Quality of cold smoked salmon offered to the general French consumer

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Introduction
Cold smoked salmon is a highly valued product in France as in many other European countries. Most of the salmon offered to the general consumer are bought fresh and smoked within the country in which it is to be consumed. The majority of salmon smoked in France are produced by aquaculture in Norway, Scotland and Ireland. Generally the Scottish and Irish salmon have a better reputation which also is reflected in price compared to the salmon bred in Norway. Furthermore, production and sales of cold smoked salmon boost around Christmas and Easter time, and it was of general importance to test whether the production and processing affected the quality during periods of high production compared to the rest of the year. Consumer’s attitude and perception of fish quality at the different times of sample collection was included. Thus, the present experiment aimed to test any differences in the quality of smoked salmon with respect to origin, with respect to the sampling time i.e. the time of the year and if any differences occurred between commercial smoke houses regarding the final product quality offered to the consumer.

Material & Methods
Cold smoked salmon from 4 different smoke houses, generated by fish produced in three different countries (Norway, Scotland and Ireland) were collected in a French hypermarket every second month during the period of one year. The samples were analysed for their chemical composition, microbiological load, and general quality aspects such as water holding capacity, colour, gaping, salt and phenol content. The chemical methods used are described in Espe et al., 2004. Furthermore, the attitude towards the smoked fish as well as the consumers’ preference, and abilities to separate the fish samples were also tested at all the 6 sampling periods. The methodology used is described in Rørå et al., 2004. The results were analysed by PCA as well as ANOVA.

Results and discussion
Country of origin had only minor effect upon chemical composition of the cold smoked salmon (Figure 1). But in general the Irish fish were redder, more yellow and contained more cantaxanthin, resulting in a higher colour score compared to the Norwegian salmon. On the other hand Norwegian cold smoked salmon contained more of the cardiovascular disease protective highly unsaturated fatty acids and astaxanthin than did the Irish fish. The Scottish fish was always in between the Norwegian and the Irish in its chemical composition. The differences in colour between the fish from Norway and Ireland, are probably due to different colouring strategies used, as the Irish use more cantaxanthin while Norwegian use astaxanthin, with the former resulting in more yellow flesh (Sheehan et al., 1998). However greater differences occurred between smoke houses independent of origin of the salmon in microbiological load (range <1000-2.5*10⁷ cfu g⁻¹), gaping or tearing of the sliced cold smoked fillets (range 1-9), sucrose level (range 0.05-1.13gKg⁻¹) as well as the liquid loss (range 1.1-8.3) in smoked salmon. Listeria was only found in some of the samples collected in October and December, the period of the year with the highest production this also coincided

¹ These results have been published in Lebensmittel Wissenscaft und Technologie 37 (2004) 627-638 and in Journal of Aquatic Food Production Technology 13(1) 2004, 69-85.
with a higher total bacterial load in the smoked salmon, indicating possible problems either in the production or the processing during periods with great production. The salmon smoked in the different plant differed in lightness and salt content and probably reflects the slightly different in house recipes used.

Generally the sampled fish were of high quality regarding biohazards as heavy metals and medical remnants, far below limits set by EU or not present, respectively. Bacteria heavily contaminated a number of samples, especially during the time preceeding Christmas. However, such data should be treated with caution as total bacterial counts do not give any information about bacteria types, i.e. harmful or not. Listeria was present in 11.4% of the samples analysed, and are in accordance with reported incidence in lightly preserved food such as smoked salmon (Jemmi 1993; Ben Embarek 1994). It was however interesting that Listeria contamination was present within samples of cold smoked salmon from one smoking plant only, and was independent of country of origin. Furthermore, Listeria contamination was only present in the two sampling periods prior to Christmas. The results therefore supports the findings of previous authors, showing a substantial variation in bacterial load among different smokehouses, even in those cases where the fish originated from the same batch (Hansen et al., 1998).

In the consumer test, where 676 consumers participated, the shelf life and appearance of the fish were rated as the most important purchase criterion when choosing a package of cold-smoked salmon in the shop (Table 1). The remaining shelf-life, the number of days left that the product could still be eaten, was the most important purchase criteria, rated as very important by 70% of the consumers. Cold-smoked salmon is a highly perishable product because of the light preservative treatments (with salt ranges between 2.5 and 3.5% w/w and phenol generally less than 0.5 mg 100 g$^{-1}$) and no other additives such as nitrate or nitrite being allowed in France. The remaining shelf-life indicated by the producers is generally limited to three weeks at 4°C, due to early sensory deterioration (Leroi et al., 1996) and also the possible hazard associated with the development of *Listeria monocytogenes* (Eklund et al., 1995; Huss et al., 1995; Jørgensen and Huss, 1998). The appearance of the package was ranked between important and less important, but 59% of the customers noted that the appearance of the fish was very important when they purchased the product.

In the sensory test the consumers focused on taste (noted by 75% of the consumers) and texture (noted by 24% of the consumers) to assess the quality and determine their preference. The consumers detected a sensory difference due to country of origin of the fish. However, there were no significant preferences according to country of origin, indicating that the price differences in the market are more due to tradition and reputation then actual quality differences.

**Conclusion**

Cold smoked Atlantic salmon are a safe and healthy product to consume, although minor differences exists both in composition and colour the usual consumer is unable to predict those small differences. The shelf life and the appearance of the fish was the most important purchase criterion when choosing a package of cold-smoked salmon in the shop. In the survey the consumers did detected a small sensory difference due to the origin of the fish, but did not prefer fish from a specific country.
References


Lebensmittelhyg., 44, 10-13.


Figure 1. Principal component analysis (PCA) of cold smoked salmon collected in a period of 1 year. The country of origin separated due to differences in colour and colouring agent (astaxanthin or cantaxanthine) and the amount of unsaturated fatty acids. N is Norwegian, S is Scottish and I is Irish fish which all have been processed by commercial smoke houses inside France.

Table 1. Ranked degree of importance of different purchase criterion (in %).

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