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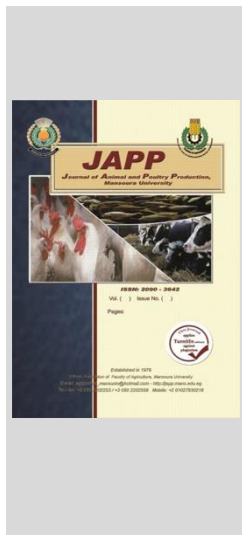
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### Relationship of Production Traits and udder Morphometry with Somatic Cell Count in Zaraibi Goats

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#### ABSTRACT

Somatic cell count (SCC) in milk is of interest to dairy goat breeders because of its influence not only on milk production but also on longevity and profitability. This study's aim was therefore to consider the production traits and udder morphometry relationships between them and SCC. For this purpose, production traits and twelve udder traits were measured from 152 clinically healthy dairy Zaraibi goats at the first four parities of lactations. The examined goats were classified into three categories according to SCC in milk; ( $\leq 470 \times 10^3$  cells/ml), (from 471 to  $\leq 500 \times 10^3$  cells/ml) and ( $> 500 \times 10^3$  cells/ml). Results showed that the goats with SCC  $\leq 470 \times 10^3$  cells/ml had significantly the highest values of all studied production parameters. Likewise, the udder and teats measurements showed to be different depending on SCC in milk. However, the studied parameters were with highly significant negative correlations with SCC. The teat position and udder attachment scores were high in goats at SCC  $\leq 470 \times 10^3$  cells/ml, and such scores negatively decreased when SCC values increased. However, the maximum  $r^2$  value (62.8%) obtained from regression equation for predicting SCC was by using average daily milk yield, days in milk, udder depth and width traits. In conclusion, including udder depth and width with teats separation and diameter traits in future breeding programs of Zaraibi goats would be useful to ensure that the selection for increased productivity is not accompanied by unwanted deterioration. In addition, these relations could be used as an indirect diagnosis of SCC in Zaraibi goats milk.

**Keywords:** somatic cell count, production traits, udder morphometry, teat traits, Zaraibi goats

#### INTRODUCTION

In both small and large dairy animal species, mastitis and high somatic cells in milk have negative effects on milk production and quality with major economic consequences in the dairy industry (Novac and Andrei, 2020). Udder health monitoring plans and modern management strategies could contribute in lessening mastitis impact (Puggioni *et al.*, 2020). In the dairy goat herds, the mastitis represents a major constraint implicating adverse effects on milk yield and composition, that commonly can reach high prevalence, being more than 30% (Quintas *et al.*, 2017).

Somatic cell count (SCC) is considered as indicator of both susceptibility and resistance of animals to mastitis and monitor the occurrence of subclinical mastitis (Shafi *et al.*, 2019). Therefore, SCC is used worldwide as an indicator of udder health in dairy animals and milk hygiene quality (Alhussien and Dang, 2018 and Vrdoljak *et al.*, 2020). While, commonly, the milk SCC is higher in normal or uninfected goats than in sheep and cows (Rupp *et al.*, 2019). The SCC of uninfected goat udder can approach about  $2000 \times 10^3$  cell/ml (Paape *et al.*, 2001). That could be mainly due to a high number of exfoliated epithelial cells in goat milk than in cows (Bagnicka *et al.*, 2016). In addition, the correlation between goat milk SCC and bacterial infections is not as simple as in cattle (Novac and Andrei, 2020). Moreover, due to the fact that goats are more sensitive than cows to the physiological stress resulted by the wide range of surround noninfectious factors. Based on the literatures, these factors include the breed, parity, stage of lactation, age, feeding system, estrous

cycle and herd size (Sandrucci *et al.*, 2019 and Novac and Andrei, 2020).

According to the high milk SCC in uninfected goat, SCC test might not be an appropriate method on its own for predicting mastitis as used for cows, and should be accompanied by other traits or measurements for a more accurate diagnosis of goat udder health and to monitor its milk quality. In this aspect, desired ways of correlations among milk yield, SCC and udder morphological traits have been determined (Kocak *et al.*, 2018 and Atasever *et al.*, 2020). Moreover, interest relationships were detected between the milk production traits and the udder morphological traits with goat milk SCC (Vrdoljak *et al.*, 2020). While, little is known about the goat SCC effect on milk composition (Stocco *et al.*, 2019). Nevertheless, some authors showed a relationship between SCC and composition of goat milk, but it is still controversial (Sandrucci *et al.*, 2019).

Therefore, the present study is an attempt to evaluate the relations between uninfected goat production traits and udder measurements with SCC in the milk. This relation could be used as indirect diagnosis of udder infection of Zaraibi goat.

#### MATERIALS AND METHODS

This experiment was conducted at El-Serw Experimental Research Station belongs to Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture ( $31^{\circ}14'36.0''N$   $31^{\circ}47'50.0''E$ ). A total of 152 clinically healthy dairy Zaraibi goats at the first four parities

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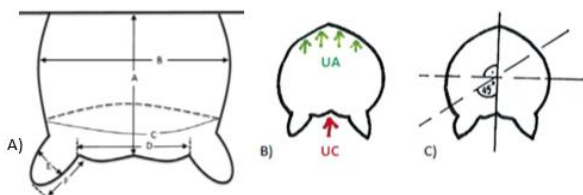
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of lactations were included in the present study. The experimental animals were weighted at beginning of the study and housed under semi-open sheds (4x3x5 m).

The feeding requirements of animals as amount of concentrate and roughage fed were based on feed allowance of NRC (1981) for lactating goats. The daily amount of concentrate feed mixture and roughage (as whole corn silage) were offered at 60:40 ratio. Diets were offered twice daily (8:00 am and 3:00 pm). Fresh water was available all time daily during the experiment.

Hand milking was done twice a day and milk yield was weighed and recorded for each doe. By following the Animal Welfare Guidelines, the measurements and milk samples were collected without doing any harm to the does. Udder and teat morphological traits were taken by one technician for each experimental animal in mid-lactation after weaning (90 days of lactation). The udder and teat morphometry of does was measured with a tape measure by external measurements of conformation as explained and showed in figure (1).

As it was described in the Figure (1) (Merkhan and Alkass, 2011) the following five udder measurements (cm) were recorded for each examined goat; udder depth was measured distance till between insertions of teats, udder width was measured at middle of the udder, udder circumference was measured circumference of the medium area of the udder and udder height from ground. The studied teats measurements (cm) were recorded as; internal distance between teats, distance between teats' ends, teat height from ground, teat length was taken as the distance from the base of the teat to tip of the teat and teat diameter was measured in the middle of the teat.



**Fig. 1. Linear description of the udder shape**  
**Explanations: A) a: udder depth, b: udder width, c: udder circumference, d: distance between teats, e: teat diameter, f: teat length;**  
**B) UA: rear udder attachment, UC: udder cleft; C) TP: teat placement**

The description of dairy goat udders is based on a methodology for dairy goat published by Novotna *et al.* (2018). The score of each teat placement (TP) of the udder was assessed from the rear, using a five-score scale (from score 1= almost perpendicular position of teats placed on the bottom of the udder, to score 5 = teats point horizontally placed high on the udder flanks). Also, udder cleft (UC) was assessed as the depth of the intermammary groove, which is an indicator of the strength of the median suspensory ligament. It was assessed using a five-score scale (from score 1= pronounced udder cleft, very pronounced suspensory ligament, to score 5= loose suspensory ligament, part of the udder is below the teat level). Moreover, udder attachment (UA) was assessed in terms of its width and how well the udder filled the room provided by the hind legs. The assessment was made from the rear using a five-score scale

(from score 1= udder very wide attachment, the room provided by the legs completely filled, to score 5= udder with very weak attachment, baggy udder with skin folds).

All goats included in the study were at about 90 days of lactation at sampling (after weaning of kids). Before the collection of milk samples, the udder and teats were carefully cleaned and wiped with moistened cotton pad. The first two to three streams of milk were discarded to minimize chances of sample contamination. About 20 ml of milk from each goat was collected aseptically into a sterile screw-capped sample tube. The milk samples tubes were marked then transported to the laboratory in ice-box at 4°C for the milk analysis.

The milk analysis measured as an average of fat, protein, ash, total solids, solids not fat and lactose using MilkoScan (FOSS, Electric, Denmark). Somatic cell count (SCC), pH value and acidity % in milk were also measured. The examined goats were classified to three categories according to SCC in milk; SCG1 ( $\leq 470 \times 10^3$  cells/ml), SCG2 (from 471 to  $\leq 500 \times 10^3$  cells/ml) and SCG3 ( $> 500 \times 10^3$  cells/ml).

The obtained data were statistically analyzed by a one-way ANOVA design using a software package (SAS, 2014). Milk production traits, milk composition, litter size, udder and teat measurements of Zaraibi does were analyzed using the following model:

$$Y_{ij} = \mu + G_i + e_{ij}$$

where  $\mu$  = the overall mean,  $G_i$  = Somatic cell count group, and  $e_{ij}$  = residual error.

The significant differences among groups were tested by Duncan's multiple range test (Duncan, 1955) and set at  $P < 0.05$ . The software Minitab 18 was used for calculations correlation coefficients, linear regression model, and coefficient of determination ( $R^2$ ). Firstly, simple correlation and regression coefficients were used to predict average somatic cell count ( $10^3$  cells/ml) with the each of milk production traits, milk composition, litter size, udder and teat measurements. Secondly, the multiple linear regression model was used to predict somatic cell count from the significant and the highest  $R^2$  of simple predictor.

## RESULTS AND DISCUSSION

### *Somatic cell count and production traits:*

The results presented in Table (1), showed that the goats (SCG1) with  $SCC \leq 470 \times 10^3$  cells/ml significantly had the highest values of all studied production parameters, while the opposite was observed with goats (SCG3) with  $SCC > 500 \times 10^3$  cells/ml. SCC was decreased significantly with increasing parity, since high mean value of parity ( $2.91 \pm 0.163$ ) was for the lower SCG1 ( $\leq 470 \times 10^3$  cells/ml). It could be noticed highly significant decreased in SCC with increasing in total parity of live. Moreover, the means of 90 d milk yield and average of total daily milk yield values of the goats in (SCG1)  $SCC \leq 470 \times 10^3$  cells/ml were ( $1.61 \pm 0.033$  and  $1.94 \pm 0.040$  kg/d, respectively) and significantly higher than the values of goats in the other two groups. This means that the total milk yield value was significantly higher in the lowest SCG1 ( $\leq 470 \times 10^3$  cells/ml) group by about 4.9% and 5.8% than the values in the SCG2 and SCG3 groups, respectively.

With regarded the goats weight, it was found that the does in the low SCC group ( $\leq 470 \times 10^3$  cells/ml) obtained ( $38.68 \pm 0.345$  kg) to be significantly higher in weight than of the SCG2 and SCG3 groups ( $37.35 \pm 0.246$  and  $36.07 \pm 0.229$

kg, respectively). Also, from Table (1) it was found that litter size had been differed ( $P<0.05$ ) by SCC levels. Since, significantly lower SCC values ( $\leq 470 \times 10^3$  cells/ml) had been for goats suckled more kids ( $2.29 \pm 0.062$  kids) than those suckled less number of kids ( $2.10 \pm 0.071$  or  $1.91 \pm 0.083$  kids/does).

Statistically, high negative correlations have been determined between 90d milk yield, average milk yield, total milk yield and days in milk with SCC (-0.72, -0.74, -0.72 and -0.71, respectively). In the same trend, the correlations estimated between does weight at 90 d of kidding and litter size with SCC were also significant and negative (-0.39 and -0.23, respectively).

**Table 1. Least square means and standard errors for production traits with different somatic cell count group and their correlations with SCC of Zaraibi does.**

|                                     | Somatic cell count levels ( $\times 10^3$ cells/ml) |                                |                                | SCC correlation |
|-------------------------------------|---|--------------------------------|--------------------------------|-----------------|
|                                     | SCG1 ( $\leq 470$ )                                 | SCG2 (471-500)                 | SCG3 ( $> 500$ )               |                 |
| No. of does (n=152)                 | 34  | 51                             | 67                             | -               |
| SCC, $\times 10^3$ cells/ml         | 461.6 $\pm$ 3.484 <sup>c</sup>                      | 490.1 $\pm$ 2.492 <sup>b</sup> | 523.8 $\pm$ 2.313 <sup>a</sup> | -               |
| Party, no                           | 2.91 $\pm$ 0.163 <sup>a</sup>                       | 2.47 $\pm$ 0.117 <sup>b</sup>  | 2.19 $\pm$ 0.108 <sup>c</sup>  | -               |
| Milk yield at 90 d of lactation, kg | 1.61 $\pm$ 0.033 <sup>a</sup>                       | 1.57 $\pm$ 0.024 <sup>b</sup>  | 1.56 $\pm$ 0.022 <sup>c</sup>  | -0.72**         |
| Avg. daily milk yield, kg           | 1.94 $\pm$ 0.040 <sup>a</sup>                       | 1.78 $\pm$ 0.029 <sup>b</sup>  | 1.76 $\pm$ 0.026 <sup>c</sup>  | -0.74**         |
| Total milk yield, kg                | 276.3 $\pm$ 4.103 <sup>a</sup>                      | 262.8 $\pm$ 2.935 <sup>b</sup> | 260.4 $\pm$ 2.723 <sup>c</sup> | -0.72**         |
| Total days in milk, days            | 238.5 $\pm$ 2.902 <sup>a</sup>                      | 228.5 $\pm$ 2.077 <sup>b</sup> | 228.3 $\pm$ 1.927 <sup>c</sup> | -0.71**         |
| Does weight at 90 d of kidding, kg  | 38.68 $\pm$ 0.345 <sup>a</sup>                      | 37.35 $\pm$ 0.246 <sup>b</sup> | 36.07 $\pm$ 0.229 <sup>c</sup> | -0.39**         |
| Litter size, no                     | 2.29 $\pm$ 0.062 <sup>a</sup>                       | 2.10 $\pm$ 0.071 <sup>b</sup>  | 1.91 $\pm$ 0.083 <sup>c</sup>  | -0.23**         |

a-d: Means in the same group with different superscripts are significantly different at  $p<0.05$ . \* Significant correlation ( $p<0.05$ ); \*\* significant correlation ( $p<0.001$ ).

**Somatic cell count and udder traits:**

The relation between some udder measurements of dairy Zaraibi goats during early lactation stage and level of SCC was found in Table (2). The average udder depth was reduced significantly ( $p<0.05$ ) by 14.46% and 21.64% in relation to SCC values  $\leq 470 \times 10^3$  cells/ml of  $471-500 \times 10^3$  cells/ml and  $>500 \times 10^3$  cells/ml, respectively. Also, the average udder width and circumference (12.46 $\pm$ 0.207 and 31.37 $\pm$ 0.444 cm, respectively) were significantly higher in low SCG1 ( $\leq 470 \times 10^3$  cells/ml) compared with that of the SCG2 and SCG3 groups. However, the udder height from ground was increased significantly only in goats at the SCC values of  $>500 \times 10^3$  cells/ml (32.45 $\pm$ 0.469 cm).

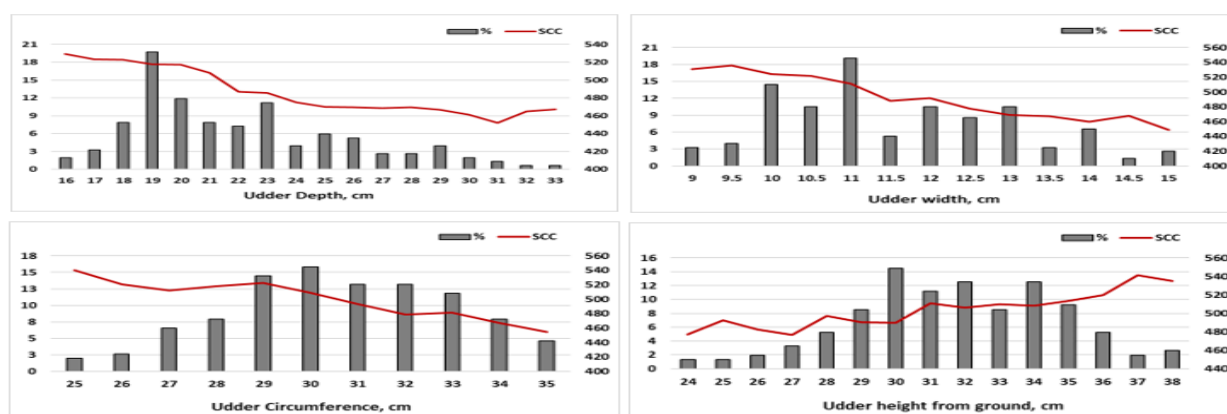
In general, a trend of decreases in udder depth, width and circumference with increase in milk SCC contains as shown in Table (2) this reflected highly negative correlations obtained for udder depth, width and circumference with levels groups of SCC (-0.64, -0.74 and -0.61, respectively). This

correlation observed to be significant positive when estimated between udder height from ground with the SCC examined.

**Table 2. Least square means and standard errors for some udder measurements with different somatic cell count groups and their correlations with SCC of Zaraibi does.**

|                              | Somatic cell count levels ( $\times 10^3$ cells/ml) |                                |                                | SCC correlation |
|------------------------------|---|--------------------------------|--------------------------------|-----------------|
|                              | SCG1 ( $\leq 470$ )                                 | SCG2 (471-500)                 | SCG3 ( $> 500$ )               |                 |
| Udder depth, cm              | 25.79 $\pm$ 0.693 <sup>a</sup>                      | 22.06 $\pm$ 0.496 <sup>b</sup> | 20.21 $\pm$ 0.460 <sup>c</sup> | -0.64**         |
| Udder width, cm              | 12.46 $\pm$ 0.207 <sup>a</sup>                      | 11.46 $\pm$ 0.148 <sup>b</sup> | 11.25 $\pm$ 0.138 <sup>c</sup> | -0.74**         |
| Udder circumference, cm      | 31.37 $\pm$ 0.444 <sup>a</sup>                      | 30.47 $\pm$ 0.318 <sup>b</sup> | 30.16 $\pm$ 0.295 <sup>c</sup> | -0.61**         |
| Udder height from ground, cm | 32.04 $\pm$ 0.707 <sup>b</sup>                      | 31.28 $\pm$ 0.506 <sup>b</sup> | 32.45 $\pm$ 0.469 <sup>a</sup> | 0.22*           |

a-c: Means in the same group with different superscripts are significantly different at  $p<0.05$ . \* Significant correlation ( $p<0.05$ ); \*\* significant correlation ( $p<0.001$ ).



**Fig. 2. The distributions of udder depth, width, circumference and height form ground measurements (%) and the relationship with somatic cell count ( $10^3$  cells/ml).**

Figure (2) presented the distributions of udder depth, width, circumference and height form ground measurements (%) and the relationship with somatic cell count (cells/ml). It is interest to show that 66% of examined goats with udder depth measurements ranged from 18 to 23 cm and its average SCC 506.40 $\pm$ 16.35 $\times 10^3$  cells/ml, while 29% of udder depth

of examined goats in range from 24 to 33 cm with average SCC of 466.37 $\pm$ 6.18 $\times 10^3$  cells/ml. Moreover, 80% of studied goats with udder width ranged from 10 to 13 cm and its average SCC was 497.53 $\pm$ 21.65 $\times 10^3$  cells/ml, while only 13% of udder width ranged from 13.5 to 15 cm with average SCC of 460.80 $\pm$ 8.64 $\times 10^3$  cells/ml. Additionally, 68% of examined goats the udder circumference ranged from 19 to 35 cm with average SCC of 466.37 $\pm$ 6.18 $\times 10^3$  cells/ml.

33 cm and its average SCC was  $496.97 \pm 18.57 \times 10^3$  cells/ml, while 20% of udder circumference ranged from 25 to 28 cm with average SCC of  $522.68 \pm 12.08 \times 10^3$  cells/ml. In addition, 60% of examined goats the udder height ranged from 30 to 34 cm with average SCC of  $486.01 \pm 8.45 \times 10^3$  cells/ml, followed by 21% of udder height ranged from 35 to 38 cm with average SCC of  $527.49 \pm 12.86 \times 10^3$  cells/ml.

**Somatic cell count and teat traits:**

The teats parameters of examined does were presented in Table (3). The results showed that internal distance between teats, distance between teats ends and teat

diameter were decreased significantly ( $p < 0.05$ ) by increased of SCC values. Moreover, goats with SCC values of  $> 500 \times 10^3$  cells/ml obtained significantly lower teat diameter and length ( $2.09 \pm 0.056$  and  $3.97 \pm 0.131$  cm, respectively). However, the teat height from ground were increased significantly only in goats at the SCC values of  $> 500 \times 10^3$  cells/ml ( $28.09 \pm 0.483$  cm). Additionally, there were highly negative correlations detected for teat internal, teat ends distance, teat diameter, teat length with SCC to be -0.45, -0.50, -0.52 and -0.32, respectively

**Table 3. Least square means and standard errors for some teats parameters with different somatic cell count levels and their correlations with SCC of Zaraibi does.**

|                                     | Somatic cell count levels ( $\times 10^3$ cells/ml) |                     |                     | SCC correlation |
|-------------------------------------|---|---------------------|---------------------|-----------------|
|                                     | G1 ( $\leq 470$ )                                   | G2 (471-500)        | G3 ( $> 500$ )      |                 |
| Internal distance between teats, cm | $9.84 \pm 0.322^a$                                  | $9.27 \pm 0.230^b$  | $9.23 \pm 0.213^c$  | -0.45**         |
| Distance between teats ends, cm     | $12.31 \pm 0.327^a$                                 | $11.77 \pm 0.234^b$ | $11.42 \pm 0.217^c$ | -0.50**         |
| Teat diameter, cm                   | $2.24 \pm 0.084^a$                                  | $2.11 \pm 0.060^b$  | $2.09 \pm 0.056^c$  | -0.52**         |
| Teat length, cm                     | $4.01 \pm 0.197^a$                                  | $4.17 \pm 0.141^a$  | $3.97 \pm 0.131^b$  | -0.32**         |
| Teat height from ground, cm         | $27.44 \pm 0.728^b$                                 | $27.40 \pm 0.521^b$ | $28.09 \pm 0.483^a$ | 0.13            |

a-c: Means in the same group with different superscripts are significantly different at  $p < 0.05$ . \* Significant correlation ( $p < 0.05$ ); \*\* significant correlation ( $p < 0.001$ ).

Generally, the teats measurements as internal distance between teats, distance between teat ends, teat diameter and teat length of examined goats showed decreases trend related to SCC contains increases as shown in SCG1, SCG2 and SCG3. With regard the negative correlation values were normally and highly. However, the teat height from the ground seem to be in the same heights.

**Somatic cell count and udder and teat scores:**

Results obtained in Table (4) showed that the teat position and udder attachment scores were  $3.53 \pm 0.148$  and  $3.33 \pm 0.154$ , respectively in goats at  $SCC \leq 470 \times 10^3$  cells/ml, in the same time such significantly negative scores decreased ( $3.27 \pm 0.106$  and  $2.94 \pm 0.110$ , respectively) when SCC values ( $471-500 \times 10^3$  cells/ml), and similar highly significant decrease were  $2.52 \pm 0.098$  and  $2.82 \pm 0.102$ , respectively when the SCC values reached  $> 500 \times 10^3$  cells/ml. Statistically, there were significant negative correlations detected for teat position and udder attachment scores with SCC (-0.52 and -0.58, respectively).

**Table 4. Least square means and standard errors for some udder scores with different somatic cell count levels and their correlations with SCC of Zaraibi does.**

|                         | Somatic cell count levels ( $\times 10^3$ cells/ml) |                       |                    | SCC correlation |
|-------------------------|---|-----------------------|--------------------|-----------------|
|                         | SCG1 ( $\leq 470$ )                                 | SCG2 (471-500)        | SCG3 ( $> 500$ )   |                 |
| Teat position, score    | $3.53 \pm 0.148^a$                                  | $3.27 \pm 0.106^b$    | $2.52 \pm 0.098^c$ | -0.52**         |
| Udder cleft, score      | $2.66 \pm 0.189^a$                                  | $2.84 \pm 0.135^{ab}$ | $2.87 \pm 0.126^b$ | -0.21*          |
| Udder attachment, score | $3.33 \pm 0.154^a$                                  | $2.94 \pm 0.110^b$    | $2.82 \pm 0.102^c$ | -0.58**         |

a-c: Means in the same group with different superscripts are significantly different at  $p < 0.05$ . \* Significant correlation ( $p < 0.05$ ); \*\* significant correlation ( $p < 0.001$ ).

**Somatic cell count regression equations:**

Table (5) shows the regression equations for predicting SCC ( $10^3$  cells/ml) according to milk production, udder and teats measurements of experimental Zaraibi does. It is important to mention four prediction of SCC, the obtained equations had an  $r^2$  value that ranged from 0.54% to 0.63%. The average daily milk yield, udder depth, days in milk and

udder width were included in these models ( $p < 0.001$ ). The regression equation including only average daily milk yield had lowest  $r^2$  value (54.3%), on the other side, it was the highest  $r^2$  value obtained for single regression equation. The maximum  $r^2$  value (62.8%) obtained by using average daily milk yield, udder depth, days in milk and udder width. However, when udder width removed from the equation the  $r^2$  value was not affected (62.3%). Moreover, the  $r^2$  value was 60.3% for the two-parameter regression equation (average daily milk yield and udder depth).

**Table 5. Regression equations for predicting SCC ( $10^3$  cells/ml) according to milk production and udder measurements in Zaraibi does.**

| Stepwise selection of parameters | Regression equation                                       | R <sup>2</sup> | P value |
|----------------------------------|---|----------------|---------|
| Step 1                           | SCC = 618 - 65.6 Avg. Milk                                | 54.3           | **      |
| Step 2                           | SCC = 647 - 49.3 Avg. Milk - 2.65UD                       | 60.3           | **      |
| Step 3                           | SCC = 715 - 26.4 Avg. Milk - 2.73 UD - 469DIM             | 62.3           | **      |
| Step 4                           | SCC = 720 - 19.3 Avg. Milk - 2.31 UD - 0.392DIM - 3.92 UW | 62.8           | **      |

Avg. Milk: average milk yield, UD: udder depth, DIM: days in milk, UW: udder width,  $r^2$ : coefficient of determination, \*\* significant correlation ( $p < 0.001$ ).

**Discussion**

On the basis of that; a) negative effects of mastitis as well as SCC on milk production and quality, b) using the SCC as indication for subclinical mastitis of the udder, c) the SCC in uninfected or normal goats is higher than that in sheep and cows, the morphological traits as udder and teats measurements will be active research field to examine the degree of relation between SCC and udder health. Thus, the 152 healthy goats represent goat sample for udder and teats measurements of Zaraibi goats as compared with most of the obtained results found in the review of this study.

In the present study milk samples were taken for analysis at 90 days of lactation after weaning of the kids. This time of taken samples is recommended to be basis for dividing the does into classes or groups according to SCC contains. As low, medium and high SCC groups to give the way of handling each group.

Generally, in the present study, the SCC can be seen to be far below the threshold value recommended in studies

about average SCC for Zaraibi goats. However, significant negative correlations were obtained between levels of SCC of the three groups with either udder (depth, width and circumference) and teats (internal distance between teats, distance between teats end, teat diameter and teat length). This means that the level of SCC reduced with the highest and longest of udder and teats parameters. In addition, some negative correlation was found between body weights of goats and SCC groups. The previous results seemed to be important for the commercial goat needs to keep the biggest does with highest and longer udders and teats to be lower in SCC.

Regarding, the relation between used udder scores with different SCC group. Similar negative correlations were recorded these results indicated that (teat position, udder cleft and udder attachment scores) showed best values with decreasing in SCC.

According to Cedden *et al.* (2008), regarding the mammary gland health, it is preferable for dairy goats to have a wide udder due to a negative phenotypic correlation between udder width and somatic cell counts, as well as between the distance between teat ends and the number of somatic cells in goat milk. Novotna *et al.* (2018) found that somatic cell count as one of udder health indicators was significantly related to udder width and udder depth. In this case, a greater number of somatic cells were found in the milk of goats of greater udder depth. On contrary, with the increase in udder width, the number of somatic cells in goat's milk was lower, with the number of somatic cells beginning to increase in udder widths greater than 17 cm. Considering the somatic cell count in milk, the udder width of 13 to 17 cm was optimal (Novotna *et al.*, 2018).

Although Santos *et al.* (2015) found that the most of udder morphological traits in Saanen goats was not related to the number of somatic cells in milk, the udder circumference was negatively correlated to the number of somatic cells, with a moderately high heritability of udder circumference, pointing out the possibility of including this trait in breeding programs. Montaldo and Martinez-Lozano (1993) worked on three different goat genotypes and found that milk obtained from globular udder had a lower California Mastitis test value than milk obtained from udder of a different form. Similar to these results, Rupp *et al.* (2011) concluded that it is desirable for the udder of dairy goats to be well attached to the abdominal wall but not too deep (hanged). That is because they have also found that with increasing the udder depth, the number of somatic cells in the milk of French Alpine and Saanen primiparous goats significantly increased. Also, the authors indicated the existence of significant phenotypic correlation between the somatic cell count in milk and teat size, with shorter and narrower teats associated with a fewer somatic cells in milk of Saanen goat, which was not found in French Alpine goat (Rupp *et al.*, 2011). Santos *et al.* (2015) found no significant association of any of the studied morphological teat traits of Saanen goats with the somatic cell count in milk, as well as with the results of the California mastitis test.

Based on the established genetic correlations, Manfredi *et al.* (2001), Rupp *et al.* (2011) and McLaren *et al.* (2016) concluded that further selection to increase the milk production of high-yielding goat genotypes does not necessarily have a negative impact on the health of their

udders if appropriate udder morphological traits are included in breeding programs.

Finally, the results of current study as daily milk yield, udder depth, days in milk and udder width were used to obtain the regression equations for predicting SCC in the milk of Zaraibi does. Four regression equations could be used (Table 5) as indirect method for degree of udder infection and level of SCC in the milk.

## CONCLUSION

According to results findings, considering the somatic cell count to be lower than  $500 \times 10^3$  cell/ml in Zaraibi goat's milk, the udder depth, width and circumference that greater than 11, 22 and 31 cm, respectively, with udder height from ground lower than 30 cm were optimal. Generally, with taking into consideration the milk production, the most indicative udder morphological parameters related to milk somatic cell count of uninfected goats are udder depth and width with teats separation and diameter. However, the correlations estimated between the former udder and teat traits with SCC were negative; therefore, including these traits in future breeding programs would be useful to ensure that the selection for increased productivity is not accompanied by unwanted deterioration. In addition, these relations could be used as indirect diagnosis of SCC in milk of Zaraibi goats.

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## علاقة صفات الإنتاج وقياس شكل الضرع مع عدد الخلايا الجسدية في الماعز الزريبي

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يعتبر عدد الخلايا الجسدية في الحليب ذا أهمية لمربي ماعز الألبان ليس فقط بسبب تأثيره على إنتاج الحليب، بل أيضا لتأثيره على طول الحياة الإنتاجية والربحية للقطيع. ولذلك كان الهدف من هذه الدراسة هو دراسة الصفات الإنتاجية والشكل المورفولوجي للضرع والعلاقة بينهما وبين عدد الخلايا الجسدية في الماعز الزريبي. لذلك تم دراسة الصفات الإنتاجية واثنى عشر صفة من الصفات المورفولوجية للضرع والحلمات لعدد 152 عنزة من ماعز الألبان الزريبي الغير مصابة بالتهاب الضرع خلال الأربعة مواسم الحليب الأولى. حيث قد تم تجميع وتحليل عينات اللبن من جميع العنزات عند اليوم 90 من موسم الحلابة وبعد فطام الجداء. وبناءً على عدد الخلايا الجسدية في الحليب تم تقسيم الماعز إلى ثلاث مجموعات وهي: المجموعة الأولى ( $10 \times 470 \geq$  خلايا/مل)، المجموعة الثانية (من 471 إلى  $10 \times 500 \geq$  خلايا/مل) و المجموعة الثالثة ( $10 \times 500 <$  خلايا/مل). أظهرت نتائج الدراسة أن الماعز التي تحتوي على عدد خلايا جسدية ( $10 \times 470 \geq$  خلايا/مل) تميزت بارتفاع جميع الصفات الإنتاجية بفارق معنوي عن المجموعات الأخرى من حيث صفات (إنتاج الحليب عند 90 يوم، متوسط إنتاج الحليب اليومي، إنتاج الحليب الكلي، عدد أيام الحليب، وزن العنزة عند 90 يوم، وعدد الجداء المولودة). وأوضحت الدراسة وجود ارتباط معنوي سلبي بين جميع صفات الإنتاج وعدد الخلايا الجسدية. على الجانب الأخر، أظهرت النتائج وجود فروق معنوية لكل من صفات عمق وعرض ومحيط الضرع بين المجموعات وفقاً لعدد الخلايا الجسدية في اللبن، مع وجود ارتباط سلبي معنوي بين تلك الصفات مع عدد الخلايا الجسدية. وقد لوحظ كذلك نفس الاتجاه من الاختلافات الهامة للصفات المدروسة للحلمات من حيث المسافة الداخلية والخارجية بين الحلمات، قطر وطول الحلمة مع عدد الخلايا الجسدية. وذلك بالإضافة إلى أنه كانت درجات تقييم موضع الحلمات وارتباط الضرع بالجسم ايجابية ومرتفعة في العنزات بالمجموعة الأولى عند عدد الخلايا الجسدية ( $10 \times 470 \geq$  خلايا/مل)، وانخفضت هذه قيم تقييم هذه الصفات سلباً بزيادة عدد الخلايا الجسدية في المجموعات الأخرى. أما بالنسبة لمعادلات الانحدار للتنبؤ بعدد الخلايا الجسدية فقد وجد أن الحد الأقصى لقيمة  $r^2$  (62.8%)، وقد تم الوصول إليها باستخدام كلاً من صفات عرض الضرع وعمق الضرع ومتوسط إنتاج الحليب اليومي وعدد أيام الحلب. ويمكن استخلاص من نتائج الدراسة أهمية إدراج عمق الضرع وعرضه مع المسافة بين الحلمات وقطر الحلمات في البرامج المستقبلية لتربية الماعز الزريبي، حتى يمكن ضمان إجراء التحسين الوراثي لزيادة الإنتاجية دون حدوث تدهور غير مرغوب في بعض الصفات الأخرى. بالإضافة إلى ذلك، يمكن استخدام هذه العلاقات التي وجدت في الدراسة كتشخيص غير مباشر لعدد الخلايا الجسدية في حليب الماعز الزريبي.