Agronomy Research **9** (Special Issue II), 489–494, 2011

Sensory and Chemical Properties of Baltic Sprat (*Sprattus sprattus balticus)* and Baltic Herring (*Clupea harengus membras*) in Different Catching Seasons

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Abstract. Baltic sprat (*Sprattus sprattus balticus*) and Baltic herring (*Clupea harengus membras L*) are two of the most caught fish species among the Estonian seacoast fishermen, and therefore it is important to understand catching season effects on sprat and herring sensory and nutritional quality. The aim of this study was to measure and compare sensory and chemical variability of Baltic sprat and Baltic herring during different catching seasons. Batches of Baltic sprat and Baltic herring were caught from different locations in Estonian coastal waters from February 2008 until April 2009. Water content, protein content, lipid and ash content were measured. Descriptive sensory evaluation of steamed fish was conducted and results analyzed using Partial Least Squares Regression. The results suggested differentiation possibilities between fish from different seasons. The variations lie in fat and water contents, hardness, characteristic flavor and sweetness of the fish flesh.

Key words: Baltic herring (*Clupea harengus membras L*), Baltic sprat (*Sprattus sprattus balticus*), descriptive sensory evaluation

INTRODUCTION

Baltic sprat and Baltic herring and dishes of these fish have been eaten by people living around the Baltic Sea for centuries. Many different technologies like smoking, spicing, salting, marinating, fermenting etc. are used to produce fish products from Baltic sprat and Baltic herring for the Baltic countries and for the Eastern European markets. Some of these product types are very sensitive to fish quality and others are less, because of strong flavor and structure additives.

Nutritional composition of Baltic sprat caught from coastal waters in Estonia has been previously monitored and reported by Krosing and Veldre (1973). Baltic herring composition has been monitored and reported by several authors (Kolakowska et al., 1992; Szlinder-Richert et al., 2010). Baltic sprat and Baltic herring are under strict surveillance when it comes to dioxins and other contaminants (Vuorinen et al., 2002; Simm, et al., 2006; Szlinder-Richert et al., 2009), but until now the composition and sensory quality of the Baltic sprat and Baltic herring from gulf of Riga and Finland have not been thoroughly studied. There is clear evidence that the ecological state of health of the Baltic Sea has changed remarkably during past decades, and it also influences the environment of the fish living in the Baltic Sea (Lankov et al., 2010; Raid et al., 2010; Ojaveer et al., 2011).

Sensory analysis gives a holistic and integrated picture of the fish whereas instrumental methods generally measure only one specific compound or a set of attributes related to one set of properties (Nielsen, 1997). Sensory analysis can be more accurately interpreted by using various data from instrumental analysis. Partial least squares technique is used to show relationship between sensory attributes and chemical variables. Baltic sprat and Baltic herring composition is known to vary the most in lipid and water content (Krosing & Veldre, 1973; Kolakowska et al., 1992; Szlinder-Richert et al., 2010). The variation in the chemical composition of Baltic sprat and Baltic herring is related to nutrition, catching season, fish size, seasonal and sexual variations. Variation in chemical composition might lead to changes in sensory attributes, including flavor, aroma, texture, and visual appearance which control the acceptability of fish as food (Flick & Martin, 1992). The aim of the current work was to evaluate the sensory properties and their relations to lipid content, water content and protein content of Baltic sprat and Baltic herring.

MATERIALS AND METHODS

Samples

Twenty-six samples of Baltic sprat and 33 samples of Baltic herring were caught from different locations in Estonia's coastal waters (Gulf of Riga and Finland) from February 2008 until March 2009. Samples were taken only from spring-spawn fish populations. Samples of fish (about 2 kg) were immediately frozen after landing and stored at −18°C. The fish was analyzed during two months followed to catching. The frozen fish samples were thawed at 4°C 48 hours before analysis. Thawed fish were de-headed, gutted, de-boned and washed. Samples for sensory analysis were packed by two in aluminum foil, steamed for 10 minutes at 65°C, and served immediately.

Composition analysis

Samples for composition analysis (minimum 1 kg) were minced twice and kept at 4°C until analyzed within the same day. All measurements were carried out in triplicate. Water content of the fish samples was measured using a halogen analyzer (HR 83, Mettler Toledo, Switzerland). The protein content of the fish samples was measured by Kjeldhal method (Velp Scientifica UDK 142, Italy). The lipid content of fish was measured by Soxhlet method (Velp Scientifica SER 148 Solvent Extractor, Italy). All necessary reagents were purchased from Sigma-Aldrich, Germany.

Sensory Analysis

Descriptive sensory analysis was performed by 5 trained panelists. Sensory analysis was conducted in a laboratory equipped with individual booths (ISO 8589–1988). The panelists were trained during five one-hour sessions to evaluate the appearance (skin color, meat color, gapping, broken skin, shape), flavor (off-flavor, characteristic flavor, off-aroma, characteristic aroma, sweetness), and texture (hardness, bone separation, cohesiveness, moistness, greasiness) attributes. All of the panelists had at least 50 hours of previous testing experience in descriptive evaluation of fish products. The samples were coded with random three-digit numbers and evaluated in two repetitions on a 9-point numerical scale, anchored at both ends. The evaluations took place shortly after the samples were steamed. Unsalted crackers and purified water were available for palate cleansing.

Statistical Analysis

The data was analyzed using the Unscrambler 9.8 (Camo Software, Norway). Partial Least Squares (PLS1) regression was used to plot average sensory scores and composition data. The data matrix included humidity content and sensory attribute scores for data regression. XLSTAT (2009, Addinsoft, France) was used to calculate the correlations between sensory and chemical or biological properties (Pearson, P = 0.05).

RESULTS AND DISCUSSION

Baltic sprat

Composition of Baltic sprat remained in range 57–73% water, 15–17% protein, 10–24% lipid, and 2–4% ash (Fig. 1). Krosing and Veldre (1973) showed in their studies that Baltic sprat composition was 66–80% water, 15–17% protein and 3–18% lipid. Research results showed an inverse relationship between water and lipid - the lower the water content the higher the lipid content and vice versa, which has also been observed by other researchers (Rehbein & Oehlenschläger, 2009). Lipid content of the fish increased from 13 ± 1.6% in spring to maximum values in October and November, on average 22 ± 3%. As the lipid content increased, the water content decreased in

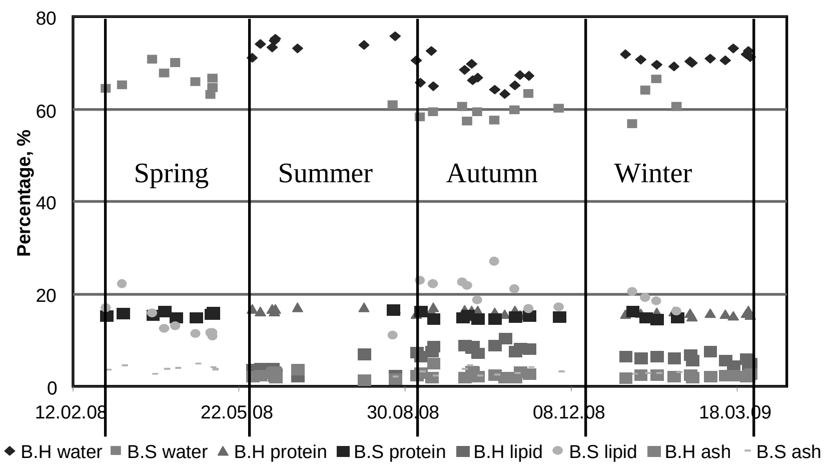

Figure 1. Baltic sprat & Baltic herring composition, where B.H water – Baltic herring water%, B.S water – Baltic sprat water%, B.H protein – Baltic herring protein%, B.S protein – Baltic sprat protein%, B.H lipid – Baltic herring lipid%, B.S lipid – Baltic sprat lipid%, B.H ash – Baltic herring ash%, B.S ash – Baltic sprat ash%.

autumn. Protein content was quite stabile, in winter on average 15.1 ± 0.6%, in autumn on average 15.3 ± 0.7%, in spring on average 15.5 ± 0.5%, and according to this study there was no distinct connection between the season and protein content of Baltic sprat and Baltic herring.

Sensory and composition measurements

Autumn samples had the lowest water content and spring samples had the highest water content (Fig. 2). There was a strong negative correlation between water and lipid content of sprats (R = -0.82, *P* = 0.05). PLS component 1 explained the hardness versus the humidity; winter and autumn samples were harder than spring and summer sprats. Autumn and winter sprats were sweeter than spring sprats.

The lipid content of Baltic sprat and greasiness attribute were significantly correlated (R = 0.48). However, no correlation was detected between lipid content, flavor, and aroma. Baltic sprat lipid content was relatively high, over 10%, even in the spring and summer periods, when it contained the least fat. This may explain the absence of seasonal variation in flavor and aroma intensity.

Baltic sprat samples grouped into three distinctive groups: samples from January and February (winter) made up the first group; samples from April and May (spring) made up the second group; and samples from late August to November (autumn) made up the third group (Fig. 2). The three groups suggest that there is a difference in sensory properties between winter, spring and autumn Baltic sprats.

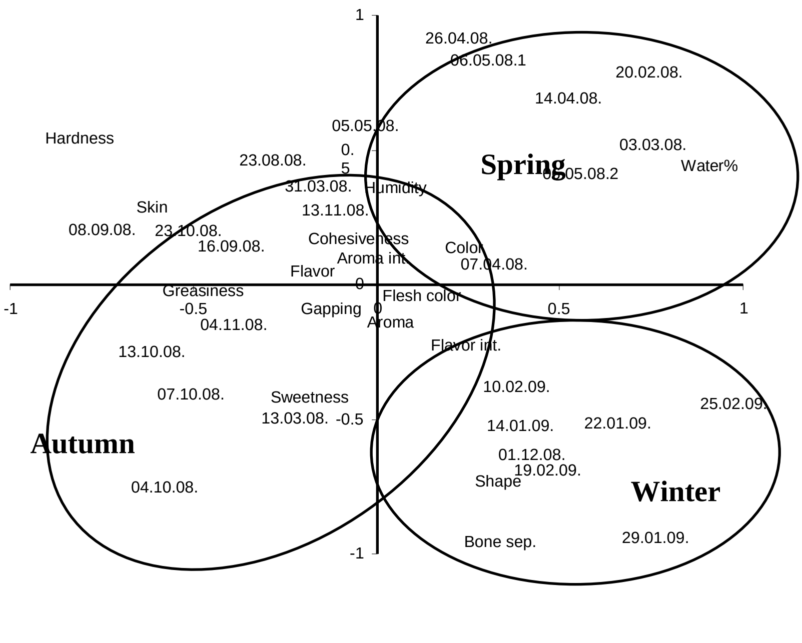

Figure 2. PLS analysis of Baltic sprat sensory attributes, sprat batches, and water content (batch code DD.MM.YY); x-explained 23% (water%), 21% (sensory attributes); y-explained 51% (water%), 15% (sensory attributes). The circles represent three seasonal groups.

Baltic herring

Composition of Baltic herring was 65–75% water, 15–17% protein, 3–10% lipid, and 2–3% ash (Fig. 1). There was a similar inverse correlation between the water and lipid content as was seen with Baltic sprats. Baltic sprat and Baltic herring contained less fat in the spring and summer. Lipid content of the fish peaked in the autumn. Autumn samples had the lowest water content (63–69%) and spring samples had the highest water content (69–75%). Protein content was quite stabile, in winter on average 15.6 ± 0.4%, in autumn on average 16.2 ± 0.5%, in spring on average 15.9 ± 0.4%, and according to this study no distinct connection between the seasons and protein content of Baltic herring was found.

The autumn, winter-spring and summer batches grouped in different sections in Fig. 3. PLS component 1 explained the skin attribute (more broken) for autumn samples and the shape attribute for winter and spring samples. PLS component 2 described darker flesh color and lower flavor for spring and summer samples. Flesh color was negatively correlated with flavor and also aroma of the Baltic herring (R = −0.46 and −0.47, respectively). Flesh color was darker in spring and summer Baltic herring, because of the spawning season.

Samples from autumn and winter had a higher lipid content (5.9–9.7%) and thus were also sweeter, more flavorful, aromatic and also harder. The lipid content of Baltic herring correlated moderately with flavor, aroma, and greasiness (R = 0.36, 0.39, and 0.46, respectively). No off-flavors were present in autumn and winter caught Baltic herring. Aroma and flavor intensity, or the fishiness factor, was more distinguishable for the summer caught Baltic herring.

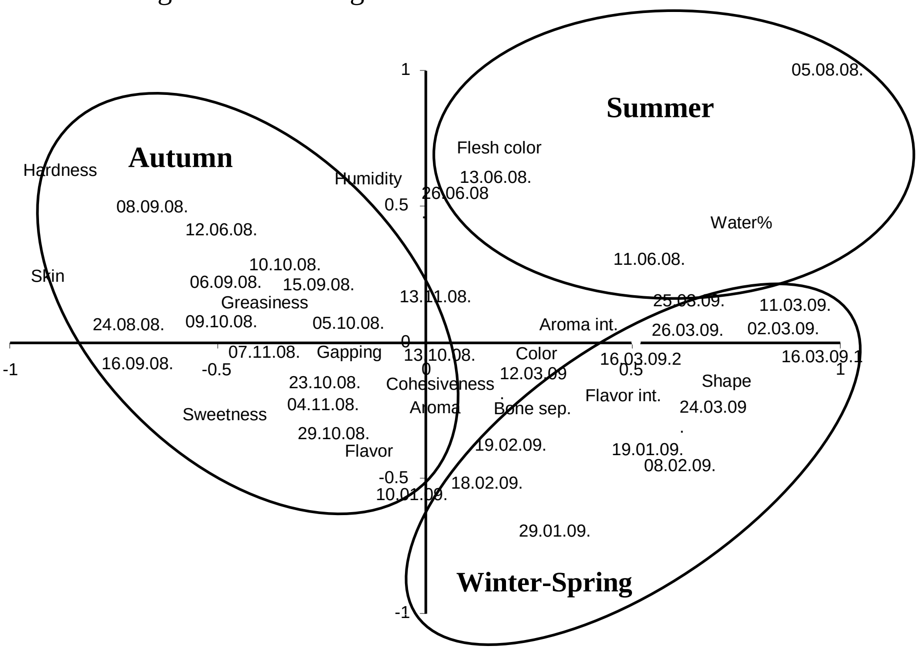

Figure 3. PLS of Baltic herring sensory attributes, herring batches, and water content (batch code DD.MM.YY); x-explained 27% (water%), 20% (sensory attributes); y-explained 31% (water%), 12% (sensory attributes). The circles represent three seasonal groups.

CONCLUSIONS

Composition parameters of Baltic sprat and Baltic herring varied in between catching seasons. Variation in fish water and lipid content during catching season was perceived by the sensory panel. Baltic sprat was described according to sensory and composition measurements better than Baltic herring, probably due to differences in catching techniques. Baltic sprat and Baltic herring caught in the autumn had the highest sensory quality and the highest lipid content. As Estonian fish catching quota is smaller than the fishing power, we recommend that most of the Baltic sprat and Baltic herring should be caught in the autumn. The following work will study the influence of seasonal variation in fish products.

ACKNOWLEDGEMENTS: We thank Heli Shpilev and Ain Lankov from Estonian Marine Institute and all the fishermen who helped to catch fish for this study. This project was financed by Estonian Agricultural Ministry and Enterprise Estonia.

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