Sensory, consumer and instrumental analysis of trout

Background

Abertay University in collaboration with Dawnfresh Seafoods Ltd investigated sensory, consumer and instrumental analysis of rainbow trout in comparison with salmon.

Scotland’s fisheries are highly important to the economic growth in Scotland. This is due to the fact that Scotland has some of the richest seas in Europe and the Scottish fishing zone makes up over 60% of UK waters. Among the fishery industry, Scotland is well known for excellent quality rainbow trout. Nevertheless, it was not clear if certain pre-harvest factors affected the final products’ sensory quality and how sensory attributes associated to consumers’ acceptability. This study proposed modelling instrumental, sensory and consumer data sets using sensometric and chemometric techniques as a means to understand the factors and sensory attributes that drive consumer acceptability.

Aims

This project aimed to investigate if the origin of the trout plays a significant role in terms of the hedonic rating of the trout, and to understand in detail the main contributing factors to the overall quality of rainbow trout including hot and cold smoking.

Method

Three sampling points were selected to represent the yearly seasonal variability expected for rainbow trout. Fish samples used in this experiment included 3 and 5kg brackish water trout (from Loch A), 3kg fresh water trout (from Loch B), 3kg salmon (from Sound of Mull), and 3kg Norwegian trout (from Grasholmen). Pre- and post-harvest factors were studied to determine their impact on the sensory attributes and consumer hedonic responses on DSI portioned fish, cold-smoked fish and hot-smoked fish. Three main factors were selected: (1) sampling point (three evenly spaced harvesting times throughout one year (water temperature average values: 6°C (sampling point 1), 14°C (sampling point 2), and 10°C (sampling point 3)), (2) fish size (3 & 5 kg), and (3) fish species (salmon & trout). All samples were subjected to chemical analysis, including nutritional composition, texture (texture analyser), and aroma compounds (GC-MS).

Sensory descriptive training was carried out using a trained panel at Abertay University between November 2015 and November 2016. Sensory descriptive terms (21 terms for DSI portioned samples, 20 terms for hot smoked fish samples, and 16 terms for cold smoked fish samples) were generated and agreed among the panel members. Validation and testing in duplicate was carried out. Consumer testing was carried out at Abertay University between March and November 2016. The consumer study included check all that applies (CATA) analysis to investigate the perceptions of consumers on a variety of attributes, and acceptability testing using main hedonic indices (nine point scale, dislike extremely to like extremely for appearance, aroma, flavour, texture, aftertaste and overall impression). The data at each sampling point were collated and analysed. Linear mixed model was performed on all dependent variables with panellists/consumers as random factors and three main factors mentioned above as fixed factors. Modified population marginal means and standard errors were calculated and reported. CATA analyses of three sample pairs: (1) 3kg VS 5kg brackish trout, (2) 3kg freshwater trout VS 3kg salmon, and (3) 3kg brackish water trout VS 3kg freshwater trout, were carried out to
understand what factors drive sensory attribute generation and subsequently overall acceptability scores. For DSI portioned fish samples, external preference mapping (PrefMap) was performed to model what sensory attributes are driving consumer acceptability by modelling trained panel descriptive attribute intensities with consumer acceptability scores.

**Results**

**Factors affecting processed trout and salmon quality**

**Hot smoked**

**Sensory attributes and consumer hedonic responses**

The trained panel results indicated that sampling point had an impact on flavour (p < 0.5) for the hot smoked samples. Interactions between sampling point (water temperature) and fish size (T x S), and sampling point (water temperature) and fish species (T x F) on some attributes were also evident. For sensory attributes that were found to be different among the samples, in general, higher average scores were given to hot smoked fish samples processed from fish harvested at the first sampling point (6ºC) and bigger fish size (5kg). Regardless of their farming locations, there was no difference between the two hot smoked trout samples in all the attributes. The colour of the hot smoked salmon set it apart from all the trout samples.

The consumer hedonic responses showed that the hot smoked fish samples processed from the fish harvested at the first sampling point were preferred (p < 0.5). Fish size and fish species did not have any effect on the consumers’ perception of the fish products except for appearance, where consumers preferred the colour of the hot smoked salmon to the hot smoked brackish water trout.

**CATA – Hot smoked samples**

With regards to the hot smoked fish samples, the symmetric plots (Figures 1(a)-(c)) differentiated sampling point (sampling points 1 and 2). Differentiations between fish size (3 and 5kg, Figure 1(a)), and water type (Loch A and B, Figure 1(c)) could also be observed. Attributes positively affected overall impression of the hot smoked samples included fresh fish attributes, smokey attributes, and tender, firm, moist, and soft texture.
Figure 1 CATA analyses for the hot smoked fish at samplings points 1 and 2: 3kg and 5kg brackish water trout (a), fresh water trout and salmon (b), and 3kg fresh water and 3kg brackish water trout (c).
Factors affecting trout and salmon quality (cold smoked)

Sensory attributes and consumer hedonic responses

The trained panel results indicated that sampling point and fish species had an impact on colour and flavour of the cold smoked products. The cold smoked fish samples processed from fish harvested at sampling point 2 received higher average scores on colour but lower average scores on flavour. Fish size did not have any impact on sensory attributes of the final products. The cold smoked brackish water trout was found to be less oily looking and more firm than the cold smoked fresh water trout.

The consumer hedonic responses showed sampling point and fish species were the two important factors dictating the differences between the samples. Cold smoked trout samples (from both Lochs) were more acceptable than cold smoked salmon on appearance, flavour, texture, and overall impression. Fish of a bigger size (5kg) gained a higher average score on texture to the smaller size fish (3kg) but not on other attributes and overall impression. Sampling point 1 also seemed to generate fish that was more preferred on flavour and overall impression than sampling point 2.

CATA – Cold smoked samples

With regards to the cold smoked fish samples, the symmetric plots (Figures 2(a) and (c)) seem to differentiate sampling point (sampling points 1 and 2). Differentiations between fish size (3 and 5kg, Figure 1(a)), fish species (salmon and fresh water trout) and water types (Lochs A and B, Figure 1(c)) were not observed. Fresh fish and smokey attributes as well as soft, firm, tender, moist texture with sweet taste are must-have attributes driving positive effect on consumers’ overall impression of the products.
Figure 2 CATA analyses for the cold smoked fish at samplings points 1 and 2: 3kg and 5kg brackish water trout (a), fresh water trout and salmon (b), and 3kg fresh water and 3kg brackish water trout (c).
Factors affecting trout and salmon quality (DSI portioned)

Sensory attributes and consumer hedonic responses

The trained panel results showed that sampling point had the greatest impact on the sensory attributes, followed by fish species and fish size. With regards to sampling point, the trained panel could pick the differences especially on appearance (colour, oiliness, evenness of colour), aroma (oily citrus seaweed), oily texture, flavour (bitter, sweet citrus, meaty), and tooth packing after taste between sample points (p < 0.5). For the sensory attributes that set the samples apart, in general, the average scores for aroma and flavour of the DSI portioned samples at sampling point 1 (water temperature = 6°C) were higher than those of the DSI portioned samples at sampling point 3 (water temperature = 10°C) and sampling point 2 (water temperature = 14°C). The effect of fish size affected the sensory attributes of the samples to a much lesser extent. The bigger fish (5kg) received higher average scores on colour, fishy aroma, and firmness, but a lower score on slimy texture than the smaller fish (3kg). The DSI portioned brackish water and fresh water trout were similar in all sensory quality, except that the brackish water trout was firmer in texture. Both trout samples gained higher average scores on appearance than salmon. The DSI portioned salmon, however, was firmer and meatier than the fresh water trout. Further data analysis on the effect of sampling point alone on the changes of sensory attributes of individual fish samples suggested that sensory quality of the fresh water trout was the most depended on sampling point. Sampling point also affected a range of sensory attributes of the salmon samples but not to the same extent as that observed in the fresh water trout. With regards to the brackish water trout, sampling point affected mostly on flavour and the effect was more pronounced in the 5kg size than the 3kg size.

The consumer hedonic responses indicated that fish species was the main factor affecting their acceptability. Fish size and water type did not have any impact on preference (p ≥ 0.5). The DSI portioned fresh water trout was the most preferred products in all measures tested. Salmon was the least impressive sample among all the samples. The consumers did not find any difference in terms of quality attributes as well as overall impression between the 3 and 5kg fish size.

CATA – DSI portioned samples

With regards to the DSI portioned fish samples, the symmetric plots (Figures 3(a)-(c)) seem to differentiate sampling point (especially sampling points #1 and #3). Differentiations between fish size (3 and 5kg, Figure 1(a); F2), fish species (salmon and fresh water trout, Figure 1(b); F1), and water type (Loch A and B, Figure 1(c); F1) can be observed. Fresh fish attributes, and tender, soft, moist, and firm texture were the top 6 attributes driving the acceptability of the trout samples.
Figure 3 CATA analyses for the DSI portioned fish at samplings points 1 to 3: 3kg and 5kg brackish water trout (a), fresh water trout and salmon (b), and 3kg fresh water and 3kg brackish water trout (c).
External preference mapping – DSI portioned samples

Figure 4 shows principle component analysis (PCA) of sensory attributes of the DSI portioned fish samples at sampling points 1-3, as well as preference mapping of the sensory attributes and consumers’ overall acceptability.
Figure 4 Principle component analysis (biplot) and external preference mapping (contour plot—i.e. how many clusters have a preference above average in a given region) for the DSI portioned fish at three sampling points: (a) sampling point 1, (b) sampling point 2, and (c) sampling point 3. Note that the left and right biplots can be superimposed).

From the PCA of all three samples points (Figures 4(a)-(c)), it can be observed that the trout (in particular the brackish water trout) contrasted with salmon in term of affective drivers. In general the trout was more aligned with positive sensory attributes. This confirmed the results obtained from LMM pairwise analysis of sensory attributes on fish type and LMM pairwise analysis of consumer hedonic responses. The positive loadings describing the trout samples (oily, salty, citrusy, seaweedy; the biplots, Figure 4(a)-(c)) could be translated to fresh fish attributes, tender, soft and moist texture, which were the positive drivers of the DSI samples analysed by CATA analysis (Figure 3). The agglomerative hierarchical clustering analysis results revealed that the brackish water trout was well liked by the majority of consumers.

Conclusions

Sampling point and fish species were the two main factors affecting sensory attributes as well as consumer acceptability for both smoked and DSI portioned fish. Between the DSI portioned fish samples there are noticeable sensory and affective differences between sampling points, water type (brackish vs fresh), and size of fish samples. However for the hot and cold processed fish these subtle sensory characteristics that differ noticeably between fish species (salmon and trout), size of fish (3Kg vs 5Kg) and water type (brackish vs fresh) in the DSI portioned samples are not observable. In its place, acceptability of smoked salmon and fish is driven by the balance of dominating sensory attributes generated during the smoking process. Therefore, processing factors and how they are controlled, for hot and cold smoked fish (salmon and trout), seem to drive overall acceptability. Positive characteristics driving overall impression of the smoked fish products include smokey (flavour and aroma), fresh fish (flavour and aroma), tender, soft and moist in texture. Attributes of significant positive impact on overall impression of the DSI portioned fish products included fresh fish (flavour and aroma), tender, soft, and moist in texture, and fishy aroma.

Recommendations

This study covered the effects of sampling point (water temperature), fish size, and fish type on sensory attributes and consumer preference on rainbow trout and salmon. The results suggested that the consumers preferred rainbow trout to salmon and sampling point affected sensory perception of the products. Further investigations worth exploring include how the feeding regimes affect the eating quality of rainbow trout. This could lead to cost optimisation and fish quality enhancement.
Key Findings

- Sampling point and fish species were the two main factors affecting sensory attributes and consumer acceptability.
- Fresh fish (flavour and aroma), tender, soft, and moist in texture were of importance characteristics driving consumer acceptability in all the products tested.
- DSI portioned trout was judged by consumers in this trial to be superior to DSI portioned salmon in terms of hedonic acceptability.
- With regards to the Scottish rainbow DSI portioned trout, water type (brackish and fresh) and fish size (3 and 5kg) did not have a pronounce effect on consumer acceptability.
- Dominating sensory attributes generated by processing during hot and cold smoking will mask subtle sensory differences between fish type, water type, size and harvesting conditions of the raw material.