

Evaluation of wild cod versus wild caught, farmed raised cod from Norway by Dutch consumers

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In this study wild- and wild caught, farmed raised cod were evaluated in 403 households (approximately 1000 consumers) in the Netherlands. The expected and experienced quality of the both product characteristics were measured in relation to information about the origin of the cod. Also the effect of freshness of the farmed cod was investigated. The quality profile of farmed and wild cod, based upon the evaluated product properties was similar. Expected and experienced quality on both products did not differ very much from each other. Farmed cod seemed to be appreciated after consumption as good as wild cod. Higher scores were given on some quality attributes in case information was given about the origin of the cod (wild or farmed).

Cod has been an important seafood product for centuries. For the Norwegians it has been treasured for thousands of years for its quality. Norway is the leader in production of farmed cod, based on long experience and knowledge of general fish farming. The main production of cod today is based on both wild caught, farmed raised (oppfôret torsk) and pure farmed (oppdrettet torsk). Since the 80's, production of farmed cod and wild caught, farmed raised cod has been limited to a few producers undertaking cod farming as a supplementary activity (Norwegian Seafood Export Council, 2002). The farmers have aimed their production at seasonal periods like Christmas, yet yearly production has been between 100 and 500 tonnes. A substantial increase in production is expected based on a planned increase in juvenile production using sea bass/sea bream technology. Several new licenses for on growing have been granted, and this part of production is adapting the technology from salmon farming. In year 2000 Norway produced 500.000 juveniles and last year the numbers doubled. The expectation this year is 2-3 million resulting in about 8000 tonnes of farmed cod in year 2005 (Trollvik, 2002).

Only a few studies (Solberg, 1989; Mørkøre, 2001, Carlehög, 2001) have been

carried out so far about the sensory aspects of farmed versus wild cod. In these studies expert panels have determined the sensory quality. Wild cod is assessed significantly different from farmed cod (in fact wild caught, farmed raised cod) by expert sensory panels with respect to basic sensory attributes of taste, smell, texture, color and gaping. A long starving time (more than 3 weeks) seems to be an important factor to develop a farmed cod product that becomes more similar in sensory properties to wild cod. However those long starving periods are not realistic. A starving period of 1-2 weeks is adequate to empty the belly before slaughtering. The feed seems to play an important factor on the chemical composition and somewhat less on the sensory attributes. However from an ongoing study it is clear that principal component analysis of the scores for the sensory attributes can differentiate various farmed cod groups due to different feeds given.

Recently a market-oriented study (Johansen and Johnsen, 2002) was carried out on the perceived quality and image of farmed cod among 13 chief cooks from exclusive restaurants in Norway. The majority of the chief cooks has the opinion that pure farmed cod has a better quality than the wild

caught, farmed raised cod. Although the color of the pure farmed cod fillet is experienced as 'greyish' it does not affect the opinion about the product. The wild caught, farmed raised cod is a poor product according to the opinions of the majority of the chief cooks. The main cause for this is in particular the soft texture of the whole fish as well as the fillet. Also the quality of the wild caught, farmed raised cod varied considerable among the different farmers, in particular with respect to outer appearance of the fish (Johansen and others, 2002).

However so far no consumer oriented studies on wild versus farmed cod were carried out. This paper describes the results of a consumer study carried out in 2002 with the aim to evaluate Dutch consumer preference response to wild cod versus farmed cod product properties in relation to information about the product origin (wild or farmed) and freshness of the farmed cod.

Material and methods

Cod raw material and processing

Due to the availability at the experimental period wild caught, farmed raised cod from Norfra A/S (Skibotn, Norway) was used in this study. The cod was caught in Finnmark and had an average weight of 2.5 kg after catch. Then it was farmed raised from July 2001 for a period of 8-9 months and fed manually. The feed consisted for 80-90% of capelin. Starvation period before slaughtering was four weeks.

On Tuesday 2nd April 2002 the first batch of cod was slaughtered. On Thursday 4th April the second batch. The cod with head on (85 kg 1st batch, 225 kg 2nd batch) was stored in ice before and during transport by plane to the Netherlands. The farmed cod arrived on Saturday 6th April and stored at chilling facilities at Amsterdam Schiphol airport. Transport to IJmuiden (The Netherlands) was carried out on Monday 8th April. The wild cod

was caught at 4th April at the North Sea and bought in Denmark via a contact person of the Netherlands Institute for Fisheries Research (RIVO). The gutted cod was transported in ice to IJmuiden on 8th April.

On Monday 8th April and Tuesday 9th April Seafood partners in IJmuiden processed the wild and farmed cod respectively (filleting and packaging in modified atmosphere (MAP)) under supervision of RIVO. Each package contained a cod fillet portion of approximately 150 grams. Next the packaging for distribution among the TasteNet participants was carried out.

Consumer test

Approximately 1000 participants of 12 years or older distributed over 403 households from TasteNet were randomly selected for this study with wild and farmed cod. TasteNet is a Dutch consumer panel with approximately 2000 consumers distributed over various locations in the Netherlands. Four groups were created of approximately 250 consumers each. Each consumer received a wild and a farmed cod sample. The consumers were asked to consume the farmed and the wild cod on two consecutive days. The samples were transported on Tuesday 9th and Wednesday 10th April to the consumers. Consumers were asked to use the cod before Saturday 13th April.

In consumer group 2, farmed cod slaughtered on 2nd April in Norway, was offered with a storage time (time between slaughtering and delivery to the consumer) of 9 days. In the other three consumer groups the farmed cod with a storage time of 6 days was used. The storage time of the wild cod offered, was also 6 days based upon catching date.

In consumer group 1 and 2 no information was given about the origin of the cod. In consumer group 3 and 4 the farmed cod was labelled as farmed cod. The origin of the wild cod in consumer group 4 was presented with a label 'wild cod, caught at sea'. None of the groups received information about the freshness of the cod.

Table 1 Sample description and codes of the wild and farmed cod

Cod samples	Consumer group 1	Consumer group 2	Consumer group 3	Consumer group 4
Wild-freshness 6 days	Label: Cod	Label: Cod	Label: Cod	Label: Wild cod, caught on sea
Farmed-freshness 6 days	Label: Cod	-	Label: Farmed cod	Label: Farmed cod
Farmed-freshness 9 days	-	Label: Cod	-	-

Each consumer was requested to fill in a set of four questionnaires. Before preparation and consumption the consumers rated the qualities they expected from the product still in the package ('expected qualities'). After preparation and consumption they evaluated the product again using the same attributes ('experienced quality') in two separate questionnaires because each cod product was consumed on two consecutive days.

Attributes used were 'Not satisfying – Satisfying', 'Dislike – Liking', 'Bad quality – Good quality', 'Not fresh – Very fresh', 'Bad taste – Good taste', 'Dry – Juicy', 'Not firm – Firm', 'Unattractive – Attractive', 'Bad color – Good color', 'Fat – Lean', 'Unnatural – Natural', 'Unhealthy – Healthy', 'Expensive – Cheap', 'Dull – Exciting' and 'Bad smell – Good smell'. The last two attributes were only used for the experienced quality measurement. The attributes were scored on seven-point scales, with neutral midpoints, labeled from left to right -3, -2, -1, 0, +1, +2, +3. In a fourth questionnaire, only presented to group 1, questions were asked about the questionnaires used. Consumers were asked to respond about the length of the questionnaire, the comprehensibility of the information about the product and the attribute scale. A few questions about the consumption habits of meat and fish were asked in the first questionnaire. The questionnaires in this study were based upon the same set of questionnaires used by Fiskeriforskning (Olsen, 2001) in a con-

sumer study with various salmon products in Germany and France.

The participants were asked to fry the cod and not to use sauces with strong taste. It was allowed to use mild spices like salt and pepper.

Quality assessment wild and farmed cod by expert panels

The sensory expert panel of Fiskeriforskning evaluated fillets from wild cod, caught at the coast of Northern Norway and the wild caught, farmed raised farmed cod in order to verify the expected difference between wild and farmed cod. In total 15 sensory attributes of the cooked fillets were evaluated on a scale from 0 to 10 by eight trained panel members. The mean scores were evaluated by statistical treatment (ANOVA, Tukey's test) using SAS Microsoft for Windows version 6.12 (SAS Institute INC, USA). Principal component analysis (PCA) was carried out on the mean scores for the 3 cod variables using Unscrambler version 6.12 (Camo, Trondheim).

In order to verify the quality of the wild cod from the North Sea used for this consumer study the Quality Index Method (Martinsdottir et al, 2001) was applied by the panel of RIVO.

Data treatment

The following statistical tests were carried out on the results of the consumer questionnaires using SPSS (SPSS Inc, Version Base 10) or Unscrambler (Camo, Version 7.5):

- Paired sample T-test for testing the differences between expected and experienced qualities within one cod variable (farmed or wild).
- Principle Component Analysis of the experienced qualities of wild and farmed cod in the four consumer groups.
- Independent T-test of the experienced qualities within each consumer group for significance between farmed and wild cod samples.
- One-way ANOVA of experienced qualities of all consumer groups.

Results

Quality assessment wild and farmed cod by expert panel

The ANOVA results of the mean sensory scores of the expert panel for the cooked fillets of wild and farmed cod are presented in Table 2. Significant differences between wild and the farmed cod were observed for the attributes whiteness, dullness, cod own taste, juiciness and fibrousness. The wild cod distinguished with a lower intensity on whiteness, dullness, cod own taste and fibrousness and with a higher intensity on juiciness. There were no significant differences between the two farmed cod groups and they were evaluated similar except for the sensory attributes old/stale smell, hardness, flakiness and cohesiveness.

Table 2 ANOVA and Tukey's test of mean scores for the sensory attributes of wild and farmed cod. Samples with same characters are not significantly different at 5 % level

Sensory attributes	Wild cod (Norway)	Farmed cod	
	Freshness 2-3 days	Freshness 4 days	Freshness 7 days
Cod own smell	4.1a	4.4a	4.9a
Sourish smell	1.7a	1.4a	1.6a
Stockfish smell	0.9a	0.8a	0.8a
Old/stale smell	2.1a	2.5a	1.3a
Whiteness	5.1b	7.2a	6.5a
Dullness	4.7b	6.5a	5.9a
Hardness	3.3a	3.1a	3.8a
Flakiness	5.9a	4.4a	5.6a
Cohesiveness	3.1a	2.8a	4.3a
Cod own taste	3.7b	5.0a	5.1a
Sourish taste	1.3a	2.1a	1.6a
Old/stale taste	1.9a	1.7a	1.8a
Wateriness	4.1a	3.9a	3.2a
Juiciness	5.7a	4.9b	4.8b
Fibrousness	4.8b	6.0a	6.4a

The observations from the sensory assessment in this study are in agreement with an earlier study on cod (Carlehög, 2001). It should be noted that the evaluated wild cod was from the coast of Norway while the Dutch consumers have been testing cod from the North Sea.

PCA gives the opportunity to investigate the relationship between the sensory attributes and the three groups of cod. The bi-plot for the principal components 1 and 2 are presented in Figure 1.

The sensory panel could discriminate the three groups of cod. For factor 1 the whiteness, dullness, cod own taste, juiciness and fibrousness are the discriminating attributes between wild and farmed cod. Hardness, flakiness, cohesiveness and old/stale smell are the attributes that separate the farmed groups from each other.

The QIM results of the RIVO panel showed that the quality of the wild cod from the North Sea was according to the specifications to be used in this study.

Consumer response

The response in this study was high. About 70% of the consumers had filled in the

questionnaires and evaluated the cod portions. Approximately 10% of the consumers could not respond due to illness, holidays etc. About 5% of the participants made clear afterwards that they did not want to participate.

The questionnaire showed that approximately 85% of the respondents consumes meat products with a frequency of 3 or more times per week. About 5% responded a meat consumption frequency of 2 times per week.

The consumption frequency of fish products among the respondents is presented in Figure 2. This shows that fish is eaten regularly. About 27% of the respondents eat fish once a week while 25% of the consumers once per two weeks. The consumption frequency of cod as main dish (Figure 3) show that respondents do not very often consume cod. Only 4% of the consumers responded that they consume cod once per week. For the major part of the respondents, cod was only once or twice a quarter of the year or less main dish.

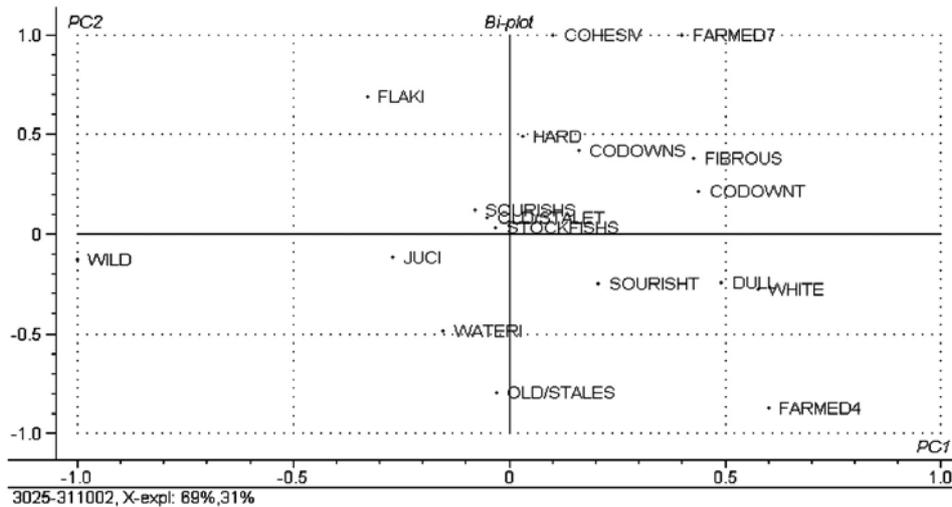


Figure 1 Bi-plot Principal Components Analysis of wild and farmed cod by FF expert panel. WILD= wild cod, caught at the coast of Northern Norway, FARMED 4= farmed cod, freshness 4 days, FARMED 7= farmed cod, freshness 7 days

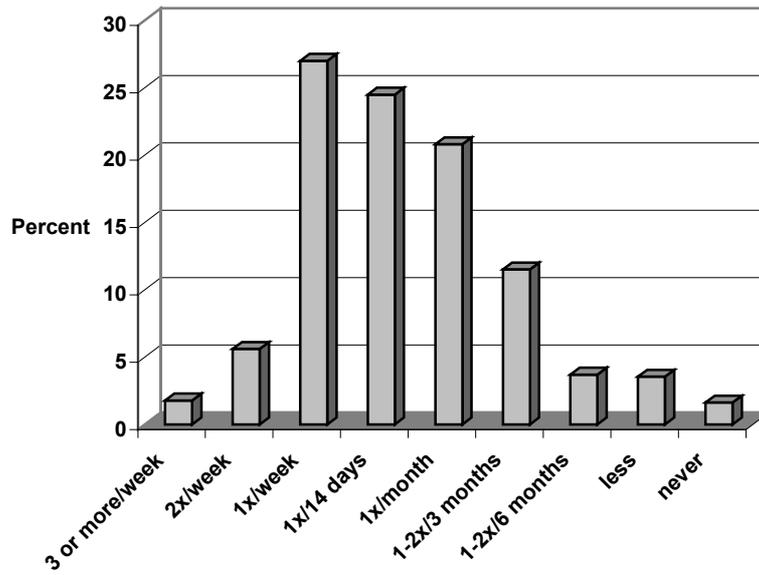


Figure 2 Consumption frequency of fish and fish dishes of respondents

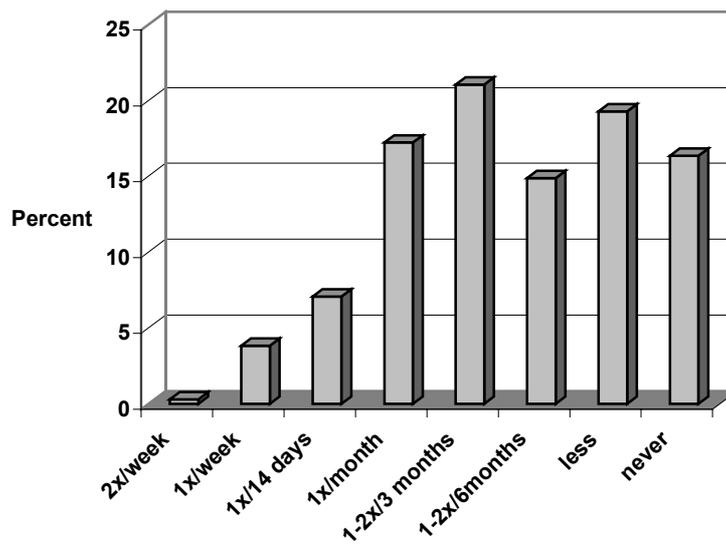


Figure 3 Consumption frequency of cod in main dishes

Expected versus experienced quality

The results, transformed on a scale from 1-7, for the expected and experienced qualities in the four consumer groups are presented in Table 3. In all the groups the scale for 'expensive-cheap' was evaluated with a score not far from 4. This implies that the opinion of the consumer is rather neutral. The results show further that only a minority of the evaluations were significantly different between expected and experienced quality. In case the difference was significant then most of the time the experienced qualities were lower than the expected.

Results from consumer group 1 shows that the difference between expected and experienced qualities of the wild cod are small. All scores (except 'expensive – cheap' preference) for the expected quality were above five. For most of the attributes the experienced quality has a (small) lower value than the expected quality. There was a significantly lower value for the experienced attribute for 'not fresh – very fresh' and for 'not firm- firm'. The attribute 'bad color -good color' and 'expensive-cheap' were evaluated significantly higher after consumption than before preparation.

The results for the farmed cod in group 1 shows that there are hardly any differences between the expected and experienced quality. Only the consumers evaluate the attribute 'not firm-firm' significantly lower before preparation cod in comparison to after consumption. Satisfaction after consumption was significantly higher rated than before consumption. There was also a slight significant increase of the 'expensive-cheap' attribute.

Six of the attributes of the wild cod ('bad quality-good quality', 'not fresh- very fresh', 'dry-juicy', 'not firm-firm', 'unnatural-natural' and 'unhealthy-healthy') in consumer group 2 have a significantly lower score for the experienced quality. For the attributes 'dry-juicy' and 'not firm-firm' the largest decrease was observed. The ratings for the attributes 'dry-juicy' and 'not firm-firm' for the farmed cod in the same consumer group were significantly lower after consumption than before. A significant decrease was observed for 'unnatural-natural' and 'unhealthy-healthy'. There were for all the other attributes no significant differences between expected quality and experienced quality.

In consumer group 3 the scores for the attributes 'not fresh-very fresh', 'dry-juicy', 'not firm-firm' and 'unnatural-natural' of wild cod before consumption were significantly higher than after consumption. For farmed cod in this consumer group the score for 'dry-juicy' was in the experienced quality situation significantly lower than before consumption. Also for 'not firm-firm' a lower value was given after consumption than before. Also the decrease in score for 'unnatural-natural' and 'unhealthy-healthy' was significant but even smaller.

The consumers in group 4 evaluated the experienced quality for 'not fresh-fresh' and 'dry-juicy' lower than the expected quality. These differences were small but significant. For the farmed cod in this group only the preference 'unnatural-natural' was evaluated significantly lower before consumption in comparison to after consumption.

Table 3 Mean scores for expected and experienced quality of wild and farmed cod (paired T-test, * $p < 0.05$)

Consumer group 1				
Information given	Cod	Cod	Cod	Cod
Sample type	Wild cod	Wild cod	Farmed cod	Farmed cod
	freshness 6 days	freshness 6 days	freshness 6 days	freshness 6 days
	Expected quality	Experienced quality	Expected quality	Experienced quality
Not satisfying - Satisfying	5.2	5.1	5.2*	5.4*
Dislike - Liking	5.2	5.2	5.2	5.4
Bad quality - Good quality	5.6	5.4	5.6	5.5
Not fresh - Very fresh	5.6*	5.2*	5.6	5.7
Bad taste - Good taste	5.4	5.1	5.4	5.5
Dry - Juicy	5.5	5.2	5.5	5.4
Not firm - Firm	5.2*	4.7*	5.5	4.8*
Unattractive - Attractive	5.2	5.2	5.3	5.5
Bad color - Good color	5.1*	5.4*	5.4	5.7
Fat - Lean	5.2	5.2	5.3	5.3
Unnatural - Natural	5.3	5.2	5.5	5.4
Unhealthy - Healthy	5.6	5.4	5.7	5.6
Expensive- Cheap	3.7*	4.0*	3.5	3.8*

Consumer group 2				
Information given	Cod	Cod	Cod	Cod
Sample type	Wild cod	Wild cod	Farmed cod	Farmed cod
	freshness 6 days	freshness 6 days	freshness 9 days	freshness 9 days
	Expected quality	Experienced quality	Expected quality	Experienced quality
Not satisfying - Satisfying	5.3	5.2	5.4	5.5
Dislike - Liking	5.4	5.3	5.3	5.4
Bad quality - Good quality	5.6*	5.3*	5.7	5.5
Not fresh - Very fresh	5.7*	5.4*	5.7	5.6
Bad taste - Good taste	5.6	5.4	5.5	5.5
Dry - Juicy	5.7*	4.9*	6.0	5.6*
Not firm - Firm	5.4*	4.9*	5.1	4.4*
Unattractive - Attractive	5.4	5.4	5.3	5.5
Bad color - Good color	5.4	5.5	5.5	5.7
Fat - Lean	5.4	5.4	5.3	5.3
Unnatural - Natural	5.6*	5.2*	5.7	5.4*
Unhealthy - Healthy	5.8*	5.6*	5.9	5.7*
Expensive- Cheap	3.9	3.9	3.7	3.8

Consumer group 3				
Information given	Cod	Cod	Farmed cod	Farmed cod
Sample type	Wild cod	Wild cod	Farmed cod	Farmed cod
	freshness 6 days	freshness 6 days	freshness 6 days	freshness 6 days
	Expected quality	Experienced quality	Expected quality	Experienced quality
Not satisfying - Satisfying	5.4	5.4	5.5	5.4
Dislike - Liking	5.4	5.5	5.4	5.4
Bad quality - Good quality	5.7	5.6	5.8	5.6
Not fresh – Very fresh	5.7*	5.5*	5.8	5.7
Bad taste -Good taste	5.6	5.6	5.6	5.6
Dry - Juicy	5.8*	5.4*	5.9	5.5*
Not firm - Firm	5.5*	5.1*	5.3	4.7*
Unattractive - Attractive	5.5	5.4	5.5	5.3
Bad color - Good color	5.5	5.6	5.6	5.6
Fat - Lean	5.2	5.2	5.3	5.3
Unnatural - Natural	5.7*	5.4*	5.9	5.6*
Unhealthy - Healthy	5.8	5.6	6.1	5.8*
Expensive- Cheap	3.9	3.9	4.0	3.9

Consumer group 4				
Information given	Wild cod	Wild cod	Farmed cod	Farmed cod
Sample type	Wild cod	Wild cod	Farmed cod	Farmed cod
	freshness 6 days	freshness 6 days	freshness 6 days	freshness 6 days
	Expected quality	Experienced quality	Expected quality	Experienced quality
Not satisfying - Satisfying	5.5	5.6	5.6	5.7
Dislike - Liking	5.5	5.6	5.4	5.5
Bad quality - Good quality	5.8	5.8	5.8	5.7
Not fresh – Very fresh	5.8*	5.6*	5.9	5.8
Bad taste -Good taste	5.6	5.6	5.5	5.7
Dry - Juicy	5.8*	5.2*	5.8	5.7
Not firm - Firm	5.4	5.1	5.3	5.3
Unattractive - Attractive	5.5	5.7	5.6	5.8
Bad color - Good color	5.7	5.8	5.8	5.9
Fat - Lean	5.3	5.4	5.4	5.6
Unnatural - Natural	5.8	5.6	5.9	5.7
Unhealthy - Healthy	5.9	5.9	6.0	5.9
Expensive- Cheap	3.5	3.6	3.6	3.6

Effect of information about origin cod

The mean scores for the experienced qualities related to (sensory) attributes of the cod evaluated by the respondents the four consumer groups are given in table 4.

From the bi-plot (Figure 4) it is clear that 77% of the total variance can be explained by PC1 and only 12% by PC2. Attributes quality and liking, respectively, taste, color and satisfying are positively correlated to each other. The samples wild and farmed cod presented with information to the consumer about their origin in consumer group 4 are on the right side of PC1.

On the opposite side the samples of wild cod with no information about the origin assessed by consumer group 1 are present. In general higher (=positive direction) values along PC1 are given to these samples. It seems that the consumers were more positive in their evaluation on the sensory attributes, when information about the product origin was given than without information. This is also clear from Figure 5 where the consumers groups are grouped according to information about the origin (category Yes) or no information about the origin (category No). The attributes firmness and juiciness contribute to PC2 which explains only 14% of the total variance.

Table 4 Mean score for experienced qualities related to (sensory) attributes of wild and farmed cod in the four consumer groups

Samples	information about origin	satisfying	liking	quality	fresh	taste	juicy	firm	smell	color
1 wild freshness 6 days	no	5.07	5.09	5.31	5.19	5.09	5.19	4.71	4.92	5.39
1 farmed freshness 6 days	no	5.42	5.42	5.49	5.63	5.46	5.36	4.76	5.19	5.63
2 wild freshness 6 days	no	5.17	5.25	5.34	5.35	5.41	4.89	4.84	5.22	5.44
2 farmed freshness 9 days	no	5.49	5.45	5.56	5.59	5.56	5.55	4.41	5.31	5.66
3 wild freshness 6 days	no	5.43	5.48	5.63	5.46	5.56	5.37	5.11	5.31	5.56
3 farmed freshness 6 days	yes	5.36	5.40	5.59	5.64	5.55	5.48	4.68	5.44	5.62
4 wild freshness 6 days	yes	5.60	5.57	5.76	5.62	5.60	5.21	5.11	5.67	5.79
4 farmed freshness 6 days	yes	5.68	5.55	5.67	5.78	5.68	5.66	5.26	5.66	5.93

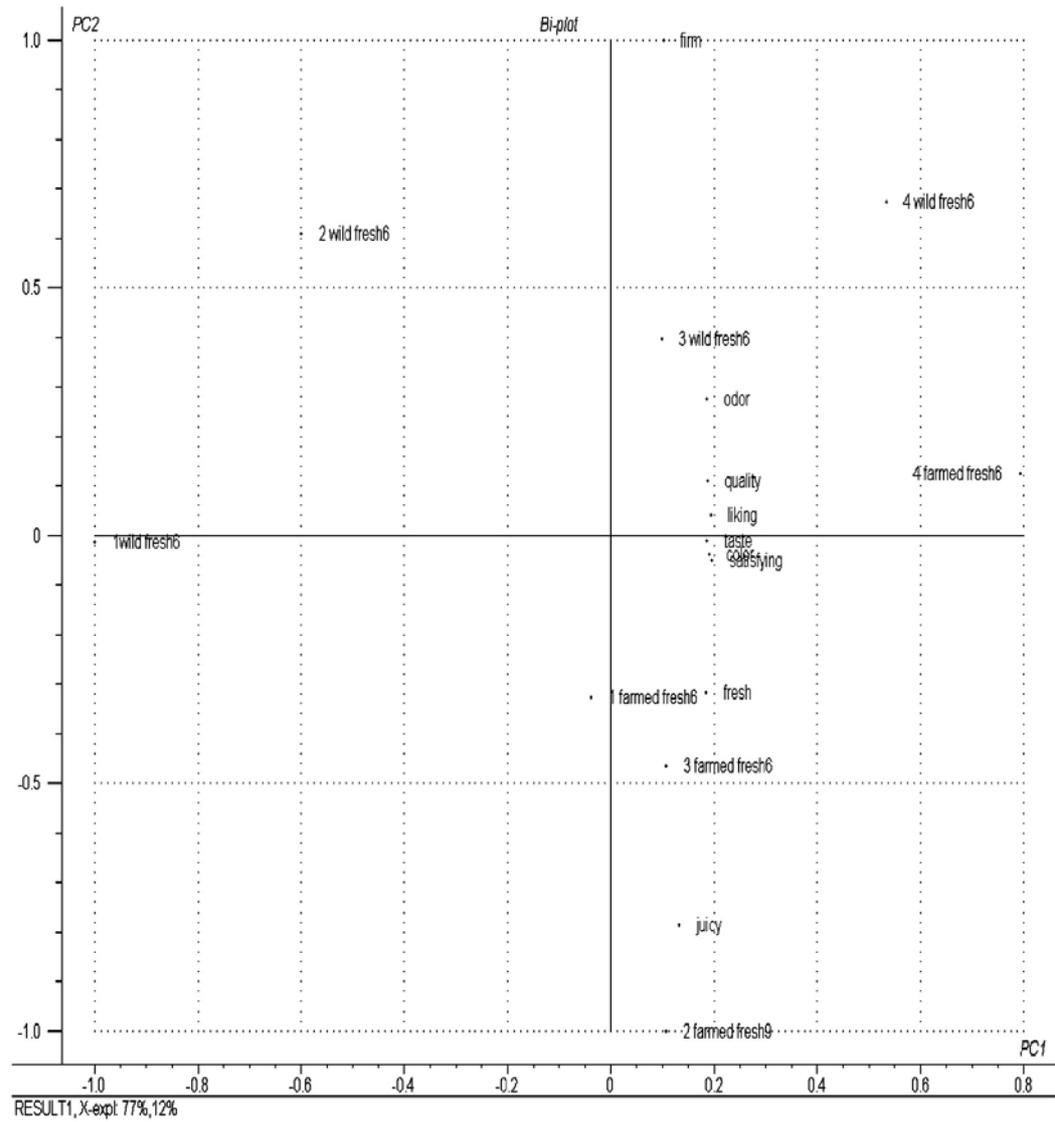


Figure 4 Bi-plot Principle Component Analysis of the scores for the (sensory) attributes of wild and farmed cod. For explanation legenda see Table 1 and 4

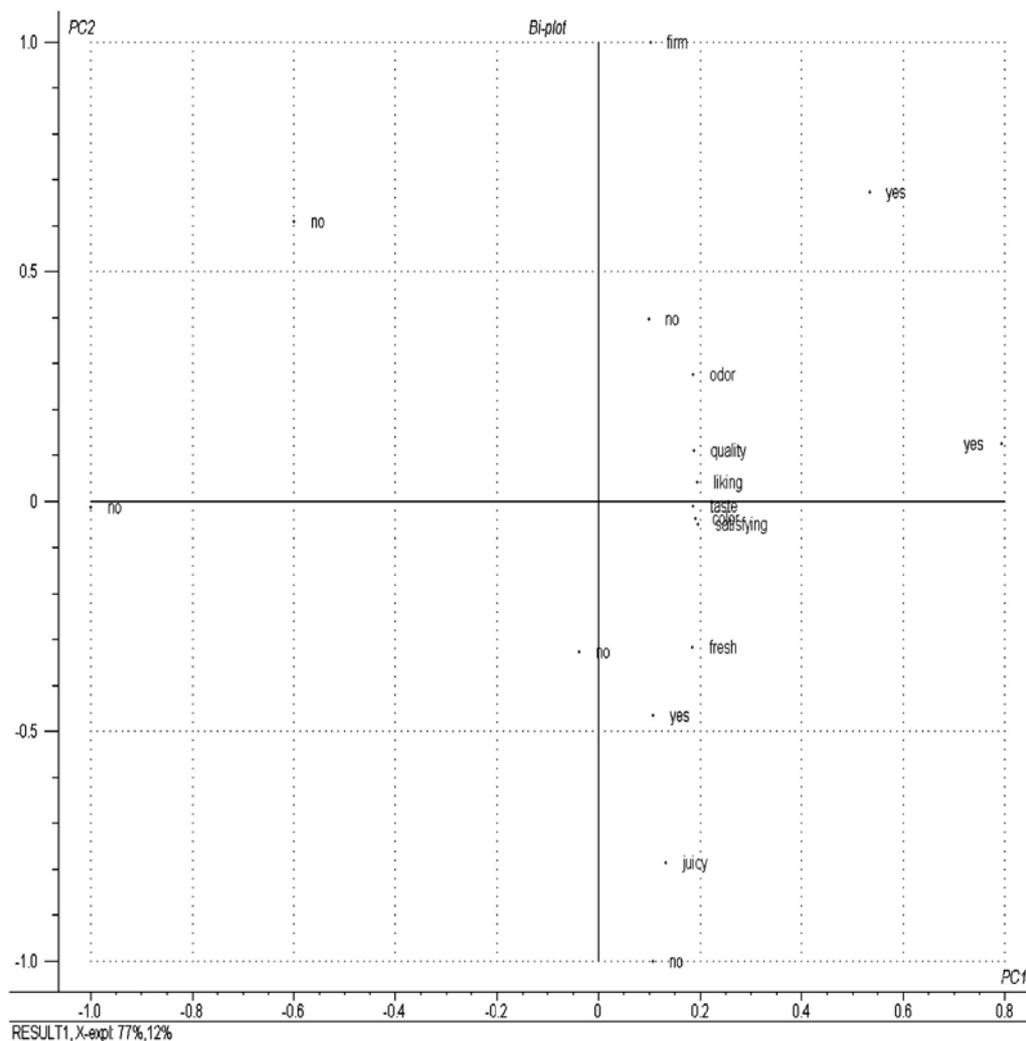


Figure 5 Bi-plot Principle Component Analysis of the scores for the (sensory) attributes of wild and farmed cod (grouped to information about origin). For explanation legenda see Table 1 and 4

Wild versus farmed cod

Differences between farmed and wild samples for the experienced qualities, were evaluated by the independent T-tests separately for each consumer group. For significance between the farmed and wild samples, mean, standard deviation,

Leven's test for equality of variance and the t-test were evaluated for each attribute. The results, given in Table 5, showed that only for a very few attributes the products are evaluated differently by the consumers. The consumers in the groups 1 and 2 (no information about origin) occasionally experienced farmed cod as fresher, having a better taste, being juicier and less firm than wild cod.

Table 5 Mean scores for attributes of wild versus farmed cod (independent T-test, * $p < 0.05$), wcod = wild cod, fcod = farmed cod

Information given Sample type	Consumer group 1		Consumer group 2	
	Cod	Cod	Cod	Cod
	Wild cod freshness 6 days	Farmed cod freshness 6 days	Wild cod freshness 6 days	Farmed cod freshness 9 days
Not satisfying - Satisfying	5.1*	5.4*	5.2*	5.5*
Dislike - Liking	5.1	5.4	5.2	5.5
Bad quality - Good quality	5.3	5.5	5.3	5.6
Not fresh – Very fresh	5.2*	5.6*	5.4*	5.6*
Bad taste -Good taste	5.1*	5.5*	5.4	5.6
Dry – Juicy	5.2	5.4	4.9*	5.6*
Not firm - Firm	4.7	4.8	4.8*	4.4*
Unattractive - Attractive	5.2*	5.5*	5.3	5.4
Bad color - Good color	5.4	5.6	5.4	5.7
Fat – Lean	5.1	5.2	5.4	5.3
Unnatural - Natural	5.1	5.4	5.2	5.4
Unhealthy - Healthy	5.4	5.6	5.6	5.7
Expensive- Cheap	4.0	3.8	3.9	3.8
Dull - exciting	4.5	4.4	4.5	4.3
Bad smell - good smell	4.9	5.2	5.2	5.3
Information given Sample type	Consumer group 3		Consumer group 4	
	Cod	Farmed cod	Wild cod	Farmed cod
	Wild cod freshness 6 days	Farmed cod freshness 6 days	Wild cod freshness 6 days	Farmed cod freshness 6 days
Not satisfying - Satisfying	5.4	5.4	5.6	5.7
Dislike - Liking	5.5	5.4	5.6	5.6
Bad quality- Good quality	5.6	5.6	5.8	5.7
Not fresh – Very fresh	5.5	5.6	5.6	5.8
Bad taste -Good taste	5.6	5.6	5.6	5.7
Dry – Juicy	5.4	5.5	5.2*	5.7*
Not firm - Firm	5.1*	4.7*	5.1	5.3
Unattractive - Attractive	5.4	5.3	5.7	5.8
Bad color - Good color	5.6	5.6	5.8	5.9
Fat – Lean	5.2	5.3	5.4	5.6
Unnatural - Natural	5.4	5.6	5.6	5.7
Unhealthy - Healthy	5.6	5.8	5.9	5.9
Expensive- Cheap	3.9	3.9	3.6	3.5
Dull - exciting	4.5	4.3	4.6	4.5
Bad smell - good smell	5.3	5.4	5.7	5.7

In consumer group 1 all scores for farmed cod except 'expensive-cheap' and 'dull-exciting' were a bit higher. Only the scores for 'not satisfying-satisfying', 'not fresh-fresh', 'bad taste-good taste' and 'unattractive-attractive' were significant higher.

Also in consumer group 2 the scores for the farmed cod samples were generally higher than for the wild cod. Significantly higher scores were given for 'not satisfying-satisfying', 'dry-juicy' and 'not firm-firm' of the farmed cod. In consumer group 3 only the score 'not firm-firm' was significantly lower for farmed cod than for wild cod. Only the score for 'dry-juicy' was significantly higher for farmed cod than for wild cod in consumer group 4.

For the one-way ANOVA and Tukey tests all results from the four consumer groups were used. Therefore the results from consumer group 1, 2 and 3 of the wild cod (labelled cod) were considered as one group of results. This was also done with the results for farmed cod with freshness 6

days (labelled farmed cod) from consumer group 3 and 4.

Mean, standard deviation and 95 % confidence interval were calculated followed by ANOVA to identify significant differences within attributes among the various groups. Next the Tukey test ($p < 0.05$) was used to identify which groups differed significantly from each other. Results are presented in Table 6.

Also ANOVA showed that the scores for the samples with information about the origin (farmed or wild) were higher for almost all attributes in comparison to the cod samples with only the information that the sample was cod. For a number of attributes these higher scores were significantly ('dissatisfy-satisfy', 'not fresh-very fresh', 'bad smell-good smell', 'unattractive-attractive', 'bad color-good color', 'unnatural-natural' and 'unhealthy-healthy'). Also the scores for the farmed cod samples with label cod were higher than for the wild samples labelled cod.

Table 6 ANOVA and Tukey's test of the mean score for the attribute scales of wild and farmed cod. Samples with the same characters are not significant at 5% level.

Information given Sample type	Cod		Farmed cod		Cod	
	Wild cod	Farmed cod	Wild cod	Farmed cod	Farmed cod	Farmed cod
	Freshness 6 days	Freshness 9 days				
Dissatisfy-Satisfy	5.21a	5.55b	5.60b	5.43a	5.49a	5.49a
Dull-Exciting	4.49a	4.41a	4.56a	4.37a	4.25a	4.25a
Disliking-Liking	5.26a	5.49a	5.57a	5.42a	5.45a	5.45a
Bad quality-Good quality	5.41a	5.64a	5.76b	5.49a	5.56a	5.56a
Not fresh – Very fresh	5.33a	5.72b	5.62b	5.63b	5.59a	5.59a
Bad taste-Good taste	5.34a	5.63b	5.60a	5.46a	5.56a	5.56a
Dry-Juicy	5.12a	5.58b	5.21a	5.36a	5.55b	5.55b
Not firm-Firm	4.87a	5.02a	5.11a	4.76a	4.41b	4.41b
Bad smell-Good smell	5.15a	5.57b	5.67b	5.19a	5.31a	5.31a
Unattractive-Attractive	5.28a	5.59b	5.67b	5.47a	5.43a	5.43a
Bad color-Good color	5.46a	5.80b	5.79b	5.63a	5.66a	5.66a
Fat-Lean	5.25a	5.51a	5.42a	5.24a	5.31a	5.31a
Unnatural-Natural	5.23a	5.64b	5.61b	5.37a	5.42a	5.42a
Unhealthy-Healthy	5.53a	5.88b	5.93b	5.62a	5.72a	5.72a
Expensive-Cheap	3.95a	3.68a	3.60b	3.82a	3.84a	3.84a

Discussion

Quality assessment by expert panel

Previous research has shown that the sensory quality of farmed cod is perceived to be different from wild cod by an expert sensory panel (Carlehög, 2001). Farmed cod has a whiter color, looks more milky, is less juicy and is experienced as more fibrous during chewing. In this study similar results were obtained.

A higher score in whiteness of the farmed cod is considered as positive while the higher score for dullness is negative in comparison with the wild cod. The higher score for cod own taste for farmed can be regarded as positive. The lower score for juiciness and the higher score for fibrousness can be regarded as negative. Overall, these differences together are considered negative for farmed cod.

Two attributes, which differ somewhat between farmed and wild cod, are cod own smell and taste. Here one could have expected that wild cod would have a higher intensity in cod own smell and taste but this is not the case. This can be explained by the considering that the wild cod was evaluated as neutral standard for 'cod own smell and taste' by the expert panel.

The sensory panel could distinguish the farmed cod from each other for the texture attributes: hardness, flakiness and cohesiveness. Farmed cod, stored for seven days was evaluated as more firm, having a better flakiness and as more cohesive.

Expected versus experienced quality

The consumers were asked to evaluate the cod product in the package before preparation (expected quality) and after preparation and consumption (experienced quality). Consumer evaluation of products, based on outer appearance of the raw product before preparation, can be linked to the activities and buying criteria of consumers in case of a purchase situation for a

new product. Evaluation of the experienced quality can be connected to after-purchase behavior. Both are of importance for the consumer attitude and satisfaction. There is evidence (Gardial *et al* , 1994) that consumers use different criteria for purchase and after-purchase assessing products. Product attributes as well as emotions are important at purchase. However a total assessment and emotions are important after purchase. The use of real products at the same time when the products are evaluated, based upon on expectation and experience, will strengthen research validity and give more reliable results.

This concept of expected and experienced qualities has been applied in a consumer study in France with Norwegian and French saithe fillets (Honkanen, 2000). Consumer scores for expected and experienced qualities for the French saithe fillets were higher for all product properties investigated. For both products the scores for the experienced quality were higher than the expected quality.

In our cod study the profiles based upon the attributes for the various cod products, presented in Table 3, were rather similar. The scores for the investigated attributes of the products were in general between 5.0-6.0 which shows that the consumers are rather satisfied with the product taking into account that seven is the maximum score. It is remarkable that the score for the experienced quality of various product characteristics was similar or lower than the expected quality within all consumer groups. According to some literature, this difference can lead to a more positive overall evaluation (Meyers-Levy and Tybout, 1989; Stayman *et al*, 1992). This is a positive result with respect to future product development, as long as cod producers manage to communicate a positive image about their products.

It has to be kept in mind that the differences are small and not always significantly. Freshness, firmness, juiciness, (un) natural and (un) healthy appearance seem to be the attributes that are sometimes evaluated lower when the product is consumed then before consumption. However, a considerable fraction of the respondents

find it difficult to assess the scales (un) natural and (un) healthy. It may well be that the consumer did not understand very well this preference or is not able to place this item in the context of this research. Evaluation of the quality of the questionnaire by the respondents in consumer group 1 confirmed that 40% of the respondents found it rather difficult to assess the scales of 'dull-exciting' and 'cheap-expensive'. Also the scales 'unnatural-natural' and 'unhealthy-healthy' were difficult to assess.

Wild versus farmed cod

The scores for attributes of the farmed cod, given by the consumers in group 1 and 2 (no information given about origin of the cod), were slightly higher than for the wild cod (Table 5). Also in the consumer groups 3 and 4, where information about the origin of the product were available for the consumer, the scores for the product properties of the farmed cod were at least of the same value (Table 5).

In this study the consumers experienced the quality of the farmed cod fillet as good as wild cod fillet or occasionally slightly better on a very few scales (freshness, taste, juiciness, firmness). This result is important because experts in this study and in previous studies have determined that some quality properties of wild cod fillets are significantly different from farmed cod fillets. However, it is also important to know whether this observation will be the case for pure farmed cod.

It would also be interesting to investigate in the future the experienced intensities of smell, taste and texture properties by the consumers. This would help to get more insight in the background of the differences and may give the opportunity in case of the farmed cod to develop a product more tuned to the needs of the consumer. It seems that the difference in storage time from 6 to 9 days after slaughtering did not effect the consumer evaluation of the farmed cod. Although the difference in the storage time of the farmed cod was not so large in this study it seems not opportune to study the effect of freshness in a

future main study.

As already mentioned it is much more interesting in future studies to focus on confirmation of the consumer appreciation of the pure farmed cod fillets in comparison to wild cod fillets when both products have a freshness of less than 6 days.

Effect of information

The principal component analysis and the one-way ANOVA are complementary tools for evaluating the importance of all variables on the final consumer experience with the farmed and wild cod. The PCA (Figure 4 and 5) showed clearly that attributes with respect to quality are correlated to each other. Attributes like taste, liking, color and quality are very close to each other while smell and freshness attributes are other discriminating factors between groups of products. Most striking in this study is the fact that consumers given the information about the cod origin (farmed or wild) seemed to evaluate the products more positive than those who did not receive this information. This is at least very clear for 2 of the 3 products with information. The information given in this study was rather simple. In that respect it may be worth to investigate which other information might also be important. Additional information could deal with the name of the catching vessel, farming location, the handling etc.

Conclusions

The results of this study leads to the following conclusions:

- The response of the approximately 1000 consumers in this study was high (approximately 85%).
- The profile of farmed and wild cod, based upon attributes evaluated by consumers, is similar. The experienced qualities of the wild or farmed cod products investigated by the consumers did not differ very much

- from the expected qualities.
- The consumers seemed to appreciate farmed cod as good as wild cod and occasionally slightly better for a very few attributes. These results do not follow the results from expert evaluations.
 - Product information about the origin of cod seemed to lead to a higher score on attributes of wild and farmed cod.

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