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The hygienic and nutritional quality of milk from Saanen goats bred in the Moravian-Silesian region

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Abstract. The aim of the study was to monitor milk yield and the hygienic and nutritional quality of milk of Saanen goats in the Moravian-Silesian region in Czech Republic. Milk samples were collected once a month during the lactation period. The average milk yield in the standardized lactation was 1,100 liters. The somatic cell count in pool samples ranged from 470 x 10^3 to 696 x 10^3. The total microorganism count ranged from 3.6 x 10^3 to 1.4 x 10^5. The pathogen *Staphylococcus aureus* was proven no more than in 6.3%. The highest values of all main components of milk were achieved within a relatively short time after kidding (April 2015). The average content of fat was 3.64 ± 0.52 g 100 ml^{-1}, 3.17 ± 0.16 g 100 ml^{-1} of protein, 2.60 ± 0.06 g 100 ml^{-1} of casein, 4.56 ± 0.24 g 100 ml^{-1} of lactose, and 12.02 ± 0.80 g 100 ml^{-1} of solids. Average content of vitamin A was 0.27 ± 0.14 mg kg^{-1} and average content of vitamin E was 0.60 ± 0.34 mg kg^{-1}. Content of vitamin E increased almost continuously during the lactation, and the content of vitamin A was significantly higher at the end of lactation. In lyophilized milk powder the average trace metal contents were 7.76 ± 0.92 g kg^{-1} Ca, 1.62 ± 0.26 g kg^{-1} Mg, 15.3 ± 1.43 g kg^{-1} K, 789 ± 111 mg kg^{-1} Na, 23.2 ± 2.73 mg kg^{-1} Zn, and 0.85 ± 0.55 mg kg^{-1} Cu. Contents of minerals varied during the lactation period, but no significant trends were observed.

Key words: total microorganism count, somatic cell count, pathogens, fat, protein, casein, lactose, vitamin A, vitamin E, Ca, Cu, K, Mg, Na, Zn.

INTRODUCTION

Goat breeding has recently expanded in the Czech Republic, primarily on private farms with direct dairy production. Consumers consider goats to be ecologically bred animals, and their specific taste is increasingly adapted to maintain human health. A similar trend can also be observed in neighbouring Austria (Mayer, 2005). Goat milk is recommended as a substitute for cow's milk, especially for people suffering from allergies to cow's milk. In human nutrition, goat milk has hypoallergenic and therapeutic effects (Park et al., 2007). The size of the fat globules is smaller in goat milk than in cow's milk, meaning it is more easily digested (Iannotti et al., 2013).

The composition of macro- and micro-nutrients in goat milk depends on the main production factors constituting the farming system, such as genotype, reproduction and sanitary characteristics of animals, agro-climatic conditions and the socio-economical environment, and the farming methods used during feeding and milking. Actually, the link between these factors can be close and complex (Addis et al., 2005, Morand-Fehr, 2005). The content of macro- and micro-nutrients depends also on the lactation stage (Hejtmánková et al., 2012, Michlová et al., 2015) and on the region of production (Kedzierska-Matysek et al., 2013).

Goat milk and goat dairy products are relatively new still more common products in human nutrition in the Czech Republic, but legislative requirements on the quality of goat milk do not yet exist. Additional information is therefore required regarding the hygienic quality and nutritional composition of raw milk at least.

The farming of Saanen goats was established in the Czech Republic in 2014. This is the best breed used for the production of dairy goats. Annual production of milk per lactation period corresponds to 20 times the animal body weight, and ranges from 300–2,000 kg in 150–300 days of lactation, depending on country. In leading countries the average is above 975 kg (Roginski et al., 2003). An increasing number of people are showing interest in goat milk, and due to the high milk yield of this breed, it seems the breeding of Saanen goats is economically appealing.

The aim of this study was to monitor the milk yield and the hygienic and nutritional quality of milk from Saanen goats in Moravian-Silesian region of the Czech Republic.

MATERIALS AND METHODS

Experimental material

The basic composition (protein, fat, lactose, solids, non-fat milk solids), content of casein, urea, vitamin E and A, selected minerals (Ca, Cu, K, Mg, K, Na, and Zn), and total microorganisms and somatic cells were determined in pool samples of Saanen goat milk from one herd that was bred in northern Moravia (Czech Republic). Monitored breeding, including 265 goats brought from the French region of Vende, is conventional, with a stable feeding ration (corn silage, hay, haylage, sugar beet, protein concentrate) and addition of probiotics that contain microorganisms such as *Saccharomyces cerevisiae* during the entire year. The mixture is stirred in feeding car Faresin. The granulated mineral licks (Caprin mix in the batch 4 g per day, Inframix s. r. o., CR) with higher concentrations of iodine are also added. In addition to the aforementioned ration, the goats received sodium bicarbonate at a dose of 50 g per head and day, as well as calcium bicarbonate and sodium chloride (*ad libitum*). All breeding females were in the first lactation. The goats were milked twice a day at regular intervals, using a BouMatic (BouMatic, USA) milking machine.

Pooled milk samples were collected once a month during the lactation period from April to September 2015. Random individual milk samples were collected monthly from May to September (approx. 15% of milked goats) for the purpose of detecting mastitis pathogens. Additionally, the ability of the milk to ferment was tested 3 times during the lactation period (July, August, and September).

Samples were collected into clean plastic 100ml sampling flasks, cooled to 4–6 °C and transferred in a thermobox to the laboratory. To ensure the homogeneity of the sample, the sampling flasks were thoroughly shaken for 2 min prior to measurement. All samples were analyzed in 3 parallel replications.

The chemicals

For the preparation of analytical samples, the following special standards and chemicals were used: DL-α-tocopherol, 98.2% (CALBIOCHEM, Canada), tocopherol set (CALBIOCHEM, Canada), retinol, > 99% (Sigma-Aldrich, Germany), pyrocatechol, > 99.5% (Sigma-Aldrich, Germany), methanol, super gradient, content min. 99.9% (Lachner, Czech Republic). Standard solutions ASTASOL (Analytika, CR) of Ca, Cu, K, Mg, Na, and Zn (1 g l^{-1}) prepared in treated distilled water (Millipore, France) were used in the preparation of calibration curves for the measurements. All commonly used chemical were of p.a. quality.

The methods

Measurement of basic components of milk including casein and urea was performed using a DairySpec FT analyzer (Bentley Instruments, Inc., USA).

Measurement of somatic cell count was performed using a DeLaval Cell counter (DCC De Laval International AB, Sweden).

Detection of inhibitors in milk was carried out using a microbiological broadspectrum inhibitor test by Delvotest T (Reybroeck & Ooghe, 2012, Sats et al., 2014).

Determination of pathogenic microorganisms was carried out by VEDIA s.r.o., (Strakonice, CR – accredited laboratory of the State Veterinary Administration of the Czech Republic; established according to the Veterinary Act No. 166/1999).

Measurement of vitamins A and E content in milk samples. Both vitamins were extracted using the method of Sánchez-Machado et al. (2006) with minor modifications by Michlová et al. (2015). The analysis was carried out using an Ultimate 3000 High Performance Liquid Chromatograph (Thermo Fisher Scientific, Dionex, Sunnyvale, USA) with a quaternary pump, refrigerated autosampler, column heater and FLD and DAD detectors. Tocols and retinol in the sample were determined by HPLC under the following conditions: analytical column Develosil 5 µm RP AQUEOUS (250×4.6 mm) (Phenomenex, Torrance, USA); isocratic elution, mobile phase methanol: deionised water (93:3, v/v) (Michlová et al. (2015). All results were expressed as mean values of three replicates.

Measurement of minerals. For the determination of Ca, Cu, Mg, K, Na, and Zn in milk, aliquots of frozen milk samples (50 ml) were lyophilized using a LYOVAC GT 2 (LEYBOLD-HERAEUS, GmbH, Germany) and then approx. 0.8 g of lyophilized milk was mineralized by dry ashing (Mader et al., 1997; 1998). Analyses were carried out in triplicate.

Concentrations of Ca, K, Mg, Na, and Zn in the digests were determined by flame atomic absorption spectrometry (FAAS) using a Varian SpectrAA 110 instrument (Varian, Inc., Mulgrave, Victoria, Agilent Technologies Inc., Palo Alto, CA, USA) in an acetylene-air flame at wavelengths 766.5 nm (K), 589.0 nm (Na), 422.7 nm (Ca), 285.2 nm (Mg) and 213.9 nm (Zn). The widths of spectral intervals were 1 nm (K, Na and Zn) and 0.5 nm (Ca and Mg).

During the measurement of Mg and Zn the background was corrected by a deuterium lamp. In the determination of Ca and Mg, 1% solution of lanthanum nitrate was added as a releasing agent. SIPS (Sample Introduction Pump System) was used for the creation of calibration dependence.

Concentrations of Cu in the digests were measured by electrothermal atomic absorption spectrometry (ETAAS) using a Varian AA 280Z (Varian, Belrose, Australia) with graphite tube atomizer GTA 120 and PSD 120 programmable sample dispenser at the wavelength 324.8 nm. Detailed temperature programs for the determination of Cu in milk are described in the Technical Report (Mader et al., 2000). The quality of analytical data was assessed by simultaneous analysis of certified reference material CRM 063R (Skim milk powder) (3.3% of all the samples). Analytical data obtained for all determined elements were found to be within the confidence interval given by the producer of the CRM.

The fermentation ability was tested using a yoghurt culture (WV2) based on the bacterial strain CCDM 176 (Milcom a.s. Laktoflora, CR). Milk samples used to cultivate the yogurt culture were first heat-treated at 85°C for 10 min. After heat treatment, the samples were colled down to a temperature of 30 °C and inoculated by 0.1% yoghurt culture CCDM 176 to 100 ml of milk. Cultivation was carried out at 30 °C for 16–19 hours. Culture mediums RS 5, 4, and M17 (Milcom a.s., Laktoflora, CR) at pH = 5.54 were used for the determination of yogurt bacterium.

The determination of colony forming units in yogurts was executed acording to the International Standard ISO 7889:2003 (Yogurt - Enumeration of characteristic microorganisms - Colony-count technique at 37 °C.) In addition, the active acidity was measured using a pH meter (Schott, SI Analytics, Germany).

Statistical analysis was performed using Statistica Version 9 (2009). The measured values were processed by analysis of variance (ANOVA), using the post-hoc Tukey's test.

RESULTS AND DISCUSSION

The average milk yield in the standardized lactation from the monitored herd of Saanen goats was 1,100 liters. Torres-Vázquez et al. (2009) observed almost the same milk yield (1,095 ± 292 liters at the first lactation) in Saanen goats from Mexico. These values are slightly higher than the average value of 975 kg given by Roginski et al. (2003), and it seems to be convenient amount in the conditions of the Czech Republic. Indicative preliminary results confirmed the ability of milk to ferment. The microorganism count of yogurt culture in the final product ranged from 9.0×10^7 to 3.7×10^8. The pH shifted from 3.9 to 4.2.

Hygienic quality of milk

The basic qualitative assessment of goat milk is based on the parameters of the Slovak technical standard STN 57 0520 GOAT MILK (1995), and Council Directive 92/46/EEC and of annex No.1 of the law 203/2003 Coll. on animal health requirements for milk. The Slovak standard for goat milk contains only two requirements – total microorganism count (TMC) $\leq 500 \times 10^3$ ml^{-1} and number of colony forming units (CFU) of Staphylococcus aureus $\leq 2 \times 10^3$ ml^{-1}. According to Kautz et al. (2014) the legal somatic cells count (SCC) limit for herd milk in dairy goats is $1{,}500 \times 10^3$ ml^{-1}. Any similar standard does still not exist in the Czech Republic.

The qualitative assessment of pooled samples of raw milk is given in Table 1. Active acidity of milk ranged from pH 6.62 to 7.22. The mean value was 6.904 ± 0.248; this is higher than the value of 6.60 ± 0.11 given by Trancoso et al. (2010).

Table 1. Qualitative assessment of the raw milk – pooled samples

Month	TMC	Psychroph. bacteria	Thermo resistant bacteria	Spore producing bacteria	Coliform bacteria	SCC
	(CFU ml^{-1})	(CFU ml^{-1})	(CFU ml^{-1})	(CFU ml^{-1})	(CFU ml^{-1})	(10^3 ml^{-1})
May	3.5×10^4	<10	$4.0.10^1$	1.0×10^1	<10	570
June	3.6×10^3	<10	<10	3.1×10^2	<10	470
July	5.8×10^3	<10	<10	3.2×10^3	<10	531
August	5.1×10^3	<10	<10	2.3×10^3	<10	696
September	1.4×10^5	<10	<10	1.8×10^4	<10	541

Screening of milk for the presence of inhibitors was in all cases negative. Unfortunately *Staphylococcus aureus* was also detected in June and July. In these months the highest presence of *Staphylococcus aureus* in milk was recorded (200 CFU ml^{-1}). This value is still 10 times lower than the requirement of the Slovak standard. In addition, Polish dairies tolerate SCC up to the value of 800 x 10^3 ml^{-1}. A value above 4,000 x 10^3 ml^{-1} is penalized. Acording to these criteria, milk from the monitored farm has very high hyginic quality; SCC ranged from 470 x 10^3 ml^{-1} to 696 x 10^3 ml^{-1} and 510 x 10^3 ml^{-1} on average.

The goats' milk secretion system differs from that of the cow (Hinckley, 1990), and evidence indicates several basic differences between the composition of goat milk and cow milk. In a monitored heard of Saanen goat (with exception of September), TMC in milk complies also with the requirements of cow's milk (TMC at 30 °C ≤ 100 x 10^3 ml^{-1} and SCC ≤ 400 x 10^3 ml^{-1} according to Regulation of the EP and of the Council (EC) No. 853/2004). SCC in the monitored Saanen goat herd was higher in all cases. According to Hinckley (1990), differences between cows and goats depend also on other requirements, especially on the somatic cell count standard in goat milk. Nevertheless, SCC in the monitord heard was relatively low. In some other studies, the determined SCCs in goat Saanen milk were higher (Laurinaviciute et al, 2004, Vilanova et al., 2008, Kautz et al., 2014).

A positive health status of the mammary glands of goats is reflected in the number of sterile samples (Table 2). Major environmental pathogens *Staphylococcus* PK-(delta hemolysin+) and *Staphylococcus* PK-(delta hemolysin-) were identified in some pool raw milk samples in each of the studied months. *Streptococcus uberis*, *Enterococcus* sp., *Aeromonas* sp., coliform bacteria, and aerobic sporulate were also determined once during the monitoring period. The ongoing lactation and isolation of the goats in the stable, and the applied system of hygiene reduced the number of sterile samples and environmental germs by about 50%, compared to the input values. The opposite trend was apparent for contagious embryos, whose main representative is *Staphylococcus aureus*. However, it is necessary to say that *Staphylococcus aureus* was diagnosed in the mammary gland of goats and the characterization of its exposure is definitely negative. The pathogen easily expands and can cause an infectious disease. Therefore, economic losses on milk production and its composition quality are high.

Table 2. Diagnostics of the presence of pathogens (in %) – individual milk samples

Month	Sample (n)	Sterile sample	Environmental pathogens *Staphylococcus* PK – (delta hemolysin +) *Staphylococcus* PK – (delta hemolysin -)	*Staphylococcus aureus*
May	48	72.9	20.8	6.3
June	48	79.2	16.7	4.1
July	40	75.0	22.5	2.5
August	40	50.0	50.0	0.0
September	36	69.4	27.8	2.8

It is valuable, that test results found no positive inhibitors in the current study. TMC, SCC (Table 1) and CFUs of *Staphylococcus aureus* in milk from the monitored farm correspond to the above given criteria.

Hygienic preparation of the mammary glands for milking, and disinfection treatment after milking did not exist until the determination of the presence of pathogens. In connection with the findings of mastitis pathogens in individual milk samples, the practice of disinfecting the milking machine using peracetic acid solution was introduced. Therefore, we can expect that the presence of pathogens will be reduced in future.

Main constituents of milk

The main components determined in Saanen goat milk are shown in Table 3. The content of main nutrients changed during the lactation period. The highest values were achieved within a relatively short time after kidding, in April. This applies to all components of the milk (i.e., fat, protein, casein and lactose), when their levels were comparable with the composition of cow's milk. Values in the summer months were marked by extreme heat, resulting in reduced content. The last collection in September, once again brought an increase in values, however, they did not reach the levels of April. The lowest observed level of urea was in April, followed by an increase in May and June, and then a slight decrease in the remaining months. In high concentrations, urea has negative effects, manifested as a reduction of immune reactions.

Hinckley (1990), Antunac et al. (2001a; 2001b), and Vilanova et al. (2008), reported lower contents of crude protein, fat, lactose and solids in Saanen goat milk. Only Trancoso et al. (2010) determined a higher content of fat (5.01 ± 1.1%), protein (3.75 ± 0.19%) and solids (13.16 ± 1.3%). According to Kozacinski et al. (2004) an increase in SCC was associated with an increase in protein and non-fat solids, and a reduction in lactose and milk fat content. However, in this study, the SCC was the highest in the middle of lactation, and in contrast, the content of protein and non-fat solids were the lowest. Changes observed in the composition of milk during the lactation period are in accordance with Antunac et al. (2001a), who found a significantly higher ($P < 0.01$) content of dry matter, non-fat solids, and lactose at the beginning of lactation in comparison with the middle of lactation. Significant correlations ($P < 0.001$) were established between the content of dry matter and the content of non-fat solids (0.76%), fat (0.77 g 100 ml^{-1}), protein (0.64%) and lactose (0.46%). At the end of the lactation period (day 200), the content of protein (3.11%) and solids (11.76%) were higher than at the first quarter of the lactation period (day 50) (2.81% and 11.91% respectively) (Antunac et al., 2001b). The same trend was observed in this study. At the end of the lactation period, the content of fat, protein, casein and solids were higher than at the middle of lactation (Table 3).

Table 3. The main composition of Saanen goat milk

Month	Fat (g 100ml^{-1})	Protein (%)	Casein (%)	Lactose (%)	Solids (%)	Solids non-fat (%)	Urea (mg l^{-1})
April	4.50	3.47	2.71	5.00	13.46	9.14	321
May	3.81	3.06	2.55	4.62	12.18	8.43	648
June	2.91	3.06	2.54	4.48	11.14	8.27	612
July	3.52	3.12	2.58	4.53	11.86	8.38	467
August	3.41	3.11	2.61	4.29	11.48	8.27	509
September	3.70	3.21	2.63	4.46	11.98	8.53	429
Average	3.64	3.17	2.60	4.56	12.02	8.50	498
SD	0.52	0.16	0.06	0.24	0.80	0.33	121
S_r (%)	14.29	5.05	2.31	5.26	6.66	3.88	24.2
Maximum	4.50	3.47	2.71	5.00	13.46	9.14	648
Minimum	2.91	3.06	2.61	4.29	11.14	8.27	321

Vitamin contents

The content of vitamin A and E in Saanen goat milk are given in Table 4. In agreement with previous determinations of vitamin A and E in the goat milk (Michlová et al., 2015), the average content of vitamin E in milk of Saanen goats was higher (2.2 times) than the content of vitamin A. However, the average contents of both vitamins were significantly lower, although the fat content in milk was comparable with the fat in the milk of other goat breeds (with the exception of Anglo Nubian goats). The average content of vitamin A was 0.27 ± 0.14 mg kg^{-1} (0.79 ± 0.08 mg kg^{-1} in the milk of various breeds of goats from different farms), and the average content of vitamin E was 0.60 ± 0.34 mg kg^{-1} (1.29 ± 0.35 mg kg^{-1}).

Table 4. Content of vitamin A and E in raw Saanen goat milk

Month	Vitamin A (mg kg^{-1})	Vitamin E (mg kg^{-1})
April	0.18	0.19
May	0.21	0.31
June	0.20	0.40
July	0.18	0.83
August	0.36	0.81
September	0.52	1.05
Average	0.27	0.60
SD	0.14	0.34
S_r (%)	51.8	56.70
Maximum	0.52	1.05
Minimum	0.18	0.19

Higher levels of both vitamins in goat milk are also given by others authors (e.g., Morand-Fehr et al., 2007, Park et al., 2007). The aforementioned authors reported very high values of both vitamins (up to 11 mg kg^{-1} of vitamin E and up to 6 mg kg^{-1} of vitamin A) depending on the farming and feeding system. On the contrary, a lower value of vitamin E (0.4 mg kg^{-1}) in goat milk was reported by Raynal-Ljutovac et al. (2008), and lower levels of vitamin A (0.13 mg l^{-1}) were also observed by Kondyli et al. (2012). In this study, the content of vitamin E increased almost continuously during the lactation, and the content of vitamin A was also significantly higher at the end of the lactation period.

Mineral contents

Contents of Ca, Cu, K, Mg, Na, and Zn in Saanen goat milk are given in Table 5. The values are related to lyophilized milk powder. Despite the fact that the feeding ratio was stable, all measured minerals showed significant variations during the lactation period. Ca and Cu contents were significantly higher at the beginning of the lactation period. The same trend was observed by Aganga et al. (2002) and Kondyli et al. (2007). On the contrary, contents of Mg, K and Na were significantly lower at the beginning of the lactation period, but only Mg increased continuously during the entire lactation period. The average Ca content in lyophilized milk powder was 7.76 ± 0.92 mg kg^{-1}; lower than the value of 10.9 ± 0.8 mg kg^{-1} d.w, as reported by Trancoso et al. (2010) and Antunac et al. (2001a, b) (0.110–0.129% in raw milk). Higher values of Ca content in the milk of other goat breeds are reported by many authors (Kondyli et al., 2007, Park et al. 2007, Mayer & Fiechter 2012, Kedzierska-Matysek et al. 2013, and others). The average Mg content in lyophilized milk powder was 1.62 ± 0.3 mg kg^{-1}, higher than that reported for Saanen goat milk by Trancoso et al. (2010) (1.03 ± 0.10 mg kg^{-1} d.w.). The Mg content found in this study was consistent with that reported by Kondyli et al. (2007) and Park et al. (2007), and higher than those reported by other authors (Aganga et al., 2002, Hejtmánková et al., 2002, Mayer & Fiechter, 2012). The average Na content in lyophilized milk powder was 790 ± 111 mg kg^{-1}, significantly lower than that reported by Trancoso et al. (2010) for Saanen goat milk (2.83 ± 0.4 g kg^{-1} d.w.). Aganga et al. (2002), Kondyli et al. (2007), Park et al. (2007), Mayer & Fiechter (2012) and Kedzierska-Matysek et al. (2013) all reported in accordance with the aforementioned higher value of Na content in goat milk. The average K content in lyophilized milk powder for Saanen goat milk was 15.27 ± 1.43 mg kg^{-1}, higher than reported by Trancoso et al. (2010) (12.2 ± 2.0 g kg^{-1} d.w.). The K content found in this study is similar to those reported by Aganga et al. (2002), Kondyli et al. (2007) and Park et al. (2007). Aganga et al. (2002) reported the highest value of K (0.487 g 100 g^{-1} in Tswana goat milk).

Table 5. Content of selected minerals in lyophilized Saanen goat milk powder

Month	Ca (g kg^{-1})	Cu (mg kg^{-1})	K (g kg^{-1})	Mg (g kg^{-1})	Na (mg kg^{-1})	Zn (mg kg^{-1})
April	9.41	1.94	13.50	1.24	649	26.40
May	7.72	0.73	13.90	1.48	691	20.90
June	6.91	0.75	16.30	1.60	825	26.70
July	6.88	0.46	14.60I	1.68	851	23.30
August	7.88	0.78	17.10	1.75	951	20.80
September	7.76	0.45	16.10	2.00	769	21.30
Average	7.76	0.85	15.30	1.62	790	23.20
SD	0.92	0.55	1.43	0.26	111	2.73
S_r (%)	11.90	64.70	9.36	16.0	14.0	11.70
Maximum	9.41	1.94	17.1I	2.00	951	26.70
Minimum	6.88	0.45	13.50	1.24	649	20.80

The average Na/K ratio was lower than that reported Trancoso et al. (2010) (0.05 vs 0.23), and also lower than the ratios reported by Kondyli et al. (2007), Park et al. (2007) and Raynal-Ljutovac et al. (2008). This low Na/K ratio might be of interest from the human nutrition point of view, especially for people suffering from high blood pressure or those under dialysis (Trancoso et al., 2010). The average Zn content in lyophilized milk powder from Saanen goat milk was 23.22 ± 2.73 mg kg^{-1}, which is similar to those reported by Trancoso et al. (2010) (26.0 ± 4.90 mg kg^{-1} d.w.) and by Haenlein & Anke (2011). Coni et al. (1996) reported a lower content of Zn in goat milk. In contrast, Elmastas et al. (2005), Kondyli et al. (2007), Kedzierska-Matysek et al. (2013) and especially Park et al. (2007), and Sanz-Ceballos et al. (2009), give higher values. The highest value (8.79 mg kg^{-1}) was reported by Aganga et al. (2002). The average Cu content in lyophilized milk powder was 0.85 ± 0.55 mg kg^{-1}, slightly higher than the value (663 μg kg^{-1} d.w.) reported by Trancoso et al. (2010) for Saanen goat milk and by Coni et al. (1996) for goat milk. The values determined in this study are consistent with values reported by Hejtmánková et al. (2002) and Kodyli et al. (2007). On the contrary, Elmastas et al. (2005), Park et al. (2007), Sanz-Ceballos et al. (2009) and Kedzierska-Matysek et al. (2013) gave higher values. The highest value (2.0 mg·kg^{-1}) was reported by Aganga et al. (2002).

CONCLUSION

Milk from Saanen goats bred in the Moravian-Silesian region in the Czech Republic can be considered to be of good hygienic quality, and relatively high content of the main nutrients, such as protein, fat, lactose and therefore the total dry matter. The high density of animals, the quality of the used milking machine, and a higher level of sanitary measures positively influenced the somatic cells and their count, and the total microorganisms count in raw milk. Important micronutrients, particularly vitamins A and E, were found to be less concentrated than would be typically expected in goat milk. Contents of Ca and Na were significantly lower, contents of Cu, K, and Zn close to the lower boundary of the values, and the content of Mg was average in comparison with the contents of these elements reported by various authors for goat milk. However, this situation may be solved in the future by making appropriate changes to the application of additives in feeding rations. On the contrary, a low Na/K ratio might be of interest from the human nutrition point of view, especially for people suffering from high blood pressure or for those under dialysis. Despite the fact that the feeding ratio was stable, measured contents of the main nutrients, vitamins and minerals were variable during the lactation period.

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REFERENCES

Addis, M., Cabiddu, A., Pinna, G., Decandia, M., Piredda, G., Pirisi, A. & Molle, G. 2005. Milk and cheese fatty acid composition in sheep fed Mediterranean forages with reference to conjugated linoleic acid cis-9, trans-11. *Journal of Dairy Science* **88**, 3443–3454.

Aganga, A.A., Amarteifio, J.O. & Nkile, N. 2002. Effect of stage of Lactation on Nutrient Composition of Tswana Sheep and Goat Milk. *Journal of food Composition and Analysis* **15**, 533–543.

Antunac, N., Havranek, J.L. & Samarzija, D. 2001b. Effect of breed on chemical composition of goat milk. *Czech Journal of Animal Science* **46**(6), 268–274.

Antunac, N., Samarzija, D. Havranek, J.L., Pavic, V. & Mioc, B. 2001a. Effects of stage and number of lactation on the chemical composition of goat milk *Czech Journal of Animal Science* **46**(12), 548–553.

Coni, E., Bocca, A., Coppolelli, S., Caroli, C., Cavallucci, C. & Trabalza Marinucci, M. 1996. Minor and trace element content in sheep and goat milk and dairy products. *Food Chemistry* **57**(2), 253–260.

Elmastas, M., Can, M. & Uzun, S. 2005. Determinations of Copper, Zinc, Cadmium and Nickel in Cows', Goats', Ewes' and Human Milk Samples Using Flame Atomic Absorption Spectrometry (FAAS) Microwave Digestion. *Analytical Letters* **38**, 157–165.

Haenlein, G.F.W. & Anke, M. 2011. Mineral and trace element research in goats: A review. *Small Ruminant Research* **95**, 2–19.

Hejtmánková, A., Kučerová, J., Miholová, D., Kolihová, D. & Orsák, M. 2002. Levels of selected macro-and microelements in goat milk from farms in the Czech Republic. *Czech Journal of Animal Science* 47(6), 253–260.

Hejtmánková, A., Pivec, V., Trnková, E. & Dragounová, H. 2012. Effect of the lactation stage on concentration of whey proteins in caprine acid whey. *Small Ruminant Research* **105**, 206–209.

Hinckley, L.S. 1990. Revision of the somatic cell count standard for goat milk. *Dairy, Food and Environmental Sanitation* **10**(9), 548–-549.

Iannotti, L., Muehlhoff, E. & Mcmahon, D. 2013. Review of milk and dairy programmes affecting nutrition. *Journal of Development Effectiveness* **5**(1), 82–115.

Kautz, F.M., Nickerson, S.C. & Ely, L.O. 2014. Use of staphylococcal vacine to reduce prevalence of mastitis and lower somatic cell counts in a registered Saanen dairy goat herd. *Research in Veterinary Science* **97**, 18–19.

Kedzierska-Matysek, M., Barlowska, J., Litwinzuk, Z. & Koperska, N. 2013. Content of macro- and microelements in goat milk in relation to the lactation stage and region of production. *Journal of Elementology* **18**, 107–114.

Kondyli, E., Katsiari, M.C. & Voutsinas, L.P. 2007. Variations of vitamin and mineral contents in raw goat milk of the indigenous Greek breed during lactation. *Food Chemistry* **100**, 226–230.

Kondyli, E., Svarnas, C., Samelis, J. & Katsiari, M.C. 2012. Chemical composition and microbiological quality of eve and goat milk of native Greek breeds, *Small Ruminant Research*, **103**, 194–199.

Kozacinski, L. Hadziosmanovic, M., Cvrtila, Z. Majic, T. & Karadjole, I. 2004. Effect of lactation and number of somatic cells on the composition and quality of goat milk. *Tierarztliche Umschau* **59**(8), 453–458.

Laurinaviciute, V., Siugzdaite, J. & Urbsiene, D. 2004. Quality and composition of milk with different somatic cell count of two breeds of dairy goats. *Medycyna weterynaryjna* **60**(11), 1168–1170.

Mader, P., Dolejšková, J., Horák, V., Hejtmánková, A., Reisnerová, H., Táborský, J., Miholová, D., Kolihová, D., Trnková E., Snášelová J., Smažík M. & Vejdová, M. 2000.

Development of methods of determination of risk chemical elements and selected organic contaminants in milk and milk products and their harmonization with EU methods. Final report of the grant project No. NAZV EP 0960006367 (in Czech).
Mader, P., Haber, V. & Zelinka, J. 1997. Classical dry ashing of biological and agricultural materials. Part I. Following the course of removal of organic matrix. *Analusis* **25**, 175–183.
Mader, P., Száková, J. & Miholová, D. 1998: Classical dry ashing of biological and agricultural materials. Part II. Losses of analytes due to their retention in an insoluble residue. *Analusis* **26**, 121–129.
Mayer, H.K. 2005. Milk species identification in cheese varieties using electrophoretic, chromatographic and PCR techniques. *International Dairy Journa*l **15**, 595–604.
Mayer, H.K. & Fiechter, G. 2012. Physical and chemical characteristics of sheep and goat milk in Austria. *International Dairy Journal* **24**, 57–63.
Michlová, T., Dragounová, H., Horníčková, Š. & Hejtmánková, A. 2015. Factors influencing the content of vitamins A and E in sheep and goat milk. *Czech Journal of Food Science* **33**, 58–65.
Morand-Fehr, P. 2005. Recent developments in goat nutrition and application: a review. *Small Ruminant Research* **60**, 25–23.
Morand-Fehr, P., Fedele, V., Decandia, M. & Le Frileux, Y. 2007. Influence of farming and feeding system on composition and quality of goat and sheep milk. *Small Ruminant Research* **68**, 20–34.
Park, Y.W., Juárez, M., Ramos, M. & Haenlein, G.F.W. 2007. Physico-chemical characteristics of goat and sheep milk. *Small Ruminant Research* **68**, 88–113.
Raynal-Ljutovac, K., Lagriffoul, G., Paccard, P., Guillet, I. & Chilliard, Y. 2008. Composition of goat and sheep milk products: an update. *Small Ruminant Research,* **79**, 57–72.
Reybroeck, W. & Ooghe, S. 2012. Validation report of the Delvotest T., Report of validatin study, January 6th, 1–13.
Roginski, H. Fuquay, J.W. & Fox, P.F. 2003. *Encyclopedia of Dairy Sciences. Vol 2.* Academic Press, London, 710 pp.
Sánchez-Machado, D.I, López-Cervantes, J. & Ríos Vázques, N.J. 2006. High-performance liquid chromatography method to measure α- and γ-tocopherol in leaves, flowers and fresh beans from Moringa oleifera. *Journal of Chromatography A* **1105**, 111–114.
Sanz Ceballos, L.S., Morales, E.R., de la Torre Adarve, G., Castro, J.D., Martínez, L.P. & Sanz Sampelayo, M.R. 2009. Composition of goat and cow milk produced under similar conditions and analyzed by identical methodology. *Journal of food Composition and Analysis* **22**, 322–329.
Sats, A., Mootse, B., Lepasalu, L. & Poikalainen, V. 2014. Use of delvotest for quantitative estimation of β-lactam antibiotic residues in waste milk and for evaluation of thermal treatment efficiency – a methodical pilot study. *Agronomy Research* **12**(3), 807–812.
Torres-Vázquez, J.A., Valencia-Posadas, M.H., Castillo-Juárez, H. & Montaldo, H.H. 2009. Genetic and phenotypic parameters of milk yield, milk composition and age at first kidding in Saanen goats from Mexico. *Livestock Science* **126**(1–3), 147–153.
Trancoso, I.M., Trancoso, M.A., Martins, A.P. & Roseiro, L.B. 2010. Chemical composition and mineral content of goat milk from four indigenous Portuguese breeds in relation to one foreign breed. *International Journal of Dairy Technology* **63**(4), 516–522.
Vilanova, M., Goncalves, M., Osorio, M.T.M., Esteves, R. & Schmidt, V. 2008. The health's udder and chemical composition of Saanen goat milk. *Acta scientiae veterinariae* **36**(3), 235–240.