

Factors Affecting the Quality of Northern Cod (*Gadus morhua*) Caught by Otter Trawl

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FACTORS AFFECTING THE QUALITY OF NORTHERN
COD (GADUS MORHUA) CAUGHT BY OTTER TRAWL

by



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ABSTRACT

Botta, J.R., and G. Bonnell. 1985. Factors affecting the quality of Northern cod (Gadus morhua) caught by Otter trawl. Can. Tech. Rep. Fish. Aquat. Sci. 1354: iv + 11 p.

The quality of cod caught by commercial trawlers during Feb., March and April in NAFO Division 2J was assessed by trained and experienced Department of Fisheries and Oceans (DFO) personnel using the DFO proposed dockside grading system. Quality was assessed immediately after the cod were brought onboard, at various stages of handling and after unloading at port. The major factors affecting the quality were: (1) length of time between catching and gutting; (2) post mortem age of the iced fish; (3) manner in which the cod were iced; and (4) amount of fish caught during a single tow.

RÉSUMÉ

Botta, J.R., and G. Bonnell. 1985. Factors affecting the quality of Northern cod (Gadus morhua) caught by Otter trawl. Can. Tech. Rep. Fish. Aquat. Sci. 1354: iv + 11 p.

La qualité de la morue pêchée par les chalutiers commerciaux pendant les mois de Février, Mars et Avril, dans le région NAFO 2J, a été évalué par le personnel instruit et compétent du Département des Pêches et Océans (DPO), utilisant le system de dechargage aux docks, proposé par le DPO. La qualité a été évaluée immédiatement après que la morue était transportée au bord du chalutier, et également, à des différent stages de manipulation, et après déchargement au port. Les facteurs majeurs affectant la qualité étaient: (1) le temps écoulé entre la pêche et le vidage; (2) l'age après décès du poisson gardé dans la glace; (3) la méthode avec laquelle la morue avait été gardée dans la glace, et (4) la quantité de poisson attrapé par un chemin de halage.

INTRODUCTION

Since 1975, the quantity of Northern cod from NAFO Divisions 2J and 3KL, caught by Canadian fishing vessels has increased dramatically. Over 200,000 metric tons were taken during 1982 (Table 1). A very substantial portion, over 40% in 1982, of this cod is caught during the winter (Feb.- April) by Otter trawlers (D.A. Tilley, Department of Fisheries and Oceans, Statistics and Systems Branch, St. John's, NF; pers. comm.) gutted and iced at sea and processed on land from 5-10 days later. Substantial quantities of this landed Northern cod are affected by excessive bruising and/or soft texture (D.R.L. White, Department of Fisheries and Oceans, Inspection Division, St. John's, NF: pers. comm.).

Consequently, a study was initiated to determine the cause(s) of these problems and to explore ways of improving the quality.

MATERIALS AND METHODS

Departmental personnel, aboard commercial offshore trawlers and ashore, assessed the quality of a large quantity of cod, recording the location of the catch, the depth at which the fish were caught, the time required to haul in the trawl, the amount of fish caught in that tow and the time that had elapsed since the fish were first brought onboard. Assessments were made by trained and experienced Inspection Officers of the Department of Fisheries and Oceans Inspection Division, using the Department of Fisheries and Oceans proposed dockside grading standards (Table 2). At sea, the quality was assessed on a random sample of 20 fish, whereas on land a random sample of ten fish was used.

In the first study, samples were taken as soon as the cod were brought onboard and every hour thereafter until the complete catch from that tow had been bled/gutted, washed and iced. Usually when a sample was taken for evaluation, a second sample from the same tow and of similar time duration since being brought onboard was bled/gutted, washed and iced and set aside to be graded after unloading at port. In this study the bleeding/gutting was a single-step operation.

A second study consisted of comparing the initial and landed quality of cod which had been commercially iced in boxes with that of cod which had been commercially iced in pens.

Once the sample was graded, the percentage of each of the four different grades was calculated. Mean percentages and standard deviations of these grades, calculated for the various treatments and treatment combinations, are presented in Tables 3-7.

RESULTS AND DISCUSSION

Although the variability was quite noticeable, the mean assessed quality of all Northern cod that was evaluated when first brought onboard was quite good,

Table 1. Quantity of Northern cod caught each year by Canadian fishing vessels for the period 1972-82.

Year	Amount caught by Canadian vessels (mt) ¹	Canadian percentage of total Northern cod caught that year (%)
1972	66,439	14.5
1973	44,137	12.5
1974	36,080	9.7
1975	42,482	14.8
1976	62,991	29.4
1977	79,561	46.1
1978	102,377	73.9
1979	130,779	78.4
1980	147,558	83.9
1981	144,099	89.7
1982	207,464 ²	90.8

¹ Anon. 1983

² Department of Fisheries and Oceans, Statistics and Systems Branch, St. John's, NF; pers. comm.

TABLE 2. Dockside grading standards (cod) that were in existence February 10, 1983.

Grades will be assigned using the combination of factors under Texture and Handling Practices (Table A). Examination in the Round, Gutted or Headed Form (Table B), and Examination of Cut Surfaces (Table C).

Table 1A Texture and Handling Practices

Grade "A"

The fish is firm and resilient and has been bled, gutted, washed and iced at sea.

Grade "B"

The fish is firm and resilient and has not been bled, gutted, washed and iced at sea;

OR

Grade "C"

The fish is slight to moderately soft and has not been bled, gutted, washed and iced at sea;

OR

The fish is soft and has been bled, gutted, washed and iced at sea.

Reject The fish is:

- i) tainted, decomposed or unwholesome, or
- ii) soft and has NOT been bled, gutted, washed and iced at sea, OR
- iii) generally soft and flabby, OR
- iv) reject by criteria in Table B or C.

Table 1B Examination in Round, Gutted or Headed Form.

Fish will be graded into Grades "A" or "B/C" by rating all characteristics which are available and averaging the number of defect points for these characteristics (eg. in headed fish, eyes and gill odour and colour cannot be examined).

Fish will be rejected if (a) the odour at the neck when broken is faint or medium or strong sour or putrid, or (b) the odour of the gills is moderate to strong sour.

Grade "A": Average defect points less than 2.

Grade "B/C": Average defect points 2 or more.

Characteristic	Defect	Points
Odour at neck when broken	Neutral	2
	Neutral	1
	Faint sour	2
Odour-gills	Slight to moderate sour	3
	Very little, if any	1
	bleaching	2
General appearance	Some loss of metallic lustre, some bleaching	3
	Bloom gone and colour faded or bleached	3
	May be slightly sunken or somewhat dull	1
Eyes	Dull, slightly sunken and/or slightly cloudy	2
	Dull, sunken and cloudy	3
	Slightly pinkish red	1
Colour of Gills	Pinkish-red to brownish red, some mucus present	2
	Brown or grey and may be covered with mucus	3

Table 1C Examination of Cut Surfaces

Fish will be graded into Grades "A", "B", "C", or "Reject" on the basis of the severity of the following defects.

Defect	Severity	Grade
Blood clots (greater than 1/2 cm in any dimension)	None	A
	No combination of blood clots exceeding 4 cm in total maximum dimension in any one fillet.	B
	One or any combination of blood clots which exceeds 4 cm in total maximum dimension in any one fillet.	C
Discolorations (including bruising)	-No single discoloration nor any combination exceeding 2 cm in total maximum dimension in any one fillet.	A
	-No single discoloration nor any combination exceeding 5 cm in total maximum dimension in any one fillet.	B
	-Any single discoloration or combination the total surface area of which does not exceed 50% of the total surface area of any one fillet.	C
	-Any discoloration, the total surface area of which exceeds 50% of the total surface area of any one fillet.	REJECT

being rated 74.3% grade A, 14.6% grade B, 11.1% grade C and 0.0% reject (Table 3). The mean assessed quality of cod from only those catches which were sampled both immediately after the cod was brought onboard and after reaching port was greatly affected by the onboard handling. With these samples the initial quality was also very good (79.8% rated grade A and none rated reject) whereas the landed quality was anything but good (only 37.0% grade A, 30.5% grade B, 32.5% grade C and 0.0% reject) (Table 3). When evaluated directly after being brought onboard, any downgrading of quality was almost entirely due to the degree of discoloration (mostly bruises with a few blood clots) of the fillets. However, when assessed after reaching port, downgrading was due equally to discoloration and to poor texture. The discoloration was caused by bruises, blood clots and enzymatic degradation of the flesh adjacent to the visceral cavity, commonly referred to as belly burn. More extensive washing of the gutted fish probably would have substantially reduced the degree of belly burn.

One onboard handling factor which was observed to vary considerably was the length of time between the cod's coming onboard and its being gutted. The present results indicate that a delay of only 1 hour had little effect whereas a 2-hour delay had a substantial effect on quality with only 50.6% of the cod rated grade A, compared to 74.3% on initial assessment, while a 4-hour delay resulted in only 30% grade A fish (Table 4). After 4 hours, the effects of the delay no longer increased with time; the quality of cod after a 9-hour delay was no lower than that delayed for 4 hours (Table 4). The downgrading was almost entirely due to increased bruising, a phenomenon also observed in cod under laboratory conditions (Varga, 1979).

Another factor which appeared to vary considerably was the amount of fish caught in any one catch, although when this factor was examined, the overall mean assessed quality did not appear to vary directly with the amount caught (Table 5). Examination of the frequency distribution of cod rated grade A revealed that the quality of catches of 4,500 Kg or less may often be higher than that of catches greater than 4,500 Kg (Table 6). However, some large catches were observed to be of very good quality and some small catches were observed to be of relatively poor quality. Moreover, the length of the delay between the time the fish are first brought onboard and the time the fish are gutted is directly related to the amount of fish per catch. This study has shown that such a delay seriously affects the assessed quality of the catch. Thus the amount of fish per catch may have both a very important indirect effect and an important direct effect upon assessed quality.

Although most Canadian offshore trawlers ice their catches in pens with shelving, some are now icing fish in boxes. When these two methods of icing were compared, it became evident that if the cod were iced in boxes and stored for only 5 or 6 days, the assessed quality did not deteriorate to any great extent (Table 7). With no delay prior to icing, there was no deterioration but with a delay of 1 or 2 hours, the amount of cod that was rated grade A on land was ten percentage points less than that when graded initially (Table 7). In general, this deterioration was far less than that observed with cod iced in pens for a similar period (Table 7). When iced in pens, stored in ice 5 days and unloaded by hand at port, cod which was 75-85% grade A initially had deteriorated to 30-40% grade A

Table 3. Mean assessed quality of Northern cod evaluated immediately after being brought onboard and after being unloaded at port.

Mean assessed quality of all cod graded immediately after being brought onboard:

	<u>Grade A</u>	<u>Grade B</u>	<u>Grade C</u>	<u>Reject</u>
Mean n = 58	74.4	14.6	11.1	0
Standard Deviation	16.3	10.2	9.3	0

Mean assessed quality of cod graded immediately after being brought onboard and after unloaded at port:

	<u>Grade A</u>	<u>Grade B</u>	<u>Grade C</u>	<u>Reject</u>
Initial Quality				
Mean n = 27	79.8	11.5	8.7	0
Standard Deviation	14.5	8.1	8.7	0
Quality after Unloading ¹				
Mean n = 27	37.0	30.5	32.5	0
Standard Deviation	24.0	14.3	21.8	0

n = number of catches that were sampled

¹ Unloaded by hand.

Table 4. Mean assessed quality of Northern cod evaluated at various times after being brought onboard but before being gutted, washed and iced.

Time onboard (Hr)	n	G r a d e			
		A	B	C	R
0	58	74.3 \pm 16.4	14.6 \pm 10.2	11.1 \pm 9.3	0
1	37	61.2 \pm 19.7	19.6 \pm 9.9	18.9 \pm 16.6	0.3 \pm 1.2
2	16	50.6 \pm 22.0	18.1 \pm 7.3	31.3 \pm 21.8	0
3	7	40.0 \pm 22.2	19.3 \pm 10.6	40.0 \pm 15.0	0.7 \pm 1.9
4	4	30.0 \pm 12.9	22.5 \pm 15.0	47.5 \pm 17.0	0
9	2	37.5 \pm 3.5	17.5 \pm 17.7	45.0 \pm 14.1	0

n = number of catches that were sampled

Table 5. Mean assessed quality of Northern cod sampled from catches of various sizes.

Amount per catch (Kg)	Time onboard (h)	n	G r a d e			
			A	B	C	R
>22,800	0	1	50	25	25	0
18,100-22,700	0	1	80	5	15	0
14,000-18,000	0	2	82 \pm 4	10 \pm 0	8 \pm 4	0
11,500-13,900	0	4	61 \pm 25	21 \pm 15	18 \pm 14	0
9,500-11,400	0	7	69 \pm 18	13 \pm 10	18 \pm 12	0
7,500- 9,400	0	6	73 \pm 13	13 \pm 5	14 \pm 11	0
5,000- 7,400	0	9	67 \pm 14	19 \pm 10	14 \pm 8	0
2,500- 4,900	0	13	83 \pm 13	11 \pm 9	6 \pm 4	0
\leq 2,400	0	15	79 \pm 16	15 \pm 12	6 \pm 7	0

n = number of catches that were sampled

Table 6. Observed frequency distribution of fish sampled from 58 different catches that were rated Grade A.

Percent Grade A	Catches $\leq 4,500$ Kg per catch (n=28)		Catches $> 4,500$ Kg per catch (n=30)	
	Observed frequency (%)		Observed frequency (%)	
100	7.1	53.6	0.0	16.7
95	14.3		3.3	
90	17.9		6.7	
85	14.3		6.7	
80	7.1	35.4	23.3	46.6
75	10.7		13.3	
70	17.9		3.3	
65	0.0		6.7	
60	3.6	10.8	3.3	36.6
55	0.0		10.0	
50	3.6		13.3	
45	0.0		3.3	
40	3.6		6.7	

Table 7. Mean assessed quality of Northern cod iced in different manners.

Time onboard (h)	Post mortem age ¹	n	Mean assessed quality (% grade A)				
			Iced in boxes		n	Iced in pens	
			Initial quality	Landed quality		Initial quality	Landed quality ²
0	5	1	70%	70%	4	88%	40%
0	6	2	78	75			
0	7	3	83	56			
0	8	4	73	44	1	80	40
0	9	4	69	20	2	85	25
0	10	3	78	20			
0	11	3	95	22	1	95	20
1	5	3	60	50	2	78	40
1	8	4	59	33			
1	9	4	51	12		55	0
1	10	1	55	10			
2	5	1	40	30	1	75	30
2	6	2	55	50			
2	8	1	50	60			
2	9				1	70	0
2	10	2	40	30			

n = number of catches that were sampled

¹ Post mortem age (days) when graded on land

² Unloaded by hand

when landed (Table 7). In all other cases observed, iced storage of Northern cod in pens for up to 11 days caused large to very large deterioration in assessed quality (Table 7) and cod iced in boxes showed quite substantial deterioration after 7 days of storage (Table 7). The deterioration increased with storage time; however, a delay prior to icing was observed to cause noticeable reduction, possibly reducing the amount of deterioration that occurred between placing the fish in ice and grading on land (Table 7). Apart from this reason it is not known why some cod delayed 2 hours and iced in boxes did not deteriorate as much as those delayed 1 hour. These results regarding the effect of both icing in boxes and the post mortem age of the fish are not surprising. British authorities have for years recommended icing in boxes over icing in pens with shelves (Reay and Shewan, 1949). It has also been known for years that cod and haddock which are gutted immediately, then rapidly washed well and stored in plenty of ice, show no marked sign of spoilage during the first five or six days of storage (Reay, 1951; Reay and Shewan, 1949).

All fish in the present study were unloaded by hand. If the fish iced in pens had been unloaded using the vacuum unloader, as it normally the case, the differences observed would probably have been greater (R.E. Mills, Department of Fisheries and Oceans, Inspection Division, St. John's, NF; pers. comm.).

It is interesting to note that the assessed quality of the Northern cod immediately after it was brought onboard was generally similar to that of cod caught by either an inshore dragger in the northeastern Gulf of St. Lawrence, or by gillnets set on Cape Ballard Bank for 1 or 2 days, then bled, gutted, washed and iced at sea prior to being graded at dockside on the day of catching (Botta et al. 1982b, 1982; Botta and Squires 1983). However, the assessed quality of Northern cod was slightly inferior to that of cod caught by baited hook on Cape Ballard Bank or by traps set near Gooseberry Cove, Trinity Bay, NF, or near Renew's, NF, and bled, gutted, washed and iced at sea prior to being graded at dockside within a few hours of catching (Botta et al. 1982a; Botta and Squires 1983).

CONCLUSIONS

Although occasionally the assessed quality of Northern cod was low when the fish were first brought onboard ship, in general the quality was very good. However, because of the effects of various onboard handling factors, this Northern cod was often of very much lower quality when graded on land. These factors were: (a) the length of the delay between catching and gutting the cod of substantially longer than 1 hour; (b) storing the cod in ice for more than 6 days; (c) icing the cod in pens with shelving rather than in boxes, and (d) catching more than 10,000 lb at any one time.

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