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A COMPARISON OF CERTAIN CHARACTERISTICS OF MEAT OF THE SIBERIAN STURGEON (Acipenser baeri Brandt) AND THAT OF ITS HYBRID WITH THE GREEN STURGEON (A. medirostris Ayres)

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ABSTRACT

The study focussed on meat of a new hybrid of the Siberian sturgeon (*Acipenser baeri* Brandt) and the green sturgeon (*A. medirostris* Ayres); the hybrid has a higher growth rate and convert feed more efficiently than the Siberian sturgeon (the maternal species) does. All the colour parameters of the hybrid meat (salmon–like coloration) were found to differ from those of the Siberian sturgeon meat (white–grey in colour). Compared to the maternal species, the hybrid meat contains less lipids (by about 3%), the reduction being compensated for by higher contents of water (by 2%) and protein (by 1%). The muscle lipids of both sturgeons contain identical fatty acids of the C14 to C22 group, the contents of unsaturated and saturated fatty acids combined being very similar. On the other hand, the hybrid lipids contain more polyunsaturated fatty acids, compared to the maternal species meat lipids, the differences resulting from higher contents of two long chain n–3 polyunsaturated fatty acids (LC n–3 PUFA): eicosapentaenoic and docosahexaenoic.

Key words: sturgeons, meat, colour, basic nutrients, fatty acids

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INTRODUCTION

The last decades of the 20th century witnessed a rapid decline in the size of natural populations of numerous acipenserids which had been a sources of dietetically valuable meat and roe (caviar). The decline has, however, boosted interest in the controlled acipenserid culture [5, 9, 16, 17]. To increase the efficiency of intensive sturgeon production, hybrids of genetically distant species have been bred; as a result of heterosis, the hybrids show high growth and survival rates [1,2, 13]. In addition to providing better culture indices, hybrids frequently differ from their parent species in having a higher quality meat [3]. Unfortunately, there are but a few papers on acipenserid hybrid meat quality, those papers concerning mostly the bester, the oldest and the best known hybrid of the beluga (*Huso huso* L.) and the sterlet (*Acipenser ruthenus* L.) [6, 12, 13].

In 1995, the first (and – so far – only) hybrid of the Siberian sturgeon (*A. baeri* Brandt) and the green sturgeon (*A. medirostris* Ayres) was bred. Comparative studies showed the new hybrid, when kept in basins, to grow by about 50% faster than the Siberian sturgeon and to be a more efficient feed converter [8]. As the literature lacks information on the hybrid's utility, it was considered necessary to initiate research aimed at determining the hybrid meat quality and to compare it with that of the maternal species, the Siberian sturgeon.

MATERIALS AND METHODS

The study involved randomly choosen individuals of the Siberian sturgeon and its hybrid, kept together in a concrete basin filled with water subject to the outdoor temperature regime. The Siberian sturgeon and the hybrid were aged 3+ and 6+, respectively. The fish were left to overwinter together, without food, in the basin. Feeding commenced in spring, after the ice cover had thawed, by offering the Aller–45/15 trout pelleted feed containing 45, 21, and 15% of protein, carbohydrates, and lipids, respectively. Initially, the feed rations were low due to the low fish demand for food; as the water temperature grew, the feed rations were increased. When the fish were sampled for their meat to be assayed, water temperature varied within 19–22°C, i.e., the range optimal for growth of most acipenserids [10]. Daily feed rations at that time were 0.8–1.0% of body weight, which was consistent with the published feeding nomograms [9].

The assays involved three individuals from each species. The fish were beheaded by using a straight cut, gutted, and filleted. One skinned fillet from each individual provided meat colour parameters, basic nutrients, and the fatty acid profiles of which were determined. Before each assay, a fillet was minced twice in a 3 mm mesh size meat grinder, the mince obtained being thoroughly mixed.

Meat colour parameters were determined in a Dr. Lange Spectro–color spectrophotometer with a 10 mm measuring aperture, D65 illuminant, 10° standard observer, and SPECTRAL–QC computer software. Prior to each series of measurements, the spectrophotometer was calibrated using the Dr. Lange black and white standards. The instrumental colour measurements made it possible to express the colour numerically in a tri–dimensional space, by determining the trichromatic coordinates compatible with the CIE Uniform Chromaticity Scale: L* (lightness), a* (redness), and b* (yellowness). The chromaticity (colour saturation) C* [(a*2 + b*2)1/2] and hue H* [=arctan (b*/a*)] were calculated. Mean values of the colour parameters were calculated from three separate measurements.

The meat water content was determined after drying the samples at 105°C to constant weight (according to the Polish Standard PN–73A–082110); the crude protein content was determined with the Kjeldahl method, using conversion factor of 6.25 {Polish Standard PN–73A–04018); the lipid content was determined with the Soxhlet technique utilising paraffin ether as solvent (Polish Standard PN–73A–820111); the total mineral content was determined by combusting the samples at 525–550^{o}C [15]. Mean values were calculated from five separate assays of each parameter.

The qualitative and quantitative analyses of fatty acids were conducted after cold extraction of muscle lipids as described by Folch *et al.* [4]. Fatty acids were methylated with a 100:100:1 mixture of chloroform:methanol:sulphuric acid [14]. Fatty acids were separated in an HP 6890 gas chromatograph with a flame–ionization detector (FID); the 0.32 mm internal diameter chromatograph capillary column was 30 m long. The liquid stationary phase was provided by 0.25μm thick Supelcowax 10 film. Separation was carried out with helium as a carrier gas, the flow rate used being 1 ml min^{-1}. The detector, injector, and column temperatures were 250, 225, and 185^{o}C, respectively. Detector signals were registered by a 10 mm min^{-1} paper speed Philips recorder using a 1 mV scale.

RESULTS

Various fish species differ significantly in their colour which depends primarily on the amount of myoglobin, the essential haeme pigment, and also on the amount of carotenoids, whenever those are present. The visual examination of meat of the Siberian sturgeon and the hybrid showed the meat of the first to be white–grey, while the other had meat similar in coloration to that of salmonids, preferred by consumers.

The instrumental colour measurement showed the Siberian sturgeon meat lightness to be 69.49, the hybrid meat producing a lower lightness (59.20). Typical of the hybrid meat were also higher values of a* and b*, which demonstrates the colour to have higher redness and yellowness, compared to the meat of the maternal species. Along the same line, the value of C*, equivalent to the overall chromaticity calculated from a* and b*, differed in the two species. The C* data showed the Siberian sturgeon meat to have a lower colour saturation (intensity). In addition, the meat of the two species differed in hue, as shown by different values of H* (Table 1). Thus the values of all the parameters provide evidence that meat of the Siberian sturgeon x green sturgeon hybrid differs in colour from the maternal species.

The analysis of basic nutrients showed the hybrid meat lipid content to be 6.4%, i.e., it was lower by more than 3 %, compared to that in the maternal species. The lower lipid content was compensated for by higher contents of water (77.4%) and protein (15.2%), the corresponding values in the Siberian sturgeon meat being 75.2 and 14.3%, respectively. The total mineral content was similar in both species (0.9%; Table 2).

Table 1. Siberian sturgeon and hybrid meat colour parameters

Sturgeon species	L* $\bar{x}$ ± SD	a* $\bar{x}$ ± SD	b* $\bar{x}$ ± SD	C* $\bar{x}$ ± SD	H* $\bar{x}$ ± SD
Siberian sturgeon	69.49 ± 3.58	0.87 ± 0.12	18.76 ± 1.91	18.78 ± 1.10	87.39 ± 3.32
Hybrid	59.20 ± 2.15	5.69 ± 0.34	25.62 ± 1.75	26.25 ± 1.21	77.52 ± 3.58

Table 2. Contents of basic nutrients (%) and energy (kcal 100 g^{-1}/KJ 100 g^{-1}) of the Siberian sturgeon and hybrid meat

Sturgeon species	Water $\bar{x}$ ± SD	Protein $\bar{x}$ ± SD	Lipids $\bar{x}$ ± SD	Mineral components $\bar{x}$ ± SD	Energy content $\bar{x}$ ± SD
Siberian sturgeon	75.2 ± 0.75	14.3 ± 0.72	9.5 ± 0.39	0.9 ± 0.03	143.2 /598.5/ ± 4.82
Hybrid	77.4 ± 0.44	15.2 ± 0.41	6.4 ± 0.47	0.9 ± 0.04	118.6 /495.7/ ± 3.99

The higher lipid level of the Siberian sturgeon meat resulted in its higher energy content, 143.2 kcal $(100\ g)^{-1}$ [598.5 kJ $(100\ g)^{-1}$], compared to 118.6 kcal $(100\ g)^{-1}$ [495.7 kJ $(100\ g)^{-1}$] in the hybrid.

Another criterion used to compare meat of the two sturgeon species involved the qualitative and quantitative analysis of fatty acids; the relevant results are summarised in Table 3.

Table 3. The Siberian sturgeon and hybrid meat lipid fatty acid profiles

Fatty acid	Siberian sturgeon		hybrid	
	mg g^{-1} lipids	%	mg g^{-1} lipids	%
$C_{14:0}$	28.73 ± 1.60	4.40	39.31 ± 2.34	4.87
$C_{15:0}$	2.36 ± 0.26	0.36	3.82 ± 0.99	0.47
$C_{16:0}$	112.43 ± 7.49	17.21	150.96 ± 10.11	18.69
$C_{18:0}$	12.01 ± 4.33	1.84	13.50 ± 2.41	1.67
$C_{20:0}$	0.84 ± 0.09	0.13	1.15 ± 0.10	0.14
Total, saturated fatty acids	156.37 ± 5.13	23.93	208.74 ± 7.34	25.84
$C_{14:1}$	1.38 ± 0.67	0.21	2.03 ± 0.56	0.25
$C_{16:1}$	33.34 ± 3.09	5.10	51.92 ± 4.65	6.43
$C_{18:1\ cis9}$	206.69 ± 8.22	31.63	206.02 ± 8.18	25.51
$C_{18:1\ cis\ 11}$	18.37 ± 0.68	2.81	22.80 ± 2.09	2.82
$C_{20:1\ n–9}$	62.45 ± 2.78	9.56	53.03 ± 3.87	6.56
$C_{22:1}$	35.21 ± 1.99	5.39	32.20 ± 3.65	3.99
$C_{22:1\ n–9}$	5.82 ± 0.09	0.89	4.79 ± 0.45	0.59
Total, mono–unsaturated fatty acids	363.26 ± 8.11	55.59	372.79 ± 9.56	46.15
$C_{18:2\ n–6}$	26.98 ± 1.98	4.13	35.25 ± 2.68	4.36
$C_{18:3\ n–3}$	6.48 ± 0.57	0.99	9.74 ± 0.87	1.21
$C_{18:4\ n–3}$	6.03 ± 0.40	0.92	10.76 ± 1.89	1.33
$C_{20:2\ n–6}$	2.82 ± 0.34	0.43	3.21 ± 0.43	0.40
$C_{20:4\ n–6}$	3.12 ± 0.30	0.48	4.55 ± 0.56	0.56
$C_{20:4\ n–3}$	6.61 ± 0.39	1.01	7.71 ± 1.01	0.95
$C_{20:5\ n–3}$	26.23 ± 3.11	4.01	48.77 ± 3.60	6.04
$C_{22:5\ n–3}$	9.54 ± 1.15	1.46	15.12 ± 1.12	1.87
$C_{22:6\ n3}$	45.98 ± 3.89	7.04	91.11 ± 7.90	11.28
Total, polyunsaturated fatty acids	133.79 ± 6.75	20.47	223.22 ± 6.89	28.01
Total, unsaturated fatty acids	497.0 ± 6.475	76.07	596.01 ± 5.90	74.16

Both kinds of meat were found to contain the same saturated and unsaturated C14 to C22 fatty acids. Lipids of both species contained five saturated fatty acids, their levels being similar. The saturated fatty acids contributed 23.93 and 25.84% to the total fatty acid pool in meat of the Siberian sturgeon and hybrid, respectively.

The unsaturated to saturated fatty acid ratio, amounting to 3.18 and 2.87 in meat of the Siberian sturgeon and hybrid, respectively, demonstrated the domination of unsaturated fatty acids, typical of fish meat. This domination was very pronounced in meat of both species.

The unsaturated fatty acids consisted of mono– and polyunsaturated acids. They contributed 46.15 and 28.01%, respectively, to all the fatty acids of the hybrid meat, while contributing 55.59 and 20.47%, respectively, to all the fatty acids of the Siberian sturgeon meat. Thus the hybrid lipids contained less monounsaturated acids, which resulted primarily from a lower contribution of the dominant oleic acid. On the other hand, the hybrid meat lipids showed a higher content of polyunsaturated fatty acids (PUFA) belonging to the n–3 and n–6 families and involving from 2 to 6 double bonds per molecule. Among those acids, linoleic, α– and γ–linolenic, octadecatetraenic, eicosadienic, arachidonic, eicosatetraenic, and docosapentaenoic acids contributed similarly to the fatty acid pool in lipids of the two species. Larged differences were found in the contents of eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids the contributions of which to the total fatty acid pool were by 2.03 and by 4.24.% higher in the hybrid meat than in that of the maternal species. Thus it was mainly the differences in the per cent contributions of those two fatty acids that were decisive for the higher total contant of polyunsaturated fatty acids in the hybrid meat lipids.

The results showed the hybrid meat, compared to the Siberian sturgeon meat, to have a markedly higher PUFA content, beneficial from the standpoint of the biological value of the lipids. Eicosapentaenoic and docosahexaenoic acids, pivotal in this respect, belong to the long chain n–3 polyunsaturated fatty acids (LC n–3 PUFA) the presence of which is the most characteristic feature of fish lipids. The beneficial effects of fish meat on human health is primarily related to the biological activity of those two acids [7, 11].

Data on the n–3 PUFA contents in 100 g fish meat and the n–3 to n–6 acid ratio are a very valuable information for a consumer. The results obtained showed the total n–3 fatty acid content to be 1170.7 mg $(100\ g)^{-1}$ hybrid

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meat, the respective contents of EPA and DHA being 311.6 and 582.1 mg (100 g)$^{-1}$ (Table 4). The contents mentioned are higher than those shown by meat of the maternal species. The n–3 to n–6 ratio, too, is better in the hybrid meat than in the Siberian sturgeon meat.

Table 4. Contents of n–3 and n–6 PUFA (mg per 100 g meat) in Siberian sturgeon and hybrid

Sturgeon species	EPA	DHA	n–3	n–6	n–3/n–6
Siberian sturgeon	250.7	439.5	964.3	314.7	2.0
Hybrid	311.6	582.1	1170.7	274.8	4.2

CONCLUSIONS

1. Meat of the Siberian sturgeon x green sturgeon hybrid shows a very desirable, salmon–like color the characteristics of which are differ than those of the maternal species (Siberian sturgeon).
2. The hybrid meat contains less lipids, more protein, and more water, compared to the Siberian sturgeon meat.
3. The hybrid meat outcompetes meat of the maternal species in having a higher total content of n–3 polyunsaturated fatty acids as well as higher contents of EPA and DHA.

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