Chemical Composition Of Meat And Sensory Quality Of Canned Meat From Harp Seal In Moltin And Pre-molting Conditions

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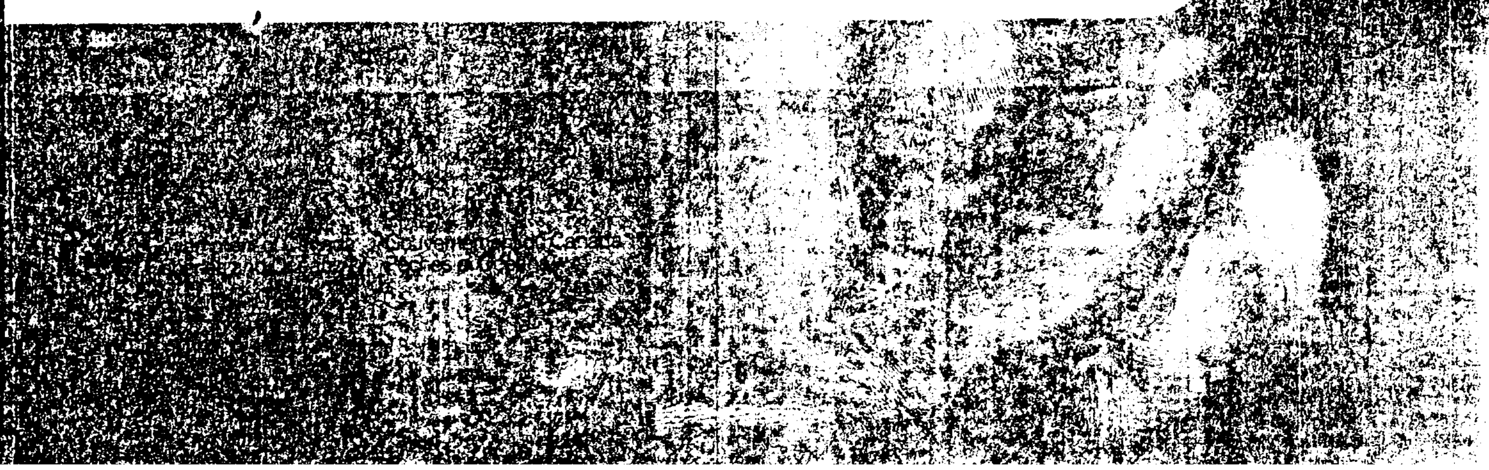

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ABSTRACT

Botta, J. R., E. Arsenault, H.A. Ryan, and N. Shouse. 1982. Chemical composition of meat and sensory quality of canned meat and frozen meat from harp seal (*Phoca groenlandica*) in molting and pre-molting condition. Can. Tech. Rep. Fish. Aquat. Sci. 1053:iv + 18 p.

Meat, of different carcass cuts, from molting and pre-molting seals of different ages was chemically analyzed. Portions of each cut of meat were: (a) canned with seasoning; (b) canned without seasoning: and (c) frozen prior to being assessed by a sensory evaluation panel. The ash, fat and protein content of meat from molting harp seal was not significantly different than that of pre-molting animals. However, moisture content of meat from molting animals was significantly higher than that from pre-molting seals, while carbohydrate level was significantly lower. Regardless of the manner of processing, judges preferred meat from molting seal. The greatest effect was with meat canned without seasoning and the least effect was with frozen meat. 8oth the age of the seal and the type of carcass cut influenced the effect of molting on the sensory quality of the meat.

Key Words: canned, composition, frozen, harp seal, meat, molting, *Phoca groenlandica*, pre-molting, quality.

RÉSUMÉ

Botta, J.R., E. Arsenault, H.A. Ryan, and N. Shouse. 1982. Chemical composition of meat and sensory quality of canned meat and frozen meat from harp seal (*Phoca groenlandica*) in molting and pre-molting condition Can. Tech. Rep. Fish. Aquat. Sci. 1053: iv + 18 p.

La composition de la chair de différentes coupes de phoques avant et en mues, a été chimiquement analysée. La chair mise en conserve, avec et saris assaisonnement ou congelée, évaluée par des juges oar Evaluation sensorielle. Le contenu des cendres, gras et protéines clans la chair de phoque en mue ne fut pas significativement différente de la chair de phoque avant la mue. Le taux d'humidité fut significativement plus élevé clans la chair de phoque en mue que clans la chair de phoque avant le mue, alors que pour le contenu en glucides ce fut l 'inverse. Indépendamment de la méthode de traitement, les juges préféraient les phoques en mue. La difference fut plus grande pour la chair mise en conserve saris assaisonnement alors que la difference a été moins pour la chair congelée. L'âge des phoques et le type de coupe influèncerent l'effet de la mue sur la qualité sensorielle de la chair.

INTRODUCTION

Harp seals are traditionally hunted in the Newfoundland area until mid-May. However, beginning in early April and continuing for approximately 4 to 6 weeks, seals 1-year old and older shed their hair, reduce feeding substantially and hence lose up to 20% of their blubber (D. Bowen, Department of Fisheries and Oceans, Research and Resource Services, St. John's, Nfld; Pers. Comm.). Consequently, during this molting season, harp seals are emaciated and in general appear of inferior quality when compared to animals caught during February and March. In recent years, there has been considerable effort by the Inspection and Technology Branch to improve the quality of seal meat available for human consumption (F. Slade, Department of Fisheries and Oceans, Inspection and Technology Branch, St. John's, Nfld; Pers. Comm.), and substantial discussion regarding the suitability of meat from molting seal for human consumption has resulted (D. White, Department of Fisheries and Oceans, Inspection and Technology Branch, St. John's, Nfld; Pers. Comm.).

Consequently, it was decided to investigate the chemical composition and sensory quality of meat from harp seals in pre-molting and molting condition.

MATERIALS AND METHODS

RAW MATERIALS

Bedlamers and old harps in pre-molting condition were shot on February 25 and 26, March 27 and 28, 1981, in the Southern Labrador area (NAFO Div. 2J) ; molting seals were shot on April 30 and May 4, 1981, in the Straits of Belle Isle (NAFO Div. 4R).

All animals were immediately bled and shortly thereafter, eviscerated, skinned, washed in seawater, placed inside heavy-duty plastic bags and stored in ice until butchered six days later. The sex of each carcass was determined prior to evisceration and the age was determined by counting, under polarized light, the dentinal annuli of thinly sectioned (approximately 100 μ thick) canine teeth (Fisher 1954). All carcasses were butchered into the various cuts shown in Fig. 1. The flank, flipper and rump were retained, the surface fat trimmed off and the excess blood removed by cool water rinses. The trimmed and rinsed cuts were then divided and treated as described below.

One quarter of the flank, flipper or rump was immediately plate frozen, then individually vacuum packaged using a CDL model 212 vacuum sealing machine and stored at -40°C (-40°F) for subsequent sensory evaluation. The vacuum, seal and cool settings were 2, 2, and 1.5, respectively; and during packaging, the vacuum level reached 71.3 cm (28.0 in) of mercury.

One quarter of the flank, flipper, or rump was individually trimmed of meat of which 225 g (0.5 lb) was placed in a one-half-pound capacity cylindrical can, then vacuum sealed and thermally processed.

One quarter of the flank, flipper, or rump was individually trimmed of meat, of which 225 g was placed in a one-half-pound capacity cylindrical can with approximately 10 g(0.35 oz) of chopped onion and 3.5 g (0.12 oz) salt, vacuum sealed and thermally processed. All cans were processed at 115.5°C (240°F) for 80 rein, the lowest initial temperature of the products was 18.3°C (65°F) giving a total F(o) value of 7.4.

One quarter of the flank, flipper or rump was individually trimmed of meat which was passed three times through a meat grinder with 7 mm diameter holes, transferred to a 450 ml (15.8 oz) capacity plastic tub with a tight-fitting lid, then frozen and stored at -30°C (-22°F). Moisture determination of each sample was initiated within three days of its being frozen.

CHEMICAL ANALYSIS

Moisture content was determined by placing 30-60 g (1 .1-2.1 oz) of ground seal meat into a pre-weighed glass dish, maintaining the sample in a 100°C (212°F) hot-air oven for two days and then reweighing it. The determination was repeated if the difference between duplicate samples was more than 1.0%. The dried sample was immediately passed through a mill containing a 20 mesh screen, promptly transferred to a plastic vial with a screw cap and stored for further analysis.

Crude fat, crude protein and ash content of the dried samples were determined using methods described by AOAC (1975). Total carbohydrate was determined by subtraction.

SENSORY ANALYSIS

All canned seal (canned plain or canned with onion and salt added) was individually emptied into an aluminum tray covered with aluminum foil and baked in a conventional oven at 177°C (350°F) for 15 min.

All frozen samples previously cut into 19 cm x 5 cm x 10 cm (7.5 in x 2 in x 4 in) size units were removed from -40°C, individually placed in an aluminum tray, covered with aluminum foil and baked in a conventional oven at 232°C (450°F) for 100 min.

Once cooked, all samples were immediately placed in pre-warmed label led glass petri dishes and placed on an electric warming tray.

Except for the 3-year-old combinations, each age x cut treatment combination was presented to three different panels of eight judges and evaluated using a triangle test (Table 1). The 3-year-old combinations were presented to one panel of eight judges. At any one session, each judge was presented with three samples (two from seal in pre-molting condition and one from seal in molting condition, or two from seal in molting condition and one from seal in pre-molting condition) all from seal of the same sex, age and cut but from separate carcasses. They were then asked to choose which sample was different from the other two. All samples were evaluated within 15 minutes and all sessions were completed by August 1, 1981.

STATISTICAL ANALYSIS

The variation in the chemical data was analyzed by considering the effects of condition, individual seals, and carcass cuts. The seals formed a random sample from populations of harp seals in molting and pre-molting condition. In the analysis of variance design, seals were nested within condition and both carcass cut and condition were considered fixed effects. If the analysis indicated a significant ($P \leq 0.05$) difference among carcass cuts, the Studentized Range Test (Snedecor and Cochran 1980) was conducted to determine differences within this main effect.

Since the triangle test is based on the assumption that if there is no detectable difference, the "different" sample will be selected by chance one-third of the time, the results of the present sensory evaluations were analyzed by comparison with tabulated values (Larmond 1977).

Unless otherwise stated, "significant" means significant at the 5% level (i.e. the probability of the difference occuring by chance alone is 5%).

RESULTS AND DISCUSSION

CHEMICAL COMPOSITION

Condition (molting or pre-molting) of the seal did not significantly affect ash, fat or protein contents but the 73.73% moisture content of molting seal was significantly (at the 1% level) greater than the 72.95% moisture content of seal in pre-molting condition (Table 2). The 0.66% total carbohydrate content of the molting seal was significantly (at the 5% level only) lower than the 1.07% carbohydrate content of seal in pre-molting condition. However, the ash, carbohydrate, fat, moisture and protein contents did significantly differ among individual seals.

The carbohydrate, fat, moisture and protein contents, but not the ash content, varied significantly with carcass cut (Table 2). The 1.07% carbohydrate content of the flank was significantly greater than the 0.66% carbohydrate content of the flipper but not significantly greater than the 0.84% content of the rump (Table 2). Also, the amount of carbohydrate contained in the flipper was not significantly different from that of the rump (Table 2). The 1.10% fat content of the flipper was significantly greater than the 0.60% fat content of the flank, but significantly less than the 1.74% fat content of the rump (Table 2). The 72.24% moisture content of the flipper was significantly greater than the 73.27% moisture content of rump which in turn was significantly greater than the 72.52% moisture content of the flank (Table 2). The flank also contained 24.66% protein which was significantly greater than the 23.01% and 22.81% protein of the rump and flipper, respectively, which did not significantly differ from each other (Table 2).

SENSORY QUALITY

Harp seal meat canned plain without seasoning

With each age group and each type of cut, there was a significant difference between samples from harp seal in molting and pre-molting condition (Table 3). With regard to 1- and 2-year-old seal, only a slight plurality of judges, who correctly identified the different sample, favored samples from seal in molting condition; in the case of older seal, particularly those 4 years and older, a large majority of judges favored samples from seals in molting condition (Table 3). The number of judges who had no preference was considerable when the younger seal were evaluated, but modest with older seal.

When carcass cuts were considered, a majority of judges, who correctly identified the different sample, favored flank, flipper and rump from seal in molting condition; a modest minority preferred samples from seal in pre-molting condition or had no preference (Table 3).

In general, when a judge correctly identified the different sample, the magnitude of difference between the duplicate and different samples was assessed as slight to moderate. A preference for a particular sample was usually based largely on flavor and texture. The samples from seal in pre-molting condition were often tougher than those from seal in molting condition. Appearance and odor were usually not dominant factors influencing sample preference.

A large majority of all samples correctly identified were rated acceptable (Table 4). However, substantially fewer samples from seals in pre-molting condition than from seals in molting condition were rated acceptable (Table 4).

Harp seal meat canned with onions and salt added

There was a significant difference between samples from seal in molting and pre-molting condition for seal 1-3 years old but not for seal 4 years old and older (Table 5). Similarly, when carcass cuts were considered rump, but not flank and flipper from molting seal significantly differed from those from pre-molting seal (Table 5). Although the condition of the seal significantly affected the sensory quality of certain cuts and age groups, the magnitude of difference was generally assessed as only slight to moderate.

Among the ages that were significantly affected by the condition of the seal, the judges' preferences were not consistent (Table 5). In the case of samples from l-year-old seal, preference was evenly divided between molting and pre-molting seal and the number of judges having no preference was very modest (Table 5). In regard to samples from 2-year-old seal, a substantial majority of judges preferred samples from seals in molting condition: with 3-year-old seal, a slight majority of judges preferred samples from seal in pre-molting condition.

An appreciable majority of judges, who correctly identified the different sample, favored rump from seals *in* molting condition to that from seal in pre-molting condition. Flavor and texture rather than odor or appearance were the major reasons for preferring a particular sample. Samples from seal in molting condition were often slightly more moist and tender than samples from seal in pre-molting condition.

The vast majority of all samples correctly identified were rated accetpable (Table 6). The samples from molting and pre-molting seal did not consistently differ in acceptability.

Harp seal meat frozen prior to cooking

The condition of harp seal significantly affected the sensory quality of seal 2 years old but not that of the other ages studied (Table 7). Like seal meat canned with onions and salt added, rump, but not flank and flipper, from seal in molting condition signficantly differed from that in pre-molting condition (Table 7).

In the case of samples from 2-year-old seal, a large majority of judges who correctly identified the different sample, favored samples from seal in molting condition, and only a modest minority favored samples from seal in pre-molting condition or had no preference (Table 7). Regarding rump, a large minority of judges favored samples from seal in molting condition, a similar number had no preference, and a smaller minority preferred samples from seal in pre-molting condition (Table 7). Thus, with rump frozen prior to cooking, the condition of the seal did not conclusively affect the judges' preference.

Flavor and texture, but not appearance and odor, were important factors affecting the judges' preference for a specific sample. In general, when a significant difference existed the samples from sea? in pre-molting condition were drier and tougher than those from seal in molting condition.

Although the majority of samples from l-year-old seal were not acceptable, a substantial majority of samples from all other age groups and all types of cuts were rated acceptable (Table 8). Except for the samples from seal 3 years old, noticeably fewer samples from seal in pre-molting condition than from seal in molting condition were rated acceptable (Table 8).

GENERAL DISCUSSION

Comparing the present results with those previously reported for seal in pre-molting condition (Botta et al. 1982), the fat and protein contents are very similar; the moisture content of pre-molting seal is similar; the moisture content of molting seal is slightly higher, and ash contents of seal in both molting and pre-molting condition are noticeably lower (Table 2). The manner in which carcass cut affected ash, fat and protein contents is very similar to that already observed; however, the effect of carcass cut on moisture content is slightly different from that previously reported (Table 2 and Botta et al. 1982). In the present study, all three cuts significantly differed in moisture content: in the former, flipper was significantly different from the other two cuts in this respect.

In general, the chemical composition of harp seal in both molting and pre-molting condition is comparable to or better than that reported for fish and for domesticated terrestrial animals (Paul and Southgate 1978). However, it is very interesting to note that all of the chemical variables differed significantly among individual seals.

Statistically, molting of the harp seal significantly increased moisture content but, as the mean moisture content of seal in pre-molting condition was only 0.78 percentage points less (Table 2), this difference may not be of practical importance. However, particularly with the seal meat canned with salt and onions added, there were numerous comments that the meat from pre-molting seal was drier, and texture was a major factor concerning preference. In general, the judges preferred the molting samples which had a significantly greater moisture content.

Likewise, statistically, molting of seal significantly decreased total carbohydrate content of the meat, but the mean carbohydrate content of seal in pre-molting condition was only 0.41 percentage points greater (Table 2) suggesting that the practical importance is questionable. With domesticated terrestrial animals, a decrease in the level of glycogen (the major carbohydrate in meat) causes a decrease in the acidity of the meat which, in turn, may increase both the capacity of the meat to bind water and its tenderness (Paul 1972; Lawrie 1974). Although the acidity of the meat was not measured during the present study, molting of the seal caused a significant decrease in the carbohydrate (including glycogen) content of the meat, an improvement in water binding capacity (as evidenced by the judges' comments and significantly greater moisture content), and an increase in tenderness (as evidenced by the judges' comments).

Concerning general acceptability, the meat canned with salt and onions added was clearly the most acceptable and the meat frozen prior to cooking the least acceptable (Tables 4, 6 and 8). In addition, the condition of the seal affected the acceptability of the meat when it was frozen or canned plain, but not when canned with onions and salt added, presently the most common form of commercial preservation (Tables 4, 6 and 8). This substantiates a previously-stated observation that flavor, as well as texture, was an important factor regarding acceptability. The relatively low acceptability of the samples that had been frozen may have been at least partially due to the rapid thawing/cooking prior to sensory evaluation. This may also partially account for the fewer differences observed with the samples which had been frozen (Table 7).

It should be stressed that as regards sensory evaluation, the only difference between the odd and duplicate samples was the condition (molting or pre-molting) of the seal prior to killing. All samples (at any one sensory evaluation session) were of the same cut, were from seal of the same age, sex and post mortem age, and were handled/processed in an identical manner.

Although the data regarding 3-year-old seal are included in this report, it should be interpreted somewhat cautiously as the number of seals studied was very small. However, except for the fact that meat of 3-year-old seal in pre-molting condition (canned with salt and onions added) was preferred to that from seal in molting condition, the results followed the general trends observed with the other three age groups (Tables 3-8).

Similarly, although the results regarding preference and acceptability were reported and discussed in detail, it must be remembered that these data resulted from secondary questions and should be interpreted more cautiously than those resulting from the primary question, i.e. is there a difference? However, it should be noted that both preference and acceptability data were relatively consistent.

It should be stressed that these results were obtained in a laboratory study conducted under well-defined conditions. Under commerical conditions, the results will not necessarily be the same. In addition, it should be remembered that the sensory quality was evaluated not by a consumer panel or through test marketing, but by a laboratory panel whose assessment will not necessarily agree with that of the general Public. Consequently, the report should be viewed as an intermediate one.

CONCLUSIONS

A laboratory study designed to investigate the suitability of meat from harp seal in molting condition for human consumption was conducted.

When the chemical composition of meat from seal in molting condition was compared to that of meat (similar carcass cut) from seal (similar age and sex) in pre-molting condition handled in an identical manner: (1) the ash, fat and protein contents were not significantly different; (2) the moisture content was significantly greater in meat from molting seal; and (3) the carbohydrate content was significantly less in meat from molting seal.

When the sensory quality of meat from seal in molting condition was compared to that of meat from seal in pre-molting condition: (1) meat, from molting seal, canned without seasoning was different and superior according to preference as well as the number of samples rated acceptable; (2) meat, from molting seal, canned with salt and onions added was moderately different and slightly preferable; and (3) meat, from molting seal, frozen prior to cooking was only slightly different and very slightly superior. Only when the meat was canned without seasoning did age of the seal and type of carcass cut not affect the difference between molting and pre-molting seals.

Meat from seal in pre-molting condition, particularly when canned, was quite acceptable.

Consequently, the present laboratory study indicated that meat from seal in molting condition is different from and slightly superior to meat from seal in pre-molting condition and certainly suitable for human consumption.

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Table 1. Form used to evaluate sensory quality of harp seal meat.

NAME ______________________ DATE ______________________

PRODUCT ____

Two of these three samples are identical, the third is different.

1. Evaluate the samples in order indicated and identify the different sample.

Code	Check different sample
____________	____________
____________	____________
____________	____________

2. Indicate the degree of difference between the duplicate samples and the different sample.

   Slight ____________________

   Moderate ____________________

   Much ____________________

   Extreme

3. Is the different sample acceptable? __________
   Are the duplicate samples acceptable? __________

4. Is the different samples more acceptable? __________
   Are the duplicate samples more acceptable? __________

5. Is the difference related to:

   Appearance ________
   Flavor ________
   Odor ________
   Texture ________

6. Comments:

Table 2. Condition and carcass cut means, including standard deviation, and results of Studentized Range Test[1].

Condition	Ash content (%)	Fat content (%)	Moisture content (%)	Protein content (%)	Total carbohydrate content[4] (%)
Molting[2]	1.17[a]	1.07[a]	73.73[a]	23.38[a]	0.66[a]
Pre-molting	1.14[a]	1.23[a]	72.95[b]	23.61[a]	1.07[b]
Carcass cut					
Flank[3]	1.15[a]	0.60[a]	72.52[a]	24.66[a]	1.08[a]
Flipper[3]	1.18[a]	0.10[b]	74.24[b]	22.81[b]	0.66[b]
Rump[3]	1.13[a]	1.74[c]	73.27[c]	23.01[b]	0.84[ab]

[1] Means not sharing the same letter are significantly different (at the 5% level) from each other

[2] n = 42

[3] n = 28

[4] Total carbohydrate content was determined by subtraction.

Table 3. Results of sensory evaluation triangle test using meat from harp seal in molting and pre-molting condition canned plain without seasoning.

Treatment	n[a]	Number of correct identifications	Preference: Samples from seals in molting condition	Preference: Samples from seals in pre-molting condition	Preference: None
Age:					
One year	72	34*	14	8	12
Two years	72	36**	16	10	10
Three years	24	21 ***	12	6	3
Four years and over	72	34*	25	6	3
Total	240	125***	67	30	28
cuts:					
Flank	80	51 ***	27	13	11
Flipper	80	36*	19	8	9
Rump	80	38**	21	9	8
Total	240	125***	67	30	28

n[a] = number of observations per treatment

* Significant at the 5% level

** Significant at the 1% level

*** Significant at the 0.1% level

Table 4. Acceptability of correctly-identified sets of harp seal, seal meat canned plain without seasoning.[1]

	Percentage of correctly-identified sets	
Treatment'	Samples from seals in molting condition	Samples from seals in pre-molting condition
Age:		
One year	82.4	70.6
Two years	88.9	83.3
Three years	90.5	76.2
Four years and over	97.1	76.5
Total	89.6	76.8
cut:		
Flank	88.2	70.6
Flipper	88.9	80.6
Rump	92.1	81.6
Total	89.6	76.8

[1] Based on answers to question 3 of sensory evaluation form.

Table 5. Results of sensory evaluation triangle test using meat from harp seal in molting and pre-molting condition canned with onions and salt added.

			Preference		
Treatment	n[a]	Number correct identifications	Samples from seals in molting condition	Samples from seals in pre-molting condition	None
Age:					
One year	72	35**	16	15	4
Two years	72	32*	21	9	2
Three years	24	16***	6	9	1
Four years and over	72	25 n.s.	16	6	3
Total	240	108***	59	39	10
cut:					
Flank	80	34 n.s.	21	10	3
Flipper	80	34 n.s.	15	15	4
Rump	80	40**	23	14	3
Total	240	108***	59	39	10

n[a] = number of observations per treatment

* = significant at the 5% level

** = significant at the 1% level

*** = significant at the 0.1% level

n.s. = not significant at the 5% level

Table 6. Acceptability of correctly identified sets of harp seal meat canned with onions and salt added[1].

	Percentage of correctly identified sets	
Treatment	Samples from seals in molting condition	Samples from seals in pre-molting condition
Age:		
One year	88.6	85.7
Two years	90.6	100.0
Three years	100.0	100.0
Four years and over	92.0	92.0
Total	93.5	91.7
cuts:		
Flank	88.2	100.0
Flipper	94.1	82.4
Rump	92.5	97.5
Total	93.5	91.7

[1] Based on answers to question 3 of sensory evaluation form.

Table 7. Results of sensory evaluation triangle test using frozen meat from harp seal in molting and pre-molting condition.

Treatment	n[a]	Number of correct identifications	Preference: Samples from seals in molting condition	Preference: Samples from seals in pre-molting condition	Preference: None
Age:					
One year	72	25 n.s.	9	8	8
Two years	72	37**	25	6	6
Three years	24	11 n.s.	8	2	1
Four years and over	72	23 n.s.	7	9	7
Total	240	96*	49	25	22
Cut:					
Flank	80	33 n.s.	18	11	4
Flipper	80	27 n.s.	17	5	5
Rump	80	36*	14	9	13
Total	240	96*	49	25	22

n[a] = number of observations per treatment

* = significant at the 5% level

** = significant at the 1% level

n.s. = not significant at the 5% level

Table 8. Acceptability of correctly-identified sets of harp seal meat frozen prior to cooking.[1]

Treatment	Percentage of correctly-identified sets	
	Samples from seals in molting condition	Samples from seals in pre-molting condition
Age:		
One year	44.0	40.0
Two years	86.5	70.3
Three years	72.7	72.7
Four years and over	73.9	69.6
Total	70.8	62.5
cuts:		
Flank	81.8	66.7
Flipper	63.0	59.3
Rump	66.7	61.1
Total	70.1	62.5

[1] Based on answers to question 3 of sensory evaluation form.

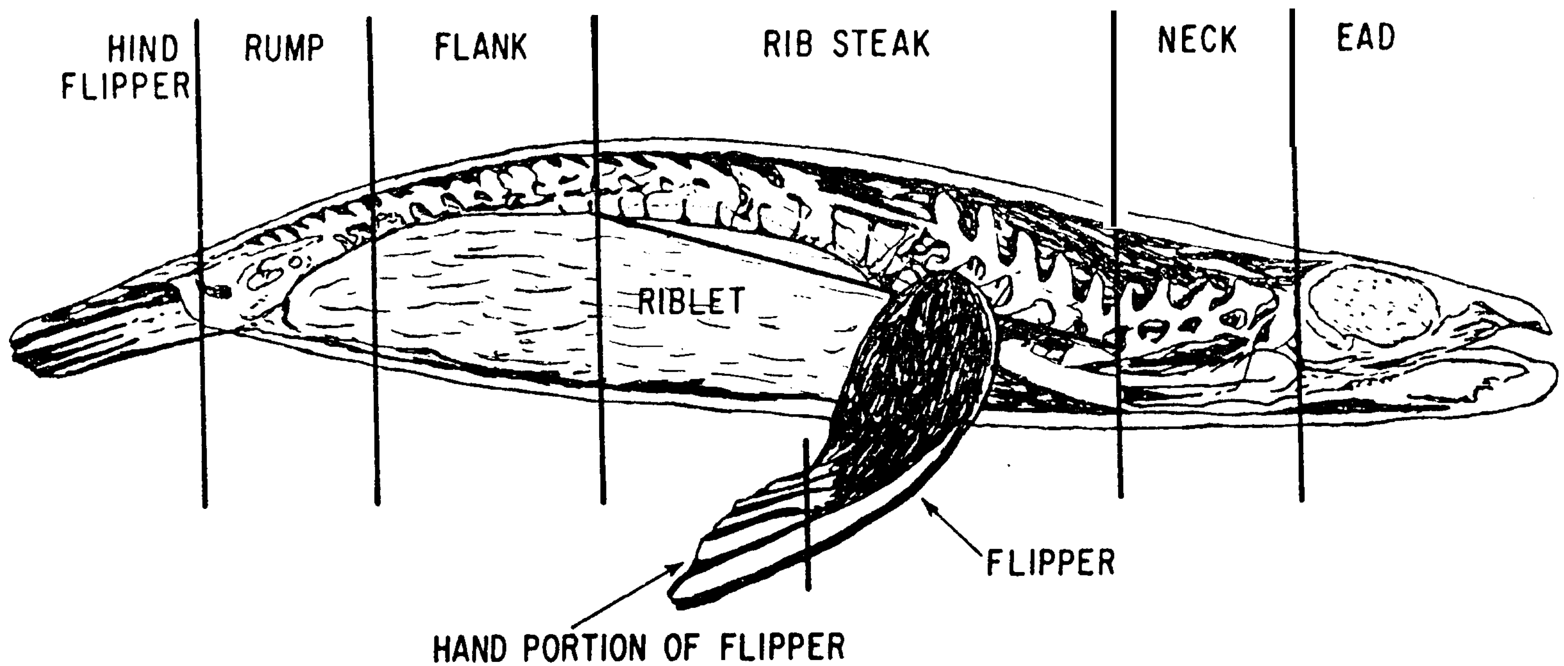

Fig. 1. Carcass cuts of the harp sea Phoca groenlandica).

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The caloric value of whole ringed seals (*Phoca hispida*) in relation to polar bear (*Ursus maritimus*) ecology and hunting behavior

IAN STIRLING AND EOIN H. MCEWAN

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in relation to polar bear (*Ursus maritimus*) ecology and hunting behavior. Can. J. Zool. 53: 1021–1027

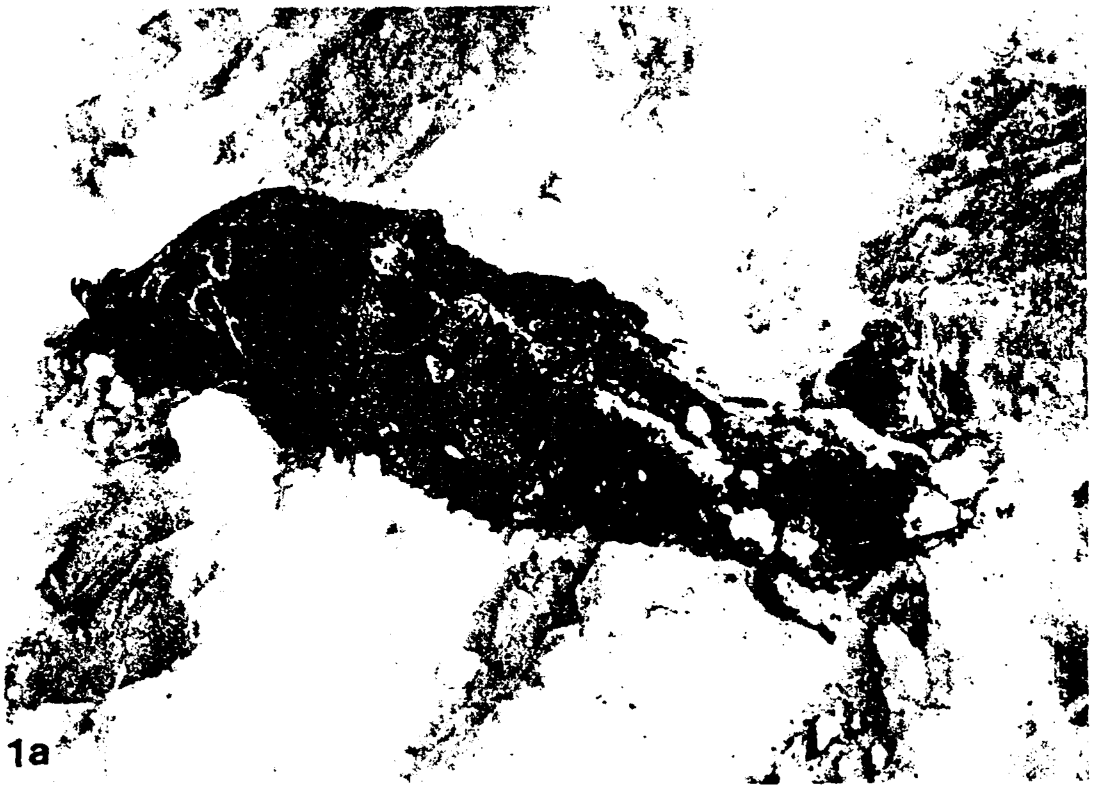
L'ours polaire (*Ursus maritimus*) se nourrit surtout de phoques annelés (*Phoca hispida*), et cela sur toute sa répartition circumpolaire. Malgré les variations saisonnières de la disponibilité et de la répartition des phoques, les ours polaires préfèrent se nourrir surtout de graisse, laissant souvent derrière eux des portions considérables de viande et de lard. On a haché 12 phoques afin d'en analyser le contenu en eau, en graisses, en protéines et en cendres. La composition en est variable: 23 à 58% de protéines, 34 à 76% de graisses, 2 à 5.5% de cendres, 47.4 à 69.5% de contenu hydrique total. Les valeurs caloriques vont de 2.3 à 5.3 kcal/g poids frais. On présente ici les relations entre le contenu total en eau et le contenu en graisses (%) ainsi qu'entre l'eau (litre) et les protéines (kg). La discussion porte sur l'importance de ces résultats en relation avec l'écologie et le comportement de chasse de l'ours polaire. [Traduit par le journal]

Introduction

The polar bear (*Ursus maritimus*), throughout its circumpolar range, feeds predominantly on the ringed seal (*Phoca hispida*). If possible, polar bears will remain on the sea ice and hunt seals throughout the year. Because they cannot successfully hunt seals from shore during periods of open water, the diet of local polar bear populations can vary seasonally depending upon the prevailing ice conditions. For example, in Hudson Bay, the sea ice melts completely and the whole of the bear population is forced to spend several months ashore each year (Nero 1971). During the summer, these polar bears consume some vegetation and carrion (Russell 1971) but gain little of nutritional value therefrom, in comparison with bears feeding on seals.

In the Western Arctic, bears may remain with the sea ice by migrating several hundred kilometres northward during the summer, as the sea ice retreats from the southeastern Beaufort Sea and Amundsen Gulf areas, returning south again in the fall when the sea freezes over (Stirling 1974*a*). In some locations in the High Arctic islands, an intermediate situation exists. The annual ice in the main channels melts by midsummer but remains in some of the deep bays and fiords until late summer, leaving only a short period of time during which the bears must remain on shore unable to hunt seals. In addition, in other areas of the High Arctic, the ice can remain, either in floes or solid sheets, permitting a continuous hunting situation.

Field observations of seals killed by polar



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bears, and of the "behavior of wild free-ranging polar bears, provide additional information. After a polar bear kills a seal, it feeds predominantly on the blubber and often abandons the meat. Not infrequently, part of the blubber is abandoned as well (Stirling 1974*b*) (Fig. 1*a*). Clearly, to a polar bear, the blubber is the preferred part of the seal. Exceptions occur, such as when a small seal is killed by a particularly hungry bear, or by a female bear with one or two cubs. Then a large part, or all, of the carcass is consumed. Polar bears scavenging on carcasses may also eat the remains of blubber and meat, and this source of food is probably of significant value to subadults not yet fully skilled at hunting, as well as to subadults that have had their own fresh kills taken away by larger bears. Unlike grizzly bears (*Ursus arctos*), polar bears generally do not cache a carcass with the intent of returning, nor remain until it is all eaten.

Ringed seal pups are born during late March and April in subnivean birth lairs located in the lee of pressure ridges in the sea ice. During this period, polar bears hunt extensively along pressure ridges and break into the lairs. Often, however, the newborn pups are killed" in the lair and abandoned by the bear (Fig. 1*b*).

In the Western Arctic, we found that over 80% of the ringed seals killed by polar bears were less than 2 years of age. However, our sample was biased in that almost all specimens from polar bear kills were collected between March and June, when conditions for collection of specimens were most favorable.

This paper presents data on the body composition and the caloric values of whole ringed seals. The sample includes various age groups of different physical conditions representative of seals captured by polar bears. These data will be used subsequently in conjunction with current long-term studies of polar bear population ecology and behavior (Stirling 1974*a*, 1974*b*) to gain a more comprehensive understanding of the ecological relationships between polar bears and seals.

FIG. 1. Ringed seals which were killed by a polar bear but only partially consumed or left intact. Fig. 1*a*, adult. Fig. 1*b*, newborn pup.

Materials and Methods

Eleven ringed seals were collected between 18 April and 6 June 1972 (Table 1) in the Amundsen Gulf in the Western Arctic and one from Norwegian Bay in the High Arctic. The newborn pups in the sample (Nos. 1, 2, 3, and 4) were killed by polar bears; the rest of the seals were collected at their breathing holes in polar bear hunting habitats. The seals were labelled, frozen, and shipped air express to Vancouver, British Columbia.

The seal carcasses were cut longitudinally and one-half was minced in a commercial meat grinder. Each ground half-carcass was thoroughly mixed and 200-g samples, in duplicate, were retained for chemical analyses. The fat was extracted from a 200-g composite sample using dichloroethane, and the chemical analyses were conducted on the fat-free material according to methods outlined in AOAC[1] (1965). The fat was recovered from the dichloroethane and quantitated. The caloric values of both the fat and fat-free dried samples were determined using an adiabatic bomb calorimeter. The percentage moisture in each of two pups and two adult seals was

[1]AOAC, Association of Official Agricultural Chemists.

TABLE 1

Data on ringed seal specimens

No.	Date, 1972	Age	Sex	wt., kg	Location	Remarks
1	18 April	< 1 mo		3.6	Amundsen Gulf	Killed by polar bear
2	21 April	< 1 mo		4.3	Amundsen Gulf	Killed by polar bear
3	1 May	< 1 mo	—	4.8	Norwegian Bay	Killed by polar bear
4	18 April	< 1 mo	.	11.6	Amundsen Gulf	Killed by polar bear
5	18 April	1 yr	;	12.3	Amundsen Gulf	Frozen out of water, dead
6	19 April	1 yr		16.6	Amundsen Gulf	Collected at breathing hole
7	6 June	2-3 mo		21.1	Amundsen Gulf	Collected at breathing hole, recently weaned
8	18 April	1 yr		21.4	Amundsen Gulf	Collected at breathing hole
9	31 May	2-3 mo		24.5	Amundsen Gulf	Collected at breathing hole, still suckling
10	6 June	2-3 mo		25.2	Amundsen Gulf	Collected at breathing hole, recently weaned
11	23 April	1 yr	.	26.4	Amundsen Gulf	Frozen out of water, alive
12	18 April	Adult	;	45.7	Amundsen Gulf	Collected at breathing hole

TABLE 2

Body composition and energy values of seals

		% water		% protein			% fat		% other	Caloric density, kcal/g	
No.	Wt., kg	1	2	3	4	5	6	7	8	9	10
1	3.6	71.1	62.0	86.6	57.5	21.5	33.6	12.7	3.4	5.138	2.33
2	4.3	71.1	62.0	83.9	55.5	21.1	33.5	12.7	4.1	5.237	2.53
3	4.8	71.1	69.5	83.0	76.8	23.5	7.5	2.3	4.8	4.925	1.61
4	11.6	71.1	51.6	86.0	37.3	18.1	56.6	27.4	2.9	5.173	3.69
5	12.3	71.1	60.9	77.9	51.1	19.3	34.4	14.4	5.5	4.742	2.54
6	16.6	71.1	52.5	77.9	35.1	16.6	55.0	26.1	4.7	5.281	3.60
7	21.1	71.1	39.0	88.7	23.4	14.0	73.6	45.2	1.8	5.260	5.13
8	21.4	71.1	56.0	83.7	43.3	19.1	48.3	21.3	3.7	5.141	2.20
9	24.5	71.1	39.9	84.1	22.7	13.7	73.0	43.9	2.6	5.293	5.03
10	25.2	71.1	37.4	87.5	21.3	13.3	75.7	47.4	1.9	5.250	5.30
11	26.4	71.1	46.4	83.3	29.3	15.7	64.8	34.7	3.1	5.049	4.25
12	45.7	71.1	46.8	82.8	29.6	15.7	64.2	34.1	3.3	5.280	4.24

EXPLANATION OF COLUMNS 1, fat-free % water (av. 4 specimens); 2, whole body % water; 3, fat-free (dry wt.) % protein; 4, whole body (dry wt.) % protein; 5, whole body (wet wt.) % protein; 6, whole body (dry wt.) % fat; 7, whole body (wet wt.) % fat; 8, whole body (wet wt.) ash, etc.; 9, caloric density of fat-free dry matter, kcal/g; 10, caloric density of whole body wet wt., kcal/g. Columns 2, 5, 7, and 8 represent gross composition (wet wt.); columns 4 and 6 represent composition (dry wt.); column 10, caloric value of 1 g fat = 9.5 kcal used.

estimated from duplicate determinations of tissue sections taken from the midgut (transverse) and shoulder (longitudinal) areas.

Results

The proximate composition and energy values of ringed seals are listed in Table 2. In the present study, a caloric value of 9.5 kcal/g of fat was used (Brouwer 1965). The energy values for three fat samples ranged from 8.1 to 9.4, averaging 8.7 kcal/g or about 9% less than the accepted value. This apparent anomaly may have been due to differences in the ages of seals measured (pups compared with adults). Unfortunately, the number of determinations carried out was too small to provide a representative value.

The major component of the body composition of ringed seals known to vary seasonally is the fat. Based on McLaren's data ([958), Fig. 2 illustrates the large seasonal variation in the blubber, excluding mesenteric fat, as a percentage of the total body weight. The amount of body fat decreases from late spring to early summer, then increases again from mid-July to October. A rapid loss of fat presumably occurs in parturient females from early April to early June as a consequence of lactation. In

TABLE 3

Gross energy values of seals based on the total amounts of protein and fat

No,	Body wt., kg	Water, litres	Protein, kg	Fat, kg	Gross energy, kcal		
					Protein	Fat	Total
1	3.6	2.23	0.730	0.427	3650	4056	7706
2	4.3	2.66	0.915	0.549	4759	5215	9974
3	4.8	3.98	0.630	0.062	3087	589	3676
4	11.6	5.98	2.130	3.232	11 075	30703	41778
5	12.3	7.49	2.458	2.722	12 781	25859	38640
6	16.6	8.71	2.769	4.340	14 675	41 230	55905
7	21.1	8.23	3.012	9.472	15963	89984	105947
8	21.4	11.98	4.079	4.540	20 802	43130	63932
9	24.5	9.78	3.341	10.745	17707	102077	119784
10	25.2	9.42	3.361	11.945	17 813	113477	131290
11	26.4	12.25	4.146	9.169	20 730	87105	107835
12	45.7	21.38	7.20	15.613	38160	148323	186483

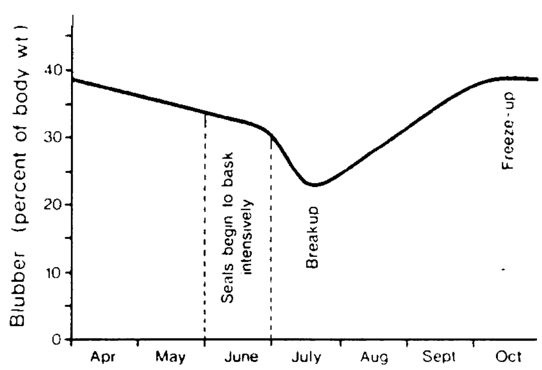

FIG. 2. Seasonal change in the percentage of the body weight of a ringed seal that is composed of blubber at 71" N (based on McLaren 1958).

contrast, there was a dramatic increase in the accumulation of fat from about 13% at birth (Nos. 1,2, and 3) to about 45% in nearly or fully weaned pups (Nos. 7, 9, and 10) (Table 2), while the mean gross energy of stored fat increased from 4.6 to 101.8 Meal (Table 3). The mean percentage fat and gross energy of fat for three yearlings and one adult amounted to 27% and 34%, respectively, and 57.2 and 148.3 Meal, respectively (Table 3).

There is a significant linear relationship between total body water (%) and fat (%), $y = 100.0 - 1.407x$, $r = 0.999$, rms[2] = 0.0041 (where x = % body water and y = % body fat (wet weight)). Our results agree with the prediction equations determined for domestic animals (Reid *et al.* 1955; Panaretto and Till 1963), The amount of protein increased from 0.73 kg (pups) to 7.20 kg (adults) (Table 3). The relationships between total body water (litres) and protein (kg) are described by the linear regression $y = 0.348x - 0.124$ ($r = 0.992$; rms = 0.042), where x = body water (litres) and y = protein (kg). A similar regression ($y = 0.265x - 0.47$) was determined for goats (Panaretto and Till 1963). The present values for total body water agreed with the values determined by tritium dilution studies on harbor seals (*Phoca ri(u/ins)* of equivalent weight reported by Depocas et *al.* (1971) and White *et al.* (1971).

[2]Root mean square (rms).

Discussion

Knowledge of the body composition and relative energy values of seals, representing various age classes, is essential in order to understand the nutrition, ecology, and hunting behavior of polar bears. In polar regions, bears require a high-energy diet of fat to meet their metabolic requirements associated with thermoregulation and the energy costs of walking and hunting. Because the availability of seals varies seasonally and regionally, the replenishment of fat depots is important to a polar bear, not only to maintain an insulating layer to reduce heat losses, but also to provide a reserve source of energy during periods of food scarcity. [n polar regions, pregnant polar bears remain in their dens from early November to April without feeding for 5 months during the birth and suckling of their young. In the Hudson Bay population, pregnant bears may not be able to feed on seals for a period of 7 to 8 months, extending from midsummer to late March or early April.

Field observations of free-ranging polar bears have shown that they are often interrupted by other bears while on their kills (Stirling 1974*b* and unpublished data). This is particularly true for subadult bears and females with cubs. Thus, it is important to their survival that bears begin to feed immediately (Stirling 1974*b*) to gain the maximum energy intake. The bears' preference for the fat of the seal is probably related to its higher caloric value relative to the rest of the body. For example, the caloric density of seal No. 6, a normal yearling, was 3.60 kcal/g, a total gross energy value of 59760 kcal. The fat content of the seal was 26% (4.3 kg), amounting to 41 159 kcal or 68.8% of the total gross energy. Similarly, in seal No. 12, 76.4% of its total caloric value was in the fat.

From freeze-up of the sea ice in the fall to breakup in the late spring, there is a marked differential segregation of ringed seals by age class which results in the highest portion of adults being located in the deep bays characterized by stable ice conditions (preferred habitat) and the highest portion of the subadults in the unstable offshore ice (McLaren 1958). In April, ringed seal pups are born in subnivean birth lairs located in the bays and fewer in the offshore ice. Polar bears often walk many kilometres along the snow-drifted pressure ridges of the offshore ice, digging out birth lairs, and lairs used for hauling-out by male and nonparturient female seals. However, the bears seldom penetrate landward into the bays during the spring despite the fact that birth lairs are more abundant there. Since polar bears hunt predominantly in the unstable offshore ice, the age structure of that portion of the ringed seal population which is predated most heavily is biased in favor of younger animals, as noted earlier. This pattern of hunting behavior may have evolved as a result of subadult seals being less experienced and wary and thus easier to capture, yet yielding a potential energy value equivalent to adults in caloric density (Table 2).

Newborn ringed seal pups killed by polar bears are often not eaten (Fig. 1b), even though the bear may have remained at the breathing hole for some time. Because newborn pups are of such low value in both caloric density and fat content, we suggest that many bears do not bother to eat them. It would appear, therefore, that a polar bear may be motivated to dig out a seal birth lair because of the possibility of catching a suckling pup or an adult female and not for the newborn pup, as was earlier suspected. Furthermore, in the offshore ice, there is a greater probability that any haul-out lair or breathing hole will be used by a yearling or subadult seal which is probably less experienced and easier to capture than an adult, and of much higher caloric value than a newborn pup.

The intraspecific agonistic behavior of ringed seals during the spring breeding season may also affect the age structure of seals killed by polar bears. Breathing holes and birth lairs are widely spaced even in areas of preferred habitat (T. G. Smith and I. Stirling, unpublished data). Subjective observations of seals in captivity have shown that ringed seals are much more aggressive to each other than are such other species as harp seals (*Pagophilus groenlandicus*) or harbor seals (K. Ronald, quoted personal communication in Stirling 1975). Ronald's observations are supported by the fact that a high proportion of the sub-ice vocalizations of ringed seals were agonistic in nature, especially during the spring (Stirling 1973). The increased aggressive behavior of dominant seals probably reduces the sub-ice movement of subadults between breathing holes, and possibly even precludes maintenance of breathing holes by subadults in closely adjacent areas. From late March to early May, dominant seals actually exclude some younger individuals from the water long enough for their breathing holes to freeze over, making them completely vulnerable to predation, although the frequency of such occurrences is impossible to determine accurately. The value of such a seal to a polar bear in terms of whole body percentage fat and caloric density then depends on how soon the seal is discovered. This is clearly demonstrated by comparing No. 11, which was recently frozen out and still alive, with No. 5, a yearling which had starved to death (Table 2). One benefit to be gained from the large part of a polar bear's life that is spent walking in search of seals (25% in summer, Stirling 1974*b*) would be to increase the probability of finding frozen-out seals while they are still fat.

During the summer, seals become unavailable to polar bears in areas such as Hudson Bay, and less available in the Western or High Arctic, because of the increased amount of open water and the greater numbers of naturally occurring holes in the ice. It is likely that the period from freeze-up in the fall until the sea ice becomes puddled in late spring before breakup is the most productive for hunting because the number of breathing holes is restricted to those that the seals can actively maintain themselves by abrading the ice with the claws of their foreflippers. The fewer the number of breathing holes, the greater the probability [hat a seal will surface at a hole where a polar bear waits. It is interesting to note that the summer period of lowered seal availability to polar bears coincides with the period when seals have the least amount of fat and, therefore, the lowest caloric density of any season of the year. It is also the period during which the bear has the lowest caloric requirement for thermoregulation.

In conclusion, the polar bear has apparently adjusted to seasonal and local variations in the availability of its food supplies by hunting intensively when it can, taking maximal advantage of the differential segregation of ringed seals by age class, using the part of the kill which is of greatest caloric value, and maintaining fat depots to meet future nutritional stresses.

Acknowledgments

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RESEARCH NOTE

Effect of Sex, Age and Carcass Cut on Composition of Harp Seal *(Phoca groenlandica)*[1] Meat

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Abstract

As part of a program to investigate utilization of meat recoverable from the inshore Newfoundland seal hunt, iodine number and proximate composition of prime cuts (flank, flipper and rump) of harp seals of five different ages were determined. The sex of the seal did not affect any of the chemical variables analyzed. Age affected mainly moisture and protein content, whereas carcass cut affected mainly fat, moisture and protein content. In general, the ash, moisture and protein contents were higher, and the fat content much lower than that of meat of domesticated terrestrial animals. Iodine numbers ranged from 90.1 to 144.8.

Résumé

En tant du programme d'utilization de la viande recouvrable de la chasse des phoques sur la côte de Terre-Neuve, l'analyses de I'indite d'iode et de la composition proximative furent faites sur les tranches principaux (flanx, nageoire et culotte) des phoques de cinq différents âges. Le sex des phoques n' a pas affecté aucun des variables chimiques analyses. L'âge influença le contenu d'humidité et de protéines, alors que les tranches de la carcasse affectent le contenu du gras, d'humidité et de protéines. En general, le contenu de cendre, d'humidité et de protéines était plus élevé clans la viande du phoque que clans la viande d'animaux terriens domestiqués alors que le contenu de gras était moins élevé. L'indite d'iode avait dcs valeurs entre 90,1 et 144,8.

Introduction

During the last 5 years, a total of 324,219 harp seals have been slaughtered for pelts by the Newfoundland inshore seal hunters (Anon., 1977-81), giving a total of 4,379,508 kg of harp seal meat (Botta *et* al., 1980) that was available for human consumption. However, very little is known about its composition. Consequently, as part of a program to investigate utilization of meat recoverable from the inshore Newfoundland seal hunt, the present study was undertaken to determine the iodine number and proximate composition of harp seal *(Phoca groenlandica)* meat.

[1] Also known as *Pagophilus groenlandicus*.

Materials and Methods

Raw Materials

Beaters, bedlamers and harps (Table 1), the major classes of harp seal slaughtered during the inshore Newfoundland hunt, were shot on March 3, March 10 and April 15, 1980, in White Bay, Newfoundland. The animals were immediately bled and shortly thereafter eviscerated, skinned, placed inside heavy duty plastic bags and stored in flake ice until butchered 3 days later. The age of each carcass was determined by counting, under polarized light, the dentinal annuli of thinly sectioned (approximately 100 μ thick) canine teeth (Fisher, 1954). All carcasses were butchered into the various cuts shown in Figure 1.

The prime cuts (flank, flipper and rump) were retained, the surface fat trimmed off and the excess blood removed by cool water rinses. The trimmed and rinsed cuts were individually passed three times through a meat grinder, with 7 mm diameter holes. A small portion of the ground seal meat was placed in a plastic bag, frozen at −40°C, immediately transferred to 100 μ thick -polyamide polyethylene pouches and then vacuum packaged using a CDL Model 212 vacuum sealing machine. The vacuum,

Table 1. Glossary of terms concerning classes of harp seal *(Phoca groenlandica)*.

Whitecoat	A newborn harp seal up to an age of about 12 days. prior to loss of the soft white natal fur.
Ragged-Jacket	A young harp seal undergoing its first molt from a whitecoat to a beater, Age ranges between 12 and 18 days.
Beater	A young harp seal in its first year of life, having completed its first molt to a sported grey coat. Age when slaughtered ranges between 3 and 8 weeks.
Bedlamer	A juvenile seal in its second, third or fourth year of life, having a spotted coat.
Harp	A seal at least 5 years of age.

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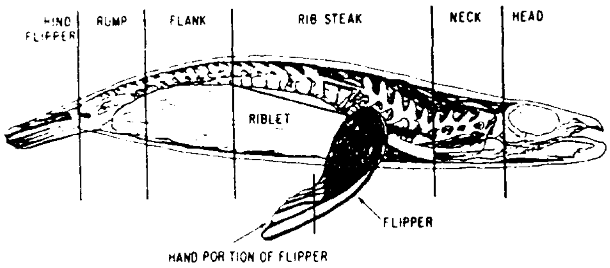

Fig 1, Carcass cuts of the harp seal *(Phoca groenlandica)*.

seal and cool settings were 2, 2 and 1.5, respectively, and during packaging the vacuum level reached 71.3 cm of mercury. The vacuum packaged samples were stored at −40°C until determination of total lipid was conducted. If necessary, the samples were repackaged every 2 mo. All analyses were conducted within 8 mo of initial packaging. The major portion of the ground seal meat was transferred to a 450 mL capacity polyethylene tub with a tight fitting lid, then frozen and stored at −35°C. Moisture determination of each sample was initiated within 3 days of the sample being frozen.

Chemical Analysis

Moisture content was determined by placing 30-60 g of ground seal meat into a preweighed glass dish, maintaining the sample in a 100°C hot air oven for 2 days and then reweighing it. The determination was repeated if the difference between duplicate samples was more than 1.0%. The dried sample was immediately passed through a mill containing a 20 mesh screen, promptly transferred to a plastic vial with a screw cap, then stored for further analysis.

Crude fat, crude protein and ash content of the dried samples were determined using methods described by AOAC (1975).

Total lipid was extracted from the vacuum packaged samples using the method of Bligh and Dyer (1959) and the iodine number of this lipid was immediately determined using the Wijs method (AOAC, 1975).

Statistical Analyses

Analyses of variance were conducted on the chemical variables by using a one-way analysis of variance with sex as a fixed main effect, and by using a two-way analysis of variance with interaction of age and carcass cut which were the fixed main effects. If the age x cut interaction were not significant ($P > 0.05$), its sums of squares and degrees of freedom were pooled with the error sums of squares and degrees of freedom resulting in a two-way analysis of variance without interaction. If this analysis of variance indicated that either age or cut significantly ($P \leq 0.05$) affected the variable, the Studentized Range Test (Snedecor and Cochran, 1967) was conducted to determine differences within each main effect. Unless otherwise stated, "significant" means significant at the 5% level ($P \leq 0.05$).

Results and Discussion

The sex of the seal did not significantly affect the iodine number of the extracted lipid, or the moisture, crude protein and crude fat contents of the meat (Table 2). Although a one-way analysis of variance revealed that the ash content of female seal meat was significantly greater than that of male seal meat (Table 2), an unbalanced three-way analysis of variance with age, cut and sex as the main effects, after age and cut were accounted for, revealed that sex did not significantly affect ash content.

Table 2. Sex means, including standard deviations.[1]

Sex	n	Ash content (%)	Moisture content (%)	Crude protein content (%)	Crude fat content (%)	Iodine number
Female	54	1.47a ± 0.38	72.79a ± 1.32	23.96a ± 1.56	1.19a ± 0.74	118.3a ± 10.9
Male	36	1.31b ± 0.32	73.11a ± 1.45	23.55a ± 1.73	1.36a ± 0.83	120.3a ± 10.3

[1]Means not sharing the same letter are significantly ($P \leq 0.05$) different from each other.

Table 3. Age and carcass cut means, including standard deviations, and results of Studentized Range Test.[1]

Age[2]	Ash content (%)	Moisture content (%)	Crude protein content (%)
Beater	1.06a ± 0.15	74.97a ± 1.32	21.06a ± 0.91
1 year old bedlamer	1.46bc ± 0.31	72.28b ± 0.85	24.76b ± 1.08
2 year old bedlamer	1.27ab ± 0.27	72.56b ± 0.81	24.29b ± 0.91
3 year old bedlamer	1.64c ± 0.37	72.47b ± 0.88	24.27b ± 0.78
4 years or older	1.59c ± 0.35	72.30b ± 0.61	24.59b ± 0.66
Carcass cut[2]			
Rump	1.33a ± 0.30	72.58a ± 1.20	23.54a ± 1.56
Flank	1.41a ± 0.42	72.56a ± 1.43	24.59b ± 1.59
Flipper	1.47a ± 0.35	73.60b ± 1.41	23.26b ± 1.49
Grand mean	1.40 ± 0.36	72.91 ± 1.37	23.79 ± 1.63

[1]Means not sharing the same letter are significantly ($P \leq 0.05$) different from each other.
[2]n for each cut of each age = 6

Age of harp seal significantly (P<O.001) affected ash content of the meat **but no consistent trend** was observed (Table 3). The 74.98% moisture content of beater cuts was significantly greater than the 72.40% moisture content of bedlamer and adult cuts (Table 3). The reverse was true for crude protein content averaging 21 .06% in beaters and 24.48% in older animals (Table 3). The protein content of 3 and 4 year old harp seals was comparable to that reported by Hoppner et *al. (1978)* for seal (species unknown) whereas the moisture content was noticeably lower.

The ash content was not significantly affected by carcass cut (Table 3). The moisture content of the flipper was 73 .6%, whereas that of both flank and rump was significantly lower, averaging 72.6% (Table 3). However, the 24.5990 crude protein content of flank was significantly greater than the 23.26% and 23 .54% crude protein content of flipper and rump, respectively (Table 3).

Age x carcass cut interaction means indicated that crude fat of rump, but not of flank and flipper, noticeably decreased as age increased (Table **4). This** was particularly true for beaters. The interaction means also indicated that the order of fat content was always flank (0.57-0.82%), flipper (0.98- 1.37%) and rump (1.37-3.45%) (Table 4). The difference between flank and rump meat was most noticeable in beaters. The crude fat content of rump was similar to, but more variable than that reported by George *et al.* (1971), for gluteus and psoas muscles of the rump area of harp seal. However, the crude fat content of 3 **and 4 year old harp seal was noticeably lower than that** reported for seal (species unknown) by Hoppner *et al.* (1978).

Age x carcass cut interaction means indicated that iodine number of each cut varied with age, but no consistent trends were evident (Table 5). These means also suggested that iodine number of each age group varied with carcass cut and, except for the 2 year old bedlamers, the order was always flank (104.7-1 13.8), flipper (112.7-126.1) and rump (119.2-136.6) (Table 5). The observed values were much higher than those reported for intramuscular beef or pork fat (Lawrie, 1974), slightly to very much lower than those reported for lipids from fish (Ackman, 1966) and moderately lower than those reported for lipid extracted from blubber of harp seals (Jangaard and Ke, 1968).

Thus age and carcass cut, but not sex, affected the proximate composition of harp seal meat studied (Tables 2-5). However, these two variables also affect the proximate composition of meat of domesticated terrestrial animals (Byerly, 1975; Rice, 1978).

The proximate composition of harp seal meat and reported values for some common animals are shown in Table 6. In general, crude fat of harp seal meat studied was lower than that reported for both meat of domesticated terrestrial animals and flesh of fatty and medium fatty fish. This was even quite noticeable with lean beef, lamb and pork. It should be noted that very little (if any) marbling occurs in harp seal meat and fat content would thus depend on the degree of trimming of surface fat. Both crude protein and ash contents were noticeably higher than those reported for both meat of domesticated terrestrial animals and the flesh of most common commercial species of fish. The high protein content (also observed by Hoppner *et al.*, 1978) may be at least

Table 4. Age x carcass cut interaction means, including standard deviations, of percent crude fat content.

Age[1]	Carcass cut* Rump	Flank	Flipper	Overall mean of each age (n = 18)
Beater	3.45 ± 0.50	0.82 ± 0.48	1.37 ± 0.36	1.88 ± 1.24
1 year old bedlamer	1.78 ± 0.51	0.60 ± 0.17	1.50 ± 0.43	1.29 ± 0.64
2 year old bedlamer	1.63 ± 0.33	0.63 ± 0.15	1.10 ± 0.42	1.12 ± 0.52
3 year old bedlamer	1.50 ± 0.42	0.s7 ± 0.19	0.93 ± 0.25	1.00 ± 0.49
4 years or older	1.37 ± 0.29	0,62 ± 0.24	0.98 ± 0.19	0.99 ± 0.39
Overall mean of each carcass cut (n = 30)	1.95 ± 0.87	0.65 ± 0.26	1 18 ± 0.39	
Grand mean of entire sample (n ¯90)				1.26 ± 0.78

[1] n for each cut of each age = 6.

Table S. Age x carcass cut interaction means, including standard deviations, of iodine number of extracted lipid

Age[1]	Carcass cut[1] Rump	Flank	Flipper	Overall mean of each age (n = 18)
Beater	136.6 ± 6.0	104.7 ±11.3	112.7 ± 11.1	118.0 ± 16.7
1 year old bedlamer	129.1 ± 4.7	115.8> 3.2	126.1 ± 3.4	123.7 ± 6.8
2 year old bedlamer	119.2 ± 12.0	115.0 ± 8.3	123.6 ±6.7	119.3 ± 9.4
3 year old bedlamer	124.2 ± 8.6	112.2 ± 6.6	113.8 ± 9.5	116.7 ± 9.6
4 years or older	123.6 ±4.8	113.8 ± 6.3	115.7 ± 8.1	117.7 ± 7 6
Overall mean of each carcass cut (n = 30)	126.5 ± 9.4	112.3 ± 8.2	118.4 ± 9.4	
Grand mean of entire sample (n = 90)				119.1 ± 10.7

[1] n for each cut of each age = 6

Table 6 Composition of edible portion of various animals.

Species[1]	Ash (%)[2]	Crude fat (%)	Crude protein (%)	Moisture (%)
Beef - lean	1.1	4 6	20.3	74.0
(raw) fat	0.3	669	8.8	24.0
Lamb - lean	0 3	8.8	20.8	70.1
(raw) fat	0.8	71 8	6.2	21.2
Pork - lean	0.7	71	20.7	71.5
(raw) fat	0.7	71.4	6.8	21.1
Chicken - raw meat only	0 8	4.3	20.5	74.4
Duck - raw meat only	0.5	4.8	19.7	75.0
Turkey - raw meat only	0.4	2.2	21.9	75.5
Harp seal - raw flank. flipper and rump	1.4	1.3	23.8	72.9
Cod - raw fillets		0.7	17.4	82.1
Haddock - raw fillets	1.3	0 6	16.8	81.3
Herring - raw flesh	0.8	18.5	16.8	63.9
Plaice - raw	0.4	2.2	17.9	79.5
Atlantic salmon - raw	1.6	12.0	18.4	68.0

[1] Harp seal values were determined in the present study; all other compositional data are from Paul and Southgate (1978).
[2] Except for harp seal. ash values were determined by subtraction

partially attributed to the high myoglobin content of harp seal muscle (George *et* al., 1971). The observed proximate composition of harp seal meat was most similar to that reported for turkey.

Thus, the proximate composition (including iodine number of the lipid) of harp seal meat studied slightly exceeds that reported for meat of domesticated terrestrial animals and, in general, depending on the species, is comparable to or better than that reported for fish.

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Utilization Of inshore Newfoundland-Caught Harp Seal (*Pagophilus groenlandicus*): Sensory Quality of Frozen Stored, Salted, and Smoked Seal Meat

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UTILIZATION OF INSHORE NEWFOUNDLAND-CAUGHT HARP SEAL (PAGOPHILUS GROENLANDICUS): SENSORY QUALITY OF FROZEN STORED, SALTED, AND SMOKED SEAL MEAT

by

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ABSTRACT

Botta, J. R., A.P. Downey, J.T. lauder, and P.B. Noonan. 1980. Utilization 'f inshore Newfoundland-caught harp seal (*Pagophilus groenlandicus*) : sensory quality of frozen stored, salted, and smoked seal meat. Fish. Mar. Serv. Tech. Rep. 916: vi + 24 p.

Laboratory - processed frozen stored (glazed or vacuum-packaged), salted, and smoked beater harp seal was subjected to sensory evaluation panels. After 19 months of storage at -23°c (-10°F) the sensory quality Of both types of frozen seal was still fair/good. Vacuum-packaging was preferable to glazing, because of better appearance in the raw state. Salted seal , although quite acceptable, was inferior , in sensory quality , to freshly f rozen seal . Smoked seal was quite good and similar, in sensory quality, to freshly frozen seal.

RÉSUMÉ

Botta, J. R., A.P. Downey, J.T. Lauder, and P.B. Noonan. 1980. Utilization of inshore Newfoundland-caught harp seal (*Pagophilus groenlandicus*): Sensory quality of frozen stored, salted, and smoked seal meat. Fish. Mar. Serv. Tech. Rep. 916: vi + 24 p.

Des phcques du Groënland, brasseurs, furent entreposés gelés (givrés ou emballés à vide), salés et fumés au laboratoire et furent soumis à 1' analyse sensorielle. Aprés 19 mois d' entreposage, la qualité sensorielle des deux types de phoque gelé f ut encore favorable/ satisfaisant. L' emballage à vide peut être préférable au givrage puisque 1' apparence à 1' état crus fut meilleur. Pour la qualité sensorielle, la viande salée, quoique acceptable, f ut inférieure à la viande fraichement gelée. Alors que la viande fumée fut parfaitement bonne et analaloque à la viande fraichement gelée.

INTRODUCTION

The amount of meat recoverable from harp seals (Pagophilus groenlandicus) harvested for the pelts by the inshore Newfoundland seal hunters during the past 6 years has, in general, been substantial (Table 1). Though approximately 35 percent of the meat from this annual hunt has been consumed fresh, very little has been commercidly processed (Table 1) (E. Pardy, Department of Fisheries and Oceans, La Scie, Nfld.; H.A. Ryan, Department of Fisheries and @cans, Grand Falls, Nfld.; F. Slade, Department of Fisheries and Oceans, Inspection and Technology Branch, St. John's, Nfld.; pers. comm.). Thus, a substantial amount of the edible meat from the inshore hunt has not been utilized.

Although Newfoundlanders prefer fresh seal meat (Anon. 1978) which is available only during the late February-early May period, and the market for the presently available canned products appears pcor, seal meat processed in some other manner may have market potential.

Consequently, it was decided to investigate the technical feasibility of producing and the sensory quality of frozen stored (both glazed and vacuum-packaged), salted, and smoked inshore-caught harp seal meat.

MATERIALS AND METHODS

PROCUREMENT OF SAMPLES FOR LONG-TERM FROZEN STORAGE

Twenty-five harp seals (beaters, 6-8 weeks old) were shot on April 13, 1977, from the longliner, LASCIE CRUISER, in the White Bay area, Newfoundland. The animals were immediately bled and eviscerated, left on the deck and later skinned, washed in seawater, placed inside heavy-duty plastic bags, and stored at approximately 0°C (32°F) overnight. The next day, the bagged carcasses were trucked to St. John's where they were stored on ice overnight.

PREPARATION OF SAMPLES FOR LONG-TERM FROZEN STORAGE

On April 15, 1977, the carcasses were butchered into the various cuts shown in Fig. 1. The excess blood was removed by cold water rinses and the surface fat trimmed away. The flank, flipper, and rump were then placed inside different 8.2 kg (18.0 lb) capacity waxed cardboard boxes and plate frozen. Each frozen 8.2 kg-block of flank, flipper, and rump was sawed into nine equal-sized pieces weighing approximately 900 g (2.0 lb) each.

Glazing the frozen samples

Half of the freshly frozen pieces of flipper and rump were glazed several times using fresh water and, after the surface had completely solidified, the pieces were packed in cardboard boxes. During the course of the experiment the pieces were reglazed at 3-4 month intervals of storage.

Vacuum-packaging the frozen samples

The other half of the freshly frozen pieces of flipper and rump and all the freshly frozen flank were vacuum-packaged in 4.0 roil. thick polyamide polyethylene pouches, using a CDL Model 212 vacuum sealing machine. The vacuum, seal, and cool settings were 2, 2 and 1.5, respectively, and during packaging, the vacuum level reached 71.3 cm (28.0 in) of mercury. The packaged pieces were then placed in cardboard boxes.

LONG-TERM FROZEN STORAGE

Some of the glazed, and vacuum-packaged flipper and rump and all of the vacuum-packaged flank were stored at -62°C (-80%). The flank was used for preliminary experiments whereas the flipper and rump were used for taste panel training and as taste panel control samples. Fresh control samples were obtained during May 1978 and treated similarly.

Most of the glazed and vacuum-packaged samples of frozen flipper and rump were stored at approximately -23OC (-10°F) for periods of up to 19 months. After each of 0, 3, 6, 10, 14 and 19 months of storage, three samples of glazed and three samples of vacuum-packaged seal meat were transferred to storage at -62°C until evaluated. At 0, 3 and 6 months of storage, glazed rump and vacuum-packaged rump were sampled, whereas at 10, 14 and 19 months of storage glazed flipper and vacuum-packaged flipper were sampled.

Cooking frozen samples

A 771 g (1.7 lb) portion of frozen seal mat, which had been transferred from -62°C to -23°C, 24 hours earlier, was placed in a small roasting pan containing one cup of tap water and cooked, uncovered, in a conventional oven at 191°C (375°F) for 60 minutes. The meat was then removed and, after the addition of some water to compensate for the evaporation that had taken place, replaced and cooked, covered, for a further 95 minutes. The cooked seal meat was carved into small segments, placed in labelled glass petri dishes, and served hot using an electric warming tray. This cooking procedure was such that, in general, the geometric center of the 771 g portion of seal meat attained a temperature of 90°C (194°F) for 10 minutes.

Sensory evaluation

An analytical panel of six judges, all trained in assessing the sensory variables (appearance, texture, odor, flavor and overall acceptability) of frozen stored flipper and rump, used a 5-point descriptive scale (Table 2) to score each sample. A score of 5 indicated the highest and a score of 1 the lowest quality. An overall acceptability score of 2 or lower indicated that the sample was unacceptable. Each judge evaluated three samples per storage time, inking a total of 18 observations of each of the sensory variables for each packaging method. One control sample and three treated samples (presented in random order) were presented to each judge per session and evaluated within 15 minutes.

PROCUREMENT OF SAMPLES FOR SALTING AND FOR SMOKING EXPERIMENTS

From April 30 to May 2, 1979, sixteen harp beaters were shot from the longliner CHRISTOPHER ANNE, in the Grey Islands area, Newfoundland. Immediately after being shot, each seal was bled, skinned, eviscerated, washed in clean offshore seawater, and packed in heavy-duty plastic bags. The bagged carcasses were then stored on ice and on May 3, 1979, were trucked to St. John's where they were stored on ice overnight.

PREPARATION OF SAMPLES FOR SALTING AND FOR SMOKING EXPERIMENTS

On May 4, 1979, the carcasses were butchered and cleaned in the same manner as were the samples to be frozen. The rump was used to prepare salted and the flank to prepare smoked seal meat. The publication of Rust and Olson (1973) was used as a general reference for the curing of meat.

Salting samples

Some of the rump was placed inside 2.3 kg (5.0 lb) capacity waxed cardboard boxes, plate frozen, wrapped in saran wrap, placed in plastic bags and stored at -62°C until used as control samples for the salted rump.

However, most of the rump pieces, measuring 10.2-15.2 cm (4.0-6.0 in) long, 7.6-10.2 cm (3.0-4.0 in) wide, and 2.5-5.0 cm (1.0-2.0 in) thick, were placed into 22.7 1 (5.0 gal) capacity plastic buckets containing either: (a) saturated salt brine; or (b) saturated salt brine with sodium nitrite (180 parts per million based on the total liquid phase including the moisture content of the seal meat), in a ratio of

0.9 kg (2.0 lb) seal meat to 1.4 kg (3.0 lb) of brine. Perforated wooden discs were put on top of the meat to keep the rump submerged and tight fitting lids placed on the buckets. The buckets were held at 5.5°C (42°F) for 25 days, then at 15°C (59°F) for 14 days, before being presented to a sensory evaluation panel.

Smoking samples

Some of the flank was placed inside 0.45 kg (1.0 lb) capacity waxed cardboard boxes, plate frozen, wrapped in saran wrap, placed inside plastic bags and stored at -62°C until used as control samples for the smoked flank.

However, most of the flank, in pieces 2.5-3.8 cm (1.0-1.5 in) thick, was placed into: (a) a brine containing 14.5% salt; (b) a brine containing 14.5% salt and 0.12% sodium nitrite; or (c) a brine containing 14.5% salt, 0.12% sodium nitrite, and 7.5% sugar. The flank was hand-pierced with a sharp knife, and different portions were placed separately into the brines in a ratio of 2.7 kg (6.0 lb) of flank to 0.45 kg (1.0 lb) of brine. The flank and brine were mixed for 1.0 minute at a slow speed, in a Hobart mixer, then transferred to 4.5 1 (1.0 gal) capacity plastic buckets with tight-fitting lids. The above specified ratio was maintained. The headspace of the buckets was flushed with nitrogen gas for 0.5 minutes, and the buckets sealed, then stored at approximately 5.5°C for 4 days. The flank was then removed from the brines, allowed to drain well, placed on racks in an Afos Mini Kiln and hot smoked (using a mixture of hardwood and softwood, sawdust and chips) for approximately 7.5 hours. During smoking, the temperature in the smoking chamber increased from 36.7°C (98°F) to 77.8°C (172°F). After being smoked for 7.5 hours, the internal temperature of the flank was 59.5°C (139°F), 62.0°C (143.6%), and 65.0°C (149°F) for flank cured in a salt brine, in a salt brine containing nitrite, and in a salt brine containing nitrite and sugar, respectively. The smoked flank was then allowed to cool, placed in plastic bags, stored at 2.0°-5.0°C (35.6°-41.0°F) and presented to a sensory evaluation panel within 48 hours.

SENSORY EVALUATION OF SALTED AND OF SMOKED SEAL MEAT

cooking salted samples

The 2.3kg-boxes of frozen rump control samples were transferred from -62°C to -23°C and, 48 hours later, thawed at approximately 5.5°C for 16 hours.

The salted rump was soaked in tap water (1.0 parts rump to 6.7 parts inter) for 16 hours at approximately 5.5°C, then removed and allowed to drain.

The thawed or soaked rump was then transferred to a large pot of boiling water (1.0 part rump to 11.5 parts water), boiled for 90 minutes, carved into small segments, placed in labelled glass petri dishes, and served hot using an electric warming tray.

Cooking smoked samples

The 0.45 kg boxes of frozen flank control samples were sawed into pieces approximately 7.5 cm (2.9 in) long, 2.8 cm (1.1 in) thick, and 1.5 cm (0.6 in) wide, then wrapped in saran wrap and stored at -23°C. Within 48 hours, they were placed (in lots of 6 pieces) in aluminum pans covered with aluminum foil, and baked for 31 minutes at 232°C (450°F).

The smoked portions of flank were cut into similar-sized pieces, placed in aluminum pans covered with aluminum foil and baked for 14 minutes at 232°C.

Immediately after cooking, the controls and treated samples were placed in label-led glass petri dishes and served hot using an electric warming tray.

Sensory evaluation

The rump control and both types of salted rump were presented to 24 untrained judges (four cliff erent panels of six judges each); at different time(s) the flank control and the three types of smoked flank were presented to a similar group. Using a 9-point hedonic scale (Table 3) the judges assessed no more than four samples, presented in random order, per session. All samples were evaluated within 15 minutes.

STATISTICAL ANALYSES

CM-square (X2) test was used to determine if there were any significant differences among frequency distributions of sensory evaluation scores for the frozen, for the "salted", or for the "smoked" samples (Snedecor and Cochrane, 1967). If some of the expected frequencies were too small (less than 1.0) then categories were combined to eliminate these small expected frequencies (Conover, 1971). It should be noted that the X^2 text was computed on the raw data, not on percentages as presented in the tables. Unless otherwise indicated "significant" means significant at the 5% level (i.e. the probability of the cliff erence occurring by chance alone is 5%).

RESULTS AND DISCUSSION

SENSORY EVALUATION

Long-term frozen seal meat

At 0 time, scores of 4 or 5 (Table 2) were assigned to 77.8%, 75.0%, 66.7%, 72.1% and 58.2% of the rump presented to the trained sensory evaluation panel when assessed for odor, appearance, texture, flavor and overall acceptability, respectively (Tables 4-8). Although only 58.2% were assigned overall acceptability scores of 4 or 5, 33.3% were assigned a score of 3 and only 8.3% scores of 1 or 2, considered unacceptable (Tables 2 and 8).

For rump stored at -23°C for 0, 3, and 6 months, the frequency distributions (the percentages of times each treatment combination received each of the scores) for the treatment - storage time groups did not significantly change when any of the sensory variables were considered (Tables 4-8). Statistical analyses also indicated that the frequency distributionof the sensory evaluation scores did not significantly differ among storage times (when looking at storage times alone, excluding treatments)(Tables 4-8). In addition, the frequency distributions of odor, appearance, texture, flavor and overall acceptability scores did not significantly differ between the glazed and vacuum-packaged rump (Tables 4-8).

Thus, with rump stored at -62°C as the control, the results of a trained sensory evaluation panel indicated the sensory quality of frozen (glazed or vacuum-packaged) rump did not significantly change during 6 months of storage at -23°C.

At 10, 14 and 19 months of storage at -23°C, flipper was sampled. After 19 months of storage, scores of 4 or 5 (Table 2) were assigned to 69.4%, 63.9%, 58.3%, 63.8% and 52.7% of the samples when assessed for odor, appearance, texture, flavor and overall acceptability, respectively (Tables 4-8). Although only 52.7'% were assigned overall acceptability scores of 4 or 5, 36.1% were assigned a score of 3 and only 11.1% scores of 1 or 2 , considered unacceptable (Tables 2 and 8).

For flipper stored at -23°C for 10, 14 and 19 months, the frequency distributions of the sensory evaluation scores of the treatment-storage time groups did not significantly change when odor, texture, and flavor data were considered but did when appearance data were considered (Tables 4-7). This significant difference may be at least partially due to the higher assessed values for the glazed and vacuum-packaged samples at 10 months of storage as well as the lower assessed values of the glazed samples at 14 months of storage (Table 5). Also the frequency distributions of the odor and appearance scores did not significantly differ among the three storage times (Tables 4 and 5) but those for texture and flavor scores did (Tables 6 and 7). For both texture and flavor this significant difference appeared to be at least partially due to the 14-month samples being assigned lower scores (Tables 6 and 7). It is not known why the 19-month samples did not receive scores as low as the 14-month samples except that in the case of the 14-month samples there may have been more leakage through the glazes and the packages. The frequency distributions of odor, appearance, texture and flavor scores did not differ significantly between the glazed and vacuum-packaged flipper.

When overall acceptability scores were statistically analyzed, the results indicated that there were no significant differences in the frequency distributions of these scores among treatment-storage time groups, among storage times, or between the glazed and vacuum-packaged samples (Table 8).

Thus, although there may have been some leakage through the glazes or the polyamide polyethylene pouches, the sensory quality of frozen flipper after 19 months of storage at -230C was still fair/good (Tables 2 and 4-8). The difference between the glazed and vacuum-packaged samples appeared to be negligible.

Statistically, one cannot definitely say that after 19 months of storage at -2 3°C (-10OF) rump would have a sensory quality similar to that observed with f lipper, or that freshly frozen flipper would have a sensory quality similar to that observed with rump. However, in practice this may be the case as it has been observed that, regarding sensory quality, cooked flipper and cooked rump from beaters are not distinguishable (G. Jones, S.T. Jones & Son, Little Bay Islands, Nfld. ; E. Noble, retired harp seal processor, St. John's, Nfld.; and H.A. Ryan, Department of Fisheries and Oceans, Grand Falls, Nfld. ; pers. comm.).

When considering the two packaging methods, the frequency distributions of any of the sensory evaluation scores of subsequently cooked rump or flipper (stored at -23°C for 0-6 months and 10-19 months, respectively) did not differ significantly. However, the appearance of raw vacuum-packaged meat was substantially superior to that of raw glazed meat .

Salted seal meat

The frequency distributions (the percentages of times each of the products received each of the scores) of the sensory evaluation scores for the "salted" products are presented in Table 9. The percentages of judges who liked the products to a very substantial degree (a score of 8 or 9) was 33.3%, 8.3% and 25% for rump control (not salted), rump salted in a saturated brine, and rump salted in a saturated brine with nitrite, respectively (Table 9). The percentage of judges who disliked the products (scores of 1-4) were 0.0%, 33.4% and 20.9% for rump control, rump salted in a saturated brine, and rump salted in a saturated brine captaining nitrite, respectively (Table 9).

Statistical analyses of the overall frequency distributions of the sensory evaluation scores for the three products indicated that the distributions significantly differed among the three products (Table 9). The frequency distribution of the control was significantly different (more higher scores) from that of the two salted products (Table 9). However, the overall frequency distribution of the sensory evaluation scores of rump cured in a saturated salt brine was not significantly different from that of rump cured in a saturated brine with nitrite (Table 10).

Thus, the results of an untrained sensory evaluation panel (Table 3) indicate that salted beater rump was quite acceptable, but less so than that of freshly frozen beater rump. The sensory quality of both types of salted meat was similar.

Smoked seal meat

The results of the smoked flank evaluations are presented in Table 11. The percentages of the 24 judges who liked the products to a very substantial degree (a score of 8 or 9) was 37.5%, 16.7%, 41.7% and 41. 7% for flank control (not cured or smoked), flank cured in a salt brine then hot smoked, flank cured in a salt brine containing nitrite then hot smoked, and flank cured in a salt brine containing nitrite and sugar then hot smoked, respectively (Table 11). The percentages of judges who disliked the products (scores of 1-4) were 8. 3%, 25.0%, 8.4% and 20.9% for flank control, flank cured in a salt brine then hot smoked, flank cured in a salt brine containing nitrite then hot smoked, and flank cured in a salt brine containing nitrite and sugar then hot smoked, respectively (Table 11). However, the frequency distributions of the sensory evaluation scores did not significantly differ among the four different "smoked" products (Table 11).

Thus, based on the results of an untrained sensory evaluation panel (Table 3), the sensory quality of both freshly smoked beater flank (all three cures) and freshly frozen flank was quite good.

GENERAL DISCUSSION

It is interesting to note that the assessment regarding overall acceptability of the 0-time frozen rump samples (Table 2 and 8) was , in general, substantiated by the assessment of freshly frozen rump used as the salted treatment control (Tables 3 and 9).

The sensory quality of beater meat was quite acceptable after 19 months of storage (glazed or vacuum-packaged) at -23°C. Although this seems impressive, it should be noted that other frozen red meats (such as beef and pork) if packaged properly to prevent desiccation and rancidity also keep well. It has been observed that the quality of wholesale prime cuts of pork and beef (when glazed after freezing and stored at -23°C) does not noticeably change until 6-7 months and one year of storage, respectively (Jul 1968). Pork and beef cuts stored in this manner, do not become unacceptable to the general public until after 2 years and 4-5 years of storage at -23°C, respectively (Jul 19681.

The sensory evaluation scores of salted rump were lower than those of freshly frozen rump, whereas the sensory evaluation scores of smoked flank did not significantly cliff er from those of freshly frozen flank. This situation may be reversed with 1-, 2-, and 3-year-old bedlamers or with old harps where the gamy taste is stronger than in beaters . Preliminary experiments with 1-year-old bedlamers indicated that curing and sinking tended to mask this gamey taste.

Common cured pork (using solutions containing nitrate/nitrite) possesses a pinkish color after heating (Rust and Olson, 1973). However, when seal meat (rump/flank) was cured in solutions containing nitrite and then heated it was dark reddish with a slight purple tinge rather than pinkish and looked more like fresh beef them cured pork. Harp seal muscle contains a great deal of myoglobin (George et al 1971) and this factor was probably largely responsible for the reddish color, as myoglobin is necessary to form nitrosohemochrome, the compound responsible for the cured meat color (Rust and Olson 197 3).

Nitrite did not produce a significant improvement in the sensory quality of salted or smoked seal meat. Legally, at the present, nitrate/nitrite is not allowed to be used with seal meat (Anon. 1979) which is regarded, not as a "meat", but as a marine meat (Anon. 1979). If it becomes desirable to use nitrate/nitrite with seal meat , it may not be cliff icult to get the regulation changed (G.C. Morgan> Agriculture Canada, Food production and Marketing Branch, St. John's , Nfld. ; and D. R. L. White, Fisheries and Oceans, Inspection and Technology Branch, St. John's, Nfld. ; pers. comm.) as, biologically and chemically, seal meat has most of the characteristics of terrestrial red meat (beef, pork, and lamb) and nitrate/nitrite would probably be used at similar levels for similar reasons.

Newfoundland consumers have stated that they would prefer to buy seal meat fresh (Anon. 1978). This does not necessarily mean that a substantial amount of high quality processed, other than canned, seal meat could not be sold, particularly during the period from mid-May to late February when fresh seal meat is not available. The results of the present laboratory study indicated that frozen seal (glazed or vacuum-packaged) stored at -2 3°C had a substantial storage life and that the sensory quality of salted and of smoked seal meat was quite acceptable.

In order to produce smoked seal meat during the period from mid-May until late February, it would probably be best to freeze the meat (store it glazed or vacuum-packaged), then thaw it and smoke it rather than smoke the fresh meat and subsequently freeze it (Eastman 1975).

The storage life of glazed or vacuum-packaged seal meat at -2 3°C was fair/good and the sensory quality of salted and of smoked seal meat was quite acceptable. It should be emphasized that this was achieved under laboratory conditions and will not necessarily be achieved under commercial conditions. It should also be stressed that the sensory quality of the products was determined by laboratory sensory evaluation panels whose assessment will not necessarily agree with that of the general public. Consequently, the present study should be viewed as the first of a series of hurdles, the others being consumer studies , test marketing, and economic analyses (R.C. Baker, Department of Food Sciences, Cornell University, Ithaca, NY; pers. comm.), none of which have been approached.

CONCLUSIONS

The results of a laboratory study designed to investigate the technical feasibility of producing and the sensory quality of frozen stored (both glazed and vacuum-packaged) , salted , and smoked inshore-caught harp (beater) meat indicated: (1) the storage life of flipper (glazed or vacuum-packaged) was at least 19 months at -23°C (-10°F); (2) vacuum-packaging was superior to glazing, because of better appearance in the raw state, although sensory quality was similar in the cooked state: (3) the sensory quality of both types of salted rump , was similar and quite acceptable, but lower than that of freshly frozen rump; and (4) the sensory quality of all three types of smoked flank was quite good and similar to that of freshly frozen flank. Before the commercial utilization of inshore-caught harp seals (beaters) is initiated, it is recommended that consumer studies be conducted.

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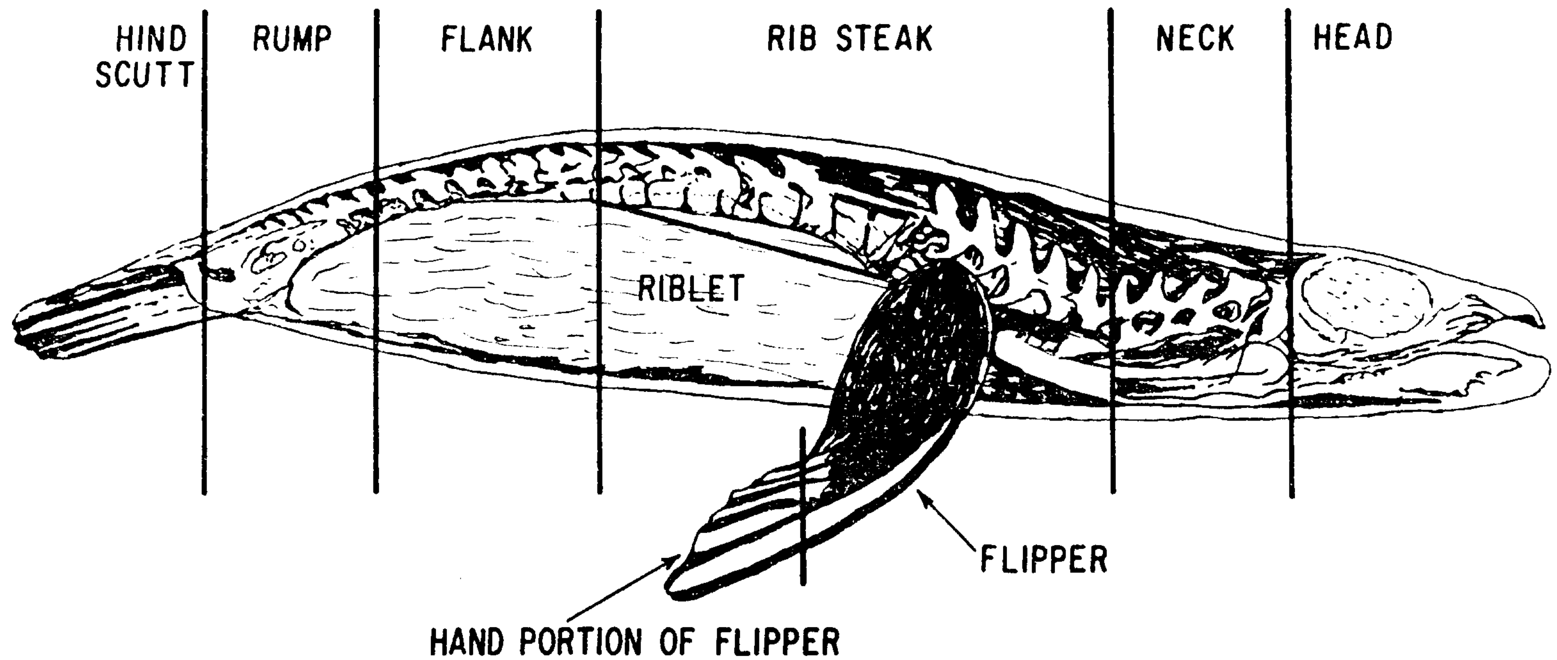

Fig. 1. A diagram of a harp seal (Pagophilus groenlandicus) carcass showing how the carcasses were butchered.

TABLE 1. Approximate amount of meat[a] recoverable from
bedlamers, and old harps) slaughtered and the amount of
1974 - 1979.

Year caught	Amount, kg (lb), of recoverable		
	Beaters	Bedlamers	Old har
1974	76,122 (167,469)	126,393 (278,064)	57,998 (127,596
1975	145,513 (320,128)	249,993 (549,984)	144,747 (318 ,444
1976	177,576 (390,668)	368,618 (810,960)	267,349 (588,168
1977	175,702 (386,545)	417,316 (918,096)	143,220 (315,084
1978	166,092 (365,402)	624,349 (1,373,568)	249,130 (548,100
1979	62,926 (138,347)	400,771 (881,696)	206,39 (454,069

Unprocessed seal meat was defined as the skinned and
flippers, the neck, the head, and the hind scutt but

[b]The number of animals slaughtered (pelts landed) was
Economics and Intelligence Branch, St. Johnfs, Nfld.
using conversion factors (5.5 kg., 12.2 lb. , per beat
84 lb. , per old harp) which were the average of conve
(Department of Fisheries and Oceans, Research and R
H.A. Ryan (Department of Fisheries and Oceans, Grand

[c]Source: Department of Fisheries and Oceans, Economics

TABLE 2. **A** copy of the form used to evaluate frozen harp seal (beater) meat (flipper and rump) that was subsequently cooked.

SENSORY ANALYSIS OF SEAL MEAT

JUDGE ____________________ DATE ____________________

NUMERICAL RATING : 5 4 3 2 1

ODOR Sample	Fresh , gamy , natural seabird odor	Sl . loss of fresh odor, strong, gamey ,oily	Sl .mildewy Sl.musty Sl stale	Mildewy Musty Stale	V .Musty Rancid Putrid V .Mildewy	COMMENTS
1						
2						
3						
4						

APPEARANCE Sample	Desirable; Dk . Brown Color Natural appearance; V.Sl. Stringy	Mod. Desirable; Dk . Brown Sl . stringy	Sl . Desire-able ;Mod. stringy ; V. Dk. Brown	S. Undesir-able ;Al-most black stringy ; Sl . redness; Sl. oily , greasy	Undesirable Almost black V . stringy Redness in-side; oily, greasy	COMMENTS
1						
2						
3						
4						

TABLE 2 (CONT'D):

NUMERICAL RATING: 5 4 3 2 1

TEXTURE Sample	Tender but firm Sl. dry	Mod. tender Sl. coarse Sl. stringy Dry	Sl. tender Coarse Sl. stringy Dry	ringy, Sl tough S.. oily	V. stringy mod tough oily	COMMENTS
1						
2						
3						
4						

FLAVOUR Sample	Fresh Sl. Gamey, Natural Flavor	Sl. loss of fresh flavor, sl. increased gamey flavor, natural flavor	l. fresh, od., gamey, atural lavour. Sl. ff flavor musty > stale)	Strong, Musty, Stale, off - Flavors	V. musty V. stale V. mildewy Rancid Putrid	COMMENTS
1						
2						
3						
4						

OVERALL ACCEPTABILITY Sample	V. Good	Good	Fair	SL. Spoiled	Spoiled	COMMENTS
1						
2						
3						
4						

TABLE 3. A copy of the form that the judges used to evaluate cooked salted rump, cooked smoked flank, and the cooked controls (freshly frozen rump and flank) of harp seals (beaters).

SENSORY ANALYSES OF HARP SEAL MEAT

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 or dislike	____ Neither like or dislike	____ Neither like or dislike	____ Neither like or dislike
____ Dislike slightly	____ Dislike slightly	____ Dislike slightly	____ Dislike slightly
____ Dislike moderately	____ Dislike moderately	____ Dislike moderately	Dislike moderately
____ Dislike very much	____ Dislike very much	____ Dislike verg much	____ Dislike very much
____ Dislike extremely	____ Dislike extremely	____ Dislike extremely	____ Dislike extremely
REASON	REASON	REASON	REASON

TABLE 4. Storage of frozen (glazed or vacuum-packaged) harp seal (beater) meat (flipper/rump) at -23°C (-10°F) for up to 19 months: Observed frequency distributions (the percentages of times each treatment combination received each of the scores) for odor scores of the subsequently cooked samples[a].

Treatment	Storage time (mo) or meat cut	Odor scores 1	2	3	4	5	Storage time (mo) or meat cut	Odor scores 1	2	3	4	5
		Observed frequencies (%) for the treatment-storage time groups (n=18)[b]										
Glazed	0	0.0	16.6	5.6	55.6	22.2	10	0.0	5.6	11.1	66.7	16.7
Vac.packaged	0	0.0	11.1	11*1	44.4	33.3	10	0.0	5.6	22*2	33.3	38.9
Glazed	3	5.6	0.0	16.7	55.5	22.2	14	0.0	11.1	33.3	38.9	16.7
Vac.packaged	3	0.0	11.1	5.6	50.0	33.3	14	5.6	Ill	22*2	61.1	0.0
Glazed	6	Ill	5.6	22.2	44.4	16.7	19	0.0	5.6	27.8	50.0	16.7
Vac.packaged	6	0.0	11.1	27.8	55.6	5.6	19	0.0	11.1	16.7	50.0	22.2
		χ^2=11.34[n.s.] with 15 d.f.[c]						χ^2 = 14.99[n.s.] with 15 d.f.[c]				
		Observed frequencies (%) for storage times, ignoring treatments (n=36)[b]										
———	0	0.0	13.9	8.3	50.0	27.8	10	0.0	5.6	16.7	50,0	27.7
———	3	2.8	5.5	11.1	52.8	27.8	14	2.8	11.1	27.8	50.0	8.3
———	6	5.6	8.3	25.0	50.0	11.1	19	0.0	8.3	22*2	50.0	19.4
		χ^2 = 7.52[n.s.] with 6 d.f.[c]						χ^2 = 6.10[n.s.] with 6 d.f.[c]				
		Observed frequencies (%) for treatments, ignoring storage times (n=54)[b]										
Glazed	Rump	5.6	7.4	14.8	51.9	20.3	Flipper	0.0	7.4	24.1	51.9	16.6
Vac.packaged	Rump	0.0	11.1	14.8	50.0	24.1	Flipper	1.9	9.2	20.4	48.1	20.4
		χ^2 = 0.26[n.s.] with 3 d.f.[c]						χ^2 = 0.84[n.s.] with 3 d.f.[c]				

[a]At 0, 3 and 6 months of storage & was sampled whereas at 10, 14 and 19 months of storage flipper was sampled.

[b]n = number of observations per treatment combination.

[n.s.]Not significant at the 5% level.

[c]Computed with scores 1 and 2 combined.

TABLE 5. Storage of frozen (glazed or vacuum-packaged) harp seal (beater) meat (flipper/rump) at -23°C (-10°F) for up to 19 months: Observed frequency distributions (the percentages of times each treatment combination received each of the scores) for appearance scores of the subsequently cooked samples[a].

Treatment	Storage time (mo) or meat cut	Appearance score					Storage time (mo) or meat cut	Appearance score				
		1	2	3	4	5		1	2	3	4	5
		Observed frequencies (%) for the treatment-storage time groups (n=18)[b]										
Glazed	0	0.0	0.0	22.2	61.1	16.7	10	0.0	Ill	5.6	77.7	5.6
Vac.packaged	0	0.0	5.6	22.2	55.6	16.7	10	0.0	0.0	27.8	38.8	33.3
Glazed	3	5.6	5.6	16.6	55.6	16.6	14	0.0	5.6	50.0	33.3	11.1
Vac.packaged	3	0.0	5.6	16.7	55.6	22.2	14	5.6	11.1	16.7	66.7	0.0
Glazed	6	11.1	22.2	16.7	33.3	16.7	19	0.0	5.6	22.2	55.6	16.7
Vac.packaged	6	0.0	16.7	33.3	38.8	11.1	19	0.0	16.7	27.8	38.8	16.7
		χ^2 = 15.21[n.s.] with 15 d.f.[c]						χ^2 ′ 26.39* with 15 d.f.[c]				
		Observed frequencies (%) for storage times, ignoring treatments (n=36)[b]										
______	0	0.0	2.8	22.2	58.3	16.7	10	0.0	5.6	16.7	58.3	19.5
______	3	2.8	5.6	16.7	55.6	19.4	14	2.8	8.3	33.3	50.0	5.6
______	6	5.6	19.4	25.0	36.1	13.8	19	0.0	11.1	25.0	47.2	16.7
		χ^2 · 11.05[n.s.] with 6 d.f.[c]						χ^2 · 6.06[n.s.] with 6 d.f.[c]				
		Observed frequencies (%) for treatments, ignoring storage times (n=54)[b]										
Glazed	Rump	5.6	9.3	18.5	50.0	16.7	Flipper	0.0	7.4	25.9	55.6	11.1
Vac.packaged	Rump	0.0	9.3	24.1	50.0	16.7	Flipper	1.9	9.3	24.1	48.1	16.7
		χ^2 = 1.08[n.s.] with 3 d.f.[c]						χ^2 = 1.32[n.s.] with 3 d.f.[c]				

[a]At 0, 3 and 6 months of storage rump was sampled whereas at 10, 14 and 19 months of storage flipper was sampled.

[b]n = number of observations per treatment combination.

[n.s.]Not significant at the 5% level. *Significant at the 5% level. [c]Computed with scores 1 & 2 combined.

TABLE 6.- Storage of frozen (glazed or vacuum-packaged) harp seal (beater) meat (flipper/rump) at -23°C (-10°F) for up to 19 months: Observed frequency distributions (the percentages of times each treatment combination received each of the scores) for texture scores of the subsequently cooked samples[a].

Treatment	Storage time (mo) or meat cut	Texture score 1	2	3	4	5	Storage time (mo) or meat cut	Texture score 1	2	3	4	5
		Observed frequencies (%) for the treatment-storage time groups (n=18)[b]										
Glazed	0	0.0	16.7	16.7	50.0	16.7	10	0.0	11.1	5.6	66.7	16.7
Vac.packaged	0	0.0	16.7.	16.7	50.0	16.7	10	0.0	5.6	16.7	36.8	38.8
Glazed	3	5.6	5.6	5.6	61.1	22.2	14	0.0	27.8	38.8	22.2	11.1
Vac.packaged	3	0.0	11.1	16.7	38.8	33.3	14	5.6	22*2	27.8	44.4	0.0
Glazed	6	Ill	22.2	16.7	38.8	11.1	19	0.0	11.1	22.2	50.0	16.7
Vac.packaged	6	0.0	22*2	16.7	S5.6	5.6	19	0.0	16.7	33.3	27.8	22.2
		χ^2 = 10.79 n.s. with 15 d.f.[c]						χ^2 = 24.06 n.s. with 15 d.f.[c]				
		Observed frequencies (%) for storage times, ignoring treatments (n=36)[b]										
	0	0.0	16.7	16.7	50.0	16.7	10	0.0	8.3	11.1	52.8	27.8
	3	0.0	11.1	11.1	50.0	27.8	14	2.8	25.0	33.3	33.3	5.6
	6	5.6	22.2	16.7	47.2	8.3	19	0.0	13.8	27.8	38.9	19.4
		χ^2 = 7.23 n.s. with 6 d.f.[c]						χ^2 = 15.22* with 6 d.f.[c]				
		Observed frequencies (%) for treatments, ignoring storage times (n=54)[b]										
Glazed	Rump	3.7	16.7	13.0	50.0	16.7	Flipper	0.0	16.7	22.2	46.3	14.8
Vac.packaged	Rump	0.0	16.7	16.7	48.1	18.5	Flipper	1.9	14.8	25.9	37.0	20.4
		χ^2 = 0.52 n.s. with 3 d.f.[c]						χ^2 = 1.18 n.s. with 3 d.f.[c]				

[a] At 0, 3 and 6 months of storage rump was sampled whereas at 10, 14 and 19 months of storage flipper was sampled.

[b] n = number of observations per treatment combination.

n.s. Not significant at the 5% level. *Significant at the 5% level. [c] Computed with scores 1 & 2 combined.

TABLE 7. Storage of frozen (glazed or vacuum-packaged) harp seal (beater) meat (flipper/rump) at -23°C (-10°F) for up to 19 months: Observed frequency distributions (the percentages of times each treatment combination received each of the scores) for flavor scores of the subsequently cooked Samples[a].

Treatment	Storage time (mo) or meat cut	Flavor score 1	2	3	4	5	Storage time (mo) or meat cut	Flavor score 1	2	3	4	5
		Observed frequencies (%) for the treatment-storage time groups (n=18)[b]										
Glazed	0	0.0	11.1	11.1	66.7	11.1	10	0.0	0.0	27.8	61.1	11.1
Vac.packaged	0	0.0	11.1	22.2	50.0	16.7	10	0.0	0.0	22.2	44.4	33.3
Glazed	3	0.0	5.6	27.8	55.6	11.1	14	0.0	22.2	44.4	22.2	11.1
Vac.packaged	3	0.0	5.6	11.1	50.0	33.3	14	Ill	16.7	33.3	33.3	5.6
Glazed	6	5.6	11.1	22.2	44.4	16.7	19	0.0	11.1	22.2	44.4	22.2
Vac.packaged	6	0.0	5.6	50.0	38.8	5.6	19	0.0	11.1	27.8	44.4	16.7
		X^2 = 16.55[n.s.] with 15 d.f.[c]						X^2 = 20.73[n.s.] with 15 d.f.[c]				
		Observed frequencies (%) for storage times, ignoring treatments (n=36)[b]										
———	0	0.0	I l l	16.7	58.3	13.8	10	0.0	0.0	25.0	52.8	22.2
———	3	0.0	5.6	19.4	52.8	22.2	14	5.6	19.4	38.9	27.8	8.3
———	6	2.8	8.3	36.1	41.7	11.1	19	0.0	11.1	25.0	44.4	19.4
		X^2 = 6.66[n.s.] with 6 d.f.[c]						X^2 = 16.08* with 6 d.f.[c]				
		Observed frequencies (%) for treatments, ignoring storage times (n=54)[b]										
Glazed	Rump	1.9	9.2	20.4	55.6	13.0	Flipper	0.0	11.1	31.5	42.6	14.8
Vac.packaged	Rump	0.0	7.4	27.8	46.3	18.5	Flipper	3.7	9.3	27.8	40.7	18.5
		X^2 = 2.00[n.s.] with 3 d.f.[c]						X^2 = 0.45[n.s.] with 3 d.f.[c]				

[a]At 0, 3 and 6 months of storage rump was sampled Whereas at 10, 14 and 19 ninths of storage flipper was sampled.

[b]n = number of observations per treatment combination.

[n.s.]Not significant at the 5% level. *Significant at the 5% level. [c]Computed with scores 1 & 2 combined.

TABLE 8• Storage of frozen (glazed or vacuum-packaged) harp seal (beater) meat (flipper/rump) at -23°C (-10°F) for up to 19 months: Observed frequency distributions (the percentages of times each treatment combination received each of the scores) for overall acceptability scores of the subsequently cooked samples[a].

Treatment	Storage time (mo) or meat cut	Overall acceptability score 1	2	3	4	5	Storage time (mo) or meat cut	Overall acceptability score 1	2	3	4	5
		Observed frequencies (%) for the treatment-storage time groups (n=18)[b]										
Glazed	0	0.0	5.6	33.3	50.0	11.1	10	0.0	5.6	22.2	66.7	5.6
Vac.packaged	0	0.0	11.1	33.3	38.8	16.7	10	0.0	0.0	27.8	44.4	27.8
Glazed	3	0.0	0.0	38.8	50.0	11.1	14	0.0	27.8	33.3	27.8	11.1
Vac.packaged	3	0.0	11.1	16.7	44.4	27.3	14	5.6	16.7	33.3	44.4	0.0
Glazed	6	5.6	16.7	22.2	38.8	16.7	19	0.0	5.6	38.8	44.4	11.1
Vac.packaged	6	0.0	11.1	50.0	33.3	5.6	19	0.0	16.7	33.3	33.3	16.7
		$\chi^2 = 13.19^{n.s.}$ with 15 d.f.[c]						$\chi^2 = 19.75^{n.s.}$ with 15 d.f.[c]				
		Observed frequencies (%) for storage times, ignoring treatments (n=36)[b]										
———	0	0.0	8.3	33.3	44.4	13.8	10	0.0	2.8	25.0	55.6	16.7
———	3	0.0	5.6	27.8	47.2	19.4	14	2.8	22.2	33.3	36.1	5.6
———	6	2.8	13.8	36.1	36.1	11.1	19	0.0	11.1	36.1	38.9	13.8
		$\chi^2 = 4.20^{n.s.}$ with 6 d.f.[c]						$\chi^2 = 11.59^{n.s.}$ with 6 d.f.[c]				
		Observed frequencies (%) for treatments, ignoring storage times (n=54)[b]										
Glazed	Rump	1.9	7.4	31.5	46.3	13.0	Flipper	0.0	13.0	31.5	46.3	9.3
Vac.packaged	Rump	0.0	11.1	33.3	38.9	16.7	Flipper	1.9	Ill	31.5	40.7	14.8
		$\chi^2 = 0.72^{n.s.}$ with 3 d.f.[c]						$\chi^2 = 0.88^{n.s.}$ with 3 d.f.[c]				

[a]At 0, 3 and 6 months of storage rump was sampled whereas at 10, 14 and 19 months of storage flipper was sampled.

[b]n = number of observations per treatment combination.

[n.s.]Not significant at the 5% level. [c]Computed with scores 1 and 2 combined.

TABLE 9. Salted harp seal (beater) meat (rump): Observed frequency distributions (the percentages of times each treatment received each of the scores) for sensory evaluation scores of the subsequently cooked samples and a test of the hypothesis that the frequency distributions of the three treatments are the same.

Treatment	Sensory evaluation score[a] 1	2	3	4	5	6	7	8	9	Contribution to χ^2 when scores less than or equal to 4 and scores greater than or equal to 8 are combined
	Observed frequencies (percentages; n=24)[b]									
Salted treatment control (not salted but freshly frozen)	0.0	0*0	0.0	0.0	25.0	8.3	33.3	33.3	0.0	10.91*
Salted in a saturated brine	4.2	4.2	4.2	20.8	8.3	29.2	20.8	8.3	0.0	6.60 n.s.
Salted in a saturated brine containing nitrite	4.2	0.0	0.0	16.7	4.2	25.0	25.0	20.8	4.2	1.74 n.s.
Total Chi-square (χ^2) with 8 d.f.										19.24*

[a] 1 = Dislike extremely
2 = Dislike very much
3 = Dislike moderately
4 = Dislike slightly
5 = Neither like or dislike
6 = Like slightly
7 = Like moderately
8 = Like very much
9 = Like extremely

[b] n = number of observations per treatment.

n.s. Not significant at the 5% level.

*Significant at the 5% level.

TABLE 10. A test of the hypothesis that the frequency distributions (the percentages of times each treatment received each of the scores) for sensory evaluation scores of the subsequently cooked samples are the same for both salted treatments when the control is ignored.

Treatment	Sensory evaluation score[a]					Contribution to x^2
	Less than or equal to 4	5	6	7	Greater than or equal to 8	
	Observed frequencies[b] (percentages; n= 24)					
Salted in a saturated brine	33.4	8.3	29.2	20.8	8.3	1.60[n.s.]
Salted in a saturated brine containing nitrite	20.9	4.2	25.0	25.0	25.0	1.60[n.s.]
Total Chi-square (x^2) with 4 d.f.						3.20[n.s.]

[a] 1 = Dislike extremely
2 = Dislike very much
3 = Dislike moderately
4 = Dislike slightly
5 = Neither like or dislike
6 = Like slightly
7 = Like moderately
8 = Like very much
9 = Like extremely

[b] n — Number of observations per treatment.

n.s. Not significant at the 5% level.

TABLE 11. Smoked harp seal (beater) meat (flank): Observed frequency distributions (the percentages of times each treatment received each of the scores) for sensory evaluation scores of the subsequently cooked samples and a test of the hypothesis that the frequency distribution of the four treatments are the same.

Treatment	Sensory evaluation score[a]									Contribution to χ^2 when scores less than or equal to 5 and scores greater than or equal to 8 are combined
	1	2	3	4	5	6	7	8	9	
	Observed frequencies (percentages; n= 24)[b]									
Smoked treatment control (not cured or smoked but freshly frozen)	0.0	0.0	0.0	8.3	8.3	20.8	25.0	33.3	4.2	0.597. s.
Cured in salt brine then hot smoked for 7.5 hours	0.0	12.5	8.3	4.2	4.2	25.0	29.2	16.7	0*0	4.59 n.s.
Cured in salt brine centdining nitrite then hot smoked for 7.5 hours	4.2	4.2	0.0	0.0	0.0	12.5	37.5	41.7	0.0	2.43 n.s.
Cured in salt brine containing nitrite and sugar then hot smoked for 7.5 hr.	4.2	4.2	4.2	8.3	0.0	8.3	29.2	41.7	0.0	1.44 n.s.
Total Chi-square (χ^2) with 9 d.f.										9.05 n.s.

[a] 1 = Dislike extremely
2 = Dislike very much
3 = Dislike moderately
4 = Dislike slightly
5 = Neither like or dislike
6 = Like slightly
7 = Like moderately
8 = Like very much
9 = Like extremely

[b] n = number of observations per treatment. n.s. Not significant at the 5% level. *Significant at the 5% level.

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Total Mercury Content of Meat and Liver from Inshore Newfoundland-caught Harp Seal (*Phoca groenlandica*)

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During the past five years, a total of 324,219 harp seals slaughtered for pelts by inshore Newfoundland seal hunters (ANON. 1977-81) provided a total of 4,379,508 kg of harp seal meat which were available and suitable for human consumption (BOTTA et al. 1980, 1982a, b). In general, the vast majority of these seals were beaters, bedlamers, and harps (Table 1) slaughtered along the Northeast coast of Newfoundland and Labrador (ANON. 1977-81) by hunters who were out of port for only a few days; however, only a small fraction of the carcasses was actually utilized for human consumption.

Table 1. Glossary of terms concerning classes of harp seal (Phoca groenlandica)

Whitecoat	A newborn harp seal up to an age of about 12 days, prior to loss of the soft white natal hair.
Ragged-Jacket	A young harp seal undergoing its first moult from a whitecoat to a beater. Age ranges between 12 and 18 days.
Beater	A young harp seal in its first year of life, having completed its first moult to a spotted grey coat. Age when slaughtered ranges between 3 and 8 weeks.
Bedlamer	A juvenile seal in its second, third or fourth year of life, having a spotted coat.
Harp	A seal at least 5 years of age.

Mercury content of harp seals caught in the Gulf of St. Lawrence has been determined (FREEMAN & HORNE 1973; JONES et al. 1976; SERGEANT & ARMSTRONG 1973) but no such evaluation of harp seals caught along the Northeast coast of Newfoundland and Labrador has been reported. Consequently, as part of a program to investigate utilization of meat recoverable from the inshore Newfoundland seal hunt, the present study was undertaken to determine the total mercury content of the meat and liver of harp seals of different ages.

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0007-4861/83/0030-0028 $01.00

EXPERIMENTAL

Beaters, bedlamers, and harps (Table 1) were shot on March 3, March 10 and April 15, 1980, in White Bay, Newfoundland. The animals were immediately bled and shortly thereafter eviscerated, skinned, placed inside heavy-duty plastic bags, and stored in flake ice until butchered 3 days later. During evisceration, the sex was determined and the liver was saved and placed inside a plastic bag (which was placed inside the gut cavity). The age of each carcass was determined by counting, under polarized light, the dentinal annuli of thinly sectioned (approximately 100 um thick) canine teeth (FISHER 1954). All carcasses were butchered into the various cuts shown in Fig. 1. The flank, flipper, and rump were retained, the surface fat trimmed off, and the excess blood removed by cool water rinses. The liver was also subjected to cool water rinses. All trimmed and washed carcass cuts were individually passed 3 times through a meat grinder with 7 mm diameter holes, transferred to a 450-ml capacity polyethylene tub with a tight fitting lid, then frozen and stored at -35C until analyzed. The livers were handled in an identical manner except they were passed through the meat grinder only once.

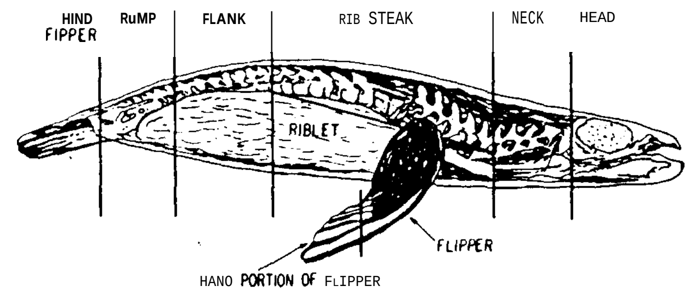

Fig. 1. Carcass cuts of the harp seal (Phoca groenlandica)

Total mercury content was determined on an acid digest of portions (0.2 to 0.5g) of these homogenates using the flameless atomic absorption method of ARMSTRONG & ETHE (1971). All samples were analyzed in duplicate, and tuna fish samples from the National Bureau of Standards and samples which had been analyzed in a Canada wide check program were included with each set of analyses. Analyses were repeated if duplicate samples varied more than ±10,0%.

RESULTS AND DISCUSSION

The total mercury content of carcass meat and liver are presented in Table 2. Within each age class, there was very little difference among the three different carcass cuts, but the content in the liver was always far greater. With all three types of carcass cuts and with the liver, there was a definite increase with the age of the seal. Although there were some observable differences between the sexes, these differences were not consistent

Table 2. Total mercury content of harp seal (Phoca groenlandica) meat and liver.

		Total mercury content (ppm)			
		Carcass cut			
Age	sex	Flank	Flipper	Rump	Liver
Beater	F	0.04	0.03	0.02	0.26
	F	0.03	0.05	0.05	0.74
	F	0.04	0.02	0,02	0.24
	M	0.02	0.02	0.01	0.37
	M	0.10	0.06	0.08	0.48
	M	0.06	0.03	0.04	0.89
	Mean	0.05±0.03	0.04±0.02	0.04±0.03	0.50±0.27
One Year	F	0.12	0.16	0.10	0.72
	F	0.14	0.15	0.13	0.82
	M	0.14	0.11	0.13	2.24
	M	0.14	0.14	0.11	2.10
	M	0.15	0.15	0.14	2.71
	M	0.20	0.22	0.21	1.41
	Mean	0.15±0.03	0.16±0.04	0.14±0.04	1.67±0.81
Two Years	F	0.16	0.18	0.12	0.86
	F	0.17	0.16	0.14	2.20
	F	0.14	0.14	0.11	2.38
	F	0.12	0.16	0.14	1.25
	M	0.16	0.16	0,14	5.07
	M	0.19	0.17	0.16	2.78
	Mean	0.16±0.02	0.16±0.01	0.14±0.02	2.42±1.48
Three Years	F	0.23	0.24	0.23	4.16
	F	0.22	0.21	0.22	5.87
	F	0.14	0.13	0.14	1.88
	F	0.18	0.20	0.17	3.77
	F	0.18	0.16	0.21	3.47
	M	0.32	0.30	0.26	4.62
	Mean	0.22±0.06	0.21±0.06	0.21±0.04	3.96±1.32
Four Years and Older	F	0.30	0.26	0.28	3.60
	F	0.32	0.25	0.28	4.65
	F	0.23	0,28	0.22	2.30
	F	0.21	0.20	0.20	0.76
	M	0.30	0.28	0.26	4.71
	M	0.27	0.28	0.22	2.47
	Mean	0.27±0.04	0.26±0.03	0.24±0.03	3.08±1.53
Overall Mean (n=30)		0.17±0.08	0.17±0.08	0.15±0.08	2.33±1.63

with either the carcass cut or the liver.

The concentration of mercury in the meat of the beaters was far less than that reported for harp seal pups (1-5 days old) taken off ice flows in the Gulf of St. Lawrence (FREEMAN & HOWE 1973). Meat of 3-year-old seals contained only moderately less than that reported for 3-year-old harp seals caught in the Gulf of St. Lawrence (SERGEANT & ARMSTRONG 1973). The concentration in liver of 3-year-old seals was quite similar to that observed by SARGEANT & ARMSTRONG (1973).

With the carcass cuts, the differences between the values reported in the present study and those reported by FREEMAN & HORNE (1973) and SERGEANT & ARMSTRONG (1973) are probably not related to differences in the stocks of harp seals as LAVIGNE et al. (1978) have shown that harp seal pups caught in the Gulf of St. Lawrence are not genetically different from those caught off the Northeast coast of Newfoundland and Labrador. Also tagging studies have indicated that there is some intermixing of harp seals between the two locations (BOWEN 1982). The lower values observed in the present study may be related to year of catching, as the results of JONES et al. (1976) also differed from those of FREEMAN & HORNE (1973). The differences may also be related to differences in feeding habits.

Even with the carcass cuts of harp seal 4 years and older, the total mercury content was always well below the acceptable Canadian limit of 0.5 ppm. Except for samples from some beaters, the liver samples always exceeded this limit by a very wide margin. Thus, meat, but not liver, from the inshore Newfoundland seal hunt was definitely acceptable for frequent human consumption.

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CANADA

DEPARTMENT OF NORTHERN AFFAIRS AND NATIONAL RESOURCES

NORTHERN ADMINISTRATION BRANCH

INDUSTRIAL DIVISION

OUR FILE NO.

YOUR FILE NO.

MR. PHILLIPS

Ottawa, June 29, 1964.

Report on Keewatin Specialty Food Program

The Keewatin specialty food program, undertaken by the Division, is now entering its third year. During the past few months, we have been doing a thorough assessment of its potential. As a result of the work of the past 30 months, it is now possible to make some safe predictions and to begin-to plan a long-range program for organized, large-scale food production in the North. In order to refresh your memory, i will briefly review the program to last summer. This report will then deal in some detail with what has happened since then.

Background

The specialty food testing and development program began in the Keewatin following the area survey which was undertaken there by the Division. Among other things, the survey pointed out that, although the sea resources of the Keewatin were probably not as extensive as in other parts of the J.retie, the potential was far greater than was being realized. What was required was a program of food processing and the establishment of a distribution system which would make traditional Arctic foods available to the Keewatin population on a year-round basis. On many occasions we have stressed our belief that the farming of the Arctic must, in reality, be based on production from the sea.

For the following reasons, the Keewatin was chosen as the area in which our first major effort would be made:

1. Its people were in the most desperate economic and probably nutritional plight of those living in any major Arctic area. The obtaining of food -was dependent on the unpredictable caribou migration, on sporadic fresh water fishing, on unorganized sea mammal harvesting, and on a totally inadequate system of food processing,; ana storage.

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2. In certain coastal Keewatin areas, the food resources of the sea could stand far heavier use.

3. The coastal Keewatin area provided most types of raw food materials used by coastal Eskimos in the Canadian Arctic.

4. There was a desperate urgency to provide sources of income and employment in the most desolate region of the Arctic.

5. From at least two coastal communities in the region, food distribution could be effected without major difficulty, not only within the region, but to other parts of the eastern Arctic.

6. We needed to determine whether the food habits of both coastal and inland Eskimos were so well established that processed foods from the Arctic would never be popular with, or acceptable to, them.

7. The introduction of processed Arctic foods as a regular part of the diet of the people in the Keewatin could help to overcome serious problems of malnutrition in the region.

In the spring and summer of 1962, Mr. Eric Hofmann began to work on the program at Whale Cove and at the Tha-Anne River. As is almost invariably the case in the first year of our experimental programs, the results showed only moderate success. Mr. Hofmann laboured under the difficulties of working on a program which was new not only to the people of the region, but to anybody. He had very few precedents to go on in establishing acceptable recipes. In addition, he was required to work under extremely difficult field conditions with the most primitive types of equipment. In spite of these difficulties, he was able to produce and have distributed to Keewatin settlements a variety of food products based on marine mammals. For reasons of which you are already aware and which had nothing to do with Mr. Hofmann or this Division, the food testing program in Keewatin communities was not successful in the winter of 1962-63. What little accurate testing that was done gave us small cause for optimism that the products would be acceptable to Keewatin Eskimos. Nevertheless, we asked for, and received, your support and the Department's for carrying on the program another year on an experimental basis. In 1963, production centered solely in Whale Cove. Because of his own added experience, greatly increased local interest in the project at Whale Cove, and beta'use of excellent staff support there, Mr. Hofmann was able to achieve some notable results last summer. In all, he produced, in quantity, 18 different varieties of foods from white whales and seal. (The food products are listed in Appendix 'A'.) All told, approximately 12,000 cans of these focal products came from the Whale Cove project in the summer of 1963.

It was decided that this food could be put to best use through distribution to, and a soundly based testing program in, 11 eastern Arctic communities, including the Keewatin region, north.ern Quebec and Baffin. Arrangements were made to have an adequate sample selection, based on community population, sent to Coral Harbour, Baker Lake, Eskimo Point, Whale Cove, Chesterfield Inlet, Rankin Inlet, Fort Chime, Great Whale River, Povungnituk, Frobisher Bay and Cape Dorset.

Method of Distribution

We believed it was important -that the test results reflect the real attitude of the Eskimo (in some cases non-Eskimo) population in these communities toward what for rest, would be familiar foods in new packages. It was decided, therefore, to ask responsible Eskimo groups such as council, prominent community leaders, or boards of directors of co-operatives to undertake distribution of the food in each community. A long letter in Eskimo was sent to each of the settlements in which the Whale Cove food products were stored. You will note from the letter, which is attached, as Appendix 'B', that it contained information on the program, on the way in which the program might develop should the food products be acceptable to a large number of Arctic residents, and a request for help in obtaining honest and accurate test results from Eskimo families which received the foods on a sample basis. Each person receiving foods was asked to provide written comments on the product on the back of the distinctive label which enclosed each tin. The labels, incidentally, were in both English and syllabics--a fact which received extremely favorable cement from a large number of

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Eskimos and which will undoubtedly have a tremendous effect on sales when these products are sold in northern stores. From February until the end of April, the testing was carried out in the selected communities.

Officers of the Industrial Division were assisted considerably by field staff including Regional and Area Administrators and in at least two communities by the teaching staff. With the exception of Coral Harbour, Industrial staff visited each of the test communities after the testing program had been carried out, so there would be a minimum risk of obtaining biased test results. The 11 communities have a total population of 4,789. The sampling covered areas in which the people had traditionally lived on food from the sea and others in which inland Eskimos had strong taboos against eating meat from sea mammals.

To June 5, we have received 4,500 written reactions--enough, we believe, to provide us with accurate data on which to make decisions effecting the future of this type of food production program in the eastern Arctic.

Reaction to the Foods

Appendix 'C' lists the ten most popular foods. The remaining eight received either extremely unfavorable reaction or were not produced in sufficient quantity to provide us with the required sampling data. Some of the food products were extremely popular with virtually all groups who tried them. This applies particularly to some of the whale products which, incidentally, received enthusiastic comment not only from coastal Eskimos but from inland groups as well. Many Eskimo people provided us with extremely elaborate and detailed, useful comments on the food products. In addition to those which suggested methods of improving the flavour of certain products, we received helpful advice on packaging and labelling. There was much positive reaction to having known foods available for future sale throughout the year. (In order to ensure maximum possible protection for consumers, a number of sample packages of each type of food were sent to Government test laboratories. Without exception, they received a high rating from a health point of view. This speaks extremely well of the care with which Mr. Hofmann undertook this program, as he was working always under trying physical conditions with the most minimal necessities in floor space and processing equipment.)

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The foods were tasted by Eskimos who were permanently wage employed, who were employed for part of the year, who lived entirely on the land, or who were on social assistance. It is our belief that all types of consumer groups in the eastern Arctic were given an opportunity to test and comment on these new food products.

Test Sales

We did not believe that we should ask retail outlets in the North to handle unknown foods on even a consignment basis this past winter. The foods which were sampled, therefore, were distributed free. In one community, however, Whale Cove, we were able to not only carry out the test program, but to put the remaining quantity of specialty foods which had been stored in that community on sale at the co-operative store. Prices were established which allowed the retailer a substantial mark up and which, at the same time, reflected as accurately as is now possible a mark up over our actual production costs. During slightly more than one month, nearly 400 tins or approximately one half of the quantity available in the store had been sold. Although not low, prices are in line with those of tinned meat products from southern Canada. Sales of southern meat products during the same period were less than one quarter those of tinned northern meats available for sale. Sales at Whale Cove by individual food product reflect the same results as the sampling program in each community. The disliked products were not purchased; the ones at the top of the hit parade sold extremely well.

Future of the Program

'We are now convinced that, as a result of the last two and a half years of experimental work, we have reached the point where we can recommend with conviction that the program not only be continued, but that it be put on a factory production basis. We are convinced that residents of the eastern Arctic want and will buy large quantities of food products produced in the North. Beginning this year, we will conduct test programs of some of the specialty food items in southern Canada. There is every reason to believe that some of the food products will find ready acceptance in a large consumer market in the South and in the export trade. This year, we are planning on producing, distributing and selling in the North

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approximately 40,000 cans of the ten most popular food products produced last year. This is the optimum quantity that can be handled using our present extremely primitive methods.

Our Financial Estimates for 1964-65 will reflect a request for major expenditures which will enable us to put this program on a sustained and efficient basis. We are proposing for Whale Cove a small plant which will be designed in such a way that it can be used for food processing during the spring and summer and for craft production during the remaining months. Thus the building will be used on a productive, year-round basis.

During the next few days we will be negotiating with retail distributors in the eastern Arctic to handle the food products this year. We are also continuing to work on improvements.on our labelling and packaging, not only for the northern consumer, but for the potential market in southern Canada.

We believe there is a potential for this type of important industry in a number of Arctic communities and that, if properly organized, financed and managed, they can be self-supporting arid can provide not only desperately needed, nutritious food throughout the North, but a variety of specialty food items for the southern Canadian and export markets. In addition, the expansion of such activities will create many new employment opportunities and a substantial source of cash income to Eskimos who continue to prefer to live as hunters, fishermen and trappers.

It may be worth recalling now that only a few years ago you and Mr. Robertson both supported us at a time when we were proposing to establish a program of Arctic char fisheries which would provide food for sale not only in southern Canada, but in the Arctic as well. At that time, you and we were cautioned that it was highly unlikely that Eskimos would pay cash for natural foods caught by other Eskimos. The intervening years have quite soundly shattered that myth. Although it is unlikely, it is possible that some persons will now suggest that Eskimo people will not buy tinned products which they are used to eating without the benefit of modern food processing techniques. We think little weight should be attached to such dated beliefs !

On the basis of our focal production and testing program, we believe that there is strong favourable consumer reaction among Eskimo people to these new processed foods. The results indeed have been far more optimistic than we had anticipated. Although I may not be in a position to help to carry to successful conclusion the program I began, I earnestly hope and expect it will receive enthusiastic support from you and consequently from the others who have the power to curtail it or to allow it to expand.

Eighteen months ago, I told you it would be a total of five years before such a program could be fully operational, if indeed initial results showed it had any promise at all. This suggested timing still reflects our views and we believe it will be 1967 before the industry is well established. With strong Departmental support, there is now no doubt in our minds about the future potential of this new industry that can one day be extremely important in the economy of the North. How soon that day comes now rests in other hands.

D. Snowden

D. Snowden,
Chief,
Industrial Division.

APPENDIX 'A'

FOOD PRODUCTS

Muktuk in oil
Smoked muktuk
Muktuk sausage
Whale meat, onions and tomatoes
Whale meatballs
Smoked whale meat
Whale meat, no salt
Whale heart
Whale oil
Smoked seal meat
Seal pemmican
Seal tripe in gravy
Seal tripe rice and tomatoes
Seal meatballs
Seal flipper
Seal heart
Seal liver
Seal meat, no salt

RESULTS

i) The apparent digestibility of ringed seals.

The relative body composition of the ringed seals used in the preparation of the diet are presented in Table 2. The experimental diet was made up in the proportion of 2:2:1 of skin and blubber, meat and viscera and skeletal elements respectively and the dietary dry matter had the proximate composition of 52.1% fat, 39.0% protein and 8.9% ash. The moisture content of the diet was 47% and the caloric density was 23.9 kJ/g, dry weight, or 12.6 kJ/g wet weight.

The apparent digestibility (AD) of the dietary dry matter, determined by the mean chromium content of the faeces, was 84% and the AD of fat and protein-N were 97.7 ± 0.6% and 84.2 ± 1.7% respectively. The assimilation of the dietary energy was 91.6 ± 1.4%

ii) Thermophysical characteristics of polar bears.

a) Surface area

The surface areas A_b) of 18 polar bears, ranging from 11-374 kg in weight, were proportional to $m_b^{0.67}$ and followed the surface area law (Kleiber 1975). The Meeh constant (c) for the bears measured with the tape pulled close to the skin was 0.09 (n = 15; R = 0.99) while those measured with the tape loose against the fur were best represented by a Meeh constant of 0.11 (n = 4; R = 0.99). The relationships are shown in Fig. 4. The 0.11 constant, representative of the fur surface area has been used to predict surface area in this study .

TABLE

THE RELATIVE BODY COMPOSITION OF

No.	Date collected	Location	Sex	Age (yr)	We (
1	August 1974	Grise Fiord N.W.T.	M	9.4	
2	August 1974	Grise Fiord N.W.T.	F	14.4	
3	August 1974	Grise Fiord N.W.T.	M	1.4	
4	May 1974	S.E. Baffin Is., N.W.T.	M	0.2	