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Age effect on technological properties of Russian sturgeon, its Siberian sturgeon hybrid and Sterlet

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Abstract

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The aim of this study was to explore the technological properties (sensory properties, colour characteristics, pH and water holding capacity) of Russian sturgeon at age of five and seven years, its hybrid with Siberian sturgeon at age of five, six and seven years and five-year-old Sterlet. The highest sensory evaluated scores for taste and flavor of after cooking were awarded to Russian sturgeon. The panel was found a non-characteristic meat flavor in Sterlet, as well as in 6-year old hybrid Siberian x Russian sturgeon. The higher color redness (a*) and yellowness (b*) in the seven-year-old hybrid Siberian x Russian sturgeon at 2 h post mortem in comparison to the Russian sturgeon were determined. The age does not affect the meat colour lightness (L*) and redness (a*) in studied Russian sturgeons. In Siberian x Russian sturgeon hybrids (age 5,6 and 7 years) along with the age the colour lightness (L*) decreased and colour redness (a*) increased. At 2 h post mortem low pH values were detected in the sterlet muscle tissue ($p \leq 0.05$). The meat pH (2 h post mortem) of Russian sturgeon was higher than pH of hybrids (Siberian x Russian sturgeon) ($p \leq 0.05$), but the age does not affect the pH in individual groups of Russian sturgeons and it`s hybrids (Siberian x Russian sturgeon). The difference of water holding capacity between Russian sturgeon and hybrids Siberian x Russian sturgeon samples was not significant ($p \geq 0.05$).

Key words: sturgeon hybrids; fish quality; colour characteristics; pH; water holding capacity

Introduction

After 1980s the world wild sturgeon production is critically low because of the overfishing. On the other hand, due to the excellent qualities of meat and caviar, they are sought after by consumers (Litvak, 2010). In this context, to meet the market requirements, the cultivation of sturgeon as aquaculture is a perspective way with significant economic value and great possibility to protect the remaining wild stocks before they become extinct. The sturgeon from aquaculture is a product with superior quality and quantity (Vasilean et al., 2010). Hybridization is often used in sturgeon aquaculture breeding for higher growth rate and survivability and for better production value. The hybrids achieve sexual puberty earlier and they are more appropriate for intensive breeding (Jankowska et al., 2005). Information about feeding and breading conditions high-intensive culture systems resulting in meat and caviar quality is actual, important and urgently needed (Memiş et al., 2006).

That is why, the objective of the study was to compare the technological properties of meat from Bulgarian local population Russian sturgeon and its hybrid with Siberian

sturgeon. Simultaneously, the influence of age (5, 6 and 7 years resp.) on fish meat characteristics was studied. The meat quality of Russian sturgeon and its hybrid with Siberian sturgeon was compared to 6 years old Sterlet.

Materials and Methods

Matrerials

Fish cultivation and feeding

The study was conducted with 6 different by type and age male Sturgeon and it`s hybrids – five- and seven-year-old Russian sturgeon (*Acipenser gueldenstaedtii*); five-, six- and seven-year-old hybrids of Siberian and Russian sturgeon (*F1 Acipenser baerii x Acipenser gueldenstaedtii*); as well as Sterlet at age of five (*Acipenser ruthenus*). The fish were grown under the same conditions on a super-intensive caged farm located in the „Kardzhali" Dam. By the type, the basin refers to large, deep dams. It is located in Southeastern Bulgaria and falls into the South Bulgarian climatic zone, East Rhodope climate area. Fish were separated by species, age and categories and were breaded in separate cages. The cages have a size 8x8 m with a depth of water of 6 m. Each cage is equipped with double polyamide fishnet. Average density during the vegetation period was 5.16-5.73 kg.m^3. Feeding was carried out with factory specialized sturgeon granulated extruded feed (Table 1).

Table 1. Chemical composition of sturgeon granulated extruded feed

Indicator	Value
Protein, %	46
Fat, %	15
Crude fibre, %	1.4
Ash, %	6.5
Total P, %	1.03
Ca, %	1.4
Na, %	0.3%
Vitamin A, IU.kg^{-1}	10 000
Vitamin C, mg.kg^{-1}	520
Vitamin E, mg.kg^{-1}	200
Vitamin D3, IU.kg^{-1}	2 303
Gross energy, MJ.kg^{-1}	21.0
Digestible energy, MJ.kg^{-1}	19.2

Fish (n = 5) for the analysis was randomly collected from each group at the end of the vegetation period (November), with the following live masses: five-year-old Russian sturgeon – 3863 ± 77.86 g; seven-year-old Russian sturgeon – 4459 ± 114.8 g; five-year-old hybrid – 3930 ± 130.0 g; six-year-old hybrid – 4070 ± 62.5 g; seven-year old hybrid – 4700 ± 228.4 g, five-year-old Sterlet 1668±119.75 g.

Sample preparation

The experiments were carried out with 6 groups: five-year-old Russian sturgeon, seven-year-old Russian sturgeon, five-year-old hybrids (Siberian x Russian sturgeon), six-year-old hybrids (Siberian x Russian sturgeon), seven-year-old hybrids (Siberian x Russian sturgeon) and five-year-old Sterlet. Samples for analysis were prepared immediately after their catch (at 2 h *post mortem*) before the occurrence of rigor mortis.

The pH analysis was carried out with average laboratory sample from light fish musculature without skin and bones, grinded twice by a mincer (grid holes 5 mm). Sampling was carried out following the Official Methods of Analysis of AOAC International (Latimer, 2012). The color characteristics were measured directly on fish left fillets. For sensory analysis the fish fillets were placed into plastic bags and were cooked 30 min at 160°C.

Methods

Sensory analysis

Organoleptic characteristics – overall view, color, flavor, taste and consistence of cooked fillets were determined using a five member panel with proven tasting abilities (Meilgaard et al., 2006). The samples were scored using 1 to 5 scales as follow: 5 – excellent; 4- very good; 3 – good; 2 – acceptable; 1 – unacceptable.

Color properties

Colourimeter CR 410 (Konica Minolta Holding, Inc., Ewing, NJ, USA), supplied by the Sending Inc. (Tokyo, Japan) was used to evaluate the CIE L*, a*, b* properties in light sturgeon muscles (Hunt et al., 2012).

pH value

The pH value of fish meat was measured with pH-meter MS 2004 (Microsyst Ltd., Plovdiv, Bulgaria), equipped with combined pH recorder S 450 CD (Sensorex pH Electrode Station, Garden Grove, CA, USA) (Young et al., 2004).

Water holding capacity

Water holding capacity (WHC) was established following the procedure described by Modzelewska-Kapitula & Cierach (2009), which modifies the method of Grau and Hamm. After the water removal from the fish muscle under pressure, it's adsorbed in the filter paper. The "free" water quantity was calculated as integration of the area formed by the tissue mark and the spot from liquid adsorbed in the filter paper.

Statistical analysis

Results were expressed as means ± standard deviation (SD) (n=9). The obtained data was analyzed by by ANOVA

software (Excel 5.0). Duncan's multiple comparison test (SPSS) was used to compare sample means. Significant differences between means less than 0.05 were considered statistically significant.

Results and Discussion

Sensory analysis

The highest scores for taste and flavor in heat treated samples were awarded to five-and seven-year-old Russian sturgeon ($p \leq 0.05$) resp. (Fig. 1). By the indicator flavor, after Russian sturgeon the seven- and five-year-old hybrids Siberian x Russian sturgeon ($p \geq 0.05$) were assessed, followed by the hybrids at 6 years ($p \leq 0.05$). Compared to the five-year-old Russian sturgeon, which receives the maximum score for the meat flavor and taste, the same age hybrid receives 1.36 times lower scores ($p \leq 0.05$).

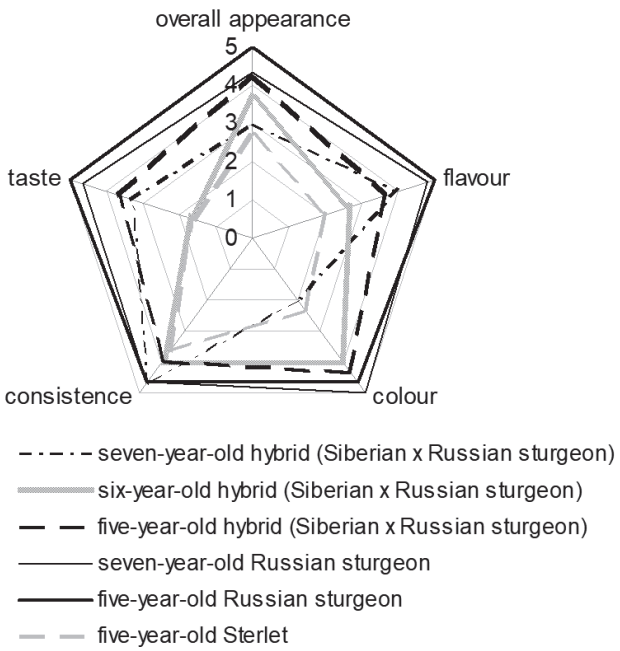

Fig. 1. Sensory properties of Sterlet, Russian sturgeon and Siberian x Russian sturgeon hybrid cooked fillets

The lowest flavor and taste was awarded to the samples from five-year-old Sterlet (*Acipenser ruthenus*). The tasting committee found a non-characteristic meat flavor. Similar conclusion was made for the six-year-old hybrid Siberian x Russian sturgeon, which was the reason for the low scores for flavor and taste in these two samples.

The highest scores for meat color were obtained for five- and seven-year-old Russian sturgeons, followed by hybrids at age of 6 and 5 years respectively. The seven-year-old hybrids (Siberian x Russian sturgeon) had the lowest scores for meat color (Fig. 1).

The tasting committee did not found statistically significant differences on the meat consistency in all tested samples ($p \geq 0.05$).

Instrumentally measured color characteristics of sturgeon muscle tissue

The highest color lightness (L*) were found in the muscle tissue of the Russian sturgeon (Table 2). No statistically significant difference between this two tested samples ($p \geq 0.05$) of Russian sturgeon was found. The lowest L* value was established in 6-year hybrid Siberian x Russian sturgeon. Compared to five-year-old Russian sturgeon in these samples the meat lightness was 11% lower (Table 2). The color lightness in three studied hybrids was significantly lower in comparison to the Russian sturgeons ($p \leq 0.05$).

The red meat color (a*) was the most intensive (Table 2) in seven-year-old hybrid Siberian x sturgeon, followed by other two five- and six-year-old hybrids. The red color component (a*) was not significantly different in the meat of six- and seven-year-old hybrids ($p \geq 0.05$). Compared to the six-year-old hybrids, the redness (a*) in Russian sturgeon at the same age was found 7,5 % lower ($p \leq 0.05$).

Table 2. Fish color characteristics (L*, a*, b*) of Russian sturgeon and hybrids (Siberian x Russian sturgeon) at 2 h *post mortem*

	The color lightness, (L*)	The color redness, (a*)	The color yellowness, (b*)
Russian sturgeon, five-year-old	$51.86^{c} \pm 1.86$	$6.15^{a} \pm 0.18$	$4.80^{a} \pm 0.07$
Russian sturgeon, six-year-old	$49.82^{c} \pm 0.18$	$5.65^{a} \pm 0.78$	$5.95^{b} \pm 0.95$
Hybrid (Siberian x Russian sturgeon), five-year-old	$49.20^{b,c} \pm 0.76$	$8.10^{b} \pm 1.51$	$7.01^{c} \pm 0.42$
Hybrid (Siberian x Russian sturgeon), six-year-old	$46.36^{a} \pm 0.74$	$8.19^{b} \pm 0.7$	$6.17^{c} \pm 1.29$
Hybrid (Siberian x Russian sturgeon), seven-year-old	$47.54^{a} \pm 0.54$	$9.60^{c} \pm 0.58$	$7.26^{c} \pm 0.39$
Sterlet, five-year-old	$48.06^{a,b} \pm 1.18$	$8.10^{b} \pm 0.94$	$7.53^{c} \pm 1.00$

***Notes*:**

Average value ± standard deviation;

$^{a, b, c,}$ *– indexes indicate statistically significant differences ($p < 0.05$) between compared average values in one column*

The red component in the muscle tissue of the two groups of Russian sturgeon (5 and 7 years) was significantly lower ($p \leq 0.05$) than hybrid forms (Table 2).

The a* value in the muscle tissue of the Sterlet (*Acipenser ruthenus*) was not statistically different from studied hybrids.

The highest color yellowness (b *) (Table 2) was found in the muscle tissue of the Sterlet, followed by the three hybrids of Russian sturgeon x Siberian sturgeon ($p \geq 0.05$). The age does not affect the yellow colour component (b*) in the meat of studied hybrids ($p \geq 0.05$), but increased in older Russian sturgeon ($p \leq 0.05$)

Compared to the five-year-old Sterlet, 5.8% lower b* values were established in the muscle tissue of the five-year-old Russian sturgeon ($p \leq 0.05$).

pH value

At 2 h *post mortem* the lowest pH values (Table 3) were detected in muscle tissue of five-year-old Sterlet ($p \leq 0.05$).

The meat pH values (2h *post mortem*) in Russian sturgeons were higher than pH in hybrids (Siberian x Russian sturgeon) ($p \leq 0.05$). Compared to the Russian sturgeon, the pH (2h *post mortem*) in the same age hybrids (Siberian x Russian sturgeon, age 5 and 6) was 3.2 and 7.5% ($p \leq 0.05$) lower.

No significant differences ($p \geq 0.05$) in meat pH between different age hybrids were found ($p \geq 0.05$).

The same trend was found in groups of Russian sturgeon. The results obtained for meat pH (2h *post mortem*) in five- and seven-year-old Russian sturgeons were not statistically different ($p \geq 0.05$).

Water holding capacity

The data for water holding capacity (WHC) correspond to the pH results (Table 3).

The lowest WHC was found in the Sterlet muscles (age 5 years) with lowest ($p \leq 0.05$) pH value (Table 3) resp. In comparison, the WHC in the same age Russian sturgeon (5 years) was 1.7 times higher ($p \leq 0.05$).

The age does not affect on meat water holding capacity in Russian sturgeons, as well as hybrids at 2 h *post mortem.*

Conclusions

✓ The sturgeon hybridization slowly effects on the sensory properties (overall view, colour, taste, flavor, and consistence) of Russian sturgeon, and Siberian x Russian sturgeon. The non-characteristic meat flavor was found in Sterlet, as well as in 6-year old hybrid Siberian x Russian sturgeon.

✓ The redness and yellowness of fish muscles (2 h *post mortem*) from seven-year-old hybrids Siberian x Russian sturgeon were higher compared to studied Russian sturgeons.

✓ The age does not affect the meat color lightness (L*) and redness (a*) in studied Russian sturgeons.

✓ In studied Siberian x Russian sturgeon hybrids (age 5, 6 and 7 years) along with the age the color lightness (L*) decreased and color redness (a*) increased.

✓ In comparison to 2h *post mortem* Russian sturgeons and hybrids, the sterlet muscle tissue had the lowest pH value ($p \leq 0.05$). In contrast, the highest pH has the Russian sturgeon, followed by hybrids Siberian x Russian sturgeon.

✓ The age does not affect on meat pH in five-and six-year-old Russian sturgeons and it`s hybrids (Siberian x Russian sturgeon; age 5, 6 and 7 years) at 2 h *post mortem.*

✓ The hybridization does not effect on the water holding capacity of the sturgeon muscle tissue.

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Table 3. Meat pH of Russian sturgeon and hybrids (Siberian x Russian sturgeon) at 2 h *post mortem*

	pH (2h post mortem)	WHC (2h post mortem)
Russian sturgeon, five-year-old	7.35^{c}±0.09	3.02^{b}±0.42
Russian sturgeon, six-year-old	7.46^{c}±0.05	2.71^{b}±0.42
Hybrid (Siberian x Russian sturgeon), five-year-old	7.12^{b}±0.08	2.36^{b}±0.62
Hybrid (Siberian x Russian sturgeon), six-year-old	7.03^{b} be ety of the on fish meat characteristics ±0.07	2.64^{b}±0.21
Hybrid (Siberian x Russian sturgeon), seven-year-old	7.14^{b}±0.05	2.44^{b}±0.20
Sterlet, five-year-old	6.78^{a} ±0.04	1.70^{a}±0.20

***Notes*:**

Average value ± standard deviation;

$^{a, b, c,}$ *– indexes indicate statistically significant differences ($p < 0.05$) between compared average values in one column*

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