Those emulsions which resisted breakage (growth of particle size to in excess of 7 microns in diameter) by shaking for less than 1 hr. had but little excess of lipophilic content over the minimum requirement. As the lipophilic content increased and therefore the L/H ratio, as in emulsions 13–16, the resistance to particle size growth also increased. A further increase of the L/H ratio to above 1, as in emulsions 45 and 46, greatly increased the stability to shaking. It would appear that the content of lipophilic groups and the L/H ratio must be high in order to obtain shaking stability and that the hydrophilic content is not a primary consideration for imparting this property.

The conclusion reached is that with a given system of emulsifiers a definite minimum content of both lipophilic and hydrophilic groups is necessary for heat stability of emulsions. The content of such groups seems to be an additive total of the weight percentage of lipophilic and hydrophilic groups furnished by the individual emulsifying agents. By making a choice of suitable emulsifiers and determining the weight percentage of lipophilic and hydrophilic groups which will be furnished by each emulsifier, the amount of emulsifiers needed to prepare fat emulsions which are stable to heat and which resist breakage by mechanical shock can be calculated.

Summary

When a given system of emulsifiers of known compositions and molecular weights was employed, it was found that in order for fat emulsions of 15% oil content to be stable to the heat required for sterilization, the emulsifiers must meet definite requirements. Minimum weight percentage of total lipophilic groups should be 0.29%; minimum weight percentage of total hydrophilic groups should be 0.57%; the polyoxyethylene groups of emulsifiers containing such groups should account for at least 70% of the mole weight of these emulsifiers; the lipophilic/hydrophilic ratio should be about 0.5. The minimum content of lipophilic and hydrophilic groups was found to be an additive total of these groups as provided by the complete emulsifying system whether composed of individual or multiple emulsifying agents and whether of similar or dissimilar functional groups.

With the emulsifiers used, an acyl group greater in length than 12 carbon atoms was found to be necessary to prepare cottonseed oil emulsions which were stable to heat.

Resistance of emulsions to breakage by mechanical shock was imparted by a rather large amount of lipophilic groups, so that the lipophilic/hydrophilic ratio was 1 or over.

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Report of the Smalley Committee, 1957-58

AGAIN THIS SEASON nine different types of samples were distributed by seven subcommittees. These included cottonseed, soybeans, peanuts, meal, vegetable oils, tallow and grease, glycerine, drying oils, and edible fats. In all, 4,497 samples were distributed to 516 collaborators, and approximately 16,000 results were tabulated. Table I shows the distribution and participation. There was a 23% increase in participation in 1957 over 1956 and a 5% increase in 1958 over the 1956-57 season. A detailed account of the expenses has been given to the Governing Board. In all cases a detailed report has been given to the collaborators, summarizing the work and listing the relative standing, based on our various grading systems. It is fitting to express our thanks to various subcommittee members for their contributions, especially to:

TABLE I

	Number of collaborators	Number of samples	Number of determinations per sample
Cottonseed	51	10	6
Soybeans	37	10	2
Peanuts	12	7	5
Meal	134	15	3
Vegetable oils	96	6	3
Tallow and grease	90	5	7
Glycerine	23	5	5–3
Drying oils	17	6	5
Edible fats	56	5	14

K. H. Fink, Armour and Company, for tabulating and mailing the tallow and grease results and calculating the final grades, also for assisting with the edible fat calculations;
F. R. Earle, Northern Regional Research Laboratory, for tabulating and mailing the soybean oil results;
C. L. Hoffpauir, Southern Regional Research Laboratory, for tabulating the cottonseed oil results;
R. A. Decker, Armour and Company, for calculating the final grades on the vegetable oils;
Oscar Wilkins, now of Barrow-Agee Laboratories, for preparing and shipping the vegetable oils and the tallow and grease samples;
Jack Rini, HumKo Company, for selecting the vegetable oil samples;
T. R. Bresnahan, Darling and Company, for selecting and shipping the bulk tallow and grease samples;
G. C. Henry, Law and Company, for handling the preparation and distribution of the edible fat samples;
W. J. Miller, Procter and Gamble, for the preparation and distribution of the edible fat samples;
Bart Teasdale, Canada Packers Ltd., for re-mailing the vegetable oil and tallow and grease samples in Canada.

Reasonably sound grading systems have been established in all the series, and certificates of proficiency will be presented this year in all categories. The Smalley awards presented this year were as follows:

Cottonseed. With 51 chemists participating, first place was given to P. D. Cretien, Texas Testing Laboratory, Dallas, Tex., with a grade of 99.70; second place to E. R. Hahn, Hahn Laboratories, Columbia, S. C., with 99.40; and honorable mention to A. H. Grimes, Barrow-Agee Laboratory, Decatur, Ala., with 98.08.

Soybean. With 37 chemists participating, first place went to J. G. Bowling, Woodson-Tenent Laboratory, Des Moines, Ia., with a grade of 100; second place to Mr. Hahn, with 99.40; and honorable mention to E. H. Tenent Jr., Woodson-Tenent Laboratory Memphis, with 99.10.

Peanut. Twelve chemists participated, and first place was won by T. C. Law, Law and Company, Atlanta, Ga., with 100; second place by Steven Prevost, Law and Company, Wilmington, N. C.; and honorable mention by P. C. Whittier, Law and Company, Montgomery, Ala., with 99.20.

Tallow and Grease. Of the 90 collaborators, first place went to E. R. Dube, Swift and Company, Jersey City, N. J., with 99.77; second place to R. L. Goode, Colgate-Palmolive Company, Jeffersonville, Ind., with 99.73; and honorable mention to Harold Beard, Armour and Company, Spokane, Wash., with 99.50.

Vegetable Oils. With 96 collaborators, first place went to F. M. Tindall, HumKo Company, Memphis, Tenn., with 99.3; second place to T. S. McDonald, Procter and Gamble, Dallas, Tex., with 98.7; honorable mention to W. F. Beedle, George W. Gooch Laboratory, Los Angeles, and to J. J. Ganucheau, Wesson Oil and Snowdrift Company Inc., Gretna, La., with grades of 98.3.

Edible Fats. Out of 56 collaborators in the edible fats series, first place was given to F. A. Adams, Procter and Gamble, Long Beach, Calif., with 99.03; second to R. A. Marmor, Pillsbury Mills Inc., Minneapolis, with 98.03; and honorable mention to William Stewart, Swift and Company, Atlanta, with 96.78.

Glycerine. First place among 23 collaborators was given to J. H. Dietz, Harshaw Chemical Company, Gloucester City, N. J., with a point score of 305; second to R. O. Fosmire, Procter and Gamble, Kansas City, Kans., with 291.5 points; and honorable mention to C. P. Morrison, Procter and Gamble, Staten Island, with 267.

Drying Oils. Seventeen chemists participated; first place went to K. E. Holt, Archer-Daniels-Midland Company, Minneapolis, with a grade of 96.00; second to J. E. Schlupp, National Lead Company, Philadelphia, with 93.75.

Meal. This, the largest and the original Smalley series, had 134 chemists participating. On the determination of moisture two were tied for first place: Mr. Whittier, Law and Company; and J. K. Sikes, Plains Cooperative Oil Mill, Lubbock, Tex., with a score of 100 each.

On the determination of oil first place was attained by Biffle Owen, Planters Manufacturing Company, Clarksdale, Miss., with 99.60. Two were tied for second place with grades of 99.40. A recalculation, using no tolerance, broke the tie, and the second place certificate was given to M. P. Etheredge, state chemist, Mississippi State College, State College; Honorable mention was given to A. G. Thompson Jr., Wesson Oil and Snowdrift Company Inc., Columbia, S. C.

On the determination of nitrogen first place was given to George Dickinson, Texas Testing Laboratory, El Paso, Tex., with 100; second to Mr. Hutton, with 99.60.

Smalley Cup. The winner this year is Mr. Thompson, with a grade of 99.40. This is the third time Mr. Thompson has won the cup: 1939-40, 1948-49, and 1957-58. He thus acquires permanent possession of the cup, which was donated to the Society several years ago by Mr. Cretien. Second place was given to Mr. Hutton, with a grade of 99.32; honorable mention to Mr. Hahn with a grade of 99.24.

R. T. DOUGHTIE JR. D. L. HENRY
LLOYD ANDERSON R. J. HOULE
D. V. STINGLEY J. P. HEWLETT
R. W. BATES, chairman

Composition and Control of Potato Chip Frying Oils in Continuing Commercial Use[1]

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A RECENT PAPER (1) included a critical review of the literature on the safety of frying oils. The change in iodine value was proposed as a simple method for determining whether thermal polymers may have formed in the heated oils used in a given industry. Results of such a survey were reported (1) for oils used in the potato chip industry. There was an average decrease of 1% in the iodine value of the oils in commercial use. Based upon the reports by Crampton and associates (2, 3), it was concluded that absence of linolenic acid in frying oils precluded the presence of toxic cyclized monomeric acids (1). Cyclized monomers from linoleate are produced with great difficulty (4), requiring temperatures of 554°F. and above (more than 100°F. above the smoke point of frying oils). Under such drastic conditions, disproportionation or even rupture of carbon to carbon bonds may occur (4).

Thus the only polymers which could be formed in the frying oils were of the nonabsorbable type and at most could only interfere with the digestibility of the oil. It was also noted that a drop of about 5% in iodine value (5, 6) is required before there is a measurable decrease in the Coefficient of Digestibility. Growth, reproduction, lactation, and longevity are not impaired when cottonseed oil is heat-polymerized to effect a drop of 5% in iodine value (6). Hence it was concluded that any change in digestibility attributable to an iodine value drop of about 1% found in the survey (1) is insignificant. This conclusion is conservative since it presupposes that the very small drop noted in the survey of frying oils in commercial use may have actually been due to polymer formation. Such is not the case, as will be demonstrated by the data presented in this report.

Polymerized Oils Prepared in the Laboratory

In order to delineate the question of polymer development in frying oils the data shown in Table I are presented. Cottonseed oil was heated at 600°F. with carbon dioxide bubbling through the oil until there was a drop of about 5 in iodine value. Crampton and associates (2, 3) employed comparable conditions in producing oils containing thermal polymers of the nonoxidative type. The same oil was also air blown at the same temperature to effect a comparable drop. The following method was employed to obtain the polymerization changes.

[1] Much of the material in this paper and in one recently published (1) was presented at the 48th Annual Meeting of the American Oil Chemists' Society in the Symposium on "Fats in Nutrition and Health," New Orleans, La., April 30, 1957.