THE ANALYST.

ON THE FATTY METAMORPHOSIS OF THE ALBUMINOIDS IN MILK AND CHEESE.

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Read before the Society of Public Analysts, on 20th February, 1878.

IN 1864, M. Ch. Blondeau contributed to the *Annales de Chimie et de Physique* (4eme Serie. t. 1) his research on the changes which the Roquefort cheese underwent probably from the influence of mycoderms.

A portion of a typical cheese was taken and divided into four parts; the first was analysed at once, the three others were replaced in cellars and analysed after one month, two months, and a year's respective sojourn.

(1.) The fresh cheese had the following composition :—

Caseine	...	...	...	...	...	...	81.03
Chloride of sodium	...	...	...	...	...	...	4.40
Fat	...	...	...	...	...	...	1.85
Lactic acid	...	...	...	...	...	...	0.88
Water	...	...	...	...	...	...	11.84

(2.) The piece which had remained in the cellars a month had all the appearance of a fatty body; its odour had changed, and its taste was sweet and agreeable. The analysis shows that a large portion of the caseine had undergone fatty change.

Caseine	...	...	...	...	...	...	61.33
Fat	...	...	...	...	...	...	16.12
Chloride of sodium	...	...	...	...	...	...	4.40
Water	...	...	...	...	...	...	18.15

(3.) The piece which had remained in the cellar two months was exactly in the condition most prized. There was a still further development of fat, and the fat itself had become partially decomposed into fatty acid.

Caseine	...	...	...	...	...	...	43.28
Fat	{	Margarine	...	...	...	18.30	} 32.30
		Oleine	...	...	...	14.00	
Butyric acid	...	...	...	...	...	...	0.67
Chloride of sodium	...	...	...	...	...	...	4.45
Water	...	...	...	...	...	...	19.30

(4.) The fourth portion, kept a year, had acquired a strong odour and a pungent taste. Ammoniacal salts of the fatty acids were formed, and there was a still further diminution of the caseine and an increase of fatty products.

Caseine	...	...	...	...	...	...	40.28
Margarine	...	...	...	...	...	...	16.85
Oleine...	...	...	...	...	...	...	1.48
Butyrate of ammonia	...	...	...	...	...	...	5.62
Caproate of ammonia	...	...	...	...	...	...	7.31
Caprylate of „	...	...	...	...	...	...	4.18
Caprate of „	...	...	...	...	...	...	4.21
Chloride of sodium	...	...	...	...	...	...	4.45
Water	...	...	...	...	...	...	15.62

This research appears to have attracted but little notice, yet, despite of its incompleteness, I cannot but consider it as a path-breaking one, and likely to be of considerable and practical interest to those engaged in the examination of foods.

I have analysed a large number of cheeses, in order to follow up a similar line of investigation, the time has, however, not yet elapsed for their re-analysis, and I therefore shall confine my remarks to the analogous change taking place in milk.

That there is really an increase of fat in decomposed milk, I believe can be established not alone from experiments or analyses undertaken with the special object in view of investigating the question, but also from what may be called accidental experiments.

(1.) A sample of “fore” milk, which in its time was rather notorious, was analysed by the writer on July 17th :—

Solids not fat...	...	...	...	...	...	9.70
Fat	...	...	...	...	...	.20
Ash	...	...	...	...	...	.71

Circumstances arose rendering an analysis by another chemist desirable. It was submitted to Mr. Wigner, who found about three weeks afterwards—

Solids not fat...	...	...	...	...	...	...	8.96
Fat	...	...	...	...	...	...	.76
Ash	...	...	...	...	...	...	.74

Free acidity calculated as Lactic Acid, 73 per cent.

(2.) Almost every sample of milk which has been analysed by a *second* chemist, on record in the pages of the *Analyst*, shows an increase of fat. Thus a milk analysed by Dr. C. Brown * on the 28th of April, gave but 2.68 per cent. of fat, the same milk on May 9th, 2.98 per cent. of fat; and the same milk, analysed by Mr. Wm. Thompson, on May 15th, gave 3.017 per cent.

A milk analysed by Dr. Hill,† gave, on the 1st of March, 2.47 of fat, the same sample was returned by the Inland Revenue chemists, on the 20th of March, as containing 2.83 per cent. of fat.

(3.) The writer analysed, very carefully, two samples of milk from Stonehouse, on the 20th December, 1877. Each milk was analysed twice, and there was a close agreement between the analyses.

Dec. 20, 1877.

(1.) Caseine and milk sugar	...	...	...	...	...	...	8.19
Fat	...	...	...	...	...	...	2.09
Ash	...	...	...	...	...	...	.62
Solids not fat...	...	...	...	...	...	...	8.81
(2.) Caseine and milk sugar	...	...	...	...	...	...	8.46
Fat	...	...	...	...	...	...	1.33
Ash	...	...	...	...	...	...	.65
Solids not fat...	...	...	...	...	...	...	9.11

The one was certified deficient in cream, and adulterated with water, the second deficient in cream only, and both were submitted to Somerset House; No. 1 alone reaching their laboratory; No. 2 bursting the bottle. The Inland Revenue chemists found, (analysed probably between 4th and 8th of January, 1878),

(1) Solids, not fat	...	...	...	...	...	...	7.84
Fat	...	...	...	...	...	...	3.38
Ash	...	...	...	...	...	...	.68

And they certified that there had been no abstraction of cream, but a small addition of water.

On examining the second sample, that is the one which through mis-fortune did not reach Somerset House, and which on the 20th of December, gave only 1.33 per cent. of fat. I found on the 23rd of January its composition, as follows:—

(2) Solids, not fat	...	...	...	...	...	...	7.62
Fat	...	...	...	...	...	...	1.79
Ash	...	...	...	...	...	...	.66

Acidity calculated as lactic acid .507 per cent.†

Further, the No. 1 milk which yielded to me on the 20th December, 2.09 per cent. of fat, and to the Government chemists on the first week of January, 3.30 per cent. of fat, on examining it on the 23rd of January, I found 3.919, or nearly 4 per cent. of fat, therefore there can be no reasonable doubt that in this particular sample of milk in about a month the fat nearly doubled in amount.

* *Analyst*, No. 18, Sep., 1877.

† It is almost unnecessary to state that the lactic acid was neutralized before extracting with ether.

I now come to a few analyses made specially to trace the changes in decomposed milk.

(1.) A milk analysed on the 24th January :—

Sp. G.	...	...	...	...	...	...	1032.1
Fat	...	...	...	...	...	...	3.52
Milk sugar	...	...	...	...	...	...	4.88
Albuminoids	...	...	...	...	...	...	4.25
Ash	...	...	...	...	...	...	.72

The same sample was divided into two parts—the one was put in a perfectly clean bottle, the other was contaminated with a droplet of the No. 1 Stonehouse milk before spoken of.

The uncontaminated milk 21 days after gave 3.41 per cent. of fat, 3.00 of milk sugar, .009 per cent. of acetic acid, .126 per cent. of lactic acid, and .0267 per cent. of alcohol, so that there was certainly no increase of fat, but some slight lactic fermentation, as evidenced by lactic acid, alcohol and oxidised alcohol.

The same milk which had been seeded with the ferment analysed at the same time, viz., 21 days afterwards, gave 3.9 per cent. of fat. Acetic acid, alcohol, lactic acid, and milk sugar were not estimated through accident.

(2.) A milk analysed January 27th gave the following results :—

Fat	...	...	...	...	...	...	2.584 per cent.
Milk sugar	...	...	...	...	...	...	4.566
Albuminoids	...	...	...	...	...	...	5.492
Ash	..	...	...	...	...	...	.720

The same milk 18 days afterwards gave

Fat	..	...	...	...	...	...	4.09
Milk sugar	...	...	...	...	...	...	2.75
Lactic acid	...	...	...	...	...	...	.119
Acetic acid	...	...	...	...	...	...	.002
Alcohol...	...	..	...	...	...	..	.0145
Albuminoids (by difference)	...	...	...	...	...	...	3.100
Ash	...	...	...	...	...	...	.72

This milk had a creamy appearance, there is a marked increase in the fat.

(3.) A milk analysed by Mr. Wigner on the 3rd of Sept., 1878.

Total solids	...	...	...	...	...	...	11.56
Fat	...	...	...	...	...	...	1.74
Solids not fat	...	...	...	...	...	...	9.82

The same milk analysed by the writer about 5 months afterwards on Feb. 3rd, 1878.

Total solids	...	...	...	...	...	...	8.37
Fat	...	...	...	...	...	...	1.19
Milk sugar	...	...	...	...	...	...	2.30
Alcohol	...	...	...	...	...	...	.009
Acetic acid	...	...	...	...	...	...	.013
Lactic acid	...	...	...	...	...	...	.351
Ammonia in combination	...	...	...	...	...	...	.070
Total nitrogen by combustion	...	...	...	...	...	...	.69
Ash	...	...	...	...	...	...	.71

In this case the fat was not increased but diminished. The whole of the volatile acids present are returned as acetic, a small portion of which was, however, butyric, or some other volatile fatty acid. The milk had an acetic ether odour.

(4.) Another milk analysed by Mr. Wigner on the 7th of Sept., 1877.

Total solids	...	...	...	...	...	...	10·615
Solids not fat...	...	...	...	...	...	...	8·015
Fat	...	...	...	...	...	...	2·600
Ash	...	...	...	...	...	...	·635
Chlorine	...	...	...	...	...	...	·061

The same milk analysed by the writer 5 months afterwards.

Total solids	...	...	...	...	...	...	9·40
Fat	...	...	...	...	...	...	3·89
Albuminoids	...	...	...	...	...	...	2·09
Milk sugar	...	...	...	...	...	...	2·31
Alcohol	...	...	...	...	...	...	·213
Lactic acid	...	...	...	...	...	...	·548
Acetic acid	...	...	...	...	...	...	·385
Ammonia in combination	...	...	...	...	...	...	·020
Total nitrogen by combustion	...	...	...	...	...	...	·313

Here, again, although the milk is the same age as the former sample, there is a very marked increase of fat. The milk had an odour of acetic ether—there were small quantities of one or more volatile fatty acids present.

(5.) A milk analysed by Mr. Wigner in November:—

Total solids	...	...	...	...	...	...	10·77
Solids not fat...	...	...	...	...	...	...	8·5
Fat	...	...	...	...	...	...	2·62

The same milk analysed by the writer 2½ months after date:—

Total solids	...	...	...	...	...	...	7·52
Fat	...	...	...	...	...	...	2·96
Solids not fat	...	...	...	...	...	...	4·56
Milk sugar	...	...	...	...	...	...	2·10
Albuminoids	...	...	...	...	...	...	2·10
Lactic acid	...	...	...	...	...	...	·081
Ammonia in combination	...	...	...	...	...	...	·012
Total nitrogen by combustion	...	...	...	...	...	...	·337

Alcohol not estimated.

In this case there was a considerable development of acetic acid, the odour of acetic ether was very powerful, and the fat is slightly increased.

The method of analysis it is, perhaps, right to mention. The fat was weighed directly, and dissolved out by ether from the solids, first made perfectly neutral by sodic carbonate, the milk sugar was converted into grape, and determined by copper solution, the precipitated sub-oxide being dissolved in acid, and deposited as copper by electrolysis on platinum foil, and then weighed.

The alcohol was obtained by re-distilling the distillate, and subsequently oxidising into acetic acid, as in the method recommended by Dr. Dupré.

The volatile acid returned as acetic was principally, but not entirely, that acid.

The alcohol calculated as ethylic was also probably a mixture of other alcohols.

The other determinations require neither comment nor explanation.

As we all know what is usually called the caseine of milk is really four albuminoid bodies, viz., true caseine, albumin, lactoprotein, and nuclein. The last was, I think, discovered in milk by Lubavin, and is in very small quantity. What share the albumin and the caseine take in the production of fat remains an interesting subject for investigation, and also what other bodies are formed. In the course of these few experiments I have found that

in decomposed milks nearly the whole of the nitrogen they contain may be obtained by first distillation with sodic carbonate and then with alkaline permanganate, and not as would be the case were the structure of the caseine and albumin unaltered a fractional part only.

I would also point out that the fatty degeneration of muscular fibre one so often observes in dissecting rooms, the formation of adipocere, and the drops of oil appearing with more or less rapidity in the nuclei or bioplasm of animal cells, are examples of the fatty transformation of albuminous and fibrinous substances, which, so far as we know, are constructed on the same type as the milk albuminoids.

The bearing of this subject in the reference of samples to Somerset House is obvious, I believe by a very thorough examination of a decomposed milk, it will be possible even after five or six months to build up by calculation its original parts, but the subject requires much work, and I will therefore not commit myself to any definite opinion, but trust to make one or two communications on this subject at some future meeting of the Society.