CXLVI. THE DEGREE OF UNSATURATION OF THE FATS OF HUMAN ADIPOSE TISSUE IN RELATION TO DEPTH FROM SKIN SURFACE.

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The variations in the degree of unsaturation of the fats of adipose tissue in relation to depth from skin surface have received a considerable amount of attention in domestic animals, but no similar analyses of human material have been made.

Spaeth [1893] was one of the earliest observers to draw attention to the difference in iodine value and melting-point of fats obtained from the back and from the kidneys of fat hogs. The kidney fats proved to have lower iodine values and higher melting-points than the dorsal tissues. Mansfeld [Henriques and Hansen, 1901] had also noted that the skin-fats of pigs and also of cows had higher iodine values than the fats adjacent to viscera.

Lummert [1898] found that in three of the dogs which he examined there existed differences between the iodine values of the fats obtained from the skin and of those obtained from the region of the intestines from the same animal, but that there was no constant relationship to be found between the three different series as the average values revealed no real distinction.

On the basis of these observations Henriques and Hansen [1901] planned to determine if the above-mentioned differences in composition of fat from different parts of an animal were constant, and if the variations occurred to an even greater extent than had previously been described. Their method of extraction was simple, consisting in melting the fats by heat, a stream of CO_2 being blown over them to prevent oxidation. Von Hübl's method for the iodine value determinations was used. In addition they determined the solidification-points of the fats.

On the evidence of their experiments these workers put forward the interesting theory that the well-marked differences which they observed were due to the fact that storage fat is deposited in regions of different temperature, the most unsaturated fats being deposited in the coolest regions.

Since the present writers know of no similar data pertaining to human fat, it was thought of interest to present these analyses made in the course of a more exhaustive examination into the composition and distribution of fat in man.

Analytical methods.

The fats were obtained from comparatively fresh normal and obese human cadavers. The normals were all male subjects, the obese female.

The autopsies on the normals (fatal accidents) were performed from 9 to 17 hours after death, the average time being 12 hours. In the case of the fat subjects, the sections were performed from 3 to 25 hours after death—the average time being 13 hours. These latter cases included some of the most adipose female subjects which the writers have observed during a space of 4 years. In three instances in this group death was due to pulmonary embolism following trauma. In another case death was due to rupture of a cerebral aneurism and in the remaining two cases nephritis and carcinoma were the respective primary causes.

The fatty tissues analysed included the panniculus adiposus abdominalis, the omentum, mesentery, perinephric and epicardial tissues. In some cases the liver triglycerides were examined. The maximum thickness of the abdominal adipose tissues of the series (8·75 cm.) was observed in a female 160 kg. in weight. Preliminary experiments employing the extraction of the molten fat by heat were made but later abandoned owing to a tendency to contamination with tissue fluids. Subsequently the tissues were extracted three times with absolute alcohol and three times with ether in the cold. The extracts were concentrated to small volume by distillation under reduced pressure at 40° in a partial atmosphere of CO_2. The residue was extracted with light petroleum, free from aromatic hydrocarbons, the petroleum layer being separated, filtered and the solvent removed by distillation under reduced pressure at 40° in an atmosphere of CO_2. The fats were stored in an ice-chest until analysed, the last traces of solvent being removed just prior to analysis.

In the case of the liver the phosphatides were removed by repeated precipitation with acetone, traces of NaCl being present to facilitate separation.

After two preliminary observations on the iodine values of the derived fatty acids it was decided to consider the triglycerides and free fatty acids by themselves, as the removal of the small amount of unsaponifiable matter did not appreciably affect the relative significance of the data. It was also decided to abandon melting-point and solidification-point determinations, since the fats

Iodine values of fats derived from fatty tissues.

(*a*) Three normal subjects.

Tissue	Iodine value			No. of observations
	Maximum	Minimum	Average	
Panniculus adiposus abdominalis	73	67	70	3
Omentum	65	62	63·5	2
Perinephric	66	58	63	3
Epicardial	65	62	63·5	2
Liver (triglycerides)*	134	121	127	3

(*b*) Six obese subjects.

Tissue					
Panniculus adiposus abdominalis	Outer half layer	72	68	70	6
	Inner half layer	73	68	70	6
Omentum		71	67	69	5
Perinephric		65	61	63	3
Liver (triglycerides)		107	72	89	4

* [Cathcart and Cuthbertson, 1931.]

differed so little in their fluidity and since such determinations provided merely a qualitative test of the most solid and most fluid triglycerides and not a measure of the degree of unsaturation of the mixture.

The iodine values were determined by the method of Wijs. This method was used throughout to preserve continuity with the earlier specimens of the series which had been analysed by this technique. It is well known that Wijs's iodising solution is very reactive to cholesterol and it might be thought that the presence of this substance in varying amount might account for such divergence in the iodine values of the different fatty tissues as existed. Parallel observations by this method and that of Rosenmund and Kuhnhenn (Yasuda modification [1931]) on the fats and the fatty acids derived from them after removal of the unsaponifiable matter, indicated that the removal of the sterols, *etc.* did not alter the relative order and preponderance of the different fats one to another in respect of their unsaturation. The Rosenmund-Kuhnhenn method gave values about 6 % lower than Wijs's method.

An excess of Wijs's solution (about 200 %) was used.

Discussion.

It was assumed that if any difference in the degree of unsaturation of the outer and inner tangential layers of the panniculus adiposus abdominalis did exist in the human subject, these obese cases would have exhibited the maximum effect considering the depth of this tissue.

It is apparent from the data that no real difference existed between these two layers in the six subjects examined, and further that the difference between the fat of this tissue and the omental fat was insignificant. The iodine number of the perinephric fat was, on the other hand, significantly lower.

In the case of the normal subjects, no division of the subcutaneous fatty tissue into outer and inner layers was possible. It is of interest that the degree of unsaturation was the same as that noted in the obese group.

On the other hand the omental fats had a lower degree of unsaturation than the subcutaneous. They were similar in value to the perinephric and epicardial fats, which in turn were of the same order of saturation as the perinephric fat of the obese group.

The close similarity in the degree of unsaturation of the subcutaneous and omental fats of the obese group may point to these tissues being storage areas for material of similar character.

It is apparent that the distinct differences in the composition of the storage fats at different depths from the skin surface which have been noted [Henriques and Hansen, 1901] in the lower animals, the dog excepted, are not, or at least only to a minor extent, reproduced in man. The general similarity of diet of these two omnivores may account for this, as the observations of Bhattacharya and Hilditch [1931] indicate that the more unsaturated the dietary fat, the less will be the differences in the unsaturation existing between the various body fats. This explanation is more probable than one based on temperature differences.

It is of interest that the triglycerides of the liver of the four obese subjects in whom this tissue was examined exhibited without exception low degrees of unsaturation as compared with the normal group, an observation in harmony with the morphological appearances.

SUMMARY.

1. The average iodine values of the fats of the panniculus adiposus abdominalis, omental, perinephric, epicardial and liver tissues of normal men were 70, 63·5, 63, 63·5 and 127 respectively.

2. In obese women the average iodine values for the fats of the outer and inner layers of the panniculus adiposus abdominalis, the omentum, and the perinephric and liver fats were 70, 70, 69, 63 and 89 respectively.

In conclusion we wish to express our thanks to Prof. J. Shaw Dunn for his kindness in supplying us with suitable material.

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