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Report

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Sensory quality of wild and farmed turbot reared under different light conditions and processed bled or unbled

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Biological optimization and development of processing methods for turbot farming
(TURPRO)

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Summary

Within the CRAFT project TURPRO it was aimed to improve the quality of the turbot farmed in recirculation systems. One of the tasks was to analyze the eating quality and shelf life of turbot grown under different rearing conditions and post slaughter processing conditions. In this report the IMARES activities are presented. Turbot reared under different light regimes: either 24 Hours Day Light or Natural Day Light from two different farms was sensory analyzed for eating quality and shelf life. And turbot from one farm was processed either bled or un-bled and thereafter sensory analyzed for eating quality.

Different light regimes during production of farmed turbot had no effect on sensory quality during the storage in ice. The colour of gutted (bled) farmed turbot is less crème and more grey than of un-gutted (un-bled) farmed turbot.

1. Introduction

Within the CRAFT project TURPRO it was aimed to improve the quality of the turbot farmed in recirculation systems. One of the tasks was to analyze the eating quality and shelf life of turbot grown under different rearing conditions and post slaughter processing conditions. In this report the IMARES activities are presented. Turbot reared under different light regimes: either 24 Hours Day Light or Natural Day Light from two different farms was sensory analyzed for eating quality and shelf life. And turbot from one farm was processed either bled or un-bled and thereafter sensory analyzed for eating quality.

2. Materials and methods

Fish

Farmed turbot (*Psetta maxima*) with a live weight on the range 600-700 g, i.e. corresponding approximately to commercial portion-size turbot, were obtained from two fish farms (Ecomares Germany and ACC, Portugal). The turbot from ECOMARES was reared under continuous daylight conditions (24 HDL). The fish from ACC was reared under two different light regimes: either 24 hours daylight or Natural day light (NDL). The fishes were slaughtered for the study at 7 March 2006 from ACC and 6 March 2006 from ECOMARES. Slaughtering was performed under commercial conditions: live chilling in ice water for 30 minutes. The fish was stored in ice for sensory analyses.

At ACC the products were further processed post mortem in two ways: the fish was led to bleed versus non-bled turbot. Tested for both production methods (24 hours daylight and Natural daylight). The turbot were stored whole and filleted after 10 days of storage. Then transported as fillets to The Netherlands and sensory tested after 13 days of storage.

At the same time of this experiment 5 kg of fillet from wild turbot was bought at the wholesaler Hugo Bijl in IJmuiden and sensory tested after 8 days of ice storage.

Table 1. Experimental overview.

Sample	analyses	Sampling moment
ECOMARES 24 HDL gutted	QDA and QIM	4-7-10-14-17
ACC 24 HDL ungutted	QDA and QIM	6-9-13-16-21
ACC Normal DL ungutted	QDA and QIM	6-9-16-21
ACC 24 HDL ungutted_bled	QDA	13
ACC 24 HDL ungutted_unbled	QDA	13
ACC Normal DL ungutted_bled	QDA	13
ACC Normal DL ungutted_unbled	QDA	13
wild fillet	QDA	8

Storage

All farmed fishes were packed in polystyrene boxes with ice (10-11 kg of fishes per box, 4 kg ice per box) and covered with a polystyrene lid. Melt water was allowed to flow away. The boxes were placed in a chilled store room at 0°C for max 21 days.

Panel

The analytical sensory panel consisted of five-seven persons, selected and trained for sensory analytical analyses and experienced in QDA (Quantitative Descriptive Analysis).

Training

Prior to the sensory assessment of turbot in the study, the panel was trained in two one hour sessions. For the training the previous developed list of 29 attributes for turbot was used (annex 1). The sample used for the training was wild turbot.

Analyses

For sensory analyses of food products the Quantitative Descriptive Analysis (QDA, also known as profile method) is common for characterization of the differences between products and to be able to provide sensory data for the interpretation of instrumental data. The method consists of procedures for describing and assessing the flavour of a product in a reproducible way. The separate attributes contributing to the formation of the overall impression given by the product are identified and their intensity assessed in order to build up a description of the flavour of the product. The QDA-analyses were carried out according to ISO standard 6564 (1985). 6 sessions 10, 13, 16, 20, 23, 27 March were organized. Before sensory analyses the turbot of each batch were filleted. The raw fillet was cut into pieces of 2 by 4 cm, for each panelist. The raw samples were presented prior to the cooked samples in randomized order, labeled with a three digit code, presented in aluminium boxes. The cooked samples were placed in aluminum boxes and prepared in a hot air oven filled with boiling water. Temp oven set at 180°C. Time preparation 5 minutes. Boxes with fish were presented to the panel immediately after cooking.

With the help of FIZZ® for window 2.10a (Biosystems), the panelists scored on a line scale from 0-100, with anchors on 0 and 100%. For the test artificial daylight (T>5000K) was used.

Freshness analyzed by Quality Index Method

Panel

The QIM panel consisted of 3-7 persons, selected and trained for using the Quality Index Method for turbot (annex 2).

Analyses

The Quality Index Method (QIM) is a method to assess fish freshness. QIM is based on well-defined characteristic changes of raw fish that occur in outer appearance of eyes, skin and gills, and odour and texture and a score system from 0-3 demerit (index) points. The descriptions of each score for each parameter are listed in the QIM scheme. The scores for all the characteristics are summarized to give an overall sensory score, the so called Quality Index. The aim when developing QIM for various species is to have the Quality Index increase linearly with storage time in ice. The assessor must evaluate all the parameters involved in the scheme. For turbot the following attributes are analyzed: appearance (dark side, mucus and texture), the eyes (form as well as brightness), gills (odour, colour and mucus) and finally the flesh (colour of the cut surface of the belly flaps). The sum of scores is calculated and results in a QI for that sample. These scores are compared with the calibration curve for wild turbot and expressed in an estimated shelf life (days on ice).

Preparation

From each batch five fishes were randomly selected and placed on ice on top of a plastic sheet in a randomized order and coded.

Statistical analysis

Statistical analyses of the sensory data was performed with SAS system for Windows V8. Analyses of Variance (ANOVA) was used for testing dependent variables (sensory attributes) against independent variables (conditions). For post hoc analysis Duncans test were used. Significance is presented at 95% ($p < 0,05$) confidence interval unless stated differently. QIM regression lines were calculated with excel.

3. Results and discussion

Sensory profile results

Comparison different products

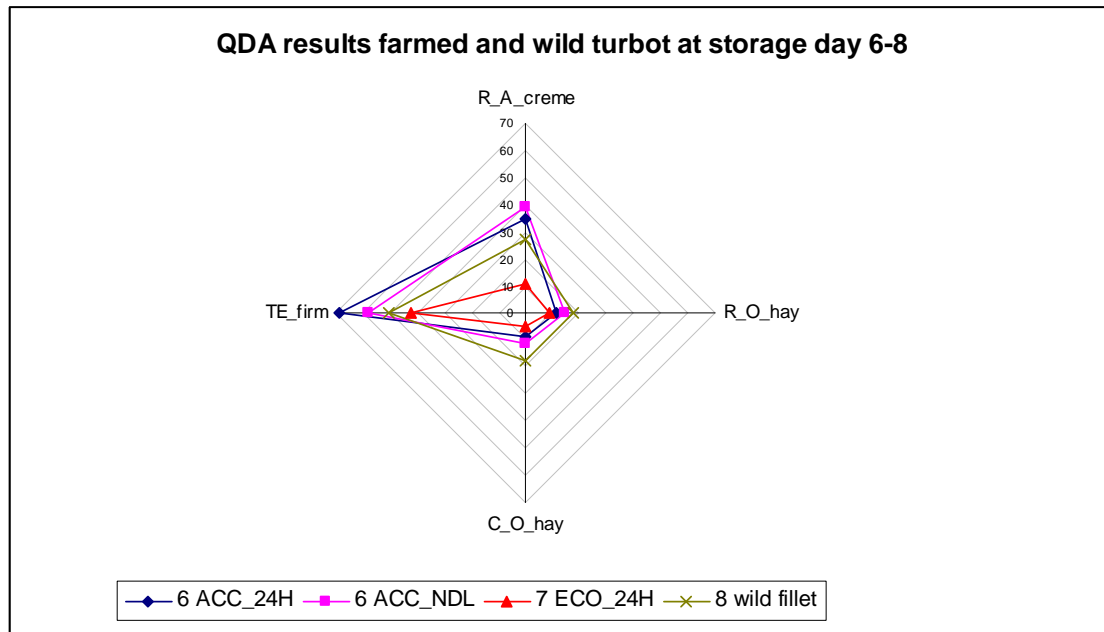
In total five different products have been tested: wild fillets stored for 8 days, Ecomares farmed turbot 24HDL stored for 7 days and ACC farmed turbot both NDL and 24HDL stored for 6 days. These products have been compared although the differences of 2 storage days (mean results table 2).

Table 2. Mean results QDA analyses different products at storage day 6-8.

Storage day	6	6	7	8
product name	ACC_24H	ACC_NDL	ECO_24H	wild fillet
R_A_crem	34,83 a	38,92 a	10,92 b	27,31a
R_A_glas	33	26,33	30,67	18,75
R_A_grey	17,75	23,08	27,25	22,31
R_O_pota	32,5	40,58	33	34,75
R_O_hay	11,33 ab	14,25 ab	8,75 b	17,94 a
R_O_mari	23,17	23,67	21,25	15,13
R_O_must	2,58	6,92	4,83	3,13
R_O_sour	8,83	7,75	12,33	6,5
C_O_milk	47	58	51,17	59,38
C_O_hay	8,75 b	11,5 ab	5,08 b	17,63 a
C_O_must	7,08	5,83	7,08	3,13
C_O_card	7,92	6,17	4,58	7,06
C_O_sour	5,17	5,08	2,25	1,81
C_O_fish	13,42 b	15,67 ab	10,42 b	27,38 a
C_A_crea	18,58	24,75	9	28,5
C_A_grey	17,33	12,67	14,67	13,88
C_A_grey2	11,08	12,92	17,33	10,06
TE_firm	68,5 a	57,83 ab	42,25 c	50,63 bc
TE_tend	54	50	51,92	63,88
TE_fibr	41,17	42,25	39,17	28,44
TE_gran	15,83	11,33	13,67	22,88
TE_stic	32,42	34,92	37	16,38
TE_dry	22,5	20,17	20,83	19,5
TA_crea	28,25	34,92	33	34,81
TA_pota	52,5	56,33	54,67	46
TA_chic	34,58	35,17	29,67	36,19
TA_stoc	27,67	23,17	21,83	21,06
TA_wate	28	32,67	41,42	25,5
TA_sour	8,25	10,83	8,25	3,94

The attributes that differed significantly are shown in figure 1.

Figure 1: QDA results of farmed and wild turbot at storage day 6-8. Only the significant different attributes are shown.



Different production methods: 24 Hours daylight versus Natural daylight. ACC produced turbot under both conditions. These products were tested during shelf life at storage day 6-9-13-16 and 20. Overall there were no significant differences between these products. At storage day 16 the odour of the raw fillet for Natural Day light was significant lower compared with 24hours daylight (7,9 and 16,8 respectively).

Different processing methods: bleeding versus non-bleeding. These products were tested after 13 days of storage only. No main effect bled-unbled and no interaction effect production method (24 HDL versus NDL) and processing method (bled unbled). Though there is a tendency to more crème colour and less grey colour for unbled raw fillets (Table 3).

Table 3. Mean QDA results for different processing conditions, after 13 days of storage.

Storage day	13	13	13	13	13
product name	ACC_24H_ungutted (stored as whole fish)	ACC_24H_bled	ACC_24H_unbled	ACC_NDL_bled	ACC_NDL_unbled
R_A_crem	37,83	32	47	32,83	31,17
R_A_grey	17	25,33	25	27,5	23,33

Different processing method: gutted – un gutted and different farms: ACC and Ecomares. Same production method (24 Hours Daylight).

During the complete storage period these two products differ for the following attributes:

Raw appearance crème: ACC being more crème (39) than Ecomares (20)

Cooked appearance crème colour: ACC being more crème (28) than Ecomares (18)

Firm texture: ACC being more firm (64 versus 53)

Dry texture: ACC being more dry (34 versus 24)

Specially the colour difference is likely to be caused by bleeding versus non-bleeding. The non-bled farmed turbot is more crème. This has been found by Morzel (2003) as well. **The firmer texture and drier texture (look at results found by Bjorn! He has looked for differences in this respect.)**

Sensory changes during shelf life.

The farmed samples were tested during maximum 20 days. In general, there are different attributes describing the fresh product (decreasing scores over storage time) and describing the 'not-so-fresh' products (increasing scores over storage time). Typical examples of attributes for the first are: raw odour fresh and potato, cooked odour potato, taste chicken, texture tender and juicy. Typical examples for 'not-so-fresh' attributes are: grabby appearance, raw odour fishy, cooked odour musty, and texture dry and granular.

Significant different attributes per product over storage time are highlighted in table 4.

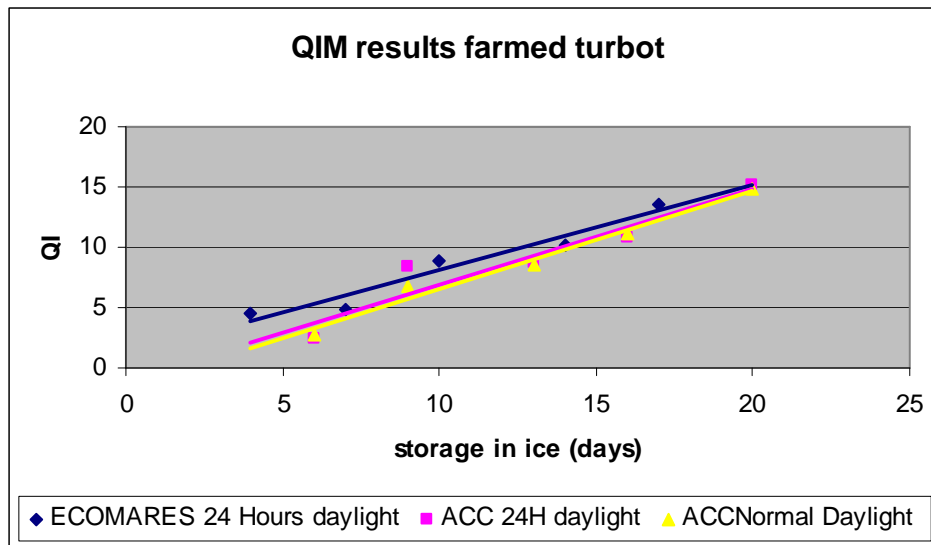
Table 4. Mean results QDA analyses for different farmed turbot grown under different rearing conditions, during storage of max 17-20 days.

productname storage	ACC 24 HDL ungutted					ACC Normal DL ungutted				ECOMARES 24 HDL gutted				
	6	9	13	16	20	6	9	16	20	4	7	10	14	17
R_A_crem	34,83	50,7	37,83	41,79	30	38,92	30,3	37,57	36,43	22,88 ab	10,92 b	14,9 ab	22,33 ab	27,64 a
R_A_glas	33	24,8	30,33	21,5	31,86	26,33	24,4	27,14	26,07	28,75	30,67	30,7	38	28,29
R_A_grey	17,75 b	23,2 ab	17 b	41,07 a	25,43 ab	23,08	31,5	27,07	28,21	27,75	27,25	34,1	49,5	33,29
R_O_pota	32,5	26,6	24,33	31,29	26,36	40,58	24,3	23,86	27,79	29,38	33	22,4	22,17	22,29
R_O_hay	11,33 ab	11,4 ab	6,5 b	16,79 a	9,57 ab	14,25 a	7,5 b	7,86 b	11,36 ab	8,25	8,75	10,3	10,33	10,14
R_O_mari	23,17	26,4	18,83	21,29	23,57	23,67	27	21,5	21,14	11,13	21,25	29,4	11	16,79
R_O_must	2,58	6	12,67	11,86	15,07	6,92 b	5,9 b	10,64 ab	19,29 a	0,75	4,83	2,9	6,83	9,07
R_O_sour	8,83	10,1	19,5	24,43	20	7,75	13,5	12,5	22,71	3,38 b	12,33 ab	6,8 ab	22,67 a	13,93 ab
C_O_milk	47	52,1	43,67	42,93	40,57	58	47,5	43,21	42,36	47,38	51,17	43,3	42,83	34,71
C_O_hay	8,75	11,3	17,5	17,86	15,29	11,5	11,2	17,43	18,43	19,13 a	5,08 b	10,9 ab	13 ab	17,86 ab
C_O_must	7,08	8,2	13,83	15,71	21,64	5,83 b	9,1 ab	16,79 ab	21,79 a	1,88 b	7,08 ab	6,6 ab	11 ab	15,36 a
C_O_card	7,92	7,4	9,5	13,36	17,29	6,17	10,4	16,43	19,29	9,5	4,58	7,7	12,17	11,21
C_O_sour	5,17	4,3	11,67	16	19,57	5,08	8,7	9,86	18,07	0,88	2,25	4,1	15,83	14,93
C_O_fish	13,42 c	17,1 bc	36 a	26,57 abc	31,43 ab	15,67	19,1	24,36	30,5	23,5	10,42	14,8	25,17	24
C_A_crea	18,58	27,8	30,5	35,57	29,43	24,75	15,8	28	33,5	27,13	9	12,5	21,33	22,79
C_A_grey	17,33	16,3	17,83	18,79	20,64	12,67	21,6	18,21	12,21	22,75 ab	14,67 b	18,4 ab	28,17 a	18,57 ab
C_A_grey2	11,08	26,3	12,67	20,43	20,79	12,92	20,8	21,5	17,79	8,5	17,33	15,7	25,17	20,07
TE_firm	68,5 a	70,7 a	53,33 b	59,57 ab	63,57 ab	57,83	64	59,43	53,86	49,25 ab	42,25 b	58 ab	66,33 a	55,14 ab
TE_tend	54	49,9	51,33	51,29	46,36	50	53	50,07	56,29	62,63	51,92	55,6	61,17	57,64
TE_fibr	41,17	45,9	56,83	45,21	40,14	42,25	46,5	50,57	44,07	27,63 b	39,17 ab	39,9 ab	61,33 a	41,36 ab
TE_gran	15,83	24	15,33	28,43	30,5	11,33 b	17,5 ab	20,93 ab	31,36 a	20,25	13,67	13,5	19,67	25,64
TE_stic	32,42	25,8	32,5	36,57	39,5	34,92	29	39,71	45,86	14,13 b	37 a	30,9 ab	38,83 a	43,71a
TE_dry	22,5 b	29,9 ab	37,17 ab	34,79 ab	43,64 a	20,17	23,8	35	33,64	17,13	20,83	26,4	27,33	28,64
TA_crea	28,25	24,8	31,83	26,71	22,86	34,92	31	27,43	22,79	38,5	33	36,3	32	28,5
TA_pota	52,5	47,7	36,83	35,86	30,5	56,33 a	44,7 ab	33,07 b	31 b	44,88 ab	54,67 a	45,3 ab	36,17 ab	27,64 b
TA_chic	34,58 ab	28,7 ab	37,83 a	24,36 ab	17,5 b	35,17	22,2	26,43	19,36	37,88 a	29,67 ab	18,5 b	35,67 ab	21,64 ab
TA_stoc	27,67	15,3	35,67	21,79	18	23,17	16,7	19,14	15,5	21,75	21,83	11,5	29	12,5
TA_wate	28	50,1	43,67	40,93	46,5	32,67	45,6	44,86	47,57	29,13	41,42	44,3	45,67	44,43
TA_sour	8,25	13,8	16,5	17,86	23,21	10,83	14,4	23,43	25,93	2	8,25	6,2	13,67	14,29

QIM analyses

The QIM results are presented as the linear relation between Quality Index scores and the storage time in ice. This QIM scheme has been developed for gutted wild turbot. If the turbot was not gutted, a score for this attribute has not been given. For comparison of the batches all sum-total scores were excluding this attribute. The results from this experiment with farmed turbot are presented in figure 2. The three calibration curves show the (dis)similarities between different treatments and sources.

Figure 2: QIM results for farmed turbot grown under different rearing conditions during storage of 17-20 days. Scores for colour of flesh fillets were omitted in the calculation.



No significant difference between the three product groups: the shelf life of farmed turbot from Ecomares and ACC is equal. There is no difference between turbot raised under 24 hours light condition or Natural day light condition. The shelf life of the farmed turbot is 20 days (QI score 15).

4. Conclusion

Different light regimes during production of farmed turbot had no effect on sensory quality during the storage in ice. The colour of gutted (bled) farmed turbot is less crème and more grey than of un-gutted (un-bled) farmed turbot.

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Ir. H. van der Mheen

Signature: _____

Date: November 2006

Annex 1

Attributes for Turbot

attributes	full name	scale	description
accronym	full name		
R_A_crem	raw appearance crème	not-much	the amount of creme colour
R_A_glas	raw appearancy glassy	not-much	the amount of glassy appearance, transparent
R_A_grey	raw appearance grey	not-much	grey colour
R_O_pota	raw odour potato	weak-strong	odour of boiled potatoes
R_O_hay	raw odour hay	weak-strong	odour like hay, little musty
R_O_mari	raw odour marine	weak-strong	marine like the sea odour
R_O_must	raw odour musty	weak-strong	Reminds of a table cloth (damp cloth used to clean kitchen table, left for 36 hours on the table)
R_O_sour	raw odour sour	weak-strong	sour odour, spoilage sour, acetic acid
C_O_milk	cooked odour milk	weak-strong	boiled milk, fruity/mushy odour
C_O_hay	cooked odour hay	weak-strong	odour like hay, little musty
C_O_must	cooked odour musty	weak-strong	Reminds of a table cloth (damp cloth used to clean kitchen table, left for 36 hours on the table)
C_O_card	cooked odour carboard	weak-strong	like wet cardboard
C_O_sour	cooked odour sour	weak-strong	sour taste, spoilage sour
C_O_fish	cooked odour fishy	weak-strong	TMA odour, reminds of dried salted fish, amine
C_A_crea	cooked appearance crème	not-much	the amount of crème colour
C_A_grey	cooked appearance grey	not-much	the amount of grey colour
C_A_grey2	cooked appearance grabby	not-much	the grabby appearance
TE_firm	texture firm	not-much	Evaluate how firm or soft the fish is during the first bite
TE_tend	texture tender	not-much	Evaluated after chewing several times
TE_fibr	texture fibrous	not-much	meaty texture, meaty mouthfeel
TE_gran	texture granular	not-much	small granular particles
TE_stic	texture sticky	not-much	sticks to your teeth
TE_dry	texture dry	not-much	Evaluated after chewing several times: dry - pulls juice from the mouth
TA_crea	taste cream	weak-strong	like whipped cream, butter or popcorn
TA_pota	taste potato	weak-strong	like boiled potato
TA_stoc	taste stock	weak-strong	like stock, clear soup little salt taste
TA_chic	taste chicken	weak-strong	like chicken flavour
TA_wate	taste watery	weak-strong	juice no flavour
TA_sour	taste sour	weak-strong	sour taste, spoilage sour

Annex 2

Quality Index Method (QIM) scheme for turbot

Quality parameter		Description	Score
Appearance	Dark side	Fresh, bright, no discolouration	0
		Rather dull or pale, somewhat darker and shrunken skin	1
		Dull, pale, fins are greenish and discoloured	2
		Dull, green and purple discolouration	3
	White side	Fresh, bright, wound near the tails is fresh red	0
		Rather mat, wound near the tails is yellow / brownish	1
		Mat, yellowish, wound near the tails is brown	2
		Yellow and purple discolouration	3
	Mucus	Clear, not clotted	0
		Slightly clotted and milky	1
		Clotted and slightly yellow	2
		Yellow and clotted	3
	Texture, backside	Firm, elastic (In rigor)	0
		Less firm, elastic	1
		Soft	2
		Very soft	3
Eyes	Form	Flat, eye socked convex	0
		Slightly sunken, eye socked shrunken	1
		Sunken and or swollen, eye socked shrunken	2
	Brightness	Black and clear, golden rim around the pupil	0
		Rather mat, faint golden rim around the pupil	1
		Mat, purple / reddish	2
Gills	Odour	Fresh, seaweedy	0
		Neutral, metallic, rubbery	1
		Musty, sour	2
		Rotten, sour, sulphurous	3
	Colour	Bright, light red	0
		Slightly discoloured	1
		Discoloured, light brown	2
		Yellowish, green / blue, brown	3

	Mucus	No mucus	0
		Clear	1
		Milky, slightly clotted	2
		Yellow, thick, clotted	3
Flesh, fillets	Colour	Fresh, crème white	0
		Slightly yellowish	1
		Yellow, discoloured	2
		Yellow, brown, blue, discoloured	3
Quality Index			0-28