

## EFFECT OF LAMBING SEASON ON MILK PRODUCTION AND COMPOSITION BETWEEN ISTRIAN AND PAG SHEEP IN CROATIA

Špehar M., Mulc D., Jurković D., Dražić M., Barać Z.

Mr.sc. Marija Špehar, Croatian Agricultural Agency, Ilica 101, 10000 Zagreb, e-mail: [mspehar@hpa.hr](mailto:mspehar@hpa.hr);  
Danijel Mulc, mag.ing.agr., Croatian Agricultural Agency, Ilica 101, 10000 Zagreb;  
Darko Jurković, mag.ing.agr., Croatian Agricultural Agency, Ilica 101, 10000 Zagreb;  
Dr.sc. Maja Dražić, Croatian Agricultural Agency, Ilica 101, 10000 Zagreb;  
Dr.sc. Zdravko Barać, Croatian Agricultural Agency, Ilica 101, 10000 Zagreb.

### **Abstract**

The objective of this study was to evaluate the effect of lambing season (month and year) on the milk production and composition (fat and protein content) for two Mediterranean dairy breeds i.e. Istrian and Pag sheep in Croatia. Since the breeds are reared only in Istria region or Pag Island, the effect of breed covers the effect of geographic (or climate) area. The study included 7.825 test-day records (3.391 for Istrian and 4.434 for Pag sheep) of 4.911 ewes (2.227 Istrian and 2.684 Pag) for period from 2006 to 2009. Total milked milk and milk composition in lactation were calculated by the test interval method. Istrian sheep produced more milk (111.2 kg) with lower fat and protein content in comparison to Pag sheep (90.1 kg). Lambing season starts in October and lasts until May for Istrian sheep. Pag sheep had shorter lambing season, from October to February. Month of lambing nested within breed had significant effect on the milk traits ( $P < 0.01$ ). Milk production was the highest for Istrian ewes lambed in December (132.5 kg) and Pag ewes lambed in November (98.3 kg). Ewes lambed in November had the highest fat and protein content for both breeds. Differences in the milk production and the composition between breeds were observed for the year of lambing effect nested within breed ( $P < 0.01$ ). Istrian ewes lambed in 2007 had the highest milk production and fat and protein contents. Pag ewes lambed in 2006 had the highest milk yield in the lactation and the milk components as well. Although the distance between breeding areas is relatively short, the seasonal differences were statistically significant for milk production and composition between breeds.

*Key words: Istrian and Pag sheep, lambing season, milk production and composition*

### **Introduction**

Sheep breeding is the dominant component of livestock production in Mediterranean countries where feed availability is seasonal and the level of management is often very poor. The production has a seasonal character and is based mainly on the autochthonous breeds, like Pag and Istrian sheep. The breeds are adapted to poor environmental conditions. Pag sheep is the largest dairy sheep population among autochthonous breeds in Croatia (Barać et al., 2004; Mioč et al., 2007). Milk is used for production of well-known Pag cheese. According to the Annual report of Croatian Agricultural Agency (CAA, 2011), breeding population accounted 5.041 sheep. Istrian sheep is the second most important native breed in Croatia with the 2.314 sheep included in the breeding program (CAA, 2011). The breed is the most productive dairy sheep breed in Croatia, specialized for production of semi-soft and full-fat cheese (Mioč et al., 2007). Milk yield and milk composition are influenced by genetics and environment.

Environmental influences on milk production in sheep have been studied for stage of lactation (Gootwine and Pollott, 2000), parity (Mavrogenis, 1996), and the common flock effect (Baro et al., 1994.; El-Saied et al., 1998). Lambing season also has a relatively large influence on milk production (Ploumi and Emmanouilidis, 1999). The effect of lambing season on milk yield has been attributed particularly to climate factors as well as to the differences in the available feeds. Despite the fact that both breeds has been reared in a Mediterranean climate, characterized by wet winters and hot dry summers, differences in annual rainfall and wide variations between locations and years still exist. Therefore, the aim of this study was to determine the differences in production and milk composition according to season of lambing (month and year) for two Mediterranean dairy breeds i.e. Pag and Istrian sheep.

## Materials and methods

Test-day records of daily milk yield, fat and protein content from 2006 to 2009 were included in data analyses for Pag and Istrian sheep breeds. Data were taken from the central database of the Croatian Agricultural Agency. Daily milk yield and milk components were recorded according to the ICAR guidelines using AT method (ICAR, 2011). For both breeds, test-day records for ewes were edited as follows: records from the first to the tenth parity were included in the analysis. Additionally, parities from the sixth to the tenth were joined into a common class (parity 6+) due to the small number of records. Stage of lactation was limited on 180 days after lambing. Lambing season starts in October for Istrian sheep (Figure 1) and lasts until May. The ewes have been lambed mostly between December and February with the highest proportion of lambings (33%) in December and January (30%). For Pag ewes, lambing season was shorter. Lambings occur from November to February. The highest proportion of lambings occurs in December (62%) and January (29%).

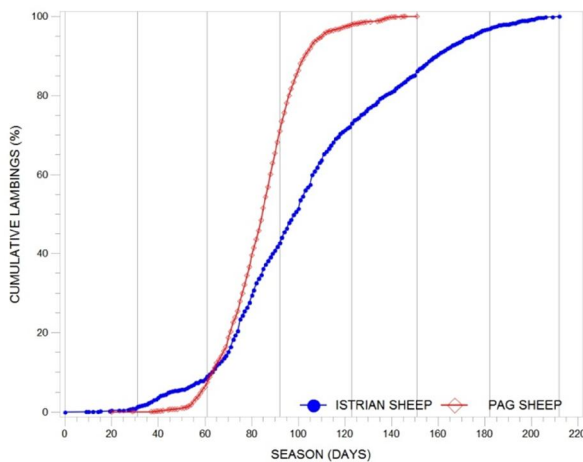


Figure 1. Cumulative lambings for Istrian and Pag sheep

In the statistical analysis, lambing season (month or year of lambing) with less than 30 records per class was joined with the previous or next adjacent lambing season. Therefore, the records from October were joined to November for both breeds, while records from April to May were included in March lambing season for Istrian sheep. Lambings occurred in March were joined to February lambing season in Pag sheep. The milked milk and milk composition in lactation were calculated according to test interval method (ICAR, 2003). After data editing, 7.825 test-

day records (3.391 for Istrian and 4.434 for Pag sheep) for 4.911 ewes (2.227 Istrian and 2.684 Pag) were included in the data analysis.

Data were analyzed using GLM procedure in SAS STAT program package (SAS, 2009) according to the following model:

$$y_{ijklm} = \mu + B_i + M_{ik} + Y_{il} + e_{ijklm} \quad (1)$$

Where:  $y_{ijklm}$  = milked milk or protein and fat content,  $\mu$  = the overall mean,  $B_i$  = breed effect ( $i=1, 2$ ),  $M_{ik}$  = month of lambing nested with breed ( $k=1, 2, \dots, 5$ ),  $Y_{il}$  = year of lambing nested within breed ( $l=1, 2, 3, 4$ ).

## Results

The proportion of variation covered by the environmental effects in the statistical model for milk traits (Table 1) ranged from 4.6 up to 15.5%. The highest proportion of variation was determined in the milked milk, followed by fat and protein content. The results showed that breed effect, month of lambing nested within breed, and year of lambing nested within breed had significant effect ( $P < 0.01$ ) on studied milk traits.

Table 1. Coefficient of determination ( $R^2$ ) and degrees of freedom (SS) for the model and p-value of effects

Model	Trait		
	Milked milk	Fat content	Protein content
<sup>1</sup> $R^2$ (%)	15.5	10.3	4.6
<sup>2</sup> SS	21	21	21
$B_i$	<.0001	<.0001	0.0064
$M_{ik}$	<.0001	<.0001	<.0001
$Y_{il}$	<.0001	<.0001	<.0001

Descriptive statistics and Least Square Means (LSM) for milk production and composition are presented in Table 2. Istrian ewes were more productive ( $111.2 \pm 56.8$  kg) than ewes of Pag breed ( $90.1 \pm 28.5$  kg). Fat and protein contents were slightly lower (7.32, 6.04) in Istrian than in Pag (7.57, 6.05) breed. After the correction to equal size of groups within the fixed effects (LSM), Istrian breed still produced more milk (107.53 kg) compared to Pag sheep (96.89 kg). However, fat and protein content for Istrian was lower (7.35 % and 5.86 %) compared to Pag breed (7.78 % and 6.41 %).

Table 2. Descriptive statistics and LSM  $\pm$  s.e. of milked milk, fat and protein content by breed

Trait	Mean		Std		LSM $\pm$ s.e.	
	Istrian	Pag	Istrian	Pag	Istrian	Pag
Milked milk (kg)	111.2	90.1	56.8	28.5	107.53 $\pm$ 1.38	96.89 $\pm$ 1.82
Fat content (%)	7.32	7.57	1.17	0.86	7.78 $\pm$ 0.09	7.35 $\pm$ 0.13
Protein content (%)	6.04	6.05	0.53	0.43	6.41 $\pm$ 0.08	5.86 $\pm$ 0.10

Although the geographical distance between breeding areas is relatively short, the seasonal differences were observed for milk production and composition between breeds. Lambing season starts in November and lasts until March for Istrian sheep. Pag sheep had shorter lambing season, from November to February. Month of lambing nested within breed had

significant effect on milk traits ( $P < 0.01$ ). Milk production was the highest for Istrian ewes lambing in December (132.5 kg) and Pag ewes lambing in November (98.3 kg). Ewes lambing in November had the highest fat and protein content for both breeds.

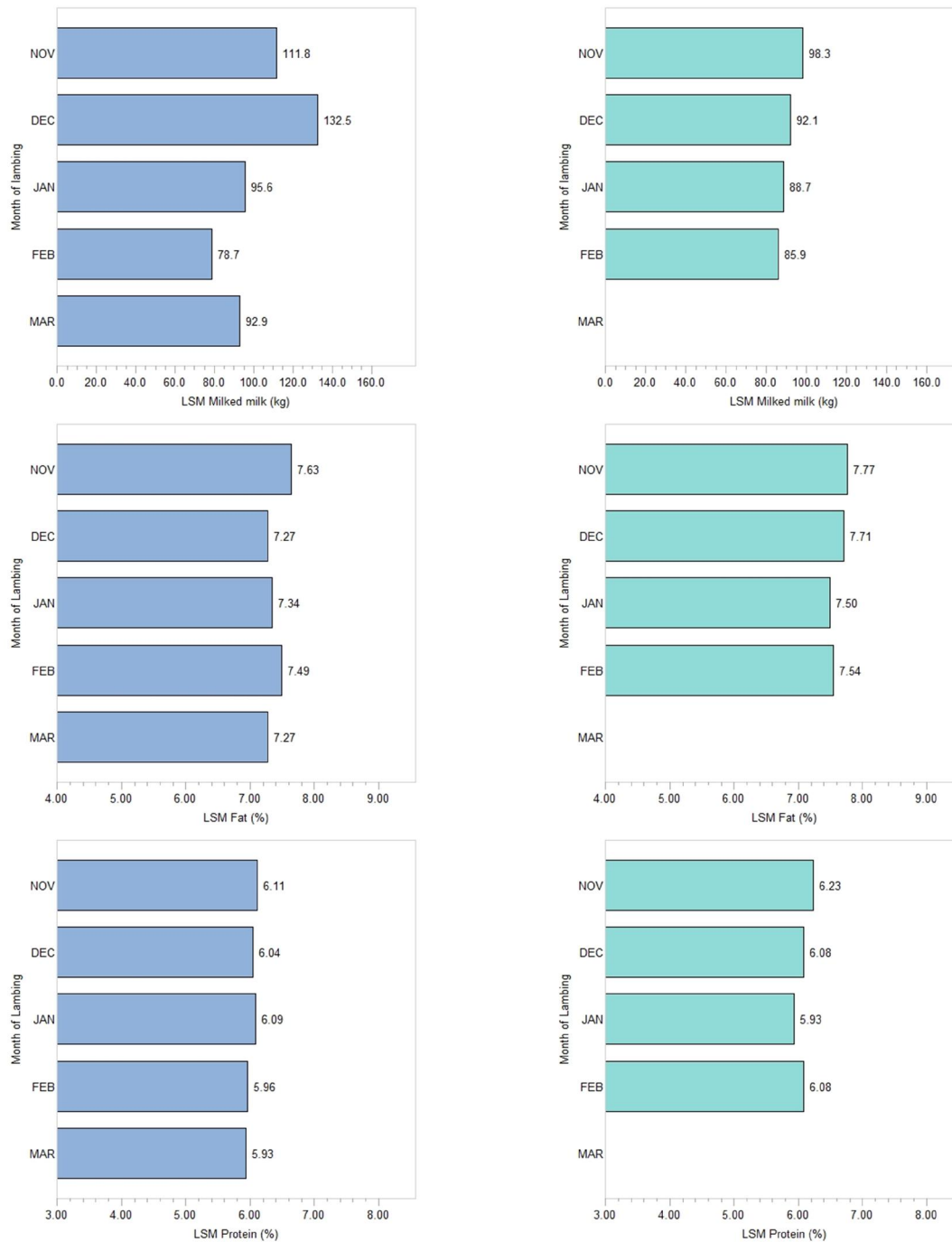


Figure 2. LSM means (LSM) of milked milk, fat and protein content in Istrian and Pag sheep by month of lambing. Differences in the milk production and the composition between breeds (Table 3) were observed for the year of lambing effect nested within breed ( $P < 0.01$ ). Istrian ewes lambing in

2007 had the highest milk production ( $141.3 \pm 2.8$  kg) and fat ( $9.76 \pm 0.19$  %) and protein ( $8.44 \pm 0.16$  %) contents.

Table 3. LSM  $\pm$  s.e of milked milk, fat and protein content in Istrian and Pag sheep by year of lambing

Year of lambing/Trait	Milked milk (kg)		Fat content (%)		Protein content (%)	
	Istrian	Pag	Istrian	Pag	Istrian	Pag
2006	87.0 $\pm$ 3.2	98.9 $\pm$ 2.9	7.01 $\pm$ 0.22	7.73 $\pm$ 0.21	5.16 $\pm$ 0.18	6.02 $\pm$ 0.17
2007	141.3 $\pm$ 2.8	98.5 $\pm$ 2.5	9.76 $\pm$ 0.19	7.40 $\pm$ 0.17	8.44 $\pm$ 0.16	5.93 $\pm$ 0.14
2008	121.7 $\pm$ 1.8	94.8 $\pm$ 2.4	8.96 $\pm$ 0.12	7.31 $\pm$ 0.16	7.26 $\pm$ 0.10	5.67 $\pm$ 0.14
2009	119.6 $\pm$ 1.7	89.9 $\pm$ 2.0	8.36 $\pm$ 0.12	6.52 $\pm$ 0.14	7.13 $\pm$ 0.10	5.43 $\pm$ 0.11

Pag ewes lambing in 2006 had the highest milked milk ( $102.1 \pm 3.4$  kg) in the lactation. Production gradually decreased during observed period. Ewes lambing in 2006 also had the highest fat and protein content.

## Discussion

Milked milk in the lactation of both, Istrian and Pag breed was similar to production of other Mediterranean breeds like Churra (Finocchiaro et al., 2005) or Sarda (Sanna et al., 1997). For low productive Sarda breed, Sanna et al. (1997) reported lower fat (between 6.18 and 6.61 %) and protein content (between 5.50 and 5.80%) compared to Istrian and Pag breed. As expected, the production was lower compared to high productive breeds such as East Frisian sheep (Hamann et al., 2004), or Awassi (Pollot et al., 2004). One breed produced only in one geographic area. The effects of breed and climate on productivity cannot be separated and therefore it cannot be concluded which breed is more productive.

Milk yield and milk composition are changing throughout the year, due to seasonal changes together with the feed availability during different lambing seasons and metabolic and endocrine changes during lactation (Hassan, 1995; Sevi et al., 1999). Milk production of the Istrian and Pag sheep was the highest for ewes lambing during winter season. For Lataxa breed, María and Gabiña (1993) found higher production for sheep lambing during December and January compared to February and March lambings. In the research of Gootwine and Pollot (2000), seasonal differences in milk production with higher production during winter season were observed for Awassi breed. Milk composition was also affected by the lambing season. Ewes lambing in November had the highest fat and protein content for both breeds. Autumn lambing ewes also had higher fat and protein content compared to winter lambing ewes in Comisana breed (Sevi et al., 2004). As opposite, spring lambing ewes from Slovakian breeds (Tsigai, Valachian and Lacune) had higher fat and protein content compared to winter lambings. Differences between breeds in the milk production and composition were also found for year of lambing. Significant effect of lambing season and year of lambing on milk production was reported for Osimi and Saidi (Hasan, 1995), Chios (Mavrogenis, 1996) and Valachian (Oravcová et al., 2007) sheep.

## Conclusion

The objective of this study was to evaluate the effect of breed and lambing season (month and year) on milk production and composition (fat and protein content) for Istrian and Pag sheep in Croatia. All studied milk traits were affected ( $P < 0.01$ ) by the mentioned effects. Istrian sheep produced more milk (107.53 kg) with higher fat and protein content in comparison to Pag sheep (96.89 kg). Month of lambing nested within breed had significant effect on milk traits ( $P < 0.01$ ). Milk production was the highest for Istrian ewes lambing in December (132.5 kg) and Pag ewes lambing in November (98.3 kg). Ewes lambing in November had the highest fat and protein content for both breeds. Differences in the milk production and the composition between breeds were observed for the year of lambing effect nested within breed ( $P < 0.01$ ). Istrian ewes lambing in 2007 had the highest milk production and fat and protein contents. Pag ewes lambing in 2006 had the highest milk yield in the lactation and the milk components as well. Although the geographical distance between breeding areas is relatively short, the seasonal differences were statistically significant for milk production and composition between breeds.

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