Determination of age and weight of bovine fetus (*Bos indicus*) by biometry

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Abstract

This study was carried out on 193 zebu fetuses (Gudali and Mbororo) at the municipal abattoir of Ngaoundere (Adamawa region-Cameroon), in order to determine their age and weight by biometry. The fetuses were measured and correlations between the different measurements were established. The sex ratio in the fetuses was 0.82 in favor of the females and the age of the fetuses varied between 106.27 ± 2.04 and 291.25 ± 5.41 days. Correlations were established between cranio-caudal length (CRL), weight and biometric parameters of the fetus through linear, polynomial and power equations according to the best value of the correlation coefficient. Overall, the highest correlation was obtained between head, body, limb, CRL and fetal weight measurements, in particular: the length of the head (R^2_{CRL}=0.9416, R^2_{weight}=0.8784), the circumference of the head (R^2_{CRL}=0.892, R^2_{weight}=0.8865), the front edge length of the side tail (R^2_{CRL}=0.9946, R^2_{weight}=0.9635), the nose-rump length (R^2_{CRL}=0.9925, R^2_{weight}=0.9602) and the tarsal-metatarsal length (R^2_{CRL}=0.9807, R^2_{weight}=0.9564). However, there was a weak correlation between CRL, weight, umbilical cord circumference (R^2_{CRL}=0.4954, R^2_{weight}=0.5083), umbilical cord length (R^2_{CRL}=0.4534, R^2_{weight}=0.453), number of placentomes (R^2_{CRL} =0.4719, R^2_{weight} =0.4407) and placental size (R^2_{CRL}=0.457, R^2_{weight} =0.4458). This information can be useful for the implementation of ultrasonography in rural environments where there is no information regarding the dates of calving, estrus or natural mating.

Keywords: zebu; fetus; gestational age; weight; Cameroon.

Introduction

Livestock is one of the main components of the Cameroonian economy. It contributes 14.47% to agricultural GDP and 4.85% of total GDP. Domestic species used at the national level include cattle, which account for 16% of national agricultural production and account for more than 50% of the country's supply of red meat and milk. The bovine sector, however, faces many constraints that hinder the increase in livestock productivity; they are mostly linked to the low genetic potential of local breeds, feed, health, husbandry practices and product flow (Kouamo et al., 2016). This translates into inadequate production on demand of animal products, particularly meat and milk. This growing demand is part of the reasons behind the need for intensification of beef production by improving breeding conditions and genetic improvement. Several breeders seek to optimize their herd production potential by reducing the interval between calving and early identification of non-pregnant females. Likewise, much work is being done on improving cattle productivity in sub-Saharan Africa, but without a good knowledge of the practices of reproductive biotechnology.

In Africa, pregnancy is usually diagnosed by transrectal palpation, but the precision of this method and the pregnancy period depend on the farmer's experience (Taverne and Willemse, 1989). Although early pregnancy diagnosis is among the most practical application for reproductive management using transrectal ultrasonography, additional information gathered using the technology that may be useful for reproductive management include evaluation of ovarian structures, identification of cows carrying twin fetuses, and determination of fetal sex (Fricke, 2002). Before the ultrasonography examination of a cow, it is necessary to know, among other things, the following: calving date, date of estrus, date of artificial insemination or natural mating (Ginther, 1998). In our context where males and females are usually bred together, controlling these parameters remains a major concern for breeders. Hence the interest of questioning the possibility of predicting the age of the fetus from the ultrasonography without first having these parameters. Therefore, this study aims to determine the age and weight by biometry of the fetus zebus slaughtered at the abattoir of Ngaoundere, in order to allow a better estimation of the calving periods. Specifically, it is about determining the characteristics of pregnant female zebu slaughtered, measuring the fetuses at different ages and establishing a correlation between the CRL, weight and measurements of the fetus.

Materials and methods

Area of study

This study was carried out in the town of Ngaoundere, Vina division, Adamawa region. Located in central Cameroon between latitude 7 ° 19 '39 N and longitude 13 ° 35' 4E, Adamawa is a vast, quadrangular pastoral area of about 70000 square kilometers. The municipal slaughterhouse of Ngaoundere is a registered establishment of the Ministry of Livestock, Fisheries and Animal Industries (*MINEPIA*) and belongs to the municipality of Ngaoundere. The climate is Sudano-Sahelian with alternation between dry (November to March) and rainy (April to October) seasons. The temperatures are rather cool, with an average of 20 ° C. Minimum temperatures (10-19^{o}C) are observed during the months of December and January, while maximum temperatures (27-34^{o}C) are encountered during the month of March. Cattle breeding is the basic economic activity of the region. With 4.0% of the country's population (Cameroon), Adamawa owns 28.0% of the national livestock population. The region is considered a privileged area of cattle breeding, because of its natural assets favourable to this activity, compared to the other production areas of the country. In Adamawa, we find mainly the zebu breed where we can distinguish the Gudali and Mbororo zebus.

Animal characteristics

The study was carried out on a sample of 193 pregnant females randomly selected with the consent of the owner. Females sampled were Gudali (85) and Mbororo (108) breeds, aged between 3 to 15 years with an average BCS of 2.47±0.05 (2-3). The slaughtered animals came from the surrounding towns of Ngaoundere (Tchabal, Mayo rey, Mbe, Galdi, Touboro).

Fetal measurements

Measurements were made on the fetuses using a meter tape and a calliper as described by Joubert (1956): CRL = taken with the flexible tape between the two eyes across the back to the base of the tail; Eye-rump length straight = grip with the inflexible ribbon from the front to the base of the tail; Nose-rump length = hold with a flexible ribbon of the muzzle, through the back to the base of the tail; Ear-rump length = grip with the flexible tape between the base of the head (mid-distance of both ears) to the base of the tail; Length of the head = grip between the muzzle and the base of the head (mid-distance of both ears); Width of the face = catch using the caliper between the two eyes; Length of the head = socket using the ribbon, distance between the two ears; Head circumference = measured at the biggest place of the head (at the height of the ears); Body cross= gap between the spine of the scapula and the base of the tail; Chest depth= taken vertical to the line of the 6th rib (immediately behind the thoracic limbs) from dorsal surface of the back ; Chest circumference ; Length of radius-ulna; Length of the metacarpus; Length of tibia; Length of tarsal-metatarsal; The length of the umbilical cord; The circumference of the umbilical cord; The size of the placentome; The number of placentome.

Determination of age of fetus

The age of the fetus was determined from the formula as follows: X = 2.5 (Y + 21); X = age of fetus in day and Y = CRL (Noakes et al., 2009).

Determination of sex and weight of fetuses

The determination of sex by early diagnosis is possible for the bovine species between the 55th and 100th day of pregnancy. Around the 47th day, the genital tubercle is located between the hind limbs. In the male, it migrates gradually towards the umbilical region, which it reaches towards the 56th day of pregnancy. In the female, it moves to the caudal region where it is identified on the 54th day (Curran et al., 1989). The sex ratio was calculated by the ratio male / female number. The weight of fetuses was recorded by Roman scale.

Statistical analysis

The data were analyzed using Statgraphics Centurion XVI. II software and comparison of means was performed with the ANOVA and Kruskal-Wallis tests for normative and non-normative variables, respectively.

Results

Sex ratio of fetuses

Of the identified fetuses, 106 were females and 87 males, with a sex ratio of 0.82.

Fetal measurements in relation to the pregnancy period

After taking the measurements and counting at the slaughterhouse, 21 fetal parameters were measured as shown in the table 1. The fetuses were grouped by period of 30 days to show the mean age of these periods. At the Ngaoundere slaughterhouse, fetuses with an average age of 291.25 ± 5.41 days were found with a CRL of 95.50 ± 2.16 cm. Depending on the age of pregnancy, there was a significant difference (p = 0.00) in the measured parameters, with the exception of:

- The circumference of the umbilical cord, which varies significantly until approximately 180 days of pregnancy, then no longer presents a significant difference;
- The length of the umbilical cord varies significantly up to approximately 150th of pregnancy when it no longer presents a significant difference;
- The size of the placentomes, which does not vary significantly between the 120th and the 180th day of pregnancy.

Table 1. Average of the fetal parameters as a function of the age of gestation.

Fetal parameters	Pregnancy period (days)							
	[90-120]	[120-150]	[150-180]	[180-210]	[210-240]	[240-270]	[270-300]	P-value
	14	23	33	43	46	32	2	
Average age (day)	106.27±2.04a	134.27±1.59b	165.14±1.33c	195.09±1.17d	223.88±1.12e	249.09±1.35f	291.25±5.41g	0
Crown Rump Length (cm)	21.51±0.82a	32.71±0.64b	45.05±0.53c	57.03±0.47d	68.55±0.45e	78.63±0.54f	95.50±2.16g	0
Ear-rump length (cm)	17.71±0.85a	25.70±0.67b	36.54±0.56c	47.22±0.49d	57.35±0.47e	67.04±0.57f	88±2.26g	0
Eye-rump length (cm)	25.86±1.05a	38.20±0.82b	53.23±0.68c	67.07±0.60d	79.58±0.58e	90.79±0.69f	108.2±2.77g	0
Eye-rump length straight (cm)	21.44±0.85a	32.22±0.66b	44.33±0.55c	56.13±0.48d	67.01±0.47e	76.75±0.56f	96±2.25g	0
Nose-rump length (cm)	9.66±0.41a	12.83±0.32b	16.66±0.27c	19.73±0.24d	22.77±0.23e	25.06±0.27f	30.05±1.09g	0
Head width (cm)	4.56±0.29a	5.53±0.23b	6.98±0.19c	7.82±0.17d	8.70±0.16e	10.36±0.19f	12.65±0.77g	0
Face width (cm)	3.47±0.17a	4.90±0.13b	6.05±0.11c	6.85±0.10d	7.48±0.09e	8.63±0.11f	10.75±0.45g	0
Head circumference (cm)	9.97±0.83a	16.01±0.64b	22.16±0.54c	27.06±0.47d	32.58±0.46e	36.08±0.55f	42.20±2.19g	0
Body cross (cm)	12.03±0.78a	18.89±0.61b	27.45±0.51c	34.44±0.45d	42.27±0.43e	48.13±0.52f	53.60±2.06g	0
Chest depth (cm)	8.10±0.41a	12.56±0.32b	17.04±0.27c	21.15±0.24d	25.35±0.23e	29.64±0.27f	34.80±1.10g	0
Chest circumference (cm)	15.50±0.87a	24.08±0.68b	33.60±0.56c	41.51±0.49d	50.18±0.48e	58.22±0.57f	65.55±2.29g	0
Radius-ulna length (cm)	3.57±0.36a	5.60±0.28b	8.04±0.23c	11.06±0.20d	14.62±0.20e	16.75±0.23f	18.05±0.94g	0
Metacarpal (cm)	3.23±0.27a	5.09±0.21b	7.68±0.18c	10.93±0.16d	14.82±0.15e	17.19±0.18f	19.05±0.72g	0
Tibia length (cm)	4.52±0.47a	7.69±0.37b	11.63±0.31c	15.67±0.27d	20.47±0.26e	24.47±0.31f	28±1.26g	0
Tarsal-metatarsal (cm)	3.96±0.43a	7.26±0.33b	11.32±0.28c	15.76±0.24d	21.04±0.23e	24.93±0.28f	29.80±1.13g	0
Weight (kg)	0.3±0.50a	1.20±0.39b	3.38±0.33c	7.06±0.29d	12.15±0.28e	18.29±0.33f	25.30±1.32g	0
Umbilical cord circumference (cm)	0.76±0.16a	1.53±0.12b	1.99±0.10c	2.32±0.09d	2.30±0.09d	2.19±0.10cd	3.15±0.42d	0
Umbilical cord length (cm)	12.41±1.98a	20.22±1.55b	25.62±1.29c	26.77±1.13c	29.60±1.09c	31.41±1.31c	28.25±5.24c	0
Number placentomes	31±3a	35±3b	48±2c	55±2d	54±2d	64±2e	85±8f	0
Placentomes size (cm)	2.39±0.28a	3.04±0.22a	3.81±0.18c	4.14±0.16c	4.88±0.16d	5.40±0.19e	7.90±0.74f	0

Correlation between CRL, weight and fetal measurements

Head of the fetus

Table 2 presents CRL and weight according to fetal head measurements. The following equations were the most expressive:

- Polynomial of type $y = ax^2 + bx + c$ (y = CRL (mm) and x = measurement of fetal head (mm));
- Power of type $y = ax^b$ (y = weight (mg) and x = measurement of fetal head (mm)).

There was a positive correlation between CRL, weight and head measurements. The length of the head presented a better correlation ($R^2 = 0.9416$) with the CRL and the circumference of the head had a better correlation ($R^2 = 0.8865$) with the weight. Head measurements had a better correlation with CRL than weight (minimum values R^2_{CRL} 0.7342 > R^2_{weight} 0.6972 and maximum values R^2_{CRL} 0.9718 > R^2_{weight} 0.9638). There was no significant difference between males and females (p> 0.05).

Table 2. Correlation between four fetal head measures (x) with weight (y) and CRL (y).

Parameters (mm)	Sex	CRL (mm)		Weight (mg)	
		Regression	R2	Regression	R2
	Total	y = 0.0037x2 + 2.1357x + 0.3474	0.9416	y = 0.009x3.8594	0.8784
Head length	Males	y = 0.0038x2 + 2.0788x + 9.5413	0.9718	y = 0.015x3.7774	0.9638
	Females	y = 0.0037x2 + 2.1621x - 5.3505	0.9192	y = 0.0063x3.9138	0.8327
	Total	y = -0.0002x2 + 2.1021x + 20.089	0.892	y = 0.2667x3.0391	0.8865
Head circumference	Males	y = -0.0004x2 + 2.2622x - 25.771	0.9211	y = 0.1489x3.1349	0.9036
	Females	y = -0.0003x2 + 2.1423x + 31.778	0.8821	y = 0.3324x3.0064	0.8781
	Total	y = -0.0344x2 + 13.024x - 233.59	0.7692	y = 0.3242x3.8335	0.7461
Head width	Males	y = -0.0377x2 + 13.489x - 257.47	0.8218	y = 0.642x3.6779	0.828
	Females	y = -0.0301x2 + 12.5x - 212.46	0.7342	y = 0.1893x3.9572	0.6972
	Total	y = -0.0118x2 + 11.907x - 181.83	0.8569	y = 0.0664x4.3509	0.8506
Face width	Males	y = -0.0065x2+ 11.089x - 145.96	0.8287	y = 0.2513x4.0556	0.8075
	Females	y = -0.0128x2 + 12.138x - 197.4	0.8796	y = 0.0265x4.5512	0.8873

Body of the fetus

Table 3 presents CRL and weight as a function of body measurements of the fetus. The following equations were the most expressive:

- Linear type $y = ax + b$, with y = CRL (cm) and x = fetal body measure (cm);
- Power of type $y = ax^b$ (y = weight (mg) and x = measurement of fetal head (mm)).

There was a very good correlation between the body measurements and the CRL. The CRL and weight had the best correlation with the front-base length of the tail ($R^2_{CRL} = 0.9946$, $R^2_{weight} = 0.9635$). There was no significant difference between males and females (p> 0.05).

Table 3. Correlation between CRL (y) and weight (y) with body measurements (x).

Parameters (mm)	Sex	CRL (mm)		Weight (mg)	
		Regression	R^2	Regression	R^2
	Total	y = 0.8727x - 1.0275	0.9925	$y = 0.0032x^{3.2987}$	0.9602
Nose-rump length	Males	y = 0.8719x - 1.0285	0.9942	$y = 0.0066x^{3.1943}$	0.9649
	Females	y = 0.8734x - 1.0291	0.9913	$y = 0.0021x^{3.3601}$	0.9602
	Total	y = 1.0233x - 0.224	0.9946	$y = 0.0068x^{3.2714}$	0.9635
Eye-rump length straight	Males	y = 1.0302x - 0.4346	0.9955	$y = 0.0132x^{3.1747}$	0.9666
	Females	y = 1.0181x - 0.0771	0.9941	$y = 0.0045x^{3.3277}$	0.9655
	Total	y = 1.1143x + 4.073	0.9891	$y = 0.0495x^{3.0376}$	0.953
Ear-rump length	Males	y = 1.118x + 4.2916	0.9923	$y = 0.1226x^{2.9016}$	0.9556
	Females	y = 1.1114x + 3.8823	0.9874	$y = 0.027x^{3.1265}$	0.9585
	Total	y = 1.5236x + 4.2809	0.9536	$y = 0.1832x^{2.978}$	0.9497
Body cross	Males	y = 1.5479x + 3.8314	0.9761	$y = 0.2485x^{2.9375}$	0.9595
	Females	y = 1.5056x + 4.5818	0.9378	$= 0.1539x^{2.9981}$	0.9479
	Total	y = 1.3236x + 1.5975	0.9672	$y = 0.0282x^{3.1924}$	0.956
Chest circumference	Males	y = 1.2988x + 2.2192	0.964	$y = 0.0657x^{3.0564}$	0.9561
	Females	y = 1.3456x + 1.0453	0.9708	$y = 0.0165x^{3.2785}$	0.9582
	Total	y = 2,6416x + 6,8747	0,9711	$y = 0.1677x^{3.2611}$	0.9547
Chest depth	Males	y = 2,5523x + 18,107	0,9675	$y = 0.4439x^{3.0807}$	0.9481
	Females	y = 2,7295x - 4,7497	0,9785	$y = 0.0865x^{3.3845}$	0.9616

Limbs of the fetus

Table 4 presents CRL and weight as a function of fetal limb measurements. The power equation $y = ax^b$ (y = weight (mg), y = CRL (mm) and x = fetal head measurement (mm)) was the most expressive. There was a very good correlation between CRL, weight and body measurements. The tarsal-metatarsal length has a highest correlation with the CRL and the weight. The measurements of the limbs showed a better correlation with the CRL than the weight (minimum values R^2_{CRL} 0.9554> R^2_{weight} 0.9246 and maximum values R^2_{CRL} 0.9842> R^2_{weight} 0.9594). There was no significant difference between males and females with p>0.05.

Umbilical cord and placentomes of the fetus

Table 5 presents CRL and weight as a function of umbilical cord measurements and fetal placentomes, respectively. The power equation $y = ax^b$ (y = weight (mg), y = CRL (mm) and x = fetal head measurement (mm)) was the most expressive. There was a weak correlation between CRL, weight, umbilical cord and placentomes parameters. There were no significant differences between males and females (p> 0.05).

Table 4. Correlation between fetal leg measures (x) and weight (y) with CRL (y)

Parameters (mm)	Sex	CRL (mm)		Weight (mg)	
		Regression	R2	Regression	R2
	Total	y = 13.768x0.789	0.9653	y = 36.68x2.5641	0.9343
Radius-ulna length	Males	y = 0.036x1.2677	0.9554	y = 100.47x2.3588	0.9246
	Females	y = 12.159x0.8159	0.9742	y = 17.502x2.7149	0.9492
	Total	y = 19.633x0.7156	0.973	y = 115.96x2.3263	0.9422
Metacarpal length	Males	y = 21.083x0.7025	0.9822	y = 220.26x2.2065	0.9573
	Females	y = 18.652x0.7248	0.9684	y = 73.102x2.4105	0.9426
	Total	y = 13.123x0.7441	0.9679	y = 29.688x2.4297	0.9455
Tibia length	Males	y = 12.14x0.7598	0.9686	y = 39.905x2.3814	0.94
	Females	y = 13.77x0.7344	0.9678	y = 25.103x2.4544	0.9512
	Total	y = 17.116x0.6919	0.9807	y = 71.362x2.257	0.9564
Tarsal-metatarsal length	Males	y = 17.638x0.6862	0.9842	y = 125.65x2.1556	0.9594
	Females	y = 16.776x0.6956	0.9784	y = 49.238x2.3219	0.9594

Table 5. Correlation between umbilical cord measurements, placentomes (x) and weight (y) with CRL (y).

Parameters	Sex	CRL (mm)		Weight (mg)	
		Regression	R2	Regression	R2
	Total	y = 0.211x0.7183	0.4954	y = 5730.4x2.3077	0.5083
Umbilical cord circumference (mm)	Males	y = 75.4x0.6543	0.3975	y = 10000x2.1175	0.4113
	Females	y = 64.76x0.718	0.5651	y = 4174.6x2.4203	0.565
	Total	y = 8.58x0.7474	0.4534	y = 6.3665x2.4679	0.453
Umbilical cord length (mm)	Males	y = 9.42x0.726	0.5352	y = 13.708x2.3246	0.5421
	Females	y = 6.97x0.7891	0.4057	y = 2.5521x2.6395	0.3994
	Total	y = 23.78x0.798	0.4719	y = 260.64x2.5461	0.4407
Number placentomes	Males	y = 39.54x0.6705	0.4496	y = 1762.3x2.08	0.4302
	Females	y = 13.49x0.9414	0.5087	y = 32.05x3.0656	0.4748
	Total	y = 40.31x0.6977	0.457	y = 1175.1x2.2741	0.4458
Placentomes size (mm)	Males	y = 76.39x0.5255	0.2599	y = 13883x1.6244	0.2469
	Females	y = 26.51x0.812	0.6153	y = 244.94x2.6894	0.5952

Discussion

Predetermination of the sex of offspring could have a significant impact on livestock breeding and production, particularly in selection programmes where the product (e.g. milk) comes from only one sex (De Vries et al., 2008). There would also be advantages in the situation where a large number of embryos is needed to establish a herd or flock of specified genotype, as when an exotic breed or species is to be introduced. Knowledge of the sex of the fetus increases the value of the sale of a pregnant cow, particularly if it carries a female in a dairy farm and a breeding male. This is especially true in dairy farms where milk-producing future bulls are more valuable than calves that are not interested in breeding patterns. Thus from the sex ratio obtained, where the females were most represented, it can suggested that dairy farms can be intensified in the region. This is in line with the program of development of the dairy sector in Cameroon. A feasibility study carried out in April 2008 by the European Union showed that the increase in milk production had not kept pace with population growth and the evolution of urban demand. The per capita availability of cow's milk consumption remained very low; around 14 kg / inhabitant per year (2009-2015), far from the target of 22 kg / inhabitant per year in 2030-2035 and most demand is currently covered by imports. Diagnosis of the sex of the fetus allows the detection of twin pregnancy consisting of a male and a female, which may lead to the birth of a female free martin calf (Rajamahendran et al., 1994). Knowing the sex of the fetus also helps to guide the behaviour to be taken when calving.

In a one-month period, the fetal measurements significantly evolved. This is similar to the work of Barone (2001) and Noakes et al. (2009) who noted that the size of the fetus gradually evolves in the course of, and more particularly in the last third of gestation. The mean fetal weight (25.30±1.32 Kg) was higher than that observed by Ebangi et al. (2002) in Purebred Gudali and Two-Breed Synthetic Wakwa Beef Cattle. However, these studies show that there is no significant difference between the weight of the male and female newborns, although the male tends to be heavier. CRL is the most representative measure in post-mortem observation of gestational age in most species (Evans and Sack, 1973; Kähn, 1989; Chavatte-Palmer et al., 2006; Kohan Ghardr et al., 2008). The CRL provides a more accurate prediction of fetal age. Before 55 days, it is possible to provide a view of the entire crown-rump length (Wright et al., 1985).

Several studies have shown that the age and weight of the fetus have a high correlation with other fetal parameters, thus making it possible to measure the most accessible parameter and to predict age from ultrasonography (Singh et al., 2004; Van Hanh et al., 2013; Djallel et al., 2017). In this study, linear, polynomial and power equations were established in order to show the best correlation trend and to relate the factors. Highest correlations were observed between age, weight and length of the head, circumference of the head, front edge length of the side tail, nose-rump length and tarsal-metatarsal length. After day 55, these parameters can be used to predict the gestation age when it is not possible to provide a view of the entire crown rump (Eman et al., 2016). Although time consuming these fetal measurements can better be used to predict the gestational age. Nevertheless, there was a weak correlation between CRL and fetal weight with umbilical cord length, umbilical cord circumference, number and size of placentomes. These parameters evolved up to a period of gestation where they became almost constant. This result is similar to that of Anthony et al. (1986) who showed that there is no relationship between the number of placentomes, sex and fetal age; but contrary to the work of Van Hanh et al. (2013) who reported a good correlation in a buffalo study. The placentome consists of interdigitated fetal cotyledonary and maternal caruncular microvilli and is the site of maternal-fetal nutrient exchange in ruminant animals. Proper establishment of the vascularity of the placentome is essential for the maternal system to support the exponentially growing fetus in the last trimester of pregnancy (Reynolds and Redmer, 2001). The cow placentomes did no significant change, although it had a progressive increase in size during gestation. There was no significant difference (P> 0.05) between the size and total number of placentomes as reported by several authors (Laven and Peters, 2001; Zhu et al., 2007). From day 60 of gestation until the end of gestation, placentomes are relative easy to visualize and simple to measure by using ultrasound scanning. But, placentome measurement cannot be an alternative for the prediction of the gestation age as indicated in this study and no scientific evidence is published to evaluate their use in predicting the gestation age in cattle.

Conclusion

This study revealed that fetal measurements evolve progressively according to the age of gestation. There is a high correlation between CRL and weight with fetal measurements (length of the head, circumference of the head, front edge length of the side tail, nose-rump length and tarsal-metatarsal length) and a weak correlation between CRL, weight, umbilical cord parameters and placentomes.

Conflict of interest

The authors declare that they have no conflict of interest.

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