A Note on Some Physical Properties of the Animal Tallows and Their Glyceride Composition

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ON the basis of the values obtained by the acetone-permanganate oxidation method of determining the GS_3 according to Hilditch and Lea (1), Hilditch and collaborators (2a,2b,2c) suggested that the GS_3 contents of the animal tallows are approximately the same as the chance values. On the basis of crystallization studies Hilditch and collaborators (3a,3b,3c,3d) suggested that the non-GS_3 glycerides in the animal tallows consisted of GS_2U and GSU_2 since little or no GU_3 was indicated to be present in these fats by the minimum limits. Longenecker (4) has suggested on the basis of the above GS_3 values recorded by Hilditch and collaborators that the animal tallows are distributed entirely by chance.

Bailey (5) found that the micro-penetration values of certain lards and beef tallows at 70°F. to 90°F. showed an increase on interesterification. Since the melting points, micro-penetration values, and other physical properties of hog and beef fats were considerably altered (increased in the first two cases) by interesterification, he concluded that in animal tallows there are considerable deviations from the pattern of glyceride distribution suggested by Hilditch and collaborators and by Longenecker. According to Longenecker's suggestions (loc. cit.), no difference in physical properties can result on interesterification since the fat is already distributed by chance. The micropenetration values at 70° F. to 100°F. will depend upon the GS_3 plus GS_2U value for the fat since the GSU_2 and GU_3 components melt below about 70°F. Further slightly increased or decreased GS_3 plus GS_2U values will have considerable effect on the micropenetration values at 70° F. to 100°F. since the marked solubility of the GS_2U in the GSU_2 plus GU_3 substrate will be an important factor in determining the magnitude of these values over this temperature range. According to the results of Hilditch and collaborators (loc. cit.), the GS_3 plus GS_2U value for the animal tallows should show an increase on interesterification since whereas the GS_3 will remain unchanged in amount, the proportions of GU_3 will be raised to the chance values, and this would simultaneously produce an increase in the amount of GS_2U as well. The melting points should hence remain unchanged while the micropenetration values should show a decrease over the temperature range of 70°F. to 90°F. Bailey found however that on interesterification both the melting points and micropenetration values increased.

Riemenschneider, Luddy, Swain, and Ault (6) determined the glyceride composition of a lard and a tallow by fractional crystallization and found that the GS_3 contents actually were markedly smaller than the chance values. This gives an explanation for the increase in melting points observed on interesterification for then the GS_3 values on which the melting points of the tallows depend will increase to the chance values during the process. However Riemenschneider and collaborators found GS_3 plus GS_2U values of 27.6 and 61.0, respectively, for the lard and tallow whereas the chance values for this factor are 31.5 and 61.7, respectively. According to these results (which are calculated on the minimum limits for the GS_2U in these fats) the GS_3 plus GS_2U values would increase on interesterification. Hence the fats should show a decrease in the micropenetration values at 70°F. to 90°F. as against the increase actually recorded by Bailey.

The writer has determined the GS_3 contents of a number of animal depot fats by the crystallization method. He thus obtained (7a), for a duck fat, and Australian ox depot, Indian ox depot, and Indian goat depot fats, actual GS_3 values of 2, 16, 17, and 22 mol. per cent, respectively, against the chance values of 3, 23, 25, and 33%, respectively, thus confirming the findings of Riemenschneider and collaborators that the GS_3 contents of animal tallows tend to be lower than that required by chance.

The writer has further determined (7a) the composition of the non-GS_3 glycerides in these tallows by a new standardized method of determining the GS_2U as GS_2A (7b), which eliminates the uncertainties and errors involved in the ordinary fractional crystallization methods. It was found that the amounts of GS_2U in these fats were considerably in excess of the amounts required under chance distribution and that the excess of the actual GS_2U values over the chance values was between 1.7 and 1.9 times the difference between the actual GS_3 values and the GS_3 chance values, as is true of all the other natural fats examined by him. Further, the proportions of the different non-GS_3 glyceride types in these tallows were practically the same as were calculated from the GS_3 and saturated acid contents according to the new rule of glyceride type distribution in the natural fats discovered by the author (7c).

In this respect the tallows behave like all other natural fats, for example cottonseed oil and cocoa butter (7c). According to these calculations, the GS_3 plus GS_2U values for the Australian ox depot, Indian ox depot, and Indian goat depot fats are 71, 75, and 85 mol. per cent, respectively, whereas the GS_3 plus GS_2U values required according to chance are 66, 69, and 77%, respectively. The tallows hence will show on interesterification GS_3 plus GS_2U values decreased by 5, 6, and 8%, respectively, from their original values. This is because of the fact that though the GS_3 values will increase to chance requirements, the GS_2U values will decrease by an amount 1.7 to 1.9 times the increase in the GS_3 values. Since, as already mentioned, the micropenetration values at 70°F. to 90°F. depend upon the GS_3 plus GS_2U values, the above decreased value for this factor which is produced on interesterification, will result in increased micropenetration values in accord with the observations of Bailey.

Summary

The results of Bailey on the alterations produced by interesterification in the melting points and micropenetration values at 70°F. to 90°F. of various animal tallows cannot be explained on the basis of the

glyceride composition of the tallows, as suggested by Hilditch and collaborators or by Longenecker. The increased melting points produced on interesterification are explained on the basis of the GS_3 contents of these fats as determined by Riemenschneider and collaborators. Both the increased melting points and increased micropenetration values are shown to be readily explainable on the basis of the glyceride type composition assigned to these tallows by the writer.

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Detergency Evaluation. III. Adjustment of Terg-O-Tometer and Launderometer Wash Test Methods to Produce Comparable Soil Removal Data

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PART I (1) of this series was concerned with the evaluation of several wash test methods, using one standardly soiled test fabric. Part II (2) of the series described the results obtained, using three standardized wash test methods with four different soiled test fabrics. The present paper presents the results obtained in an attempt to adjust the Terg-O-Tometer wash method to provide soil removal data and detergent comparison results equivalent to the Launderometer wash method using four 10-minute washes.

Bacon and Smith (3) demonstrated that one of the major factors in the removal of soil was the amount of mechanical work applied during the washing operation. Their work was done in the Launderometer, varying the energy applied by changing the number of stainless steel balls used with the wash load. The soil removal characteristics were shown to be directly proportional to the amount of mechanical work done.

The work to be reported here has a very practical application because many laboratories use the Launderometer while others use one or another of the machines recently designed to overcome certain specific shortcomings of those previously used. These machines were developed to simulate either actual washing principles, as with the Terg-O-Tometer, or to provide highly variable but controllable application of energy to the washing operation.

In most cooperative efforts to evaluate soiled fabrics or detergents much variation has been encountered in spite of effort to control all variables. This is attributed to a considerable extent to variation in technique. Part II of this series indicated that the Terg-O-Tometer might prove more valuable for interlaboratory testing because the technique involved is much less complicated than for the Launderometer methods.

The present work was undertaken as an attempt to develop a wash test method using the Terg-O-Tometer, which would essentially reproduce the degree of soil removal obtained by our Launderometer method, provide the same statistical comparison between detergents, reduce the amount of time required for the test in comparison with the Launderometer, and provide more data in the way of a larger number of replicate samples for improved test reproducibility.

Soiled Test Fabric

The soiled test fabric used was a carefully standardized product already described in detail (4). Briefly, standardization constituted maintenance of soil removal characteristics under specified wash test conditions using a standard detergent. Batches of soil were chosen which fall within narrower limits than those generally established for the statistical control limits.

Wash Test Methods

Launderometer. Four 10-minute washes. This method was described in considerable detail in Part I of these papers. Briefly it utilized the Launderometer, multiple washes (four, of 10 minutes each), 100 ml. of fresh solution for each wash, 10 rubber balls per jar, and two hand rinses.

Terg-O-Tometer Method. This method consisted of single washes of varying duration. The wash test load was adjusted to either 30 or 60 g. per liter, using 500 ml. of detergent solution. The load consisted of 5 swatches of standardized soil, 4″ x 6″ in size, trimmed to provide the required weight of fabric to volume of solution. After the wash of either 3, 5, 10, 20, or 40 minutes' duration, the swatches for any detergent in question were piled one on top of the other and wrung once through a hand wringer. They were then rinsed in water of the same hardness in the Terg-O-Tometer for five minutes (or 2 minutes with the 3-minute wash) at the same temperature as the wash, and then again wrung through the hand wringer, placed on an aluminum drying plate in a flat position, and oven dried.

The cycle rate was maintained as in previous tests at 144 per minute. The angle of rotation of the agitators was maintained as before at 345-350°.

Wash Test Conditions.

Water hardness—50 ppm.
Detergent solution—0.2%
Temperature—140°F.

(Previous tests were conducted at 120°F., which has important bearing upon soil removal.)

Detergents. The detergents used in these tests were the same as for Parts I and II:

1. Built nonionic
2. Built alkylaryl sulfonate
3. Pure soap
4. Loralkyl sulfate