THE DIFFERENTIATION BETWEEN POOR AND ADULTERATED MILK.

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LYTHGOE (*J. Ind. and Eng. Chem.*, 1914, **6**, 899), as the result of the examination of 600 to 700 samples of milk in the laboratory of the Massachusetts State Board of Health, proposes to distinguish between poor and adulterated milk by calculation of the percentage of milk sugar present in the sample, from the percentage of fat and the percentage of total solids. Starting with Olson's formula (*J. Ind. and Eng. Chem.*, 1909, **1**, 256) for the calculation of proteids from the total solids, $P = TS - TS/1{\cdot}34$; and with Van Slyke's formula (*J. Amer. Chem. Soc.*, 1908, **30**, 1166) for the calculation of the proteins from the fat, $P = 0{\cdot}4(F - 3) + 2{\cdot}8$, he has evolved the two following formulæ for the calculation of the milk sugar:

$$(a)\quad S = TS - [F + 0{\cdot}7 + (TS - TS/1{\cdot}34)]$$
$$(b)\quad S = TS - [F + 0{\cdot}7 + \{0{\cdot}4(F - 3)\} + 2{\cdot}8]$$

and it is suggested that "the value of S obtained by both formulæ is nearly the same when the milk is pure, and varies from 4·5 to 5 per cent.; in skimmed or watered milks the values disagree, and are above 5 in the former and below 4 in the latter."

If this fact can be established, the Public Analyst will at last be in a position to rebut easily that familiar and ever-recurring defence, "the sample was sold exactly as it came from the cow." With a view to testing the statement, 100 samples, received for analysis under the Sale of Food and Drugs Acts and reported upon as genuine, were chosen at random from a large number of samples, and the values of S for both formulæ were calculated.

The greatest difference between S (*a*) and S (*b*) was 0·61.

The smallest difference between S (*a*) and S (*b*) was 0·01.

Percentage of samples showing a difference less than 0·1 ...	39
" " " between 0·1 and 0·15 ...	25
" " " " 0·16 and 0·20 ...	21
" " " " 0·21 and 0·25 ...	6
" " " " 0·26 and 0·30 ...	5
" " " " 0·31 and 0·35 ...	3
" " " " 0·36 and 0·40 ...	Nil
" " " " 0·41 and 0·45 ...	Nil
" " " over 0·45 ...	1

Number of samples giving a value for S (*a*) under 4·0 ... ... Nil
" " " between 4·0 and 5·0 58
" " " over 5·0 42
" " " of S (*b*) under 4·0 ... ... Nil
" " " between 4·0 and 5·0 39
" " " over 5·0 61

The following six samples show a value for both S (*a*) and S (*b*) above 5·0, and, therefore, on the formulæ are skimmed:

Fat.	Solids-not-Fat.	S (*a*).	S (*b*).
4·2	9·55	5·36	5·57
4·1	9·40	5·27	5·46
4·0	9·29	5·22	5·39
3·9	9·26	5·22	5·40
3·8	9·23	5·22	5·41
3·7	10·84	6·45	7·06

It is obviously possible for a genuine milk to show a large difference, as it could not be argued, with any hope of success, that any of the above samples had been adulterated. On the basis that samples giving a value above 5·0 are skimmed, and below 4·0 are watered, at least 42 per cent. of the samples which complied with the Board of Agriculture standard had been deprived of a portion of their fat.

The values of S (*a*) and S (*b*) were then calculated on 100 samples, received for analysis and chosen at random, which did not comply with the Board of Agriculture standard and were reported upon as adulterated, with the following results:

The greatest difference between S (*a*) and S (*b*) was 0·54.
The smallest difference between S (*a*) and S (*b*) was 0·01.

Percentage of samples showing a difference less than 0·1 15
" " " between 0·1 and 0·15 ... 13
" " " " 0·16 and 0·20 ... 12
" " " " 0·21 and 0·25 ... 11
" " " " 0·26 and 0·30 ... 22
" " " " 0·31 and 0·35 ... 12
" " " " 0·36 and 0·40 ... 9
" " " " 0·41 and 0·45 ... 5
" " " over 0·45 1

Number of samples giving a value of S (*a*) under 4·0 5
" " " between 4·0 and 5·0 32
" " " over 5·0 63
" " " of S (*b*) under 4·0 11
" " " between 4·0 and 5·0 22
" " " over 5·0 67

The following six samples show a value for both S (*a*) and S (*b*) falling between and 4·0 5·0, and, therefore, according to the formulæ, are poor, but genuine samples

Fat.	Solids-not-Fat.	S (*a*).	S (*b*).
2·86	8·33	4·79	4·89
2·85	8·06	4·59	4·62
2·55	8·15	4·74	4·83
2·27	8·19	4·84	4·98
2·23	7·52	4·35	4·33
2·10	7·61	4·45	4·47

It is possible that there may be a little difficulty in persuading an English Public Analyst to realise that the above samples are "poor, but genuine." No less than 22 per cent. of the samples which failed to comply with the Board of Agriculture standard would, on these formulæ, have to be passed as genuine.

The values for S (*a*) and S (*b*) were then calculated on twenty samples of milk, which had admittedly been skimmed:

The greatest difference between S (*a*) and S (*b*) was 0·79.
The smallest difference between S (*a*) and S (*b*) was 0·03.
Percentage of samples showing a difference of less than 0·1 25
" " " between 0·1 and 0·15 ... 10
" " " " 0·16 and 0·20 ... 5
" " " " 0·21 and 0·25 ... 5
" " " " 0·26 and 0·30 ... 10
" " " " 0·31 and 0·35 ... 5
" " " " 0·36 and 0·40 ... 5
" " " " 0·41 and 0·45 ... 5
" " " over 0·45 30
Percentage of samples giving a value for S (*a*) under 4·0 25
" " " between 4·0 and 5·0 40
" " " over 5·0 35
" " " for S (*b*) under 4·0 30
" " " between 4·0 and 5·0 25
" " " over 5·0 45

The following five samples, although admittedly skimmed, show a value for both S (*a*) and S (*b*) between 4·0 and 5·0, and, therefore, according to the formulæ, are "poor, but genuine":

Fat.	Solids-not-Fat.	S (*a*).	S (*b*).
1·61	7·88	4·77	4·94
0·57	6·76	4·20	4·23
0·42	7·36	4·69	4·89
0·39	6·75	4·24	4·29
0·30	7·31	4·68	4·89

It would be ludicrous to describe any of the above samples as "poor, but genuine." No less than 25 per cent. of the samples of skimmed milk gave a value for both S (*a*) and S (*b*) falling between 4·0 and 5·0.

It is quite obvious that a sample which has been adulterated may give a value nearly the same for both S (*a*) and S (*b*), and also give a value falling between 4·0 and 5·0; the formulæ, therefore, show no advantage over the Board of Agriculture standard, especially if that standard is administered, as in due course it will be administered, under the provisions of The Milk and Dairies (Consolidation) Act, 1915.

Further, in this connection, attention may well be drawn to the now well-recognised formula, demonstrated by Richmond ("Dairy Chemistry," p. 152), that watered milk may easily be distinguished from abnormal milk by a consideration of the ratio of lactose, protein, ash. Richmond has shown that this ratio is extraordinarily exact, and that the average proportion is 13 : 9 : 2. He has determined the milk-sugar, protein, and ash on a large number of samples, and, by plotting the figures thus obtained against the average figures for solids-not-fat, has shown that well-defined breaks occur between 8·8 per cent. and 8·9 per cent. and between 8·4 per cent. and 8·5 per cent., thus demonstrating that a naturally abnormal milk may be distinguished from a watered milk by a marked departure from the ratio.

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