# The Examination of Mixtures of Coconut Oil and Palm Kernel Oil and the Determination of Butter Fat in Margarine*

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SOMEWHAT recently the present authors in a paper dealing with the Reichert-Polenske figures of mixtures of palm kernel oil and other fats (*Analyst*, 1926, 51, 72) pointed out that the relationship between the Reichert and Polenske values of a mixture of fats might give useful assistance in distinguishing between coconut and palm kernel oils, and even within certain limits give some indication as to the relative amount of the two fats present. This suggestion has now been followed up, and the Reichert and Polenske values have been determined for a complete range of mixtures of these two oils. The

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TABLE I.

REICHERT AND POLENSKE VALUES OF COCONUT AND PALM KERNEL OILS.

| Palm-kernel oil per cent | Process. | Percentage of Coconut Oil. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 0 | Reichert | 0.6 | 2.0 | 3.3 | 4.4 | 5.2 | 5.7 | 6.3 | 6.6 | 6.9 | 7.2 | 7.4 |
| | Polenske | 0.4 | 1.4 | 2.3 | 3.5 | 5.1 | 6.8 | 9.4 | 11.8 | 13.8 | 15.2 | 16.8 |
| 10 | Reichert | 1.2 | 2.5 | 3.6 | 4.7 | 5.5 | 6.1 | 6.5 | 6.8 | 7.0 | 7.3 | ... |
| | Polenske | 1.2 | 2.1 | 3.6 | 4.8 | 6.5 | 8.4 | 10.6 | 12.4 | 14.6 | 16.6 | ... |
| 20 | Reichert | 1.8 | 3.3 | 4.2 | 5.0 | 5.7 | 6.3 | 6.6 | 6.9 | 7.2 | ... | ... |
| | Polenske | 1.7 | 2.6 | 4.4 | 5.4 | 7.6 | 9.6 | 11.5 | 13.3 | 15.4 | ... | ... |
| 30 | Reichert | 2.2 | 3.7 | 4.7 | 5.2 | 5.9 | 6.5 | 6.7 | 7.0 | ... | ... | ... |
| | Polenske | 2.5 | 3.6 | 5.1 | 7.2 | 8.8 | 10.3 | 12.5 | 14.4 | ... | ... | ... |
| 40 | Reichert | 2.6 | 4.0 | 5.0 | 5.5 | 6.2 | 6.6 | 6.8 | ... | ... | ... | ... |
| | Polenske | 3.2 | 5.1 | 6.8 | 8.4 | 9.5 | 11.8 | 14.0 | ... | ... | ... | ... |
| 50 | Reichert | 3.1 | 4.4 | 5.3 | 5.8 | 6.4 | 6.7 | ... | ... | ... | ... | ... |
| | Polenske | 4.3 | 6.0 | 8.0 | 9.3 | 11.2 | 13.0 | ... | ... | ... | ... | ... |
| 60 | Reichert | 3.5 | 4.8 | 5.6 | 6.1 | 6.6 | ... | ... | ... | ... | ... | ... |
| | Polenske | 5.6 | 7.6 | 9.1 | 10.8 | 12.6 | ... | ... | ... | ... | ... | ... |
| 70 | Reichert | 3.9 | 5.2 | 5.9 | 6.3 | ... | ... | ... | ... | ... | ... | ... |
| | Polenske | 6.2 | 8.5 | 9.7 | 12.3 | ... | ... | ... | ... | ... | ... | ... |
| 80 | Reichert | 4.3 | 5.5 | 6.1 | ... | ... | ... | ... | ... | ... | ... | ... |
| | Polenske | 7.4 | 9.5 | 11.5 | ... | ... | ... | ... | ... | ... | ... | ... |
| 90 | Reichert | 4.7 | 5.6 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | Polenske | 8.6 | 10.6 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 100 | Reichert | 4.8 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | Polenske | 9.7 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

results obtained are given in Table I.

It has not been thought necessary to determine the Kirschner value in each case, for the previous papers (*Analyst*, 1925, 50, 53; 1926, 51, 72) showed, as was indeed previously known, that there is a very definite mathematical relationship between this figure and the amount of coconut and/or palm kernel oil present. For the same reasons mixtures containing butter fat have not been studied, as in this case also the Kirschner value is a linear function of the amount of butter fat present, whilst the effect of the presence of butter fat on the Reichert and Polenske values may be allowed for by finding the approximate percentage of butter from the Kirschner value (in conjunction with the Polenske value) and subtracting the calculated Reichert and Polenske values due to this amount of butter from the observed figures, the result giving the Reichert and Polenske values due to the coconut and palm kernel oils present, together with, of course, the small amount due to any neutral fats.

Although this may seem rather complicated, it is really quite

TABLE II.

DETERMINATION OF BUTTER FAT IN MARGARINE

| | Butter Fat Per Cent | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Polenske | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 | 1.0 |
| Kirschner | 0.2 | 0.5 | 0.7 | 1.0 | 1.2 | 1.5 | 1.7 | 2.0 | 2.2 | 2.5 | 2.7 |
| Polenske | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.3 | 1.4 | 1.4 | 1.5 | 1.5 | 1.6 |
| Kirschner | 0.3 | 0.6 | 0.8 | 1.1 | 1.3 | 1.6 | 1.8 | 2.1 | 2.3 | 2.6 | 2.8 |
| Polenske | 2.0 | 2.1 | 2.1 | 2.2 | 2.2 | 2.3 | 2.4 | 2.4 | 2.5 | 2.5 | 2.6 |
| Kirschner | 0.5 | 0.8 | 1.0 | 1.3 | 1.5 | 1.8 | 2.0 | 2.3 | 2.5 | 2.8 | 3.0 |
| Polenske | 3.0 | 3.1 | 3.1 | 3.2 | 3.2 | 3.3 | 3.4 | 3.4 | 3.5 | 3.5 | 3.6 |
| Kirschner | 0.7 | 1.0 | 1.2 | 1.5 | 1.7 | 2.0 | 2.2 | 2.5 | 2.7 | 3.0 | 3.2 |
| Polenske | 4.0 | 4.1 | 4.1 | 4.2 | 4.2 | 4.3 | 4.4 | 4.4 | 4.5 | 4.5 | 4.6 |
| Kirschner | 0.8 | 1.1 | 1.3 | 1.6 | 1.8 | 2.1 | 2.3 | 2.6 | 2.8 | 3.1 | 3.3 |
| Polenske | 5.0 | 5.1 | 5.1 | 5.2 | 5.2 | 5.3 | 5.4 | 5.4 | 5.5 | 5.5 | 5.6 |
| Kirschner | 0.9 | 1.2 | 1.4 | 1.7 | 1.9 | 2.2 | 2.4 | 2.7 | 2.9 | 3.2 | 3.4 |
| Polenske | 6.0 | 6.1 | 6.1 | 6.2 | 6.2 | 6.3 | 6.4 | 6.4 | 6.5 | 6.5 | 6.6 |
| Kirschner | 1.0 | 1.3 | 1.5 | 1.8 | 2.0 | 2.3 | 2.5 | 2.8 | 3.0 | 3.3 | 3.5 |
| Polenske | 8.0 | 8.1 | 8.1 | 8.2 | 8.2 | 8.3 | 8.4 | 8.4 | 8.5 | 8.5 | 8.6 |
| Kirschner | 1.1 | 1.4 | 1.6 | 1.9 | 2.1 | 2.4 | 2.6 | 2.9 | 3.1 | 3.4 | 3.6 |
| Polenske | 10.0 | 10.1 | 10.1 | 10.2 | 10.2 | 10.3 | 10.4 | 10.4 | 10.5 | 10.5 | 10.6 |
| Kirschner | 1.2 | 1.5 | 1.7 | 2.0 | 2.2 | 2.5 | 2.7 | 3.0 | 3.2 | 3.5 | 3.7 |
| Polenske | 12.0 | 12.1 | 12.1 | 12.2 | 12.2 | 12.3 | 12.4 | 12.4 | 12.5 | 12.5 | 12.6 |
| Kirschner | 1.3 | 1.6 | 1.8 | 2.1 | 2.3 | 2.6 | 2.8 | 3.1 | 3.3 | 3.6 | 3.8 |
| Polenske | 14.0 | 14.1 | 14.1 | 14.2 | 14.2 | 14.3 | 14.4 | 14.4 | 14.5 | 14.5 | 14.6 |
| Kirschner | 1.4 | 1.7 | 1.9 | 2.2 | 2.4 | 2.7 | 2.9 | 3.2 | 3.4 | 3.7 | 3.9 |
| Polenske | 15.5 | 15.6 | 15.6 | 15.7 | 15.7 | 15.8 | 15.9 | 15.9 | 16.0 | 16.0 | 16.1 |
| Kirschner | 1.5 | 1.8 | 2.0 | 2.3 | 2.5 | 2.8 | 3.0 | 3.3 | 3.5 | 3.8 | 4.0 |

simple; an example may make it clearer. A sample of margarine is found to have Reichert value 6.2; Polenske value, 5.3; Kirschner value, 2.5; it is required to find its composition. From Table III (*Analyst*, 1925, 50, 57) or Table I (*Analyst*, 1926, 51, 73) it is seen that a fat having a Kirschner value of 2.5 with a Polenske value of 6.2 contains 6 per cent of butter fat. The Reichert value due to 6 per cent of butter fat is 1.5, whilst the Polenske value is 0.2. Subtracting these figures from the experimental results obtained for the sample of fat in question, we get 4.7 and 5.1 as the Reichert and Polenske figures, respectively, of the sum of the coconut, palm kernel and neutral oils present in the mixture. The proportion of coconut and palm kernel oils is then obtained from Table I as described below, and is found to be coconut oil 20 per cent; palm kernel oil 30 per cent.

In order that the process of finding the approximate percentage of butter fat present in a mixture may be made as easy as possible, Table II has been compiled.

This table, which is more or less ideal, is a composite one which has been developed from graphs from the tables given in the two papers to which reference has already been made. Its mode of use will be fairly obvious. When the Polenske and Kirschner values of a fat are known, the horizontal lines in the table are examined until the two figures are found; the figure at the top of the vertical column will indicate the amount of butter fat in the mixture. For example, in the case of a given mixture of fats the Polenske and Kirschner values were 5.6 and 2.5 respectively. The two nearest figures to these are 5.4 and 2.4, from which the interpolated value for the percentage of butter fat is 6.3; the actual proportion added was 6.0 per cent.

An examination of Table I will show that the Reichert value due to palm kernel oil alone (mixed, of course, with neutral fat in varying proportions) is in all cases numerically less than the Polenske value, whilst in the case of coconut oil alone the Reichert value is the greater until about 40 per cent of coconut oil is present. The table has been subjected to critical examination by H. D. Richmond, to whom the authors are greatly indebted. Mr. Richmond writes as follows: "I think the most that can be expected from your results are, first, it is possible to distinguish coconut oil and palm kernel oil; second, that when the two exist in the same mixture and the percentage of coconut oil is well under 50 per cent, an approximate idea of the relative proportions of the two oils can be deduced within about 15 or 20 per cent either way."

It should be emphasized that the accuracy of the process depends upon the factors of the oils—chiefly of the butter-fat—which have been used in the mixtures, and also that different mixtures of coconut and palm kernel oil may give identical results, as will be seen from an inspection of the table.

In such cases, therefore, the composition of the coconut oil class part of the oil should be checked by one of the recognized methods, that of Shrewsbury and Knapp (*Analyst*, 1910, 35, 385), which gives the total amount of such oil, being particularly suitable. Other processes are those of Burnett and Revis (*Ibid.*, 1913, 38, 255) and Stokoe (*J. Soc. Chem. Ind.*, 1921, 40, 57T). It is highly desirable that when the composition of a

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