Quantitative Comparison Between Serum Components and Somatic Cells in Bovine Quarter Milk

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ABSTRACT. Quantitative comparisons between serum components and somatic cells in 202 bovine quarter milks collected at 3 dairy farms were conducted. Detection of serum components was carried out by an immunological technique, and cell counts were calculated by Breed's method. A high correlation (r=0.77) between cell counts and γ-globulin contents was demonstrated, while correlation between cell counts and serum albumin was not close (r=0.45). In a comparison between cell counts and γ-globulin contents, 19 (65.4%) out of 29 milks containing over 500,000 cells/m*l* had γ-globulin less than 1.138 mg/m*l*, which was also seen in 97% of 172 milks having less than 500,000 cells/m*l*. From these results, it was suggested that the γ-globulin content of milk might be of use for differentiating normal milk from abnormal ones.—KEY WORDS: cell count, milk (bovine), serum component.
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From the point of view of milk hygiene and economic loss in dairy herds, bovine mastitis is one of the most important problems [6, 10, 12–14]. At present, it is well known that a definition of bovine mastitic milk has yet to be made, and the differentiation of mastitic milk from normal milks by a single test method is difficult [1–4]. Mastitic milks are currently assessed on the basis of the somatic cell counts in raw milk. In the case of bulk milk, the milk would be registered as abnormal for acceptance to the milk industry or the cooperative, if it had cell counts of more than 300,000 cells/m*l* or 500,000 cells/m*l*. Except for colostrum and milk of the dry period, an increase of somatic cells, as well as a rise in serum albumin and globulin, can be explained as a result of inflammation of the mammary gland [1–3, 5, 7, 9, 11]. Although serum albumin has been considered to be a sensitive indicator for the degree of inflammation [1, 9], little information on the correlation relationship between cell counts and serum albumin is known.

In the present study, quantitative comparisons were made between the cell counts, serum albumin and γ-globulin concentrations of 202 quarter milk samples obtained at 3 dairy farms in Miyazaki prefecture. Milks were collected at the milking time in the morning or evening, and, at that time, clinical mastitic milk and colostrum were removed from the test samples. Serum albumin and γ-globulin were detected and identified by a radial immuno-diffusion test, using antisera against bovine serum albumin (Fraction V, Sigma Chemical Co., U.S.A.) and bovine γ-globulin fractions (Fraction II, Miles Lab. Inc., U.S.A.). Calculations of the concentrations (mg/m*l*) were carried out using the standard curves, $\log Y = -2.427 + 0.208X$ for serum albumin, and $\log Y = -2.684 + 0.238X$ for γ-globulin. Cell counts were counted and calculated by Breed's technique, using a

Table 1. Concentrations of serum components and counts of somatic cells in 202 quarter milk samples

Serum components			Somatic cell counts	
Ranges of contents	No. of samples (%)		Ranges of cell counts	
(mg/m*l*)	Albumin	γ-Globulin	(× 10,000/m*l*)	No. of samples (%)
0.10–0.20	136 (67.3)	0	≦ 10	137 (67.8)
0.21–0.30	44 (21.8)	9 (4.5)	10– <20	18 (8.9)
0.31–0.40	13 (6.4)	19 (9.4)	20– <30	11 (5.4)
0.41–0.50	7 (3.5)	21 (10.4)	30– <40	3 (1.5)
0.51–0.60	1 (0.5)	33 (16.3)	40– <50	3 (1.5)
0.61–0.70	0	36 (17.8)	50– <60	2 (1.0)
0.71–0.80	0	27 (13.4)	60– <70	3 (1.5)
0.81–0.90	0	24 (11.9)	70– <80	3 (1.5)
0.91–1.00	0	11 (5.4)	80– <90	3 (1.5)
1.01–1.10	1 (0.5)	7 (3.5)	90– <100	0
1.11–1.20	0	2 (1.0)	100– <110	0
1.21–1.30	0	2 (1.0)	110– <120	3 (1.5)
1.31–1.40	0	2 (1.0)	120– <130	0
> 1.41	0	9 (4.5)	≧ 130	16 (7.9)
Total (%)	202 (100.0)	202 (100.1)		202 (100.0)

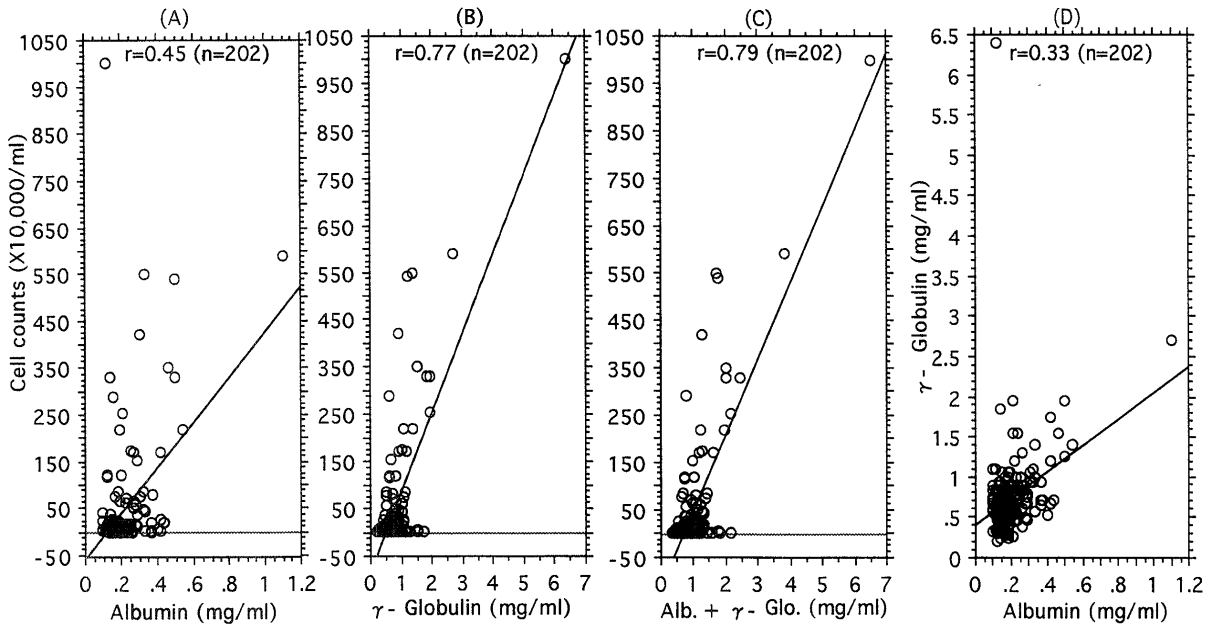

Fig. 1. Correlation relationships among cell counts, serum albumin and γ-globulin concentrations of 202 milk samples. (A): cell counts and serum albumin, (B): cell counts and γ-globulin, (C): serum albumin and γ-globulin, (D): serum albumin and γ-globulin.

microscope at magnification of 400-times.

The results are exhibited in Table 1. As can be seen in this table, 180 (89.1%) milks out of 202 samples had serum albumin ranging from 0.1 to 0.3 mg/m*l*, and 22 (11%) milks contained more than 0.3 mg/m*l*. For the γ-globulin contents, 189 (93.6%) samples had less than 1.2 mg/m*l*, and the remaining 13 (6.4%) milks had more than 1.21 mg/m*l*. Cell counts of 155 (76.7%) samples were less than 200,000 cells/m*l*, 166 (82.1%) were less than 300,000 cells/m*l*, and 172 (85.1%) were less than 500,000 cells/m*l*. The mean ± standard deviation of serum albumin and γ-globulin contents of all 202 milks were 0.199 ± 0.105 and 0.733 ± 0.523 mg/m*l*, respectively.

Correlation relationships between the cell counts and the two serum components are shown in Fig. 1. As shown in Fig. 1 (A), the correlation between cell counts and serum albumin was not close (r=0.45), but, as shown in Fig. 1 (B), between cell counts and γ-globulin it was close (r=0.77). In addition, as indicated in Fig. 1 (C), the correlation between cell counts and total contents of the both serum components was also close (r=0.79). The correlation between serum albumin and γ-globulin was not close (r=0.33), as shown in Fig. 1 (D).

Although correlation between cell counts and serum components has been recognized by some investigators [1–3, 8, 9], little information concerning correlation among them, such as r-value, has been reported. In the present experiment, a high correlation between cell counts and serum albumin was not demonstrated (r=0.45), but a high correlation (r=0.77) was indicated between cell counts and γ-globulin. This was an unexpected result. However, the high correlation (r=0.79) observed between cell counts and the total serum components seems to be dependant on the distribution of the γ-globulin values.

Table 2. Comparison between cell counts and γ-globulin concentrations of 202 milk samples

Ranges of γ-Globulin (mg/m*l*)	< 500,000 cells/m*l* No. of samples (%)	> 500,000 cells/m*l* No. of samples (%)
0.210–0.364	15 (8.7)	0
0.364–0.518	32 (18.6)	2 (6.9)
0.518–0.672	54 (31.4)	4 (13.8)
0.672–0.826	33 (19.2)	5 (17.2)
0.526–0.980	25 (14.5)	3 (10.3)
0.980–1.138	8 (4.7)	5 (17.2)
1.134–1.288	1 (0.6)	2 (6.9)
1.288–1.442	1 (0.6)	2 (6.9)
1.442–1.596	2 (1.2)	1 (3.4)
1.596–1.750	1 (0.6)	0
> 1.750	0	5 (17.2)
	172 (100.1)	29 (99.8)

We also made a quantitative comparison between cell counts and γ-globulin concentrations, and the results are exhibited in Table 2. As shown in this table, 172 (85.1%) out of 202 milks had cell counts less than 500,000 cells/m*l*, and the γ-globulin concentrations of these 172 samples ranged from 0.21 to 1.75 mg/m*l*. In the 172 milks, 167(97%) samples contained γ-globulin less than 1.138 mg/m*l*. Of the 202 samples, 29 (14.9%) had cell counts of more than 500,000 cells/m*l*, and 19 (65.4%) milks of these 29 samples also contained γ-globulin at less than 1.138 mg/m*l*.

It is widely known that somatic cells and serum components increase following the onset of inflammation of the bovine mammary gland. The fact that serum albumin and γ-globulin are secreted from the blood stream following

inflammation of the mammary gland, just like the increase in somatic cells [1–4], would indicate that milk samples containing high levels of serum components would be abnormal, even if their cell counts were registered at a normal level; and conversely, milk samples containing a low level of serum components should be considered normal.

Therefore, it was considered that milks having γ-globulin less than 1.138 mg/m*l* should be regarded as a normal, eventhough data of the systematic blood characters of the cows from which the milk samples were taken were not available. Furthermore, this value is not so different from the mean + standard deviation.

While we have indicated a γ-globulin level of 1.138 mg/m*l*, the standard normal level of γ-globulin contents of quarter and bulk milks should be decided by comparison with the results of some other diagnostic tests.

Nevertheless, at the very least, we consider that if γ-globulin concentration, which correlated well with cell counts, is used as an assessment criteria for raw milk, in addition to cell counts, it would be effective for a more accurate diagnosis of bovine milk.

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