but the loss of tannin was such as not to warrant the adoption of the process for general use. It might, however, be applied in certain cases with satisfactory results. From the colorless filtrate the tannin should be removed by agitation with acetic ether, and the remainder of the general purification process then carried out.

MILK, SKIM MILK, AND WHEY; A STUDY OF THEIR COMPARATIVE COMPOSITION AND SPECIFIC GRAVITY.

BY C. B. COCHRAN, WEST CHESTER, PA.

THAT the specific gravity of a milk is dependent upon the composition of the milk and varies according to the per cent. of each constituent is generally admitted. Upon this fact is based Richmond's extended formula. Having given the specific gravity, total solids, and ash of a sample of milk it is possible to calculate by means of this formula the percentage of fat, proteids, and sugar.

The formula is as follows: $P = 2.8T + 2.5A - 3.33F - 0.7\frac{G}{D}$ (P = proteids; T = total solids; A = ash; F = fat; D = density, water at 60°F being taken as one; and $G = 1000D - 1000$) From this formula Richmond calculates that each gram of proteids in 100 cc. of milk raises the gravity 2.57°; or that the density of the proteids of milk in solution is 1.346.

Dr. Duprè has found by direct experiment that one per cent. of casein raises the specific gravity of milk 2.55°, or that the density of casein in solution is 1.34.

Mr. Hehner by a different method of investigation concludes that the specific gravity of casein in solution is 1.3106.

From this figure as its density in solution, we conclude that each per cent. of casein raises the gravity of milk 2.36°.

I have recently made a comparative study of the specific gravity and composition of milk and the whey obtained therefrom. One of my objects in this work was to obtain data for determining the effect of each per cent. of casein on the specific gravity of milk and the density of casein in solution.

The following table shows the results of my work:

	Specific gravity of milk.	Total solids of milk.	Solids not fat of milk.	Specific gravity of whey.	Total solids of whey.	Casein removed	Effect on specific gravity of one per cent. casein.	Density of casein in solution.	Effect on specific gravity of whey of one per cent. total solids.
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
1...................	1.035	9.27	9.13	1.028	6.62	2.51	2.83	1.394	4.23
2...................	1.035	9.27	9.13	1.0266	6.1	3.03	2.80	1.390	4.36
3...................	.....	....	...	1.0266	6.1	0.52	2.69	1.370	4.36
4...................	1.0291	14.05	8.35	1.0285	6.62	2.33	2.78	1.386	4.30
5...................	1.0291	7.71	7.61	1.0249	5.98	1.63	2.63	1.358	4.16
6...................	1.0338	8.91	8.71	1.0282	6.50	2.21	2.62	1.355	4.34

In order to avoid as far as possible the influence of the fat, separator skim milk was used in all those analyses that were made to furnish a basis for determining the effect of casein on specific gravity. In the calculation allowance was made for the effect of the small amount of fat still remaining in the skim milk.

The method of work was as follows: Having determined by analysis the total solids, fat, solids not fat, and specific gravity of a sample of skimmed milk a few drops of a strong solution of rennet, or acetic acid is added to about one pint of the milk in a flask which is then tightly corked and stood on a water bath until coagulation has occurred and a clear whey separated.

After thorough cooling the whey is filtered and if clear the total solids it contains and specific gravity determined. The difference between the total solids of the whey and the solids not fat of the skim milk is taken to represent the casein removed. Divide the difference in specific gravity between skim milk and whey by per cent. of casein removed and the quotient represents the loss of specific gravity due to removal of one per cent. casein. The density of casein in solution is now found by the formula $D - D' = \frac{1-x}{100x}$; D = specific gravity of whey; D' = specific gravity of skim milk, minus all fat; x = effect of one per cent. curd on density.

By this method of work the numbers in columns 7 and 8 were obtained. The average of these results shows that each per cent. of casein removed lowers the gravity of the solution 2.72 degrees; and that the density of the casein in solution is 1.376.

The solids coagulated by rennet freed from fat were found to contain 1.08 per cent. ash. All the remainder is regarded as casein or proteid matter. The disturbing influence produced by the removal of so small an amount of mineral matter with the casein would have only a very slight influence on the specific gravity. Moreover if this mineral matter is combined with the proteids as they exist in the milk it is proper that it should be considered as a part of the proteid matter in determining its density in solution.

The results obtained vary much more than I like to see. I am unable to explain the cause of the variation in the results here obtained. The specific gravity was obtained in all cases by weighing in a specific gravity flask furnished with side tube and cap. The solids were obtained by drying on asbestos fiber. The sugar of the residue from whey very easily caramelizes on drying, and for this reason it is more necessary to use an absorbent like asbestos for whey than for milk.

Having determined specific gravity and total solids of a large number of samples of whey, I conclude that when the coagulation is properly performed under similar conditious, the specific gravity, and total solids of whey of pure milk will vary within quite narrow limits. I find the specific gravity to be 1.027 or higher and in all but one case as low as 1.0285. The total solids vary between 6.5 per cent. and 6.9 per cent. If a sample of whey be reheated, further coagulation will take place. In this way the specific gravity of a whey was reduced from 1.028 to 1.0266.

A milk that had been allowed to decompose for a period of twenty days furnished a whey that had a specific gravity of 1.0255. The whey had an acidity corresponding to 0.76 per cent. of lactic acid. The lowering of the specific gravity was a natural result of the fermentation.

If the number representing the specific gravity of the whey above 1000 be divided by 4.25, the quotient represents fairly well the per cent. total solids contained in the whey. For example a whey of sp. gr. 1.028 will contain $28 \div 4.25 = 6.59$ per cent. total solids.

As might be expected I find the whey of any given milk has the same composition no matter whether it is taken from the original milk, the cream, or skim milk. This being the case a knowledge of the variation in specific gravity and composition of whey of pure milk may be of value in determining adulteration, especially when the milk comes into the hands of the analyst in a churned or soured condition. It is also equally valuable in testing cream for added water.

The following table illustrates the value of the whey test in this particular. It shows the specific gravity of the whey in comparison with the composition of milk and cream both in pure and watered samples:

Numbers.	Specific gravity.	Total solids.	Solids not fat.	Specific gravity of whey.	Total solids of whey.	
1	1.0307	14.32	8.78	1.028		A partially creamed sample of milk.
2	1.0315	12.05	8.55	1.027		Poor milk.
3	1.0273	10.90	7.50	1.023		Watered milk.
4	1.0204	12.05	6.15	1.0213		Watered cream.
5	1.0318	14.68	9.49	1.0255	5.89	Whey separated after milk had stood three weeks.
6	1.031	12.05	8.45	1.028	6.59	
7	1.0312	12.45	8.55	1.027	6.35	
8	1.032	12.90	8.80	1.0275	6.47	
9	1.0329	13.22	9.02	1.0273	6.42	
10..........	1.0324	12.98	8.88	1.0283	6.66	
11..........	1.0329	12.40	8.90	1.027	6.35	
12..........	1.0278	8.81	8.71	1.0234	5.50	Watered skim milk.

In closing this article I desire to call attention to Hehner and Richmond's original formula, which is expressed in a working form in Richmond's milk scale. Does this formula express the true relation existing between the fat, solids not fat, and specific gravity of a milk? Or is it possible to establish any such relation? So far as I know this formula has never met either the approval or disapproval of American chemists in any authoritative way. Chemists of repute oftentimes report very different results on what I believe are fair samples of the same milk. This difference is largely due to different methods of work, and as a consequence the results in one or both cases are incorrect.

I have had much experience with Richmond's milk scale, using it as a check in analytical work, and am very favorably impressed with its accuracy. If this formula or some other one should receive authoritative approval as a check in the analysis of normal milk it might assist in establishing the adoption of similar methods of analysis or at least in methods that gave concordant results, and would serve to correct faulty analyses.

In case the chemist obtains results not in accord with the formula which may be chosen let him regard it as necessary to investigate the cause of this disagreement.

Such a course would prevent loss of public confidence in milk analysis which at present is likely to occur.

IRIDIN, THE GLUCOSIDE OF THE IRIS ROOT.[1]

BY G. DE LAIRE AND FERD. TIEMANN.

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IN the dried rhizomes of iris florentina we have discovered a new glucoside of peculiar composition and remarkable properties. It is prepared as follows:

The alcoholic extract from ten kilos of powdered iris root is stirred with two liters of lukewarm water and one liter of a mixture of acetone and chloroform of 0.950 specific gravity.

If allowed to stand quietly the liquid separates into two layers, a lower aqueous solution of grape sugar, organic acids, coloring substances, etc., and an upper acetone-chloroform solution containing the substances of the alcoholic extract insoluble or only slightly soluble in water.

The glucoside extracted from the root by means of the alcohol swims in the dark-colored syrup in amorphous white masses. The two layers are separated by decantation, the white flakes collected on a filter, washed with a little hot water and dried at 100°. The white powder obtained in this way was washed with ether and light petroleum to free it from adhering impurities and crystallized from boiling dilute alcohol (one volume ninety per cent. alcohol to two volumes water). We call the substance obtained in this way

Iridin ($C_{24}H_{26}O_{13}$). It forms fine white needles which become yellow in moist air and melt at 208°. It dissolves scarcely at all in alcohol, somewhat more easily in acetone. At ordinary

[1] This paper was intended for the World's Congress of Chemists, but arrived too late for presentation.