pf*	3.56	significant	p<0.05	
	Pf	*Pc*	0.91	insignificant	p>0.5	

Flour consumption for this operation was between 2.27 and 2.53% (table 4) from the total weight of processed meat.

Significant statistical differences were calculated between recorded losses for frying preceded by flouring of brow trout samples and of the other two breeds. Between rainbow and brook trout frying samples preceded by flouring, statistical differences were insignificant.

Homogeneity of the analysed samples for this parameter was very good, calculated values for variability coefficient were below 10%.

Processing of trout meat by frying preceded by flouring recorded average losses of 30.45%, with 2.91% less than in the case of frying (without flouring).

Analysing the recorded losses for all types of processing function of breed we observed that brown trout samples had higher losses, followed by rainbow trout samples and the smallest losses were recorded at brook trout samples.

Losses resulted by frying (with and without flouring) were realised on the base of water and fat content, so brook trout samples with a higher content in water recorded greater losses in comparison with the brook trout samples which had the smallest water content.

CONCLUSIONS

Mean values of collagen percentage of 3.95% for rainbow trout; 3.97% for brook trout and 4.04% for brown trout; confirm the data from literature regarding the low proportion of collagen in fish meat, fact which makes that this one to be easier to be cooked.

Histological studies for side muscles gathered from rainbow, brook and brown trout, revealed a mean diameter of muscle fibre of 58.11±3.84μ in the case of rainbow trout specimens, 89.94±4.32 for brook trout specimens and 97.21±5.30 μ at brown trout specimens.

These results showed us that texture is more consistent for brook and brown trout meat in comparison with rainbow trout meat, and we consider that these result mainly appear due to the higher degree of genetic improvement in this direction of rainbow trout.

Profile on transversal section of muscular fibres had an ellipsoidal shape; this fact was enlightened by the rate between great diameter and small diameter (DM/Dm) which varied between 1.41/1–1.65/1.

Between the two processing types applied to rainbow, brook and brown trout meat, the highest losses were recorded at frying – in average 33.36% and the lowest ones were observed at frying preceded by flouring – in average 30.45%.

Analysing the recorded losses for all types of processing function of breed we observed that brown trout samples had higher losses, followed by rainbow trout samples and the smallest losses were recorded at brook trout samples.

REFERENCES

[1] Banu C. and Dumitraş A., 1978: Tehnologia prelucrării peştelui, Editura Didactică şi Pedagogică, Bucureşti.

[2] Banu C. et al., 2007: Calitatea şi analiza senzorială a produselor alimentare, Editura Agir, Bucureşti

[3] Banu C. et al., 2010: Peştele, aliment funcțional, Editura Agir, Bucureşti

[4] Dunajski, 1979: Texture of fish muscle, J. Texture Stud, 10, 301–318

[5] Hatae et al., 1986: Contribution of the connective tissues on the texture differences of various fish species, Bull. Jpn. Soc. Sci. Fish., 52, 2001–2008

[6] Hatae et al., 1990: Role of muscle fibres in contributing firmness of cooked fish, J. Food Sci., 55, 693–696

[7] Hurling et al., 1996: Fibre diameter and fish texture, J. Texture Stud, 27, 679–685

[8] Ionescu Aurelia et al., 2006: Procesarea industrială a peştelui, Editura Fundației Universitare "Dunărea de Jos", Galați

[9] Johnston A.I., et al., 2000: Muscle fibre density in relation to the colour and texture of smoked Atlantic salmon (*Salmo salar L.)*, Aquaculture 189, 335–349

[10] Nistor Cătălin Emilian, 2013: Contribuții la cunoaşterea calitații cărnii de păstrăv crescut în bazine piscicole din Moldova, Teză de doctorat, USAMV, Iași

[11] Nistor C.E. et al., 2013: Research regarding variation of muscular fibre diameter from Oncorhynchus mykiss, Salmo trutta fario and Salvelinus fontinalis breed farmed in NE part of Romania, Lucrări Științifice-Seria Zootehnie, vol. 60:173 – 176

[12] Offer et al., 1983: On the mechanism of water-holding in meat: the swelling and shrinking of myofibrils. Meat Sci, 8, 245–281

[13] Offer et al., 1989: The structural basis of the water-holding, appearance and toughness of meat and meat products, Food Microstruct, 8, 151–170

[14] Paltenea Elpida et al., 2006: Calitatea nutrițională a sturionilor de cultură. Editura Fundației Universitare "Dunărea de Jos", Galați

[15] Paltenea Elpida et al., 2007: Evaluarea calității cărnii sturionilor de cultură în stare proaspătă şi refrigerată. Lucrări ştiințifice, Zootehnie şi Biotehnologii, vol 40 (2):433-443, Timişoara

[16] Sandu Gh., 1995: Metode experimentale în zootehnie. Editura Coral-Sanivet, Bucureşti

[17] Simeanu, Cristina et al., 2013: Technological features of meat gathered from *Polyodon spathula* sturgeon breed, Lucrări Ştiințifice-Seria Zootehnie, vol. 60: 209-215

[18] Usturoi M.G. et al., 2009: Industrializarea peştelui. Editura "Ion Ionescu de la Brad", Iaşi.