

MORPHOMETRY OF FETAL PLACENTA AND ITS ASSOCIATION WITH CALF AND DAM IN ONGOLE (*BOS INDICUS*) COWS

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ABSTRACT

Placenta plays a vital role in the exchange of nutrients between the dam and fetus, ensures fetal growth and survival. Its structural and functional characteristics significantly affect the health and productivity of both calf and dam. The present study was conducted to assess the morphological characteristics of normally expelled foetal placenta and its association with various calf and dam parameters in the native Ongole (Bos indicus) cows. The objectives of the present study aimed to assess the morphological characteristics of foetal placenta expelled normally in Ongole cows and examine their association with various calf and dam parameters. It also evaluated the influence of factors such as calf sex, dam weight, parity and season on placental traits and expulsion duration. The study was conducted at the Livestock Research Station, Lam, Guntur, A.P, and a total of 123 placentas from normally calved animals were used. The mean values for duration of placenta expulsion, weight of placenta, number of cotyledons, overall cotyledon diameter, placental efficiency and placenta density were recorded to be 203 ± 6.5 minutes, 3.18 ± 0.06 , 77.03 ± 1.32 , 6.16 ± 0.06 cm, 8.38 ± 0.17 and 0.03 ± 0.004 respectively. 73.98% of placenta expelled ≥ 4 hrs. The placenta weight was found to be 0.84% of dam's weight and 12.51% of calf birth weight. The number of cotyledons differed significantly ($P < 0.05$) between male (71.37 ± 1.44) and female (82.42 ± 1.96) births. Gravid horn constituted 68% of total number of cotyledons. The largest and smallest cotyledon size observed during the study was 11.15 ± 0.16 cm and 1.66 ± 0.07 cm, respectively. The results indicate that, while the duration of placental expulsion was affected by calf sex, the placenta weight and placental efficiency were found to be related to calf birth weight. Further, the dam weight had a significant positive correlation ($P < 0.05$) with placenta weight ($r = 0.187$) and cotyledon diameter ($r = 0.225$). Parity of the dam did

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not show any effect on placental characteristics. The duration of placenta expulsion (minutes) was the shortest in summer calvings (188.46 ± 24.95) followed by winter calvings (191.67 ± 7.78) and the longest in rainy season calvings (225.83 ± 11.39).

Key words: Ongole cow, morphometry of fetal placenta, placental expulsion, placental efficiency.

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INTRODUCTION

The fetal placenta or chorio-allantois, a transient structure formed during pregnancy, plays a crucial role in the development of the offspring (Bhageerathi *et al.*, 2002). It nourishes the embryo, facilitates respiration and waste elimination, serves as an immunological barrier and produces essential hormones such as estrogen and progesterone (Sen *et al.*, 2013). It produces enzymes necessary for the attachment of trophoblast and intracellular digestion. Placenta structurally resembles adult organs such as liver, lung, kidney, small intestines and endocrine glands (Burton and Fowden, 2015).

Studying placental characteristics such as the duration of placental expulsion, placental weight, placental efficiency, number of cotyledons and cotyledon density is crucial for the assessment of maternal and fetal health (Kamal *et al.*, 2017). These placental characteristics may provide insights into fetal development and overall pregnancy outcomes. For instance, abnormal placental weight can indicate potential complications such as intrauterine growth restriction or placental insufficiency. The duration of placental expulsion

correlates with labor progression and can highlight issues that may require immediate medical intervention (Kamal, 2017). Factors such as parity, calf sex and season of calving can impact placental development and consequently neonatal behaviour and survival (Orihuela and Galina, 2021).

Given the importance of placenta in offspring development, few studies explored the relationship between placental characteristics and dam and calf parameters. However, there is a noticeable gap in the literature regarding placental characteristics in Ongole cattle. Therefore the present study is aimed to study the effect of parity, calf sex and season of calving on certain placental characteristics in Ongole (*Bos indicus*) cows.

MATERIALS AND METHODS

The present study was undertaken at Livestock Research Station (LRS), Lam farm, Guntur, Andhra Pradesh. A total of 123 healthy, regularly vaccinated and well managed pregnant cows and heifers (Breed – Ongole) were selected. During the last trimester of pregnancy the animals were shifted to individual enclosures and maintained under uniform conditions of

feeding and management till parturition. The daily ration of each animal consisted of 2-4 kg high protein feed consisted of 20 % DCP and 70 % TDN, 20-30 kg chopped green fodder and 7-8 kg paddy straw. Drinking water was available adlibitum.

Placental characteristics

Immediately after parturition the date and time (hh : mm) of calving was recorded followed by the weight of the calf (kg) using a digital scale with accuracy of 0.1 kg and its gender was noted. Placentae were collected immediately after expulsion and the following characteristics were documented.

Duration of placenta expulsion

Time required for the complete expulsion of the placenta following calving was recorded in minutes (min). Animals with retained placenta after birth were excluded from the study.

Weight of placenta

The entire placental mass was weighed in kilograms using a digital scale with accuracy of 0.1 kg.

Placental efficiency (PE)

Placental efficiency was calculated as per the following formula (Wilson and Ford, 2001).

$$PE = CBW(gm) / PW(gm)$$

CBW= calf birth weight (grams)

PW = placental weight (grams)

Number of cotyledons

After complete expulsion of placenta, it was cut open to spread over a clean plastic sheet and total numbers of cotyledons were counted separately in gravid and non-gravid horns.

Cotyledon density (CD)

Cotyledon density was calculated as per the following formula (Ocak *et al.*, 2014).

$$CD = CN / PW(gm)$$

CN= cotyledon number

PW= placental weight (grams)

The placental characteristics in relation to various calf and dam parameters, including parity and season of calving, were assessed. Analysis of the data was carried out using student t- test, ANOVA and Pearson's correlation coefficient as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Duration of placental expulsion

The time taken for the expulsion of placenta varied from 90 to 390 min with a mean of 203.18 ± 6.5 min (Table 1) which is similar to the findings of Acharya and Kohli (1968) in Harijana cows (207.69 min) and Rao and Rao (1980) in Ongole cows (253.2 min). Expulsion of placenta occurred below 240 min in 91 (73.98%) animals and beyond 240 min in 32 (26.02 %) animals. Effect of sex of calf on duration of placenta expulsion was significant ($P <$

0.05) with cows delivered females calves took comparatively longer duration than the male counterparts (Table 2) (216.29 ± 9.16 vs. 189.41 ± 8.96 min). On the contrary, Rao and Rao (1980) observed a non significant effect of sex of calf on the duration of placenta expulsion. Retrospective analysis of the effect of parity and season of calving on duration of placenta expulsion revealed that while parity had no effect, the rainy season calvings took longer duration for expulsion of placenta (Table 3).

Weight of the placenta

The weight of foetal placenta (mean: 3.18 ± 0.06 kg, range: 1.86 and 5.5 kg) was not significantly affected by sex of calf, parity of the dam and season of calving ($P > 0.05$) (Tables 1, 2 and 3). The placenta weight was found to be 0.84% of dam's weight and 12.51% of calf birth weight. Rao and Rao (1980) observed in Ongole cows that the placental weight was 0.66% of the dam's weight and 10.05% of calf weight. A highly significant positive correlation ($P < 0.01$) was observed between the weight of placenta and dam weight ($r = 0.187$), birth weight of calf ($r = 0.338$), average diameter of cotyledons ($r = 0.306$) and largest size of cotyledon ($r = 0.264$). The placental weight showed significant negative correlation with placental efficiency ($r = -0.708$) ($P < 0.01$) and cotyledon density ($r = -0.219$) ($P < 0.05$). Rao and Rao (1980), Kadu and Kaikini (1975) also reported that the weight of placenta was not affected by parity of dam and sex of calf. Tomar *et al.* (1974) also did not find any association between sex of calf and placenta weight. However, Acharya and Kohli (1968) reported

significant effect of calf sex on the weight of placenta in Harijana cows.

Placental efficiency

The mean placental efficiency was recorded to be 8.38 ± 0.17 (range 4.1-14) in Ongole cows with no significant association to parity as also observed by Kamal *et al.* (2017a) in HF cattle. On the other hand, Dwyer *et al.* (2005) and Bravo *et al.* (2009) observed increased placental efficiency with parity in early part of reproductive life but then declined with each successive pregnancy as the animal ages. The placental efficiency in male and female births was observed as 8.62 ± 0.26 and 8.15 ± 0.23 respectively with no significant effect of calf gender ($P > 0.05$). The placental efficiency was observed to be significantly higher in summer (9.44 ± 0.71) compared to winter (8.24 ± 0.20) and rainy season (8.27 ± 0.29). A highly significant positive correlation was found between placental efficiency and calf birth weight. This suggests that higher the birth weight higher is the placental efficiency providing the increased uterine capacity of the dam (Konyali *et al.*, 2007). A significant negative correlation was found between placental efficiency and placenta weight and average diameter of cotyledon. This is due to the fact that placental efficiency is defined as the grams of foetus produced per gram of placenta (Wilson and Ford, 2001) and hence any change in calf birth weight and placenta weight will affect the placental efficiency.

Cotyledons

In the present study, the placentae of two non gravid horns were found to be

completely devoid of cotyledons. Dufty (1974) and Rao and Rao (1980) observed three and one similar case in Hereford and Ongole cows, respectively. The number of uterine caruncles in the dam is determined prior to her birth ranging from 75-120 (Atkinson *et al.*, 1984). A corresponding number of foetal cotyledons attach to the maternal caruncles to form approximately 75-120 placentomes that serve as functional units for foeto-maternal exchange. Long *et al.* (2009) noted the presence of spare caruncles not covered or attached to a cotyledon throughout gestation and hence the cotyledon number seems to be more dynamic in nature and probably dependent on specific modulating factors. In *Bos indicus* cattle it was reported that a maximum of 20 cotyledons were initially present from day 40 to 50 post-insemination. The number triples, and gradually increases further, averaging approximately 80 up to day 70 post-insemination (Assis Neto *et al.*, 2010). Usually there was no change in the number of bovine cotyledons from day 90 of gestation, while the mean weight and surface of each placentome may continue to increase (Laven and Peters, 2001) resulting in their characteristic mushroom-like shape (Leiser *et al.*, 1997).

The number of cotyledons in each placenta varied from 45 to 124 with a mean of 77.03 ± 1.32 which was comparable with the findings of Kulkarni (1983) and Murugeppa *et al.* (1997), in different breeds. In the present study, it was observed that majority of placentae (57.7%) possessed 66-85 cotyledons and in very few placentae (4.9 %) the cotyledon number was beyond

hundred (106–124). There was no significant effect of parity and season of calving on total number of cotyledons. A significant difference in the number of cotyledons was found in male and female births with 71.37 ± 1.44 and 82.42 ± 1.96 respectively. Rao and Rao (1980) observed that parity and sex of the calf had no significant influence on the total number of cotyledons.

The number of cotyledons in gravid and non gravid horn was noted to be 51.86 ± 0.94 (32-80) and 25.02 ± 0.75 (1-49) respectively. Gravid horn constituted 68% of the total cotyledons present in the placenta. Elsewhere, it was reported that the gravid horn constituted 56.39 % (Rao and Rao, 1980) and 60.0 % (Bhosrekar and Sharma, 1973) of the total cotyledons present in the placenta. It was further observed that there was a highly significant positive correlation between total number of cotyledons and cotyledon density. Kamal *et al.* (2017) hypothesized that various factors occurring during early pregnancy, like growth during adolescent pregnancy in primiparous animals and a high level of milk production in pluriparous animals, might affect the number of cotyledons, while factors mainly occurring later in gestation affect the size of the cotyledons and hence the total cotyledon surface area. The cotyledon number in the placenta was not influenced by parity and season of calving in Ongole cows. However, it appears that sex of calf influenced the number of cotyledons in gravid (more number with female birth) and non-gravid (more number with male birth) horns. The cotyledon density varied from 0.012 to 0.50 (mean of 0.03 ± 0.004)

which was not affected by parity of dam, sex of calf and season of calving (Tables 1, 2 and 3) ($P > 0.05$). On the contrary Ozyurek and Turkyilmaz (2020) observed significant effect ($P < 0.05$) of parity on cotyledon density in Morkaraman sheep.

The overall average diameter of cotyledon in the placenta was 6.16 ± 0.06 (4.17 to 8.29). Further the sizes of the largest and smallest cotyledon were 11.15 ± 0.16 cm 1.66 ± 0.07 cm, respectively. It was also observed that the largest sized cotyledon was always located in gravid horn while the smallest sized cotyledon located in non-gravid horn. Roberts (1971) and Bhosrekar

and Sharma (1973) also reported that cotyledons were small in size in the horn opposite to the one that contains foetus. It has been clearly established that the size of cotyledons vary with the stage of pregnancy as well as their position in the uterus with largest cotyledons (above 13 cm) situated near the middle of allanto-chorionic sac (Hafez, 1955). The dam's parity, calf sex and season of calving, in general, did not influence the cotyledon diameter. A significant positive relationship of cotyledon diameter with dam weight ($r=0.225$, $p<0.01$) and placenta weight ($r=0.036$, $P<0.00$) was recorded.

Table 1. Effect of parity on placental characteristics in Ongole cows (Mean $\pm$ SE)

S.No	Parameters	Parity			Overall (n = 123)
		1st parity (n = 29)	2-4 parity (n = 41)	≥ 5 parity (n = 53)	
1	Duration of placenta expulsion (minutes)	$189.66 \pm 15.60a$	$201.58 \pm 8.55a$	$212.16 \pm 10.59a$	203.18 ± 6.50 (90 - 390)
2	Placenta weight (kg)	$3.04 \pm 0.13a$	$3.08 \pm 0.09a$	$3.33 \pm 0.11a$	3.18 ± 0.06 (1.86 - 5.5)
3	Placental efficiency	$8.18 \pm 0.38a$	$8.57 \pm 0.26a$	$8.34 \pm 0.28a$	8.38 ± 0.17 (4.1 - 14)
4	No of cotyledons	$74.34 \pm 2.42a$	$78.88 \pm 2.73a$	$77.08 \pm 1.78a$	77.03 ± 1.32 (45 - 124)
5	Cotyledon density	$0.03 \pm 0.002a$	$0.03 \pm 0.01a$	$0.02 \pm 0.0009a$	0.03 ± 0.004 (0.012 - 0.5)

Values bearing different superscript within a row differ significantly ($P<0.05$).

Figures in parenthesis indicate range

Table 2. Effect of calf sex on placental characteristics in Ongole cows (Mean $\pm$ SE)

S.No	Parameters	Calf sex	
		Male (n=59)	Female (n=64)
1	Duration of placenta expulsion (minutes)	189.41 $\pm$ 8.96b	216.29 $\pm$ 9.16a
2	Placenta weight (kg)	3.25 $\pm$ 0.09a	3.11 $\pm$ 0.09a
3	No. of cotyledons	71.37 $\pm$ 1.44b	82.42 $\pm$ 1.96a
4	Placental efficiency	8.62 $\pm$ 0.26a	8.15 $\pm$ 0.23a
5	Cotyledon density	0.02 $\pm$ 0.001a	0.04 $\pm$ 0.008a

Values bearing different superscript within a row differ significantly ($P < 0.05$).

Table 3. Effect of season of calving on placental characteristics in Ongole cows (Mean $\pm$ SE)

S.No.	Parameters	Seasons		
		Summer (n=13)	Winter (n=66)	Rainy (n=44)
1	Duration of placenta expulsion (minutes)	188.46 $\pm$ 24.95b	191.67 $\pm$ 7.78b	225.83 $\pm$ 11.39c
2	Placenta weight (kg)	3.25 $\pm$ 0.09a	3.25 $\pm$ 0.09a	3.11 $\pm$ 0.012a
3	No of cotyledons	73.46 $\pm$ 2.59b	78.88 $\pm$ 1.76b	78.38 $\pm$ 2.49a
4	Placental efficiency	9.44 $\pm$ 0.71a	8.24 $\pm$ 0.20a	8.27 $\pm$ 0.29a
5	Cotyledon density	0.02 $\pm$ 0.001a	0.03 $\pm$ 0.001a	0.04 $\pm$ 0.01a

Values bearing different superscript within a row differ significantly ($P < 0.05$).

CONCLUSION

The study found that calf birth weight is one of the major variables affecting placenta weight and placental efficiency. Majority of cows expelled placenta in less than four hrs after parturition. The duration of placental expulsion was significantly influenced by the sex of the calf with cows delivering female calves took comparatively longer duration to expel placenta than their male counterparts. Almost, 2/3 of cotyledons and largest sized cotyledons were always present in the gravid horn. Two placentae in

the non gravid horn were completely devoid of cotyledons. In general, season of calving and parity of dam did not influence the placental characteristics.

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