Utilization of Atlantic Cod *(Gadus morhua)* Judged to Have "Blackberry" Odor

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UTILIZATION OF ATLANTIC COD (*GADUS MORHUA*) JUDGED TO HAVE "BLACKBERRY" ODOR

by

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ABSTRACT

Botta, J.R., E.A. Byrne, and B.E. Squires. 1985. Utilization of Atlantic cod (Gadus morhua) judged to have "blackberry" odor. Can. Tech. Rep. Fish. Aquat. Sci. 1383: iv + 11 p.

A laboratory-type study was conducted to determine if Atlantic cod filmets judged to have "blackberry" odor could be utilized after subsequent frozen storage.

Processed, but not frozen, raw fillets from cod caught by trap and gutted and iced at sea were only fit for utilization as saltfish or offal due to substantial "blackberry" odor. Regardless of the package size (0.5, 2.3 or 7.5 kg) or the storage temperature (-15, -20, or -26°C), after 8 or 12 weeks of storage, the thawed fillets contained very little (nil to very slight) "blackberry" odor. Based on the assessment of these raw thawed fillets and the sensory evaluation results of cooked fillets, it was concluded that "blackberry" odorous cod were suitable for utilization in products other than saltfish or offal, following frozen storage at -15°C or colder for at least 8 weeks.

RESÜME

Botta, J.R., E.A. Byrne and B.E. Squires. 1985. Utilization of Atlantic cod (Gadus morhua) judged to have "blackberry" odor. Can. Tech. Rep. Fish. Aquat. Sci. 1383: iv + 11 p.

Une etude de laboratoire a ete entreprise afin de determiner si les filets de la morue de l'Atlantique possedant une odeur de mure (dimethyl-sulfure) pourraient etre utilises apres plusieurs conservages geles.

Les filets crues de la morue, procedes et non pas geles qui avaient ete attrapes par piege et eventres etaient convenable pour l'utilisation comme poissons-sales ou rebuts. Sans faire aucun cas de la grandeur de l'emballage (0.5, 2.3 ou 7.5 kg) ou de la temperature de l'emmagasinage (-15, -20 ou -26°C), apres huit a douze semaines de conservation, les filets degeles ne possedaient que de traces d'odeur de mure. Se basant sur le classement de ces filets degeles crues et sur les resultats de l'evaluation gustative des filets cuits, nous avons conclu que la morue possedant une odeur de mure apres plusieurs emmagasimages geles a -15°C ou a'plus basse temperatures, pour au moins huit semaines, pourraient etre utilises dans des produit autres que poissons-sales et rebuts.

INTRODUCTION

Cod caught in waters adjacent to northern Newfoundland and southern Labrador during July and August sometimes possess a pronounced and offensive odor referred to as "blackberry" odor (Sipos and Ackman 1964).

The problem is caused by cod feeding on a particular zooplankton (Limacina helicina) which secretes dimethyl-β-propiothetin. This compound is broken down upon digestion to dimethyl sulphide, the actual odoriferous compound, which is present in the cod's stomach and flesh (Ackman et al. 1966; 1967; and Sipos and Ackman 1964). Fish that possess this odor are either discarded to be used as offal or a limited volume used to produce saltfish (D.R.L. White, Department of Fisheries and Oceans, Inspection Division, St. John's, NF; pers. comm.).

Although the problem usually occurs annually in the Strait of Belle Isle/southern Labrador area, during certain years it has occurred on such a large scale that it has been a problem with cod caught as far south as Trinity Bay (F.J. Lee, Department of Fisheries and Oceans, Inspection Division, Grand Falls, NF; pers. comm.). Recently, 1981 was such a year and a tremendous volume of otherwise useful cod had to be discarded.

The Seafood Technology Section was requested to investigate the possibility of utilizing cod judged to have "blackberry" odor. It is known that dimethyl sulphide is a very volatile compound (Windholz 1983) and that any "blackberry" odor of moderate intensity disappears during the salting of cod (A. Kenny, National Sea Products Ltd., Halifax, NS; pers. comm.). In addition, in 1981 while conducting re-inspections on cod previously rejected for possessing "blackberry" odor, local inspection officers experienced great difficulty in detecting the odor in products that had been stored frozen for moderate periods of time (F.J. Lee, Department of Fisheries and Oceans, Inspection Division, Grand Falls, NF; pers. comm.). Therefore, it was decided to investigate the disappearance of the odor in "blackberry" odorous cod stored at different temperatures as a means of utilizing such fish.

MATERIALS AND METHODS

RAW MATERIALS

Atlantic cod were caught by commercial trap fishermen in the Strait of Belle Isle, near the southern tip of Belle Isle, on August 3, 1984. The cod were gutted and iced, three parts fish to one part ice, within several hours of being caught. Approximately 16 hours after being caught, the cod were unloaded by bucket at Quirpon, NF, and placed inside insulated plastic containers (1.0 m x 1.0 m x 1.0 m) which were insulated with 6.3 cm thick polyurethane and fitted with insulated covers. The unloaded cod were iced at a ratio of three parts fish to one part ice. The filled containers were trucked to the Fishery Products International Ltd. fish plant at St. Anthony, NF, where they were stored in the holding area until processed August 7, 1984.

The cod were filleted by hand, skinned by machine, trimmed by hand then packaged into 7.5 kg blocks, 2.3 kg packages and 0.5 kg packages. Four individual packages containing 7.5 kg of fillets were placed inside a polyethylene bag inside a cardboard carton which was then sealed with tape. Each 2.3 kg package contained six portions of fillets that were wrapped with polyethylene. Ten of these packages were placed inside a cardboard carton which was sealed with tape. With the 0.5 kg packages, the fillets were wrapped in polyethylene film prior to being placed inside each package. Twelve of these packages were placed inside a cardboard carton which was sealed with tape. Thus, in general, the fillets were packaged as if they were intended for export.

The packaged fillets were frozen using a plate freezer, placed in cartons and stored in an air blast freezer (-25°C) for 14 days. The samples were kept at -18°C during transportation to St. John's, NF. Upon arrival at St. John's, the samples that had been assessed at St. Anthony, NF, were stored at -40°C until sampled after a total storage time of 12 weeks, including storage time at St. Anthony and during transportation. All other samples were stored at -15°C, -20°C, and -26°C until sampled after a total storage time of 8 and 12 weeks.

When the samples had been stored frozen for a total of 12 weeks, fifteen 2.3 kg packages that had been stored at each of -15°C, -20°C and -26°C were transferred to -40°C where they were stored until assessed by a sensory evaluation panel. Commercial control samples were also presented to the sensory evaluation panel. These samples of an average quality brand intended for the food service market were obtained from a local fish company. They had been packaged in the same manner as the "blackberry odorous" samples which were to be presented to the sensory evaluation panel. Immediately after the commercial control samples were received, they were stored at -40°C until assessed by the sensory evaluation panel.

ASSESSMENT OF RAW COD

Prior to being frozen at St. Anthony, NF, fillets contained in 15 blocks, fifteen 2.3 kg packages and thirty 0.5 kg packages were assessed using a 1 to 7-point scale (nil odor to heavy odor) by a trained and experienced Fish Inspection Officer. During each sampling at St. John's 15 blocks, fifteen 2.3 kg packages and thirty 0.5 kg packages were sampled from each of the different storage temperatures then placed at +10°C for 24 hours and assessed by trained and experienced Fish Inspection Officers using the same procedure that was used at St. Anthony.

ASSESSMENT OF COOKED COD

Both the frozen commercial control samples and the "blackberry odorous" samples stored at -40°C were trimmed, sawn into equal-sized pieces (1.5 cm x 2.5 cm x 6.0 cm), wrapped with an oxygen impermeable film and restored at -40°C until evaluated (within 6 weeks). When required for evaluation purposes, these small pieces were removed from -40°C, placed into an aluminum pan, covered with aluminum foil, baked at 204°C for 50 minutes in a conventional oven, transferred to coded glass petri dishes and served hot using an

electric warming tray. Evaluations were made in partitioned booths with daylight fluorescent lighting using room temperature tap water for rinsing between samples. Generally, samples were evaluated within 15 minutes of cooking.

The "blackberry odorous" samples that had been stored at -15°C, -20°C and -26°C as well as commercial control samples were presented to 20 judges at various sessions. Each judge evaluated four samples per session and a total of 15 different samples (fillets) of each treatment using a 9-point hedonic scale (Table 1).

ASSESSMENT OF DATA

Mean odor scores of raw fillets and mean sensory evaluation scores of cooked fillets were calculated for all treatment combinations assessed/ evaluated.

For each of the package sizes assessed, analysis of variance was conducted on the results of assessing raw fillets and evaluating cooked fillets using a one-way analysis of variance with temperature/storage time combination as the fixed main effect. When analysis of variance indicated significant differences among the temperature/storage time combinations, pairwise t-tests were conducted on differences between means, with levels adjusted to Sidak's inequality for all main-effect means (SAS 1982), to identify these differences. Unless otherwise stated, "significant" means significant at the 5% level.

RESULTS AND DISCUSSION

QUALITY OF RAW COD

When processed at St. Anthony, the "blackberry" odor was of moderate intensity in the fillets contained in both the 0.5 kg packages and the 2.3 kg packages, but was between moderate-heavy and heavy intensity in the fillets of the 7.5 kg packages that were evaluated (Fig. 1). However, regardless of what temperatures the frozen samples were stored at, when evaluated eight weeks later, the "blackberry" odor averaged between nil and very slight intensity for fillets in all three types of packages (Fig. 1). When evaluated again after a total of 12 weeks of storage, very similar results (average intensity between nil and very slight) were obtained. After 12 weeks of storage the samples which had been evaluated at St. Anthony, then frozen and stored at -40°C after being transported to St. John's were re-evaluated. The intensity of the "blackberry" odor in these samples also averaged between nil and very slight (Fig. 1).

Analysis of variance of the odor grades of raw fillets revealed that there was a very highly significant ($P \leq 0.001$) difference among the eight different treatment combinations for each of the three different types of packages. The pairwise t-test revealed that for each of the three different

Table 1. Form used to evaluate sensory quality of "blackberry odorous" cod fillets.

DATE _____ TASTER _____ PRODUCT _____

Taste test these samples and check how much you like or dislike each one. Use the appropriate scale to show your attitude by checking at the point that best describes your feeling about the sample. Please give a reason for this attitude. Remember, you are the only one who can tell what you like. An honest expression of your personal feeling will help us.

Code _____	Code _____	Code _____	Code _____
_____ Like extremely	_____ Like extremely	_____ Like extremely	_____ Like extremely
_____ Like very much	_____ Like very much	_____ Like very much	_____ Like very much
_____ Like moderately	_____ Like moderately	_____ Like moderately	_____ Like moderately
_____ Like slightly	_____ Like slightly	_____ Like slightly	_____ Like slightly
_____ Neither like nor dislike	_____ Neither like nor dislike	_____ Neither like nor dislike	_____ Neither like nor dislike
_____ Dislike slightly	_____ Dislike slightly	_____ Dislike slightly	_____ Dislike slightly
_____ Dislike moderately	_____ Dislike moderately	_____ Dislike moderately	_____ Dislike moderately
_____ Dislike very much	_____ Dislike very much	_____ Dislike very much	_____ Dislike very much
_____ Dislike extremely	_____ Dislike extremely	_____ Dislike extremely	_____ Dislike extremely
REASON:	REASON:	REASON:	REASON:

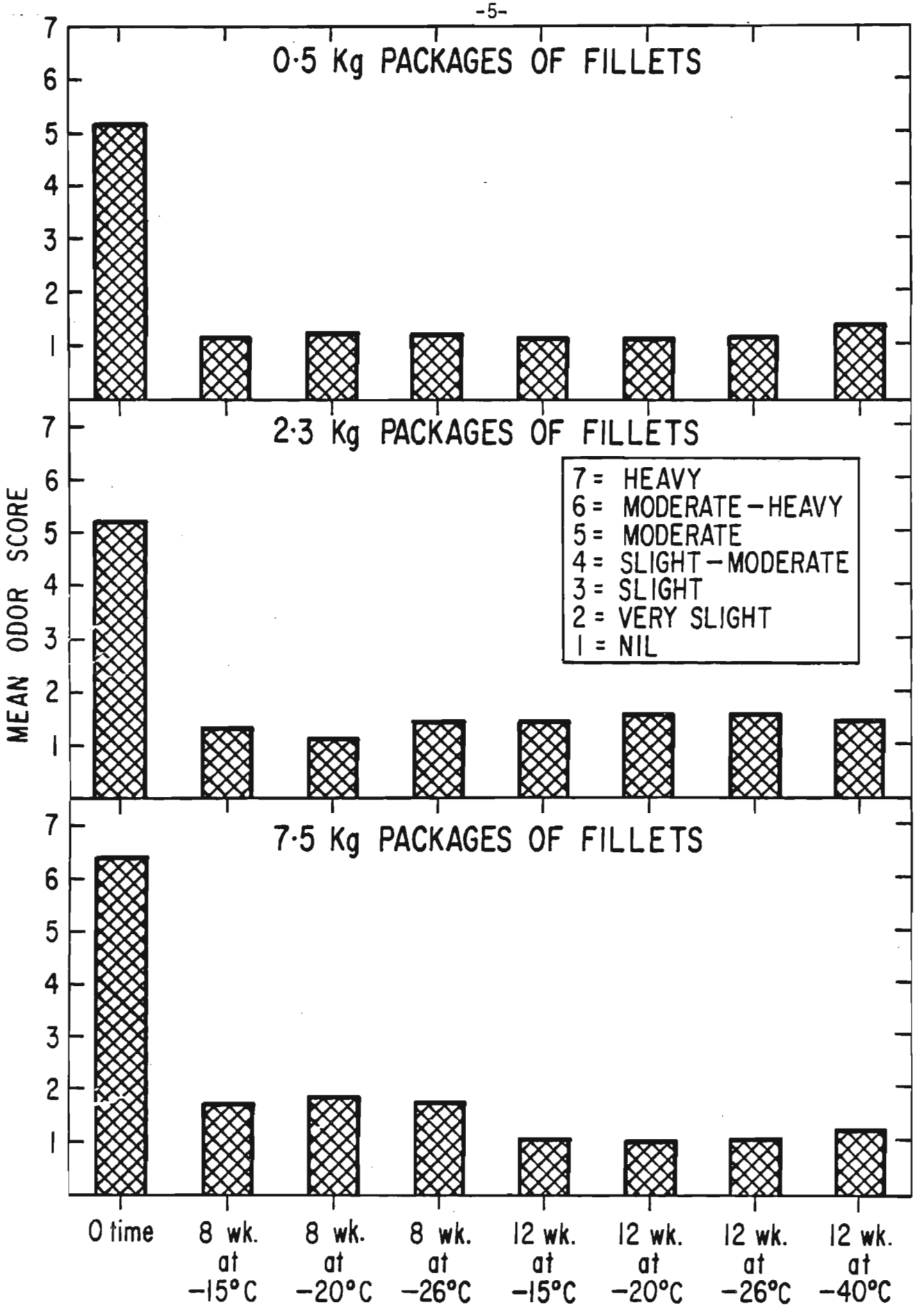

Fig. 1. Mean odor scores of raw fresh or thawed cod fillets judged to have "blackberry" odor.

types of packages, the "blackberry" odor of the processed, but not frozen, fillets was significantly stronger than that of any of the samples which had been stored frozen for 8 or 12 weeks prior to being thawed and assessed (Table 2). With fillets packed in 0.5 kg packages or in 2.3 kg packages, the "blackberry" odor of samples stored frozen for 8 weeks then thawed and assessed did not significantly differ from samples stored frozen for 12 weeks then thawed and assessed (Table 2). However, with fillets packaged in 7.5 kg packages, the "blackberry" odor of samples stored frozen 12 weeks was significantly less than that of samples stored 8 weeks, but even at 8 weeks the mean odor scores were less than very slight (Fig. 1, Table 2).

QUALITY OF COOKED COD

A substantial number of the cooked samples of each of the four treatments were disliked by the 20 judges resulting in relatively low means for each of the treatments (Fig. 2). However, analysis of variance of the taste panel results revealed a very highly significant ($P \leq 0.001$) difference among the four different treatments. The pairwise t-test revealed that the commercial control samples did not significantly differ from the "blackberry odorous" samples that were frozen and stored at -15°C (Table 3). Similarly, the "blackberry odorous" samples stored at -20°C did not significantly differ from the "blackberry odorous" samples stored at -26°C (Table 3). However, the sensory quality of samples stored at either -20°C or -26°C was significantly higher than that of the samples stored at -15°C or that of the commercial control samples (Table 3). Thus, the "blackberry odorous" samples which had been frozen and stored, particularly those stored at -20°C or -26°C, were observed to be acceptable.

The statistical differences among the samples were confirmed by analyzing the written comments of the 20 judges. In general, the comments referred to the four primary sensory variables (appearance, flavor, odor and texture). There were far more negative comments regarding the commercial control samples or the "blackberry odorous" samples stored at -15°C than there were regarding the "blackberry odorous" samples stored at -20°C or -26°C. With all treatments the negative comments most frequently refered to texture. However, with both the commercial control samples and the samples stored at -15°C, there were a substantial number of comments critical of flavor or odor but these did not specifically refer to "blackberry" odor. In fact, the commercial control samples, not judged to have "blackberry" odor, received the greatest number of negative comments regarding flavor and/or odor. In contrast, the "blackberry odorous" samples stored at -20°C or -26°C received more positive comments than negative ones regarding flavor and/or odor.

GENERAL DISCUSSION

The two inspectors who assessed the samples which had been stored 8 weeks were different from the inspector who assessed the processed samples at St. Anthony. When evaluated after 12 weeks of storage, all three inspectors assessed all samples and very little (if any) difference was observed among the inspectors.

Table 2. Results of pairwise t-test of odor grades of raw fresh and thawed cod fillets judged to have "blackberry" odor.

Treatment combination	Fillets in 0.5 kg packages		Fillets in 2.3 kg packages		Fillets in 7.5 kg packages	
	n	Mean[1]	n	Mean[1]	n	Mean[1]
0 time	30	5.20[a]	15	5.27[a]	15	6.47[a]
8 wks. at -15°C	30	1.17[b]	15	1.33[b]	15	1.73[b]
8 wks. at -20°C	30	1.27[b]	15	1.13[b]	15	1.87[b]
8 wks. at -26°C	30	1.23[b]	15	1.47[b]	15	1.73[b]
12 wks. at -15°C	30	1.13[b]	15	1.47[b]	15	1.07[c]
12 wks. at -20°C	30	1.13[b]	15	1.60[b]	15	1.00[c]
12 wks. at -26°C	30	1.17[b]	15	1.60[b]	15	1.07[c]
12 wks. at -40°C	30	1.40[b]	15	1.47[b]	15	1.20[c]

[1] Means not sharing the same letter are significantly different from each other.

n = number of observations per treatment combination.

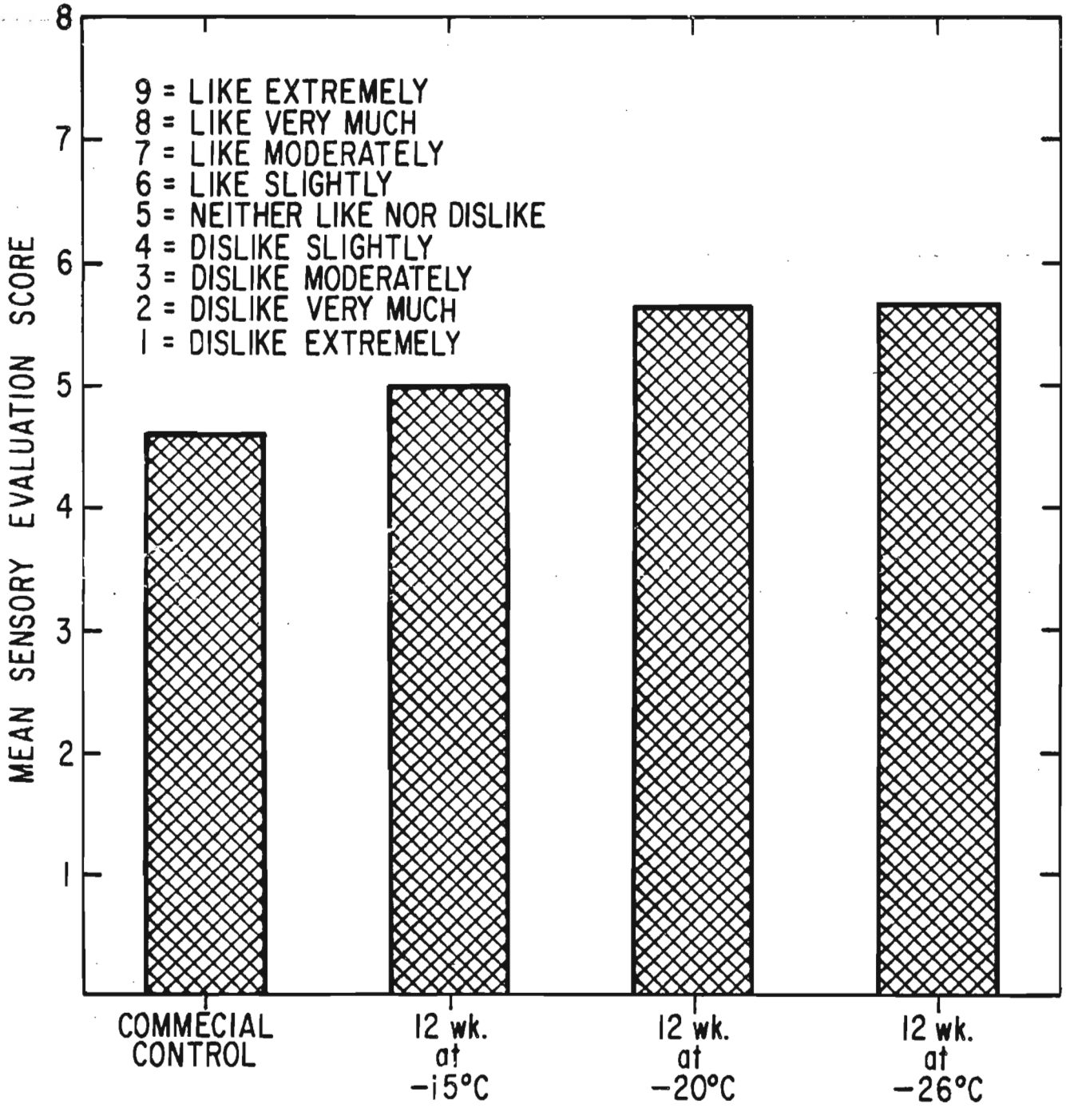

Fig. 2. Mean sensory evaluation scores of cooked cod fillets.

Table 3. Results of pairwise t-test of sensory evaluation scores of cooked cod fillets[1].

Treatment	Fillets in 2.3 kg packages	
	n	Mean[1]
Commercial Control	298	4.63[a]
12 wks at -15°C	298	5.00[a]
12 wks at -20°C	298	5.64[b]
12 wks at -26°C	298	5.68[b]

1 Means not sharing the same letter are significantly different from each other.

n = number of observations per treatment.

The samples re-assessed after approximately 12 weeks of storage at -40°C were the identical samples originally evaluated at St. Anthony. Although the original assessment indicated substantial "blackberry" odor, the re-assessment indicated very little (nil to very slight).

It should be noted that during the assessment of the raw fillets, all inspectors were actively trying to discover if "blackberry" odor was present in the samples. However, during the course of their routine activities at fish processing plants, inspectors may not be actively seeking the presence of "blackberry" odor in the commercial fillets.

The cooked samples were evaluated without any salt, sauces or other flavorings added to the product. This may have been a cause for some of the low scores given to the products.

It is suspected that either long storage time or storage at a temperature warmer than -20°C was the cause of the sensory quality of the commercial control samples being significantly lower than the -20°C or -26°C samples, but not lower than the -15°C.

It is not certain whether the odor disappeared during frozen storage, during thawing prior to assessing raw fillets, or during direct cooking of frozen fillets. Regardless of when the odor disappeared, cod fillets which were not acceptable when processed were later acceptable in both the thawed (raw) and cooked state. However, it should be stressed that the samples were thawed at +10°C for 24 hours (which is the standard procedure within the NF Region used by the Department of Fisheries and Oceans, Inspection Division, for re-inspecting fish) but if thawed differently, the results could change.

Although the present observations are based on only one lot (8,000 kg) of head on/gutted cod the results are consistent with dimethyl sulphide being a very volatile compound, its disappearance during the salting of fish, diminishing during iced storage (Ackman 1965; Ackman et al. 1967; and Windholz 1983) and the difficulty that was observed (1981) in detecting "blackberry" odor while re-inspecting frozen/thawed cod that had been previously rejected. In addition, Ackman et al. (1972) observed that dimethyl sulphide was driven off during the cooking of mackerel.

The Government of Canada, Fish Inspection Regulations, Section 6(1a) state "no person shall import, export or process for export or attempt to import, export or process for export any fish that is tainted, decomposed, or unwholesome or otherwise fails to meet the requirements of these Regulations". Tainted is defined as any fish that is rancid or has an abnormal odor or flavor. Thus, any fish tainted with "blackberry" odor would have to be detained and, pending re-inspection results, released.

CONCLUSIONS AND RECOMMENDATIONS

A laboratory-type study was conducted to determine if Atlantic cod fillets judged to have "blackberry" odor could be utilized after subsequent frozen storage.

Although immediately prior to freezing, the raw fillets were judged to have "blackberry" odor, it was found that regardless of the package size (0.5 kg, 2.3 kg, or 7.5 kg) or frozen storage temperature (-15°C, -20°C, or -26°C) samples stored for 8 or 12 weeks then thawed and assessed contained very little (if any) "blackberry" odor.Taste panel evaluation of samples (2.3 kg packages) cooked after being stored at -15°C, -20°C, or -26°C for 12 weeks confirmed that the samples were acceptable for direct human consumption.

It is recommended that fish processing companies faced with cod judged to have "blackberry" odor consider using frozen storage as a means of eliminating the odor. Such odorous products must be detained when processed and frozen, but should be re-inspected 60 days later, and released for use, if the "blackberry" odor has disappeared.

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