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Chapter

Milk Quality, Somatic Cell Count, and Economics of Dairy Goats Farm in the Czech Republic

Jana Rychtarova, Zuzana Krupova, Michaela Brzakova, Marketa Borkova, Ondrej Elich, Hedvika Dragounova, Ruzena Seydlova and Zuzana Sztankoova

Abstract

Mammary gland anatomy in small ruminants is very similar to that of cows; however, milk synthesis throughout lactation exhibits many functional particularities in small ruminants compared with that of cows. Goat's milk is beneficial for human nutrition owing to the fatty acid composition, fat globule size, and conjugated linoleic acid content. As a raw material for dairy products, goat's milk must be safe for human consumption. The number of mesophilic microorganisms, somatic cells, and selected mastitis pathogens should be limited. A prerequisite for the production of milk of high hygienic quality is the health of the mammary gland. Goat's milk processing into cheese and other products is in the Czech Republic mostly performed on farms, partly for direct sales to consumers and partly for supplying selected stores. Revenues from dairy commodities represent the most important source of income for dairy goat farms. Mammary gland health has an important effect on the economics of dairy goat farms. Profitability can fall by up to 1/3 owing to indirect effects of udder health problems.

Keywords: goat, milk quality, somatic cell account, economics, farm profitability

1. Introduction

1.1 Goat breeding in the Czech Republic

According to FAOSTAT database, approximately 1 billion goats were bred worldwide in 2018; the largest number of goats were bred in Asia (approximately 52%). The European Commission (EC) has reported a total of 74.6 million sheep and goats in 27 countries of the European Union in 2019, which represents a decrease of 15% compared to the number reported in 2000. Almost a quarter were bred in Greece (33%) and a high percentage in other countries, such as Spain (24%), Romania (14.5%), France (11%), and Italy (10%). According to the EC, approximately 0.4% of sheep and goat stocks are bred in the Czech Republic.

Goat breeding has a long tradition in the Czech Republic. Since 1941, based on the law 'Act No. 361/1941 Coll. 'About the Breeding of Farm Animals', performance control has been introduced in Bohemia. According to statistical data obtained from

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performance control, 10 breeds of goats were bred in the Czech Republic in 2019. The most common breeds were White Shorthair and Brown Shorthair goat (both are Czech national goat breeds). The number of goats in the Czech Republic has fluctuated significantly. Since 2018, there has been a slight decrease in the number of goats reared. In 2020, 28,919 goats (the Czech Statistical Office, CZSO) were bred in the Czech Republic. According to the preliminary results of the general agricultural account for 2019 published by the CZSO at current prices, small ruminant breeding in the Czech Republic amounted to approximately EUR 8,601 thousand, which in 2019 accounted for 0.4% of animal production and 0.2% of the total output of the agricultural sector. The CZSO data show that small enterprises predominate in the Czech Republic, most breeding 1–10 goats (88.2% of enterprises) - 41.8% of the total number of farmed animals. However, with the growing demand for goat's milk products, companies that keep more than 400 goats have been emerging in the Czech Republic in recent years. A total of 6.2% of goats were bred on such farms. In the Czech Republic, goat breeding is focused mainly on milk production and, subsequently, on manufacturing of cheese and dairy products, such as kefir and yoghurt. In 2019, goat cheese production reached 266 tonnes at a price of approximately 11.5 EUR/kg.

In the Czech Republic, goat's milk is processed directly on farms and distributed as milk products. Although goat breeding is not one of the main areas of animal production, it is essential for the agricultural sector. In recent years, the Ministry of Agriculture of the Czech Republic has intensively supported research and development in sheep and goat breeding. Sponsored projects: P1 -'Influence of genetic polymorphism of lipogenic enzymes on milk fat composition and fatty acid (FA) content in milk of small ruminants' and P2 - 'Research of factors influencing profitability, quality, and safety of milk and dairy products in small ruminant farms in the Czech Republic'—have closely monitored milk production, hygienic quality of raw milk, and composition, including by-products. Based on the results, measures were proposed to improve both microbiological and nutritional quality of milk while achieving maximum economic profit.

2. Material and methodology

As part of the projects (P1 and P2) mentioned above, milk production was monitored on a farm with shorthair goat breeding. An integral part was the monitoring of daily milk yield and the content of individual milk components. The contents of fat, protein, lactose, and non-fat solids were determined. Sampling was always performed during morning milking and took place at regular monthly intervals from April to August (during the years 2013–2017). The obtained average values of milk yield indicators and milk components content during the monitored

	2013	2014	2015	2016	2017
Daily milk yield [kg]	0,990 ± 0,050	1,540 ± 0,044	1,806 ± 0,055	1,207 ± 0,070	1,100 ± 0,047
Fat [%]	3,941 ± 0,145	2,955 ± 0,089	3,178 ± 0,080	3,019 ± 0,068	3,051 ± 0,086
Protein [%]	3,174 ± 0,046	2,913 ± 0,021	2,879 ± 0,022	2,980 ± 0,019	3,026 ± 0,038
Lactose	4,251 ± 0,027	4,381 ± 0,025	4,412 ± 0,021	4,390 ± 0,017	4,382 ± 0,038
Non-fat solid	8,332 ± 0,051	10,716 ± 0,115	11,259 ± 0,097	11,237 ± 0,070	11,165 ± 0,127

Table 1.
Average values of milk and milk components in goat's milk (own measurement).

Acid	2013		2014		2015		2016		2017	
	Mean (%)	SE	Mean (%)	SE	Mean (%)	SE	Mean (%)	SE	Mean (%)	SE
Butyric C4:0	1,58	0,045	2,4	0,082	2,42	0,079	2,5	0,064	2,3	0,029
Caproic C6:0	1,73	0,036	2,49	0,07	2,56	0,048	2,62	0,021	2,51	0,02
Caprylic C8:0	1,94	0,048	2,54	0,096	2,63	0,092	2,81	0,054	2,73	0,017
Capric C10:0	6,94	0,251	8,39	0,355	8,75	0,289	9,27	0,248	9,3	0,08
Lauric C12:0	2,99	0,123	3,19	0,148	3,42	0,108	3,79	0,146	4	0,06
Myristic C14:0	8,92	0,151	9,57	0,206	9,98	0,24	9,97	0,236	10,56	0,12
Myristoleic C14:1	0,12	0,012	0,11	0,007	0,1	0,007	0,14	0,013	0,12	0,009
Pentadecanoic C15:0	1,13	0,03	1,08	0,015	1,05	0,023	0,92	0,036	1,07	0,03
Palmitic C16:0	27,98	0,656	27,45	0,627	26,7	0,911	27,35	0,302	27,57	0,343
Palmitoleic C16:1	1,07	0,033	0,49	0,025	0,51	0,015	0,63	0,017	0,58	0,026
Stearic C18:0	11,82	0,731	10,99	0,564	11,23	0,798	8,83	0,345	9,56	0,443
SUMA t-C18:1	2,14	0,095	2,35	0,066	1,77	0,164	1,87	0,111	1,84	0,212
C18:1n9c	22,82	0,572	19,87	0,859	19,07	0,657	19,76	0,503	18,6	0,406

DOI: http://dx.doi.org/10.5772/intechopen.97509

Acid	2013		2014		2015		2016		2017	
	Mean (%)	SE	Mean (%)	SE	Mean (%)	SE	Mean (%)	SE	Mean (%)	SE
Linoleic C18:2n6c	2,26	0,081	1,9	0,062	2,42	0,042	2,67	0,097	2,43	0,144
Arachidic C20:0	0,31	0,012	0,28	0,014	0,26	0,009	0,2	0,006	0,24	0,013
α-Linolenic C18:3n3	1,01	0,063	1,03	0,066	1,06	0,05	1,13	0,024	1,13	0,121
CLA			0,69	0,031	0,59	0,044	0,55	0,047	0,46	0,039
omega-6	2,41	0,085	2,92	0,062	2,62	0,043	2,89	0,101	2,65	0,144
omega-3	1,14	0,07	1,2	0,003	1,27	0,047	1,31	0,026	1,31	0,123
SUFA	67,52	0,618	70,38	0,976	70,89	0,619	70,05	0,425	71,7	0,147
MUFA	28,02	0,655	24,67	0,943	34,2	1,347	24,38	0,427	23,03	0,256
PUFA	4,25	0,149	3,84	0,084	4,3	0,127	5,56	0,04	5,28	0,253
Omega6/omega3	2,11		2,43		2,06		2,21		2,02	
AI	2,07		2,42		1,82		2,37		2,61	

[a]The overview does not include minority FAs with a content below 0.05%.
t-C18:1 = trans isomers C18:1 including e.g. vaccenic acid (t11-C18:1); CLA = conjugated linoleic acid (mixture of isomers c9,t11-C18:2 and t9,c11-C18:2; SFA = saturated fatty acid; MUFA = monounsaturated fatty acid; PUFA = polyunsaturated fatty acid.

Table 2.
Profile of the most important FA[a] in individual samples of goat's milk (own measurement).

period are presented in **Table 1**. Part of this monitoring (project P1) was also the screening of the composition of fat acids (FAs) in goat's milk (**Table 2**).

The composition of FAs in the milk of White Shorthair goats was analyzed. The animals were monitored from 2013 to 2017 (P1) on the largest goat farm in the Czech Republic—an organic farm that maintained the same feeding strategy in all monitored years. The winter feed ration that was fed at the beginning of the study, consisted of haylage of approximately 2 kg/piece/day, hay ad libitum, and a grain mix, which was dosed during milking in the milking parlor in a total amount of 300 g/piece/day. The summer feed consisted of meadow vegetation of approximately 2 kg/piece/day (loaded into the stable), hay ad libitum, and grain mix, which was also dosed during milking in the milking parlor in a total amount of 300 g/piece/day. In 2013, only the goats in first lactation were included; in 2014, the animals in second lactation were selected; in the following years (2015–2017), only the animals in third lactation were included. The methodology for determining the FA content has been described by Borková et al. [1]. Based on the obtained results, the atherogenic index (**AI**) [AI = (C12:0 + 4 × C14:0 + C16:0) / (monounsaturated fatty acid + polyunsaturated fatty acid)] was calculated.

Three individual sets of milk samples (P2) were collected from 2 farms in the Czech Republic (White Shorthair goat farms) during lactation (April, June, and August; at least 30% of the animals were always taken from the farm) to monitor the occurrence of bacteria in goat's milk. Concurrently, microbiological analysis of the pooled milk samples was performed in an accredited laboratory.

The bio-economic model EWSH1 of the ECOWEIGHT software package [2] was used to quantify the effect of udder health on the economics of goat farms. The model makes it possible to comprehensively consider the above-mentioned changes on farms. The impact on the production and the flock structure (culling rate and fertility) and the costs and sales were considered. The universal design of this software allows for widespread evaluation of production and economic farm data [3], despite the fact that it is primarily used to calculate the economic importance of traits for breeding of small ruminants [4].

3. Results and discussion

3.1 The benefits and composition of goat's milk

The goat's milk is very beneficial as part of the human diet, but consumption of cow's milk significantly exceeds that of goat's milk. Milk and dairy products are the dominant source of income (50–80%) for small ruminant farms. Therefore, the quantity and quality of milk are important for sustaining sales and breeding costs. As the demand for goat's milk increases, so do milk quality requirements, especially those of milk components essential for higher-quality cheese production. The amount and composition of proteins and lipids are among the most important indicators of the nutritional quality of goat's milk. Therefore, it is important to monitor the proportion of individual proteins in goat's milk and the composition of FAs in milk fat. Goat's milk and its products are a valuable source of nutrients for humans. A significant advantage of goat's milk compared to cow's milk is the composition of milk fat. Goat's milk fat is rich in lower saturated FAs, such as caproic acid (C6:0), caprylic acid (C8:0), and capric acid (C10:0). These FAs are beneficial for treating intestinal diseases, malabsorption syndromes, cystic fibrosis, and heart disease [5, 6]. In contrast, lauric acid (C12:0), myristic acid (C14:0), and palmitic acid (C 16:0) are considered hypercholesterolemic FAs, which increase the proportion of low-density lipoprotein (**LDL**) cholesterol in plasma and increase the risk of cardiovascular disease.

Table 2 shows that the goats in first lactation had a lower saturated FA milk content (up to 14 carbons). Similar conclusions were reached for cattle by Kelsey et al. [7]. Our result is also consistent with that of Akerlinda et al. [8], who reported a reduced production of saturated FAs in first calves due to incomplete development of the mammary gland, which may reduce the production of saturated FAs. In contrast, the first lactation animals showed the highest milk content of saturated FAs with a larger number of carbon atoms. The effect of lactation order was not significant for monounsaturated FAs, except oleic acid. From 2013 to 2017, the average PUFA content was 3.84% to 5.56% of the total FAs. The average ratio of omega-6 to omega-3 FAs was favorable in all monitored years, ranging from 2.02 to 2.43. The optimal ratio of omega-6 to omega-3 PUFA levels in human nutrition is in the range of 2:1–6:1 [9]. There was no trend in PUFA content between animals in first and subsequent lactations. However, some differences were observed from 2014 to 2017 for animals in third lactation, probably due to the animal's individuality or environmental factors, such as hay and haylage quality.

The atherogenic index (AI) is an indicator of the nutritional value of goat's milk; a higher value is associated with a higher risk of atherosclerosis. Stergiadis et al. [10] reported the amount of the atherogenic index in cow's milk in the range of 2.56 to 2.69 (depending on the breed). Thus, goat's milk shows a more favorable ratio of saturated to unsaturated FAs than cow's milk. The best average atherogenic index (AI) value in goat's milk fat was found in 2015. In contrast, in 2017, there was a rapid increase in the AI value comparable to that of cow's milk.

3.2 Hygienic quality of goat's milk

Goat's milk must meet the hygienic standards of food safety as a raw material for incorporation into dairy products. The limiting factor should be the total number of microorganisms, the number of somatic cells, and the content of selected mastitis pathogens. Monitoring the hygienic quality of raw goat's milk products, intended for human consumption, should be one of the basic husbandry obligations. Goat's milk used for milk products in the Czech Republic must meet the following legislative requirements:

- Raw goat's milk used to manufacture products without heat treatment must not contain more than 500,000 CFU/mL for the total plate count (**TPC**) and 500 CFU/mL for *Staphylococcus aureus*;

- Raw goat's milk used to manufacture heat-treated (pasteurized) milk products must not contain more than 1,500,000 CFU/mL for the TPC.

Bacteria in milk intended for consumers should be effectively eliminated by pasteurization (except for spore-forming bacteria, such as *Bacillus*). Bacteria in raw milk can be a source of thermostable enzymes with proteolytic and lipolytic effects that survive pasteurization, reducing the quality of milk as a raw material for further processing. Such bacteria can negatively affect the composition and processing of goat's milk, resulting in a reduced yield of dairy products, which can cause economic losses to the producers. Therefore, it is necessary to monitor mastitis bacteria in raw goat's milk to evaluate the health status of the herd. It is also important to monitor somatic cells count (**SCC**) in milk, which may indicate the health status of the mammary gland and the overall health of the animal.

Somatic cells count (SCC) in goat's milk has been the subject of many recent studies. It is known that SCC in the milk of small ruminants shows significantly higher values and variability compared to that of cows, even in the case of a healthy mammary

DOI: http://dx.doi.org/10.5772/intechopen.97509

gland [11]. High SCC levels in goat's milk do not always indicate bacteriological contamination or inflammation of the mammary gland, but they may also indicate the animal's overall condition. In addition, the SCC of goat's milk is affected by factors other than infection, and it can fluctuate depending on the stage of lactation, lactation order, etc. Therefore, it is necessary to assess the condition of the animals more comprehensively by measuring SCC in pool milk samples and to monitor the relationship between the SCC values of goat's milk and the occurrence of mastitis pathogens, and chemical composition and technological properties of milk. The obtained information can be used to improve the quality of goat's milk on farms, especially its technological properties, which can be economically beneficial to farmers.

The occurrence of bacteria in raw goat's milk (pool and individual samples) was monitored on selected goat farms (P2) in the Czech Republic.

From **Table 3**, it is evident that the values of the total number of microorganisms in raw goat's milk on both farms (P2) throughout the monitored period met the legislative limit of the Czech Republic for the requirement for the production of heat-treated pasteurized milk products, including the requirement for the production of raw milk products. The numbers of *Staphylococcus aureus* for the production of raw milk products were exceeded only in Farm B in August, in the case of *Staphylococcus aureus*, effectively eliminated.

Table 3 shows that the values of the TPC in raw goat's milk from both farms met the legislative limit for the Czech Republic. The milk was suitable for the production of heat-treated pasteurized milk products and raw milk products. The numbers of *S. aureus* in raw milk products were exceeded only by those in milk samples collected from Farm B in August. Coliform bacteria and *S. aureus* were effectively eliminated by pasteurization.

The pathogens detected in individual milk samples taken during lactation from the 2 farms (P2) are shown in **Table 4**. The most frequently observed are the so-called environmental pathogens, of which coagulase-negative staphylococci are predominant (in 27.9% of all monitored samples). Other commonly observed pathogens are *Staphylococcus* PK-(delta haemolysin negative) (23.4% of samples), *Staphylococcus* PK-(delta haemolysin positive), *Enterococcus* sp., and *Streptococcus uberis*. *Staphylococcus intermedicus* and *Trueperella pyogenes* were detected in only 1 case. However, there was minimal detection of contagious pathogens. *S. aureus* was detected in both farms (5.4% of samples), and *Mannheimia* sp. was detected in 0.5% of cases.

Month	**TPC**	**CB**	**PB**	**TB**	*S. aureus*	**Yeasts**	**Fungy**	**SCC**
Farm A	CFU/ml	CFU/ml	CFU/ml	CFU/ml	CFU/ml	CFU/ml	CFU/ml	10^3/ml
April	$2,3.10^4$	<10	<10	<10	$8,0.10^1$	$8,0.10^2$	<10	946
June	$6,8.10^4$	<10	<10	<10	$1,5.10^2$	$1,2.10^2$	<10	949
August	$2,0.10^5$	$1,5.10^4$	<10	<10	$2,0.10^2$	$3,6.10^3$	<10	948
September[a]	$2,0.10^2$	<10	<10	<10	<10	<10	<10	—
Farm B								
April	$8,9.10^4$	<10	<10	<10	$2,8.10^2$	<10	<10	1149
June	$1,2.10^4$	<10	<10	<10	$1,0.10^2$	<10	<10	825
August	$1,1.10^3$	<10	<10	<10	$7,5.10^2$	<10	<10	1267
September[a]	<10	<10	<10	<10	<10	<10	<10	—

[a]*Pasteurized milk, Total plate count (TPC), Coliform bacteria (CB), Psychrotrophic bacteria (PB), Thermoresist. Bacteria (TB),* Staphylococcus aureus *(S.aureus), Somatic cell count (SCC).*

Table 3.
The microbiological quality of the pooled of the raw goat milk.

Mikroorganisms	Farm A (107 ks)	Farm B (115 ks)	Total	Total (222 ks)
	(%)	(%)	(%)	Number[a]
Enterococcus sp.	3	2	2,3	5
Mannheimia sp.[b]	1	—	0,5	1
Staphylococcus aureus[b]	9	2	5,4	12
Staphylococcus PK- (delta hemolyzin +)	4	5	4,5	10
Staphylococcus PK- (delta hemolyzin -)	28	19	23,4	52
Staphylococcus intermedicus	—	1	0,5	1
Streptococcus uberis	1	3	1,8	4
Trueperella pyogenes	1	—	0,5	1

[a]*The number of individual milks with the occurrence of bacteria in the milk (77 pcs) is lower than the number of total detected cases of bacteria (total of 86 cases), which is caused by the occurrence of 9 milk samples with the detected presence of two different bacteria.*
[b]*Contagious pathogens.*

Table 4.
Summary of the occurrence of bacteria in individual samples of goat milk.

Individual goat's milk samples were divided into milk samples with and without bacteria (**Table 5**). Pathogenic bacteria were found in 37.4% of the samples. The mean somatic cell count value for the samples containing bacteria was found to be 1.960 × 10^3/mL (statistically significantly higher compared to the mean SCC value for the group without bacteria). However, goat's milk samples that were free of mastitis pathogens also had a high value of somatic cell score. The average SCC value of goat's milk without mastitis was 1.422 × 10^3/mL, which may be affected by several factors, such as the animal's health and stress factors. Somatic cells have their own enzymes that can negatively affect the properties (mostly technological) of milk. Therefore, it is appropriate to monitor pathogenic bacteria, SCC values, and the total number of microorganisms in raw goat's milk.

As part of the project's solution mentioned in the introduction, several other indicators of the quality of the produced and processed goat's milk were monitored. Great attention has been paid to the refinement and expansion of knowledge about the relationships between the quality parameters of milk of small ruminants, especially the microbiological quality and content of somatic cells and its technological properties. For example, a negative effect of high SCC on rennetability and thermostability was observed. For milk samples with SCC > 1,000 thousand cells/mL, a longer renneting time and lower thermostability values were found. The effect of SCC on milk components was also observed. Individual milk

	Samples without bacteria detection	Samples with bacteria detection
No of samples (n)[a]	114	68
Proportion of cases (%)	62,6	37,4
Average number of SCC (10^3/ml)	1422	1960

[a]*Simultaneously with the bacteriological analysis of individual milk samples, the number of somatic cells in these samples was determined. For technical reasons, perform the PSB determination only on 182 samples out of a total of 222.*

Table 5.
Sample frequency and SCC values in groups with or without bacteria.

samples with SCC > 1,000 thousand cells/mL showed a decrease in lactose content. Furthermore, the impact of SCC on the composition of individual protein fractions and the content of chlorides, sodium, and potassium in milk was studied. The results have been published on an ongoing basis or are currently being prepared for publication [12–20].

The implementation of the obtained results was then mediated by economic evaluation of the impact of the mammary gland health on production economics. The production and economic data were analyzed using the ECOWEIGHT program. Because of the direct processing of milk on farms and the sale of milk in the form of dairy commodities, it was possible to evaluate the indirect effect of the mammary gland health on the economy of breeding. The calculation was modeled on goats of the White Shorthair breed.

3.3 Economic aspects of udder health

Udder health, reflected by the incidence of clinical and subclinical mastitis, is an important factor that influences the quantity and quality of milk as well as animal welfare. As mentioned above, the somatic cells count (SCC) in milk, also expressed as a somatic cell score (SCS), is an indirect indicator of udder health. With an increase in SCC, the quality of goat's milk decreases and its technological properties deteriorate, thereby causing a decline in the overall efficiency of milk and dairy commodity production [21]. Economic evaluation of the SCC (or SCS) effect can be carried out directly using basic milk price correction [22]. When milk is processed and sold as final products (e.g. cheese, yoghurt, kefir, and cottage cheese), the effect of the mammary gland health status can only be determined indirectly.

Evaluation of the udder health effect on production economy was based on the qualitative data described above and on own investigation of production and economic data provided by dairy goat farmers (P2) over the period 2015 and 2018. Production system is mostly intensive, purebred and closed, just purchasing the young bugs. Young goats needed for flock replacement are reared at farm. Goats are mated at autumn followed by kidding on February. Milking of goats starts early after kidding and a half of produced milk is used for kids' nutrition until full weaning of kids at 47 days of age. In the basic production system presented in **Table 6** the average production and economic data of White Shorthair goat farms have been taken into account. Based on the similarity between the production and economic parameters and breeding systems, it can be assumed that our findings would also

Farm parameter (unit)	Variant abbreviation	Value	
		Base	Changed[a]
Milk yield per 280d of milking period (kg/goat)	MY	749	674
Fat content (%)	F%	3,09	2,78
Protein content (%)	P%	2,94	2,65
Conception rate of goats (%)	CON	95,8	86,2
Litter size (kids/litter)	LS	1,89	1,70
Labour costs (EUR/goat/year)	—	89,98	98,97
Veterinary costs (EUR/goat/year)	—	17,70	19,50

[a]The cumulative change in production and economic data at once was taken into account in the variant "All".

Table 6.
Selected production and economic data of dairy goat farms (own calculation).

be valid for local farms of Brown Shorthair goats. In terms of indirect udder health indicators, an average SCC of 710,000 cells/mL milk was recorded on evaluated farms [23]. Considering that the SCC of 1,000 thousand cells/mL milk is generally stated as a limiting value, the presented production and economic data correspond to the parameters of a healthy farm.

Variation in the parameters, listed in **Table 6**, reflects the described relationship between the SCC and the farm's basic production level. The average value of production parameters (milk yield per milking period, fat content, protein content, goat conception rate, and litter size) applied in the base setting was changed by −10% and then all parameters were adjusted in one calculation (variant All). To take into account the additional costs of the treatment of animals with health problems, the value of labour and veterinary costs was also increased by 10% in all variants. The bio-economic model EWSH1 of the ECOWEIGHT software package [2] was used to quantify the effect of udder health on the economics of goat farms.

Revenue from dairy commodities represents the most important source of income for dairy goat farms in the Czech Republic (92% on average). A smaller fraction comes from the sale of animals and subsidies (see **Table 7**). Similarly, for New Zealand farmers, Solis-Ramirez et al. [24] reported that sales of milk and dairy products accounted for up to 99% of revenue, and only 1% came from other sources (subsidies were not accounted for, and sales of farm animals were recorded only for 1 of the evaluated farms).

The most significant costs of goat farms in the Czech Republic (**Table 7**) are milking and processing cheese (42%), feeding (25%) and labour (17%) (other costs account for 16%). The cost of veterinary care does not exceed 3% of the total cost. For comparison, dairy goat flocks in New Zealand [24] have a comparable cost structure with high feed (21% for concentrates and minerals), milk processing (20%), and labour costs (15%). If the indirect effect of udder health on the

Parameter (unit/goat/year)	Base	MY	F%	P%	CON	LS	All
Cheese yield (kg)[a]	65.2	58,7	58,5	59,1	63,7	64.2	49.1
Culling of goats due to reproduction (%)[b]	12	12	12	12	28	12	28
Total revenues (EUR)	983.98	893.62	953.48	956.80	967.78	963.76	825.23
Where: cheese a by-products	903.48	813.15	872.97	876.30	892.16	892.01	758.07
Other[c]	80.47	80.47	80.47	80.47	75.61	71.75	67.16
Subsidies (EUR)[d]	38.19	38.19	38.19	38.19	38.04	37.73	37.58
Total costs (EUR)[e]	642.85	626.19	652.29	652.06	645.87	645.87	622.52
Total profit (EUR)	379.28	305.62	339.33	342.89	359.94	355.62	240.33
Farm profitability (%)[f]	59%	49%	52%	53%	56%	55%	39%

[a]*Based on the milk yield intended for cheese processing (0.107 kg cheese/kg milk).*
[b]*Percentage of total loss (culled and death).*
[c]*Revenues from other categories (bugs and reared animals) and culled goats.*
[d]*Include support for performance testing, rearing and breeding of animals and conservation of genetic animal resources.*
[e]*The labour and veterinary costs were of 89.98 EUR and 17.70 EUR in the base system and increased by 10% in the studied variants (described in details in **Table 6**). Other costs include: fixed costs (96.25 EUR/goat/year) and costs for other categories (goats and rearing of young animals) expressed per goat.*
[f]*The ratio of profit (revenues - costs) and total breeding costs expressed in percent.*

Table 7.
Production and economic data of farms according to the basic setting and studied variants (own calculation).

economy of Czech goat farms (variant All) is considered, the share of other costs increases from 17–24%, reflecting the overall change in the level of production and the basic flock structure. The reduction in milk yield available for further processing (−58 kg) and the number of weaned kids (−0.21 kids per goat) resulted in a higher culling rate of goats, higher need for rearing goats for flock replacement (by 4 young goats/100 goats of the basic flock), and an overall reduction in the production lifetime of goats (by 0.5 years). Thus, there are not only additional costs (for the veterinary treatment and rearing of young goats) but also losses in sales. Consequently, farm profitability can fall by up to 1/3 owing to indirect effect of udder health problems. The profit remains positive, most likely due to the high intensity of production. However, farms with lower production levels may experience a drop in profit below the zero cost-effectiveness limit. Similarly, in the case of goat farming in New Zealand and Brazil [24, 25], high variability in farm profitability was found (from 10–179%), and the different production intensity of local farms was reported as one of the main reasons.

4. Conclusion

Goat's milk and goat's products are growing in popularity. At the same time, the requirements for its quantity, quality, and safety are growing. On small ruminant farms in the Czech Republic, milk usually does not go as a delivery to a dairy as in cow's milk production, but it is processed locally into products where detailed research into the properties of goat's milk is needed. The application with the quality limitation for internal use on farms in the quality system can contribute to the formal support of the quality system for official quality verification purposes, but above all practically to animal health, product quality, consumer food safety, and farm operational security. Our results show that mammary gland health indirectly affects economics of dairy goat farms. As in the case of dairy cattle, the additional costs associated with the treatment of sick animals (cost of medicines, veterinary treatment, and work of herdsman) and the actual decrease in milk production owing to disease incidence will be the most important factors that define economic consequences. Nevertheless, higher prevalence of subclinical infections, occurring commonly in dairy flocks of small ruminants, should be considered.

Acknowledgements

This research was supported by the Ministry of Agriculture of the Czech Republic, institutional support MZE RO0718 (V001 and V003) and MZE-RO1420.

Conflict of interest

"The authors declare no conflict of interest."

Notes/thanks/other declarations

Thanks are due to the Czech dairy goat farmers for cooperation in the production and economic data collection.

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Author details

Jana Rychtarova[1], Zuzana Krupova[1], Michaela Brzakova[1], Marketa Borkova[2], Ondrej Elich[2], Hedvika Dragounova[2], Ruzena Seydlova[2] and Zuzana Sztankoova[1]*

1 Institute of Animal Science, Prague, Czech Republic

2 Institute of Dairy Research, Prague, Czech Republic

*Address all correspondence to: sztankoova@seznam.cz

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