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Sensory Attributes and Chemical Composition of Maraena Whitefish (*Coregonus maraena*) from German Aquaculture

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Abstract

Landlocked populations of maraena whitefish (Coregonus maraena) are an interesting species for aquaculture and can be raised in ponds and lakes. Their balanced chemical composition and their excellent sensory characteristics make them particularly suitable for human consumption. This paper aims to assess the sensory and nutritional quality of maraena whitefish (Coregonus maraena) raised in different aquaculture plants in Northern Germany. The evaluation focused on the physico-chemical parameters and sensory attributes of fish at market size.

Keywords: main components, sensory evaluation, whitefish, *Coregonus maraena*, aquaculture.

1. Introduction

The *Coregonidae* subfamily belongs to the salmon family and includes marine, anadromous and freshwater species in Northern Europe, Asia and North America. Most species are pelagic, form schools and feed on benthic prey (crustaceans, molluscs, large insect larvae, and small fish). The economic importance and commercial value should not be underestimated. Some species are intensively fished and some are cultivated in aquaculture, resulting in hybrid stocks. The genetic integrity of several wild populations and species is threatened (HELCOM [9]). Some species are extinct following the formation of hybrid swarms and habitat modification (KOTTELAT & FREYHOF [12]). This adaptive capacity leads to uncertainty and confusion in the classification and correct taxonomy of this fish genus. *Coregonus maraena* is widespread in the Baltic basin and has traditionally been known as *Coregonus lavaretus*. Following the suggestion of KOTTELAT & FREYHOF [12], *Coregonus lavaretus* should now only be applied to some Swiss and French whitefish populations. There are only few natural populations of *Coregonus maraena* left. They need high quality clean water conditions (ARNDT [1]), and most of the natural populations declined because of pollution. Additional reasons were the blocking of spawning rivers and overfishing. The catch rates of maraena whitefish drastically dropped in the 1990s (SCHULZ [23]). Since then up to now, restocking and reproduction projects took place in Mecklenburg –Vorpommern (LORENZ & al. [16]). The spawning and relevant catch areas of *C. maraena* are in the Peene River, Achterwasser Lagoon and Szczecin Lagoon (SCHULZ [23], SCHULZ [24]). Resource studies showed that the Darß–Zingster Bodden chain and its catchment areas can principally offer favourable spawning and growing conditions (LORENZ & al. [16]). But there are still problems in the development of juveniles (JÖNSSON & al. [10], LORENZ

[14], LORENZ & al. [15], LORENZ & al. [16]). Besides restoring wild populations, the rearing in aquaculture plants was intensified. Wild *C. maraena* has been known as a tasty fish in the 1930s. The re-establishing as high quality product from aquaculture provides new sales opportunities for fish farmers in Mecklenburg-Vorpommern and Schleswig-Holstein (LORENZ & al. [16]). The aim of this study was to assess the nutritional quality and sensory attributes of the maraena whitefish (*C. maraena*) from aquaculture, sold on the German market. Fish at market size was analyzed for chemical composition. Sensory evaluation of prepared fillets included the main attributes appearance, odour, taste and texture.

2. Materials and Methods

2.1. Fish samples

Maraena whitefish was reared in earth ponds in Mecklenburg-Vorpommern (Group MV) and in Schleswig-Holstein (Group SH), Northern Germany, respectively. Group MV came from sexually mature individuals who were caught in cooperation with local fishermen during spawning season in the German part of the Szczecin Lagoon and adjacent Peene River. Group SH originated from a reproduction cycle in the aquaculture plant. Fish were mainly fed with trout feed chosen by the fish farmers. Whole fishes were purchased in October-November 2013 (Group MV) and in May 2014 (Group SH) directly from the German aquaculture plants, respectively. Gutted fish was stored frozen at -20 °C until analyzed. Sample details are given in Table 1. Ten fish from each group were taken for chemical investigation. Skinned fillets were homogenised with a blender for 30 seconds at 5000 rpm (Grindomix GM 200; Retsch, Haan, Germany).

2.2. Chemical analysis

Analytical methods were previously described (BOIȚEANU & al. [2]). In brief, following determinations were performed: pH-value (with a pH meter); water (gravimetrically); ash (in a muffle furnace at 550 °C); salt (NaCl; by auto-titration); lipid (by a modified Smedes method); protein (with a LECO TruSpecN based on the principles of the Dumas combustion method); total phosphorus content (photometrically, calculated as P_2O_5); total volatile basic nitrogen (TVB-N, using the EU reference method). Fatty acid composition was estimated as described by KARL & al. [11]. Fatty acid methyl esters were obtained from the extracted lipids by trans-esterification with potassium hydroxide. Fatty acid composition was determined according to the DGF standard method.

2.3. Sensory assessment

Maraena whitefish samples were subjected to sensory evaluation in order to describe their species characteristics and sensory quality. Skin-on fillets were placed in individual boilable film-type pouches and heated for 8 minutes in a water bath (90ºC) or pan-fried in edible tasteless oil, respectively. After heat treatment the samples were blind coded and served immediately to the panel of tasters. Tap water and unsalted crackers were used for cleaning the palate. Tasting sessions were conducted in a sensory analysis laboratory with separate cabins. In total, 6 assessors trained in the evaluation of fish were asked to describe and comment the prepared samples. Assessments included appearance, odour, taste and texture. Attributes were described in terms, mainly based the on the sensory lexicon of DRAKE & al. [4]. Spider - diagrams showed the most important attributes usually used in quantitative descriptive analysis (QDA) for fish and fishery products (MEILGAARD & al. [19]). The length of a spoke is proportional to the number of namings for an attribute, relative to the maximum of 6 (number of panellists). At the end of the session the individual personal view was asked, using a scoring system from 0= bad, 3=undefined to 5= very good.

Table1. Slaughter data of maraena whitefish (*Coregonus maraena*) from two different aquaculture plants

Species	n	Average weight of whole fish ±SD*	Average weight of fillets ±SD	Slaughter Yield ±SD
C. maraena Group SH	10	380 ± 21 g	236 ± 16 g	80 ± 2%
C. maraena Group MV	10	291 ± 39 g	211 ± 27 g	73 ± 3%

*) SD= standard deviation

3. Results and Discussions

3.1. Proximate composition

The analytical results for chemical composition, pH-values and the TVB-N contents in the fillet flesh of *C. maraena* are summarized in Table 2 and reflected the composition of raw unprocessed muscle flesh. A study of the breeding conditions and the product quality of *C. maraena* from a plant with natural ponds and a recirculation aquaculture system (Schmidt & al. [22]) reported findings for the water (72.9-74.2%) and protein (19.9-20.4%) content of *C. maraena* fillets comparable to the results presented here. Also the minor components were similar: ash (1.2-1.3%), phosphate (0.54-0.57%, calculated as P2O5), and salt (0.15%). However, the mean lipid content (5.5-6.5%) analyzed by Schmidt & al. [22] was only half of that found in this study for Group SH (11.1%). Whitefish muscle from the Italian lakes showed also good protein levels (17.6-20.4%), but low total lipid contents (1.2-4.2%) in all seasons (Orban & al. [21]). In the recent investigation the water content varied between 65.8% and 71.8% in Group SH with an arithmetic mean of 68.6%, and between 71.6% and 74.3% in Group MV with an arithmetic mean of 73.0%. Parallel to that, the lipid content in Group SH was distinctly higher and roughly uniform compared to Group MV. In aquaculture the fat content of the fish can be influenced by the feed and the feeding. In ponds the feeding regime is easier to handle as in lake aquaculture which can result in a higher feeding intensity and fish growth as well as higher fat content. The natural phosphate content in fish flesh shows a high variability and can also be affected by the amount of bone fragments (Martinez–Valverde & al. [18]). However, most data are in the range of 0.2-0.3 g P/100 g (≙ 0.5-0.7 g P2O5/100 g) (Oehlenschläger [20]) and confirmed in this study.

3.2. Chemical spoilage indicators and pH

Total volatile bases nitrogen (TVB-N) is one of the most widely used indicators of fish quality and spoilage. The upper limit for many seawater fish is considered to be 30 mg/ 100 g TVB-N (HOWGATE [7]). This maximum level is part of the requirements on freshness categories laid down by the Commission Regulation (EU [3]). It is known that TVB-N levels are more suitable for spoilage assessment in marine than in freshwater fish. TVB-N levels in fresh rainbow trout (MANTHEY–KARL & al. [17]) and in carp meat (JEŽEK & BUCHTOVA [6]) are very low (17.2 mg/100 g and 12.3 mg/100 g, respectively). The pH range for fresh fish is between 6.6 and 6.8 (FOOD SAFETY AUTHORITHY OF IRELAND [8]). In the present study, the pH values of maraena whitefish (6.1±0.1) were in a normal range and similar to those reported by SCHMIDT & al. [22] (6.5±0.1). TVB-N results and the pH results indicate optimal fish freshness.

Table 2. Chemical composition of the edible part, pH-value and spoilage indicators of maraena whitefish (*C. maraena*) from two different plants (Group SH and Group MV) (mean values ± SD)

Component	*C. maraena* Group (SH)	*C. maraena* Group (MV)
Water (%)	68.6 ±1.5	73.0±1.1
Protein (%)	19.5±0.8	20.4±0.5
Lipid (%)	11.1±1.8	6.5±1.6
Ash (%)	1.2±0.1	1.3±0.1
NaCl (%)	0.1±0.02	0.2±0.02
P_2O_5 (%)	0.57±0.02	0.54±0.02
TVB-N (mg/100g)	14.0±1.2	not determined
pH	6.1±0.1	6.5±0.1

As the only significant source of highly unsaturated n-3 fatty acids, fish has an exceptional importance in the human diet. Although mainly marine fish species store these fatty acids at high levels, freshwater fish can also contain considerable amounts. This is especially true for farmed fish reared with feed containing fish oil. Also the present study mirrored the strong influence of fish feed on the fatty acid composition in the muscle flesh. The fatty acid composition of both groups shows that high quality feed was used during rearing which possessed a high percentage of essential fatty acids. Saturated fatty acids were just barely above 20% of the total fat content. The higher proportion of oleic acid and linoleic acid in the fillets of *C. maraena* Group SH indicates a higher amount of plant constituents in the feed. However, with converted levels of about 0.7 g Σ EPA + DHA in 100 g fillet, *C. maraena* is a good source of these fish specific essential fatty acids (Table 3). The European Agency for Food Safety (EFSA) recommends a preventive supply of DHA and/or EPA > 0.3 g per day (EFSA [5]). A meal, consisting of *C. maraena* of analyzed size can make a valuable contribution.

Table 3. Main fatty acid (FA) composition of maraena whitefish (*C. maraena*) lipids from different aquaculture plants (% of fatty acids measured; SFA = saturated fatty acids; MUFA = monounsaturated fatty acids; PUFA = polyunsaturated fatty acids; mean values ± SD)

FA (common name)	*C. maraena* (SH) (n=10)	*C. maraena* (MV) (n=10)
Oleic acid (18:1n–9c)	41.6±0.7	28.5±0.8
Linoleic acid (18:2n6c)	13.3±0.4	10.4±0.5
Arachidonic acid (20:4n6)	0.2±0.02	0.5±0.1
α-Linolenic acid (18:3n3)	4.0±0.1	6.6±0.7
Eicosapentaenoic acid (EPA) (20:5n3)	1.1±0.2	3.2±0.2
Docosahexanoic acid (DHA) (22:6n3)	4.5±0.4	7.1±1.2
∑ n-3	11.0±0.5	18.7±0.9
∑ n-6	15.2±0.4	12.2±1.4
∑ SFA	15.2±0.4	21.4±0.9
∑ MUFA	52.4±0.6	39.6±1.2
∑ PUFA	26.2±0.7	31.0±1.6
∑EPA + DHA	5.6±0.5	10.3±1.3

3.3. Sensory evaluation

The results for the sensory assessment of *C. maraena* Group MV are shown in the figures 1-4. Group SH is not presented separately, because only minor differences were found between both groups. Muscle flesh of *C. maraena* was pale to white with a partly lightly reddish color. Cooked fillets revealed the pure, delicious and freshwater fish typical sweet

taste as a characteristic for this species ((5/6) = 5 of 6 namings). The odor was also pleasant and comparable to other boiled freshwater fish (4/ 6 namings). However, the texture was relatively dry (4/ 6 namings) and firm with short-fibers (3/ 6 namings) (Figure 1). The attributes for pan–fried maraena whitefish were described as pure, without off -flavours (odor and taste) (4/ 6 namings); with firm, dry texture (6/ 6 namings) (Figure 2). A beetroot–like smell and/or taste is typical in freshwater fish which is grown in a natural water environment. Only few panelists criticized this which demonstrated a sufficient conditioning in fresh water before slaughter. The higher fat content as in Group SH (Figure 3) had a favorable impact on the texture which became less dry (not shown).

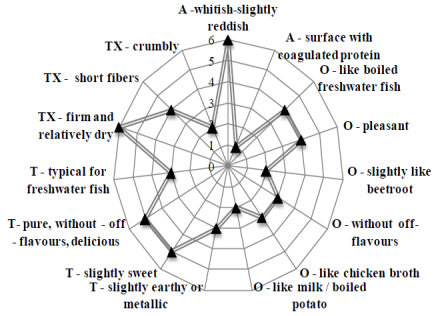

Figure 1. Spider diagram of cooked maraena whitefish (*Coregonus maraena),* Group MV. Main attributes based on the number of namings by the panellists). A= appearance; O= odour; T= taste; TX= texture

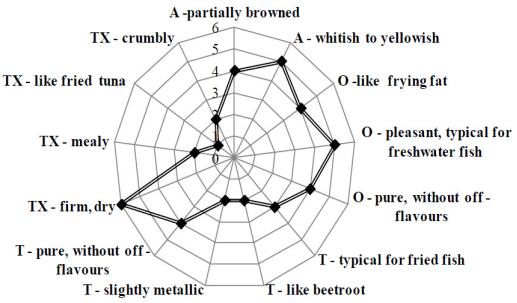

Figure 2. Spider diagram of pan- fried maraena whitefish *(Coregonus maraena),* Group MV. Main attributes based on the number of namings by the panellists). A= appearance; O= odour; T= taste; TX= texture

Figure 3. *Coregonus maraena,* Group SH

The general opinion of the experienced judges was that cooked whitefish had a unique aromatic taste (unanimous opinion) and that the agreeable sweet smell was more distinctive in the cooked fillets (5/ 6 namings). The pan-fried preparation was also pleasant (5/ 6 namings), but the particular fine characteristics were slightly covered by the own natural taste of the frying fat (Figure 4). The overall sensory judgment for both preparations of whitefish samples was rated as „good" (5/ 6 namings) for pan-fried samples and „very good" (4/ 6 namings) for cooked samples (Figure 5).

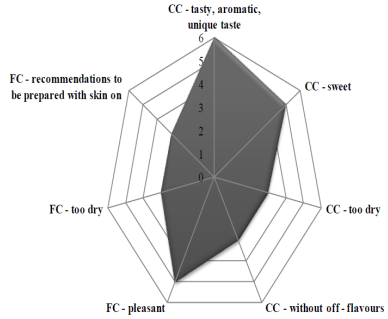

Figure 4. Spider diagram showing the general sensory impression after evaluation by QDA of cooked (CC) and pan-fried (FC) maraena whitefish (*Coregonus maraena),* Group MV. Main attributes based on the number of namings by the panellists

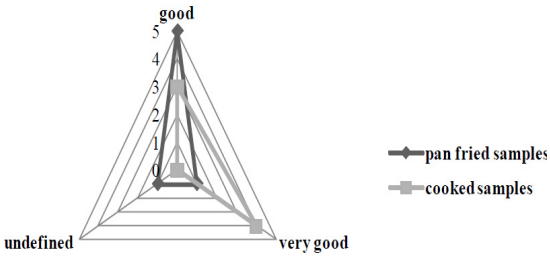

Figure 5. Spider diagram showing the overall judgment expressed in gradual (0-5) scores obtained after applying QDA for cooked and pan-fried maraena whitefish (*Coregonus maraena*), Group MV. The three attributes' evaluation was based on the number of namings by the panellists

4. Conclusions

C. maraena from aquaculture with at least medium fat content were rated as a very attractive high quality fish which leads to the conclusion that this species can successfully contribute to a healthy and well balanced diet.

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