THE COMPOSITION OF HUMAN FAT.

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ALTHOUGH it is not probable that members of this Society will be frequently called upon to make an analysis of human fat, yet one can easily conceive the possibility of such a case occurring, and I have therefore thought that, apart from their purely scientific interest, my figures might have a practical value.

Human fat appears to have been but little studied since the days of Chevreul and Heintz—at least, no description of its characteristics is to be found even in books

* This has since been done in a fresh sample, and the water found to be slightly acid. The analysis of this sample showed the following constituents :

						Grains per gallon.
Total solids	...	...	...	...	...	6·160
Chlorine ...	...	...	...	...	...	0·960
Nitric acid	...	...	...	...	...	traces
Oxygen absorbed	...	...	...	...	...	0·022
Ammonia ...	...	...	...	...	...	none.

dealing specially with physiological chemistry. Chevreul* found that it consisted of an olein and stearin, the latter being distinguished from mutton stearin by yielding "margaric," and not stearic acid. Heintz† came to the conclusion that the composition of the fat was of a more complex nature, and that, in addition to olein and palmitin, there were small quantities of several other acids, one of them being a liquid acid.

The specimen of fat which I have examined, and for which I am indebted to the kindness of Dr. Arnold Chaplin, was separated from the tissue at as low a temperature as possible. It was of a pale yellow colour, and had a consistency somewhat less than that of butter. On crystallization from ether there was only a slight deposit, which, when washed with ether and dried, melted at 51.5° C. Under the microscope the crystals had some resemblance to those frequently obtained from flare lards, being arranged in fan-shaped bunches, while the individual crystals had the characteristic chisel-shaped ends.

The determination of the chemical and physical constants of the fat gave the following figures:

FAT.					
Specific Gravity at 25° C. (Water at 25° = 1)	...	...	...	...	0.9033
Melting-point	...	...	...	...	17.5°
Solidification-point	...	...	...	...	15°
Saponification No.	...	...	...	...	195
= Equivalent	...	...	...	...	287
Reichert Value (2.5 grammes)	...	...	...	...	0.3 $\frac{N}{10}$ alkali.
Acidity No. (1 gramme)	...	...	...	...	6.3 mgs. KOH = 0.32 per cent oleic acid.
Bromine Heat Value	...	...	...	...	11.3° C.
= Iodine Value, 11.3×5.5	...	...	...	...	62.15
Iodine Value (Hübl)	...	...	...	...	61.5
FATTY ACIDS.					
Melting-point	...	...	...	...	35.5°
Solidification-point	...	...	...	...	30.5°
Iodine Value	...	...	...	...	64
Iodine Value of Liquid Acids	...	...	...	...	92.1

In order to obtain some idea as to the nature of the fatty acids, Twitchell's modification of Jean's method of fractional precipitation was employed (ANALYST, xx., p. 165). 1.9478 grammes of the fatty acids (iodine number 64) were dissolved in 25 c.c. of 95 per cent. alcohol; 1.5 grammes of lead acetate dissolved in 10 c.c. of the same alcohol were added, and the flask well corked, allowed to stand over-night. In the morning some of the liquid was filtered, the acids recovered by shaking with ether and hydrochloric acid, and their iodine number determined. The precipitate was well washed with alcohol, the fatty acids recovered, dried, and weighed, and their iodine number also determined. In each case precautions were taken to prevent oxidation. The results obtained were:

	Grammes.	Iodine No.	Per cent.
Solid Acids	0.9779	37	50.2
Liquid Acid (by difference)	0.9699	92	49.8

* *Recherches sur les Corps Gras*, 1823.

† *Pogg. Annal.*, 1851, p. 238.

The acids from the filtrate were liquid at 15° C., while those from the precipitate melted at 35·5° C., and had a molecular equivalent of 278.

From these figures the amount of liquid and solid acids can be calculated.

Liquid Acids in filtrate	...	...	...	...	...	...	Per cent.
„ „ precipitate reckoned as Oleic Acid	...	...	...	...	...	...	49·8
	$\frac{37 \times 50\cdot2}{100} = \frac{18\cdot57}{0\cdot9}$						20·6
Total Liquid Acids	...	...	...	...	...	...	70·4
With Iodine No.	$\frac{64 \times 100}{70\cdot4} = \dots$						90·9

From this it appears that the liquid acids probably consist of oleic acid, with a small amount of a more unsaturated acid, possibly linolic.

With regard to the solid acids, the high molecular equivalent (278) of the lead precipitate, of which only 20 per cent. is accounted for by the liquid acids, leads to the conclusion that stearic acid, or some other acid of high molecular weight, is present.

Further evidence of the composition of the solid acids was obtained by crystallizing the fatty acids from 70 per cent. alcohol. The crystals, after being well washed with the same alcohol and dried, melted at 50·5° C. This melting-point being lower than that of any mixture of stearic and palmitic acid in Heintz's table, points to the presence of myristic acid, since the precipitate was quite free from liquid acids. The filtrate, on standing, yielded a second deposit, which also melted at 50·5° C.

Human fat, therefore, would seem to consist of about 70 per cent. of liquid acids, principally oleic acid, 30 per cent. of solid acids, probably palmitic with small amounts of stearic and myristic acids, and traces of lower volatile acids.

DISCUSSION.

The PRESIDENT said that Mr. Mitchell's figures were very valuable, and he hoped to see them incorporated in future text-books on physiology, in supersession of the very imperfect data at present available on the subject of human fat. The fact that the results now brought forward were perfectly novel, to a certain extent prevented discussion of them; but they were certainly worthy of consideration, and credit was due to Mr. Mitchell for bringing them forward.

Mr. HEHNER said he would like to ask Mr. Mitchell for some further explanation of the grounds upon which he assumed that the fluid fatty acids consisted chiefly of oleic acid, with a small amount of linolic acid. He (Mr. Mitchell) had, by means of their lead salts, divided the acids into liquid and solid. He (Mr. Hehner) had shown to the Society that the separation of the lead salts by means of ether was at most but a partial one, and this was borne out by Mr. Mitchell's figures. For instance, the "solid" fatty acids having an iodine absorption of 37 per cent., should not, theoretically, have had any iodine absorption at all, if the process of separation had worked perfectly; and from the fact that the original fat had an iodine absorption of 61, it would seem that separation had really been effected very imperfectly. Certainly the "liquid" fatty acids had an iodine absorption of 92, practically that of oleic acid, but was it not possible that these liquid fatty acids contained a considerable quantity of

the solid acids? At all events, this was the conclusion which he (Mr. Hehner) had arrived at from his own investigations in connection with this process of separation. With lards, to which human fat appeared to have a great resemblance, this process seemed also to give very variable results. The figures which Dr. Muter had published in this connection all showed iodine absorptions of about 90 or 91 for the fluid acids, but further investigation had shown that, from American lard, at all events, much higher figures were obtained, indicating that there must have been a considerable quantity of another fatty acid besides oleic acid, and, considering that solid saturated fatty acids were undoubtedly included in the fluid ones, the amount of the unsaturated fatty acid would be larger than appeared from the iodine absorption. He therefore did not think it followed that because a liquid fatty acid obtained in this way had an iodine absorption of about that of oleic acid, that oleic acid was necessarily present.

Mr. BEVAN inquired what part of the body the fat had been taken from. In the case of the pig, the lard varied very considerably, according to the part of the body from which it was obtained. Also whether Mr. Mitchell had determined the Valenta number, and the refractive index in the oleorefractometer.

Mr. MITCHELL, referring to the question of the iodine absorption of the liquid fatty acids, said that no system of identification which depended simply upon the iodine absorption test could be regarded as conclusive, but that since, so far as he was aware, no acid absorbing less than 90 per cent. of iodine had yet been found in fats, he considered it probable that when an iodine number of about 90 was obtained in the liquid acids prepared by Twitchell's method it represented oleic acid. Twitchell had shown that in his process of separation there was a fractional precipitation, the lead salt of oleic acid being precipitated first, then that of linolic, and finally that of linolenic acid. He therefore calculated any iodine absorption in his precipitate as oleic acid. Since by this fractionation process he (Mr. Mitchell) had found that the acids from the filtrate only absorbed 92 per cent. of iodine, whereas Twitchell frequently had an iodine absorption of over 100, it was highly probable that acids more unsaturated than oleic acid were only present in small quantities. At the same time, the data were insufficient for anything more than a probable conjecture. He believed that the fat he had examined was from the kidneys. He had not determined either the Valenta number or the refractive index.