Wageningen IMARES
Institute for Marine Resources & Ecosystem Studies

Location IJmuiden
P.O. Box 68
1970 AB IJmuiden
The Netherlands
Tel.: +31 255 564646
Fax: +31 255 564644

Location Yerseke
P.O. Box 77
4400 AB Yerseke
The Netherlands
Tel.: +31 113 672300
Fax: +31 113 573477

Location Texel
P.O. Box 167
1790 AD Den Burg Texel
The Netherlands
Tel.: +31 222 369700
Fax: +31 222-319235

Internet: www.wageningenimares.wur.nl
E-mail: imares@wur.nl

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Sensory quality of different commercially available turbot of farmed and wild origin.

A.A.M. Schelvis and Martine Veldman

This research was performed within a CRAFT project: COOP-CT-2004-508070
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 compare the eating quality and shelf life of turbot grown under standard rearing conditions and post slaughter processing conditions and wild caught turbot. In this report the IMARES activities are presented.
In same experiment sensory evaluation performed on farmed turbot from Iceland, this is reported in paper Roth: The subsequent effect of pre and post mortem muscle activity on muscle pH, rigor, texture hardness and sensory properties of turbot. *Scophthalmus maximus* (sensory results not reported in this paper anymore: present in this report to not get lost the data/results).
The sensory profile of fresh farmed and wild turbot only differs on texture attributes: The wild turbot being less firm.
The sensory spoilage pattern is similar for farmed and wild turbot but developed faster for wild caught turbot. The same can be seen for the Quality Index: Zeelandvis farmed turbot has longest shelf life of at least 18 days, followed by Stolt farmed turbot with 18 days of shelf life. The wild caught turbot in this study had a shelf life of 11 days. The farmed turbot from Zeelandvis stays in rigor mortis for 8 days and remains stiffer thereafter.

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 compare the eating quality and shelf life of turbot grown under standard rearing conditions and post slaughter processing conditions and wild caught turbot. In this report the IMARES activities are presented.
In same experiment sensory evaluation performed on farmed turbot from Iceland, this is reported in paper Roth: The subsequent effect of pre and post mortem muscle activity on muscle pH, rigor, texture hardness and sensory properties of turbot. *Scophthalmus maximus* (sensory results not reported in this paper anymore: present in this report to not get lost the data/results).

2. Materials and methods

Fish

Farmed turbot (*Psetta maxima and scopthalmus maxima*) with a live weight in the range 600-700 g, i.e. corresponding approximately to commercial portion-size turbot, were obtained from two fish farms (Zeeland Vis B.V. Yerseke, The Netherlands and Stolt Sea Farm S.A., Spain). The storage experiment started on Tuesday the 8th November and it ended on Monday 28th November 2005. Wild turbot were obtained from a wholesaler (Hugo Bijl) in IJmuiden. This fish was caught in the week before the experiment started. The farmed fish were slaughtered in a commercial way: life chilling in ice water for 30 minutes.

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 21 days. The wild caught turbot were placed in ice in plastic boxes with also a hole in each corner of the box. These boxes were placed in a chilled store room at 0°C for 14 days. From each batch 10 fishes were stored at 0°C separately for measuring the onset and resolution of *rigor mortis*.

Sensory profile by Quantitative Descriptive Analyses

Panel

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

Training

Prior to the sensory assessment of turbots in the study, the panel was trained in two one hour during sessions. For the training the attribute list developed for turbot in 2004 was used. For training three different batches of wild turbot were bought at the wholesaler Hugo Bijl in IJmuiden.

Analyses

The QDA-analyses were carried out according to ISO standard 6564 (1985). The list with 29 attributes and its definition is shown in annex 1. The wild turbot were sampled and tasted after 5, 8, 11 and 15 days of storage. The farmed turbot were sampled and tasted after 8, 11, 15, 18 and 22 days of storage. Seven sessions were organized and every session 4-6 samples were tasted. Every sample was assessed in duplicate within one session. Sample presentation order was randomized between panelists. 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 samples were cooked separately in glass scales in the microwave for one minute on the middle level (+/- 600 Watt). After cooking the samples were immediately served on plastic plates. With the help of FIZZ® for window 2.10a (Biosystems), the panelists scored on a line scale from 0-100, with anchors at 0 and 100%. For the test artificial daylight (T>5000°K) was used.

Freshness analyzed by Quality Index Method

Panel

The QIM panel consisted of four till six persons, selected and trained for using the Quality Index Method.

Training

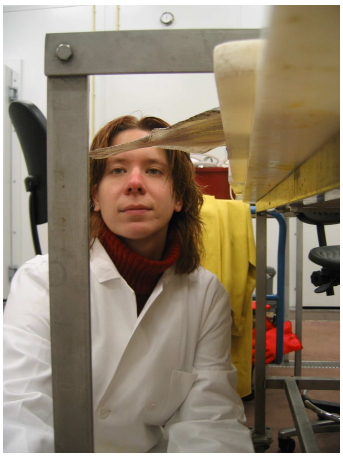
For the QIM assessment of turbot the panel was trained in two one hour during sessions. For the training the QIM scheme developed for wild turbot was used (annex 2). For training three different batches of wild turbot were bought at the wholesaler Hugo Bijl in IJmuiden.

Analyses

For turbot the following attributes were 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 was calculated and resulted in a QI for each fish. These scores were compared with the calibration curve for wild turbot and expressed in an estimated shelf life (days on ice).

Sampling and analyzing was performed after 5, 8, 11, 15 days of storage for the wild caught turbot and 8, 11, 15, 18 and 22 days of storage for both farmed turbot batches. From each batch 5 fishes were randomly selected and placed on a plastic sheet on top of ice in a randomized order and coded.

Evaluation of Rigor



The method to measure *rigor mortis* Index values (RIs) is the following (Bito et al., 1983). The sag of the tail is measured when the front half of the fish's body is placed on a horizontal table. The deflecting Index is calculated as:

DI = 100*deflection (cm)/ 0,5 * fish length = 200 x D/L

DI = deflection index D= deflection in cm L= fish length in cm
DI values rang from 100% for soft fish to 0% indicating high degree of rigor mortis as the fish is rigid. The turbot were stored flat between measurements at a temperature of 0°C. Deflection index values were calculated for 10 individual fishes from each sample, measured on day 5, 8, 11 and 15

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

Product changes during shelf life

Per product the results were analyzed during the shelf life. In table 1 the results (panel means) are presented. The farmed turbot samples were tested during 22 days. The wild turbot samples were tested during 15 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.

Table 1: Mean results QDA farmed and wild turbot during storage.

storage	5	8			11			15			18		22	
productname	Wild	Stolt gutted	Wild	Zeelandvis gutted	Stolt gutted	Wild	Zeelandvis gutted	Stolt gutted	Wild	Zeelandvis gutted	Stolt gutted	Zeelandvis gutted	Stolt gutted	Zeelandvis gutted
R_A_crem	50,43	40,08 ab	60,08 a	30,92 b	38,21 ab	54,57 a	34,29 b	45,9	39,1	37,9	52,83	51	53,2	44,17
R_A_glas	21,07	41,25 a	24,17 b	26,08 ab	22,21	21,14	20,36	42,1	23,2	34,2	23	20,58	22	38
R_A_grey	21,86	14,5	16,42	23,42	12,64	17,86	12,71	28,4	26,3	27,2	18,75	18,42	10,6	32,67
R_O_pota	32,07	30,17	33,17	27,17	21,43	29,57	24,5	18,4	33,8	30,1	26,67	29,42	18,4	20,33
R_O_hay	10,21	15,33	14,17	9	8,36	15,14	7,5	10,1	19,4	14,9	18,67	22,25	8,2	21,67
R_O_mari	21,14	26,92	24,75	15,83	13	20,21	11,07	16,4	21,9	18,2	20,58	19,83	20,2	38,5
R_O_must	7,36	7,33	3,92	1,08	2,36 b	16,71 a	2,14 b	12,7	25,8	18,9	21	19,5	41	61,5
R_O_sour	7,07	9,75 ab	16,17 a	3,33 b	6,79 b	21,14 a	7,14 b	34,1 ab	51,7 a	17,3 b	51,25	31,75	63,4	76,67
C_O_milk	49,86	47,17	50,83	43,5	42,79	46,43	46,29	30,4 b	26,8 b	50,6 a	24	45,92	20,8	24,33
C_O_hay	5,29	12,83	15,5	17,75	10,36	13,07	14,79	10,6	12,7	15,1	18,92	13,42	6,6	16,83
C_O_must	6,86	8,58	6	8,08	7,57	7,36	5,07	30,2	29	12,6	37,83	16,5	20,2	59,5
C_O_card	10,43	21,25	19,83	17	15	11,36	10,93	31,1	20,6	26,4	30,67	33,5	31,6	48,33
C_O_sour	4,07	8,17	5,92	3,92	10,86	9,07	7,43	28,6	30,4	12,3	45,58	17,83	58,6	68,67
C_O_fish	23,5	21,75	23,5	25,33	19,46	23,21	16,64	39,8	53,1	26,1	45,58	32,92	46,4	64,67
C_A_crea	45,43	40	46,5	30,33	33	43	34,93	37,1	38,2	31,3	46,25	48,58	53,6	50,2
C_A_grey	10,14	8,58 b	7,58 b	26,08 a	8,71	14,43	13,71	24,9	23,5	33,7	18,67	18,25	9,4	29,6
C_A_grey2	17,07	12,33 b	13,58 b	28,5 a	7,93	17,36	12,86	28,8	32,7	31,6	22,33	23	13	32,4
TE_firm	48,07	67,67 a	52,25 b	59,5 ab	64,57 a	46,86 b	58,86 ab	65,6 a	45,5 b	55 ab	53,33	50,08	49,33	23,5
TE_tend	51,57	41,5	50,33	45,58	52,86	49,71	50,43	48,4	32,3	43,8	37,67	38,25	59,67	39
TE_fibr	37,5	51,42	39,58	48	53,21	52,14	50,14	44,9	49,6	56,4	51,42	40,42	44,67	32,5
TE_gran	17,07	35,42	19,17	27,83	21,57	20,29	21	21,9	31,4	33,5	27,92	31	17,67	35,5
TE_stic	20,5	8,75	8,5	10,5	19,5	19,5	18,43	18,8	28,6	12,2	30,75	20,75	23,33	25
TE_dry	24,07	39,92	21,25	29,17	25,43	20,86	24,29	33,8	38,1	46,9	39,42	35,5	42	67
TA_crea	43,43	35,92	43,58	24,92	33,93	37,43	36,57	20,4	17,1	19,9	8,75	26,08	9,33	0,5
TA_pota	48,14	43,83	34,75	33,67	35,93	38,71	44,57	26,3	24,1	36,2	17,25	32,58	19,67	2,5
TA_chic	49,64	43,42	37,5	37,08	39,43	40	38,79	19,3	19,8	23,2	10,33	24,17	9,67	3,5
TA_stoc	32,71	28	24,83	20,92	25,43	28,79	24,36	14	16	18,9	9,83	16	8,67	2
TA_wate	9,43	23,25	15,67	28,75	31,93	24,29	20,14	36,9	20,2	36,6	29,58	23,5	34,67	34,5
TA_sour	2,71	5,5	9,92	2,75	7,29 ab	17,14 a	2,79 b	28,6 ab	38,5 a	12,8 b	53,67	28,58	59,33	71,5

Sensory differences between wild and farmed turbot

Figure 1 show the mean results (per product during the shelf life) for the three different products. Only the significant different attributes are presented.

Cooked odour sour: stolt most sour (26), wild least sour (11), Zeelandvis not different from both (17)

Cooked appearance grey: zeelandvis more grey (23) than stolt (14) and wild (13)

Firm texture: Stolt most firm (62), wild least firm (48), zeeland vis (54) did not differ significantly with the other products.

Cream taste: Wild most creamy taste (37) Zeelandvis (26) and Stolt (24)not different from each other.

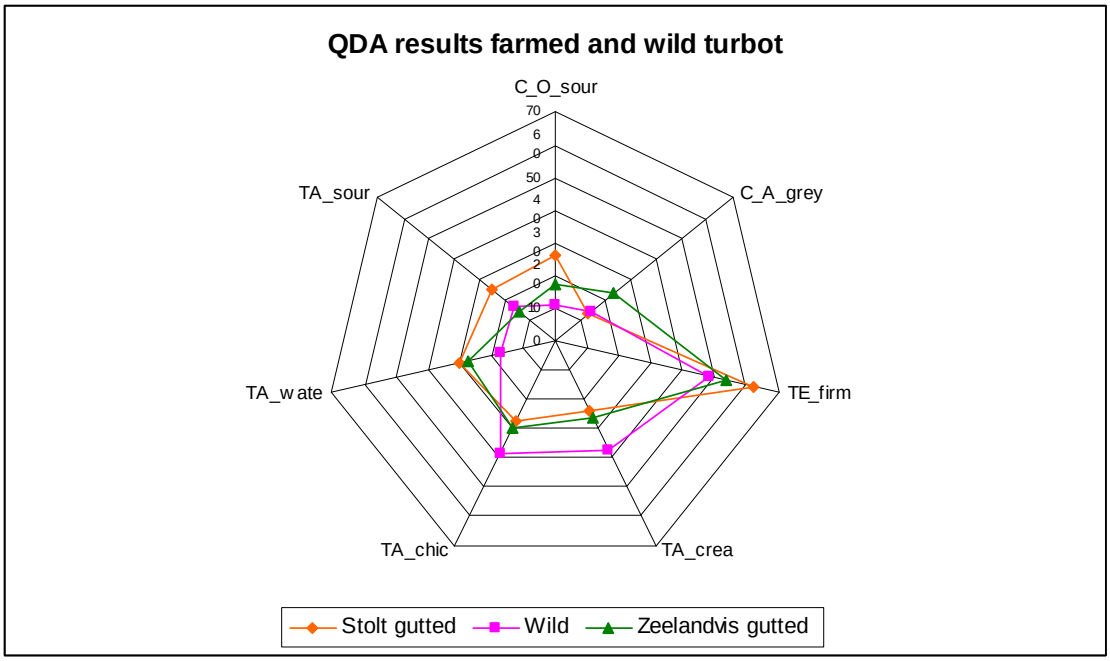
Chicken taste: Wild most chicken taste (38), Stolt least (27), Zeeland vis not different from both (30).

Watery taste: Wild least watery taste (17), Stolt and zeeland vis are the same (30 and 27 resp)

Sour taste: Stolt most sour (25), zeelandvis least (14), Wild in the midle not different from each (16).

The shelf life can be determined by analyzing the increase of spoilage related attributes like sour and fishy. For wild turbot the sour taste increased significantly between day 11 and 15. The panel rejected the wild turbot sample for tasting at day 15. For farmed turbot the sour taste increased significantly between day 18 and 22, at day 22 the panel rejected the samples for tasting.

Figure 1: Mean results QDA farmed and wild turbot. Significant main effect products.



Sensory differences between wild and farmed turbot, independent from spoilage patterns, are expected to be most clear at storage day 5-8 where both varieties are at intermediate freshness stages and therefore real spoilage characteristic attributes are not dominant yet. Due to logistics it was impossible to sample the farmed turbot at day 5 of storage. At day eight the following attributes were significantly different (figure 2)

Raw appearance crème: Wild most crème (60), Zeelandvis (31) least crème Stolt in the midle not sign different (40).

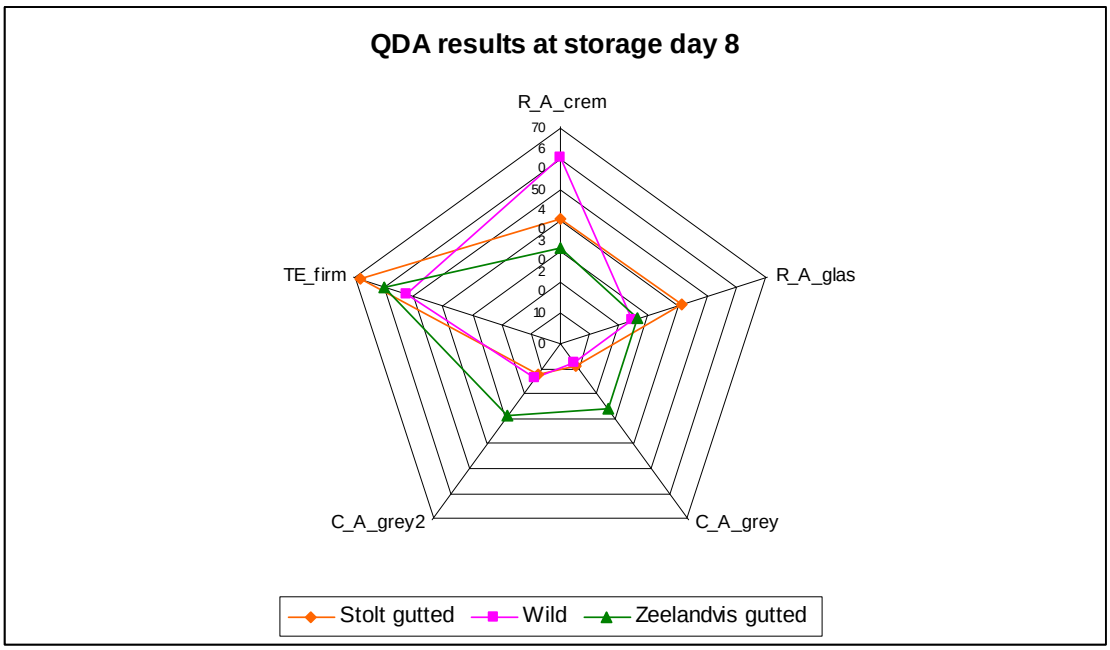
Raw appearance glassy: Stolt most glassy appearance (41), Wild least glassy appearance (24) Zeelandvis in middle not different (26)

Cooked appearance grey: Zeelandvis (26) most grey, Different from both Stolt and wild (9 and 8)

Cooked appearance grabby: Zeelandvis more grabby (28,5), differ with both Stolt and Wild (12 – 14).

Firm texture: Wild least firm (52) Stolt most firm (68) Zeelandvis differ not from both (60).

Figure 2: QDA mean results per product at storage day 8.

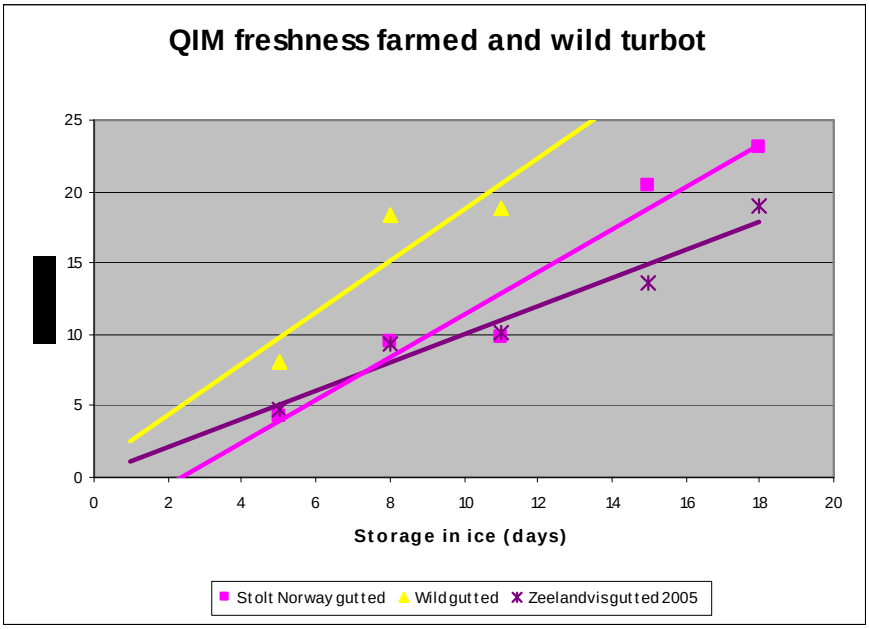


For day 11 similar trends were noticed but more dominant spoilage attributes for wild turbot.
At day 18 the both farmed batches differed on spoilage attributes; Zeelandvis being less spoiled compared with Stolt.
At testing day 22 both farmed turbot were rejected for testing.

QIM analyses

The QIM results are presented as the linear relation between Quality Index scores and the storage time in ice. This QIM scheme was developed for wild turbot. The results from this experiment with farmed turbot are presented in figure 3. The three calibration curves show the difference between farmed and wild turbot.
The shelf life for wild turbot is 13 days (QIM manual 2001). In this study the wild turbot was only assessed until storage day 11 and with a QI of 21 was at the borderline of acceptance. At the same day of storage both farmed species had a QI of 11 (Zeelandvis) and 13 (Stolt). This difference in onset of freshness was due to the different production types: wild caught or farmed.
After 18 days of storage both farmed batches scored QI of 18 (Zeelandvis) and 23 (Stolt). At this point the freshness of fresh farmed turbot was on the borderline of acceptance. The shelf life of farmed turbot is therefore maximum 18 days (QI 21), this is 7 days longer than wild turbot.

Figure 3: QIM results farmed and wild turbot.



Onset of rigor mortis

Deflecting index is presented in figure 4. DI of 0% represents a complete stiff fish (in rigor). After 5 days of storage both the farmed turbot from Stolt as well as the wild turbot were recovered from rigor. The farmed turbot from Zeelandvis stayed in rigor for a longer period (8 days) and did not recover as much from rigor as compared with the wild turbot and the farmed turbot from Stolt. Experiments performed in 2004 (Schelvis 2006) showed similar results for farmed turbot from Zeelandvis slaughtered under similar conditions. In this experiment the post slaughter electro stimulation had a positive effect on the onset and duration of the rigor mortis.

Figure 4: Deflecting index farmed and wild turbot.

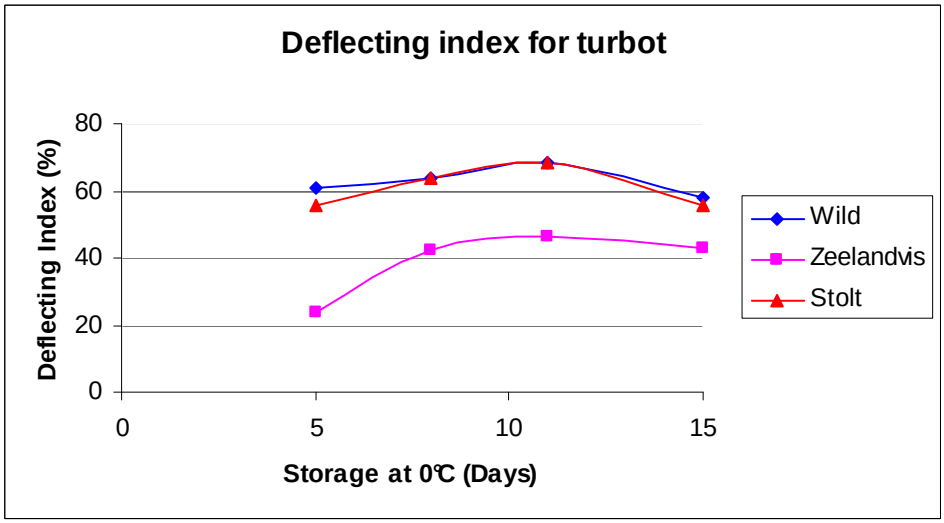
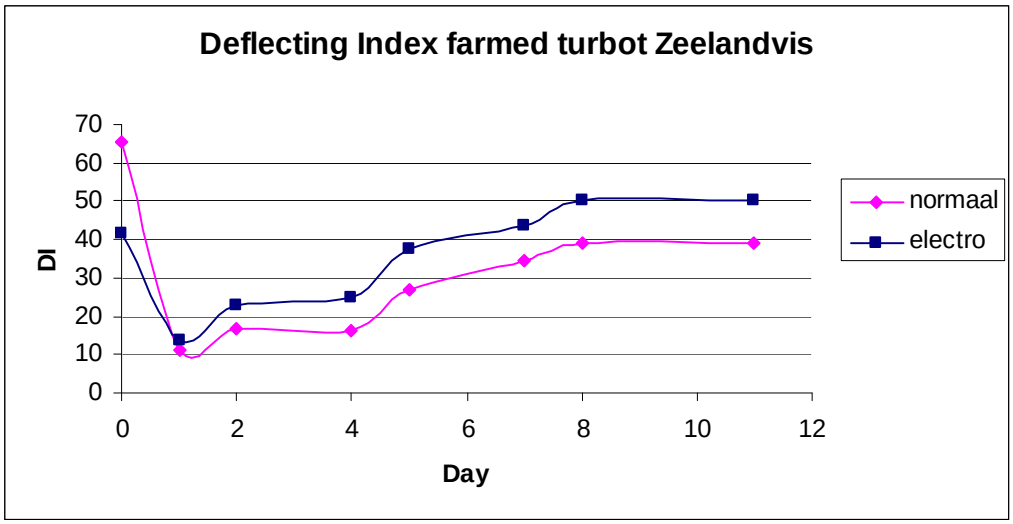


Figure 5: Deflecting Index for farmed turbot from Zeelandvis. Normal slaughter procedure compared with post slaughter electro stimulation to reduce the duration of rigor mortis. (exp 2004)



Sensory analyses fish from Iceland

(Materials and methods reported in:The subsequent effect of pre and post mortem muscle activity on muscle pH, rigor, texture hardness and sensory properties of turbot. *Scophthalmus maximus*. (sensory results not reported in this paper anymore: present in this report to not get lost the data/results)
After 7 days of storage, synchronously with the texture analysis, 2 groups of fish (2 Electrical stimulated 5 Hz, 3 min (El-stim 5 Hz) and 4) Exsanguinated live in ice slurry (Exsanguinated)) were sensory analyzed at Wageningen IMARES by Quantitative Descriptive Analyses (QDA). For sensory analyses of food products the 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 in instrumental data. In general both batches can be described as fresh (low scores on attributes like sour and musty) with a characteristic taste (high scores for attributes potato, milk and chicken) and firm, tender texture. The only significant difference between the two treatments is for the grey colour of the raw product. Batch 2 electrical stimulated with 5 Hz pulsed direct current (pDC) (el-stim 5 Hz) had a more grey appearance than exsanguinated fish (exsanguinated) (scores 21,1 and 5,8 respectively). Several sensory analysis on cooked samples has failed to distinguish textural differences between stressed, electrocuted or ustressed fish (Ruff et al. 2002a; Scherer et al. 2005; Morzel et al. 2003d), but a colour change may often be the result of stress. The electric stimulated carcasses displayed a more grayish colour as compared to live exsanguinated fish. A colour change is often associated with a change of muscle pH (Robb et al. 2000), but in this case there was no difference between these groups in pH or rigor, so the reason of this colour difference is likely to be of different origin, like bleed-out effects (see part C).

4. Conclusion

The sensory profile of fresh farmed and wild turbot only differs on texture attributes: The wild turbot being less firm.
The sensory spoilage pattern is similar for farmed and wild turbot but developed faster for wild caught turbot. The same can be seen for the Quality Index: Zeelandvis farmed turbot has longest shelf life of at least 18 days, followed by Stolt farmed turbot with 18 days of shelf life. The wild caught turbot in this study had a shelf life of 11 days. The farmed turbot from Zeelandvis stays in rigor mortis for 8 days and remains stiffer thereafter.

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Schelvis, Rian, Martine Veldman, Karin Kruijt and Hans van de Vis (2006) Sensory quality and onset of *rigor mortis* for farmed turbot under various post slaughter conditions. Wageningen IMARES report C051/06.

Ir. H. van der Mheen

Signature: _____

Date: November 2006

Annex 1

Attributes for Turbot

attributes accronym	full name	scale	description
R_A_crem	raw appearance crème	not-much	the amount of creme colour
R_A_glas	raw appearance 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 cardboard	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 mouth feel
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, seeweedy	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