Milk yield and quality characteristics of Cinisara and Modicana cows reared on a farm in the province of Palermo (Sicily-Italy)

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INTRODUCTION

The loss of biodiversity in the livestock sector is mainly due to the growing interest in economic profits. Consequently, a gradual abandonment of traditional farming techniques and the replacement of indigenous breeds with more selected and productive breeds had been taking place.
In Italy, about 24% of cattle breeds are considered at risk or endangered, while 31% are now extinct\textsuperscript{1}. However, there are still a high number of indigenous breeds in Italy, for these animals the risk of extinction is higher. Their survival is mainly due to the adaptation ability to the habitat which is characterized by unfavourable climatic conditions for cosmopolitan breeds. Modicana and Cinisara cows, which originate from Sicily, are some of the breeds at risk and they have been included in the “Register of native cattle breeds of limited diffusion”\textsuperscript{2}.
The Modicana cow takes its name from and is native to Modica, in the province of Ragusa (Sicily). This breed has now spread throughout Sicily, and particularly in the provinces of Palermo, Ragusa and Enna.
In spite of this, the replacement of native breeds has led to a marked decrease in the number of Modicana cows. This has led to Modicana, with only 4015 individuals left, being included in the breeds in danger of extinction\textsuperscript{1}. Modicana is a medium sized, very rural animal, which is well adapted to different climatic situations and to extensive farming systems; it is a dual purpose cow (meat and milk).

SUMMARY

Introduction - In Italy there are a large number of indigenous breeds at high risk of extinction. These include the Modicana and Cinisara cows that are native to Sicily and are included in the “Register of native cattle breeds of limited diffusion”.
Aim - The present study investigates the variability of the main quality parameters of milk from two Sicilian cow genotypes regarding the physiological and environmental factors that affect milk production.
Materials and methods - 99 individual Modicana and 87 Cinisara milk samples were taken. The cows were different in terms of parity and lactation and were reared on pasture on the same farm in the province of Palermo at 1077 meters above sea level. Milk yield, total protein, lipids (MilkoScan, Italian Foss Electric, Padova, Italy), and somatic cell count (SCC) (n*1000/ml of milk) (Fossomatic, Italian Foss Electric, Padova, Italy) were evaluated for each individual.
Results and discussion - Higher milk yields were recorded before 60 days of lactation, in summer and autumn, when the majority of births are concentrated. Fat and protein percentages remained constant during lactation. SCC did not vary significantly and was below the maximum limit identified for bulk milk by current legislation. The Modicana and Cinisara milk was richer in fat and protein than other more specialized dairy breeds. Cinisara presented a higher somatic cell linear score (LS) than Modicana. The higher values of LS in Cinisara than in Modicana might be due to the shape of the udder which in Cinisara has thicker and large teats which makes milking more difficult. However, the LS showed no changes either in the course of lactation, nor in terms of parity.
Conclusions - Milk yield was not high in Modicana and Cinisara compared to other more specialized dairy breed, however they produce more concentrated milk, higher in protein and fat. These are important characteristics since Modicana and Cinisara milk is intended for the production of typical cheeses.
In Cinisara and Modicana cows the production was affected by season. An improvement of use of pastoral resources may favour a constant milk yield and quality. The data from the study would help to preserve and improve the traits of these native breeds which are indispensable for the development of regions and marginal pastures of Sicily, and for the preservation of animal biodiversity.

KEY WORDS
Cinisara cow, Modicana cow, milk yield, milk quality.
The Cinisara belongs to the group of Podolica breeds. It is a medium-sized animal with a very solid skeletal structure, and is distinguished as a local Sicilian ecotype. It is found almost exclusively in the province of Palermo, in marginal coastal areas and in interior mountainous areas of north-west Sicily. The Cinisara takes its name from Cinisi, a coastal town in the western part of the province. A few of these cows are reared in the mountain areas of Trapani, Messina and Enna.

Cinisara is a rural cow, and is reared mainly in extensive farming systems, in conditions that could be described as "extreme" since it has adapted to discontinuous food availability and to the soil and climatic conditions of the farming areas. Despite the AIA (Italian Association of Breeders) having set up various recovery programs for indigenous breeds, Modicana and especially Cinisara cows are not yet out of danger because of the tendency to replace native breeds with highly specialized breeds. In fact, only a few farms continue to rear them, especially due to their characteristics of resilience, longevity and for the quality of milk. Over the last decade, the number of Cinisara cows has decreased from about 7400 to 5071. From these nuclei of animals, Modicana and Cinisara products (milk, dairy, and meat) need to be promoted in order to increase farm profitability and encourage the diffusion of the two breeds. The Modicana and Cinisara milk is intended for the production of typical cheese, such as "Caciocavallo Palermitano" and "Ragusano" stretched curd (pasta fi lata) cheese and ricotta cheeses.

In the light of these considerations and the interest of the different actors of the food chain in the recovery, development and conservation of animal biodiversity, this work contributes to the knowledge of the milk yield and quality from Modicana and Cinisara cows reared in the area of origin. This study investigates the variability of the main quality parameters of the milk of the two Sicilian genotypes in terms of parity, lactation phase and season, in order to identify potentiality for improvements.

MATERIALS AND METHODS

Sampling and data collection
99 Modicana and 87 Cinisara individual milk samples in three phases of lactation (<60; 60-150; >150 days in milk) were taken for a total of 297 and 261 milk samples for Modicana and Cinisara respectively. Daily milk yield was also recorded. Samples were collected during the rolling monitoring of the Italian Breeder Association.

The cows were reared at pasture on the same farm at 1077 meters above sea level in the province of Palermo. The cows were fed almost only natural pasture, and integrations were given solely in adverse climate periods, in winter and summer. These consisted of forage: mainly clover hay, sulla (Hedysarum coronarium) or a combined cropping of vetch and oats ad libitum. Some of these integrations were concentrates, distributed as a function of the animal’s physiological phase.

Milk analysis
The following characteristics were evaluated for the milk samples: percentage of total protein and lipids (MilkoScan, Italian Foss Electric, Padova, Italy), somatic cell count (SCC) (n*1000/ml of milk) (Fossomatic, Italian Foss Electric, Padova, Italy).

Statistical analysis
Data underwent statistical analysis by ANOVA. Fixed effects were breed, parity, lactation phase, productive season. In addition, interactions breed-parity, breed-season and breed lactation phase were included in the model. Before of the statistical analysis somatic cell count were converted into linear score (LS) according the formula:

\[ LS = \log_2 (\text{thousands of somatic cells per ml}: 100) + 3 \]

RESULTS AND DISCUSSION

Table 1 reports the average daily milk yield, fat, protein percentage, SCC and LS in Cinisara and Modicana cows.

The Modicana milk yield was in agreement with data reported in PSR Sicilia about native Sicilian breeds at risk of extinction whereas Cinisara had a lower milk yield. Modicana showed similar fat and protein values as other studies. Although milk yield was not high in Modicana and Cinisara compared to other more specialized dairy breed, indigenous breeds produce more concentrated milk, with higher fat and protein percentages. These are interesting characteristics since Modicana and Cinisara milk is intended for the production of typical cheeses. Protein percentage was similar to that has been reported for northern Italian indigenous breeds such as the Bianca Val Padana and Rendena (3.48%) whereas fat percentage was comparable to Pezzata Rossa d’Oropa (3.56%) and Burlina (3.6%) in Cinisara.

In addition, comparison with the qualitative data collected in Friesian cows reared in the province of Palermo highlighted more protein in the two native breeds (3.32% vs 3.43% vs 3.48% in Friesian, Modicana and Cinisara). Moreover, also the environment adaptability of various breeds influences the quality of the milk. Local ones, which have evolved over time in the area, are able to better adapt to the environment, and also to effectively use the local forage resources.

SCC in both breeds was below 400000 cells/ml of milk, thus below the maximum limit identified for bulk milk by current legislation. In particular, below 300000 cells/ml, is the maximum limit required by Italian legislation to produce “fresh pasteurized high quality milk”. SCC we observed is in line with the national average reported by the National Reference Centre for cow’s milk between 2010 to 2016. Furthermore, higher log SCC values were detected by Todaro et al. (2004) in Modicana milk taken from a dairy industry.

Table 1 - Daily milk yield and quality of Modicana and Cinisara cows (mean and standard deviation).

<table>
<thead>
<tr>
<th></th>
<th>MODICANA Breed</th>
<th></th>
<th>CINISARA Breed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 297</td>
<td>n = 261</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>10.08</td>
<td>9.88</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>2.082</td>
<td>2.08</td>
<td></td>
</tr>
<tr>
<td>Daily milk yield (l/d)</td>
<td>3.60</td>
<td>3.60</td>
<td></td>
</tr>
<tr>
<td>Fat (%)</td>
<td>0.672</td>
<td>0.605</td>
<td></td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.43</td>
<td>3.49</td>
<td></td>
</tr>
<tr>
<td>0.359</td>
<td>0.363</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.67</td>
<td>4.01</td>
<td></td>
</tr>
<tr>
<td>SCC (n*1000/ml)</td>
<td>243.88</td>
<td>292.59</td>
<td></td>
</tr>
<tr>
<td>186.606</td>
<td>198.152</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LS</td>
<td>3.67</td>
<td>1.544</td>
<td></td>
</tr>
<tr>
<td>1.565</td>
<td>1.544</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n = number of observations
LS = somatic cell linear score = \( \log_2 (\text{thousands of somatic cells per ml}: 100) + 3 \)
As it is known SCC is important for the farmer because of the minimum quality parameters imposed by the law, and because it is a good indicator of the presence of clinical or subclinical mastitis. The increase in the number of somatic cells is generally associated with a lower milk, fat and protein yield, which negatively affect the technological characteristics of the milk.

Table 2 shows the trend in milk yield and quality of Modicana and Cinisara cows during lactation.

In the lactation periods considered, significant differences in the milk yield were highlighted. Milk yield was higher (P ≤ 0.01) during first 60 days, then decreased with an increase in the number of days in milk.

Fat and protein percentages remained constant during lactation. On the contrary, in selected dairy breed curves of fat and protein percentages are characterised by decline by 50 day post calving followed by an increase to the end of lactation. LS did not vary significantly with the progress of lactation, also other authors did not found effect of parity and stage of lactation on the SCC for bacteriologically negative cows. Whereas according other authors, the effect of stage of lactation on somatic cells is relatively minor.

The comparison of LS in the two native breeds, revealed higher scores in Cinisara than in Modicana. This might be due to the shape of the udder which in Cinisara has thicker and large teats which makes milking more difficult. In fact, studies carried out different breed and/or species have reported a relationship between the shape of the udder and the milk somatic cell count.

The distribution of the deliveries in native Sicilian cows is not uniform throughout the year, as farmers prefer to plan calving during periods when there is a greater availability of forage pasture. Consequently, milk yield and quality differs over the course of the season.

Also M’hamdi et al. (2012) reported that the season of calving affected milk yield in Tunisian Holstein cows related to the best feeding levels during the first months of lactation. Summer and autumn (P ≤ 0.01) were the most productive for both breeds (Table 3). This was probably due to the fact that most deliveries occur at the end of spring - early summer - and the animals reach the peak of production in the summer and maintain high productivity in autumn.

In relation to the summer peak production, significant lower protein and fat (P ≤ 0.01) contents were found, probably due to a dilution effect. The lower protein and fat percentage in the summer has also been found in other studies on Modicana.

In relation to parity (Table 4), there were significant variations in milk yield in both breeds. We observed an increase in production with parity only after the fifth lactation (P < 0.05).

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**Table 2** - Daily milk yield and quality in Modicana and Cinisara cows during lactation.

<table>
<thead>
<tr>
<th></th>
<th>&lt;60 DIM</th>
<th>60-150 DIM</th>
<th>&gt;150 DIM</th>
<th>Breed</th>
<th>Breed/Lacation phase</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily milk yield (l/d)</td>
<td>12.33^a</td>
<td>12.15^a</td>
<td>11.22^a</td>
<td>Modicana</td>
<td>Cinisara</td>
<td>ns</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>3.46</td>
<td>3.51</td>
<td>3.70</td>
<td>3.54</td>
<td>3.56</td>
<td>ns</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.36</td>
<td>3.39</td>
<td>3.44</td>
<td>3.39</td>
<td>3.36</td>
<td>ns</td>
</tr>
<tr>
<td>LS</td>
<td>3.30</td>
<td>3.94</td>
<td>3.51</td>
<td>3.99</td>
<td>3.86</td>
<td>4.11</td>
</tr>
</tbody>
</table>

**Table 3** - Milk yield and quality of Cinisara and Modicana cows during the production season.

<table>
<thead>
<tr>
<th></th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Autumn</th>
<th>Breed</th>
<th>Breed/Season</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily milk yield (l/d)</td>
<td>10.10^a</td>
<td>9.80^a</td>
<td>10.34^a</td>
<td>11.51^a</td>
<td>Modicana</td>
<td>Cinisara</td>
<td>ns</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>3.54a</td>
<td>3.66a</td>
<td>3.78a</td>
<td>3.43b</td>
<td>3.54a</td>
<td>3.60a</td>
<td>ns</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.49^a</td>
<td>3.52^a</td>
<td>3.38^a</td>
<td>3.16^a</td>
<td>3.47ab</td>
<td>3.43bc</td>
<td>na</td>
</tr>
<tr>
<td>LS</td>
<td>3.56</td>
<td>3.99</td>
<td>3.09</td>
<td>3.71</td>
<td>3.97</td>
<td>4.16</td>
<td>*na</td>
</tr>
</tbody>
</table>

**Table 4** - Effect of parity on milk yield and quality in Modicana and Cinisara cows.

<table>
<thead>
<tr>
<th></th>
<th>2nd lactation</th>
<th>3rd-5th lactation</th>
<th>&gt;5th lactation</th>
<th>Breed</th>
<th>Breed/Parity</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily milk yield (l/d)</td>
<td>10.77^a</td>
<td>10.19^a</td>
<td>10.49^a</td>
<td>10.87^a</td>
<td>Modicana</td>
<td>Cinisara</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>3.46</td>
<td>3.64</td>
<td>3.58</td>
<td>3.68</td>
<td>3.43</td>
<td>ns</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.45</td>
<td>3.44</td>
<td>3.41</td>
<td>3.37</td>
<td>3.32</td>
<td>ns</td>
</tr>
<tr>
<td>LS</td>
<td>3.86</td>
<td>3.86</td>
<td>3.50</td>
<td>3.53</td>
<td>4.38</td>
<td>*na</td>
</tr>
</tbody>
</table>

**LS = somatic cell linear score = log 2 (thousands of somatic cells per ml.: 100) + 3**
No significant changes in fat, protein and LS according to parity were detected. The increased milk yield with parity and no changes in fat percentage have been also observed in the study by Sabbioni et al. (2012) on Bianca Val Padana and Italian Friesian dairy cows. Furthermore, these authors have reported increasing in protein and LS with number of lactations. Moreover, in crossbreed and indigenous cows no significant changes in somatic cells has been also reported with increasing number of lactations.

CONCLUSIONS

Milk yield was not high Modicana and Cinisara compared to other more specialized dairy breeds, however they produce more concentrated milk, higher in protein and fat. These are important characteristics since Modicana and Cinisara milk is intended for the production of typical cheeses. In Cinisara and Modicana cows, the highest milk yield was recorded up to 60 days of lactation, whereas the quality of milk was constant during lactation. Moreover the production was affected by season, with higher yield in the summer and autumn and lower protein and fat in summer.

An improvement of use of pastoral resources may favour a more constant milk yield and quality. These data would help in the preservation and improvement of these native breeds which are indispensable for the development of the regions and marginal pastures of Sicily as well as for the preservation of animal biodiversity.

References