Composition of Fat From a North American Black Bear*

R. A. RASMUSSEN, P. W. MORGAL, and E. J. MILLER
Michigan Agricultural Experiment Station, East Lansing, Michigan

Very little information on the composition of bear fat is available in the literature. The values reported are either for samples of uncertain history prior to analysis, or for fat that had been rendered under adverse conditions and held for rather long periods of time before being analyzed. It has been pointed out by Hoyt (3) that technical information on bear fat based on modern analytical technique is decidedly meager. Therefore when a relatively fresh sample of bear fat of known history became available it seemed worthwhile to study its characteristics.

The early American Indians used bear fat as a food and preserved it by treatment with the barks of various plants which probably functioned as antioxidants (6). Rendered bear fat per se, however, appears to be rather resistant to oxidation (9), (3), (10) for, in one instance at least, it showed little if any rancidity after a year's storage. In another instance only slight rancidity (Kreis test) was evident even after storage for a year in contact with water and albuminous matter (3). Most fats are not so resistant to rancidification (5) especially when in contact with animal tissue and water (7).

Bear fat contains about 60 to 80 per cent of unsaturated fatty acids (Table 2), and therefore the reason for its resistance to rancidification is not apparent.

Material and Methods

The bear fat used for the analyses herein reported was rendered Nov. 19, 1942, from the subcutaneous adipose tissues of a very fat North American female black bear (Ursus Americanus) killed about 100 miles east of Sault Ste. Marie, Ontario, Canada on Nov. 9, 1942. The contents of the pleural, thoracic, and peritoneal cavities were removed immediately after the bear was shot and the carcass cooled outdoors. The bear was then brought in an open trailer to East Lansing, Michigan. The temperature was near the freezing point when the bear was killed and remained thereabouts for nearly a day afterward. The temperature ranged from —5 to 35° F. during the period from Nov. 9 to Nov. 18 when adipose tissue was removed. The carcass at that time weighed 200 pounds. The fatty tissue was stored at 0° C. until Nov. 19 when it was rendered (45 lbs. of rendered fat were secured). Three methods of rendering were used: vacuum at 95° C., ether and alcohol extraction followed by distilling off the solvent and drying in vacuo at 95° C., and heat rendering with a final temperature of 165° C. for an hour to remove moisture. The fatty tissue contained 4.4 per cent of moisture.

The methods employed for analysis are those found in Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists (1).

Results and Discussion

The bear fat was a pale yellow oil at room temperature and had a slight lard-like odor. On cooling to 2° C. it became semi-solid but would still flow. At 0° C. the fat would no longer flow and was of dough-like character.

In Table I are presented the values secured for the various determinations. Since no significant differences were found among the three samples rendered by different methods, only average values are reported.

TABLE I

Physical and Chemical Constants of Black Bear Fat

Melting Point °C.	—5.0
Specific Gravity $\frac{25}{25}$	0.9127
Specific Gravity $\frac{100}{4}$	0.8652
Refractive Index (20° C.)	1.4693
Refractive Index (40° C.)	1.4628
% Free Fatty Acids (as oleic)	4.4
Saponification No.	192.3
% Soluble Fatty Acids	2.6
% Insoluble Fatty Acids	91.9
% Saturated Fatty Acids (corrected)	10.4
% Unsaturated Fatty Acids (corrected)	79.4
Iodine No. (Wijs)	92.0
Iodine No. Saturated Fatty Acids	20.2
Iodine No. Unsaturated Fatty Acids	109.2
Thiocyanogen No.	76.9
% Unsaponifiable Matter	0.1

The values from Table 1 are in agreement with the values reported in the literature and are presented in the last column of Table 2 for convenience in comparison. The data in Table 2 are reported for an arctic bear (Ursus artos) by Schneider and Blumenfeld (10), for two Himalaya bears (Ursus torquatus Wagner) by Hooper (2), for two Japanese black bears (Ursus torquatus Japonicus Shinz) by Itagaki (4), and Ueno and Kuzei (11), for belly and kidney fat from a Bulgarian black bear by Raikow (9), and for two black bears (Ursus Americanus) by Hoyt (3).

The low Reichert-Meissl numbers (0.33-1.66) and the saponification values (Table 2) indicate the presence of longer chain fatty acids. The only saturated fatty acids found in the fat of the Japanese black bear (11) were stearic and palmitic.

Bear fat has a high percentage of unsaturated fatty acids (58.2 to 79.4, Table 2) and according to Ueno and Kuzei (11) these unsaturated fatty acids yield a considerable amount of stearic acid on hydrogenation.

In the present study 79.4 per cent of unsaturated fatty acids with an iodine no. of 109.2 and a thiocyanogen no. of 76.9 were found. Calculations of the various fractions (1) are reported in Table 3.

The determined percentage of saturated fatty acids was 10.4 which is in good agreement with the calculated value of 10.9 for saturated fatty acid glycerides.

* Published with the permission of the Director of the Experiment Station as Journal Article No. 640 (n.s.).

The major portion of the unsaturated fatty acids (62.8%) was present as oleic acid. However, this sample of bear fat contained a high percentage of linoleic acid (10.9%) and linolenic acid (5.8%).

It is evident from Table 2 that the melting points of the different samples of bear fat vary over a wide range. At room temperature some are solid while others are liquid. This is reflected in the degree of saturation of the fatty acids as indicated by the iodine numbers. The bear fats that are solid at room temperature have iodine numbers below 63.2 while the liquid fats have iodine numbers above 80.7. Various reasons have been postulated for the difference in hardness of bear fats (3), (9) but Maynard (8) has shown that within the species the major influence on body fat is found in the nature of the fat in the ration consumed. The bear loses a large part of its depot fat during the hibernating period and this would result in new fat being laid down each year. Since all the animals reported were killed in the fall or just after the beginning of hibernation which is at the end of the period of most rapid fat storage, the most probable reason for a liquid or hard fat would be found in the ration consumed during the fattening process.

TABLE III

Calculated Values from Determined Values

% Saturated Fatty Acid Glycerides	10.9
% Oleic Acid Glycerides	71.7
% Linoleic Acid Glycerides	17.4
% Oleic Acid	62.8
% Linoleic Acid	10.9
% Linolenic Acid	5.8

Summary and Conclusions

The physical and chemical constants have been determined on a sample of bear fat of known history. The values are within the range of those reported in the literature.

Calculations (1) based on the iodine number, thiocyanogen number, percentages of saturated and unsaturated fatty acids, and the unsaponifiable matter indicate that this sample of bear fat contained 71.7 per cent of oleic and 17.4 per cent of linoleic acid

TABLE II

Summary of Available Analytical Data on Bear Fat

	Arctic Bear (10)*	Himalaya Bears (2)		Japanese Black Bear (4)	Japanese Black Bear (11)	Black Bear (9) killed near Sofia, Bulgaria		Black Bear (3)		Black Bear
		1	2			Belly Fat	Kidney Fat	Adirondacks	Quebec	Ontario, Canada
Melting Point °C.	below room	37.5	34.5	22.5	30.0	below room	below room	17.0	26.5	—5.0
Fatty Acids	37.5	42.0	40.0		38.2	32.0 to 32.3	30.5 to 31.0			
Saturated					54.4					
Solidifying Point of Fatty Acids	36.1									
Specific Gravity	0.9156 15/15	0.9013 50/4	0.9007 50/4	0.9212	0.8618 100/4	0.9209 15/15	0.9211 15/15			0.8652 100/4
Fatty Acids	0.9347 15/15									
Refractive Index	1.4664 (20) 1.4562 (50)				1.4591 (40)	1.4666 (25) 1.4613 (40)	1.4666 (25) 1.4613 (40)	1.4695 (20)	1.4665 (20)	1.4693 (20) 1.4628 (40)
Fatty Acids	1.4545 (40) 1.4500 (50)									
Acid No.	30.6	13.8	33.2	1.6	2.9	2.2	2.2	3.7	1.4	
Reichert-Meisel No.	0.33	0.93	0.86			1.66	1.15			
% Insoluble Fatty Acids	94.5	94.8	93.8					94.8	94.4	91.9
Saponification No.	191.0	203.8	204.3	140 to 146.9	197.2	192.6	198.2	195.6	196.6	192.3
Fatty Acids	203.0				203.0					
Saturated					211.7					
Unsaturated					202.5					
% Saturated Fatty Acids					41.8			15.5	30.2	10.4
% Unsaturated Fatty Acids					58.2			79.3	64.2	79.4
Iodine No.	80.7	52.8	62.8	62.4	62.8 (Wijs)	98.5	107.0	90.1 (Hanus)	63.2 (Hanus)	92 (Wijs)
Fatty Acids	76.5	57.3	63.0		65.2					
Saturated					14.2					20.2
Unsaturated					99.0			98.8	82.8	109.2
Acetyl No. of Fatty Acids	5.7									
% Unsaponifiable Matter					0.3			0.08	0.10	0.1

* Numbers in parentheses refer to Literature Cited.

glycerides, and that the percentages of oleic, linoleic and linolenic acids present were 62.8, 10.9, and 5.8 respectively.

The differences in bear fats reported in the literature probably reflect differences in the food fat consumed during the fattening process.

LITERATURE CITED

(1) A. O. A. C. 5th Ed., 1940, Chap. 31, Oils, Fats and Waxes.
(2) Hooper, David, The Fat of the Himalaya Bear (Ursus torquatus Wagner), Pharmaceutical Jour. (4) *26*, 803-4, through Chem. Zentr. *2*, 336 (1908).
(3) Hoyt, L. F., Bear Grease, Oil and Soap, *11*, 85 (1934).
(4) Itagaki, S., Bear Fat, J. Pharm. Soc. Japan, *522*, 743 (1925) through C. A. *20*, 2590 (1926).
(5) Jensen, L. B., Microbiology of Meats, The Garrard Press, Champaign, Ill., 1942, Page 9.
(6) Kephart, Horace, Camping and Woodcraft, New Ed. 1930, MacMillan, New York, Page 331.
(7) Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats and Waxes, MacMillan & Co., Ltd., London, 1909, Page 37-44.
(8) Maynard, L. A., Animal Nutrition, 1st Ed. 1937, McGraw-Hill, New York, Page 74.
(9) Raikow, P. N., Analyse eines Barenfetts, Chem. Zeitung, *28*, 272 (1904).
(10) Schneider, C. and Blumenfeld, S., Beitrag zur Kenntnis Animalscher Fette, Chem. Zeitung, *30*, 53 (1906).
(11) Ueno, Seiichi, and Kuzei, Nobuo, Studies on Terrestrial Animal Oils and Fats 3, J. Soc. Chem. Ind. Japan, *32*, 312 (1929).

The Solubility of Gases in Butter Oil, Cottonseed Oil, and Lard

P. S. SCHAFFER and H. S. HALLER
Division of Dairy Research Laboratories, Bureau of Dairy Industry, Agricultural Research Administration, U. S. Department of Agriculture

Introduction

There appears to be no literature concerning the solubility of the common gases in butter oil and very little in connection with the other edible oils and fats. Schmidt-Nielsen (1) reported the solubility of air in various oils and, later, Vibrans (2) determined the solubility of the common gases in cottonseed oil, corn oil, lard, and hydrogenated cottonseed oil shortening.

The present work was undertaken in view of the desirability of having solubility data on butter oil and because of the scarcity of data on other fats and oils. The solubility of air, hydrogen, oxygen, nitrogen, and carbon dioxide was determined in butter oil, cottonseed oil, and lard.

Experimental

With the exception of air, the gases were taken directly from commercial cylinders and were used without purification. The butter oil was obtained from butter prepared from fresh cream in the laboratory. The cottonseed oil and lard were good grade commercial products.

The apparatus consisted of a reaction flask of 125 ml. capacity connected to a water jacketed gas burette provided with mercury leveling bulb and a differential manometer containing dibutyl phthalate. The reaction flask was suspended by means of a thick walled rubber tube into a hot air bath maintained thermostatically to within $\pm$ 0.5° C. An externally mounted motor with a crank arm movement was connected to the reaction flask to provide shaking. The system was provided with a connection to a vacuum pump for evacuating the reaction flask. All samples consisted of 50 ml. oil measured at the temperature of the experiment. The solubilities in all cases were determined at 40°C. In addition, the solubility of gases in butter oil was also determined at 60° C.

The preliminary preparation of the oils consisted of evacuation to a pressure of about one mm., heating to a temperature of approximately 85° C. and shaking vigorously to remove all dissolved gases. The oil was then allowed to cool under vacuum to the temperature at which the experiment was conducted. Shaking was then discontinued and the gas was allowed to enter the reaction chamber from the gas burette and the leveling bulb adjusted so as to provide a pressure of the gas on the surface of the oil equal to atmospheric pressure. It was assumed that there was no surface solution of the gas during the few seconds required to make the zero reading on the gas burette. Shaking of the sample was then begun and the leveling bulb continuously adjusted so as to provide a pressure just slightly in excess of atmospheric pressure until there was no apparent absorption. The pressure was adjusted to atmospheric and the shaking of the sample continued. The pressure was adjusted at intervals if necessary in order to maintain a pressure equal to that of the atmosphere. After shaking for approximately one hour a reading of the burette was taken. The difference between this reading and the zero reading was taken as the volume of the gas dissolved by the 50 ml. of oil at the prevailing temperature of the gas burette and atmospheric pressure.

Results

All results shown are averages of at least two determinations and are expressed in terms of milliliters of gas under standard conditions (0° C. and 760 mm.) dissolved under atmospheric pressure in 100 milliliters of the oil. Differences in the values of three determinations were not over three-tenths of one percent, and in most cases were considerably less than this value.

TABLE I

The Solubility of Gases in Butter Oil, Cottonseed Oil, and Lard

Gas	Ml. gas dissolved in 100 ml. of Fat			
	Butter Oil		Cottonseed Oil	Lard
	40° C.	60° C.	40° C.	40° C.
	ml.	*ml.*	*ml.*	*ml.*
Oxygen	14.2	12.7	12.7	11.5
Nitrogen	8.9	7.9	6.2	6.6
Hydrogen	5.4	6.8	4.7	5.0
Air	10.1	9.6	8.7	8.8
Carbon Dioxide	109.5	91.0	87.6	100.3

In addition to the above data runs were also made on butter oil at 25° C. However, the oil was semiplastic and consistent results could not be obtained and were therefore not reported.