Acta Agraria Kaposváriensis (2010) Vol 14 No 2, 301-306
Kaposvári Egyetem, Állattudományi Kar, Kaposvár
Kaposvár University, Faculty of Animal Science, Kaposvár

Comparative study of the meat quality of common carp strains harvested from different fish ponds

D. Varga, A. Szabó, R. Romvári, Cs. Hancz
Kaposvár University, Department of Nature Conservation, 7400 Kaposvár, Guba S. u. 40., Hungary

ABSTRACT

This study analyzed, whether there exist detectable differences among carp meat quality traits of fish harvested from different fish ponds at the age of 3 years. The slaughter and meat quality traits of altogether 40 carps was determined. It was stated that sex has a detectable effect on pH 24 and that body weight significantly affects flesh dry matter content. It was experienced that the water holding capacity of carp flesh is relatively low, and is expressedly sensitive towards induced effects like freezing and cooking.
(Keywords: carp, meat quality)

INTRODUCTION

Common carp is the dominant species in Hungary's fish production, with its share over 75%. This is largely mirrored in the national fish consumption habits as well, carp is the most popular fish in Hungary. In parallel with the alterations of the national consumption the proportion of processed products is increasing, giving a more expressed basis for the research concerning carp meat quality. Benthic zone is essential part of the fish pond biotop. Nutrients, organic material and mico-organisms are present here in a largely higher density than in the pond-water (*Anvimelech et al.,* 2002). The species in study, the common carp (*Cyprinus carpio L.*) is covering its nutrient demands mostly from the pond bottom thus it was hypothesized that its characteristics have a profound effect (directly via its consumption and indirectly through the water) on the carp meat quality.

Taking into account that carp consumption in Europe and North America is minimal or nil, relevant research results are rarely published in the leading scientific journals. *Hancz et al.* (1995) analyzed the alterations of carp body composition after natural and concentrated fish diet feeding regimes under laboratory conditions. Moreover *Oberle et al.* (1997) investigated the effects of divergent feeding protocols on the fillet composition, but fillet flesh quality was not involved. In the studies of *Körmendi et al.,* 2002; *Romvári et al.,* 2002; *Lengyel et al.,* 2001; *Trenovszki et al.,* 2008; *Bauer et al.,* 2009 mostly the body fat content, the fatty acid profile and the total body composition was determined. The production and meat quality of carp populations reared under different natural conditions has not yet been compared, thus, the present study aimed to perform such a comparison.

MATERIALS AND METHODS

Fishes

Altogether 40 market-size common carp, *Cyprinus carpio*, were taken from four Hungarian fish farms. The carps were collected at the harvesting time (November-

December). Semi-intensive fish production in polyculture is performed at the farms, where the main species is the common carp. The main difference between farms is the geographical characteristics. First and second fish farms (TG1, TG2) are dam-like, built on clayey soil. The third and fourth (TG3, TG4) farms are in plains, built around banks. TG3 is on peaty soil, there is a large reedy marsh around the ponds; TG4 is on salty, alkaline soil. TG1 and TG2 are filled by streams, TG3 is filled with groundwater and TG4 is filled from the Tisza-river and by groundwater. Fish feeding is similar in each fish farm: 80% maize and 20% other grains.

Different carp strains were reared at farms: TG1: Attala mirror, TG2: Attala scaled, TG3: Hortobágy lean (scaled), TG4: Szeged mirror.

Slaughtering, slaughter value

Carps were processed after percussive stunning in accordance with the rules of the *Carp Performance Testing Codex* (2001). Before the conventional processing, the following biometric traits were registered: body length, standard length, head length, tail length, body height, body width. After the processing the separated parts of the body were measured, and the slaughter value and fillet yield were calculated.

The following indexes were calculated: profile index (body length / body height), cross-section index (body height / body width), head index (body length / head length), tail index (body width / tail length)

Fillet flesh quality investigation

Fillet pH was measured at 45 min and 24 h post mortem, by a Testo 205 precision pH meter (Testo AG, Lenzkirch, Germany). The colour (CIE Lab, L*–lightness, a*–redness, b*–yellowness) of the fresh fillet was determined by a Minolta ChromaMeter 300 apparatus (Minolta, Osaka, Japan). Dripping loss was determined by the method of *Honikel,* (1998). To determine the so-called cooking loss, fillet samples (100 g) were closed into sealed bags and were cooked at 75 °C for 20 min. The exudate weight, as expressed in the percentage of the initial sample weight was referred to as cooking loss. The thawing loss was determined by the same manner, i.e. samples (25 g) were frozen (−20 °C) and thawed to room temperature after 2 days. Moreover, fillet dry matter content was determined by drying to constant weight at 103 °C.

NIRS analysis

Carp fillet samples of ca. 25 g were freeze dried and ground on an IKA laboratory mill. Samples were filled into a small ring cup sample holder, and were scanned with a FOSS NIRSystem 6500 spectrometer (Foss NIRSystems INC., Silver Spring, MD) equipped with a sample transport module. Spectra were collected in reflectance mode between 800 and 2500 nm wavelength at 2 nm intervals, and were stored as log(1/R). Spectrum acquisition was performed with the WinISI II version 1.5 spectral analytical programme (InfraSoft International, Port Matilda, PA). All samples were scanned twice and the average spectra were used in the statistical analysis.

Statistical analysis

SPSS 10 for Windows (1999) were used to the statistical analysis. First step was excluding outliers beyond double range of standard deviation. ANOVA with Tukey-test ($P<0.05$) were used to compare the slaughtering and flesh quality parameters. Fixed factors were sex, strain and origin. The statistical analysis of NIR data was discriminant analysis, to classify samples according their origin, i.e. fish pond.

RESULTS AND DISCUSSION

Table 1 shows the mean values and standard deviations in weight, slaughter weight, fillet yield, slaughter value, dry matter, profile index, cross-section index, head index, tail index, pH 45 min, pH 24 h, and cooking loss, dripping loss, thawing loss and colour parameters according to fish farms.

Table 1

Slaughter and flesh quality parameters per fish farms/carp strains (mean±s.d.)

Parameters	Attala mirror	Attala scaled	Hortobágy lean (scaled)	Szeged mirror
Weight	1499.6 ±141.5^{b}*	954.5 ± 303.9^{a}	1941.8 ± 269.5^{c}	1488.6 ± 209.3^{b}
Slaughtered weight	915.8 ± 90.6^{bc}	513.8 ± 188.1^{a}	1088.4 ± 137^{c}	844.4 ± 120.5^{b}
Fillet yield	45.7 ± 1.8^{bc}	40.1 ± 6.6^{ab}	43.7 ± 2.9^{c}	42.7 ± 1^{b}
Slaughtering value	61.1 ± 2.5^{b}	53.6 ± 6.6^{ab}	56.2 ± 2.8^{a}	56.7 ± 1.6^{a}
Profile index	2.1 ± 0.1^{a}	2.5 ± 0.2^{b}	2.5 ± 0.2^{b}	2.1 ± 0.1^{a}
Cross-section index	2.5 ± 0.2^{a}	2.5 ± 0.4^{a}	2.4 ± 0.1^{a}	2.5 ± 0.1^{a}
Head index	3.2 ± 0.1^{a}	3.7 ± 0.2^{bc}	3.7 ± 0.2^{c}	3.5 ± 0.2^{a}
Tail index	2.5 ± 0.3^{ab}	2.4 ± 0.3^{ab}	2.2 ± 0.2^{a}	2.5 ± 0.3^{b}
pH 45 min	6.4 ± 0.1	not determined	6.4 ± 0.2	not determined
pH 24 h	6.2 ± 0.1^{a}	6.4 ± 0.2^{b}	6.2 ± 0.2^{a}	6.4 ± 0.2^{ab}
Cooking loss	21.4 ± 1.6^{b}	16.1 ± 2.6^{a}	14.7 ± 2.2^{a}	17 ± 2.4^{a}
Dripping loss	2.4 ± 0.8^{a}	2.9 ± 0.6^{a}	2.1 ± 0.6^{a}	2.9 ± 1.2^{a}
Thawing loss	6 ± 1.6^{a}	5.1 ± 1.9^{a}	6.5 ± 1.8^{a}	6 ± 1.8^{a}
Dry matter	27.9 ± 3.4^{a}	27.5 ± 6.5^{a}	32.7 ± 4.9^{a}	29.1 ± 3.9^{a}
L	46.7±3.5^{a}	43.9±3.1^{a}	44.9±3.6^{a}	46.6±3^{a}
a*	2.6±1.2^{a}	3.2±1.8^{a}	3.8±1.4^{a}	2.9±1.4^{a}
b*	1.5±1.2^{b}	0.8±1.4^{ab}	0.9±1.1^{ab}	0.1±0.9^{a}

^{a,b} P<0.05

According to our possibilities fish groups from the different farms were selected to provide maximum homogeneity, but due to the largely different local conditions in the technology and natural circumstances the slaughter weight was considerably different among groups. Sex had a defined effect on the weight, namely females largely exceeded males, most probably due to the well developed ovaries. By analysing slaughter value the prescriptions of the *Carp Performance Testing Codex* (2001) were followed and the slaughter value showed large differences among farms. This trait of carps originating from farm TG1 showed the highest values. Interestingly fillet samples in this group showed the highest cooking loss, referring to a low water holding capacity of carp flesh.

The somatometric indices of fish are basically connected to the strains. However, mirror and scaled strains showed a clear significant difference only in the profile index. It is an intriguing result that the water holding capacity of carp flesh is relatively low (independently of farm), total losses (cooking, thawing and dripping) ranging from 23 to 30%, leading to the conclusion that the culinary processing is best when using only mild treatment conditions, mostly on fresh fillet. When comparing our results to those of other freshwater species, it seems to be relatively high; in case of African catfish *Szabó et al.* (2009) described ca. 12% for the total losses. In the catfish, similarly to the carp the induced losses (cooking and thawing) were rather high, as compared to the spontaneous dripping.

The colour of meat is basically determined by its hem pigment contents, in particular by myoglobine and haemoglobin. Carp flesh is low in myoglobine and is classified as white meat. Results in our study concerning colour (L, a*, b*) are characteristic to carp flesh. The fillet of female individuals was in every case characterized by higher L values, as compared to the males (46.7±2.75 vs. 45.1±3.54, $P<0.05$). According to *Gregory and Grandlin* (1998), in poultry paler meat colour is associated with lower ultimate pH, which is consonant with our results.

The pH value measured at 45 minutes *post mortem* was always only slightly higher that at 24 h p.m. This was caused by the muscle to meat conversion, by the breakdown of glycogene. The relatively mild pH fall is attributed to the low glycogene concentration of fish flesh, as compared to mammals. Interestingly, a defined sex effect was found on the fillet pH, namely in the entire dataset the male individuals had significantly higher fillet pH values, as compared to the females (*Figure 1*).

The NIRS analytical results indicate that simple classification of ground, freeze-dried samples is effective, when performing the analysis on the entire spectral interval (*Table 2*).

Figure 1

Sex-dependent difference in the pH 24 value of carp fillets (1-male, 2-female)

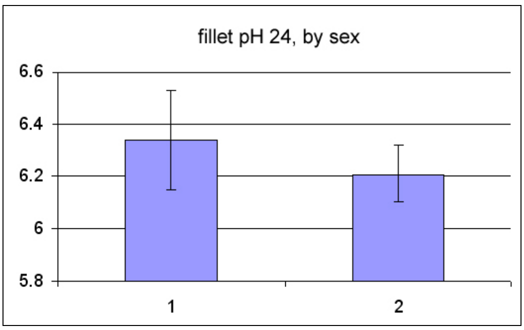

Table 2

Classification results of the 40 carp fillet samples, based on NIR spectra, by discriminant analysis

Attala mirror	18	0	0	1
Nagyberki scaled	0	20	0	0
Hortobágy lean	0	0	17	1
Szeged mirror	0	0	1	15
Total	18	20	18	17
Misses	0	0	1	2
Succesfully classified	18	20	17	15
Standard error of cal.	0.21			
R^2	0.75			
Standard error of cross val.	0.24			
1-VR	0.69			

REFERENCES

Agaba, M.K., Tocher, D.R., Zheng, X., Dickson, C.A., Dick, J.R., Teale, A.J. (2005). Cloning and functional characterisation of polyunsaturated fatty acid elongases of marine and freshwater teleost fish. Comp. Biochem. Physiol., B 142. 342-352.

Anvimelech, Y., Ritvo, G. (2002). Shrimp and fish pond soils: processes and management. Aquaculture. 220. 549-567.

Bauer, C., Schlott, G. (2009). Fillet yield and fat content in common carp (*Cypricus carpio*) produced in three Austrian carp farms with different culture methodologies. J. Appl. Ichthyol., 25. 591-594.

Carp Performance Testing Codex (2001). Ponty teljesítményvizsgálati Kódex 3. OMMI, Budapest.

Cibert, C., Fermon, Y., Vallod, D., Meunier, F.J. (1999). Morphological screening of carp Cyprinus carpio: relationship between morphology and fillet yield. Aquatic Living Resources. 12. 1. 1-10.

Gregory, N.G., Grandlin, T. (1998). Animal Welfare and Meat Science. CABI Publishing, London, UK.

Hancz Cs., Körmendi S., Bánhegyi P. (1995). Egynyaras ponty nevelése természetes táplálékon és abraktakarmányon. Halászatfejlesztés. 18. 172-175.

Körmendi S., Varga L., Balogh I., Hideg B., Széli Zs. (2002). A ponty testanyag összetételének szezonális változása tógazdaságokban. XXVI. Halászati Tudományos Tanácskozás. HAKI, Szarvas, 1-35.p.

Lengyel P., Sándor Zs., Györe K., Szabó P., Pekár F., Zubkova E., Alexis M., Csengeri I. (2001). A ponty és néhány más hazai pontyféle testösszetételének alakulása a takarmányozással összefüggésben. XXV. Halászati Tudományos Tanácskozás. HAKI, Szarvas, 153-162.

Oberle, M., Schwarz, F.J., Kirchgessner, M. (1997). Growth and carcass quality of carp (*Cyprinus carpio L.*) fed different cereals, lupin seed or zooplankton. Archives of Animal Nutrition. 50. 1. 75-86.

Romvári, R., Hancz, Cs., Petrási, Zs., Molnár, T., Horn, P. (2002). Non-invasive measurement of fillet composition of four freshwater fish species by computer tomography. Aquacult. Int., 10. 231-240.

Schwarz, F.J., Kirchgessner, M. (1993). Digestibility, growth and carcass composition of carp (*Cyprinus carpio* L.) fed different starches. Archives of Animal Nutrition. 43. 3. 275-282.

spss for Windows 10 (1999). Copyright SPSS Inc., 1989-1999.

Szabó, A., Romvári, R., Szathmári, L., Molnár, T., Locsmándi, L., Bázár, Gy., Molnár, E., Horn, P., Hancz, Cs. (2009). Effects of dietary vegetable oil supplementation on fillet quality traits, chemical and fatty acid composition of African catfish *(Clarias gariepinus)*. Archiv für Tierzucht. 52. 321-333.

Trenovszki M., Hegyi Á., Lugasi A., Kertészné L.V., Müller T., Szabó T., Urbányi B., Horváth L. (2008). Pontyok takarmányozásának és húsminőségének összehasonlítása különböző tógazdaságokból-, illetve egy ketreces kísérletből származó minták analizálásával. XXXII. Halászati Tudományos Tanácskozás. HAKI, Szarvas.

Corresponding authors:

Dániel Varga
Kaposvár University, Faculty of Animal Science,
Department of Nature Conservation
H-7400 Kaposvár, Guba S. u. 40., Hungary
Tel.: +36 82 505 800; fax: +36 82 320 175
e-mail: varga.daniel@ke.hu