VITAMIN A CONTENT OF FUR SEAL OILS

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ABSTRACT

Results of tests in 1946 showed the apparent vitamin A potency of oil from livers of Alaskan bachelor seals to vary from 13,105 to 394,145 spec. units per gram of oil with an average value of 112,000. The oil content of livers varied from 0.20 to 2.17 percent by weight. The oil from carcass and blubber contained from 490 to 2,040 spec. units of vitamin A per gram of oil.

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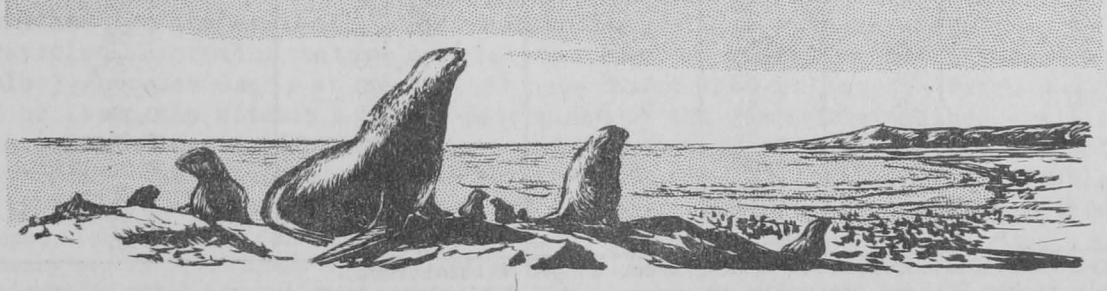
INTRODUCTION

The Alaskan fur seal, Callorhinus ursinus, yields not only a valuable fur but also oil and a protein feeding meal as byproducts. Recently, interest has been expressed as to the oil being a possible commercial source of vitamin A.

The Alaskan seal herd, which is protected by international treaty, has increased to over 3 million animals. Insofar as is known, the Pribilof Islands in the Bering Sea are the only places the herd ever goes ashore. A few of the breeding bulls land as early as the latter part of March, but most of the herd arrive during June. The migration out to sea begins in September, and some seals are known to proceed as far southward as the coast of southern California.

The Alaska fur-seal herd is classified into four groups, according to Bower (1945). The adult males are called "bulls;" they weigh more than 500 pounds each. The adult females are named "cows." They reach sexual maturity at 3 years of age and average about 75 pounds. The immature males, which do not mature until 6 or 7 years of age, are known as "bachelors." The young of both sexes are designated as "pups," and they average about 12 pounds in weight at birth.

Fur seals are polygamous, and each breeding bull has his own harem. The average harem has about 40 cows but a harem of about 100 cows has been recorded. It is from the surplus bachelors that the pelts are taken. In size and in the quality of the fur, the 3-year-old males have been found to yield pelts of maximum value. The number of animals in the herd as a whole and in the various age groups is carefully determined annually, and the number of 3-year-old animals to be killed the following year is based on these figures. In 1944, 1945, and 1946, the sealskins taken from the Pribilof Islands totaled 47,652, 76,964, and 64,523, respectively.



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A byproducts plant is located on St. Paul Island in the Pribilofs. During 1943, a total of 58,319 carcasses were handled and yielded 61,099 gallons of blubber oil, 14,160 gallons of carcass oil, and 782,000 pounds of seal meal.

SOUTH AFRICAN EXPERIMENTS

Since no extensive study has been made of the liver of the Alaskan fur seal, the results of the investigation made of the South African fur seal fishery, Black, et al, (1945) may be of interest. It was reported that, in general, the percentage of vitamin A in the livers from bulls was greater than in the livers from pups taken from the same locality. For the livers from bulls, the vitamin A potency depends greatly on the locality from which the seals are obtained. The bulls from the east coast of the Union yield livers consistently higher in vitamin A than those from the southwest African coast. This difference in the vitamin A content of livers of bulls from different localities is believed to be related to the vitamin A content of the food consumed, which consist of fish and squid. The accumulated data indicate that livers of fish from the east coast are also richer in vitamin A than those from the same species on the west coast.

The blubber oil extracted, as reported by these workers, by the customary cooking and pressing method contained no vitamin A, but a blubber oil sample extracted by alkali digestion contained 29 international units of vitamin D per gram.

Since 1942, the seal livers collected on the Government Guano Islands have been sent to Cape Town or Gansbaai for processing. The production of vitamin A in 1944 totaled 163 billion international units, most of it coming from bull livers. It is estimated that if all the available livers had been utilized, a total of 580 billion units of vitamin A could have been produced.

ALASKAN LIVER OILS

A preliminary study investigating the possibilities of the utilization of oils from the livers of the Alaskan bachelor seals as a source of vitamin A has been made. During the summer of 1946, some livers were removed from the bachelor seals. The livers were frozen and shipped to the Fishery Technological Laboratory, Seattle, Wash., for analyses of oil content and vitamin A. The oil was extracted from the liver with petroleum ether. The results of the analysis of eight individual livers are given in Table 1. The oil content of the livers was low, averaging 1.20 percent. The potency of the livers varied widely. In the small number

Table 1 - Vitamin A and Oil Content of Seal Livers

Sample Number	Weight of Individual Liver		Oil Content of Liver	Liver Oil Potency	Liver Potency
	Grams	Pounds	Percent by weight	Spec. units per gram of oil[1/]	Millions of spec. units per lb. of liver
1	710	1.56	2.00	394,145	3.58
2	720	1.59	1.12	369,200	1.88
3	840	1.85	2.08	29,780	0.28
4	825	1.82	1.28	35,870	0.21
5	685	1.51	2.17	13,410	0.13
6	840	1.85	0.36	26,665	0.04
7	870	1.92	0.40	13,105	0.02
8	700	1.54	0.20	13,775	0.01
(Av. of 8 samples)	744	1.71	1.20	111,994	0.77
9[2/]	-	-	1.38	111,030	0.69

1/ Spec. unit equals 2,000 times E (1%, 1 cm. at 328 millimicrons).
2/ Sample number 9 was a composite of approximately 10 pounds of liver.

of samples analyzed spectrophotometrically, the vitamin A potency ranged from 13,000 to 394,000, and averaged 112,000 spec. units of vitamin A per gram of oil.[1/] Another analysis was made on a composite from about 10 pounds of frozen livers. The oil content of these livers was 1.38 percent, and the vitamin A potency was 111,000 spec. units per gram of oil. Of the eight livers analyzed (Table 1) only livers Nos. 1 and 2, which have potencies of 3.58 and 1.88 millions of spec. units per pound of liver, respectively, show high enough vitamin A content for possible commercial exploitation.

ALASKAN CARCASS AND BLUBBER OILS

The fur seal carcass and blubber oils extracted at the plant in the Pribilof Islands were also analyzed for vitamin A content. The results of the analysis are given in Table 2. By the ultraviolet absorption method of analysis, the carcass and blubber oils had average potencies of 2,025 and 490 spec. units per gram of oil, respectively; by the Carr-Price reaction the carcass oil and blubber oil both had lower potencies of 595 and 120 equivalent units, respectively.

Table 2 - Analyses of Seal Carcass Oil and Seal Blubber Oil for Vitamin A Potency

Item	Amount unsaponifiable fraction in oil	UNSAPONIFIABLE FRACTION — VITAMIN A POTENCY: Ultraviolet absorption at 328 millimicrons	UNSAPONIFIABLE FRACTION — VITAMIN A POTENCY: Antimony trichloride read at 620 millimicrons	WHOLE OIL — VITAMIN A POTENCY: Ultraviolet absorption at 328 millimicrons	WHOLE OIL — VITAMIN A POTENCY: Antimony trichloride read at 620 millimicrons
	Percent by weight	Spec. units per gram[1/]	Equivalent units per gram	Spec. units per gram[1/]	Equivalent units per gram
Fur Seal Carcass Oil	4.94 4.92 4.98 4.95 4.95(av.)	832 858 865 869 856(av.)	603 597 612 604(av.)	2,040 2,010 2,025(av.)	603 594 592 595(av.)
Fur Seal Blubber Oil	1.90 1.90 3.08 2.92 2.45(av.)	327 335 334 328 331(av.)	--	490 493 492(av.)	121 119 120(av.)

1/ 2,000 times E (1%, 1 cm., 328 mmu.).

The unsaponifiable fraction of the two oils was obtained by the use of the A.O.A.C. method (1945) for saponification and extraction. For the carcass oil, the vitamin A potency obtained for the unsaponifiable fraction by either method of analysis was in fair agreement with the result obtained with the Carr-Price method for the whole oil.

DISCUSSION OF METHODS

The E values at the various wave lengths between 300 and 350 millimicrons were determined for the seal oils. The reliability of the vitamin A analyses by the ultraviolet absorption method can be predicted by examining the E value ratios (Table 3) because Oser, et al, (1945) have found that unless the ratio $\frac{E\ 300}{E\ 328}$ is 0.72 or less, the vitamin A values determined by the ultraviolet method are likely to be unreliable even if the values are determined on the unsaponifiable portion of the oil. The extinction ratios obtained for the fur seal liver oil (Table 3) are typical for those of a normal vitamin A oil. However, the E value ratios of

1/ A spec. (abbreviation for spectrophotometrically determined) unit of apparent vitamin A potency equals 2,000 times E (1%, 1 cm. at 328 millimicrons). The Service will use this designation until a regulatory agency or some other organization will promulgate another designation which will be generally accepted.

the seal blubber and carcass oil show that the vitamin A results by the ultraviolet absorption method may be unreliable due to the extraneous absorption of the light by non-vitamin A materials present in the oils.

Table 3 - Extinction Ratios at Respective Wave Lengths of Light for Seal Liver, Blubber, and Carcass Oils

	Liver Oil	CARCASS OIL		BLUBBER OIL	
		Whole oil	Unsaponifiable fraction	Whole oil	Unsaponifiable fraction
$\frac{E\ 300}{E\ 328}$	0.669	1.194	0.900	1.168	1.214
$\frac{E\ 310}{E\ 328}$	0.850	1.150	1.004	1.130	1.151
$\frac{E\ 320}{E\ 328}$	0.962	1.103	1.015	1.155	1.048
$\frac{E\ 325}{E\ 328}$	1.000	1.041	1.024	1.064	1.030
$\frac{E\ 330}{E\ 328}$	0.982	0.972	0.970	0.958	0.968
$\frac{E\ 340}{E\ 328}$	0.813	0.829	0.778	0.759	0.765
$\frac{E\ 350}{E\ 328}$	0.569	0.690	0.556	0.547	0.524

This preliminary study of the Alaskan fur seal oil has shown that the vitamin A content of the carcass and blubber oils is not only low but that the vitamin A determinations, which were made by the ultraviolet absorption method, are apparently unreliable. Of the eight individual livers that were examined, only two had vitamin A content high enough for possible commercial exploitation. Further studies on a larger number of seal livers are needed to determine the frequency of the higher potency livers and to determine if the vitamin A content of the livers is highly correlated with other characteristics--such as age, weight, or length of the seal--which can be used as an index to segregate the livers of higher potency from those of lower potency.

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