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Preliminary communication

OFF-FLAVOUR COMPOUNDS IN COMMON CARP (*CYPRINUS CARPIO* L.) FLESH IN CONTEXT OF TYPE OF FISH POND

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The aim of our study was to survey the geosmin (GSM) and 2-methylisoborneol (MIB) concentrations of the sediment and that of common carp (*Cyprinus carpio*) flesh in three different Hungarian fish farms (clayey, marshy, and sodic ponds).

Results showed that the concentrations of off-flavour compounds of the sediment and fish fillets were related to the natural environment. The GSM concentration of bottom soil samples was higher, than MIB in each fish farm. Both off-flavour compounds were the highest in the marshy fish pond and the lowest in the sodic pond. In case of fish flesh, significant differences were found between the farms in GSM level and fat content. In the fish flesh the same tendency was found as in the sediments, but surprisingly, MIB concentration was higher in the fillets, referring to accumulation.

Keywords: common carp, off-flavour, geosmin, 2-methylisoborneol

Earthy-musty odour accumulated in potable water and fish flesh is a serious problem worldwide. Off-flavour problems are well studied among the commercial fish species: Nile tilapia (Yamprayoon & Noomhorn, 2000), Atlantic salmon (Farmer et al., 1995), rainbow trout (From & Horlyck, 1984), and channel catfish (Martin et al., 1987).

This off-flavour is mainly caused by two isoprene compounds. Geosmin (GSM) and 2-methylisoborneol (MIB) are synthesized by microorganisms as metabolites.

The uptake of earthy-musty odorous compounds occurs through the gills or skin, in addition the consumption of the producer organisms leads to the off-flavour accumulation in adipose tissue.

According to several studies, the highest GSM concentrations can be found in common carp (*Cyprinus carpio*) tissues compared to other fish species. This phenomenon is related to the fact, that carp is a benthic species and acquires most of the natural feed from the pond bottom soil by bioturbation. The ratio of GSM and MIB producer microorganisms is the highest in the pond sediments (Papp et al., 2007).

Common carp is one of the dominant freshwater species in world fish production. The off-flavour tainting in farmed carp is frequent, and it is a result of poor water quality and wrong feeding regime. The aim of the present study was to compare GSM and MIB concentrations in sediments and carp fillets in different fish farms in Hungary.

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1. Materials and methods

1.1. Fish farms and sample collection

Altogether 30 market-size common carps, *Cyprinus carpio*, were taken from three Hungarian fish farms at harvesting time (November). Bottom soil samples were collected also at the same time. Five samples were taken randomly at each farm with Ekman-Birge grab sampler.

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 fish farm is dam-like, built on clayey soil. The second and third farms are in plains, built around banks.

The second farm is on sodic, alkaline soil. Farm three is on marshy soil, there is a large reedy marsh around the ponds. Fish feeding was similar in each fish farm (Table 1).

Table 1. Main characteristics of the fish farms investigated

Type of pond	Clayey	Sodic	Marshy
Size of pond (ha)	18	241	15
Fish nutrition:			
Maize (%)	80	80	80
Wheat (%)	5	20	15
Triticale (%)	15	0	5
Rearing regime:	Polyculture	Polyculture	Polyculture
Stocked fish species (%):			
Common carp (*Cyprinus carpio*)	90	90	85
Grass carp (*Ctenopharingodon idella*)	5	2.5	5
Silver carp (*Hypothalmichthys molitrix*)	5	4.5	5
Pikeperch (*Sander lucioperca*)	0	0	5
Catfish (*Silurus glanis*)	0	5.5	0

1.2. Sample preparation and analysis

Fish were stunned immediately after harvesting by a blow on the head. The left fillet was dissected freshly, homogenized (IKA Basic A11), and stored frozen (–70 °C) till analysis. Fillet dry matter content was determined by drying to constant weight at 103 °C. Fillet fat content was determined from raw samples by extraction with petroleum-ether and drying the extract at 103 °C to a constant weight according to ISO (1985).

Off-flavour analysis was carried out with an improved method of Zhou and co-workers (1999) in five fish samples in each group.

1.3. Statistical evaluation

The basic data were tested for normality (Shapiro-Wilk test). For the analysis of the effect of origin on fat and dry matter content and concentration of GSM and MIB one-way ANOVA was used, followed by Tukey's post-hoc test. Relationship between the fat content and off-flavour tainting was evaluated by linear regression. In all instances SPSS 10 for Windows (1999) was used.

1.4. Ethical issues

The experiment was approved by the Animal Experimentation Ethics Committee of the Kaposvár University, as allowed by the Somogy County Animal Health and Food Control Authority (allowance no.: XV-I-31/446-10/2012).

2. Results and discussion

Fat and dry matter content of the fish flesh and GSM and MIB concentrations of fish flesh and sediment samples are shown in Table 2.

Table 2. Fat and dry matter content of the fish flesh and GSM and MIB concentrations of fish flesh and sediment samples

Sample \ Soil	Clayey	Sodic	Marshy	Sig. P
		Mean±SD		
Fish fillet				
Fat content (%)	5.1±1^{ab}	3.7±1.1^{a}	8.5±3.5^{b}	0.01
Dry matter content (%)	29.6±1.6	25.9±2.8	27±3.96	NS
MIB (ng g^{-1})	0.18±0.11	0.11±0.11	0.19±0.08	NS
GSM (ng g^{-1})	0.12±0.11^{ab}	0.02±0.01^{a}	0.13±0.03^{b}	0.05
Pond bottom soil				
MIB (ng g^{-1})	0.018	0.015	0.035	
GSM (ng g^{-1})	0.07	0.045	0.17	

MIB: 2-Methylisoborneol; GSM: geosmin; NS: not significant. Values in a row marked with different superscripts are significantly different

2.1. Off-flavour compound in the sediment

In case of the bottom soil samples GSM concentration was higher in each fish farm compared to MIB. Both off-flavour compound concentrations were the highest in the marshy fish pond and the lowest in the sodic pond.

MIB and GSM concentrations of the water depend on the eutrophication. Algal bloom is frequent in the ponds with high organic matter content (eutrophic ponds). It is proven that odorous compounds are associated with algal blooms in several water bodies. Populations of *Anabaena* sp. and their GSM producing activity increase with the concentration of ammonia and phosphorus in the water (SAADOUN et al., 2001). In our case, the high concentration of GSM and MIB in the bottom soil can be explained with the high organic matter content of the marshy pond.

2.2. Off-flavour taint of the fish flesh

Regarding fish flesh, significant differences were found between the farms in GSM level and fat content. The same tendency was observed in the fish flesh as in the sediments, but surprisingly, MIB concentration was higher in the fillets (Table 2). The highest GSM and MIB concentrations were detected in the fillets from the marshy fish farm.

Uptake of odorous compounds by fish may go through by absorption in the gills, alimentary canal, and skin. The mainly benthic feeder common carp uptakes GSM and MIB firstly through the alimentary tract, and secondly via the gills.

Relevant results on off-flavour compounds in common carp flesh are limited. Nevertheless, according to authors, there is a strong relationship between phytoplankton density and off-flavour compounds concentration in water and in several fish tissues.

According to PAPP and co-workers (2007), feeding has a major impact on the concentration of GSM and MIB in common carp flesh. Uptake of off-flavour compounds in carps fed natural and commercial feed was lower, as compared to the carps fed grains. This phenomenon is indirectly linked to the fat content, because grain feeding leads to a higher lipid content of carp flesh. GSM and MIB are liposoluble and accumulate in adipose tissue, thus off-flavour compounds are strongly related to the fat content (crude fat % of total body) of the fish (TUCKER and MARTIN, 1991; TUCKER, 2000; PAPP et al., 2007).

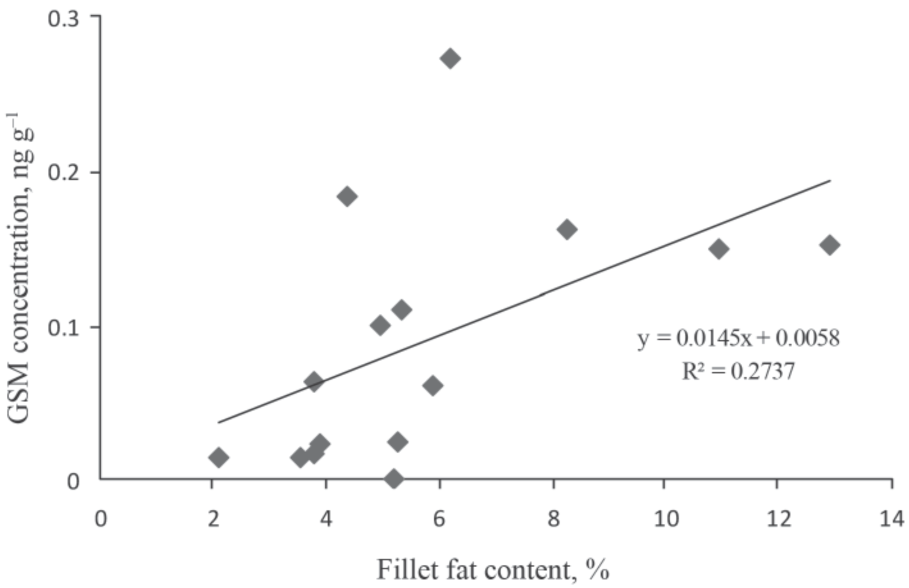

Fig. 1. Relationship between the fillet fat content and the concentration of GSM in fillet.

In our study, relationship between odorous compounds and fat content (using the entire dataset) is weak (Fig. 1), maybe due to the small number of samples. But, in the marshy group the higher fillet fat content is coupled with the higher off-flavour concentration.

3. Conclusions

Our comparison of three different fish ponds showed that the presence of off-flavour compounds, such as GSM and MIB, is remarkable in the sediments and also in the fish fillets. Overall, GSM and MIB tainting of fish fillets showed a general relationship with the environment and via this with the fat content.

Common carp as a benthic feeding species directly ingests and absorbs the bacterial-algal mat from the sediment, and off-flavour compounds accumulate in the visceral and intramuscular fat. Carp producers have to maintain good water quality and follow strict feeding regime in order to decrease the earthy-musty odour in common carp flesh and achieve a better quality.

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