The digestibility of fats — A Correlation of Experimental Data

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THE digestibility of fats has been studied extensively in a number of laboratories over the past 30 years, the major portion of the data having been collected by several groups of workers, each of which used some one type of experimental subject. In one set of experiments digestibilities were compared in two types of subjects (1, 2). Dogs were employed in several laboratories in some of the very early work (3, 4). The first intensive studies were conducted in the laboratories of the Office of Home Economics of the U. S. Department of Agriculture, by Langworthy, Holmes and Deuel, who reported the digestibilities in adult humans of a wide variety of natural and hydrogenated fats in a series of publications over a period of more than ten years (5-16). Their work, a large portion of which was done during the fat shortage following the first World War, included practically every fat which could be considered a potential source of food. More recently there has been a series of publications by Hoagland and Snider of the Animal Nutrition Division, Bureau of Animal Industry of the U.S.D.A., reporting the digestibilities of some of the more common animal and vegetable fats, shortenings, and several synthetic saturated triglycerides in albino rats (17-21). One of the most significant investigations to date was conducted...
ducted in the Department of Pediatrics of Johns Hopkins University. In this series of experiments Holt and Tidwell and their associates used human infants as experimental subjects and made some very interesting observations (22-24). In a series of experiments at the University of Pittsburgh on the digestibility of some high melting shortenings, comparisons were made between two different types of experimental subjects, adult humans and albino rats (1, 2).

**Correlation Between Different Types of Experimental Subjects**

It appears to have been more or less tacitly assumed throughout all these investigations that the coefficient of digestibility found for a fat with any given experimental subject could be used to predict the digestibility of that fat in any other type of experimental subject. However, no attempt has ever been made to establish this assumption statistically. In order to make such a correlation we have assembled the data found in the literature, and in Table I are shown the data for those fats whose digestibilities have been reported in two or more types of experimental subjects. Certain trends may be observed by inspection of the table, but the variations introduced by inherent experimental errors introduce a confusion which prevents an accurate assessment of the relationship by this crude means. For that reason we have plotted the data for the two groups of subjects which have been used most extensively, adult humans and albino rats, in Figure 1. Now the true correlation becomes more apparent. The coefficient of correlation, calculated by the equation:

$$r = \frac{\sum X_1 X_2}{\sqrt{(\sum X_1^2)(\sum X_2^2)}}$$

is + 0.76, which is a relatively strong positive correlation for biological work of this nature. It becomes especially significant in view of the fact that the data used were collected in a number of different laboratories by a variety of techniques, which rules out the usual consistency of error.

For a better visual appreciation of the significance of the r value, the regression of each digestibility on the other has been calculated and the curves obtained are shown in the figure. If there were no correlation at all, the two lines would be perpendicular; perfect correlation results in coincident curves (26). It is evident that the two curves more closely approach the latter, indicating good correlation. Thus it may be concluded that the coefficients of digestibilities of fats found for albino rats may be used to predict the digestibilities of these fats in adult humans, and vice versa. In other words, if two fats are equally digestible in rats, they are probably equally digestible in humans; and if fat A is more digestible than fat B in the one group, it will probably be more digestible in the other. There is no apparent reason why this conclusion cannot be extended to include other experimental subjects.

**Factors Affecting the Digestibility of Fats**

In all the literature to date it has been shown that fats as a class are well digested by any of the experimental subjects, the majority being more than 90% assimilated. Various characteristics of fats have been proposed as the factor which causes the variations which do exist. Without reciting the whole list, we will refer here only to the two which have been most often suggested. In the early work of Langworthy, Holmes, and Deuel it was repeatedly concluded (5, 14, 15) that an inverse relationship existed between the digestibility of fats and their melting points. To quote from one of their later papers which was a review of their work to that time (15), “the observed data seem to warrant the conclusion that the thoroughness of digestion is inversely proportional to the melting point.”

The above hypothesis has persisted and still is occasionally referred to even though there have been numerous publications in the literature which suggested that the inverse proportionality which apparently exists with melting point is coincidental and not an evidence of true causal relationship. Thus, as early as 1917 Lyman (3) suggested “that the melting point of the ester is not the only factor, probably not the chief factor, determining the rate of hydrolysis and absorption.” He suggested “that the nature of the fatty acid radical of an ester has an effect on digestibility aside from its effect upon the melting point of the compound.” From their work on the digestibility of animal and vegetable fats in albino rats Hoagland and Snider (20) observed that “it is apparent that some factor other than the melting point determined the relative digestibility of these fats, possibly their stearic acid content.” It has been shown by Mattil and Higgins (25) that stearic acid is almost entirely undigested by albino rats when fed as tristearin mixed with triolein, and only slightly more digestible when fed in the mixed glycerides distearo-mono51ein and dioleomonostearin. This same effect of tristearin has been reported by Hoagland and Snider (21), who found its digestibility to be of the order of 6 to 8%, while tripalmitin was 82 to 84% and trimyristin and trilaurin completely assimilated by albino rats.

From experiments with human infants Holt and Tidwell and their collaborators (22-24) concluded that “no single factor in the composition of a fat can be taken as an index of retention; the composition of the whole must be considered. Individual fatty acids are selectively absorbed when a mixed fat is fed.” They calculated the following digestibilities for the various fatty acids in normal fat mixtures:

- Unsaturated acids................................. 98%
- Short chain saturated............................ 90%
- Palmitic............................................. 88%
- Stearie............................................... 60%
- Longer than stearic.............................. 40%