The Relationship between Milk Productivity Traits and Milk Technological Properties in Lowland Black and White Cows

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1. Introduction

Milk is a very complex product of many metabolic processes. Over 100 indicators defining its nutritive and technological properties have been identified. Cattle breeding programs refer only to the traits of milk yield and basic components, however, several important technological features are not taken into account. The possibility of incorporating other selected factors is limited. Breeding directions depend on statistical optimisation, heritability and feature correlation. Generally, there is a negative correlation between the selection efficiency and the number of selected traits.

Seeking monogenic indicators, expressed by high satisfactory phenotype effects, is an alternative breeding method. Polymorphic milk proteins such as alfa-lactoglobulin, beta-lactoglobulin as well as alpha slbeta-and kappa-caseins may be recognized as potentially important genetic markers of milk trait differentiation.

The capacity of milk to coagulate is an important technological feature. The protein coagulation process course significantly influences the curd structure and firmness, fat absorption as well as other components affecting technological effectiveness and nutritive and flavour values of cheese products. In the process of curd formation, kappa-casein, which is located on the surface of casein micelles plays a principal role. Kappa-casein displays polymorphism, which in lowland Black-and-White cattle depends on the pair of co-dominant allels labelled as $CASK^A$ and $CASK^B$. The positive effects of the kappa-casein B variant has been uniformly demonstrated in many previous experiments. It was stated that the $CASK^B$ genetic variant is characterized by shortening of the protein coagulation process [SCHAAR 1984, AALTONEN and ANTILLA 1987, RAMPILI at al. 1988, GRAVERT et al. 1991, WALAWSKI et al. 1994], an increase in cheesemaking properties [SCHAAR 1984, MARZIALI and NG KWAI-HANG 1986, effectiveness of milk processing [GIBSON et al. 1990, PEDERSEN 1991]. The utilisation of polymorphic milk protein systems in dairy breeding programs was even more difficult due to the fact that milk traits could not be determined for male individuals. The implementation of the polymerase chain reaction (PCR) and the restricted fragment length polymorphism (RFLP) procedures currently allows the identification of DNA fragments that encode the CASK polymorphic variants [ROGNE et al. 1989, PINDER et al. 1991, DE NISE et al. 1992, KAMINSKI and FIGIEL 1993]. As well the conditions for CASK genotype identification regardless of sex, age and physiological state of tested animals were created. Finally, the

organizational aspects of milk protein polymorphism utilization as an additional factor of milk trait selection programmed are discussed [ERHARD and SENFT 1989, ZOGG 1990, PEDERSEN 1991].

Breeding decisions which introduced radical changes to the herd genetic structure should proceed after a detailed recognition of phenotype results. It has been stated that an increase of $CASK^B$ allele frequency will result in the improvement of coagulation properties in herds that supply raw material to processing plants. The influence of CASK polymorphism on other important milk features has been analysed only in a few cases. The previous experiment [WALAWSKI et al. 1994] involved the following traits; milk yield, dry matter, fat, total protein, casein, lactose, citric acid, basic mineral elements such as calcium, magnesium, potassium and chlorides, lysozyme and alkaline phosphates activity, secretion disturbance indicators as well as milk properties such as density, acidity, heat stability and coagulation technological features. In this experiment the homozygote CASK BB cows had as shorter rennet coagulation time ($\bar{X}$ = 375 sec) when compared with heterozygote CASK AB cows ($\bar{X}$ = 397 sec) and homozygotes AA ($\bar{X}$ = 428 sec), satisfactory heat stability ($\bar{X}$ = 11.3 ml ethanol/10 ml milk) and acidity (pH 6.67) as well as lower somatic cell count ($\bar{X}$ = 3.50 × 10^3/ml) when compared with homozygotes CASK AA ($\bar{X}$ = 427 × 10^3/ml). However, the milk yield of CASK BB ($\bar{X}$ = 17.1 kg) and CASK AB cows ($\bar{X}$ = 17.2 kg) was significantly lower than the CASK AA genotype cows ($\bar{X}$ = 19.7 kg).

The association between milk productivity traits, milk nutrition value and milk technological properties has not been sufficiently explained on a large scale. The main goal of the following research was to explore the correlation between milk traits analysed for the purpose of CASK polymorphism possible application such as an additional breeding factor in a breeding program and the changes in milk coagulation properties expected in cows reared in a mass breeding population.

2. Materials and methods

The experiment was carried out on two large Black-and-White cattle herds; 128 cows, were used: sheltered, tied and kept in good nutritive and zoohygienic conditions. The diet was balanced regarding to energy, protein and mineral components. The animal metabolic profile was examined with the use of the wide range of blood and milk diagnostic indices. The cows were milked twice a day mechanically in their stalls.

At the following times during the first lactation, milk yield, secretion disturbance as well as milk components and properties were taken. The assays were carried out between the 20^{th}-30^{th} day (Term 1), the 80^{th}-90^{th} day Term 2), 150^{th}-160^{th} day (Term 3), 210^{th}-220^{th} day (Term 4) and 270^{th}-280^{th} day (Term 5) after calving.

In the samples collected from the two following days, the average daily milk yield, dry matter, fat, total protein and lactose contents were examined with the use of Milkoscan 104A-SN FOSS apparatus. The casein content wass destermined by calorimeteric tecnique, the phosphorus level by the Fieske-Subborow technique, the chlorides by the Mohr method, calcium, sodium and potassium were tested with the use of a Ftafo-4 photometer. The magnesium content was examined by Lange method and lysozyme level by the Smolelies-Hartesell method. The Bessey-Lowry technique was used to determine alkaline phospatase (AP) and acid phosphatase (AcP) activity. The somatic cell count (SCC) was tested by a FOSSOMATIC apparatus.

The diagnostic assays were carried out at the department of Animal Genetics Laboratory at the University of Agriculture and Technology in Olsztyn, the central service laboratory in the university of Agriculture and technology in Olsztyn and the milk components and somatic cell count were tested at the laboratory of milk assessment in Malbork-Kaldowo. Milk density was determined with a lactodensimeters technique, the coagulation time with the rennin procedure and the heat stability index was determined indirectly with the ethanol test. All diagnostic assays were carried out based on the procedure outlined by LASKOWSKI (1981), RUTIKOWSKA (1981, PAWELSKI (1983) and PIJANOWSKI (1984).

The results illustrating the following lactation phases and the average results for the entire lactation period were statistically verified by simple correlation coefficients calculated separately in both experimental herds.

3. Results and discussion

The data shown in table 1 of the arithmetic mean and the dispersion coefficients indicate that both of the examined herds fulfil the basic requirements of milk production traits and milk processing technologies. Regarding breeding and technological standards [GAUNT 1980, CAMPBELL and MARSCHALL 1982, PIJANOWSKI 1984] it has been found that the examined cows produce a satisfactory average daily yield in the period of the I lactation (herd B-16.6 kg, herd M-15.5 kg), high levels of milk dry matter (over 13%), fat (ca 4.4%) and lactose (over 4.7%) and a different level of total protein (herd B-3.38%, herd M-3.15%) as well as casein contents (herd B-2.57%, herd M-2.36%). The average amount of somatic cell count (SCC) in milk from herd B ($\bar{X} = 268 \times 10^3$/ml) indicated the moderate disturbances of secretion, whereas the sanitary state of milk from herd M ($\bar{X}$ = 159 × 103/ml) is completely satisfactory, however the large values of standard deviation (s) shows, a significant differentiation in the udder health status in both experimental herds.

The level of diagnostic indices of milk components and milk properties in both herds is similar in accordance with the range of veterinary and technological standards. A relatively high content of calcium (herd B-105 mg/100g, herd M-102 mg/100g), phosphorus (relatively: 297 and 281 mg/100 g) and magnesium (81.5 and 84.5 mg/100 g) has been observed. The correlation between the sodium content (0.98-0.38 mg/100g) and potassium (14.4 and 14.0 mg/100g) as well as the reasonable chloride level (1.17 and 1.21 mg/100g) and the low activity of lysozyme (6.0 and 6.1 U), alkaline phosphates (11.8 and 12.0 U) and acid phosphates (4.4 and 4.1 U) indicate satisfactory milk sanitary standards. The casein index, defining the share of casein in the total protein content (herd B-76.0%, herd M-75%) in both herds, fulfils the requirements (75%) which should characterise milk fit for immediate consumption and processing. Regading the physical and chemical properties of milk, the expected levels of rennin coagulation (in both herds 339 sec.), acidity (in both herds pH 6.70) and heat stability (herd B-4.2, herd-M-3.6 ml ethanol/10 ml of milk) have been found. The milk density was however different. In herd B (30.2o Ld) it was satisfactory but too low in herd M (29.0o Ld), resulting from the large fat contents (4.45%) and low level of milk protein content (3.15%).

The correlation between udder inflammation occurrence and the course of milk coagulation processes has frequently been recorded [KISZA 1969, POLITIS and NG-KWAI-HANG 1988, SOWINSKI et al. 1988].

The results of WALAWSKI et al. (1994) indicated that the genetic polymorphism of kappa-casein is correlated with different coagulation and mastitis susceptibility indices. Moreover, experiments have shown that udder inflammation influences lactose, chlorides, sodium an potassium levels as well as indices of acidity, heat stability, alkaline an acid phosphates activity differences in milk [KISZA 1968, quotation form LASKOWSKI 1981, PIJANOWSKI 1984, POLITIS and NG-KWAI-HANG 1988, SOWINSKI et al. 1988].

In this study milk diagnostic indices similar to optima! values have been achieved. They indicate the connection with the mastitis occurrence. The differentiation of somatic cells count in herd B did not cause pathological changes in milk content or properties.

Considering the results obtained in the aspect of possible utilisation of kappa-casein

polymorphism in the genetic improvement of milk processing properties, one can anticipate that the positive effect appearing in shortening of milk coagulation time will not cause negative effects related to mastitis susceptibility, economically important milk usability features and the basic milk components and properties. Form the results in table 1 it can be estimated that genetically determined, positive milk coagulation properties are more pronounced in environmental conditions favouring the appearance of secretion disturbance due to the inflamed mastitis state. Such conditions are manifested by higher correlation coefficients and a wider range of statistically important correlation between coagulation and diagnostic indices levels characterising pathologic changes of milk components and properties. In the majority of cases, the correlation coefficient values are significantly higher in cows form herd B, where a greater risk due to a mastitis subclinical state occur. Apart form mentioned earlier features of yield, heat stability and pH, in cows form herd B, the statistically important values of correlation coefficient between milk coagulation and the content of lactose, calcium, magnesium, sodium, chlorides and lysozyme have been found. Moreover, in herd M, a statistically significant correlation between milk coagulation time and phosphorus content has been found.

The results shown in tables 2 and 3 illustrate the regularity in several lactation stages of experimental cows. In herd M (table 2), the correlation between milk coagulation and milk yield as well as acidity is stable, between the somatic cell count and milk heat stability is statistically significant in the first and the last stage, although the calcium content show a statistically significant correlation in the middle and final stage of lactation. In herd M the basic tendencies of correlation coefficient values differentiation between milk coagulation and features of yield, contents and milk properties are generally preserved (table 1), although the results from following periods are irregular (table 3). Significantly high correlation coefficient values have been achieved for yield, acidity and heat stability in the first stages of lactation (term 1 and 2), for chloride contents in the middle stage (term 3), form milk yield, dry matter, lactose, calcium, phosphorus, lysozyme and somatic cell count the statistically important values were achieved only in last lactation stages term 4 or 5).

The relationship between kappa-casein polymorphism and milk coagulation has been documented with multiple results achieved in many experiments [SCHAAR 1984, MARZIALLI and NG-KWAL-HONG 1986, AALTONEN and ANTILLA 1987, RAMPILLI et al. 1988, GRAML et al. 1988, GRAVERT et al. 1991, WALAWSKI et al. 1994].

Kappa-casein allele B recognised as an economically important marker of positive technological milk properties [SCHAAR 1984, GRAML et al. 1988, ERHARDT and SENFT 1989, GIBSON et al. 1990, ZOOG 1990 PEDERSEN 1991].

Kappa-casein genotype implementation in bulls [ROGNE et al. 1989, PINDER et al. 1991, DE NIESE et al. 1992, KAMINSKI and FIGIEL 1993] allow the application of a direct mating system and selective distribution of semen, resulting in a significant shortening of the milk coagulation rate in cows reared in mass populations.

Breeding experience clearly shows that the emergency changes in genetic improvement conception creates potential risks due to the negative correlation of parallel selected traits. The results achieved by WALAWSKI et al. (01994) show th possible occurrence of undesirable breeding effects shown by the tendency to lower the milk yield in cows of genotype kappa-casein BB. Our results do not support this, indeed cows with high milk yields have a low rennet

coagulation index.

A positive element of our research is that the achieved results also indicate a significant association between the shortening of milk coagulation time and the mastitis resistance of cows. Such regularity is in accordance with the results of WALAWSKI et al. (1994), who, in cows of genotype kappa-casein BB, which are genetically specialized in having a short time of milk coagulation, also found statistically important profitable lower diagnostic indices of mastitis subclinical changes. The results indicating the possible occurrence of a genetically determined correlation between protein polymorphism and milk secretion disturbances are especially interesting because the very low value of heritability coefficients characterizing quantitative traits of natural resistance exclude the possibility of effective application of traditional programme of animal selection. The mechanisms of genetic relations between alpha S1, beta-and kappa-casein linkage protein system and the mastitis is actually not recognized. The uniformity of the achieved results are encouraging for further research into casein polymorphic variants as potentially applicable genetic markers of natural resistance in cattle.

4. Conclusions

Research within the Black-and-White cattle breeding programme has been conducted concerning kappa-casein polymorphism as a potential selective factor. The research results indicated the positive effects of technological milk properties that are associated with milk productivity traits and udder health status.

The statistically significant association between the anticipated shortening of milk coagulation time and the disturbances in secretion, yield, acidity and heat stability has been reported. The positive effect of shortening milk coagulation time is more clearly shown in environmental conditions that favour subclinical changes of mastitis.

5. References

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Table 1 . Correlation between milk yield, composition and technological properties and coagulation rate of milk originating from two herds of Black and White cows.

No.	Milk indices specification	Arithmetical mean ± Standard deviation $(\bar{x} \pm s)$				
		Correlation coefficients (r)				
		Herd B		Herd M		Breedingeffect
		x ± s	r	x ± s	r	
xxxx	Coagulation time (sec.)	339 ± 138	xxxxxxxxxxxxxxxx	339 ± 138	xxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxx
1.	Milk yield (kg)	16.6 ± 4.8	-0.35 **	15.5 ± 4.1	-0.17 **	positive (++)
2.	Dry matter (g/100g)	13.32 ± 1.01	-0.08	13.12 ± 1.12	-0.06	not significant
3.	Fat (g/100g)	4.40 ± 0.85	-0.08	4.45 ± 0.05	-0.10	not significant
4.	Total protein (g/100g)	3.38 ± 0.42	+0.08	3.15 ± 0.35	-0.00	not significant
5.	Casein (g/100g)	2.57 ± 0.43	+0.02	2.36 ± 0.34	-0.08	not significant
6.	Lactose (g/100g)	4.79 ± 0.24	-0.20 *	4.75 ± 0.26	-0.00	positive tendency
7.	Calcium (mg/g)	1.05 ± 0.14	-0.20 *	1.02 ± 0.11	-0.12	positive (+)
8.	Magnesium (mg/g)	81.5 ± 16.0	+0.14 *	84.6 ± 17.2	+0.12	negative tendency
9.	Phosphorus (mg/100mg)	29.7 ± 3.9	-0.03	28.1 ± 3.9	+0.18 **	not clear
10.	Sodium (mg/g)	0.98 ± 0.08	+0.27 *	0.38 ± 0.09	-0.04	positive (+)
11.	Potassium (mg/g)	1.44 ± 0.19	+0.10	1.40 ± 0.18	+0.06	not significant
12.	Chlorides (mg/g)	0.117 ± 0.020	+0.27 **	0.121 ± 0.02	+0.10	positive (+)
13.	Alkaline phosphatase (U)	11.8 ± 14.9	+0.10	12.0 ± 17.8	+0.02	not significant
14.	Acid phosphatase (U)	4.4 ± 5.0	-0.04	4.1 ± 8.4	-0.01	not significant
15.	Lysozyme (U)	6.0 ± 5.1	-0.14 *	6.1 ± 4.4	+0.09	not clear
16.	Density (Lº)	30.2 ± 2.2	-0.03	29.0 ± 1.3	-0.00	not significant
17.	Heat stability (ethanol ml/10ml)	4.2 ± 2.1	+0.30 **	3.6 ± 1.9	+0.20 **	positive (++)
18.	Acidity (pH)	6.70 ± 0.14	+0.15 **	6.70 ± 0.11	+0.15 *	positive (+)
19.	Somatic cell count (10^3/ml)	268 ± 496	+0.26 **	159 ± 197	+0.10	positive (+)

xx - value of correlation coefficient statistically highly significant (p = 0.01)

x - value of correlation coefficient statistically significant (p = 0.05)

Table 2. Variability of milk indices in several stages of lactation I in cows originating from the herd M

No.	Milk indices Specification	Variability in several stages of lactation (x ± s) Correlation coefficients (r)					
		Term 1	Term 2	Term 3	Term 4	Term 5	Total
x	Coagulation time (sec.)	315 ± 122	343 ± 107	377 ± 142	329 ± 130	329 ± 160	339 ± 138
1.	Milk yield (kg)	18.3 ± 3.0 -0.30 xx	17.6 ± 2.7 +0.24	13.8 ± 3.3 -0.23	12.7 ± 3.6 -0.08	13.2 ± 4.6 -0.40 xx	13.3 ± 4.1 -0.17 xx
2.	Dry matter (%)	12.89 ± 1.02 +0.08	12.62 ± 0.72 -0.07	13.01 ± 1.01 +0.02	13.09 ± 1.10 -0.32 x	14.01 ± 1.22 +0.03	13.32 ± 1.01 -0.08
3.	Fat (%)	4.33 ± 0.93 +0.09	4.04 ± 0.61 +0.01	4.28 ± 0.78 -0.05	4.48 ± 0.97 -0.34 x	5.13 ± 1.04 -0.05	4.45 ± 0.95 -0.10
4.	Total protein (%)	2.93 ± 0.23 +0.01	2.97 ± 0.24 -0.16	3.16 ± 0.38 -0.10	3.22 ± 0.28 -0.18	3.46 ± 0.32 +0.09	3.13 ± 0.35 -0.00
5.	Casein (%)	2.21 ± 0.30 +0.14	2.21 ± 0.27 -0.19	2.43 ± 0.42 +0.04	2.40 ± 0.31 -0.24	2.56 ± 0.26 -0.08	2.37 ± 0.43 +0.02
6.	Lactose (%)	4.85 ± 0.23 +0.06	4.84 ± 0.18 -0.18	4.81 ± 0.18 +0.13	4.65 ± 0.34 +0.10	4.62 ± 0.24 -0.29 x	4.79 ± 0.24 -0.20 x
7.	Calcium (mg/g)	1.02 ± 0.10 +0.07	0.98 ± 0.11 -0.19	1.01 ± 0.09 -0.09	1.02 ± 0.09 -0.27 x	1.08 ± 0.11 -0.07	1.02 ± 0.11 -0.12
8.	Magnesium (mg/g)	79.1 ± 16.8 +0.02	78.9 ± 13.8 -0.01	83.6 ± 16.6 +0.21	89.9 ± 18.4 +0.12	91.3 ± 16.6 +0.24	84.6 ± 17.2 +0.12
9.	Phosphorus (mg/100mg)	26.9 ± 3.8 -0.03	27.1 ± 2.8 +0.13	28.9 ± 3.3 +0.22	28.7 ± 3.8 +0.07	29.0 ± 4.7 +0.36 xx	28.1 ± 3.9 +0.18 xx
10.	Sodium (mg/g)	0.37 ± 0.05 -0.23	0.35 ± 0.06 -0.05	0.37 ± 0.04 -0.12	0.39 ± 0.11 -0.06	0.42 ± 0.13 +0.11	0.38 ± 0.09 -0.04
11.	Potassium (mg/g)	1.38 ± 0.21 +0.01	1.43 ± 0.17 +0.02	1.42 ± 0.18 +0.15	1.40 ± 0.14 +0.14	1.39 ± 0.17 -0.07	1.40 ± 0.18 +0.06
12.	Chlorides (mg/g)	0.109 ± 0.017 -0.06	0.114 ± 0.016 +0.15	0.118 ± 0.015 +0.29 x	0.127 ± 0.020 +0.00	0.135 ± 0.021 +0.23	0.121 ± 0.020 +0.10
13.	Alkaline phosphatase (IU)	9.0 ± 3.9 -0.17	8.5 ± 4.5 -0.08	9.1 ± 6.5 -0.10	13.1 ± 17.5 +0.25	20.5 ± 33.4 -0.00	12.0 ± 17.9 +0.02
14.	Acid phosphatase (IU)	2.8 ± 3.4 +0.09	3.4 ± 3.0 -0.23	3.2 ± 2.7 +0.09	3.3 ± 2.6 +0.00	8.2 ± 17.3 +0.00	4.1 ± 8.4 -0.01
15.	Lysozyme (U)	5.8 ± 4.4 -0.12	6.0 ± 3.4 -0.08	6.0 ± 4.4 +0.02	5.9 ± 3.5 -0.01	6.7 ± 6.0 +0.38 xx	6.1 ± 4.4 +0.4
16.	Density (Ld°)	28.6 ± 1.3 +0.18	28.9 ± 1.2 -0.22	29.2 ± 1.2 +0.20	29.3 ± 1.4 -0.04	29.2 ± 1.4 -0.19	29.0 ± 1.3 -0.00
17.	Heat stability (ethanol ml/10ml)	3.4 ± 2.1 +0.14	3.7 ± 2.2 +0.44 xx	4.2 ± 1.7 -0.00	3.5 ± 1.5 +0.12	3.2 ± 1.6 +0.23	3.6 ± 1.9 +0.20 xx
18.	Acidity (pH)	6.68 ± 0.14 +0.41 xx	6.70 ± 0.08 +0.19	6.74 ± 0.09 -0.07	6.71 ± 0.10 +0.08	6.69 ± 0.12 +0.01	6.70 ± 0.11 +0.15 x
19.	Somatic cell count (10^3/ml)	182 ± 235 -0.09	99 ± 59 +0.23	116 ± 134 +0.04	220 ± 278 +0.10	178 ± 179 +0.45 xx	159 ± 197 +0.10

xx - value of correlation coefficient statistically highly significant ($p = 0.01$);
x - value of correlation coefficient statistically significant ($p = 0.05$)

Table 3. Variability of milk indices in several stages of lactation I in cows originating from the herd B

No.	Milk indices specification	Variability in several stages of lactation (x ± s)					
		Correlation coefficients (r)					
		Term 1	Term 2	Term 3	Term 4	Term 5	Total
xxx	Coagulation time (sec.)	291±148	374±138	403±269	441±194	392±161	380±173
1.	Milk yield (kg)	21.2±4.7 -0.28*	18.7±3.9 -0.25*	15.8±3.5 -0.33**	14.3±3.2 -0.33**	13.0±3.5 -0.19	16.6±4.8 -0.35**
2.	Dry matter (%)	13.23±1.03 -0.04	13.02±0.95 -0.09	13.13±0.95 -0.08	13.47±0.93 -0.19	13.77±1.05 -0.14	13.32±1.01 -0.08
3.	Fat (%)	4.51±0.96 -0.04	4.14±0.81 0.20	4.27±0.78 +0.07	4.30±0.82 -0.17	4.56±0.83 -0.10	4.40±0.85 -0.08
4.	Total protein (%)	3.12±0.36 -0.12	3.25±0.37 +0.18	3.35±0.35 -0.12	3.48±0.38 +0.05	3.70±0.40 -0.08	3.38±0.42 +0.08
5.	Casein (%)	2.57±0.40 -0.33**	2.48±0.41 +0.20	2.55±0.37 -0.02	2.65±0.42 -0.07	2.82±0.41 -0.06	2.57±0.43 +0.02
6.	Lactose (%)	4.87±0.20 +0.14	4.87±0.23 +0.06	4.75±0.26 -0.34**	4.74±0.23 -0.33**	4.72±0.22 -0.13	4.79±0.24 -0.2**
7.	Calcium (mg/g)	1.06±0.12 -0.10	1.02±0.14 -0.07	1.03±0.10 -0.30*	1.04±0.12 -0.27*	1.11±0.17 -0.28*	1.05±0.14 -0.20**
8.	Magnesium (mg/g)	73.7±15.7 -0.01	74.4±15.7 +0.11	83.7±14.0 -0.01	87.1±17.0 +0.16	88.4±11.0 -0.04	81.3±16.0 +0.14*
9	Phosphorus (mg/100mg)	29.1±4.0 +0.11	28.1±2.8 -0.07	28.8±3.3 -0.22	30.4±3.3 -0.06	32.1±4.6 -0.13	29.7±3.9 -0.03
10.	Sodium (mg/g)	0.38±0.05 +0.29*	0.36±0.07 +0.09	0.38±0.10 +0.37**	0.39±0.09 +0.35**	0.40±0.07 +0.13	0.38±0.08 +0.27**
11.	Potassium (mg/g)	1.37±0.24 +0.05	1.39±0.32 -0.03	1.47±0.15 -0.01	1.48±0.16 +0.08	1.47±0.15 +0.15	1.44±0.19 +0.10
12.	Chlorides (mg/100g)	0.107±0.015 +0.28*	0.110±0.016 +0.06	0.119±0.020 +0.29*	0.124±0.020 +0.32**	0.127±0.020 +0.01	0.117±0.020 +0.27**
13.	Alkaline phosphatase (IU)	8.3±4.8 +0.24*	8.5±4.6 -0.10	11.1±6.4 -0.10	15.2±20.8 +0.14	16.0±23.5 +0.04	11.8±14.9 +0.10
14.	Acid phosphatase (IU)	4.4±5.1 +0.10	5.0±6.6 -0.12	4.1±4.4 +0.09	4.0±4.1 -0.4	4.3±4.6 -0.16	4.4±5.0 -0.4
15.	Lysozyme (U)	5.9±5.7 -0.14	7.1±6.3 -0.01	5.2±4.3 -0.04	5.4±3.6 -.33**	6.3±4.8 -0.19	6.0±5.1 -0.14*
16.	Density (Ld°)	29.7±1.5 -0.17	30.2±3.7 +0.13	30.3±1.8 -0.23	30.4±1.4 -0.15	30.6±1.5 -0.10	30.2±2.2 -0.03
17.	Heat stability (ethanol ml/10ml)	4.0±2.9 +0.55**	4.2±2.2 +0.16	4.1±1.7 +0.23	4.2±1.5 +0.22	4.3±1.5 +0.37**	4.2±2.1 +0.30**
18.	Acidity (pH)	6.71±0.07 +0.14	6.70±0.21 +0.25*	6.69±0.13 +0.26*	6.67±0.11 +0.24*	6.72±0.12 +0.06	6.70±0.14 +0.15**
19.	Somatic cell count (10/ml)	280±592 +0.43**	198±349 +0.31**	269±601 +0.34**	322±529 +0.16	268±366 +0.06	268±496 +0.26**

xx - value of correlation coefficient statistically highly significant (p = 0.01);
x - value of correlation coefficient statistically significant (p = 0.05)