ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume LIX 10 Number 1, 2011

EXPLORATORY ANALYSIS OF DYNAMICS OF FREQUENCY DISTRIBUTION OF RAW COW MILK QUALITY INDICATORS IN THE CZECH REPUBLIC

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Received: August 9, 2010

Abstract

HANUŠ, O., JANŮ, L., SCHUSTER, J., KUČERA, J., VYLETĚLOVÁ, M., GENČUROVÁ, V.: *Exploratory analysis of dynamics of frequency distribution of raw cow milk quality indicators in the Czech Republic.* Acta univ. agric. et silvic. Mendel. Brun., 2011, LIX, No. 1, pp. 83–100

A consistent link of the raw milk quality (RMQ) to the farmer price is essential. The aim was to analyse the properties of milk quality indicators (MQIs) and propose a new synthetic relative MQI (SQSM) from among various individual MQIs. SQSM could serve for consistent inclusion each quality change into the price. The paper was focused on exploratory analysis (normality (N) testing of files of MQIs). On the basis of the results, the MQIs were divided into two groups without and with necessity of original data transformation (TRN). Log and Box–Cox TRNs were tested in terms of possibilities of the files approach to the normal data frequency distribution (FD). The compositional MQIs deviated less and health and hygienic MQIs more from normal FD in original data ($P < 0.05$). The TRNs approached the data files to N very markedly in health and hygienic MQIs. The synthesis of various values of MQIs into SQSM was proposed. SQSM values were derived from model file of real data about MQIs and validated for use at farmer milk price modifications by the normality FD test. 33.3% of month SQSM files were normal ($P > 0.05$), the other were very close to the N with negligible deviations. The useability of the SQSM system for the balancing of raw milk purchase price premiums and penalties was tentatively confirmed.

dairy cow, raw milk, bulk sample, milk quality indicator, exploratory analyse, data frequency distribution

The raw milk quality (RMQ) is a crucial factor of the dairy food chain safety (Vyletělová *et al.*, 1999, 2000 and 2001; Cempírková and Thér, 2000; Cempírková, 2001, 2002 and 2007; Hanuš *et al.*, 2004 a). The regular RMQ control system satisfies the important social order (Baumgartner *et al.*, 2000). Therefore the current RMQ investigation and its payment are very important measures. It was confirmed by the results of the authors Deneke *et al.*, (2004). They concluded that farms with service agreements about their milking plants had lower tank cell counts, higher RMQ and lower losses due to penalization. The positive development of cow RMQ, which was caused due to the legislative changes of the milk quality indicators (MQIs) discrimination limits, was compared during the period of ten years in the Czech Republic (CR). The expressive improvement was observed both compositional and especially health and hygienic indicators (Janů *et al.*, 2007). E. g. the arithmetical means of the total mesophilic bacteria count (TMBC) were 203.8 ths.ml^{-1} in 1994 and 44.5 ths.ml^{-1} in 2003 (today 37.4 ths.ml^{-1}). A treble reduction was relatively 78.2 (2003) and 81.6% (today). A ten times as numerous reduction in the coli bacteria count was found. Also the decrease of the occurrence frequency in the inhibitory substance residues from 0.64 to 0.24% (today 0.17%) was very important. A stagnation was stated in somatic cell count (SCC, x = 272 and xg = 228 ths.ml^{-1} in 1994; x = 252 and xg = 230 ths.ml^{-1} in 2003). The current RMQ is quite comparable or better within the bounds of the dairy developed countries with large dairy cow herds and is nearing the quality in the dairy developed countries with small dairy cow herds (Hanuš *et al.*, 2003). The relationships among occurrences of different risky microorganism groups in the various organic materials (feed, raw milk, excrements) at the agricultural beginning of milk food chain were evaluated in other paper (Hanuš *et al.*, 2004, a) including the good absolute results under average conditions of model farms in the CR. A reserve for the next improvement of the RMQ is particularly in the SCC in the CR. Despite this fact it can be stated that the milk production and processing chain is probably the safest of those considered for comparison (Hanuš *et al.*, 2004, b). It was confirmed by a monitoring result in Germany as well. According to the official survey results it was stated (circular of AFEMA, Baumgartner and Schuster, 2005) that milk and milk products pertained to the safest food on the market. The general aspects of quality in market chains were defined by Titchener (1998). Kvapilík (1997, 2004, 2005 a, b), Wet (1998), Hamann (2002), Bossuyt (2003) and Kvapilík and Střeleček (2003) were concerned with questions of the payment of raw cow milk in accordance with its quality or economy. It means with a link of the purchase price to the values of the MQIs in different point of views. E. g. in terms of the rules and links of the farmer price construction according to supplier-processor contracts, which are the main instruments for the RMQ growth. Some of the rules are in other publication (Dairy Crest, 2002). Some materials (Hanuš, 2000; Janů *et al.*, 2005, 2007; Hanuš *et al.*, 2007) were concerned with the problem of the possibility of creating a new, consistent, synthetic, relative quality indicator of raw cow milk for every change of its quality to be taken into account in the purchase price. For a further improvement of MQIs a consistent link of the RMQ to the farmer price is essential. This fact was often underestimated in the CR during last time (Hanuš, 2000; Janů *et al.*, 2005 and 2007; Hanuš *et al.*, 2007).

Aim of the work

The aim of this work is to prepare a basis for formulation possibility of construction rules of an evaluation algorithm, which will be able to synthetize the different MQIs into one relative quality value. Further, the aim of the mentioned algorithm will be to create a new synthetic relative RMQ indicator (SQSM) from among various individual MQIs, which will be consistently able to include each of the quality changes into the price. It has to be flexible in terms of number of the possibly included MQIs. Therefore, an analysis of the properties and behaviour of the MQIs during the period is necessary. That is reason, why this work was focused on statistical exploratory analyse of the one-dimensional data sets about real MQIs in terms of their dynamics evaluation of data frequency distribution (FD). Such a kind of evaluation has not been performed in the CR up to now. Nevertheless, any study about FD of MQIs for purposes of the obtaining of knowledge and subsequently construction rules of a synthetic RMQ indicator is not known as well. In general, the existence of hypothesis about mentioned synthetic RMQ indicator was allowed due to milk analytical methods and statistical methods expansion during last time. Possible application of SQSM system in the practice could improve objectivity of milk payment according to its quality and in this way support higher quality more consistently as compared to today circumstances. The work was carried out in terms of further promotion of the milk food chain safety as well as for the improvement of the competitive ability of the dairy production branch.

MATERIAL AND METHODS

Evaluated set of bulk milk samples

The bulk milk samples (MSs) of a large data set were regularly obtained (once or several times per month) from commercial dairy herds for the RMQ determination (mostly according to the standard CSN 57 0529) within the framework of the official milk payment system during twelve calendar months of 1994 and 2003. The MSs were treated by a low temperature of about 6 °C and immediately transported to the accredited milk laboratory. Some of them were preserved, some of them not, but the MSs were generally analysed in accordance with the relevant standard operation procedures of the accredited laboratory. The MSs came from both of the milked populations of the dairy cows in the country, Holstein and Czech Fleckvieh. There were investigated different numbers of MSs for different MQIs. The maximum sample number was for milk freezing point and some other MQIs (n = 72 607) and the minimum for free fatty acids (n = 11 540). The data sets of 1994 and 2003 were a slightly different as to the MQIs, which are regularly measured. E. g. the casein content was measured and whey protein content calculated in 2003 only similarly the free fatty acid concentrations.

Legislation aspects of standards for raw cow milk quality

In general, the discrimination limit values according to the valid standards (EEC 92/46; Regulation 853/2004 and CSN 57 0529) were used for the purposes of evaluations and comparisons of the raw MQIs in this work. During the mentioned period the legislative discrimination limit for the SCC was changed. That was made with the limit $\leq$400 ths.ml^{-1} being valid for the first quality class by the end of 1994 (there also existed a lower class for the $\leq$500 ths.ml^{-1} standard quality). From the beginning of 1995 the limit $\leq$400 ths.ml^{-1} was already valid for the standard RMQ, which means that the quality criterion was made stricter (CSN 57 0529 and its amendments and appendices). The TMBC standard discrimination limit was made more restrictive in a very marked way. In 1994 the value $\leq$300 ths. CFU.ml^{-1} was valid for the first class of quality. There were also lower classes of quality (II ≤800 and III ≤ 2 000 ths.CFU.ml^{-1}). From the beginning of 1995 the limit ≤100 ths.CFU.ml^{-1} was valid for the first class of quality and from 1998 already for the allover standard RMQ (CSN 57 0529).

Investigated MQIs with their abbreviations and units

With tested MQIs that were measured and calculated the following listed abbreviations and units have been used: F milk fat content (g.100ml^{-1}; %); L lactose content (monohydrate; g.100g^{-1}; %); SNF solids non fat content (g.100g^{-1}; %); DM dry matter (g.100g^{-1}; %; calculated indicator); CP crude protein (total N×6.38; g.100g^{-1}; %); CAS casein (casein N×6.38; g.100g^{-1}; %); WP whey protein content (g.100g^{-1}; %; calculated indicator); MFP milk freezing point (°C or m°C × (–1)); SCC somatic cell count (ths.ml^{-1}); F/CP ratio between fat and crude protein, calculated indicator of nitrogen/protein metabolism of dairy cow herd; U urea concentration (mmol.l^{-1}); SH titratable acidity (in ml 0.25 mol.l^{-1} NaOH solution); FFA concentration of milk fat free fatty acids (mmol.100g^{-1}); TMBC total mesophilic bacteria count (ths.CFU.ml^{-1}); CBC coli bacteria count (CFU.ml^{-1}); TRBC thermoresistant bacteria count (CFU.ml^{-1}); PBC psychrotrophic bacteria count (CFU.ml^{-1}); RIS occurrence frequency of residues of inhibitory substances (%; antibiotic drugs occurrence); MFA milk fermentation ability by dairy noble culture (Rx, *Lactobacillus bulgaricus* and *Streptococcus thermophillus*, in ml 0.25 mol.l^{-1} NaOH solution).

Used milk analytical methods

Chemical and physical methods and also indirect instrumental methods

The MFPs were measured by the two analytical methods. The first was carried out with MilkoScan 6000 system (Foss Electric, Denmark). This was adjusted according to the reference cryoscopic method results in regular intervals. It means an alternative measurement of the milk freezing point equivalent. The other measurement procedure was performed by the own cryoscopic method, which was the instrument Cryo-Star automatic Funke-Gerber (Germany). The mentioned procedure was realized with that part of the analysed MSs that showed suspicious values by the first measurement method. The selected measurement mode was reference Plateau Search in this case. The used instrument was under regular calibration by the standard NaCl solutions and regularly took part in the national analytical proficiency testing with successful results. The work was performed according to CSN 57 0538. The incidental interference effects were monitored. The other investigated MQIs, such as the F, L, CP, CAS, DM, SNF, U, FFA, were measured by the instrument MilkoScan 6000 (Foss Electric, Denmark; MIR-FT mid infra red spectrophotometric apparatus with mathematical evaluation of the whole IR spectrum by means of Fourier's transformations), which was regularly calibrated according to the reference method results (standard CSN 57 0536, by Gerber's method for fat content, Kjeldahl's method for crude protein content and polarimetric and gravimetric methods for lactose and SNF contents, according to the standard CSN 57 0530; for U and FFA according to the direct ureolytic, photometrical and titration method results). The SCC was determined by the Fossomatic instrument (Foss Electric, Denmark) according to the standard CSN EN ISO 13366-3. Both the previously mentioned instruments took part in the relevant national proficiency testing with regularly good results. The TMBC was determined by the Bactoscan 8000 instrument (Foss Electric, Denmark) under similar conditions as with the previous apparatus. The Bactoscan was continuously calibrated according to results of the plate cultivation for TMBC. The colonies of mesophilic bacteria species were counted after their growth for 72 h. of incubation at 30 °C (CSN 57 0101).

Microbiological cultivation methods

The residues of inhibitory substances were investigated by the reaction of the Delvo-Test method, which is performed on the basis of the growth of test microbial strain *Bacillus stearothermophilus* var. *calidolactis*. The other microbiological MQIs (CSN 57 0101, CSN ISO 6730, CSN ISO 4832) were also investigated in an accredited testing laboratory. All these MQIs are formulated in CFU.ml^{-1}: TRBC, PBC, CBC. The GTK-M Agar (Milcom Tábor) was used as a cultivation medium for PBC and TRBC determination. The VRLB Agar (Milcom Tábor) was used for CBC cultivation. The temperature/time combinations of the microbiological cultivation conditions were 6.5 °C/10 days for PBC, 30 °C/72 hours after previous MS inactivation by heating at 85 °C for 10 min. for TRBC and 36 °C/24 h. for CBC.

Performed statistical procedures

The validation of the large data file was carried out by determination of the discrimination limits for all the MQIs. These limit values were derived from mean values and measure of variability as x ± 1.96 or 2.58 × sx, which included 95 or 99% of probability that the values belong to the data file. If it was not possible, e. g. due to a marked deviation of data distribution from the normal FD, another procedure including the application of a qualified estimation was chosen. The result shows that data filtration should not let through wrong, improbable values subsequent evaluation. Of course, the data files always include values out of the legislative framework of standard RMQ. The possible occurrence of extreme by low or high values (especially at such MQIs as TMBC, SCC, CBC, TRBC and PBC) was solved individually by the excluding them in view of the previous development of the values in the existing data source. The really used validation limits for the MQIs were published previously (Janů *et al.*, 2007). This validation was basis for data files I (validated, but no standardized, NST). The data files II (validated and standardized, ST) were obtained due to the limitation of MQIs values by valid standard limits (CSN 57 0529), it means due to the standardization (STN). The statistical evaluation of the data files was performed separately for the individual calendar months because of the generally valid model of the month payment system for raw milk. The main statistical characteristics, such as the arithmetical (x) and geometrical mean (xg), standard deviation (sx) and variation coefficient (vx), were calculated for the month data files. If necessary, the MQIs (SCC and microbiological indicators in this case) data were logarithmically transformed ($\log_{10}$) before the evaluation of the main statistical characteristics and their mutual relationships because of no presumption of the normal data FD (Ali and Shook, 1980; Shook, 1982; Reneau, 1986; Meloun and Militký, 1994; Kupka, 1997; Hanuš *et al.*, 2001). Box-Cox (BC) transformation (TRN) was tested as well. The FD normality of the values of the MQIs data files was tested in terms of their normality by the Q and Q-Q graphs in the framework of the exploratory analysis (Meloun and Militký, 1994; Kupka, 1997). The third and fourth central statistical moments of the MQIs data files, it means the obliqueness (a_3) and acuteness (excess, a_4) were tested. The synthetic SQSM indicator was calculated on the basis of the own previous and here performed research according to following formulas: DX = (IND – x)/sx, where: IND is individual value of MQI of supplier, x is month arithmetical average of MQI of all milk suppliers and sx its standard deviation; SQSM is the average: sum of right oriented (according to RMQ growth) DXs of MQIs of identical raw milk delivery divided by the relevant number of MQIs. The eight chosen most frequent and important MQIs were included as combination into SQSM calculation: F, CP, SNF, MFP, log SCC, log TMBC, log CBC (last three as transformed MQIs, TRN), RIS. The weights of the used MQIs were same, it means no preference for some of the MQIs. FD of month files of SQSM indicator (2003) was investigated by exploratory analysis as well. In general a lot of statistical tests were performed. It is not possible to demonstrate all the results by figures here. All year months were used for a demonstration (tables and figures) of the obtained results only in the most important MQIs and in the cases of most important phenomenons.

RESULTS AND DISCUSSION

General result description of the raw milk quality

As mentioned above, the RMQ was improved during the reference period. The negligible deviations between arithmetical means and medians of month data files of compositional MQIs and indispensable in hygienic MQIs were found in the previous paper (Janů *et al.*, 2007). The logarithmic and BC data transformations decreased these deviations markedly especially in health and hygienic MQIs. An exploratory analysis of one-dimensional data files of MQIs was shown as necessary.

Exploratory analysis according to individual MQIs

SNF: month tests a_3 and a_4 mostly differed from standard normal FD ($P < 0.05$), but the deviations were practically negligible, a_4 values were often near to 3 (Tab. I), therefore TRN is not necessary; STN (II) mostly turned over the a_3 from right-hand to left-hand asymmetry (A); the month FD of data files are similar between years 1994 and 2003. **CP**: the rate of a_3 FD normal files increased during reference period (1994–2003); deviations from normality (N; $P < 0.05$) were negligible (Tab. I); the influence of STN (II) was small; TRN is not necessary. **F**: all files (1994 and 2003, Tab. I, Fig. 1 1–12, I and II) differed from normal FD ($P < 0.05$); changes between years were small;

I: *The normality evaluation of raw milk data files*

Fat, Set I, 2003					Fat, Set I, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	0.26	5.66	no	no	1	–1.14	3.90	no	no
2	0.26	5.5	no	no	2	–0.84	2.12	no	no
3	0.34	5.03	no	no	3	0.27	4.45	no	no
4	0.48	4.79	no	no	4	0.21	4.73	no	no
5	0.35	5.1	no	no	5	0.26	4.71	no	no
6	0.21	5.64	no	no	6	0.31	4.51	no	no
7	0.23	4.33	no	no	7	0.17	4.57	no	no
8	0.16	4.66	no	no	8	0.27	5.06	no	no
9	0.29	4.82	no	no	9	0.19	4.77	no	no
10	0.30	5.28	no	no	10	0.14	4.52	no	no
11	0.40	5.22	no	no	11	0.17	4.41	no	no
12	0.49	4.79	no	no	12	0.46	4.51	no	no

CP, Set I, 2003					CP, Set I, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	0.00	3.67	yes	no	1	0.33	3.85	no	no
2	–0.09	3.75	no	no	2	0.43	3.94	no	no
3	–0.06	3.76	no	no	3	0.44	4.03	no	no
4	–0.05	3.89	no	no	4	0.42	4.09	no	no
5	–0.11	3.99	no	no	5	0.15	4.16	no	no
6	–0.02	3.79	no	no	6	0.08	4.07	no	no
7	0.06	3.60	no	no	7	0.02	3.90	yes	no
8	0.12	3.67	no	no	8	0.07	3.75	no	no
9	0.10	3.74	no	no	9	0.09	3.88	no	no
10	0.07	3.73	no	no	10	0.14	3.85	no	no
11	0.06	3.75	yes	no	11	0.24	4.11	no	no
12	0.07	3.94	no	no	12	0.38	4.03	no	no

Lactose, Set I, 2003					Lactose, Set I, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	–0.77	4.70	no	no	1	–0.43	4.05	no	no
2	–0.69	4.53	no	no	2	–0.53	4.60	no	no
3	–0.69	4.43	no	no	3	–0.57	4.31	no	no
4	–0.71	4.51	no	no	4	–0.61	4.07	no	no
5	–0.63	4.32	no	no	5	–0.44	4.36	no	no
6	–0.52	4.62	no	no	6	–0.51	4.59	no	no
7	–0.63	4.72	no	no	7	–0.37	4.17	no	no
8	–0.68	4.65	no	no	8	–0.44	4.25	no	no
9	–0.76	4.57	no	no	9	–0.48	4.27	no	no
10	–1.04	5.49	no	no	10	–0.40	4.16	no	no
11	–0.84	4.85	no	no	11	–0.53	4.48	no	no
12	–0.52	3.79	no	no	12	–0.62	4.44	no	no

SNF, Set I, 2003					SNF, Set I, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	–0.33	3.81	no	no	1	–0.99	3.69	no	no
2	–0.38	3.93	no	no	2	0.05	3.87	yes	no
3	–0.36	3.87	no	no	3	–.005	3.70	yes	no
4	–0.42	3.78	no	no	4	–0.07	3.88	no	no
5	–0.28	3.86	no	no	5	–0.17	4.02	no	no
6	–0.22	3.60	no	no	6	–0.23	3.82	no	no
7	–0.20	3.61	no	no	7	–0.26	3.58	no	no
8	–0.23	3.36	no	no	8	–0.19	3.61	no	no
9	–0.28	3.76	no	no	9	–0.21	3.68	no	no
10	–0.30	3.78	no	no	10	–0.12	3.62	no	no
11	–0.23	3.66	no	no	11	–0.17	3.72	no	no
12	–0.22	3.96	no	no	12	–0.07	3.80	no	no

MFP, Set I, 2003					MFP, Set I, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	–0.55	5.97	no	no	1	0.43	4.25	no	no
2	–0.35	5.50	no	no	2	–0.55	4.16	no	no
3	–0.36	5.97	no	no	3	–0.74	4.96	no	no
4	–0.41	5.97	no	no	4	–0.27	4.22	no	no
5	–0.36	6.11	no	no	5	–0.46	4..68	no	no
6	0.01	7.84	yes	no	6	–0.41	4.29	no	no
7	–0.03	7.46	yes	no	7	–0.51	4.41	no	no
8	0.18	6.60	no	no	8	–0.51	4.24	no	no
9	0.04	6.59	yes	no	9	–0.51	4.51	no	no
10	–0.27	5.68	no	no	10	–0.45	4.32	no	no
11	–0.39	7.14	no	no	11	–0.42	4.62	no	no
12	–0.36	6.73	no	no	12	–0.54	4.34	no	no

Urea, Set I, 2003					Casein, Set I, 2003				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	0.09	2.18	no	no	1	–0.06	3.69	yes	no
2	–0.01	2.21	yes	no	2	–0.12	3.71	no	no
3	0.34	3.06	no	yes	3	–0.09	3.77	no	no
4	0.01	2.24	yes	no	4	–0.14	3.83	no	no
5	0.06	2.21	yes	no	5	–0.09	4.00	no	no
6	0.04	2.29	yes	no	6	–0.03	3.79	yes	no
7	0.02	2.33	yes	no	7	0.06	3.59	yes	no
8	–0.01	2.31	yes	no	8	0.08	3.60	no	no
9	0.00	2.27	yes	no	9	–0.27	3.47	no	no
10	–0.03	2.26	yes	no	10	0.03	3.73	yes	no
11	0.03	2.13	yes	no	11	–0.01	3.82	yes	no
12	0.25	2.51	no	no	12	–0.75	3.99	no	no

SCC, Set II, 2003					SCC, Set II, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	0.18	2.34	no	no	1	0.18	2.18	no	no
2	0.05	2.27	yes	no	2	0.15	2.17	no	no
3	0.06	2.24	yes	no	3	0.16	2.2	no	no
4	–0.02	2.27	yes	no	4	0.14	2.16	no	no
5	–0.02	2.14	yes	no	5	0.09	2.12	no	no
6	–0.21	2.24	no	no	6	0.001	2.12	yes	no
7	0.01	2.05	yes	no	7	–0.13	2.09	no	no
8	–0.27	2.21	no	no	8	–0.12	2.06	no	no
9	–0.14	2.22	no	no	9	0.03	2.16	yes	no
10	–0.03	2.35	no	no	10	0.05	2.16	yes	no
11	–0.01	2.37	yes	no	11	–0.05	2.19	yes	no
12	–0.07	2.32	no	no	12	–0.04	2.18	yes	no

SCC, Set I, 2003					SCC, Set I, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	2.17	13.91	no	no	1	2.11	11.65	no	no
2	2.15	13.06	no	no	2	2.22	11.95	no	no
3	1.61	9.12	no	no	3	2.13	12.02	no	no
4	1.75	10.33	no	no	4	2.01	11.11	no	no
5	3.49	36.32	no	no	5	2.23	12.96	no	no
6	1.89	10.33	no	no	6	1.89	10.31	no	no
7	1.9	10.86	no	no	7	1.65	8.19	no	no
8	1.71	9.76	no	no	8	1.70	8.46	no	no
9	2.07	12.73	no	no	9	1.97	10.39	no	no
10	2.3	14.3	no	no	10	2.19	12.23	no	no
11	2.21	12.67	no	no	11	2.11	11.58	no	no
12	2.29	14.63	no	no	12	1.81	5.42	no	no

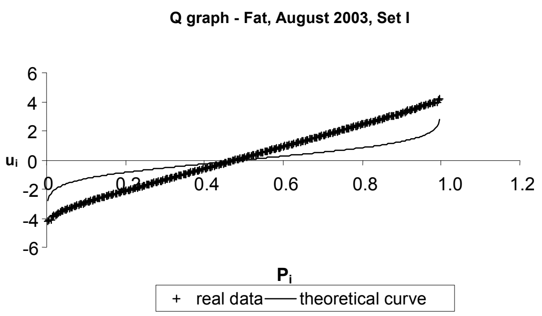
TMBC, Set II, 2003					TMBC, Set II, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	1.97	6.95	no	no	1	0.46	2.07	no	no
2	2.02	6.96	no	no	2	0.45	2.34	no	no
3	2.01	6.77	no	no	3	0.28	2.06	no	no
4	1.96	6.53	no	no	4	0.28	2.00	no	no
5	1.46	4.38	no	no	5	0.12	1.99	no	no
6	1.26	3.70	no	no	6	0.26	1.97	no	no
7	1.63	5.20	no	no	7	0.06	1.96	yes	no
8	1.52	4.61	no	no	8	0.28	1.99	no	no
9	1.68	5.31	no	no	9	0.24	1.98	no	no
10	1.96	6.79	no	no	10	0.24	2.02	no	no
11	1.46	4.47	no	no	11	0.19	1.98	no	no
12	1.68	5.41	no	no	12	0.26	2.02	no	no

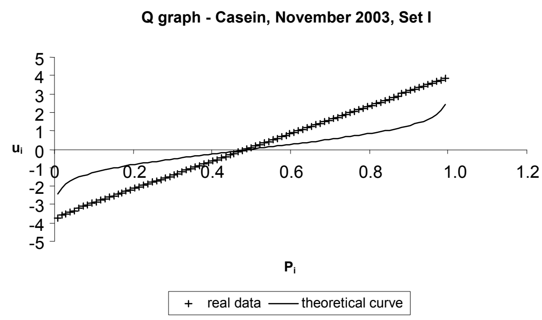
TMBC, Set I, 2003					TMBC, Set I, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	14.55	245.70	no	no	1	7.53	71.99	no	no
2	13.86	239.17	no	no	2	7.07	60.52	no	no
3	13.39	221.63	no	no	3	6.65	50.70	no	no
4	13.55	227.96	no	no	4	7.27	63.44	no	no
5	11.38	160.91	no	no	5	5.57	36.69	no	no
6	11.65	166.19	no	no	6	6.32	48.08	no	no
7	11.91	174.91	no	no	7	5.27	33.01	no	no
8	12.56	193.87	no	no	8	6.51	51.18	no	no
9	13.39	213.02	no	no	9	6.97	57.59	no	no
10	14.64	256.34	no	no	10	8.22	81.94	no	no
11	12.39	189.35	no	no	11	8.17	82.24	no	no
12	13.71	234.57	no	no	12	9.17	102.29	no	no

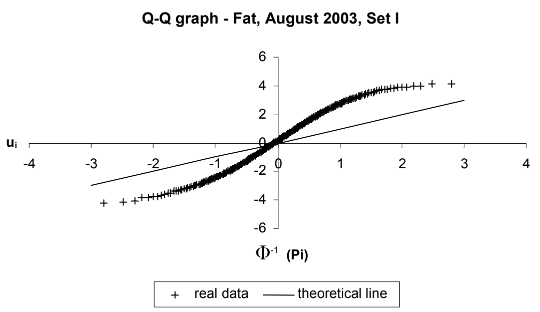
PBC, Set I, 2003					PBC, Set I, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	5.14	35.17	no	no	1	7.06	77.17	no	no
2	10.38	122.22	no	no	2	5.55	44.08	no	no
3	2.18	11.46	no	no	3	6.26	56.75	no	no
4	8.59	90.11	no	no	4	10.64	157.98	no	no
5	5.5	37.67	no	no	5	6.86	7.33	no	no
6	6.83	53.73	no	no	6	7.21	73.88	no	no
7	5.59	43.94	no	no	7	5.48	40.49	no	no
8	4.99	29.49	no	no	8	7.34	79.02	no	no
9	6.6	55.21	no	no	9	6.39	59.39	no	no
10	10.47	117.38	no	no	10	7.53	79.60	no	no
11	1.97	6.25	no	no	11	8.26	102.55	no	no
12	4.95	31.6	no	no	12	14.51	310.14	no	no

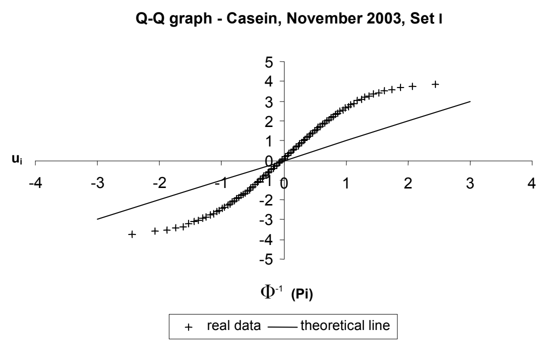
F fat (g.100ml^{-1}; %); L lactose (%); SNF solids non fat (%); DM dry matter (%); CP crude protein (%); CAS casein (%); WP whey protein (%); MFP milk freezing point (°C or m°C × (–1)); SCC somatic cell count (ths.ml^{-1}); F/CP ratio between fat and crude protein; U urea (mmol.l^{-1}); SH titratable acidity (in ml 0.25 mol.l^{-1} NaOH solution); FFA milk fat free fatty acids (mmol.100g^{-1}); TMBC total mesophilic bacteria count (ths.CFU.ml^{-1}); CBC coli bacteria count (CFU.ml^{-1}); TRBC thermo-resistant bacteria count (CFU.ml^{-1}); PBC psychrotrophic bacteria count (CFU.ml^{-1}); MFA milk fermentation ability (in ml 0.25 mol.l^{-1} NaOH solution).

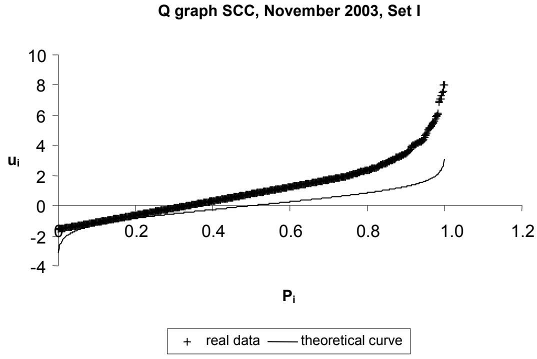
STN led to the longer distance from N; the files were gently left-hand as a rule; TRN is not necessary. **L**: all files with right-hand A differed from normal FD (Tab. I; $P < 0.05$), however, deviations were negligible; STN was not carried out; 2003 files (I) were more oblique; TRN is not necessary. **CAS**: all files 2003 (I) differed from normal FD ($P < 0.05$) in a_4 but some of them were normal in a_3; differences were minimal with irregularities about right- and left-hand A (Tab. I; Fig. 1). **MFP**: all files 1994 (I and II) and 2003 (II) were different from N (Tab. I; $P < 0.05$),

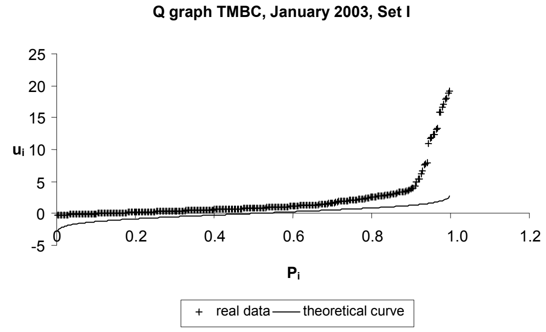


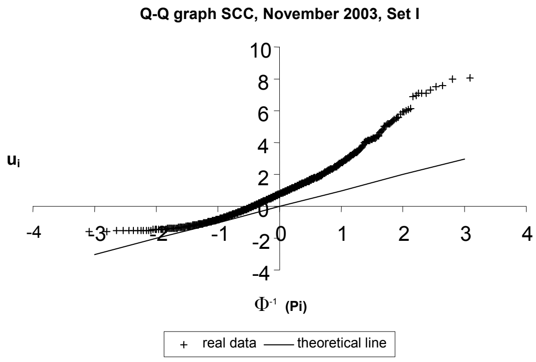


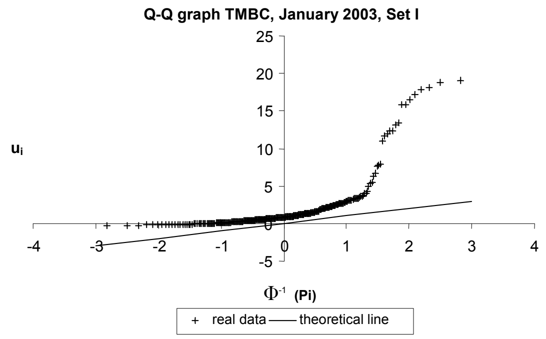


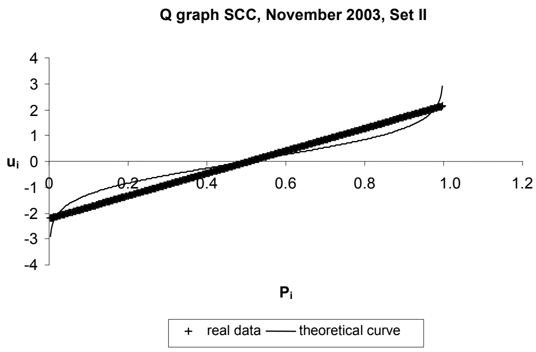


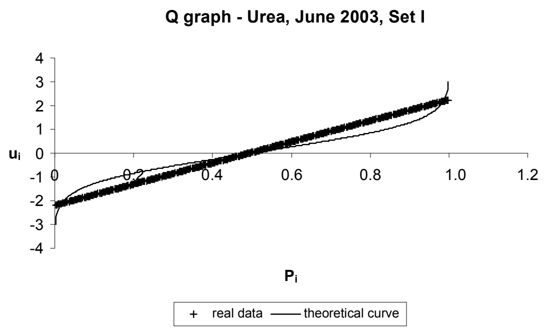

Q graph SCC, November 2003, Set I
ui
Pi
+ real data —— theoretical curve

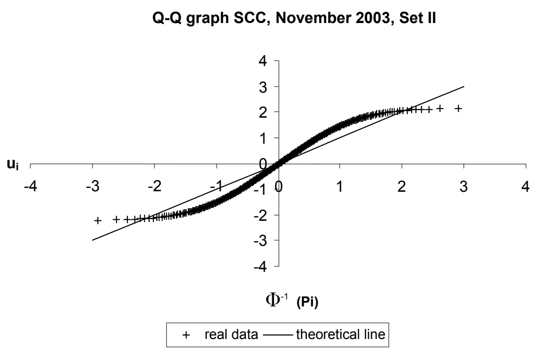

Q graph TMBC, January 2003, Set I
ui
Pi
+ real data —— theoretical curve

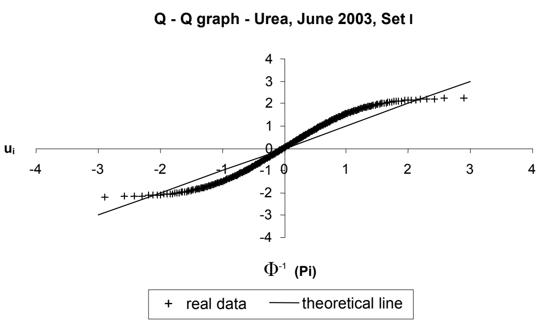

Q-Q graph SCC, November 2003, Set I
ui
Φ-1 (Pi)
+ real data —— theoretical line

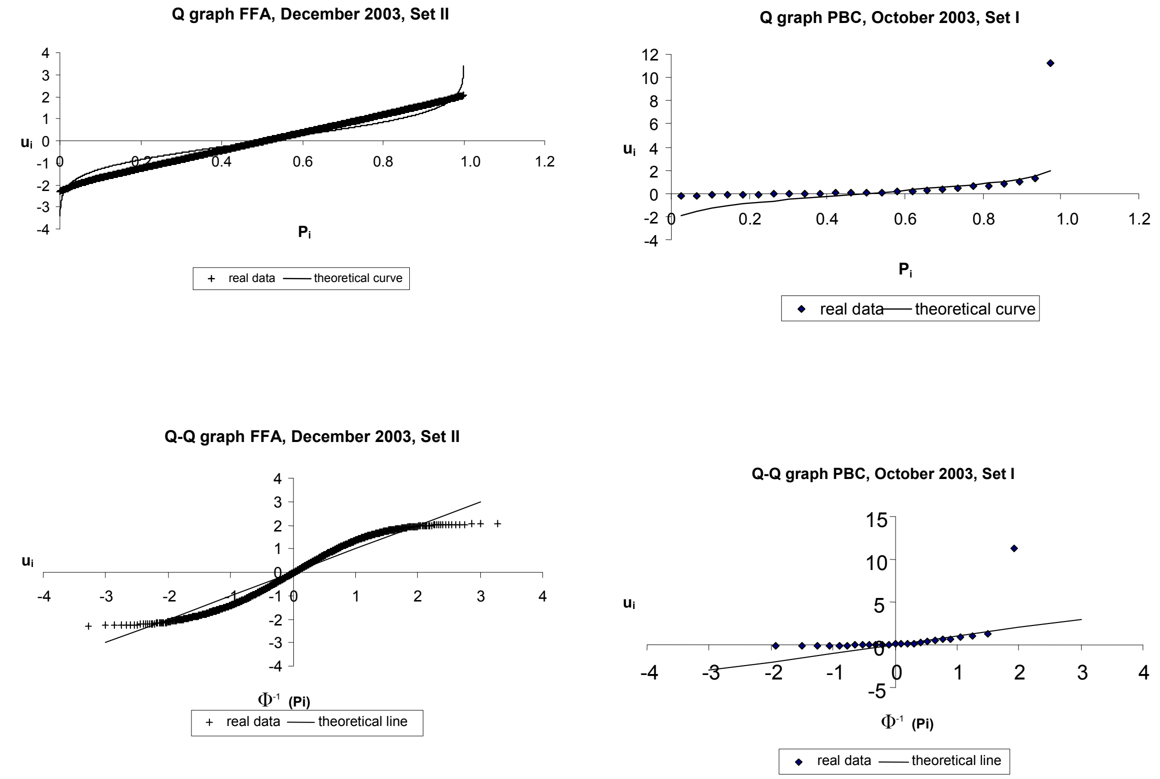

Q-Q graph TMBC, January 2003, Set I
ui
Φ-1 (Pi)
+ real data —— theoretical line


Q graph SCC, November 2003, Set II
ui
Pi
+ real data —— theoretical curve


Q graph - Urea, June 2003, Set I
ui
Pi
+ real data —— theoretical curve


Q-Q graph SCC, November 2003, Set II
ui
Φ-1 (Pi)
+ real data —— theoretical line


Q - Q graph - Urea, June 2003, Set I
ui
Φ-1 (Pi)
+ real data —— theoretical line



1: *Q and Q-Q graphs of fat, casein, SCC, TMBC, urea, FFA and PBC data files*

only some of month files 2003 (I) were normal in a_3 ($P > 0.05$); a_4 was higher in 2003 in comparison with 1994, which could have been caused by increasing of the technological discipline in raw milk production; STN turned mostly over the a_3 from slightly right-hand to slightly left-hand A; TRN is not necessary. **SCC**: all nonstandard files (Tab. I; Fig. 1; 1994 and 2003, 1–12, I) differed markedly from normal FD in a_3 with left-hand A and in a_4 as well; STN (II) led to better N and slightly right-hand A and a_4 was markedly reduced in both years; log TRN (Tab. II; Fig. 2) led to slightly right-hand A, the deviations from normal FD were significant, but smaller in comparison with not transformed files, therefore TRNs are necessary. **TMBC**: month files (Tab. I; Fig. 1; 1994 and 2003) I were markedly different from N ($P < 0.05$) with left-hand a_3 A; STN led near to N, mostly in 1994; log TRN (Tab. II; Fig. 2) led near to N, in particular for a_4, although the files still differed from N ($P < 0.05$) mostly with slightly left-hand A, only month

II: *The normality evaluation of logarithmic transformed data*

log SCC, Set II, 2003					log SCC, Set II, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	–0.83	3.34	no	no	1	–0.77	3.01	no	yes
2	–0.96	0.63	no	no	2	–0.80	3.07	no	yes
3	–0.93	3.58	no	no	3	–0.79	3.09	no	yes
4	–1.00	3.77	no	no	4	–0.79	3.04	no	yes
5	–0.95	3.56	no	no	5	–0.87	3.29	no	no
6	–1.20	4.23	no	no	6	–0.92	3.32	no	no
7	–0.90	3.35	no	no	7	–1.08	3.72	no	no
8	–1.24	4.30	no	no	8	–1.03	3.53	no	no
9	–1.10	4.04	no	no	9	–0.94	3.50	no	no
10	–1.07	4.03	no	no	10	–0.93	3.50	no	no
11	–1.07	4.14	no	no	11	–1.01	3.70	no	no
12	–1.07	3.92	no	no	12	–1.01	3.65	no	no

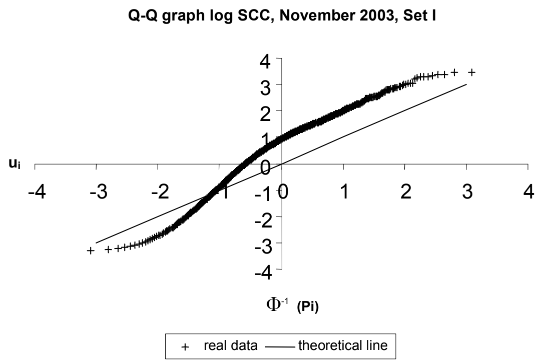
log SCC, Set I, 2003					log SCC, Set I, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	–0.37	3.45	no	no	1	–0.30	3.14	no	no
2	–0.44	3.65	no	no	2	–0.29	3.24	no	no
3	–0.49	3.51	no	no	3	–0.31	3.20	no	no
4	–0.50	3.65	no	no	4	–0.34	3.15	no	no
5	–0.38	3.68	no	no	5	–0.33	3.35	no	no
6	–0.55	3.89	no	no	6	–0.41	3.29	no	no
7	–0.41	3.31	no	no	7	–0.51	3.45	no	no
8	–0.64	3.93	no	no	8	–0.49	3.55	no	no
9	–0.47	3.81	no	no	9	–0.37	3.38	no	no
10	–0.46	3.99	no	no	10	–0.34	3.46	no	no
11	–0.40	3.97	no	no	11	–0.38	3.59	no	no
12	–0.47	3.90	no	no	12	0.25	2.98	no	yes

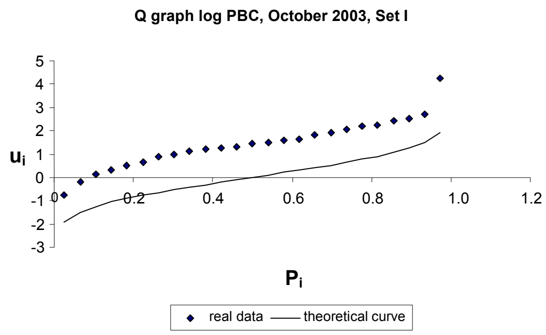
log TMBC, Set II, 2003					log TMBC, Set II, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	0.30	2.27	no	no	1	–0.35	2.31	no	no
2	0.54	2.27	no	no	2	–0.63	2.38	no	no
3	0.47	2.22	no	no	3	–0.79	2.87	no	yes
4	0.51	2.22	no	no	4	–0.73	2.82	no	no
5	0.11	2.11	no	no	5	–0.93	3.47	no	no
6	–0.03	2.15	yes	no	6	–0.73	2.89	no	yes
7	0.20	2.10	no	no	7	–0.99	3.60	no	no
8	0.16	2.11	no	no	8	–0.72	2.80	no	no
9	0.24	2.12	no	no	9	–0.77	2.98	no	yes
10	0.36	2.23	no	no	10	–0.76	2.99	no	no
11	0.08	2.18	no	no	11	–0.81	3.11	no	yes
12	0.18	2.20	no	no	12	–0.75	3.03	no	yes

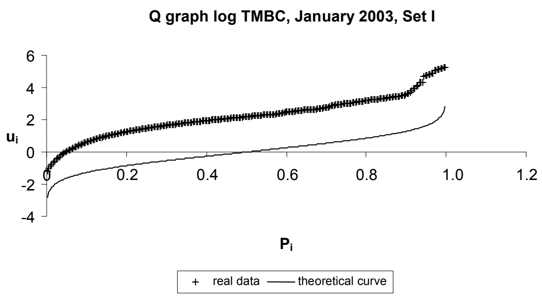
log TMBC, Set I, 2003					log TMBC, Set I, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	1.03	5.05	no	no	1	0.71	3.45	no	no
2	1.14	4.64	no	no	2	0.57	3.66	yes	no
3	1.07	4.39	no	no	3	0.50	3.72	yes	no
4	1.05	4.15	no	no	4	0.61	4.04	no	no
5	0.76	3.81	no	no	5	0.76	4.24	no	no
6	0.65	3.70	no	no	6	0.65	3.96	no	no
7	0.87	3.99	no	no	7	0.71	4.06	no	no
8	0.79	3.86	no	no	8	0.65	3.94	no	no
9	0.92	4.31	no	no	9	0.68	4.25	no	no
10	1.05	4.76	no	no	10	0.64	4.27	no	no
11	0.79	4.12	no	no	11	0.64	4.28	no	no
12	0.85	4.18	no	no	12	0.67	4.46	no	no

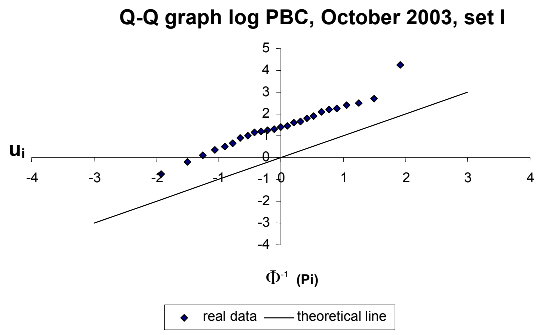
log PBC, Set I, 2003					log PBC, Set I, 1994				
			normality					normality	
month	a_3	a_4	a_3	a_4	month	a_3	a_4	a_3	a_4
1	1.82	5.51	no	no	1	–0.24	1.93	no	no
2	0.64	2.55	no	yes	2	–0.19	1.99	no	no
3	0.93	2.77	no	yes	3	–0.27	2.08	no	no
4	0.90	2.61	no	yes	4	–0.12	1.99	yes	no
5	1.23	3.77	no	yes	5	–0.21	1.98	no	no
6	0.90	3.48	no	yes	6	0.03	1.87	no	no
7	0.80	2.57	no	yes	7	–0.35	2.07	no	no
8	0.45	1.94	no	no	8	–0.22	2.02	no	no
9	1.28	3.40	no	yes	9	–0.24	1.93	no	no
10	1.19	3.29	no	yes	10	–0.29	2.27	no	no
11	0.60	2.03	no	yes	11	–0.30	2.37	no	no
12	0.58	2.12	no	no	12	–0.25	2.19	no	no

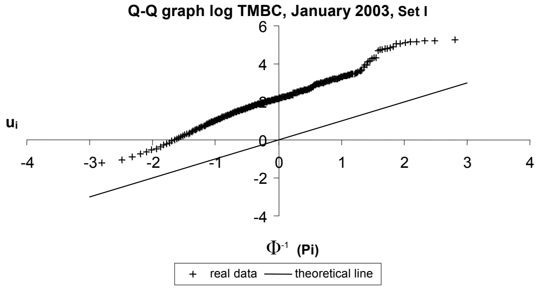
files 1994 (II) showed right-hand A; TRNs are necessary. **PBC**: all files I in both years (Tab. I; Fig. 1) differed markedly from normal FD ($P < 0.001$) in a_3 with left-hand A and in a_4 as well; month a_3 and a_4 values varied very strongly; STN (II) still led to N approach with left-hand A; log TRN (Tab. II; Fig. 2) caused that all month files I both years had been markedly near to the N in comparison with the original data, but











2: *Q and Q–Q graphs of logarithmic transformed data files (SCC, TMBC and PBC)* still with significant differences; STN (II) at TRN led to further approach to the N; TRNs are necessary. **CBC**: all files (1994 and 2003, 1–12, I) with exception one in a_4 were different from normal FD (from $P < 0.05$ up to $P < 0.001$); STN showed approach to N with mostly right-hand A in 1994 and left-hand A in 2003; log TRN led to approach to N in all files (I and II), but the differences were still significant ($P < 0.05$), but practically negligible, I and II files 1994 were mostly right-hand and 2003 left-hand; TRNs are necessary. **TRBC**: almost all files (1994 and 2003, 1–12, I and II) with exception of some a_4 the values deviated from N ($P < 0.05$ and $P < 0.001$); STN led to approach to N; log TRN led to marked approach to N (still $P < 0.05$) in comparison with the original data in all files as well; TRNs are necessary. **U**: month files (Tab. I; Fig. 1; 2003, I) did mostly not deviate ($P > 0.05$) from normal FD in a_3; most deviations were in a_4 ($P < 0.05$); TRNs are not needed. **FFA**: two month files (Fig. 1; 2003, I) were different from N ($P < 0.05$) with left-hand A of a_3; STN showed approach to N; TRNs could be suitable. **SH**: help file I (n = 76) was not different from N ($P > 0.05$); STN led to difference from normal FD and turned over left-hand to right-hand A; this indicator is used for quality payment only occasionally. **MFA**: assisted file I (n = 76) was different from N ($P < 0.05$); STN showed N ($P > 0.05$) and turned over a_3 from right-hand to left-hand A; despite this fact the TRNs are not necessary; this indicator is used for quality payment only occasionally.

General conclusion about exploratory analysis

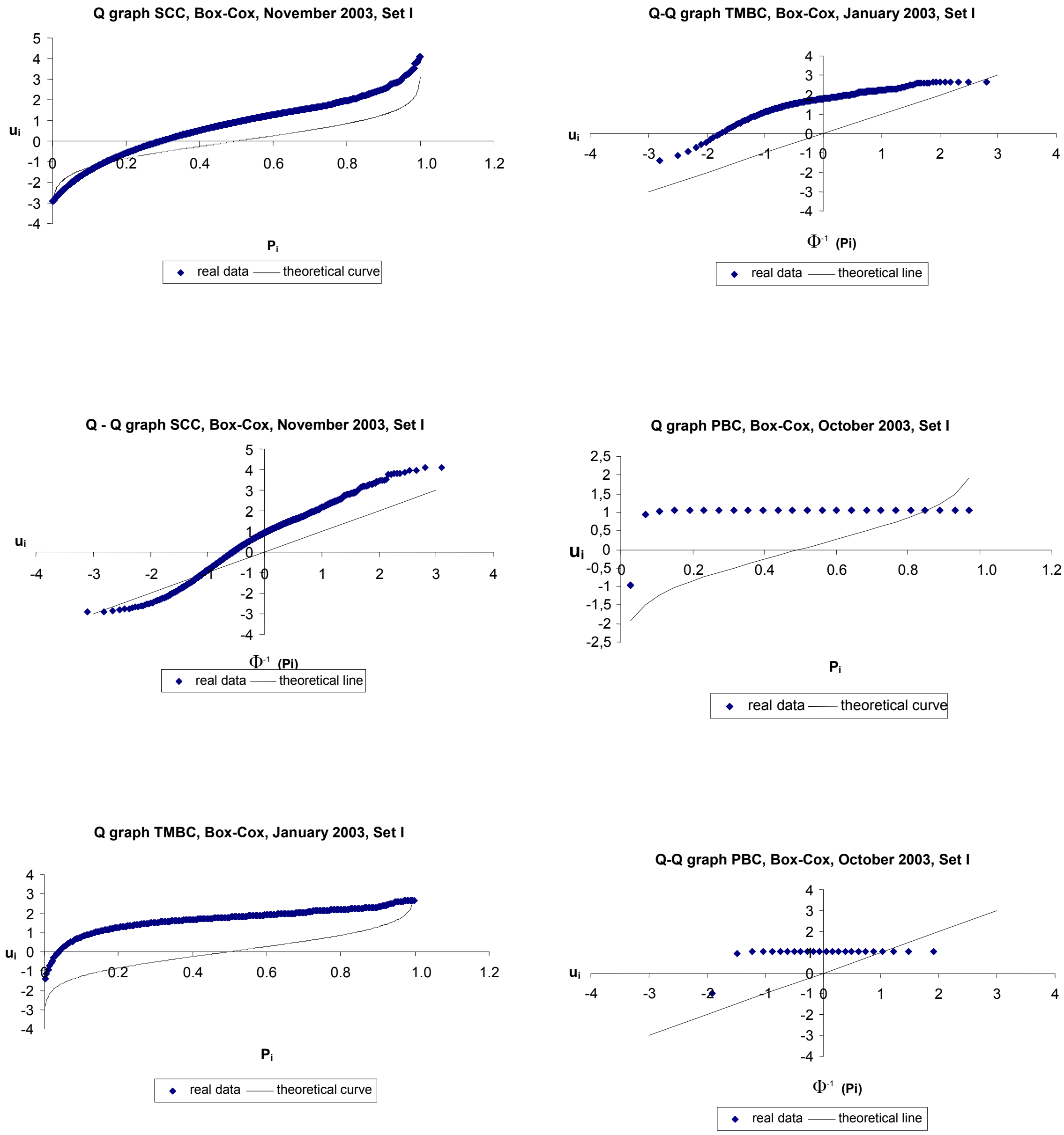
The exploratory analysis was performed in data MQIs (files I and II, 1994 and 2003). The obliqueness (a_3) and acuteness (a_4) values of the data files of MQIs including their quantil-quantile graphs were interpreted. The compositional MQIs had usually the character of data FD, which was quite near to the N ($a_3 = 0$ and $a_4 = 3$). However, these small deviations

III: *The normality evaluation of data files after Box–Cox transformation*

SCC, Set I, 2003, after Box-Cox transformation						TMBC, Set I, 2003, after Box-Cox transformation					
			normality		Box-Cox				normality		Box-Cox
month	**a_3**	**a_4**	**a_3**	**a_4**	**para.**	**month**	**a_3**	**a_4**	**a_3**	**a_4**	**para.**
1	0.0015	3.54	yes	no	0.19	1	–0.0003	2.10	yes	no	–0.402
2	–0.0004	3.73	yes	no	0.214	2	–0.0008	1.65	yes	no	–0.628
3	0.0003	3.45	yes	no	0.27	3	–0.0004	1.72	yes	no	–0.548
4	0.0002	3.61	yes	no	0.261	4	–0.0007	1.68	yes	no	–0.576
5	0.0006	3.53	yes	no	0.233	5	0.0002	2.28	yes	no	–0.285
6	0.0003	3.78	yes	no	0.255	6	–0.0003	2.50	yes	no	–0.224
7	0.00001	3.24	yes	no	0.22	7	0.0008	2.13	yes	no	–0.345
8	0.000008	3.75	yes	no	0.3085	8	0.0005	2.23	yes	no	–0.305
9	0.0002	3.81	yes	no	0.227	9	–0.0004	2.10	yes	no	–0.371
10	–0.0004	4.07	yes	no	0.208	10	–0.0003	1.94	yes	no	–0.456
11	0.0002	3.96	yes	no	0.179	11	0.0001	2.44	yes	no	–0.276
12	0.00004	4.02	yes	no	0.2175	12	–0.0008	2.28	yes	no	–0.324

PBC, Set I, 2003, after Box-Cox transformation					
			normal.		Box-Cox
month	**a_3**	**a_4**	**a_3**	**a_4**	**para.**
1	cannot	cannot	–	–	cannot
2	–0.0070	1.61	yes	no	–0.60
3	0.0030	1.26	yes	no	–1.10
4	–0.0100	1.29	yes	no	–1.00
5	0.0750	1.00	yes	no	–4.00
6	–0.0450	1.75	yes	no	–0.70
7	0.0690	1.27	yes	no	–1.00
8	–0.0190	1.52	yes	no	–0.90
9	cannot	cannot	–	–	cannot
10	0.0600	0.99	yes	no	–4.30
11	–0.0900	1.22	yes	no	–1.00
12	–0.0067	1.66	yes	no	–0.50

Cannot = cannot be done; no = $P \leq 0.05$; **yes** = $P > 0.05$; para. = parameter



3: *Q and Q–Q graphs of Box–Cox transformed data files (SCC, TMBC and PBC)*

from N were statistically significant (P < 0.05) because of the high numbers of cases in the MQI data files. Of course, in spite of this significance the practical importance of deviations was negligible. On the contrary, the health and hygienic MQIs deviated mostly from mentioned character very visibly (Tab. I; Fig. 1), according to expectation. Log data TRN approached the FD towards the N (Tab. II; Fig. 2) in these files of MQIs usually in a satisfactory way. BC transformation enabled the best approach of files of chosen MQIs (SCC, TMBC and PBC) to the N, especially in terms of more important obliqueness of data files ($a_3 = 0$, Tab. III; Fig. 3). BC TRN differs from logarithmic TRN. Log TRN depends on relevant basis. BC transformation needs a change of the control term according to character of the concrete data file. It is more difficult for routine using this otherwise statistically effective means in the prepared evaluation algorithm. In general, the exploratory analysis results distributed the investigated MQIs into two groups in terms of necessity of their data TRNs including of type of TRN or their total inutility. It is important knowledge in terms of creation of the evaluation algorithm rules for work with the MQIs data at their synthesis into SQSM.

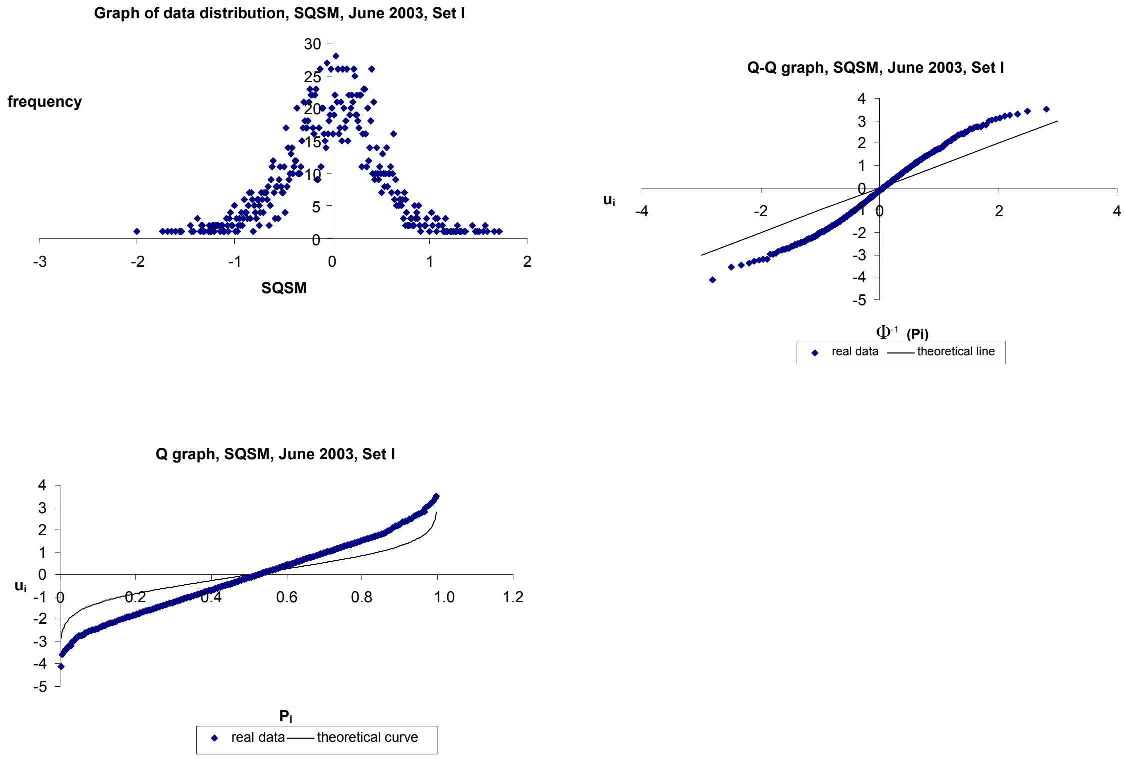
Preliminary SQSM indicator derivation and investigation

The concrete SQSM values varied from –2.33 up to 2.61 in different months (Tab. IV; 2003). The theoretically probable range is supposed from –3.0 up to 3.0 approximately in the mentioned calcula-

IV: *The evaluation of SQSM indicator frequency distribution*

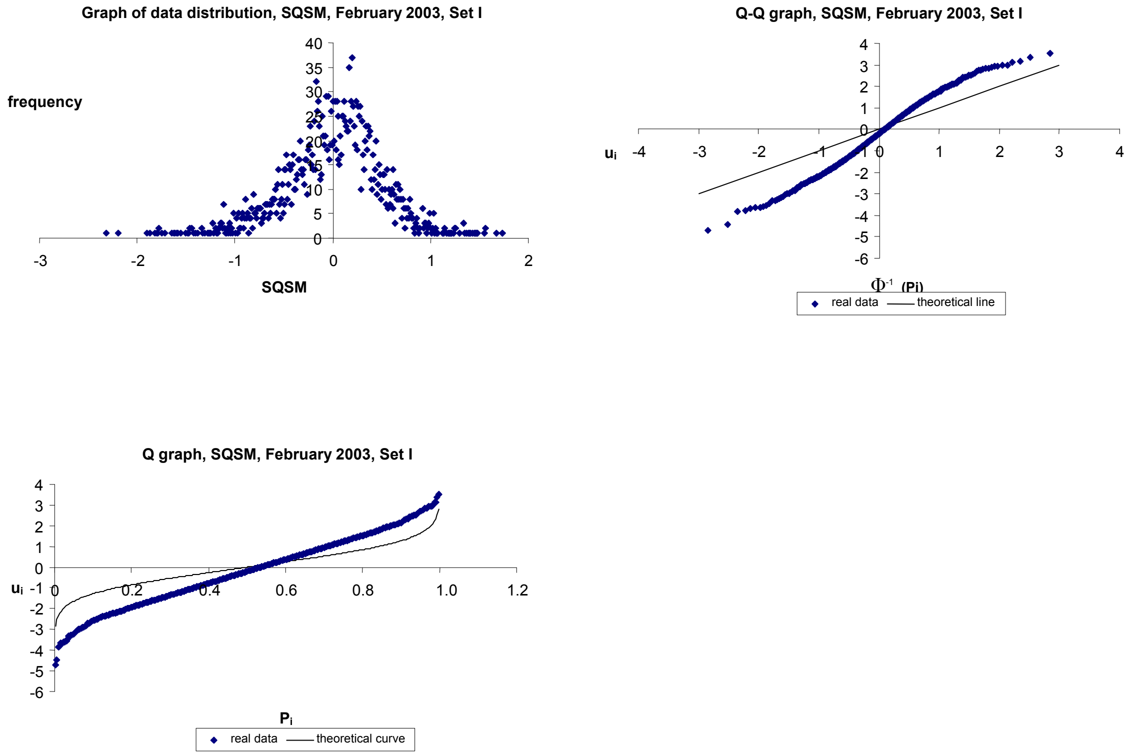
month	x	sx	m	max.	min.	a_3	$s(a_3)$	SN	a_4	$s(a_4)$	N
1	1.3×10^{-15}	0.486	0.0206	1.76	−1.88	−0.23	0.053	no	3.60	0.106	no
2	-3.8×10^{-16}	0.495	0.0311	1.74	−2.32	−0.37	0.048	no	4.12	0.096	no
3	-8.6×10^{-15}	0.507	0.0240	2.22	−2.11	−0.18	0.053	no	3.65	0.105	no
4	3.7×10^{-15}	0.501	0.0365	1.74	−1.93	0.17	0.050	no	2.21	0.099	no
5	6.2×10^{-16}	0.495	0.0062	1.75	−2.33	0.19	0.050	no	2.36	0.101	no
6	-9.8×10^{-16}	0.485	0.0313	1.71	−2.00	0.10	0.051	yes	2.91	0.101	yes
7	5.3×10^{-15}	0.475	0.0198	1.77	−1.93	−0.28	0.059	no	3.84	0.118	no
8	-2.5×10^{-15}	0.460	0.0000	1.87	−1.49	0.03	0.061	yes	3.40	0.123	no
9	2.0×10^{-14}	0.505	0.0282	1.94	−1.98	−0.10	0.051	yes	3.66	0.102	no
10	-7.2×10^{-15}	0.494	0.0144	1.85	−1.90	−0.17	0.052	no	3.86	0.105	no
11	-3.3×10^{-15}	0.494	0.0109	2.61	−1.74	−0.05	0.054	yes	3.86	0.107	no
12	1.1×10^{-14}	0.495	0.0140	2.07	−1.85	−0.11	0.054	no	4.04	0.108	no

x = arithmetical mean; sx = standard deviation; m = median; max. = maximum; min. = minimum; a_3 = obliqueness coefficient; $s(a_3)$ = stand. dev. of a_3; a_4 = acuteness coefficient; $s(a_4)$ = stand. dev. of a_4; SN = a_3 symmetry normality; N = a_4 normality; no = $P \le 0.05$; yes = $P \ge 0.05$



4: *Gauss curve, Q and Q–Q graph of SQSM data file (2003, June)*

tion processing. In the model the log TRN was suitable for some real data of MQIs but BC TRN was not necessary. The SQSM arithmetical averages, whose expected value is zero, varied from -8.6×10^{-15} up to 2.0×10^{-14}. Similarly, the median values varied from 0 up to 0.0365, near the zero (Tab. IV). The month obliqueness values (a_3), also expected as zero values, varied from −0.37 up to 0.19 (Tab. IV). 33.3% of obliqueness cases were speculated about as normal FD (Tab. IV; $P > 0.05$). The acuteness values (a_4), which were expected as equal to 3.0, varied from 2.21 up to 4.12 (Tab. IV). 8.3% of acuteness values were speculated about as normal FD (Tab. IV; $P > 0.05$). Of course, the obliqueness as symmetry measure is more important in terms of purpose of work hypothesis. The derived data files of SQSM values show N of their FD quite well. Despite the occurrence of significant differences from normal



5: *Gauss curve, Q and Q–Q graph of SQSM data file (2003, February)*

FD (because of a high number of cases in relevant data files) these deviations from N could be seen as no important for practical use purposes. The real FD curve (Gauss curve) and Q and Q–Q graphs of „normal" FD of file of SQSM values (2003 June; Tab. IV) are shown in Fig. 4. The SQSM data file, which most deviates from N (2003 February; Tab. IV), is shown in Fig. 5. It could be possible to assign the milk purchase prices to the introduced SQSM values. Probably, the mentioned process could balance the premiums for milk deliveries by penalties towards the equivalence.

CONCLUSION

The basic statistical evaluation of the raw cow MQIs was carried out with the data files 1994 and 2003 (Janů *et al.*, 2007). It was performed for the possibility to write up the changes and influences on RMQ during the mentioned reference period. There was stated the general quality improvement, which was caused by the application of RMQ discrimination limits, where some of them were made more restrictive, in the official payment policy. This paper is the second step of the mentioned research. The mentioned selected model files of the real data, which were processed in consideration of the practical dynamic of the RMQ (basic statistic), were evaluated by exploratory analysis of the one-dimensional data files of the MQIs to explain and regulate the FD of RMQ values. The goal was to obtain the relevant knowledge for final proposal of evaluation algorithm for the regular consistent including of quality into price by new synthetic RMQ indicator, SQSM. The behaviour of FDs of MQI data files and month SQSM data files during reference period was analysed and described. The useability of the SQSM system for the balancing of raw milk purchase price premiums and penalties was preliminary confirmed. In general it means that the two important steps will be carried out in the next period of the research and development:

1. an improvement of proposal for the construction of the evaluation algorithm for the synthesis of more MQIs into one-dimensional relative RMQ indicator, SQSM;
2. a validation of the functions and the result reliability of the proposed evaluation algorithm (for SQSM synthesis) and attestation of possibilities for the efficient modifications of algorithm on the model files of real data.

In the framework of modern trends of preference of quality programmes this is a case of abandonment of basically anachronistic vision about the necessity of existence of quality classes for RMQ payment within the bounds of standard quality. SQSM system could be tested in payment system of a seleced dairy plant in the case of its positive approach.

SUMMARY

The raw milk quality (RMQ) is a crucial factor of the milk food chain safety. A consistent link of the RMQ to the farmer price is essential. The aim was to analyse the properties of milk quality indicators (MQIs) and propose a new synthetic relative MQI (SQSM) from among various individual MQIs. SQSM could serve for consistent inclusion each quality change into the price. The paper was focused on exploratory analysis (normality (N) testing of files of MQIs). On the basis of the results, the MQIs were divided into two groups without and with necessity of original data transformation (TRN). Log and Box-Cox TRNs were tested in terms of possibilities of the files approach to the normal data frequency distribution (FD). The compositional MQIs deviated less and health and hygienic MQIs more from normal FD in original data ($P < 0.05$). The TRNs approached the data files to N very markedly in health and hygienic MQIs. The synthesis of various values of MQIs into SQSM was proposed: DX = (IND – x)/sx, where: IND is individual value of MQI of supplier, x is month arithmetical average of MQI of all milk suppliers and sx its standard deviation; SQSM is the average: sum of right oriented (according to RMQ growth) DXs of MQIs of identical raw milk delivery divided by the relevant number of MQIs. The eight chosen most frequent and important MQIs were included as combination into SQSM calculation: fat, crude protein, solids non fat, milk freezing point, log somatic cell count, log total mesophilic bacteria count, log coli bacteria count (last three as transformed MQIs, TRN), residual inhibitory substances. SQSM values were derived from model file of real data about MQIs and validated for use at farmer milk price modifications by the normality FD test. 33.3% of month SQSM files were normal ($P > 0.05$), the other were very close to the N with negligible deviations. The useability of the SQSM system for the balancing of raw milk purchase price premiums and penalties was tentatively confirmed.

Supported by the research projects NAZV QF 4003, INGO LA 09030 and MSM 2678846201 and by activities of National Reference Laboratory for Raw Milk in Rapotín as well.

REFERENCE

ALI, A. K. A., SHOOK, G. E., 1980: An optimum transformation for somatic cells concentration in milk. J. Dairy Sci., 63, 487–490.

BAUMGARTNER, C. und Expertengruppe für Qualitätssicherung und Qualitätsmanagement 2000: Qualitäts 2000. Leitfaden für den Betrieb von Routine – Untersuchungsgeräten in Rohmilch – Prüfungslaboratorien, 1. Ausgabe, Oktober, 32.

BAUMGARTNER, C., SCHUSTER, J., 2005: Circular of AFEMA n. 13, November, 5.

BOSSUYT, R., 2003: Bezahlung des Milchpreises nach Qualität deren Gründe und Methoden in Belgien. AFEMA Tagung, Mosonmagyaróvár, Mai.

CEMPÍRKOVÁ, R., 2002: Psychrotrophic vs. total bacterial counts in bulk milk samples. Vet. Med.– Czech, 47, 8, 227–233.

CEMPÍRKOVÁ, R., 2007: Contamination of cow's raw milk by psychrotrophic and mesophilic microflora in relation to selected factors. Czech J. Anim. Sci., 52, 11, 387–393.

CEMPÍRKOVÁ, R., 2001: The technology of dairy cows breeding in relation to the hygienic quality of milk. (In Czech) Collection of Scientific Papers Faculty of Agriculture in České Budějovice, Series for Animal Sciences, 18, 1, 33–46.

CEMPÍRKOVÁ, R., THÉR, R., 2000: The effect of living conditions on selected indexes of raw cow's milk. (In Czech) Collection of Scientific Papers Faculty of Agriculture in České Budějovice, Series for Animal Sciences, 17, 1, 55–71.

CSN 57 0529, 1993: Raw cow milk for dairy factory treatment and processing. CNI Prague.

CSN ISO 6730, 1996: Milk – Enumeration of colony-forming units of psychrotrophic microorganisms – Colony-count technique at 6.5 °C. CNI Prague.

CSN ISO 4832, 1995: Mikrobiology – General guidance for the enumeration of coliforms – Colony count techniques. CNI Prague.

CSN 57 0101, 1964: Microbiological analyse of milk and milk products. Determination of sporulated aerobic bacteria 30 °C/72 hours. CNI Prague.

CSN 57 0538, 1998: Determination of freezing point in milk, cryoscope method. CNI Prague.

CSN 57 0536, 1999: Determination of milk composition by mid–IR analyzer. CNI Prague.

CSN 57 0530, 1972: Methods for testing of milk and milk products. CNI Prague.

CSN EN ISO 13366–3, 1998: Milk – Enumeration of somatic cells – Part 3: Fluoro-opto-electronic method. CNI Prague.

DENEKE, J., FEHLINGS, K., RABOLD, K., AKSEN, T., BAUMGARTNER, C., 2004: Milk hygiene and udder health problems: Results of a survey of 5000 dairy farms. Copyright 2000–2004 MilkProduction.com.

DAIRY CREST, 2002: Dairy Crest Ltd.; Milk Supply Agreement Flat Payment. July, UK.

EEC 92/46, COUNCIL DIRECTIVE, 1992: Milk and milk product quality. Official Journal, L 268, 14/9/1992, 1–32.

HAMANN, J., 2002: Milk quality and milk payment in Europe – Interactions with aspects of food safety. Summary of papers presented during the Milchhygienesymposium der Landwirtschaftskammer Hannover, 9th–12th September, Training–Research Station Echem.

HANUŠ, O., 2000: Scheme of an algorithm for software objective determination of milk quality and its permanent relation to moneyness – SyntQLact – a specific approach to improvement of qualitative parameters and realization of consumers' safety prevention principles. (In Czech) Proceedings VÚCHS Rapotín, November, 136–142.
HANUŠ, O., BJELKA, M., GENČUROVÁ, V., JEDELSKÁ, R., KOPECKÝ, J., 2003: The relationships of the average sizes of the dairy cow herds and some qualitative-hygienic milk parameters. (In Czech) Výzkum v chovu skotu, XLV, 163, 3, 1–12.
HANUŠ, O., BJELKA, M., TICHÁČEK, A., JEDELSKÁ, R., KOPECKÝ, J., 2001: Substantiation and usefulness of transformations in data sets of analyzed milk parameters. (In Czech) Chov a šlechtění skotu pro konkurenceschopnou výrobu. Proceedings VÚCHS Rapotín, September, 122–137.
HANUŠ, O., FRELICH, J., VYLETĚLOVÁ, M., ROUBAL, P., VORLÍČEK, Z., JEDELSKÁ, R., 2004 a: Technologically difficult, pathogenic and food risky bacterial contamination of raw milk and other materials from dairy cow herds. Czech J. Anim. Sci., 49, 11, 489–499.
HANUŠ, O., HLÁSNÝ, J., GENČUROVÁ, V., BJELKA, M., 2004 b: Milk, versatile important foodstuff. Physiology of rise, taking care of production and value for human. (In Czech) Suppl., Osteological bulletin, 9, 4, 3–15.
HANUŠ, O., JANŮ, L., VYLETĚLOVÁ, M., MACEK, A., 2007: A validation of algorithm practicability of the relative synthetic raw milk quality indicator (SQSM) for consistent modification of farmer price. (In Czech) Acta univ. agric. et silvic. Mendel. Brun., LV, 5, 71–82.
JANŮ, L., HANUŠ, O., BAUMGARTNER, C., MACEK, A., JEDELSKÁ, R., 2007: The analysis of state, dynamics and properties of raw cow milk quality indicators in the Czech Republic. (In Czech) Acta fytotechnica et zootechnica, 10, 3, ISSN 1335–258X, 2007, 74–85.
JANŮ, L., HANUŠ, O., MACEK, A., GENČUROVÁ, V., 2005: The importance, systems and next possibilities of consistent raw milk payment according to quality. (In Czech) Výzkum v chovu skotu, XLVII, 171, 3, 22–31.
KUPKA, K., 1997: Statistical quality management. Statistické řízení jakosti.
KVAPILÍK, J., 2005 a: The milk purchase prices and protein and fat content. (In Czech) Zpravodaj Svazu chovatelů a plemenné knihy Českého strakatého skotu, 2, 16–18.
KVAPILÍK, J., 1997: Milk and purchase treaties. (In Czech) Náš Chov, 1, 12–14.
KVAPILÍK, J., 2004: Milk purchase prices in the European dairy companies. (In Czech) Proceedings VÚCHS Rapotín, Aktuální problémy řízení v chovu skotu, 119–131.
KVAPILÍK, J., 2005 b: Milk production and reform of the Common Agricultural Policy. (In Czech) Conference proceedings Den mléka, ČZU Praha, ISBN 80-213-1327-7, 10–15.
KVAPILÍK, J., STŘELEČEK, F., 2003: Cattle and sheep quotas negotiated between the Czech Republic and the EU. Czech J. Anim. Sci., 48, 11, 487–498.
MELOUN, M., MILITKÝ, J., 1994: Statistical evaluation of experimental data. (In Czech).
REGULATION (EC) No. 853/2004.
RENEAU, J. K., 1986: Effective use of dairy herd improvement somatic cell counts in mastitis control. J. Dairy Sci., 69, 1708–1720.
SHOOK, G. E., 1982: Approaches to summarizing somatic cell count which improve interpretability. Nat. Mast. Council, Louisville, Kentucky, 1–17.
TITCHENER, A., 1998: The building of national policy of quality – National Quality Programme (NQP). Budování národní politiky jakosti – Národní program jakosti (NQP), RESOURCE London, Prague, March, 66.
VYLETĚLOVÁ, M., BENDA, P., HANUŠ, O., KOPUNECZ, P., 1999: Determination of total psychrotrophic microorganisms in bulk milk samples and their relationship to total count of mikroorganisms. (In Czech) Czech J. Food Sci., 17, 6, 216–222.
VYLETĚLOVÁ, M., FICNAR, J., HANUŠ, O., 2000: Effects of lipolytic enzymes *Pseudomonas fluorescens* on liberation of fatty acids from milk fat. (In Czech) Czech J. Food Sci., 18, 5, 175–182.
VYLETĚLOVÁ, M., HANUŠ, O., PÁČOVÁ, Z., ROUBAL, P., KOPUNECZ, P., 2001: Frequency of Bacillus bacteria in raw's milk and its relation to other hygienic parameters. (In Czech) Czech J. Anim. Sci., 46, 3, 260–267.
WET DE, H., 1998: Milk payment systems in the member countries of Int. Dairy Fed., IDF Bulletin, 331.

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