Investigation of the relationship between kids vitality and placental characteristics in hair goats

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SUMMARY

The research was carried out to determine the relationship between kids birth weight and placental characteristics of hair goats grown in poor condition during the critical period of pregnancy. Particularly, it was aimed to investigate the placental relation of high mortality rate especially in twin kids. Placentas were collected from 52 goats at normal kidding. There were 36 singleton and 16 twin pregnancies and 42 female and 26 male kids. During the mating period (September), the goats grazed on poor pasture for 12 hours and nothing was added to the pasture. The date of mating was recorded and goats were fed indoor after the 60th day of pregnancy. During the time they were inside, 200 g/day barley, *ad libitum* the hay and water were given. Kids were weighed and sexed at 12-24 h after birth. Placentas were collected immediately and brought to laboratory and placentas were carefully disturbed water and weighed. Each placenta was opened with a scalpel and the cotyledons were separated from chorioallantois and counted. The effects of birth type, sex, parity and vitality on placental and cotyledon traits were analyzed by the general linear model procedure in SPSS using a completely randomized design. When the birth weight was 2.83±.07 in live kids, it was 1.31±.23 in dead kids and this difference was statistically very significant ($p<0.001$). In addition, placental efficiency was affected by the vitality of kids ($p<0.05$) and we observed that there was no x large cotyledon (>51 mm diameter) in the dead kids. The low placental and cotyledon characteristics of kids who died before weaning showed that placental and cotyledon traits have an effect on kids' vitality. The result showed that there were significant differences ($p<0.05$) among parity for placental weight and cotyledon density. Birth type affected placental weight ($p<0.001$), cotyledon density ($P<0.01$) and average cotyledon surface area (ACSA) ($p<0.05$). Large cotyledon number, cotyledon length and cotyledon width were affected ($P<0.01$) by birth type. It was observed that there is a direct correlation between ACSA and cotyledon length ($r=0.985$; $p<0.01$), cotyledon width ($r=0.969$; $p<0.01$). However, a negative correlation between ACSA and small cotyledon number (-0.553; $p<0.01$), cotyledon density (-0.779; $p<0.01$) is determined for hair goats. As a result, we suggest that cotyledon efficiency is a much more precise and reliable measure of placenta functional ability. These data have shown that manipulation of the prenatal period can affect birth weight, newborn losses, average daily live weight gain, market weight, health and meat production economy and profitability in the livestock industry.

KEY WORDS

Average cotyledon surface area, birth type, cotyledon, hair goat, placenta.

INTRODUCTION

Breeding small ruminants, goats in particular, is an important livestock activity for people living in rural areas. In Turkey, there are around 10 million hair goats.[1] They have been adapted to the climate and geographical conditions of Turkey; therefore, the hair goats are resistant to diseases, heat and cold weather and have high ability to benefit from rough and poor pastures. In the studies, the litter size of hair goats is reported as 1.09 and 1.18.[2,3] In addition, Atay et al.[2] reported that there were reproductive problems and loss of kids in weaning. It has been reported that birth weight, breed, region, birth type, and parity affect the survival and mortality rate of the kids.[4]

The placental growth in goats occurs before fetal growth and the development of the placenta is very important for best fetal growth.[5] Because the placenta helps the circulation of food, gas and waste products into maternal and fetal metabolism.[6] Goat and sheep have an epitheliochorial - cotyledonary placenta, as well as the number and size of cotyledons detect the appropriate area for nutrient transfer between mother and fetus systems.[7] Thus, placental mass and nutrient exchange capacity play an essential role in determining the fetal growth organs and birth weight, postpartum vitality and long-term health. There is a significant positive correlation (generally 0.5-0.09) between the birth and placental weight in sheep and humans.[8] These data have shown that in the livestock industry, manipulation of the prenatal period will affect birth weight, newborn losses, average daily live weight gain, market weight, health and meat production economy and profitability.[9]

The nutritional level of a mother for the regulation of fetal and placental development in sheep and goats have an important effect during the pregnancy.[6] It is possible to manipulate the placental development of goats by feeding.[10] Since goat farming is carried out under extensive conditions, it is not possible to regulate and control placental development in Turkey. Because the mating season is in autumn, goats are grazing in the poor pasture and no additional feeding is done. In addition, researchers reported that the nutritional

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consumption of grazing sheep in West America is 50% less than the recommendations of the National Research Council (NRC) without supplementation.[11]

Although there are studies for placental traits on many species and breeds, there are no studies on hair goats. As a result, our main aim in this study was to determine the relation between kid weight and placental characteristics of hair goats grown in poor conditions during the critical periods of pregnancy. In particular, it was aimed to investigate the relation between placental traits and the high mortality rate of kids.

MATERIALS AND METHODS

The study was applied in a private farm located in the Cayirli district in the Erzincan province (39º 49' N, 39º 57' E and sea level 1618 m). In this study, we used 52 hairs goats aged between 3-6 years. The distribution of kids according to parity, birth type, and sex, was shown in Table 1. There were 36 singleton and 16 twin pregnancies and 42 female and 26 male kids. During the mating period (September), the goats grazed on poor pasture for 12 hours and nothing was added to the pasture. The date of mating was recorded and goats were fed indoor after the 60th day of pregnancy. During the time they were inside, 200 g/day barley, *ad libitum* the hay and water were given.

Table 1 - The distribution of kids according to parity, birth type, and sex.

Birth type	Parity 2-3		Parity ≥4		Total
	Female	Male	Female	Male	
Single	8	8	10	10	36
Twin	2	2	22	6	32
Total	10	10	32	16	68
Total (parity)	18		34		

Kids were weighed and sexed at 12-24 h after birth. Placentas were collected immediately and brought to laboratory and placentas were carefully disturbed water and weighed. Each placenta was opened with a scalpel and the cotyledons were separated from chorioallantois and counted. After that, cotyledons were classified by size according to Konyali et al.[12] and Ocak et al.[13] and recorded. The length (CL), width (CWi) and depth (CDe) of the 30 cotyledons of the same size chosen from the placenta were measured by digital compass. Placental efficiency (PE), cotyledon density (CD) and cotyledon efficiency (CE) were calculated according to Konyali et al.[12]. Additionally, TCSA was calculated according to the following formula:

$$[((CWi + CL) / 4) \times 2] \times 3.14 (\pi) \times TCN$$ [12,13,14]

Average cotyledon surface area (ACSA) was obtained by dividing TCSA by cotyledon number. The kids were weaned after two months from birth. Only six of the 68 kids died in the two-month study.

The effects of birth type, sex, parity and vitality on placental and cotyledon traits were analyzed by the general linear model (GLM) procedure in SPSS using a completely randomized design. Additionally, kid sex was used in the model as a cofactor to adjust the placental and cotyledon traits except vitality. To determine relationships between placental and cotyledon traits Pearson correlation was used, at the 95% confidence interval.[12,15]

RESULTS

According to the vitality of kids, the mean of birth weight (BW), placental and cotyledon traits were given in Table 2. When BW was 2.83±.07 kg in live kids, it was 1.31±.23 kg in

Table 2 - Placental and cotyledon traits according to the vitality of kids.

	Live kids				Dead kids				P
	Medium	SE	Minimum	Maximum	Medium	SE	Minimum	Maximum	
BW	2.83	.07	2.1	3.78	1.31	.23	1.0	1.7	.000
PW	390.4	24.71	200	690	293.3	79.43	180	350	.252
CN	98.74	3.28	56	127	86.66	10.54	48	106	.282
CNs	5.90	.92	0	22	4.00	2.97	0	6	.545
CNm	71.61	3.53	18	102	75.00	11.36	37	94	.778
CNl	20.58	3.14	0	59	7.66	1.10	6	11	.231
CNxl	.61	.17	0	4	–	–	–	–	–
CL	2.88	.07	1.65	3.75	2.66	.23	2.57	2.72	.396
Cwi	2.01	.05	1.3	2.4	1.81	.16	1.64	1.90	.259
Cde	.39	.01	0.2	0.64	.36	.05	0.30	0.40	.656
PE	10.58	.34	7.67	16.43	7.43	1.10	6.43	9.44	.010
CD	.28	.01	0.12	0.51	.29	.05	0.27	0.30	.854
CE	5.36	.26	3.59	8.74	3.73	.84	2.93	5.35	.075
ACSA	7.68	.19	4.63	9.66	7.03	.61	6.62	7.25	.324

BW: Birth weight; PW: Placental weight; CN: Cotyledon number; CNs: Cotyledon number small (<10 mm diameter); CNm: Cotyledon number medium (between 10 and 30 mm diameter); CNl: Cotyledon number large (between 31 and 50 mm diameter); CNxl: Cotyledon number x large (>51 mm diameter); CL: Cotyledon length; Cwi: Cotyledon width; Cde: Cotyledon depth; PE: Placental efficiency; CD: Cotyledon density; CE: Cotyledon efficiency; ACSA: Average cotyledon surface area.

Table 3 - Effect of parity, birth type and sex on placental traits (X ± SE).

	BW (kg)	PW (g)	CN	PE	CD	CE	ACSA (cm^2)
Mean	2.63±.08	363.7±13.6	99.48±2.7	10.72±.2	0.292±.01	5.12±.21	7.58±.13
Parity	0.322	**0.045**	0.525	0.117	**0.033**	0.530	0.207
2-3	2.51±.14	321.5±24.2	102.05±4.8	11.42±.5	0.325±.01	4.92±.38	7.33±.23
≥4	2.76±.07	406.0±12.6	96.90±2.5	10.01±.2	0.260±.00	5.32±.19	7.84±.12
Birth type	0.168	**.000**	0.055	0.235	**0.011**	0.077	**0.006**
Single	2.81±.08	281.7±14.7	91.45±2.9	10.19±.3	0.332±.01	4.54±.23	7.00±.14
Twin	2.46±.13	445.7±23.7	107.50±4.5	11.25±.4	0.253±.01	5.70±.36	8.16±.22
Sex	**0.033**	0.925	0.204	**0.026**	**0.042**	0.735	0.918
Female	2.51±.17	368.7±28.2	96.50±5.7	10.14±.6	0.271±.01	5.11±.45	7.63±.28
Male	2.91±.18	369.1±30.4	103.32±6.1	11.55±.6	0.315±.02	5.26±.49	7.60±.30

BW: Birth weight; PW: Placental weight; CN: Cotyledon number; PE: Placental efficiency; CD: Cotyledon density; CE: Cotyledon efficiency; ACSA: Average cotyledon surface area.

Table 4 - Effect of parity, birth type and sex on cotyledon traits (X ± SE).

	CNs	CNm	CNl	CNxl	CL (mm)	CWi (mm)	CDe (mm)
Mean	6.04±.7	69.60±2.8	23.4±2.2	0.35±.1	2.85±.05	1.97±.03	0.38±.01
Parity	0.303	0.789	0.383	0.120	0.229	0.213	0.237
2-3	7.23±1.3	68.46±5.0	26.3±3.9	0.02±.0	2.75±.09	1.91±.06	0.36±.02
≥4	4.85±.7	70.74±2.6	20.5±2.0	0.67±.1	2.94±.04	2.04±.03	0.40±.01
Birth type	0.414	0.400	**0.001**	0.277	**0.009**	**0.006**	0.086
Single	6.98±.8	73.21±3.0	11.0±2.3	0.12±.1	2.63±.05	1.82±.03	0.34±.01
Twin	5.10±1.2	65.99±4.8	35.8±3.7	0.57±.2	3.06±.08	2.13±.06	0.42±.02
Sex	0.513	0.051	0.192	0.404	0.760	0.839	0.593
Female	6.71±1.5	76.37±6.4	19.6±5.0	0.55±.3	2.84±.11	1.99±.08	0.37±.03
Male	5.39±1.4	65.54±5.9	25.2±4.7	0.34±.2	2.88±.10	1.98±.07	0.38±.02

CNs: Cotyledon number small (<10 mm diameter); CNm: Cotyledon number medium (between 10 and 30 mm diameter); CNl: Cotyledon number large (between 31 and 50 mm diameter); CNxl: Cotyledon number x large (>51 mm diameter); CL: Cotyledon length; CWi: Cotyledon width; CDe: Cotyledon depth.

dead kids and this difference was statistically very significant ($p<0.001$). In addition, PE was affected by the vitality of kids ($p<0.05$) and we observed that there was no CNxl in the dead kids. Even if it is not statistically significant, PW, CN, CNl, CL, CWi, Cde, CE and ACSA were higher in live kids than dead kids.

The mean BW, PW, CN, PE, CD, CE, and ACSA are determined to be 2.63±.08 kg 363.7±13.6 g, 99.48±2.7, 10.72±.2, 0.292±.01, 5.12±.21 and 7.58±.13 cm^2 respectively (Table 3). While parity and birth type are not effective on birth weight, sex affected birth weight. There are significant differences between parity and PW, CD ($P<0.05$). As the parity of the does rose, PW increased, but the CD decreased. Even if it is not significant, BW and ACSA increased and CN decreased with parity. Birth type affected PW ($p<0.001$), CD ($p<0.05$). Although the ACSA increased with the parity, this was not statistically significant.

In the study, it is determined that while single born goats have 281.7±14.7 g placenta, twin born goats have 445.7±23.7 g placenta. When we look at the kid sex, it can be seen that, it is affected by BW, PE, and CD ($p<0.05$). Otherwise, CN and CE are not affected by any factors. Effects of parity, birth type and sex on cotyledon traits were shown in Table 4. Although the parity and sex are important factors on many traits, we did not find any statistically significant effect parity and sex of kids on the cotyledon traits. However, CNs was lower in ≥4 parity goats than 2-3 parity goats. Also, CNm, CNxl, CL, Cwi and CDe were highest in ≥4 parity goats.

On Table 5, we showed Pearson correlation coefficients of placental and cotyledon traits for hair goats. A positive correlation between BW and CL ($r=0.295$; $p<0.05$), CWi ($r=0.239$; $p<0.05$), PE ($r=0.428$; $p<0.01$), CE ($r=0.321$; $p< 0.01$), ACSA (0.278; $p<0.05$) were calculated. As a matter of fact, while there was no significant correlation between the birth weight and the number of cotyledons in the correlation analysis, a very significant positive correlation between the birth weight and the number of long cotyledons has been determined. There was high positive correlation between ACSA and CL ($r=0.985$; $p<0.01$), CWi ($r=0.969$; $p<0.01$). However, a negative correlation between ACSA and CNs (-0.553; $p<0.01$), CD (-0.779; $p<0.01$) was determined for hair goats. There were positive correlation between parity and PW ($r=0.464$; $p<0.01$), CL ($r=0.434$; $p<0.01$), CWi ($r=0.408$; $p<0.01$), CDe ($r=0.383$; $p<0.01$) and ACSA ($r=0.432$; $p<0.01$).

DISCUSSION

The low placental and cotyledon characteristics of kids who died before weaning showed that placental and cotyledon

Table 5 - Pearson correlation coefficient of placental and cotyledon traits.

	Parity	BW	PW	CN	CNs	CNm	CNl	CNlx	CL	CWi	CDe	PE	CD	CE
BW	.032													
PW	.464**	.148												
CN	-.001	-.083	.297*											
CNs	-.317**	-.213	-.313**	.451**										
CNm	-.124	-.090	-.180	.596**	.437**									
CNl	.210	.067	.578**	.252*	-.284*	-.603**								
CNlx	.303*	.097	.372**	.000	-.294*	-.111	.152							
CL	.434**	.295*	.702**	-.023	-.623**	-.459**	.640**	.400**						
CWi	.408**	.239*	.689**	.049	-.424**	-.385**	.573**	.456**	.911**					
CDe	.383**	-.191	.354**	.355**	-.049	-.248*	.632**	.405**	.226	.283*				
PE	-.255*	.428**	-.226	-.135	-.134	-.107	.002	.200	.045	.109	-.086			
CD	-.524**	-.116	-.794**	.218	.633**	.536**	-.527**	-.403**	-.800**	-.708**	-.201	.203		
CE	.228	.321**	.547**	-.428**	-.497**	-.518**	.247*	.410**	.476**	.464**	.019	.385**	-.675**	
ACSA	.432**	.278*	.712**	.007	-.553**	-.438**	.626**	.433**	.985**	.969**	.255*	.073	-.779**	.481**

BW: Birth weight; PW: Placental weight; CN: Cotyledon number; CNs: Cotyledon number small (<10 mm diameter); CNm: Cotyledon number medium (between 10 and 30 mm diameter); CNl: Cotyledon number large (between 31 and 50 mm diameter); CNxl: Cotyledon number x large (>51 mm diameter); CL: Cotyledon length; Cwi: Cotyledon width; Cde: Cotyledon depth; PE: Placental efficiency; CD: Cotyledon density; CE: Cotyledon efficiency; ACSA: Average cotyledon surface area; *: P<0.05, **: P<0.01.

traits have an effect on kids' vitality. In our study, we found the result that kids' birth weight was lower than those of Yilmaz et al.[16] (3.15 kg) and Celik Tozlu and Oflaz[17] (3.7 kg) in the same breed. Also, when compared to other goat breeds, it has been observed that the result of birth weight were lower than Angora, Kilis, Honamli and Norduz which were reported by Daskiran et al.[18]

Our study gave an interesting finding in relation to ACSA which is that twins had more ACSA than singletons ($p<0.01$). Dwyer et al.[19] and Ocak et al.[20] reported that birth type was effective on PW as same as this study. Also, PW as showed by some researchers[12,14], increased with the parity. While the CD decreases with the parity as Alkass et al.[21], single born goats have higher CD than twin born goats similar to the result of the study by Ocak et al.[22]

Cotyledon number is formed on the 30th day of pregnancy and there was no change in cotyledon number in the later periods although there was a change in size. Twins had more cotyledons than singletons. This situation is not in line with the results of past caprine studies of the findings of Ocak et al.[20] and Ocak et al.[22], however it is in accordance with the ovine studies by Dwyer et al.[19] and Jawasreh et al.[23] and the caprine study by Konyali et al.[24]. Konyali et al.[12] reported that placental efficiency is an important element of uterine capacity. But it has been shown that variation in concepts within a litter was important for this feature, resulting in the conclusion that PE was an individual conceptual property[22,25]. For this reason, it has been contended by Ocak et al.[22] that CE was a much more precise and reliable measure of feto-maternal nutrition. In the study by Sen and Onder[14], it was reported that the CE increased, PE decreased with the parity and it was statistically significant. Also, Ocak et al.[22] reported that twins placenta had CE 4 times higher than the PE. Parity did not affect CL and CWi as reported by Ocak and Onder (2011)[26] which is different from our study. CNl, CL, and CWi were affected ($p<0.01$) by birth type and they were higher in twin births compared to single births. A very important and noticeable result was that twin placentas had a higher number of CNl and bigger CL and CWi, ($p<0.05$) but fewer ($p>0.05$) numbers of CNs and CNm. This situation is an important indicator of the relationship between cotyledon size and fetus development.

There was already a higher correlation between placental weight and CNl than CN. This result showed us that only the number of cotyledons was not a sufficient parameter for the birth weight of the kids, thus the cotyledon length may be used as a parameter for bigger birth weight. The high correlation that we found between ACSA and BW, CL and CWi showed us that cotyledon sizes were a crucial parameter for lamb birth weight. Further studies should be carried out on the enlargement of the cotyledon dimensions in the prenatal period at the histological level and nutrition.

CONCLUSION

From this result, we suggested that CE was a much more precise and reliable measure of placenta functional ability. In our study, parity and birth type did not affect PE and CE. However, CE was highest in ≥4 parity and twins. The main reason for the difference between the results of other researchers and our study in parity could be that ACSA was not affected statistically by the parity and birth type. Because of the effects of cotyledon traits on birth type such as ACSA, new studies are needed to increase vitality and to reduce the death of kids by improving the nutrition of the prenatal period.

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