

## Haematological profile of messinese goat kids and their dams during the first month post-partum

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The neonatal period represents a transition phase from the sheltered intrauterine to the exposed extrauterine environment. Changes in haematological profile in five pairs of twin kids and their dams were investigated over a month after the birth. During that period red blood cells (RBC), white blood cells (WBC), haemoglobin (Hb), haematocrit (Hct), mean corpuscular volume (MCV), mean cell haemoglobin (MCH), mean cell haemoglobin concentration (MCHC) and platelets (PLT) level were determined in all animals. Two-way ANOVA showed an increase in RBC ( $P<0.001$ ), WBC ( $P<0.0001$ ), MCV ( $P<0.0001$ ), MCHC ( $P<0.0001$ ) and PLT ( $P<0.001$ ). Knowledge of the blood physiological reference values in goat kids provides information useful for the diagnosis and treatment of some neonatal diseases and contributes to recognizing the adaptation mechanisms developing over their first month of life.

**KEY WORDS :** blood /goats / kids / haematological parameters /neonatal period

Despite the *Caprinae* is one of the less studied systematic group of domestic animals especially in terms of haematology, a great variation in the haematological parameters was observed within and between different breeds of goats. It is difficult, therefore, to present an universal complete blood count for that animal [Domina *et al.* 1998, Daramola *et al.* 2005, Iriadam 2007]. About Messina goat, originally spread in the Peloritani and Nebrodi mountains and traditionally kept on the territory of

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Messina [Zumbo *et al.* 2004], no reference values were published so far on clinical profile. It has, however, been reported that traditional husbandry system produces lower haematological values compared to modern husbandry [Zamfirescu *et al.* 1995]. In fact, grassland pasture of low nutritive value, climatic factors and stresses such as birth, can lead to various responses in blood [Zamfirescu *et al.* 1995, Egbe-Nwiyi *et al.* 2000, Piccione *et al.* 2007, Bornez *et al.* 2009, Waziri *et al.* 2010]. In all species the first week *post-partum* is crucial and the newborns remain in metabolically unstable status, but in kids, neonatal mortality and morbidity seems to be relatively higher than in other farm species, in particular during the first days of life [Piccione *et al.* 2008]. This represents a transition phase from the intrauterine to the exposed extrauterine environment [Piccione *et al.* 2006, 2009]. Nearly half of all pre-weaning lambs day on the day of birth, whilst the rate of lamb losses is greatly reduced beyond the first week of life [Piccione *et al.* 2009]. Limited information is available on the haematological count and characteristics of the kids in relation to their adult life. From week 34 of intrauterine life till the first *post-partum* hours, all blood components and the coagulation factors are subjected to continuous changes, even after this period [Mayor *et al.* 1985, Franzoi *et al.* 2002, Piccione *et al.* 2008]. Moreover, several changes were assessed in kids, during the first month of life, both on the haematochemical components and on the serum proteins profile [Piccione *et al.* 2011 in press, Zumbo *et al.* 2011]. Changes in haematological profile were earlier assessed in other species, both after the birth and during suckling period, but, since that time none or very few authors investigated the haematological profile of kids. Facing the above we intended to estimate the differences existing between adults and kids during the first month of life. Particularly, we studied the haematological profile during the first month of life in order to obtain useful information about neonatal care.

### Material and methods

The study was conducted in a farm situated in the northeastern Sicily (38°2'N, 14°40'E), at an altitude of 420 m above the sea level, in March (environmental temperature varying from 8 to 22°C). Five adult multiparous Messina does were used, with a mean body weight of 25.5±1.02 kg, and two kids delivered by each doe as twins. The kids were marked as “a” and “b” in relation to the order of being delivered – the first was “a” and the second was “b”. The kids were mixed for gender. All does had free access to water and were grazed on grassland, while the kids were offered their dams' milk only and were kept in a sheltered outdoor pen. All animals were clinically healthy, the does being preventively treated for internal parasites at the start of the study. Their health status was evaluated daily based on behaviour, rectal temperature, heart rate, respiratory profile, cough, nasal discharge, ocular discharge, appetite, faecal consistency, navel examination and haematological profile. All kids were term born, with a mean weight of 3.07±0.30 kg. From all animals, dams and kids, blood samples were withdrawn at 08:00 a.m. once a week, for one month, from the external jugular

vein by vacutainer tubes (Terumo Corporation, Japan) containing ethylenediamine tetraacetic acid ( $K_3$ EDTA). From adults the blood was collected into 10 ml test tubes, and from the kids into 2 ml tubes. Until pending analysis, the samples were kept at ambient temperature and, within two hours from sampling, were subjected to a double analysis: of whole blood and of diluted blood (1 part lysant:1 part blood) with a special blood lysing buffer approved for goat haematology (Concentrated Lysing Reagent Vet for ovine species, SEAC, Florence, Italy). All samples were analysed with an automated analyser for haematology (HECO Vet C, SEAC, Florence, Italy). So red blood cells (RBC), white blood cells (WBC), haemoglobin (Hb), haematocrit (Hct), mean corpuscular volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC) were assessed in whole, whereas platelets (PLT) – in diluted blood. Next, to obtain RBC number, the PLT value was subtracted from RBC value of whole blood. All results were expressed as means with standard deviations (SD). To all normally distributed data ( $P < 0.05$ , Kholmogorov-Smirnov's test) two-way Repeated Measure Analysis of Variance (ANOVA), was applied to evaluate the influence of the time of sampling on all traits assessed and the differences between does and kids haematological values. If ANOVA showed an acceptable level of significance ( $P < 0.05$ ), Bonferroni's test was applied for *post-hoc* comparison. Regression of the parameters studied on postnatal age (days of life), with 95% confidence intervals and the correlation coefficient ( $r$ ), was determined. Data were analysed using STATISTICA 7 software (Statsoft Inc., USA).

## Results and discussion

Table 1 shows the means and SD of the haematological values of the dams, with the statistical significances and in Table 2 are shown the means and SD of the haematological values of the kids with the statistical significance. ANOVA showed significance both of sampling time and of the age of does. During the *post-partum* days the does showed a significant decrease in RBC ( $P < 0.001$ ;  $F_{(4,48)} = 6.24$ ), WBC ( $P < 0.0001$ ;  $F_{(4,48)} = 6.77$ ), Hct ( $P < 0.001$ ;  $F_{(4,48)} = 5.81$ ) and MCV ( $P < 0.0001$ ;  $F_{(4,48)} = 45.29$ ). Instead, a significant increase after the birth was observed only on PLT ( $P < 0.0001$ ;  $F_{(4,48)} = 210.26$ ), which constantly increased from day 7 till day 28 after birth. The opposite trend was showed in kids, with a significant increase since day 14 after birth of RBC, WBC, MCV and MCH, and an inconstant increase of PLT. A significant effect of time was observed on RBC ( $P < 0.001$ ;  $F_{(2,48)} = 10.37$ ), Hct ( $P < 0.001$ ;  $F_{(2,48)} = 8.03$ ), MCV ( $P < 0.001$ ;  $F_{(2,48)} = 46.48$ ), MCH ( $P < 0.001$ ;  $F_{(2,48)} = 35.34$ ), MCHC ( $P < 0.001$ ;  $F_{(2,48)} = 79.12$ ) and PLT ( $P < 0.001$ ;  $F_{(2,48)} = 14.36$ ). The application of linear regression model ( $y = a + bx$ ) showed a correlation among individual values for postnatal age (days of life) and RBC ( $r = 0.74$ ), and PLT ( $r = 0.74$ ). A negative correlation was identified between postnatal age and MCV ( $r = -0.84$ ). Figure 1 shows the regression between the postnatal age (days) and the haematological values (RBC, MCV and PLT) of 10 kids with 95% confidence interval and the correlation coefficient ( $r$ ).

The kids showed a substantial increase in RBC during the early life. This shift is not due to an abnormal response, but is called “adaptive period”, during which, in all species, the stem cells change into normal erythrocytes that, in the embryo, are principally produced by the liver, and by the bone marrow in adults [Piccione *et al.* 2010]. In the goat foetus, bone marrow haematopoiesis is initiated shortly before day 70 of intrauterine life, although some hepatic and splenic erythropoiesis occur even at the time of birth [Zanjani *et al.* 1974]. Moreover, as observed in newborn calf [Mohri *et al.* 2007], the erythrocyte size continues to decrease after the foetal life for the first 3-4 months, but their number increases as demonstrated by the positive correlation (this study,  $r=0.74$ ). Another factor involved is erythropoietin level in the kids. This glycoprotein, produced by the peritubular capillary endothelial cells in the kidney in this period of life is not adequately produced because of the underdevelopment of the kidneys, still immature anatomically and functionally [Piccione *et al.* 2006]. WBC of the kids showed an increasing value in relation to an improvement of the immunological system that during this period (14 days *post-partum*) after receiving the immunoglobulins from colostrum, acquires a passive immunity [Vihan and Ray 1983, Quigley *et al.* 2001, Jeffcott 2008]. In earlier investigations conducted on calves, a similar significant variation of WBC was attributed to high concentration of cortisol that, just in the foetus, increases during the last days of intrauterine life and decreases progressively after the birth, for about 11-20 days; during weaning time

**Table 1.** Mean values ( $\pm$ SD) of the hamatological parameters of five Messinese goats, monitored during the first month after parturition of the twin kids (after birth), expressed in their units of measurements

Parameter	reference values*	Experimental conditions					
		immediately after birth	7 days after birth	14 days after birth	21 days after birth	28 days after birth	
RBC (K/uL)	8.00-18.00	16.34 $\pm$ 0.86	10.92 $\pm$ 0.72 <sup>■</sup>	13.62 $\pm$ 1.01 <sup>■</sup>	13.25 $\pm$ 0.95 <sup>■</sup>	12.01 $\pm$ 2.49 <sup>■</sup>	
WBC (M/uL)	4.00-13.00	14.27 $\pm$ 0.99	9.55 $\pm$ 1.87 <sup>■</sup>	10.15 $\pm$ 1.66 <sup>■</sup>	10.15 $\pm$ 1.66	10.47 $\pm$ 1.96	
Hb (g/dL)	8.00-12.00	10.45 $\pm$ 1.02	9.22 $\pm$ 1.37	8.52 $\pm$ 1.48 <sup>■</sup>	8.52 $\pm$ 1.48	8.47 $\pm$ 0.77	
Hct (%)	22-38	28.52 $\pm$ 1.68	26.17 $\pm$ 3.55	22.87 $\pm$ 3.92 <sup>■</sup>	22.87 $\pm$ 3.92 <sup>■</sup>	24.70 $\pm$ 2.64	
MCV (fL)	16-25	19.37 $\pm$ 1.43	15.75 $\pm$ 1.73	14.75 $\pm$ 0.70	14.25 $\pm$ 1.30	16.00 $\pm$ 1.14	
MCH (Pg)	5.2-8.0	6.07 $\pm$ 0.42	5.52 $\pm$ 0.55	5.42 $\pm$ 1.80	5.42 $\pm$ 0.44	5.92 $\pm$ 1.28	
MCHC (g/dL)	30-36	36.7 $\pm$ 1.35	35.35 $\pm$ 1.02	36.77 $\pm$ 0.64	37.02 $\pm$ 0.84	34.42 $\pm$ 1.32 <sup>■</sup>	
PLT (K/uL)	490-160	91.5 $\pm$ 16.55	202.5 $\pm$ 6.87 <sup>■</sup>	131.50 $\pm$ 17.55 <sup>°</sup>	246.5 $\pm$ 27.07 <sup>■</sup>	393.00 $\pm$ 11.31 <sup>■♦♦</sup>	

Significances—**time**:<sup>■</sup> vs immediately after birth; <sup>°</sup> vs 7 days after birth; <sup>◇</sup> vs 14 days after birth; <sup>♦</sup> vs 21 days after birth.  
\*Reference values from: “Schalm’s Veterinary Hematology”, Lippincott, Williams and Wilkins, 2000, pag.1075-1084.

the WBC increase is significant [Mohri *et al.* 2007, Hoar 2007]. It was well established that during the first week of life, neutrophils are the dominant WBCs in the kids, whereas by about week 2 of age dominant become leukocytes [Kramer 2000]. In newborns, natural suckling admitted, the higher values of leukocytes can be interpreted as natural adaptation of the immune system to the immunoglobulin delivered from the mother [Guedes *et al.* 2010]. The MCV showed a significant decrease in kids only in days following the birth. It is characteristic of kids of every species and because the volume of red blood cells is by 21% higher in newborn than in adult animals [Huisman *et al.* 1969, Mbassa and Poulsen 1993]. This explains the obtained variations on MCH and MCHC. In the present study the PLTs occurred as an important parameter not only because in the goat blood their count is difficult to establish, but also for the change showed during the experimental period in kids. Very few authors examined the goat platelets, that seem to have a fine structure, similar to those observed in humans, with clear vacuoles and, in coloured smears, usually gathered in fairly numerous groups [Lewis 1976, Domina *et al.* 1998]. In the present study PLT showed an increase in kids and in adults. The thrombopoietin is the reason for the increase in platelet count in kids. In fact, during the early days of life the haematological system in all animals is still not completely developed and megakariocytes are the prevalent form of PLT, little in number, big in size [Frolich *et al.* 1998]. We can hypothesize that in kids the platelets, during the first month after birth, acquire the ultimate shape and the specific physiological number.

The results presented here contribute to the knowledge of adaptation process in kids during the first month of life. We witnessed the beginning of development of a mature haematological system by the kids. Knowledge of the physiological values for the kids of this species provides useful information for the diagnosis and treatment of some neonatal diseases. Moreover, the values presented here

Table 2. Mean values (±SD) of the haematological parameters of ten Messina twin kids, monitored during the first month of life, expressed in their units of measurements

Parameter	Immediately after birth		7 days after birth		14 days after birth		21 days after birth		28 days after birth	
	twin a	twin b	twin a	twin b	twin a	twin b	twin a	twin b	twin a	twin b
RBC(K/uL)	7.83±0.59*	8.31±1.17*	9.76±1.48	9.30±1.33	11.52±1.66*	11.13±1.62*	11.26±1.47*	12.86±2.49*	12.29±1.44*	12.01±1.14*
WBC(N/uL)	6.22±1.83*	6.55±0.54*	8.92±3.41	5.40±0.36	14.04±2.68*	13.40±2.53*	9.14±1.71	11.80±2.47*	10.28±1.87	12.98±2.34*
Hb(g/dL)	9.38±0.86	9.87±1.34	8.90±1.37	8.92±1.39	9.02±0.78	9.04±0.87	8.80±1.44	9.74±0.84	9.70±1.32	9.26±1.36
Hct(%)	28.24±3.21	31.32±4.90	28.48±3.94	27.32±4.11	26.46±1.70*	26.28±1.95*	27.26±0.93*	30.46±1.00*	30.70±3.89	29.40±3.39
MCV(fL)	29.84±3.94*	30.85±1.90*	25.00±2.91*	26.25±1.92*	21.60±2.30*	20.20±1.78*	20.40±2.19*	20.60±1.81*	19.40±1.81*	18.00±0.70*
MCH(Pg)	9.84±0.73*	10.05±1.43*	7.76±0.93*	8.60±0.74*	7.76±0.63*	6.92±0.65*	6.62±0.69*	6.54±0.61*	6.10±0.48*	5.66±0.39*
MCHC(g/dL)	33.30±1.65*	32.30±0.84*	31.08±1.41*	32.52±0.63*	34.06±0.94*	34.24±0.79*	32.26±0.49*	31.96±0.27*	31.62±1.27*	31.50±1.11*
PLT(K/uL)	173.20±44.60*	161.00±12.04*	168.4±13.66*	114.00±13.26*	116.80±15.20	193.60±24.14*	196.00±30.56	213.20±17.81*	362.00±33.55*	430.80±33.92*

Significances – groups: \* vs goat, • vs twin a; time: ■ vs immediately after birth; ◊ vs 7 days after birth; ◊ vs 14 days after birth; ♦ vs 21 days after birth.

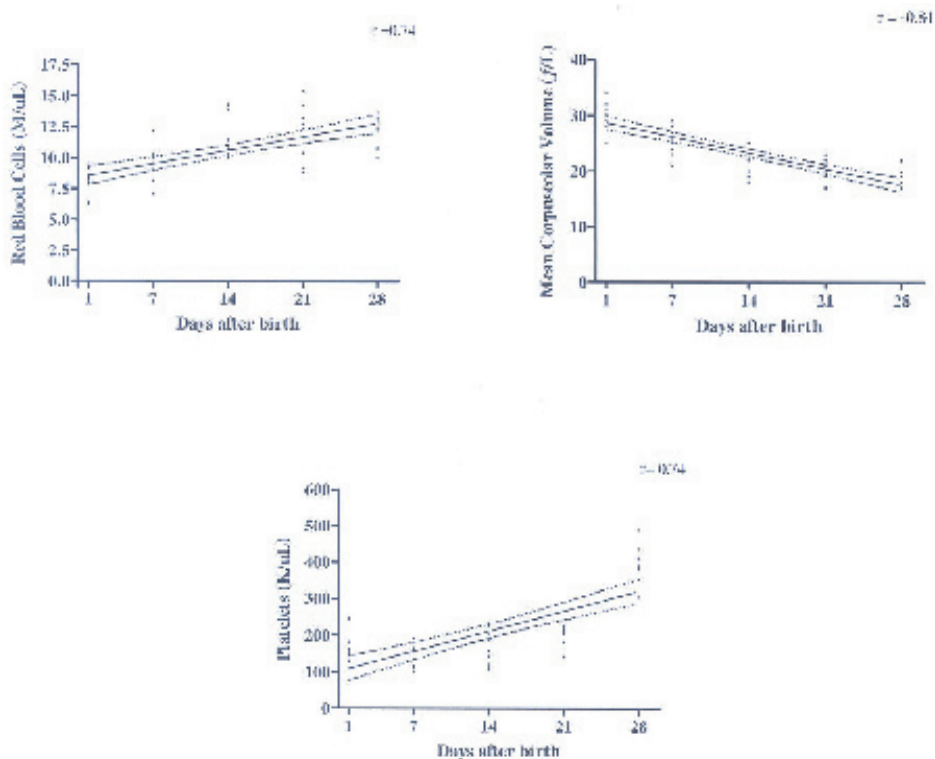


Fig. 1. Regression of postnatal age (days of life) and RBC (M/uL), MCV (f/L) and PLT (K/uL) of kids with 95% confidence intervals and the correlation coefficient ( $r$ ).

obtained for messinese goats seem to be very similar to those reported from arid climatic zones [Daramola *et al.* 2005]. Further comparative studies between this breed and goats living in other climatic zones should be conducted.

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