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Estimation of foetal age using ultrasonic measurements of different foetal parameters in red Sokoto goats (*Capra hircus*)

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ABSTRACT

The ultrasonic measurements of occipitonasal length (ONL), orbital (OD), biparietal (BPD), placentome (PD) and umbilical cord (UCD) diameters of red Sokoto goat foetuses with known gestational age (GA) were obtained. The data were subjected to simple linear regression analysis. The derived age prediction equations were GA = 22.881 + 6.668ONL, GA = 26.938 + 14.300BPD, GA = 17.326 + 43.534OD, GA = 48.116 + 11.869PD, GA = 35.796 + 65.195UCD where GA is the gestational age (days), ONL - occipitonasal length, BPD - biparietal, OD - orbital, PD - placentome and UCD - umbilical cord diameters (cm). The foetal ages ranged between 57 and 124 days. The coefficient of correlation (R) between occipitonasal length (R = 0.97), biparietal (R = 0.98), orbital (R = 0.92), umbilical cord (R = 0.77) diameters and gestational age were highly significant ($P<0.001$). The placentome diameter had low correlation (R = 0.45) with gestational age. These results suggest that occipitonasal length, biparietal, orbital and umbilical cord diameters can be used to estimate foetal age in red Sokoto goats, while placentome diameter is not useful for age prediction in this breed.

Key words: age, foetuses, goats, head parameters, umbilical cord

Introduction

Nigeria is among the top six countries of the world in goat meat production (DUBEUF et al., 2004). The red Sokoto goats are the dominant and most widely distributed in the northern Savannah belts of Nigeria (GALL, 1996). RICHARDSON et al. (1976) stated that morphological parameters which show rapid rate of growth were needed for accurate determination of developmental age. Studies on the growth of various organs and different

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structures and how they positively or negatively correlate with gestational age have provided useful information for foetal age estimation in exotic small ruminant breeds.

KELLY and NEWNHAM (1989) found the occipitonasal length to be more accurate than biparietal diameter while SERGEEV et al. (1990) reported that the occipitonasal length was more difficult to measure than biparietal diameter and had the same accuracy for predicting foetal age in Booroola-South Australian Merino sheep. GONZALEZ et al. (1998) found a high correlation (R = 0.96) between the biparietal and foetal orbital diameters and gestational age using transrectal ultrasonography in Manchega sheep. Similar correlation using the trans-abdominal approach was reported in Suffolk and Finn sheep (HAIBEL and PERKINS, 1989; 1990). AMER (2007) established gestational age equations for crown rump length and biparietal diameter in Egyptian Baladi goats with a very significant ($P<0.001$) correlation between the parameters.

GONZALEZ et al. (1998) reported a positive correlation (R = 0.72) between umbilical cord diameter and foetal age in Manchega sheep. DOIZE et al. (1997) reported that gestational age increased rapidly with the placentome size in sheep and goats. They observed a poor correlation between placentome size and gestational age in ewes ($R^2 = 15.59\%$) while in goats the placentome size can be used ($R^2 = 70.32\%$). These and other parameters, like diameter of the trunk, long and short axis of the heart, width of the ribs, weight of internal organs, stomach and kidney diameters at long axis are fast becoming indispensable and reliable tools in estimating the age of foetuses in exotic breeds of animals (GARCIA et al., 1993; GONZALEZ et al., 1998; LEE et al., 2003; AMER, 2007).

There are many studies on abattoir foetuses of Nigerian indigenous breeds of goats (IGBOKWE, 2006; NWAOGU, 2007; NWAOGU and EZEASOR, 2008; NWAOGU and OKOLIE, 2009). None of these have studied foetal age prediction. Hence the need to generate formulae which can be used by researchers to estimate foetal age in Nigerian breeds of goats. This study was designed to estimate the foetal age by using the real time ultrasonic measurements of occipitonasal length, biparietal, orbital, placentome and umbilical cord diameters of red Sokoto goat foetuses.

Materials and methods

Animal management and breeding. Ten adult female and two male goats used in this study were obtained from Obollo Afor market in Udenu Local Government Area, Enugu State. The animals were brought out to graze in the field during the day and kept in pens at night. Forage browsing was supplemented with bambra nut chaff and yam peels once a day. The animals were bred in the animal house, Department of Veterinary Surgery, Faculty of Veterinary Medicine, University of Nigeria, Nsukka after 4 weeks of acclimatization. Fertile bucks were used to detect does exhibiting estrus as previously described by OSUAGWUH and AIRE (1986) and NOAKES et al. (2001). Estrus detection was

carried out twice daily at 7.00 am and 6.00 pm. Animals exhibiting estrus by allowing mounting were separated and kept together with the buck until they were out of estrus.

Ultrasonic pregnancy detection and measurements. Suspected pregnancies in the goats were confirmed by ultrasound pregnancy test at the Veterinary Teaching Hospital, University of Nigeria, Nsukka. A real time ultrasonic (RTU) instrument with sector probe C5 - 8 MHz (SA 600V, Medison Co. Ltd, Seoul, Korea) was used. The does were restrained in dorsal recumbency and trans- abdominal B - mode scanning performed as described by RUSSEL and GODDARD (1995). The foetal occipitonasal lengths (ONL), biparietal, orbital, umbilical and placentome diameters (BPD, OD, UD, PD) were measured with an electronic caliper as previously described (KELLY et al., 1987; DOIZE et al., 1997; GONZALEZ et al., 1998; LEE et al., 2003; AMER, 2007).

The data obtained were subjected to simple linear regression analysis using Statistical Package for Social Sciences for Windows version 15.0 (SPSS Inc. USA). Formulae depicting the relationship between gestational age (GA) and the parameters were obtained. The derived formulae were used to estimate the gestational age of abattoir foetuses whose occipitonasal lengths, biparietal, orbital, umbilical cord and placentome diameters were measured.

Results

The relationships between the head parameters and gestational age are shown in Figures 1 to 3. The derived growth equations were GA = 22.881 + 6.668 ONL, GA = 26.938 + 14.30 BPD and GA = 17.326 +43.534 OD where GA is the gestational age in days, ONL - occipitonasal length, BPD and OD - biparietal and orbital diameters in centimeters respectively. The occipitonasal length, biparietal and orbital diameters showed high significant ($P<0.001$) and positive correlation ($R = 0.97, 0.98, 0.92$) with gestational age. The relationships between the umbilical cord, placentome diameters and gestational age are shown in Figures 4 and 5. The derived growth equations were GA = 35.796 + 65.195 UCD and GA = 48.116 + 11.869 PD where GA is the gestational age in days, UCD and PD are the umbilical cord and placentome diameters in centimeters. The umbilical cord diameter showed significant ($P<0.01$) and positive correlation ($R = 0.77$) while the placentome diameter showed a weak positive correlation ($R = 0.45$) with foetal age.

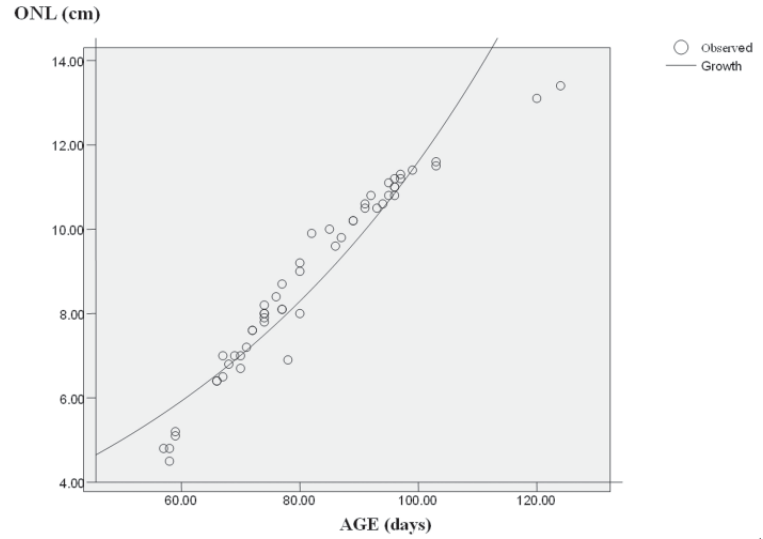

Fig. 1. Relationship between occipitonasal length (ONL) and foetal age of red Sokoto goats. Growth equation GA = 22.881 + 6.668 ONL where GA is the gestational age (days) and ONL - occipitonasal length (cm). R = 0.97.

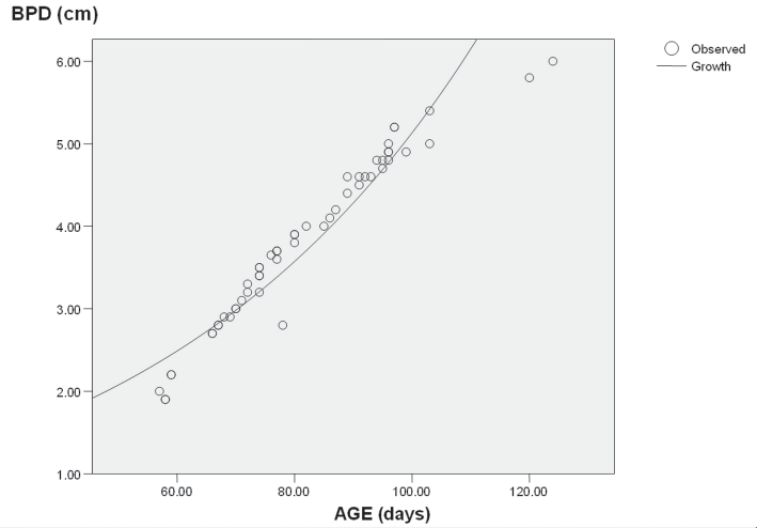

Fig. 2. Relationship between biparietal diameter (BPD) and foetal age of red Sokoto goats. Growth equation GA = 26.938 + 14.30 BPD where GA is the gestational age (days) and BPD - biparietal diameter (cm). R = 0.98.

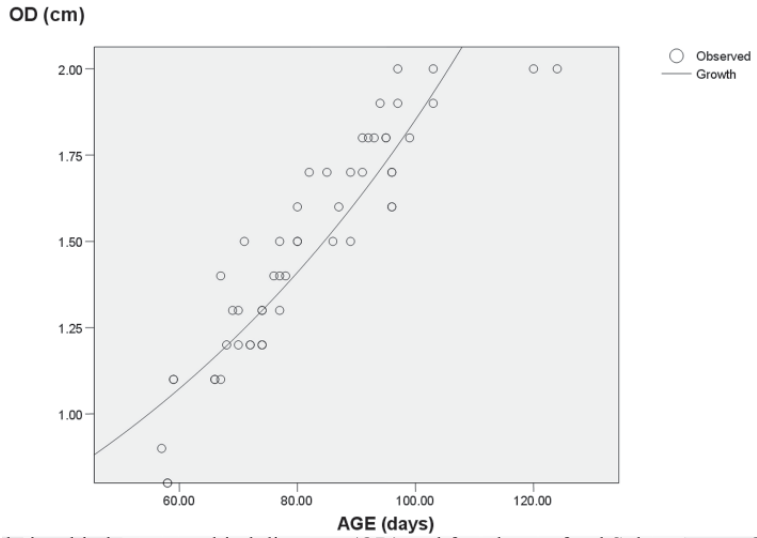

Fig. 3. Relationship between orbital diameter (OD) and foetal age of red Sokoto goats. Growth equation GA = 17.326 +43.534 OD where GA is the gestational age (days) and OD - orbital diameter (cm). R = 0.92.

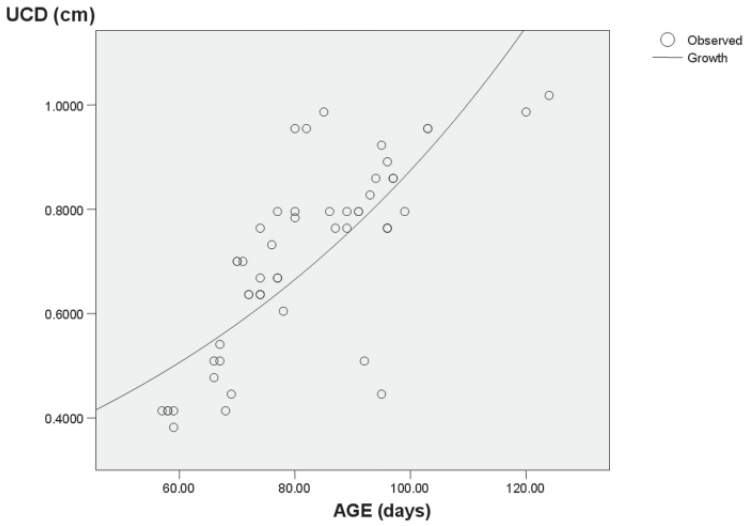

Fig. 4. Relationship between umbilical cord diameter (UCD) and foetal age of red sokoto goats. Growth equation GA = 35.796 + 65.195 UCD where GA is the gestational age (days) and UCD - umbilical cord diameter (cm). R = 0.77.

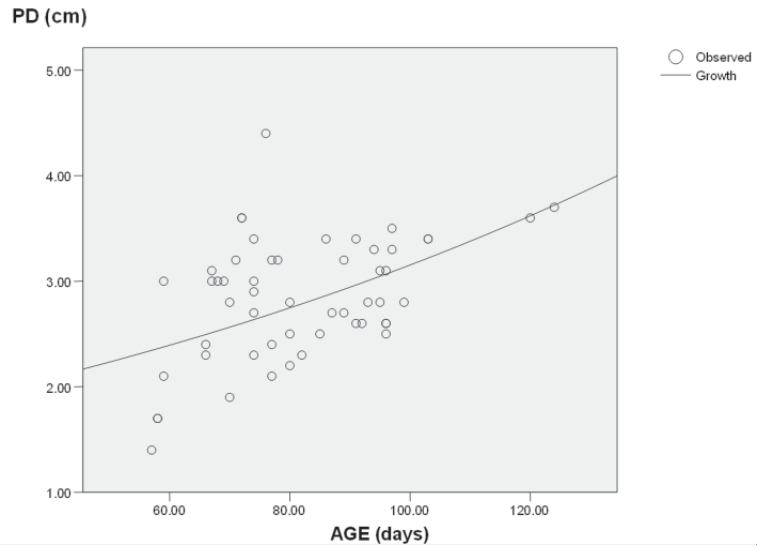

Fig. 5. Relationship between placentome diameter (PD) and foetal age of red sokoto goats. Growth equation GA = 48.116 + 11.869PD where GA is the gestational age (days) and PD - placentome diameter (cm). R = 0.45.

Discussion

This study is the first to provide baseline information on the use of head parameters and umbilical cord diameter for foetal age estimation in red Sokoto goats. The high rate of growth of the head parameters was demonstrated by the high significant correlation (R = 0.92-0.98) between these parameters and the foetal age in red Sokoto goats. The low percentage deviation of the predicted values from those observed, as evidenced by the very high values obtained for all the parameters, suggests that the relative changes in the parameters studied were adequately described by the growth curves. The prediction equations derived from them could be used in predicting foetal age of the red Sokoto goats from gestation day 57 to 124. This observation corroborates with previous reports on foetal age estimation in exotic small ruminant breeds (HAIBEL and PERKINS, 1990; SANTIAGO et al., 2005; AMER, 2007).

In the present study the umbilical cord diameter regression equation is 59.29% useful (R = 0.77). GONZALEZ et al. (1998) reported a similar correlation coefficient of R = 0.72 in Manchega sheep. The placentome diameter regression equation is only 20.25% (R = 0.45) useful as a predictor of age. This observation disagrees with the report of DOIZE et al. (1997) that placentome size could be used along with pregnancy diagnosis by

transrectal ultrasonography as an indication of gestational age from 30 to 90 days in goats (R^2 = 70.32%) but not in ewes (R^2 = 15.59%).

The correlation coefficient (R) is an indicator of the strength of the linear relationship between the gestational age and the parameters. From the growth curves it can be observed that all the points seem to lie near a line indicating that the relationship between age and the parameters are all linear. The closer the scattered points are to the best line of fit, the higher the proportion of the total variation in the data that is explained or accounted for by the regression model. The biparietal diameter is the best explained by its regression model: GA = 26.938 + 14.300 BPD; R = 0.98, while the placentome diameter is the least explained by its regression model: GA = 48.116 + 11.869 PD; R = 0.45.

The rate of percentile increment of the head parameters except the orbital diameter was somewhat uniform within the developmental period. In the present study, the age of the foetuses ranged between 57 and 124 days. Regarding the orbital diameter, the percentile increment was lowest at the early third trimester (5%), while the period when the maximum rate of growth was reached was in the late 2nd trimester (46.67%). This suggests therefore, that the orbital diameter may not be a reliable tool for estimating foetal age at later stages of foetal life in red Sokoto goats. This observation is supported by earlier reports that different organs and structures grow at different rates (OSUAGWUH and AIRE, 1987) and that the differential growth may be related to the functional importance of these organs during foetal life (RICHARDSON et al., 1976).

In conclusion, the results of this study suggest that occipitonasal length, biparietal, orbital and umbilical cord diameters can be used to estimate the foetal age between gestation day 57 and 124 in red Sokoto goats. The placentome diameter is not useful for age prediction in this breed.

References

AMER, H. A. (2007): Determination of first pregnancy and foetal measurements in Egyptian Baladi goats. Vet. Italiana 44, 429-437.

DOIZĚ, F., D. VAILLANCOURT, H. CARABIN, D. BELANGER (1997): Determination of gestational age in sheep and goats using transrectal ultrasonographic measurements of placentomes. Theriogenology 48, 449-460.

DUBEUF, J., P. MORAND-FERH, R. RUBINO (2004): Situation, changes and future of goat industry around the world. Small Rumin. Res. 52, 165-173.

GALL, C. (1996): Red Sokoto goats In: Goat Breeds of the World. Bohler Verlag. Würzburg Germany, pp. 55-56.

GARCIA, A., M. K. NEARY, G. R. KELLY, R. A. PIERSON (1993): Accuracy of ultrasonography in early pregnancy diagnosis in the ewe. Theriogenol. 39, 847-861.

GONZALEZ, B. A., M. J. SANTIAGO, S. A. LÓPEZ (1998): Estimation of foetal development in Manchega dairy ewes by transrectal ultrasonographic measurements. Small Rumin. Res. 27, 243-250.

HAIBEL, G. K., N. R. PERKINS (1989): Real time ultrasonic biparietal diameter of second trimester Suffolk and Finn sheep foetuses and prediction of gestational age. Theriogenol. 32, 863-869.

HAIBEL, G. K., N. R. PERKINS (1990): Real time ultrasonic measurements of foetal biparietal diameter for the prediction of gestational age in small domestic ungulates. Soc. Theriogenol. Newsletter 13, No 5.

IGBOKWE, C. O. (2006): Morphological studies on the development of vomeronasal organ in Red Sokoto goats. MSc Thesis. University of Nigeria, Nsukka.

KELLY, R. W., J. P. NEWNHAM (1989): Estimation of gestational age in Merino ewes by ultrasound measurement of foetal head size. Aust. J. Agric. Res. 40, 1293-1299.

KELLY, R. W., J. P. NEWNHAM, T. JOHNSON, E. J. SPEIJERS (1987): An ultrasound technique to measure placental growth in ewes. Aust. J. Agric. Res. 38, 757-764.

LEE, Y., O. LEE, J. CHO, H. SHIN, Y. CHOI, W. SHIM, W. CHOI, H. SHIN, D. LEE, S. SHIN (2003): Ultrasonic measurement of foetal parameters for estimation of gestational age in Korean black goats. J. Vet. Med. Sci. 67, 497-502.

NOAKES, D. E., T. J. PARKINSON, G. C. W. ENGLAND (2001): Endogenous and exogenous control of ovarian cyclicity In: Arthur's Veterinary Reproduction and Obstetrics. 8th ed. W. B. Saunders Co. London, pp. 51-62.

NWAOGU, I. C. (2007): Morphologial studies on the development of gastrointestinal tract in West African dwarf goats. Ph.D Thesis. University of Nigeria, Nsuklka.

NWAOGU, I. C., D. N. EZEASOR (2008): Studies on development of omasum in West African dwarf goats. Vet. Res. Commun. 32, 543-552.

NWAOGU, I. C., OKOLIE, I. P. (2009): Studies on morphological features of foetal and adult ovaries in Kano brown goats. Anim. Reprod. Sci. 115, 58-65.

OSUAGWUH, A. I. A., T. A. AIRE (1986): Studies on the estimation of the developmental age of the caprine fetus 1. External measurements and appearance. Tropical Vet. 4, 39-51.

OSUAGWUH, A. I. A., T. A. AIRE (1987): Studies on the estimation of the developmental age of the caprine fetus 2. Use of internal organs. Tropical Vet. 5**,** 53-59.

RICHARDSON, C., C. N. HERBERT, S. TERLECKI, (1976): Estimation of the developmental age of the ovine foetuses and lambs. Vet. Rec. 99, 22-26.

RUSSEL, A. J., P. J. GODDARD (1995): Pregnancy diagnosis and foetal number determination in small ruminants In: Veterinary Ultrasonography. CAB International, Wallingford, pp. 257-274.

SANTIAGO, M. J., B. A. GONZALEZ, B. A. GOMEZ, D. A. TOLEDANO, S. A. LOPEZ (2005): Prediction of gestational age by transrectal ultrasonographic measurements in the moufles (*Ovis gmelini musimon*). J. Zool. Wildl. Med. 36, 457-462.

SERGEEV, L., D. O. KLEEMANN, S. K. WALKER, D. H. SMITH, T. I. GROSSER, T. MANN, R. F. SEAMARK (1990): Real time ultrasound imaging for predicting ovine foetal age. Theriogenol. 34, 593-601.

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NWAOGU, I. C., K. O. ANYA, P. C. AGADA: Procjena dobi ploda u crvenih Sokoto koza (*Capra hircus*) pomoću ultrazvučnih mjerenja različitih pokazatelja. Vet. arhiv 80, 225-233, 2010.

SAŽETAK

Provedena su ultrazvučna mjerenja okcipitonazalne dužine (OND), orbitalnoga promjera (OP), biparijetalnoga promjera (BPP), promjera placentoma (PP) i promjera pupčanoga tračka (PPT) plodova crvene Sokoto koze poznate gestacijske dobi (GD). Rezultati su bili analizirani pomoću jednostavne linearne regresije. Izvedene jednadžbe za predviđene dobi bile su GD = 22,881 + 6,668 OND, GA = 26,938 + 14,300 BPP, GA = 17,326 + 43,534 OP, GA = 48,116 + 11,869 PP, GA = 35,796 + 65,195 PPT gdje je GD gestacijska dob u danima, OND - okcipitonazalna dužina, BPP - biparijetalni promjer, OP - orbitalni promjer, PP - promjer placentoma i PPT - promjer pupčanoga tračka u cm. Dob plodova kretala se od 57 do 124 dana. Koeficijent korelacije (R) između okcipitonazalne dužine (R = 0,97), biparijetalnoga (R = 0,98), orbitalnoga (R = 0,92), i promjera pupčanoga tračka (R = 0,77) te gestacijske dobi bio je značajno velik (P<0,001). Promjer placentoma bio je u niskoj korelacije (R = 0,45) s gestacijskom dobi. Rezultati upućuju na zaključak da se okcipitonazalna dužina, biparijetalni, orbitalni i promjer pupčanoga tračka mogu rabiti za procjenu dobi ploda u crvenih Sokoto koza, dok promjer placentoma nije od koristi za određivanje dobi plodova.

Ključne riječi: dob, plodovi, koze, pokazatelji glave, pupčani tračak