# FATTY ACID CONTENT OF DEPOT FAT IN THE NORTHERN FUR SEAL (Callorhinus ursinus) 1

Authors: WALDORF, ALAYN, and VEDROS, NEYLAN A.

Source: Journal of Wildlife Diseases, 15(4) : 573-577

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-15.4.573

# FATTY ACID CONTENT OF DEPOT FAT IN THE NORTHERN FUR SEAL *(Callorhinus ursinus)* [1]

ALAYN WALDORF and NEYLAN A. VEDROS, Naval Biosciences Laboratory, School of Public Health, University of California, Berkeley, California 94720, USA.

*Abstract:* The fatty acid content of depot fat samples from 15 northern fur seals *(Callorhinus ursinus)* were determined by gas-liquid chromatography. *Callorhinus ursinus* has a high proportion of short chain saturated acids; C10, C11, C12, C13, C15. Unsaturated longer chain acids C16:1, and C16:2, and C18:1 also were found. Results obtained are compared to a previously reported milk lipid analysis of the northern fur seal.

## INTRODUCTION

The major breeding rookeries of the northern fur seal *(Callorhinus ursinus)* are located on St. Paul, Pribilof Islands. Both for economic and conservation reasons, some 25,000-35,000 of the animals are harvested annually. Major products include fur, animal food and protein extracts.

The only quantitative data available on the lipids of the northern fur seal are based on an incomplete analysis of milk fat.[5] It is believed that the fatty acids from depot fat of a species are representative, with slight variations, of the fatty acids which would be found elsewhere in the animal.[2]

Quantitative gas-liquid chromatography (GLC) analyses of the fatty acid composition of the following lipid materials taken from true seal species have been reported: blubber fat from the harbor seal *Phoca vitulina,*[3,9] blubber fat and milk lipids from the grey seal *Halichoerus grypus,*[1,3,4] fatty acid composition of lipids from southern elephant seal *Mirounga leonina,*[13] and the fatty acids of depot fat and milk lipids from harp seal *Pagophilus groenlandica,*[2,10] and hooded seal *Cystophora cristata.*[10]

The quantitative analysis of depot fat of the northern fur seal and determination of the fatty acids present is the subject of this report.

## MATERIALS AND METHODS

**Animals.** A sample of depot fat was obtained from 15 northern fur seals in August, 1977 on St. Paul Island, Alaska. The animals were young adult bull seals age 3 to 4 years. The samples were taken at the time of pelt harvest and all animals were healthy by gross observation when the samples were collected.

**Depot Fat.** Fat samples were immediately frozen after collection from either the chest or the back of an animal and stored -70 C until the extraction process.

Procedure for extraction is after Jangaard *et al.*[9] All procedures were carried out under a blanket of inert nitrogen. All solvents used were Burdict and Jackson glass distilled. Two gm of depot fat were macerated in a Waring blender with excess anhydrous sodium sulfate [2] (0.6 gm). The oil was extracted with 10 ml hexane. The sample was then filtered through a Whatman #1 filter in a

[1] This research was supported by the Office of Naval Research.

[2] Sigma Chemical Co., Saint Louis, Missouri 63178, USA.

Coors #3 Buchner funnel with slight vacuum. The hexane was removed on a rotary evaporator and the extracted oil was clear and gold to amber in color.

Saponification procedure was that of AST *et al.*[6] Reagent grade potassium hydroxide,[2] (130 mg) was dissolved in 4 ml anahydrous methanol[2] (0.1%) on a steam bath for two minutes. A 150 mg sample of the extracted oil was added to the methanol solution and reacted until fat globules dissolved. Stirring of solutions was momentarily stopped only to observe for the presence of remaining fat globules. One ml of distilled water was added and immediately treated dropwise with 4N aqueous hydrochloric acid[2] until the lower layer had a pH below three. Stirring and heating was continued until all of the fatty acids were liquified. The maximum temperature was 94 C. The solution was brought below the boiling point of hexane. The fatty acids were extracted with a minimum of two 1.5 ml portions of hexane. The extracts were then collected in a one-half dram vial and concentrated under inert nitrogen on a steam bath.

Procedure for esterification was that of Metcalf *et al.*[11] effected with boron trichloride-methanol reagent.[3] The mean lipid recovery of 15 depot fat samples was 73%.

**Chromatography.** Gas-liquid chromatography of methyl esters was carried out on a Varian Aerograph model #2740 [4] equipped with a flame ionization detector and automatic linear temperature programmer using a glass column (1.82 m × 2 mm) packed with 10% SP3200 on 100-200 mesh Chromosorb W. The injector temperature was 230 C, and the detector temperature was 250 C. Helium was used as carrier gas at a flow rate of 20 ml/min. After injection, the column was maintained at 150 C for 3 min then programmed at 2 C/min to 235 C.

A baseline analysis on two standard marine oil samples (Pufa, 4-7033, lot #275-3; Qual Mix S 4-7034, lot #266-38) [3] were analysed prior to the depot fat methyl ester samples.

In all analyses, the solvent used was redistilled hexane. Identification of the separated components was carried out by plotting the log of the retention times over an increasing property of the homologous series, the carbon chain length.

## RESULTS AND DISCUSSION

The fatty acid compositions of depot fats in *C. ursinus* are shown in Table 1.

The northern fur seal depot fat contains a proportion of shorter chain saturated fatty acids - decanoic, undecanoic, dodecanoic and tridecanoic acid - not found in true seals, *P. vitulina,*[9] *H. grypus,*[1,3,4] *P. groenlandica,*[2,10] and *C. cristata.*[10] A higher concentration of pentadecanoic acid (C15) is found in the northern fur seal than in the other seal species.

In comparison to true seals, two differences are seen in the content of unsaturated fatty acids of the northern fur seal.[1,2,3,4,9,10] In the northern fur seal, C16:1 and C18:1 are found in approximately one half the concentration as in the four species of true seals, whereas C16:2 and C18:2 occur in much higher quantity in the latter species.

Differences between fatty acids in true seals and those of *C. ursinus* could be associated with the physiology of heat control. *C. ursinus,* of the family Otariidae, is a fur seal distinct from the true seals of the family Phocidea. The fur of *C. ursinus* forms a dense pelt and serves as a good insulator, while true

[3] Supelco Inc., Supelco Park, Bellefonte, Pennsylvania 16823, USA.

[4] Varian Inc., Walnut Creek, California 94596, USA.

TABLE 1. Fatty acid components of *Callorhinus ursinus* determined by gas-liquid chromatography.

| FATTY ACID carbon length | DEPOT FAT[1] % BY WT. | MILK[2] % BY WT. |
|---|---|---|
| C10 | 0.08 | 0.4 |
| C11 | 0.06 | N.S.A. |
| C12 | 0.07 | 0.2 |
| C13 | 0.02 | N.S.A. |
| C14 | 3.28 | 6.5 |
| C14:1 | 0.17 | 1.1 |
| C15 | 1.75 | N.S.A. |
| C15:1 | 0.35 | N.S.A. |
| C16 | 8.02 | 16.0 |
| C16:1 | 3.58 | 9.4 |
| C16:2 | 3.27 | N.S.A. |
| C17 | 0.87 | 1.3 |
| C18 | 1.36 | 2.4 |
| C18:1 | 13.67 | 26.7 |
| C18:2 | 8.51 | 3.8 |
| C18:3 | N.S.A. | 17.4 |
| C19:1 | 0.73 | N.S.A. |
| C20 | 0.16 | N.S.A. |
| C20:1 | 12.51 | N.S.A. |
| C20:5 | 5.4 | N.S.A. |
| C21 | 4.61 | N.S.A. |
| C22 | N.S.A. | N.S.A. |
| C22:1 | 3.66 | 5.4 |
| C22:2 | N.S.A. | 5.2 |
| C22:5 | N.S.A. | N.S.A. |
| C22:6 | 0.23 | N.S.A. |
| C24:1 | 3.43 | N.S.A. |

[1]Weight percentage determined from average of 15 depot fat samples.
[2]From U.S. Ashworth, G.D. Ramaiah and Mark C. Keyes; J. Dairy Sci. 49 (10) 1206-1211. 1966.
N.S.A. - possibly present but no significant amount

seals have only a light fur covering. Harrison and King[8] suggests that in the true seals the blubber plays a more significant role in insulation. It is believed that the lower melting unsaturated fatty acids are more advantagous for the purpose of insulation.[2] Therefore, there is a conversion of dietary fats in true seals to form larger quantities of C16:1 and C18:1.[2]

The quantity of saturated acids C21 (4.61% by weight) found in the northern fur seal is higher in concentration than in other marine mammal lipids.[1,2,3,4,9,10] The high concentration of C21 in *C. ursinus* may be due to a difference of dietary fats from those of atlantic species. Numerous reports have shown that blubber fatty acids are modified by basic dietary fats.[3,10,12,13]

The blubber analysis was compared to milk lipids of *C. ursinus* which were analyzed by Ashworth *et al.*[5] (Table 1). The blubber oil analysis may be considered typical in the northern fur seal species of mature male seal blubber; however, since the sample was milk, comparisons must be made with due reservation.

Ackman *et al.*[4] found an enrichment in hexadecanoic acid (C16) in the fatty acids of the milk lipids from grey seal and

fin whale compared with their respective depot fats. The same is found in the northern fur seal, an increase of hexadecanoic acid in the milk lipids and a higher proportion of polyunsaturated acids in the blubber than in milk lipids.

Octadecatrienoic acid (C18:3) is reported in the milk lipids, but in the blubber oil this polyunsaturated acid could not be detected in more than trace amounts.

The grey seal milk and blubber fatty acids - C19:1, C20:5, C22:1, C22:2, C22:5, C22:6, - are similar in concentration to the blubber fatty acids of the northern fur seal.[4] However, the corresponsing northern fur seal milk fatty acids are lower in concentration than in the blubber fatty acids. It is apparent that although the totals for long chain unsaturated fatty acids are similar in the blubber and milk samples the quantities and components differ.

The overall pattern of fatty acid composition of blubber oil in *C. ursinus* is broadly similar to the composition for depot fats of marine mammals. The most notable differences in blubber fatty acid contents of *C. ursinus* and true seals are in the ratio of saturated versus unsaturated 16-carbon and 18-carbon fatty acids, the existence of short chain saturated acids, and the higher proportion of C21.

The differences of fatty acid content between *C. ursinus* and the true seals although small, appears to go beyond species variation. There are three possible explanations for these differences. The blubber in *C. ursinus* is secondary to the dense pelt for insulation purposes, its function and make-up are more specifically intended for nutritional storage than insulation. The blubber layer of *C. ursinus* contains large quantities of connective tissue. There is a fibrous connective tissue infiltration and a rich blood supply. Thirdly, *C. ursinus* shares neither geographical areas nor common food sources with the previously analyzed seal species.

## Acknowledgements

We wish to thank Dr. Alvin W. Smith and Mr. Henry Bray for assistance in collecting the specimens and Dr. Harold Guard for advice on fatty acid analysis.

## LITERATURE CITED

1. ACKMAN, R.G. and R.D. BURGHER. 1963. Component fatty acids of the milk of the grey (Atlantic) seal. Can. J. Biochem. Physiol. 41: 2501-2502.
2. ——, S. EPSTEIN and C.A. EATON. 1971. Differences in the fatty acid composition of blubber fats from north western Atlantic fin whales *(Balaenoptera physalus)* and harp seals *(Pagophilus groenlandica)*. Comp. Biochem. Physiol. 40B: 683-697.
3. —— and S.N. HOOPER. 1974. Long chain monethylenic and other fatty acids in heart, liver, and blubber lipids of two harbor seals *(Phoca vitulina)* and one grey seal *(Halichoerus grypus)*. J. Fish. Res. Bd. Can. 31: 333-341.
4. —— and P.M. JANGAARD. 1965. The grey (Atlantic) seal; fatty acid composition of the blubber from a lactating female. Can. J. Biochem. 43: 251-255.
5. ASHWORTH, U.S., G.D. RAMAIAH and MARK C. KEYES. 1966. Species difference in the composition of milk with special reference to the northern fur seal. J. Dairy Sci. 49: 1206-1211.
6. AST, HERBERT J. 1963. Inadvertent isomerization of polyunsaturated acids during ester preparation. Anal. Chem. 35: 1539-1540.

7. BAKER, RALPH C., FORD WILKE and C. HOWARD BALTZO. 1970. The northern fur seal. United States Dept. Inter. Circular 336, Washington, D.C.
8. HARRISON, R.J. and J.E. KING. 1965. *Marine Mammals* Hutchinson, London.
9. JANGAARD, P.M., R.G. ACKMAN and R.D. BURGHER. 1963. Component fatty acids of the blubber fat from the common or harbor seal *Phoca vitulina conclor de kay*. Can. J. Biochem. Physiol. 41: 2543-2546.
10. —— and P.J. KE. 1968. Principle fatty acids of depot fat and milk lipids from harp seal *(Pagophilus groenlandica)* and hoded seal *(Cyspophora cristata)* J. Fish. Res. Bd. Can. 25: 2419-2426.
11. METCALF, L.C. and A.A. SMITH. 1961. The rapid preparation of fatty acid esters for gas chromatograph analysis. Anal. Chem. 33: 364-365.
12. NOTEVARP, O. and V. FYRST. 1965. Fatty acid composition of Norwegian fish liver oils, herring oils, whale oils and whale blubber fat. Proc. Fourth Scand. Symp. Fats and Oils, Turku. 31 August- 3 September 1965 pg. 21-33.
13. TSUYUKI, HIDEO and SHINGO HOH. 1967. Studies on the oils contained in blubber of a southern elephant seal. Sci. Rept. Wales Inst. #20 pg. 213-221.

*Received for publication 27 March 1978*