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Short communications

THE IMPACT OF VITATON ON THE REARING PARAMETERS AND MEAT QUALITY OF STURGEON HYBRIDS

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ABSTRACT. The aim of the studies was to determine the impact of the feed supplement Vitaton, a preparation containing β-carotene, on the growth rate, feed utilization, and meat quality of reciprocal back cross hybrids of Siberian sturgeon, *Acipenser baerii* Brandt × green sturgeon, *Acipenser medirostris* Ayres, (SSZ group) and Siberian sturgeon × Russian sturgeon, *Acipenser gueldenstaedti* Brandt, (SRS group). It was confirmed that β-carotene results in a statistically significant increase in growth rate of about 20% and a decrease in the value of the feed conversion ratio (FCR) by 9.6% in the fish from the SSZ group. Statistically significant differences between the Vitaton and control subgroups in the SRS group occurred only with regard to the FCR at values of 1.64 ± 0.08 and 1.71 ± 0.09, respectively. The results of meat quality tests indicated that under the influence of Vitaton there was a statistically significant increase in the fat content to 13.21 ± 1.04% in comparison with the control group values of 9.57 ± 2.33% and a decrease in the water content from 72.73 ± 1.57% to 68.82 ± 1.28% in the fish from the SRS group. No significant impact of β-carotene was noted in the studied fish with regard to meat color.

Key words: SIBERIAN STURGEON (*ACIPENSER BAERII*), GREEN STURGEON (*ACIPENSER MEDIROSTRIS*), RUSSIAN STURGEON (*ACIPENSER GUELDENSTAEDTI*), HYBRIDS, VITATON, β-CAROTENE, GROWTH RATE, MEAT QUALITY

The meat quality of fish reared in intensive cultivation is largely dependent on the composition of the artificial feed they are nourished with (Gabrielsen and Austreng 1998, Hamre et al. 2004, Solberg 2005). Thus, the feed composition should not only reflect the basic nutritional needs of fish but also the content of the appropriate biologi-

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cally active ingredients that improve the dietary values of the meat while stimulating the metabolism of the fish and increasing the effects of culture. Carotenoids, pigments synthesized by bacteria, fungi, and lower animals, belong to this group of substances and are a component of the feed of higher animals, including fish. Once consumed, carotenoids undergo various transformations and a portion of them is stored in the muscle tissues as is the case in salmonid fishes.

Dozens of different types of carotenoids are found in fish tissues, but the most frequent are astaxathin, cantaxathin, tunaxanthin, doradexanthin, lutein, zeaxanthin, and β-carotene (Czeczuga and Bartel 1989, Czeczuga 1992, Baek and Ha 1998, Ostroumova 1998). From nine to 16 carotenoids occur in the sturgeons, and the amount and composition of these pigments vary among the species (Czeczuga 1995). Relatively small amounts of carotenoids are stored in the muscle tissues at values of 0.706 $\mu g\ g^{-1}$ in Siberian sturgeon, *Acipenser baerii* Brandt, to 0.743 $\mu g\ g^{-1}$ in Russian sturgeon, *Acipenser gueldenstaedti* Brandt; levels in the intestines and liver are several dozen times larger (Czeczuga 1995).

It has been confirmed that carotenoid content in fish feed, including that of sturgeons, significantly increases their resistance to harmful environmental factors and increases growth rates (Abrosimov 1992, Gabrielsen and Austreng 1998, Ostroumova 1998). It has also been confirmed experimentally that naturally occurring carotenoids are more biologically active than synthetic ones (Gabrielsen and Austreng 1998).

Vitaton, a preparation containing approximately 8% β-carotene has been manufactured in Ukraine for several years. This product is made naturally from corn that has undergone a biotechnological process with the fungus *Blakslea trispora*, a natural producer of carotenoids. In addition to β-carotene, the dominant biologically active ingredient, this preparation also contains a variety of vitamins, free amino acids, and essential fatty acids (Gamygin et al. 2004).

The aim of the studies was to evaluate the effects of the β-carotene contained in Vitaton on the results of the culture and meat quality of selected sturgeon hybrids.

Two reciprocal back cross hybrids were chosen for the study; the first was the SSZ group (Siberian sturgeon × (Siberian sturgeon × green sturgeon, *Acipenser medirostris* Ayres)) and the second was the SRS group (Siberian sturgeon × (Russian sturgeon × Siberian sturgeon)). These hybrids contain the genomes of the two sturgeon species which have the highest muscle tissue carotenoid content, namely the green and

Russian sturgeons (Czeczuga 1995, Kolman et al. 2002), which means that these fish are capable of accumulating β-carotene in their muscle tissues. The study material was comprised of juveniles aged 1+ that had mean initial body weight of 1986.2 ± 18.3 g and 1668.3 ± 15.8 g in the SSZ and SRS groups, respectively. Each of the groups was divided into two sub-groups that served as the control and experimental groups, the latter of which was fed feed supplemented with Vitaton. Each of the sub-groups was reared in two replicates at a stocking density of 30 fish each. The sturgeon were fed granulated trout feed manufactured by Aller-Pl, Poland. During the final phase of the technological process, fat was added to the feed for the control group. In addition to an equal amount of fat, 1g kg^{-1} of Vitaton was added to the feed for the experimental group. This dose guaranteed that the amount of β-carotene in the feed for the experimental group was approximately 80 mg kg^{-1}. The basic composition of the two feeds did not differ significantly (Table 1). The feed was delivered continuously with band feeders at a daily ration of 0.6% of the stock biomass.

TABLE 1

Basic chemical composition (% of wet weight) of the feed fed to the sturgeon hybrids during rearing

	Feed with Vitaton	Feed without Vitaton
Dry weight	91.62	93.04
Total protein	46.22	46.89
Raw fats	13.32	13.82
Ash	8.60	8.72

The experimental rearing was conducted in tanks that were part of a recirculating system. The fish were acclimated to the new feed for a period of two weeks. The experimental rearing period was 55 days long. Rearing was conducted at a water temperature of approximately 20°C. The oxygen saturation of the water flowing into the tanks did not drop below 70%, and the concentration of undissociated ammonia (NH_3-N) and nitrites (NO_2-N) did not exceed values recognized as harmful to sturgeon (Kolman 1999).

Measurements to monitor fish body weight (BW, ± 1 g) were taken every two weeks. All of the fish in each tank were weighed individually and the data obtained were used to calculate the mean body weight of the fish in each variant. The daily growth rate (DGR; % d^{-1}) means of the sturgeon were calculated according to the following formula: $DGR = (BW_f - BW_b)\, BW_b^{-1}\, n^{-1}\, 100$; where BW_f – mean final body weight (g), BW_b – mean initial body weight (g), n – rearing time (days).

Meat color was determined with a Dr Lange Spektro-color spectrophotometer and the Spektral – C computer program. The pigment parameters were expressed according to the Commission Internationale d'Eclairage (CIE) system. The different parameters refer to [L*] – brightness from 0 for an ideally black body to 100 for an ideally white body; [a*] – red if the value is positive, green if the value is negative and gray if the value is zero; [b*] – yellow if the value is positive and blue if the value is negative and gray if the value is zero.

The following analytical method was used to determine the chemical composition of the fish meat: water content was determined by drying the samples to a constant mass at a temperature of 105°C; total protein content was determined with the Kjeldahl method; total fat was determined with the a Soxhlet method; the total content of mineral components was determined by sample mineralization at temperatures of 525-550°C (Rutkowska 1981).

Statistically significant differences among the mean values of the studied parameters were determined with ANOVA analysis of variance at a significance level of P = 0.05.

The analysis of the results regarding changes in mean fish body weight in the various groups and replicates indicated that the Vitaton feed supplement had a notable impact on the growth rate in group SSZ. The mean daily growth rate (DGR) was about 20% higher in the fish from the Vitaton experimental group in comparison with that from the control group (Table 2).

TABLE 2

Body weight and feed conversion ratio in the SSZ and SRS hybrid groups (mean values ± SD)

	SSZ group		SRS group	
	Vitaton	Control	Vitaton	Control
Initial body weight (g)	1975.8 ± 17.5	1995. ± 16.2	1672.2 ± 16.2	1665.3 ± 15.4
Final body weight (g)	2447.3 ± 19.2*	2390.9 ± 20.5*	2019 ± 19.4	2005.5 ± 18.7
Daily growth rate (DGR; % d^{-1})	0.43*	0.36*	0.39	0.37
Feed conversion ratio	1.48 ± 0.07*	1.76 ± 0.10*	1.64 ± 0.08*	1.71 ± 0.09*

** Statistically significant differences (P < 0.05)*

In addition to the increased growth rate in the SSZ group, the impact of β-carotene was also reflected in the feed conversion ratio, which was 9.6% lower in the Vitaton variant (Table 2). The differences confirmed were highly statistically significant (P < 0.05). The differences in fish growth rates and feed conversion ratios between the Vitaton and control variants in the SRS group were less spectacular but still statistically significant (P < 0.05); the DGR was 4.2% higher while the feed conversion ratio was lower by 4.2% (Table 2).

The supplementation of feed with β-carotene had a similar impact on bester, *Huso huso* (L.) × *Acipenser ruthenus* L., and Russian sturgeon (Gamygin et al. 2004). During a 60-day rearing period, β-carotene resulted in an increase in bester growth rate by 19-22% and a decrease in the feed conversion ratio by 14-19%, and with respect to Russian sturgeon there was a decrease of about 17-22% in the feed conversion ratio (Gamygin et al. 2004).

In the current studies, β-carotene (Vitaton) added to the feed only impacted slightly the color of the fish meat. It was not possible to detect unequivocally with visual inspection any difference among the fillets from fish of different variants. However, spectrophotometric tests did indicate that the fish meat from the Vitaton variant was darker as was indicated by the lower value of parameter [L*]. In the SSZ group, the difference in the values of the parameters [L*] and [a*] between variants was statistically significant (Table 3). However, as regards the SRS group, statistically significant differences were confirmed for the contents of the red and yellow color component of the meat color (parameters [a*] and [b*]) (Table 3).

TABLE 3

Comparison of the basic parameters of meat color obtained from fish from the SSZ and SRS groups in the Vitaton and control variants (mean values ± SD)

Parameter	SSZ group		SRS group	
	Vitaton	Control	Vitaton	Control
[L*]	63.27 ± 2.29*	71.59 ± 3.07*	55.12 ± 3.58	58.26 ± 1.53
[a*]	-1.49 ± 0.18*	-1.02 ± 0.31*	-3.45 ± 0.15*	-2.42 ± 0.53*
[b*]	16.77 ± 0.74	15.27 ± 0.66	13.19 ± 0.17*	11.99 ± 0.40*

** Statistically significant differences (P < 0.05); [L*] – color brightness; [a*] – value of the red component of meat color; [b*] – value of yellow component of meat color*

The tests conducted on the basic chemical composition of the fish meat from the SSZ group did not indicate any significant differences in protein or fat content among the variants (Table 4). However, in the case of the SRS group, there was a statistically significant difference between the fat content of fish from the Vitaton and control variants. The fat content in fillets from the Vitaton variant of the Siberian × Russian sturgeon hybrid was in excess of 27% higher in comparison to the control (Table 4). Evidence that β-carotene results in the intensified accumulation of fat in the tissues was provided by the results of studies conducted on Russian sturgeon, the fat content of which was about 18% higher in the experimental group in comparison with that of the control group (Gamygin et al. 2004). However, as was the case in studies of SSZ and SRS hybrids, the protein level remained practically unchanged.

TABLE 4

Comparison of the basic chemical composition of the meat (% of wet weight) of fish from the SSZ and SRS groups and the Vitaton and control variants (mean values ± SD)

Components	SSZ group		SRS group	
	Vitaton	Control	Vitaton	Control
Water	73.59 ± 0.54	73.58 ± 0.39	68.82 ± 1.28*	72.73 ± 1.57*
Fat	9.10 ± 0.15	9.17 ± 0.36	13.21 ± 1.04*	9.57 ± 2.33*
Protein	16.12 ± 0.44	16.42 ± 0.12	17.02 ± 0.12	16.92 ± 0.17
Ash	1.07 ± 0.03	1.07 ± 0.05	1.09 ± 0.04	1.05 ± 0.03

* *Statistically significant differences ($P < 0.05$)*

The comparison of results that characterize changes in growth rate, feed utilization, and meat composition in both hybrids permits concluding that the impact of Vitaton on the analyzed parameters varied. The growth potential of the fish was impacted to a greater degree in the SSZ group, while in the SRS group there was an increase in the amount of stored substances – fat deposits in the muscles. The reason for the different reactions of the studied sturgeon hybrids to Vitaton probably lies in their different behavior and the related metabolic character. Sturgeon hybrids inherit both morphometric and behavioral traits largely from the paternal line (Kolman et al. 1997, 2003, Szczepkowski and Kolman 2002). In the case of the studied hybrids, the initial paternal lines were species that differed diametrically with regard to both behavior and physiology. The green sturgeon is a typically marine species adapted to inhabiting waters of high salinity. This species is typically a nocturnal predator (Artiukhin and Andronov 1992). However, the Russian sturgeon inhabits marine waters of low salinity and can even create freshwater populations. Typically, this species is polyphagous and is slightly more active at night (Kazancheev 1981).

CONCLUSIONS

1. Feed supplements of Vitaton in quantities of that ensure approximately 80 mg kg^{-1} of β-carotene resulted in an increased growth rate in the hybrid reciprocal back cross hybrids of Siberian × green sturgeon of about 20% with a simultaneous decrease in the FCR of about 9.6%. In the SRS group, the growth rate increased by about 4.2% and the FCR decreased by about 4.2%.
2. In the SSZ group, the β-carotene supplement was not noted to have had a significant impact on the basic chemical meat composition, but in the SRS group the fish from the Vitaton variant had an increase in muscle fat by about 27% in comparison with the control group.
3. Under experimental conditions, the contents of about 80 mg kg^{-1} of β-carotene in the feed had a slight impact on the color of the meat of both hybrids. Spectrophotometric tests indicated that the meat of the fish from the Vitaton variant was slightly darker and that there was a small increase in yellow and red components of the color.

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STRESZCZENIE

WPŁYW PREPARATU VITATON NA WSKAŹNIKI HODOWLANE ORAZ JAKOŚĆ MIĘSA HYBRYDÓW JESIOTRÓW

Celem badań w trakcie eksperymentalnego chowu było określenie wpływu β-karotenu naturalnego pochodzenia, zawartego w preparacie Vitaton, na podstawowe wskaźniki hodowlane oraz jakość mięsa hybrydów zwrotnych jesiotra syberyjskiego, *Acipenser baerii* Brandt i zielonego, *Acipenser medirostris* Ayres (grupa SSZ) oraz jesiotra syberyjskiego z rosyjskim, *Acipenser gueldenstaedti* Brandt (grupa SRS). Stwierdzono, że w grupie SSZ β-karoten powodował zwiększenie tempa wzrostu o ok. 20% i zmniejszenie współczynnika pokarmowego pasz o 9,6% (tab. 2). Wpływ β-karotenu na wskaźniki hodowlane u ryb SRS był mniejszy, ale spowodował wzrost zawartości tłuszczu w mięsie o ponad 27% w porównanwiu z kontrolą (tab. 4). β-karoten nie wywołał istotnej zmiany barwy mięsa badanych ryb (tab. 3) i jedynie wyniki badań spektrofotometrycznych wykazały w grupie Vitaton nieco ciemniejszą barwę mięsa i niewielki wzrost żółtego i czerwonego komponentu barwy. Zróżnicowanie oddziaływania β-karotenu na badane hybrydy jesiotrów można tłumaczyć różnym behawiorem i związanym z tym metabolizmem gatunków ojcowskich, tzn. różnicami pomiędzy jesiotrem zielonym i rosyjskim.