Analytical, Nutritional and Clinical Methods Section

Industrial application of the Creamatocrit method to estimate the total contents of lipids in natura cow milk

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Abstract

A simple microcentrifugation-based method is proposed as an alternative to the Gerber test to check the total contents of lipids in raw milk, with advantages for industrial application. The method consists of the filling of capillary tubes with the sample of the milk to be analysed and centrifugated for 5 min at 15000 rpm. After centrifugation, the fat percentage is obtained by calculating the ratio of the lengths of the creamy phase to total phase. The value of percentage found is then corrected by the equation of the method that predicts values of Gerber with 95% confidence limits. Its industrial application has been assessed through comparative tests carried out with samples obtained at the milk reception of a dairy plant. The values obtained with the Creamatocrit for samples of in natura cow milk were compared to the standard Gerber test and the Laktotest, a test equipment recently adopted by the dairy plant. The analyses accomplished by the Gerber test, the Laktotest and the Creamatocrit method presented 0% rejection of in natura milk. The average errors in the value of fat percentage, obtained in relation to the Gerber test, was 3.8% for the micro centrifugation method and 2.3% for the Laktotest. The results obtained were encouraging, providing strong evidence for the industrial application of the method proposed. © 1999 Elsevier Science Ltd. All rights reserved.

1. Introduction

Milk is the first and almost the only food taken by neonates. In general, the basic composition of the milk is the same, regardless of mammal species, but the percentage of each of the main milk components varies among the species (de Oliveira, 1986).

In its complexity, milk is an emulsion of fatty globules, stabilised by albuminoid substances in a serum that contains lactose, proteic material, mineral and organic salts and small amounts of diverse products, such as: lecithin, urea, amino acids, citric acid, lactic acid, acetic acid, alcohol, vitamins, enzymes and other components in solution (Behmer, 1976).

The milk fat presents a very complex constitution, coming in the form of globules emulsified in the liquid phase.

Skimming is a very common chemical analysis method for the determination of milk's composition, including the characterisation of lipo-proteic material. This method is used mainly to control the quality and

composition of raw milk, but, unfortunately, it is prone to fraudulent use (Behmer, 1976).

Fast methods for the estimation of total contents of lipids in milk depend on the destruction of the lipo-proteic envelope of the fat globules by sulfuric acid, centrifugation and further reading of the liquid fat volume (de Oliveira, 1986).

The 'Gerber acid-butirometric' test is probably the most commonly used technique for milk fat determination; adopted by research and quality control laboratories. However, its safety is compromised by the fact that testers can be exposed to the high temperatures reached during the digestion of milk protein by the sulfuric acid and by its potential to cause environmental damage due to the reagents employed.

In this work, a method based on micro centrifugation – denominated Creamatocrit – is proposed as an alternative to the Gerber test. Evidences obtained from an industrial pilot experiment indicate that this method can be adopted with advantage by dairies.

Fleet & Linzell were responsible for the first use of this method in 1964; they were motivated to use it to test samples of goat milk due to the fact that samples of

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reduced volume could be used without compromising the effectiveness of the method.

The Creamatocrit was used by Collares et al. (1997) for the estimation of the total lipid contents of in natura or pasteurised milk with satisfactory results: correlation of $R^2 = 0.968$ and prediction of values with errors smaller than 5%.

In this work, the industrial application of the micro-centrifugation method has been assessed with samples of in natura milk obtained at the milk reception of the Agricultural Cooperative Ltd. dairies of Uberlândia (CALU). The results of the tests were compared with results obtained using the standard Gerber test and the Laktotest; an equipment recently acquired by the company.

2. Material and methods

At the milk reception, samples of in natura milk were collected and tested for their total fat contents using: (i)

the Creamatocrit method (Collares et al., 1997), (ii) the standard Gerber test (Behmer, 1976), and (iii) the Laktotest G-900 (LAKTRON Metallurgical Industry Ltd). The testing methods (ii) and (iii) are part of the routine procedures employed by CALU dairies to verify the fat contents of raw milk and, based on the test results, accept or reject milk deliveries.

The Laktotest is an electronic apparatus based on the turbidimetry principle (Haugaard & Pettinati, 1959; Grappin & Jeunet, 1970). Its main disadvantage is that it requires periodic calibration using the Gerber test.

The tests with the Gerber test and Laktotest were made in duplicate and, for the Creamatocrit, the percentage of total lipids was obtained by taking the arithmetic average of percentages obtained from 12 capillary tubes for sample tested.

The objective of the method is the comparison of the rejection index of in natura milk at a dairies' milk reception that adopts methods (ii) and (iii) as part of its quality control procedure with that of a milk reception that uses method (i), the Creamatocrit, for quality control.

Table 1
Results obtained for the test at the milk reception of CALU dairies

A [a]	G [b] (%)	Creamatocrit			Laktotest	
		Read value	Corrected value	Error (%)	Value obtained	Error (%)
1	3.70	4.86	3.70	0.0	3.62	2.16
2	3.60	4.70	3.57	0.83	3.57	0.83
3	3.15	4.22	3.18	0.95	3.15	0.00
4	3.10	4.38	3.31	6.77	3.10	0.00
5	3.70	4.97	3.79	2.43	3.66	1.08
6	3.65	4.58	3.47	4.93	3.70	1.37
7	3.60	5.00	3.82	6.11	3.66	1.67
8	3.20	4.57	3.46	8.13	3.33	4.06
9	3.20	4.57	3.46	8.13	3.18	0.63
10	4.70	6.15	4.76	1.28	4.78	1.70
11	3.60	4.85	3.69	2.50	3.71	3.06
12	3.90	4.93	3.76	3.59	3.76	3.59
13	3.30	4.49	3.40	2.87	3.49	5.76
14	3.40	4.40	3.32	2.35	3.46	1.76
15	3.50	4.70	3.57	2.00	3.58	2.29
16	4.30	5.78	4.46	3.72	4.50	4.65
17	3.50	4.78	3.64	4.00	3.73	6.57
18	3.40	4.46	3.37	0.88	3.34	1.76
19	3.70	5.11	3.91	5.66	3.74	1.08
20	3.60	4.50	3.41	5.28	3.53	1.94
21	3.90	5.10	3.90	0.0	3.99	2.31
22	3.80	5.04	3.85	1.32	3.85	1.32
23	4.40	5.85	4.52	2.73	4.29	2.50
24	4.40	5.73	4.42	0.45	4.20	4.55
25	4.30	5.24	4.01	6.74	4.30	0.0
26	3.60	4.85	3.69	2.50	3.54	2.52
27	3.90	4.92	3.75	3.85	3.89	0.26
28	4.40	5.78	4.46	1.36	4.55	3.41
29	3.50	4.27	3.22	8.0	3.28	6.29
30	4.10	6.00	4.64	13.18	4.09	0.24

[a] Sample's unique identification number.
[b] Results obtained by the Gerber test.

3. Results and discussion

The results shown in Table 1 were obtained from the tests carried out at CALU's milk reception of in natura milk for the determination of the contents of total milk lipids. As already mentioned, the tests employed were the Creamatocrit, the Gerber test and the Laktotest.

The analyses performed by the Gerber test and those performed by the Creamatocrit and the Laktotest equipment presented a null rejection index for the in natura milk. The samples presented total lipids contents 3% above the value demanded by the Brazilian legislation. In relation to the Gerber test, the average error in the value of fat percentage obtained was 3.8% for the Creamatocrit and 2.3% for the Laktotest (Fig. 1).

The results obtained using the Laktotest apparatus showed a linear relation to the standard Gerber test, with correlation coefficient of 0.966 (Fig. 2). Fig. 3 presents the satisfactory linear correlation ($R = 0.924$)

Fig. 3. Graph showing the statistical correlation between the Creamatocrit method and the Laktotest in the determination of the lipid contents of in natura milk.
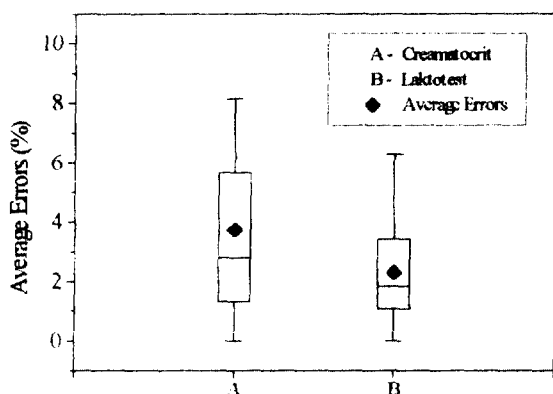

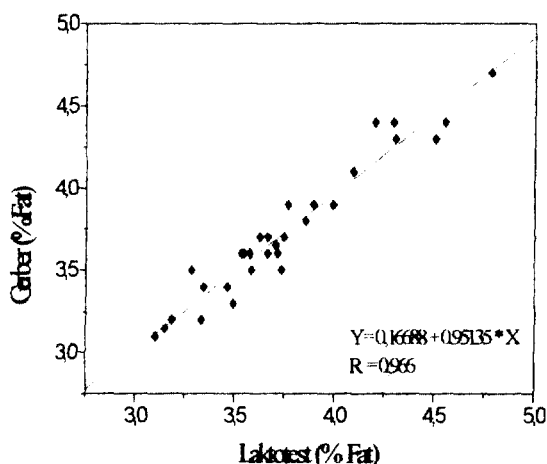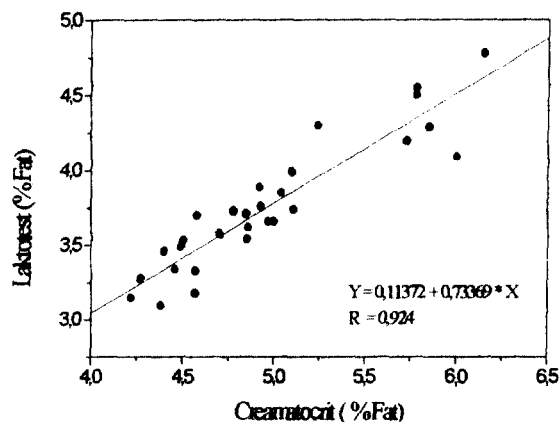Fig. 1. Average errors of the Creamatocrit method and Laktotest in relation to the Gerber test.

Fig. 2. Graph showing the statistical correlation between the Gerber test and Laktotest in the determination of the lipid contents of in natura milk.

between the results obtained with the Creamatocrit and the Laktotest.

The Creamatocrit method showed itself appropriate for the estimation of the contents of total in natura milk lipids, presenting an average error slightly superior to the Laktotest, that is the method adopted by CALU dairies.

Furthermore, the micro centrifugation method (Creamatocrit) requires an initial investment almost ten times lower than the Laktotest does and two times lower than the Gerber test does. The operational cost of the Creamatocrit is also 50% inferior to the Laktotest and approximately 85% inferior to the operational cost of the Gerber test.

In relation to the time of analysis, it takes on average, 35 s for the Laktotest to analyse a sample. In the Gerber test, each analysis lasts approximately 15 min. For the proposed method, the analysis of a sample takes around 6 min. However, the simultaneous centrifugation of 24 capillary tubes in the micro centrifuge is possible, meaning that 12 samples can be tested in duplicate.

Therefore, the Creamatocrit constitutes an excellent alternative for industrial application, reducing equipment and operational costs, time of analysis and risks of work accidents. An additional advantage comes from the fact that Creamatocrit is environment-friendly as it does not require the use of any chemical reagents whatsoever and employs very small samples.

Acknowledgements

References

Behmer, M. L. A. (1976). Tecnologia do leite: leite, manteiga, queijo, caseína, sorvetes e instalações, produção, industrialização, análise. Nobel, São Paulo

Collares, F. P., Gonçalves, C. V., & Ferreira, J. S. (1997). Creamato-crit as a rapid method to estimate the contents of total milk lipids. *Food Chemistry, 60,* 465–467

de Oliveira, J. S. (1986). Queijo: Fundamentos Tecnológicos. São Paulo: Icone Ed.; Campinas, SP: Ed. da UNICAMP

Fleet, I. R., & Linzell, J. L. (1964). A rapid method of estimating fat in very small quantities of milk. *Journal of Physiology, 175,* 15–17

Grappin, R., & Jeunet, R. (1970). Essais de l'appareil Milko-Tester Automatique destiné au dosage en série de la matière grasse du lait. *Lait, 50,* 235–256

Haugaard, G., & Pettinati, J. D. (1959). Photometric milk fat determination. *Journal of Dairy Science, 42,* 1255