

## THE COMPARATIVE ANALYSIS OF MILK PERFORMANCE IN CZECH PIED CATTLE RAISED IN THE CZECH REPUBLIC VERSUS POLISH HOLSTEIN-FRIESIAN, SIMMENTAL AND CZECH PIED CATTLE RAISED IN POLAND

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**Abstract.** The aim of this study was to analyse milk yield, milk composition and other performance indicators in Czech Pied cows raised in the Czech Republic as compared with Polish Holstein-Friesian, Simmental and Czech Pied cows raised in Poland. The experimental materials comprised cows enrolled in the milk recording scheme in 2011, of the following breeds: Polish Holstein-Friesian (PHF) (438 376 cows), Simmental (SIM) (9 559 cows), Czech Pied tested in Poland (CP-P) (34 cows), Czech Pied tested in the Czech Republic (CP-Cz) (110 436 cows). The following parameters were determined: yield [kg] of milk, fat and protein, content [%] of fat and protein in 305-day lactations: the first lactation (L-I), the second and subsequent lactations (L-IIS), the length of: inter-pregnancy interval (IPI), inter-calving interval (ICI), gestation period and dry period, as well as artificial insemination efficiency and conception rates on selected days of IPI. PHF cows produced the highest yields of milk and milk components in the analysed lactations, in comparison with the other cattle breeds. Milk fat content was relatively high in all cattle breeds, exceeding 4% in both L-I and L-IIS. Milk protein content was highest in CP-Cz and CP-P cows, at 3.53 – 3.54% in L-I and 3.46% in L-IIS. PHF cows calved at the youngest age, had the longest IPI, ICI and lactation periods, and the shortest gestation period, compared with the other cattle breeds. Over a three-year period, SIM cows produced 25% less milk than PHF cows. The average lifetime productivity of the highest-yielding CP-Cz cows was 108342 kg milk (3.39% protein content and 3.79% fat content) and 7038 kg fat and protein. The highest number of CP-Cz cows conceived at 120 days or more (41.6%) and within 90 days (39.9%) of calving, which testifies to the success at first insemination. High genotypic diversity was noted in CP-Cz cattle, which contributed to a considerable increase in milk yield in cows containing 87% or more CP-Cz genes.

**Keywords:** Polish Holstein-Friesians, Czech Pied cattle, Simmental cattle, milk yield, inter-calving interval, longevity.

### Introduction

Due to the decreased longevity of PHF cows, cattle breeders in Poland have recently shown an increasing interest in other breeds characterized by high fertility, good health and lower nutritional requirements, which have high potential for milk production also under less favourable management conditions. The Simmental is an example of such a breed. The semen of Simmental bulls has been used in Polish dairy cattle herds for several years.

The Simmental cattle population in Poland is estimated to be about 45 000 head. In 2011, 9 559 SIM cows were included in the milk recording scheme. The average milk yield in the analysed herds was 5450 kg, and milk fat and protein content reached 4.11% and 3.36%, respectively (Polish Federation of Cattle Breeders and Dairy Farmers, 2012). Recent years have witnessed a significant increase in productivity in the Simmental cattle population, including an increase in the yields of milk, fat and protein (Litwińczuk et al., 2003).

According to Kuczma (2009), Simmental cows after their third lactation maintain good health and provide high-quality beef that can be sold at a reasonable price, which is an important economic consideration. The Simmental breed has been successfully established due to its desirable milk and beef production traits, longevity and high fertility.

The Simmental is one of the most popular breeds in the Czech Republic, accounting for nearly half of the local dairy population. It is referred to as “Fleckvieh” or “Czech Pied”. Local purebred pedigree bulls, followed by imported sires, are used for reproductive purposes to increase milk output while maintaining satisfactory beef production potential. Polish breeders and farmers purchase in-calf heifers in the Czech Republic.

The “Fleckvieh” or “Czech Pied” breed was developed in the second half of the 19<sup>th</sup> c. when Simmental and Bernese cattle were first imported from Tyrol (Switzerland). The introduction of artificial insemination techniques in the 1960s supported the

selection of top breeding bulls for crossing with cows raised in the Czech Republic, leading to the prevalence of beef genotypes. In order to improve the milk performance of cows, Czech cattle were crossbred with Ayshires and Red Holsteins (Frelich et al., 2001; Bouška et al., 2006), which gave rise to a dual-purpose breed with a clear predominance of milk production traits over beef production potential (Sambraus, 2006, Večeřa and Falta, 2010).

In the Czech Republic, over 90% herds of cattle containing 51% and more CP-Cz genes have been included in the milk-recording program. In 2011, the average milk yield in the analysed herds was 6 545 kg, and milk protein and fat content reached 3.48% and 4.01%, respectively (Kadečka and Rozman, 2006; Kvapilík et al., 2012). In Germany, the respective values are 6991 kg milk, 3.49% protein and 4.15% fat. According to the German breeding program, the proportion of Red Holstein genes in the genotype of Simmental cattle may reach up to 25%.

Czech Pied cattle are characterized by a relatively high milk yield, exceeding 10 000 kg per lactation in the highest-producing cows. Peak milk production is achieved in the third and fourth lactation. The average number of lactations per cow is 3.7. Numerous sixth lactation and older cows remain in the dairy herd. In 2011, the average lifetime productivity of 10 top Czech Pied cows in the Czech Republic was 108 342 kg milk and 7 038 kg protein and fat (3.39% protein content, 3.72% fat content).

The objective of this study was to analyse milk yield, milk composition and other performance indicators in Czech Pied cows raised in the Czech Republic as compared with Polish Holstein-Friesian, Simmental and Czech Pied cows raised in Poland.

### Material and methods

The experimental materials comprised cows enrolled in the milk recording scheme in 2011, of the following breeds: Polish Holstein-Friesian (PHF) - 438 376 cows, Simmental (SIM) - 9 559 cows, Czech Pied tested in the Czech Republic (CP-Cz) - 110 436 cows, plus a herd of 34 Czech Pied cows (CP-P) raised in Poland since 2009 when in-calf heifers were imported from the Czech Republic.

The cows were included into the Performance Testing Scheme, and were evaluated in Poland by the Polish Federation of Cattle Breeders and Dairy Farmers (PFCBDF, 2012) using the AT4 method, and in the Czech Republic by Českomoravská společnost chovatelů a.s. Praha using the A4 method (Kvapilík et al., 2012).

Milk yield and composition were analysed during 305-day lactations: the first lactation (L-I), the second and subsequent lactations (L-IIS). The actual amount of produced milk (kg) was converted into the amount of average daily value-corrected milk (VCM) and fat-corrected milk (FCM), according to the following formulas:

$VCM = -0.05 * \text{milk (kg)} + 8.66 * \text{fat (kg)} + 25.98 * \text{protein (kg)}$  (Arbel et al., 2001).

$ECM = \text{milk (kg)} * [(0.383 * \text{fat [\%]} + 0.242 * \text{protein [\%]} + 0.7832) / 3.140]$  (Arbel et al., 2001).

The yield [kg] of milk fat and protein, and the content [%] of milk fat and protein were also determined. In addition to milk production traits, the following reproductive performance parameters were analysed: the length of: inter-pregnancy interval (IPI) including the rest period and the service period, inter-calving interval (ICI), gestation period and dry period, as well as artificial insemination efficiency and conception rates on selected days of IPI.

The collected data were compared among cattle breeds and between the first and subsequent lactations. Data on milk production are presented as means. Arithmetic means and standard deviations were calculated for the remaining parameters, using Statistica ver. 9 software. The significance of differences between means was estimated by Fisher's test.

### Results and Discussion

Milk production over lactations of normal length is given in Table 1. PHF cows were characterized by the highest yields of milk and milk components in the analysed lactations. Actual milk yield in the second lactation was 888 kg higher than in the first lactations. The milk yield converted into VCM (including the yields of milk protein and fat) was higher in PHF cows by 861 kg in L-I and by 1051 kg in L-IIS. Lower yields of milk (below 6 000 kg) and milk components were recorded in SIM cows tested in Poland.

Czech Pied cows raised in the Czech Republic and Poland were characterized by higher yields of milk and milk components than SIM cows, by 978 kg (L-I) and 1293 kg (L-IIS), and by 775 kg (L-I) and 1616 kg (L-IIS), respectively. Vaněk (2004) reported lower milk production levels for CP-Cz cattle raised in the Czech Republic, at 4630 kg in primiparous cows and 5125 kg in multiparous cows.

Milk fat content exceeded 4% in all cattle breeds, both in the first and subsequent lactations. Milk protein content was highest in CP-Cz and CP-P cows, at 3.53% (CP-Cz) and 3.54% (CP-P) in first lactation cows, and at 3.46% in older cows of both breeds. Milk protein content was higher in SIM cows than in PHF cows, which indicates that SIM cows are superior to PHF cows with regard to the concentration of the most valuable milk component. Also in a study by Pešek et al. (2005), who compared the productivity of HF and CP-Cz cows kept together, milk fat content and milk protein content were higher in CP-Cz cows, by 0.4% (4.59% vs. 4.19%) and by 0.29% (3.42% vs. 3.13%), respectively. Similar values were noted in CP-Cz cows by Samková et al. (2009), at 4.57% fat and 3.41% protein. According to Bogucki et al. (2009), the average fat and protein content of milk from PHF cows was 4.38% and 3.31%, respectively. In comparison with PHF cattle, SIM cows raised in Poland were characterized by lower fat concentrations (4.07% - 4.14%) and higher protein concentrations (3.35% - 3.61%) in milk (Barłowska et al. 2004).

Table 1. Yields of milk and milk components during 305-day lactations

Parameter	Lactation	Breed *				
		PHF (PFCBDF 2012)	SIM PFCBDF 2012)	CP-Cz (Kvapilík et al. 2012)	CP-P** (own study)	
Number of cows	N	438 376	9 559	110 436	34	
Statistical measurements					LSM	Sd
Yield [kg]						
Milk	L-I	6 555	4 959	5 937	5 734	807,64
	L-IIS	7 443	5 544	6 837	7 160	1119,74
VCM	L-I	7 416	5 773	7 171	6 846	952,23
	L-IIS	8 494	6 472	8 076	8 411	1283,91
ECM	L-I	6 507	4 989	6 051	5 722	784,84
	L-IIS	7 458	5 589	6 839	7 276	1258,31
Fat	L-I	265	202	242	224	31,43
	L-IIS	306	227	272	283	54,18
Protein	L-I	213	167	210	203	28,15
	L-IIS	243	187	237	242	41,29
Content [%]						
Fat	L-I	4.04	4.08	4.08	4.03	0,19
	L-IIS	4.11	4.09	4.09	4.10	0,25
Protein	L-I	3.25	3.36	3.53	3.54	0,18
	L-IIS	3.26	3.37	3.46	3.46	0,19
* symbols: PHF- Polish Holstein-Friesian cattle; SIM- Polish Simmental cattle, CP-Cz- Czech Pied cattle raised in the Czech Republic; CP-P - Czech Pied cattle raised in Poland; ** The herd consisting of 34 exploited in Poland CP-P cows was brought under a statistical analysis. However, the data concerning the remaining cattle races was used from the national assessment of the active population cows.						

Table 2. Reproductive performance indicators

Parameter	Breed *				
	PHF (PFCBDF 2012)	SIM (PFCBDF 2012)	CP-Cz (Kvapilík et al. 2012)	CP-P** (own study)	
Number [N]	438 376	9 559	110 436	34	
Statistical measurements					
Age at first calving [days]	824	874	862	886	135,07
IPI [days]	148	121	111	86	23,36
ICI [days]	430	410	395	371	14,26
Gestation period [days]	282	286	284	284	13,67
Lactation period [days]	365	340	345	323	18,22
Dry period [days]	65	70	50	47	7,43
* symbols: PHF- Polish Holstein-Friesian cattle; SIM- Polish Simmental cattle, CP-Cz- Czech Pied cattle raised in the Czech Republic; CP-P - Czech Pied cattle raised in Poland; ** The herd consisting of 34 exploited in Poland CP-P cows was brought under a statistical analysis. However, the data concerning the remaining cattle races was used from the national assessment of the active population cows.					

Table 2 shows the reproductive performance parameters of the examined cows. PHF cows calved at the youngest age, had the longest IPI, ICI and lactation periods and the shortest gestation period. Cows of the other breeds calved later than PHF cows, by 62 days (CP-P), 50 days (SIM) and 38 days (CP-Cz). CP-P cows and CP-Cz cows had the shortest IPI and ICI. The lactation period lasted for 323 days in CP-P cows and 345 days in CP-Cz cows, and the dry period was shorter, at 47 and 50 days, respectively.

In a study of CP-Cz cows conducted by Vaněk (2004), the average IPI and ICI lasted for 74 and 385 days. Řehák et al. (2012) found that CP-Cz cows had shorter IPI and ICI than HF cows, at 96 and 382 days vs. 125 and 403 days, respectively. The gestation period typically lasted for 288 days in CP-Cz cows and 280 days in HF cows, which is consistent with the earlier findings of Miciński (2009) and Miciński et al. (2009).

A comparison of the average lifetime productivity of PHF and SIM cows raised in Poland and culled in 2011

(Table 3) revealed that over a three-year period, PHF cows produced almost 25% more milk than cows of SIM race. The yields of milk protein and fat were also lower in SIM cows.

Table 4 shows that the average lifetime productivity of the highest-yielding CP-Cz cows was high, substantially exceeding 100 000 kg milk between the 8<sup>th</sup> and 16<sup>th</sup> lactations. The average number of lactations in 10 top CP-Cz cows was 11, and their average lifetime productivity reached 108 342 kg milk and 7 038 kg protein with fat.

**Table 3. Average lifetime productivity of cows raised in Poland and culled in 2011 (PFCBDF 2012)**

Parameter	Breed	
	PHF	SIM
Number [N]	174 422	2 811
Herd life [years]	3.01	2.98
Milk [kg]	20 123	15 265
Fat [kg]	841	624
Protein [kg]	672	521
Fat [%]	4.18	4.09
Protein [%]	3.28	3.41

**Table 4. Average lifetime productivity of CP-Cz cows in the highest-yielding herds in the Czech Republic 2011 (Kvapilík et al. 2012)**

Herd/farm	Number of lactations	Milk [kg]	Content [%]		Fat + protein [kg]
			Protein	Fat	
ZESPO CZ, s. r. o.	11	122 549	3.29	3.63	7783
Agr. Lhota p. Libčany	16	115 036	3.56	3.56	8052
DVPM Slavíkov	11	114 139	3.31	3.60	7128
VOD Zdislavice	11	107 579	3.44	3.89	7258
ZAS Koloveč	8	105 739	3.23	3.16	6177
ZD Rodvínov	12	105 148	3.51	4.14	7122
ZDV Sirákov	11	104 377	3.59	3.68	6682
VOD Zdislavice	10	103 102	3.38	3.84	6686
Krofta Ladislav	10	103 081	3.19	4.23	6076
Agrodružstvo Načeradec	8	102 673	3.35	4.15	7412
Mean /total	11	108 342	3.39	3.79	7038

**Table 6. Milk performance of CP-Cz cows subject to the proportion of CP-Cz genes and lactation (Kvapilík et al. 2012)**

Specification	Number of lactations	Milk [kg]	Fat [%]	Fat [kg]	Protein [%]	Protein [kg]
Subject to the proportion of CP-Cz genes						
51 to 74%	19 560	6 499	4.03	262	3.49	227
75 to 87%	46 827	6 469	4.02	260	3.48	225
87% and more	44 049	6 645	3.98	264	3.48	231
Subject to lactation						
L-I	35 879	5 937	4.08	242	3.53	210
L-IIS	74 557	6 837	3.97	272	3.46	237

Table 5 presents conception rates in CP-Cz cows raised in the Czech Republic in 2007–2011. The highest number of CP-Cz cows conceived at 120 days or more (41.6%) and within 90 days (39.9%) of calving, which testifies to the success at first insemination. Since Simmentals are early-maturing cattle, heifers should be inseminated at the age of 16 to 19 months. In Czech Pied cattle, the average age at first calving is 28 months and 11 days. The average length of ICI and IPI is 395 and 111 days, respectively. An increase in milk production insignificantly reduced ICI, from 401 days in 2008 to 395 days in 2011. In Holstein cows tested in the Czech Republic in 2011, the average age at first calving and ICI duration were 25 months and 22 days, and 417 days, respectively (Kvapilík et al., 2012).

**Table 5. Conception rates [%] on selected days of IPI in CP-Cz cows raised in the Czech Republic in 2007–2011 (Kvapilík et al. 2012)**

Year	IPI (days)			
	up to 75	76 to 90	91 to 120	120 and more
2007	27.2	11.7	18.3	42.8
2008	27.3	11.9	18.5	42.3
2009	28.3	11.9	18.4	41.4
2010	28.4	12.1	18.5	41.0
2011	28.7	12.0	18.7	40.6
TOTAL	28.0	11.9	18.5	41.6

High genotypic diversity was noted in CP-Cz cattle evaluated in the Czech Republic (Table 6), which contributed to a considerable increase in milk yield in cows containing 87% or more CP-Cz genes. Milk fat content dropped insignificantly to 3.98%, while milk protein content remained at a stable, high level of 3.48%. An analysis revealed that the yields of milk, fat and protein increased, whereas the content of fat and protein in milk decreased in multiparous cows. An increase in productivity, as compared with primiparous cows, reached 900 kg milk, 30 kg fat and 27 kg protein, while fat and protein concentrations were lower, at 3.97% and 3.46%, respectively.

Table 7 shows a comparison of 10 herds of the highest-yielding CP-Cz cows kept in the Czech Republic and five herds of highest-yielding SIM cows raised in Poland. The average productivity was higher in CP-Cz cows than in SIM cows. In the 10 highest-yielding CP-Cz

herds in the Czech Republic, the average fat and protein content was 3.94% and 3.41%, respectively. In the five highest-yielding SIM herds in Poland, the respective values reached 4.28% and 3.41%.

**Table 7. Comparison of herds of highest-yielding CP-Cz cows raised in the Czech Republic and highest-yielding SIM cows raised in Poland**

Farm name	Number of cows	Milk [kg]	Fat [%]	Fat [kg]	Protein [%]	Protein [kg]
Czech Republic (Kvapilík et al. 2012)						
Agrodruštvo Načeradec	65	9 534	4.44	423	3.37	321
ZAS Koloveč-Kanice	767	8 845	3.64	322	3.51	311
ZS Nažovice, a.s.	382	8 503	3.95	336	3.52	300
VFU Brno-Nový Dvůr	94	8 080	4.01	324	3.68	298
ZD Bělčice – Hornosín	221	8 594	4.05	348	3.44	296
Farma u Drhovských	73	8 627	3.79	327	3.41	294
ZD Krasná Hora, a.s.	678	8 217	4.00	329	3.57	293
VOD Zdislavice	41	8 418	4.14	349	3.48	293
ZAS Koloveč	23	8 559	3.54	303	3.38	289
ZD Velký Beranov	163	8 255	3.86	319	3.49	288
Mean	251	8563	4.28	338	3.41	298
Poland (PFCBDF 2012)						
Krzyczki-Żabiczki-J.Sadowski	19	7 737	4.53	351	3.33	258
Kruszynek-J.Wroniecki	26	7 695	4.32	332	3.33	256
Lipnica – L. Kapuściński	6	7 629	4.51	344	3.52	269
Jaćmierz – J. Stączek	37	7 405	4.05	300	3.40	252
Pępowo sp. z o.o.	356	7 282	4.01	292	3.46	252
Mean	89	7550	4.28	324	3.41	257

### Conclusions

The following conclusions can be drawn from the present study, which set out to determine milk performance and reproductive performance indicators in PHF, SIM and Czech Pied cows raised in Poland as compared with Czech Pied cattle raised in the Czech Republic:

– PHF cows were characterized by the highest yields of milk and milk components in the analysed lactations, in comparison with the other cattle breeds.

– Milk fat content was relatively high in all cattle breeds, exceeding 4%.

– In CP-Cz and CP-P cows, the content of protein throughout the I lactation was 3.53 and 3.54% and in the remaining lactations it reduced to 3.46% in both races.

– PHF cows calved at the youngest age, had the longest IPI, ICI and lactation periods, and the shortest gestation period, compared with the other cattle breeds.

– Over a three-year period, SIM cows produced 25% less milk than PHF cows.

– The highest number of CP-Cz cows conceived at 120 days or more (41.6%) and within 90 days (39.9%) of calving, which testifies to the success at first insemination.

– A comparison of the highest-yielding herds showed that CP-Cz cows were characterized by higher productivity than SIM cows at a lower milk fat.

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