the usual deodorizing process. Sulfur is cheap so there are practically no extra costs. In laboratory tests the addition of sulfur produced no attack on iron. The absolute residual amount of sulfur left in the oils and fats after deodorization is very small and only slightly higher than that present in ordinary deodorized oils and fats (chosen at random) as the following Table IV shows. The presence of sulfur in ordinary oils shows that there can be no objection against it.

Summary

The efficiency of antioxidants is judged by means of a modified Swift test. Addition of 0.05% sulfur during the deodorizing process yields a 4-1.4 times prolonged keeping time of oils and fats.

There is a linear relation between iodine value and the remaining speed of oxidation in % in the tests made with sulfur. The reduction of the velocity is inversely proportional to the iodine value. The effects of gallate and the sulfur seem to be additive. The residual amount of sulfur left in the oils and fats after deodorization is very small and only slightly higher than that present in ordinary deodorized oils and fats.

REFERENCE

1. Bertram, S. H., J. Am. Oil Chem. Soc., *26*, 83-85 (1949).

[Received May 27, 1952]

The Fatty Acids of Cottonmouth Moccasin Depot Fat[1,2]

C. B. POLLARD and JOSEPH McLAUGHLIN JR.,[3] Organic Chemistry Laboratories, University of Florida, Gainesville, Florida

SNAKE oil, as used in this article, refers to the lipids obtained from the fat lobes of the cottonmouth moccasin, *Agkistrodon piscivorus*. Well-fed snakes in good physical condition have fat lobes deposited along both sides of the intestines in the area between the stomach and vent. At its maximum this fat deposition involves about one-fourth of the total length of the snake; at the end of the hibernation period the fat deposit may have disappeared completely.

Experimental and Discussion

The cold-pressing method extraction was employed for all samples since it helps to eliminate changes in the lipids by heat or oxidation. From 10 to 30 snakes were butchered soon after capture, and the lobes were pooled. The fat lobes were dried on filter paper, and all connective tissue and blood vessels were carefully removed. The supply of fat was wrapped in filter cloth before it was pressed. The expressed oil was centrifuged at 1,400 r.p.m., and clear samples were siphoned off for analyses.

Results of preliminary analyses were: D_4^{25}, 0.9268; n_D^{25}, 1.4690; Saponification Number, 192.6; Iodine Number (Hanus), 104.4; Thiocyanogen Value, 77.2; Soluble Acids, 0.13; Hehner Number, 94.85; Reichert Meissl Value, 0.07; Polenske Value, 0.04; Saturated Acids, 22.7; Unsaturated Acids, 72.7; Free Fatty Acids, 0.52; Acetyl Value, 4.1; and Unsaponifiable Residue, 0.46.

From the above data it would appear that the content of low molecular weight fatty acids is slight. Only negligible quantities of high molecular weight alcohols and waxes are indicated by the unsaponifiable residue.

Although an "apparent" acetyl value of 4.1 was determined in the preliminary analyses, the corrected acetyl value was so low that it may be concluded that little, if any, hydroxy acids are present in moccasin snake oil.

Percentage-content of fatty acids was determined primarily by distillation, through a Lecky-Ewell column at pressure of 1.0 mm.; and by spectrophotometric studies.

Distillation of Methyl Ester Fractions. A sample of moccasin snake oil was separated into two portions by the lead salt-ether method (1). Each portion was converted to its methyl ester and was distilled. Data produced by these fractional distillations are presented in Tables I and II. The unsaturated acid fraction was 71.0% and the saturated acid fraction, 24.4% of the original moccasin snake oil based on weights.

TABLE I

Physical and Analytical Data on 13 Fractions of Methyl Ester of Liquid Acids[a] from Cottonmouth Moccasin Fat Lobes

Fraction	Temperature (°C.)	Weight of Fraction (in g.)	n_D^{25}	Saponification Equivalent	Iodine Value (Hanus)
1	107-117	0.2	1.4452	.....	56.3
2	117-128	0.7	1.4445	230.0	50.8
3	128-132	1.0	1.4449	250.0	63.6
4	133-138	1.7	1.4460	263.5	70.3
5	138-148	3.7	1.4483	280.0	80.1
6	149-153	13.2	1.4520	298.2	102.9
7	153-157	8.1	1.4532	302.1	104.9
8	158-162	4.2	1.4542	293.5	104.9
9	162-165	1.2	1.4598	296.8	87.4
10	165-168	0.9	1.4679	290.0	120.3
11	168-169	1.9	1.4679	276.0	109.3
12	170-200	4.3	1.4805	313.3	212.0
13	Residue	4.2	.....	.....	.....

[a] "Liquid" acids were produced by lead salt-ether method. Fractions were obtained by distillation at 1 mm. of 45.3 g. of the methyl esters of these "liquid" acids.

TABLE II

Physical and Analytical Data on Nine Fractions of Methyl Ester of Solid Acids[a] from Cottonmouth Moccasin Fat Lobes

Fraction	Temperature (°C.)	Weight of Fraction (in g.)	n_D^{25}	Saponification Equivalent	Iodine Number (Hanus)
1	121-124	0.2	1.4358	.....	3.2
2	125-128	0.3	1.4365	.....	0.7
3	129-139	4.1	Solid	270.9	1.7
4	140-143	4.5	Solid	275.3	0.3
5	144	3.3	Solid	280.2	0.0
6	145-150	1.2	1.4398	277.0	6.5
7	150-154	1.0	Solid	281.9	11.7
8	154-164	3.9	Solid	299.5	8.4
9	Residue	0.7	Solid	292.5	9.3

[a] "Solid" acids were produced by Lead Salt-Ether Method. Fractions were obtained by distillation at 1 mm. of 20.0 of the methyl ester of these "solid" acids.

[1] This paper is abstracted from a portion of a dissertation submitted by Joseph McLaughlin Jr., to the Graduate Council of the University of Florida in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

[2] Presented at the 43rd meeting of the American Oil Chemists' Society, Houston, Tex., April, 1952.

[3] Present address: Biochemistry Dept., AMSGS, Walter Reed Army Medical Center, Washington, D. C.

TABLE III

Interpretation of the Data in Tables I and II by the Hilditch Method of Calculation

Acid	"Liquid" Ester Fractions	"Solid" Ester Fractions	Total Ester Fractions
	(%)	(%)	(%)
Arachidonic and Clupanodonic	10.98	0	10.98
Hexadecenoic	6.43	0.10	6.53
Linoleic	16.00	0	16.00
Myristic	1.15	0.62	1.77
Oleic	34.48	0.77	35.25
Palmitic	1.39	14.54	15.93
Stearic	0	8.37	8.37

Interpretation of the data in Tables I and II by the Hilditch (2) method of calculation produces the information presented in Table III.

Spectrophotometric Data of Moccasin Snake Oil. The procedure used in this phase of the investigation is one which was devised by Mitchell, Kraybill, and Zscheile (3) and was later elaborated upon by Beadle and Kraybill (4). Figure 1 gives the spectrophotometric curve for the moccasin snake oil after isomerization according to the method mentioned. On comparison of the values obtained with those reported as standard values, it is found that the following percentages of fatty acids are shown to be present: 15.4 of linoleic; 3.9 of linolenic; and 11.57 of arachidonic. From an evaluation of all spectrophotometric and other information obtained, it appears that the following amounts of fatty acids were present: 15.4% of linoleic, and 11.4% of arachidonic (it must be realized that the arachidonic would also include all other 4 as well as all 5 and 6 double bond acids). It is not believed that the spectrophotometric values of linolenic are sufficient indication for any linolenic acid since it was not possible to show the presence of linolenic by any other means.

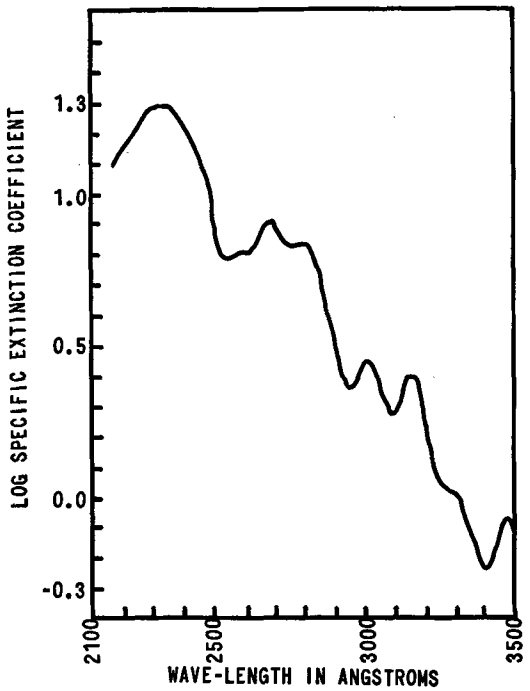

FIG. 1. Uutra-violet absorption spectra of Moccasin snake oil after isomerization according to the method of Mitchell, Kraybill, and Zscheile.

Conclusions

Based upon this research on moccasin snake oil, the following percentages of fatty acids are reported for the fat lobes of the cottonmouth moccasin: myristic, 1.77; palmitic, 15.93; stearic, 8.37; hexadecenoic, 6.53; oleic, 35.25; linoleic, 15.70; and arachidonic (this also includes all 5 and 6 double bond acids), 11.18. The total of all the fatty acids found is 94.73% by weight of the original moccasin snake oil.

Two methods of testing the reliability of the analyses performed are: a) the combined unsaturation of the reported composition of the moccasin snake oil as compared to the unsaturation of the original moccasin snake oil with all unsaturations determined by their Iodine Value; and b) the saponification equivalent of the reported composition of the moccasin snake oil as compared to the saponification equivalent of the original moccasin snake oil. Upon the performance of these calculations it is found that the reported composition of the moccasin snake oil agrees very closely with that of the original moccasin snake oil.

A further check of the myristic acid present was made by adding the "solid" fatty acid fraction to an ethanol solution at 6°C. for 24 hours. The ethanol solution had previously been saturated with respect to stearic and palmitic acid. Upon recovering and weighing the undissolved fatty acid, it was found that the palmitic and stearic portion was at least 98%, by weight, of the original acid mixture. From this evidence it may be inferred that the amount of myristic acid present is very slight.

Summary

From the investigation of the moccasin *(Agkistrodon piscivorus)* fat it is found that it is intermediate between the composition of fish oil and mammalia fats for the fatty acids present. The amount of saturated fatty acids in moccasin snake oil is more than that present in fish oils while the amount of unsaturated fatty acids present in moccasin snake oil is less than that for fish oil. It might be pointed out that at least two separate methods were used to determine the percentages of each fatty acid present.

The authors wish to express their thanks to Ross Allen of Ross Allen's Reptile Institute, Silver Springs, Florida, for the moccasin fat lobes used in this investigation.

REFERENCES

1. Official and Tentative Methods of Analysis of the Association of Agricultural Chemists, Sixth Edition (1945), published by the Association of Official Agricultural Chemists, Box 540, Benjamin Franklin Station, Washington 4, D. C.

2. Hilditch, T. P., "The Chemical Constitution of Natural Fats," John Wiley and Sons Inc., 2nd Ed. (1947), pp. 483-512.

3. Mitchell, J. H. Jr., Kraybill, H. R., and Zscheile, F. P., Ind. and Eng. Chem., Anal. Ed., *15*, 1 (1943).

4. Beadle, B. W., and Kraybill, H. R., J. Am. Chem. Soc., *66*, 1232.

[Received May 27, 1952]