POSTPARTUM UTERINE AND OVARIAN CHANGES AND THE EFFECT OF OESTRUS SYNCHRONIZATION ON REBREEDING IN THE SAVANNA BROWN GOAT

BY

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CERTIFICATION

This thesis by Mohammed Umaru Kawu entitled *"Postpartum uterine and ovarian changes and the effect of oestrus synchronization on rebreeding in the Savanna Brown Goat"* meets the requirements for the award of the degree of Master of Science, Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

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I hereby declare that this thesis has been written by me and that it is a record of my research work. This work has not been presented for any other higher degree programme. All quotations are indicated and the sources of information are specifically acknowledged by means of references.

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DEDICATION

This work is dedicated to my parents, my wife, Rahina and daughters (Ummi-Salma and Fatima-Zahra) and to all who are still in the business of research despite the harsh weather.

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A B S T R A CT

The study was designed to determine: (i) gross and histological changes in the uterus and ovaries between d24 to d32 postpartum (pp); (ii) pp interval to resumption of ovarian activities and conception (iii) and effect of time of oestrus synchronization on rebreeding in the Savanna Brown (SB) goat.

Eight multiparous SB goats (n=2 per group) were slaughtered on d24, d26, d28 and d30 to 32 pp in order to determine gross and histological changes in their genitalia between d24 to 32 pp. The uterine horns showed symmetry of shape and size (length, diameter, and circumference)' during this period. The caruncles were convex-shaped and light brown in colour. A few caruncles were blood- tinged between d24 to 26 pp. The mean (± SEM) weight of the entire uterus was 30.20 ± 9.93g at d24 pp. A slight decrease in uterine weight was recorded at d26 and d28 pp. This was followed by a an increase in the uterine weight to 36.75 ± 7.73g at d30 to 32 pp. The mean distance of the intercaruncular space in both uterine horns at d30 to 32 pp was significantly longer ($P < 0.05$) than at d24 pp. This distance in the left uterir.e horn

was significantly shorter ($P < 0.05$) on d24 pp than at d26 and d30 to 32 pp. The mean length of the left oviduct at d30 to 32 pp was significantly longer ($P < 0.05$) than at d26 pp. Except in a few instances, there was a slight increase in the mean length, diameter and circumference of the uterine horns from d24 to 32 pp. Re-epilialization of the caruncles, intercaruncular space and maternal crypts was complete between d24 and 32 pp.

In general, larger numbers of secondary and tertiary follicles were recorded from both ovaries from d28 and 32 pp. More primary follicles were observed from d24 to d26 pp . The mean weight of the right ovary at d28 pp was significantly greater ($P < 0.05$) than at d24 and d26 pp. The diameter of the largest follicle in the right ovary at d28 pp was significantly wider ($P < 0.05$) than at d26 pp. The number of tertiary and secondary follicles in the right ovary at d30 to 32 pp were significantly more ($P < 0.05$) than at d26 pp. The weight of fluid in all follicles of both ovaries at d28 pp was significantly heavier ($P < 0..05$) than in the other interval groups.

Too few corpora lutea were observed grossly and mainly at d26pp. Histologically, large numbers of primary, growing

and tertiary follicles were observed in ' all the pp interval days studied. In contrast to the gross observations, more growing and mature corpora lutea were seen histologically between d.24 to 32 pp.

The first pp oestrus in the multiparous SB goat (n=5) occurred at 19.5 ± 2.50 days pp, while the rebreeding interval averaged 40.50 ± 1.50 days. Conception rate at the first and second pp oestrus was 0. and 100%, respectively. Based on progestrone (P_4) profile. (n=20), resumption of ovarian activity occurred around d5pp.

Following oestrus synchronization with Syncro-Mate-B (SMB) at d21, d28 and d35pp (n=5 per group) , 14 out of the 15 animals exhibited oestrus within 24.0 - 33.(3 hours post-synchronization. The overall conception rates per group were: 75%(d21), 80%(d28), and 100%(d35), respectively. The mean (±SEM) rebreeding interval per group were: 48.33+0.33 , 47.27+5.12 and 53.80±5.53 days, respectively.

From the general and specific findings of this study the following conclusions were drawn:

I. Uterine involution in the SB goat is complete by d24 pp. Thereafter an increase in most uterine parameters

occurred between d24 and 32 pp. Postpatum ovarian activity occur more in the right than the left ovary
between d24 and 32 pp.

2. The first pp oestrus, in multiparous SB goats could occur as early as 19.5 days pp, while the rebreeding interval averages 40.5 days. Fertility at the first pp oestrus is compromised, but improved at the second pp oestrus. Based on P4 profile, resumption of ovarian activity in multiparous SB goats could commence as early as d5 pp.

3. The rebreeding intervals of 47 to 53 days achievable with SMB synchronization is capable of reducing the kidding interval of 222 days to 200 days. Postpartum synchronization with SMB is capable of achieving good oestrus and conception rates. Fertility following SMB synchronization increases with increasing pp interval from the commencement of the synchronization.

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LIST OF ABBREVIATIONS

A.B.A	Animal breeding abstracts
AI	Atificial insemination
CAP	6-Chloro-delta^{6}-17-acetoxyprogesterone
CL	Corpus luteum
d	Day
FGA	Fluorogesterone acetate
FSH	Follicle stimulating hormone
GnRH	Gonadotrophin releasing hormone
HCG	Human chorionic gonadotrophin
hr	Hour
LH	Luteinizing hormone
MAP	6-alpha-Methyl-17-alpha-acetoxyprogesterone
MGA	Melengesterol acetate
P_4	Progesterone
PMSG	Pregnant mare serum gonadotrophin
PP	Postpartum
SB	Savanna Brown goat
SMB	Syncro-Mate-B
WAD	West African Dwarf goat

CHAPTER 1

INTRODUCTION

Small ruminants are produced to supply meat, milk and skin (David- West, 1985). Goats and sheep are important in all ecological zones (arid, semiarid, subhumid, highland) and all types of agricultural systems (small holder mixed farming, agropastoral, pastoral, urban, commercial ranching) in tropical Africa Tropical Africa contains one-third of all the world's goats and one-sixth of its sheep, and on the average there is one goat or sheep on every 10 hectares of tropical Africa. Sheep and goats are equivalent, in weight terms, to about 17% of the total domestic ruminant biomass (DRB) of tropical africa, with approximately 1.1 head of goats and sheep per person employed in the agricultural sector (Wilson, 1991).

Nigeria is endowed with 13.9 million catlle, 34.5 million goats, 22.1 million sheep, 3.4 million pigs and 104.3 million poultry (RIMS Report,1992). In most parts of the country, particularly in rural Nigeria, goats are important sources of meat.

The recent downturn in the economy of most African countries, including Nigeria has further worsened the already precarious position of protein supply to the populace, especially in the rural areas. This situation

has also necessitated a shift in the meat consumption habit of the sophisticated urban populace, due to the high cost of beef. Urban elites now own backyard goat and sheep flocks to supplement fish and beef as protein sources.

One important way to meet this growing demand for animal protein on a sustainable basis is to develop an intensive goat production industry, involving oestrus synchronization, twice yearly kidding and feedlot fattening of kids in Nigeria. It is, therefore, desirable that information on the reproductive performance of goats be provided to support this emerging industry.

One of the factors that could retard the emergence of a profitable goat production industry in Nigeria, is a prolonged postpartum (pp) anoestrus, which in the Savanna Brown (SB) goat has been reported to contribute to its long kidding interval of approximately 222 days (Molokwu and Igono, 1978). To achieve a twice yearly kidding, this interval has to be reduced through manipulation of the physiological activities occurring during the pp period. Such physiological activities include resumption of ovarian functions and uterine involution. In order to effectively manipulate these activities, information on the normal changes is

desirable. In an earlier study of uterine involution in primiparous SB goat, Fasanya et al.(1987) reported that re-epithelialization of the uterine caruncles and by implication uterine involution was complete between day (d) 24 and d28 pp, while resumption of ovarian activity occurred at 48 days pp (Fasanya et al., 1992b). Like the Yankasa sheep (Osinowo, 1982; Osinowo and Ekpe. 1985), to achieve twice yearly kidding, the SB doe must be rebred within 33 days postpartum. Molokwu 1983) had suggested 23 days pp as the earliest rebreeding period for the SB doe. While successful oestrus synchronization has been reported in the SB doe (Ogunbiyi et al.,1980; Alemede and Fasanya, 1996), its use to facilitate early rebreeding and twice yearly kidding has not been documented.

Therefore, any effort to rebreed the SB goat through oestrus synchronization around the period of completion of uterine involution and resumption of ovarian activity, will in effect provide a useful linkage between the information already available about its reproductive potentials and the use of oestrus synchronization to enhance those potentials. Hence, this study was designed to achieve the following objectives:

1.To determine the gross and histological changes of the uterus and ovaries between d24 and 32 pp.

2.To determine the pp interval to resumption of ovarian activities and conception.

3. To determine the effect of time of oestrus synchronisation on rebreeding in the SB goat.

CHAPTER 2

LITERATURE REVIEW

2.1 Postpartum Interval to Oestrus

The endocrine events associated with the occurrence of the first postpartum (pp) oestrus include:(i) increased episodes of Luteinizing hormone (LH) secretion, (ii) short-lived (2 to 4 days) secretion of progestrone (P_4);(iii) pre-oestrus secretion of oestradiol-17Beta followed by; (iv) ovulatory surge of LH. The roles of prolactin, cortisol and estrone are not clear (Humphrey et al., 1983).

The occurrence of oestrus within a few hours (15-27 hrs) in grade Rambouillet ewes have been reported (Gardner et al.,1955; Baker and Wiggins, 1964a; Smith, 1966). It also appears that ovulation does not occur in association with these immediate pp heat periods and therefore mating during such a heat will obviously be infertile (Hunter, 1968a).

Baker and Wiggins (1964a) also reported that ewes having an immediate pp heat exhibited a second oestrus earlier (61 days) after lambing when compared to ewes not having an

immediate pp heat (73 days). Reports on the Romanov sheep in Russia and some English breeds have indicated that first pp heat occurred at an average of 30-40 days and 44 days, respectively (Gerasimov, 1957; Gordon, 1958b;). Nel and Pretorius (1968) had also reported interval to first pp oestrus to average 23.5 days in a flock of grade Karakul ewes. Among a flock of Corriedale ewes, Rubianes et al. (1996) recorded interval to first pp oestrus of 59.8±4.2 and 53.3± 4.8 days, for suckled and weaned ewes, respectively.

At Shika, Nigeria, Osinowo and Ekpe (1985) reported an immediate pp heat within 24hrs after lambing in 8 of 16 Yankasa ewes and first pp oestrus (after the immediate pp heat) at an average of 34.3±1.6 days (ranges 8-64 days). In the West African dwarf(WAD) sheep of southern Nigeria, Orji and Steinbach (1980a) reported a pp anoestrus duration and oestrous cycle length of 54.90 and 17.27 days, respectively. Based on pp progestrone concentrations, Akinpelumi et al. (1998a) also observed that silent heat occurred at 8.2 days in Yankasa ewes, while behavioural oestrus occurred at 42.9 days pp. In local goats, intervals to first pp oestrus of

20.1±6.9 and 83.5 days have been reported for the SB and WAD goat, respectively (Otchere and Nimo, 1978; Molokwu, 1982). Kirpatrick and Akindele (1974) had also reported a pp anoestrus of 37.5 (range 13-62) days in WAD goats. In the East African and Galla goats, Bradford et al. (1989) reported intervals to first pp oestrus of 68 and 77 days, respectively.

In cattle, Olds and Seath (1953) reported a pp oestrus interval of 32.1±18.6 days in a herd of Holstein cattle (n=210), with significantly wide variation between cows. Similarly, Buch (1955) reported PP interval to first oestrus to average 33 days in Holstein - Friesians (n=322). Saiduddin et al.(1968) also reported non-standing heat during the first 20 days after calving in 64% of 62 dairy cows. This proportion decreased markedly after the first 20 days postcalving, indicating that the cows tend to exhibit a low degree of oestrus behaviour when interval to first oestrus is short. Similar oestrous observations and P4 profiles of 50 dairy cows indicated that 48% of the animals

showed at least one silent pp oestrus and 27% of 110 oestrous cycles were apparently silent (Wiel et al., 1979).

Among tropical cattle breeds, first pp oestrus is usually observed at a much later period than in the temperate breeds. Kohli and Suri (1957) and Dawuda et al.(1988) have reported first pp oestrus to occur at 222 ± 3.9 and 137.6±4.1 days in the Hariana (India) and Bunaji (Nigeria) cows, respectively. In contrast, Rojas et al.(1969) and Donkin (1980b) reported first pp oestrus at 36 days and 49±23.4 days in Phillipine and Zimbabwean (*Friesland* cows) cows, respectively. In a similar report, 61 primiparous (*Bos taurus* and *Bos indicus*) cows showed first pp oestrus at 56±32 days (Iglesia et al., 1992).

In mares, immediate pp oestrus ("foal heat") has been reported to occur from day 5-13pp (Aehnelt and Plas, 1946) and also from 1-10 days pp (Mahaffey, 1950). Similar observations were made among 18 local mares and 6 Arab-Barb mares in Senegal, where pp oestrus intervals of 11.8 and 8.8 days were reported for the two breeds respectively. Baker

et al. (1953) reported a pp oestrus duration of 2.82 days in sows, occurring 1-3 days after farrowing in 58.6% of 29 sows; 2.82 days duration in 8-12 days after farrowing in 75-90% of the sows. Oestrus accompanied by ovulation has been reported to occur shortly after parturition in the rat, Guinea pig and rabbit (Hammond, 1925; Boling et al., 1939; Blandau and Soderwall, 1941)

2.2 Postpartum Interval to Ovulation and Corpus Luteum Formation

In domestic animals, the first pp ovulation occurs in most cases without a corresponding behavioural oestrus. Miller and Wiggins (1964) reported that silent ovulation occurred without oestrus within 20-68 days in a flock of 5-6 year-old lactating Rambouillet ewes. Postpartum intervals to ovulation in Ile-de-France ewes have been reported to occur at an average of 20-60 days pp, with more than 60% of the ewes having their first ovulation within 25 days of lambing (Mauleon and Dauzier, 1965). Contrary to the aforementioned studies, Rubianes et al.(1996) did not observe the presence of corpora lutea (CL) (indicative of recent ovulation) among

a flock of Corriedale ewes laparatomised at either d17 or 30 pp. However, an earlier study by the latter author, indicated the occurrence of ovulation on d18 and 25 in 2 of 3 Corriedale ewes (Rubianes and Ungerfeld, 1993).

Rectal palpations in a herd of 125 cows indicated that the first ovulation occurred at 28.2 days with 19.2% and more than 80% of the cows ovulating at 3 weeks and 35 days, respectively. Of the ovulating cows, more than 30% did not show overt oestrus, and the interval between first and second ovulations averaged 23.6 days (Schilling, 1976). Similarly, of 213 first ovulations in 62 Holstein cows, 46.5% occurred without detected oestrus activity and of the remaining 114 first ovulations, 32.5% were accompanied by standing oestrus (Saiduddin et al., 1968). Observations in a Holstein - Friesian herd at 10-50 days pp indicated that 62% of the cows had ovulated by 28 days pp, and 68-69% by 39-40 days pp (Tennant, 1967).

Morrow et al. (1968) reported an interval of 3.7 days between the first and second pp ovulation in high yielding

dairy cows, which was significantly shorter than the interval from the second to the third ovulation. Also the post-gravid involuting uterus did not exert a unilateral influence on the interval to first pp ovulation and the length of the subsequent oestrus cycle. However, a bilateral carry-over effect early in the pp period was observed to shorten the interval from the first to second ovulation. In a related study, Marion and Gier (1968) observed that when the postgravid horn was on the right, 92% of the ovulation at 11-15 days postcalving occurred from the opposite ovary, and this tendency persisted to a lesser degree until the postgravid horn had regressed to near normal. Donkin (1980a) reported a similar finding in the Zimbabwean *Friesland* cows, where 62% of postcalving ovulations and more distinct CL occurred in the right than in the left ovary. The study also reported an interval to first pp ovulation of 41±20.8 days; first pp ovulation with oestrus, 58±23.0 days; and interval between ovulations, 25 days. In another aspect of the later study, 64% of the first pp ovulations among a herd of 406 occurred without behavioural oestrus, compared to 48% in subsequent cycles with 42% of the ovulations being

accompanied by the formation of an ill-defined CL. In subsequent cycles the percentage of postpartum ovulation was 29% (Donkin, 1980c).

2.3. Postpartum Interval to Uterine Involution

Uterine involution implies the time required for the recently pregnant uterus to resume the condition in which fertilisation, nidation and embryonic development can proceed (Hunter, 1968b). This factor is thought to impose a significant limitation to the frequency of pregnancy in livestock, especially when periparturient diseases intervene. The uterus is usually considered involuted when it has returned to its normal non-pregnant position, and when the two horns are similar in diameter and showing normal consistency and tonus (Anon, 1968).

Histological examination of the uteri of 3 ewes, 1 each on d22, 26 and 30 indicated that except for the blood vessles, the glandular mucosa and cotyledons had completely involuted (Uren, 1935). The presence of considerable amount of blood and cellular debris has been reported in sheep within 4-6

weeks pp (Robinson, 1957; Heap et al., 1963). Zourgui and Elze (1976) studied the macroscopic measurements of 9 primiparous mutton Merino ewes and estimated that uterine involution is complete between 20-24 days pp. In general uterine involution in sheep is thought to be completed by d17-30pp (Call et al., 1976; Rubianes and Ungerfeld, 1993).

For the SBG, Fasanya et al.(1987) had observed that caruncular re-epithelialization as an indication of uterine involution begins by d20pp and is completed by d24-28 pp. The uterine parameters decreased appreciably until d16 pp and thereafter the decrease was gradual and by d28-32 pp the means of these parameters were similar to those of the non-pregnant does slaughtered 3 days postoestrus. Rubianes and Ungerfeld (1993) made a similar observation among the Corriedale ewes. They reported that uterine weight and length of uterine horns decreased ($P<0.01$) during the first 17 days and then remained constant, and on d17 and d30, no difference was observed between experimental and control cyclic ewes in uterine parameters.

Early studies of pp uterine involution in cattle involved rectal palpation of the uterus at intervals ranging from a few days to approximately 2 weeks (Anon, 1968). Though there were variations, most earlier data indicate that the major portion of uterine involutionary process in a cow is completed in the first 3 weeks following parturition, and the reduction in uterine size is minimal following the 4th week pp. Except in cases of endometritis, there is no significant relationship between fertility and the involutionary status of the uterus of normal cows (Tennant and Peddicord, 1968). In Herefords, uterine involution is reported to be completed between 46 to 47 days pp (Buch et al., 1955; Foote and Hunter, 1964; Foote and Saiduddin, 1964). Similar intervals to uterine involution of 45.1 and 47 days have been reported for a herd of Holsteins and Holstein-Friesians, respectively (Buch,1957; Higaki et al., 1959).

Changes in the uteri of 57 clinically normal pp dairy cows were studied by Gier and Marrion (1968). They reported a rapid decrease in the dimensions of the postgravid horn

during the first few days pp, re-epithelialization of the caruncular surface by d25pp, continuous shrinking and reduction in the size of the postgravid uterus until it reached a pregravid size by d40-50 pp. In contrast to the latter, sloughing of caruncular tissue and the initiation of caruncular re-epitheliazation in the Bunaji (Zebu) was observed as early as d10pp and completion of uterine involution by d20 to 25pp (Eduvie et al., 1984). Dawuda et al. (1988) had also reported completion of uterine involution by 35.5±9.7 days pp in the same breed, while Denis and Gachon (1974) reported an involutionary interval of 29 ± 1.0 days for the Senegalese Bunaji.

Records of twice weekly palpations in 415 Friesland cows in Zimbabwe indicated two phases of uterine involution; the first being more rapid and marked than the second; and an average interval to completion of uterine involution of 28± 10.1 days. Also uterine involution significantly affected the number of ovulations with oestrus occurring in the first 100 days pp (Donkin, 1980a; 1980d). This has been attributed

to the depressing effect of endometritis on uterine involution and pp fertility (Tennant and Peddicord, 1968).

Conception rates in a herd of Hereford and Angus cows (n=255) indicated that cows in which first breeding occurred prior to involution of the uterus were more fertile at the second breeding, that is, after completion of the involutionary process (Perkins and Kidder, 1963). In a similar finding, Matveev (1970) reported that AI in 108 cows prior to the completion of uterine involution and after completion in 45 cows resulted in conception rates of 18.5 and 88.8% and average service periods (SP) of 81 and 41 days, respectively. Histological biopsies of the uterus of some cows also indicated that d60pp was a more favourable time for implantation of the fertilised ovum than at 21, 30 or 45 days pp (Perkucin et al., 1964).

Some studies in buffaloes have reported intervals to completion of uterine involution of 29.8±0.73 (Bhalla et al., 1966) and 32.9±8.2 (Perera et al., 1987) days, respectively. Haase et al. (1977) also reported an enhancing

effect of transportation on uterine involution among newly calved Murrah buffaloes. The time required for uterine involution averaged 21.85 and 26.42 days in the transported (n=59) and non-transported buffalo cows (n=73), respectively.

2.3.1 Effect of Exogenous Hormone Treatment on Uterine Involution

The effects of hormone therapy on uterine involution is quite equivocal in most domestic species. In one study, lactating autumn lambing ewes either received no treatment, or were given 20 mg P4 on alternate days between 5 and 17 days pp, with or without additional oestradiol and/or pregnant mare serum gonadotropin (PMSG) treatments (Foote et al., 1967). Neither the treatments, the time of involution, nor the number of gravid horns had any effect on uterine involution or histology, and the uterine involution appeared to be complete by d24 pp. Similarly, Wyk et al.(1972) reported no significant effect of early weaning and oestradiol treatment on uterine involution in a flock of primiparous Merino and Karakul ewes.In cattle, Cameron and

Fosgate (1964) reported intervals of 41.0 and 42.7 days, respectively to completion of uterine involution in lactating Holstein and Jersey cows, injected with 200 or 150 U.S.P. units of oxytocin for 42 days and in untreated controls. In a related study, neither ovariectomy nor physiologic levels of oestradiol-17Beta (administered throughout the involutional interval) significantly influenced uterine involution of either intact or ovariectomised cows, but the administration of 30 mg of P4 each day significantly increased the involution interval in both intact and ovariectomised cows (Marion et al., 1968). Similarly, Britt et al.(1972) had observed no significant difference in uterine dimensions between control and melengesterol acetate (MGA) or MGA plus oestradiol treated postcalving Holstein cows during the involution process. Although the diameter of the largest uterine horn decreased until 7 weeks pp, this was not significant among treatment groups. However, a temporary plateau in the diameter of the largest uterine horn in cows treated with MGA during the week after treatment was observed. Also no significant differences in uterine involution was observed in the

Friesland cows of Zimbabwe, fed 180mg methyl acetoxyprogestrone (MAP) (for 20 days, from day d15pp) when compared to untreated controls (Donkin, 1980e).

In contrast to the later studies, Foote and Hunter (1964) reported a significant decrease in pp intervals to uterine involution, oestrus and ovulation in a herd of pluriparous Hereford cows treated with P_4 injections, a single dose of oestrogen injection, and a combination of these treatments.

In mares, Sexton and Bristol (1985) had observed that treatment with 150 mg P_4 and 10 mg oestradiol-17Beta (commencing within 18hrs pp) resulted in significantly greater uterine gland proliferation and density, and also increased interval time required for uterine involution in the early pp period, which might enhance fertility. In contrast, Arrot et al.(1994) did not observe any difference in the mean values for measures of uterine involution between quarterhorse mares treated with 100 mg oestradiol-17Beta (begining at 'foal heat') and untreated controls.

These conflicting reports indicate that the stimulatory effect of ovarian hormones is not exactly unequivocal.

2.3.2 Effect of Lactation and/or Weaning on Uterine Involution

Riesen et al. (1968) studied the effect of suckling on the completion of uterine involution in a herd of dairy cows. The study showed that the rate of uterine involution was more rapid in suckled than in non-suckled animals at d1 to 10 and d20 to 30 pp, respectively. This resulted in the suckled animals being nearly fully involuted by 30 days pp, while the non-suckled cows were not involuted at either 30 days pp or during the first oestrus cycle. Similarly, Lauderdale et al. (1968) observed that suckling independent of pp interval caused a decrease in the mass of the endometrium, the circular and longitudinal muscle mass of the myometrium, endometrial gland mass and lymphocute count. In the same vein, Okano et al. (1981) reported that the uterus of primiparous nursing cows had contracted and recovered its elasticity by d54pp, while the weaned cows showed only few signs of uterine involution. The correlation

between suckling and enhanced uterine involution has been attributed to, among other reasons, the contracting effect of high plasma levels of the prostaglandin $F_{2\alpha}$ metabolite, 13,14-dihydro-15-keto prostaglandin $F_{2\alpha}$ (PGFM) during the early pp period (Eley et al., 1981).

In apparent contrast to the findings of the afore-mentioned studies, Horvath (1977) observed no differences in the interval to uterine involution between suckling and non-suckling cows. Eduvie et al.(1984) also reported no significant effect of suckling on uterine involutionary process of the Bunaji (Zebu) cattle.

2.3.3. Effect of Parity, Breed and Sire-line on Postpartum Uterine Involution

Analysis of 61 service periods from 4 pairs of identical and 8 pairs of fraternal Hereford twins indicated that the interval to uterine involution was significantly shorter in the first than in the second service period (Foote et al., 1960). Jana and Mishra (1978) made a similar observation that uterine involution period was significantly less in

primiparous (32.61±0.49 days) than in pluriparous cows (36.94±0.52 days). Ottenacu et al.(1983) also reported early involution of the cervix after calving in primiparous than in multiparous cows. Jana and Mishra (1978) also reported involution intervals of 34.89± and 23.91±0.30 days for the gravid and non-gravid horns, respectively in a herd of *Bos indicus* and *Bos taurus* cows, and their crosses. The number of days required for the involution of the gravid horn was highly significant in pluriparous cows within breed groups.

Menge et al.(1962) reported that inbred cows had significantly earlier uterine involution period than outbred animals (39.6 vs. 45.0 days). Choudhury et al.(1974) also observed for a herd of Holstein Friesian x Haryana primiparous cows that sire influence was significant on the time required for the completion of uterine involution. In the Black and White breed (*Bos taurus*), uterine involution was observed to be completed on the average by 32.33±8.42 days pp and the uterine diameter on the last day of involution was 3.73±0.64cm, which was significantly smaller

in high milk producers and primiparous cows (Ambrozic et al., 1994).

Involution or regression of the CL of pregnancy in cows had been reported to occur in less than 10 days pp and also between d10-17 (Matveev, 1967). Wagner and Hansel (1969) also reported the degeneration of the CL of pregnancy by d7 pp in cows. Morrow et al.(1968) rectally palpated 110 high producing dairy cows and reported that the CL of pregnancy regressed rapidly during the early pp period and was usually not palpable by d14pp.

2.4.1 Postpartum Interval to Breeding and Conception

Rebreeding interval is the period from parturition to the next successful breeding and conception, and it is also referred to as the service period. In order for ewes to lamb every 6 months the rebreeding interval must be 33 days or less (Osinowo and Ekpe, 1985). The best lambing and kidding crops achieved in both temperate and tropical breeds is 3 in 2 years. This may be because most temperate breeds are seasonal breeders, and the usually low reproductive performance in the tropics due to poor nutrition and disease

burden. Schalk (1963) reported 8 ewes lambing in the second half of December that were remated the following February while still lactating, and in July gave birth to 10 full-term lambs. A study of 150 Ile-de-France ewes first mated in April - May produced 177 lambs; remating for the second time between October and November produced 148 lambs, and resulted in an average of 2.1 lambs per ewe per year when compared to the normal flock average of 1.5 (Bigotte, 1963).

Ranges of pp interval to conception have also been reported for various other sheep breeds such as Karakul x Fur-milch ewes in the former USSR (5-79 days), Rambouillet ewes in the USA (8-253 days) and Karakul ewes in Namibia (15-89 days) (Hunter, 1968a). For Romonov ewes rebreeding intervals of 20-50 days have been reported with the shortest interval occurring after October lambings (Tchamitchian et al., 1973).

Osinowo and Ekpe (1985) reported parturition to conception interval of 42.5±1.5 days in the Yankasa sheep. The pattern of pp conception was 8.2% (1-4 weeks pp), 80.3% (5-8 weeks pp), and 11.5% (9-12 weeks pp). Akinpelumi et al.(1998a) also reported rebreeding interval of 42.5 days in the

Yankasa at the same location, Shika, Nigeria. A few of the ewes though, conceived at about 33 days pp, and hence the study concluded that twice-yearly lambing is possible in the Yankasa. Sahni and Roy (1972) had reported an average rebreeding interval of 31 days pp in the Bilkaneri ewes of India, and a similar pp conception pattern as in the Yankasa (8.7% occurring within 22-50 days pp; 43.6% within 51-150 days pp; 27.1% within 151-250 days pp; and 21.70% within 250-300 days pp). Restall et al.(1977) observed a similar pattern of low fertility rate in a flock of Merino ewes (< 70%) until 30 days pp, which improved in later matings to approximately 30%.

The analysis of a 4 year reproductive record of 44 WAD goats showed that 65% of them kidded twice a year, 12.5% once per year and 12.5%, three times in 2 years (Oppong and Yebuah, 1981). For the Malaya goat and the Indian Barbary goat, kidding to conception intervals of 30-40 and 54.25±2.56 days, respectively have been reported (Paramsoothy, 1957; Prasad and Pandey, 1982).

In cattle, like in most domestic species, fertility improves with increasing pp interval. Reproductive records of a herd

of 7071 cows at the first, second and third 20-day pp intervals showed conception rates of 20.8%, 37.7% and 51.0%, respectively (Shannon et al., 1952). The study concluded that a minimum interval of 50 days post-calving to first insemination was required for satisfactory fertility. A related finding was made amongst 1233 calvings of 515 Holstein-Friesians, Jerseys and Guernseys, where calving rate of 65.0% was obtained after service at 71-85 days pp, irrespective of the breed (Bower and Merilan, 1958). Analysis of reproductive data on 255 service periods of purebred Hereford and Angus cows indicated that conception to first service pp was significantly higher for cows bred 79 days pp or later than for cows bred at a shorter pp interval (Perkins, 1963). In a similar report, Saiduddin et al.(1968) observed that Holstein cows bred at the first pp oestrus had a fertility rate of 46.5%, while those bred at the first oestrus after 74 days had a fertility rate of 69.0% ($P < 0.005$). Whitmore et al.(1974) also reported lower fertility in cows bred at the first pp oestrus, when compared to those bred at first oestrus following the 74th day pp.

Richards (1946) reported service periods of 83 and 161 days for the White Fulani and Shuwa Zebu cattle breeds, respectively. Sada (1968) reported larger service period intervals of 184.2, 168.1 and 100.1 days for the N'dama, West African Shorthorn and Sokoto Gudali cattle, respectively.

Data on 1,648 oestrous cycles of 202 mares in Portugal revealed that of the females mated during 'foaling' oestrus (that is, within 8 days of foaling), 30.7% conceived versus 44.1% of those mated more than 24 days pp and 32.5% in those that had not foaled the previous year (Cannes-Simoes and Nunes-Duarte, 1963). A related study of 336 oestrus cycles in 182 Thorough bred mares showed that 60% of the mares exhibited oestrus within 14 days of foaling and of these, 46% conceived at this oestrus, and of the 72 mares which did not exhibit foaling heat, 57 came into oestrus 20-30 days after parturition, and 15 developed anoestrus (Du plessis, 1964).

2.4.2 Oestrus Synchronisation in Goats

In temperate sheep and goats, the most commonly used methods for the control and manipulation of the breeding season for

many years is the sponge (progestogen - impregnated pessary). In recent years, the sponge technique has become more refined and better understood and utilised (David, 1985). In the goat milk industry of the United Kingdom, progestogen sponges have been used to achieve: (1) batch kiddings to ensure even milk supplies; (2) early and late season breeding to extend the milking period; and (3) out-of-season breeding to attempt to maintain milk supplies (David, 1985).

In a study of 55 mature Angora goats that were synchronized at the end of the anoestrus season, conception rates of up to 73% were reported in the does treated with melengesterol acetate (MAP) sponges plus 500 I.U. pregnant mare serum gonadotropin (PMSG) on sponge withdrawal, and also in those treated as in the later in addition to being given 250 I.U. human chorionic gonadotropin (HCG). Kidding rates of 46% were recorded for both groups, while the untreated controls recorded a conception rate of 18%. Laparotomies on 8 of the does from each group showed a high incidence of silent ovulations (Pretorius and Van Der Westhuysen, 1971). Fuenmayor et al.(1973) also reported the use of vaginal sponges impregnated with 40 mg florogestone acetate (FGA) in

25 Nubian x Criollo goats. About 65% of these goats exhibited oestrus within 48 hours (hr) of sponge withdrawal, and within 72 hr all the goats were in oestrus. The 60-day non-return rate was 95.6% and 81.8% of the does kidded, averaging 1.78 kids per goat. Similarly, Serna et al.(1978) recorded an impressive oestrus response rate of 73% in goats that were synchronized with vaginal pessaries impregnated with 20mg FGA followed by an injection of 15mg prostaglandin $F_{2\alpha}$. Breeding after the prostaglandin $F_{2\alpha}$ treatment resulted in a high pregnancy rate. Bosu et al.(1978) also reported a fertility rate of 77% in a prostaglandin $F_{2\alpha}$ - induced oestrus, and concluded that prostaglandin $F_{2\alpha}$ is luteolytic when administered to female goats at about 4 days before or after oestrus.

In a related study with SB goats synchronized with a double injection regimen (10 days apart) of 7.5 mg prostaglandin $F_{2\alpha}$, Ogunbiyi et al (1980) reported oestrus response rates of 64 and 84%, respectively, at the first and second treatments. Breeding at oestrus induced by the second injection resulted in 90% conception. The study concluded that two injections of prostaglandin $F_{2\alpha}$ 10 days apart is superior to a single

injection for oestrus synchronisation in the goat. In a related study, Alemede and Fasanya (1996) reported oestrus rates of 70 and 75%, respectively in 2 groups of SB goats injected with 7.5 mg and 10 mg prostaglandin $F_{2\alpha}$. The period of response ranged from 48-144 hr with majority of the does exhibiting oestrus within 72 hr after treatment. The study concluded that 10 mg prostaglandin-$F_{2\alpha}$ is more effective than 7.5 mg in synchronising oestrus in SB goats.

The effectiveness of natural mating or artificial insemination following oestrus synchronization in goats with progestagen- impregnated intravaginal sponges (60mg Repromap(R)) and PMSG injection at sponge withdrawal was studied by Bongso et al. (1982). Breeding at the synchronised oestrus using intact bucks or AI with frozen-thawed semen resulted in conception rates of 71 and 81%, respectively. In a similar study with Saanen goats, Karatzas (1982) reported conception rates of 27.7 and 30%, respectively, at the first synchronized oestrus for does mated naturally and by artificial insemination. These reports suggest that artificial insemination following

induced oestrus in goats is effective and viable and could be more advantageous than natural mating.

Superovulation with gonadotropins following pretreatment with progestagen has reportedly been successful in goats. Superovulation in Nubian doelings with 6 mg norgestomet ear implants and follicle stimulating hormone (FSH) resulted in 100% oestrus response rate with surgical collection of 15.1 viable embryos per doeling (Senn and Richardson, 1992). In a similar report, Krisher et al. (1994) observed a high number of ovulations when Nubian and Nubian-cross dairy goats were synchronized with Syncro-Mate-B and superovulated with FSH, augmented with gonadotropin releasing hormone (GnRH) and (or) prostaglandin $F_{2\alpha}$.

An ealier attempt at superovulation in Feral goats with 1200 I.U. PMSG in conjunction with GnRH, resulted in an ovulation rate of 91% (Cameron et al., 1988). Amstrong et al. (1982) recorded a mean ovulation rate of 2-3 follicles per doe whether PMSG was administered at the same time or 2 days before removal of the progestagen pessary. However, increasing the dose of PMSG has been reported to increase

the ovulation rate in non-lactating goats and to advance the time of ovulation (after progestagen removal) in lactating and non-lactating does (Ritar et al., 1984). In the Nigerian WAD goat, ovulation rate has been reported to average 1.57 ova per doe follwing prostaglandin $F_{2\alpha}$ induced oestrus (Akusu et al., 1986). Feed restriction in goats synchronized with prostaglandin $F_{2\alpha}$ tended to delay the onset of oestrus, lower the ovulation rate and incidence of multiple ovulations and pregnancy rate (Mani et al., 1992). It is clear from the aforementioned reports therefore, that using the right hormone dose and feeding level, impressive oestrus, ovulation and conception rates can be achieved in synchronized goats. This is particularly true under good management system.

CHAPTER 3

MATERIALS AND METHODS

3.1 Experimental Animals

3.1.1 Group 1

Eight multiparous Savanna Brown (SB) goats purchased from local markets around Zaria were used for this phase of the study. Their ages ranged from 2.5-3.5 years and they weighed between 15-25kg.The animals were kept for a 6-week observation period during which they were fed *ad libitum* with hay and maize offal. Strategic prophylactic antihelmintic treatment was administered to the animals at the begining and the end of the rainy season. During this period, no buck was allowed to run with the does.

After the 6-week observation period, an aproned buck was used to check for oestrus twice daily, at 9:00a.m. and 5:00p.m. Animals that exhibited oestrus were isolated and bred by a fertile buck. The animals that showed oestrus were allowed to run with the bucks until they were out of heat. The animals were allowed to graze freely throughout

the period of oestrus detection, breeding and during the postpartum period until slaughter (Fasanya et al., 1987).

3.1.2 Group 2

A total of 40 multiparous Savanna Brown (SB) goats weighing 15-25 kg and aged 2.5-3.5 years were used for this phase of the study. The animals were provided by the Small Ruminant Research Programme of the National Animal Production Research Institute (NAPRI),Ahmadu Bello University, Shika, Zaria. The experiment was carried out between the months of May and September, at Shika,Zaria (latitude:11° 12'N, longitude:7° 33'E and altitude:610m). The animals were grazed for 6 to 8 hours daily on improved pasture (*Digitaria* , *Chloris*, and *Bracharia* species) with a daily supplementary concentrate ration of about 15% crude protein fed at the rate of 300g/head/day. Strategic prophylactic antihelmintic treatment was administered to the animals at the begining and the end of the rainy season. The breeding programme for these animals involved a 2-week flushing and teasing activity. Animals that exhibited oestrus during this period were isolated and bred to fertile bucks. Immediately following parturiton, the does were randomly

alloted to the experimental subgroups described in sections 3.5.1 and 3.6.1.

3.2 Gross and Histological Changes in the Uterus and Ovaries Between Day 24 and 32 Postpartum

Following parturition, the 8 does described in section 3.1.1 were used to determine gross and histological changes in the genitalia between days 24 and 32 pp. Two does each were randomly alloted to four slaughter groups at d24, d26, d28 and d30 to 32 pp (1 animal each on d30 and d32pp). At slaughter their reproductive organs were dissected out and immediately subjected to gross observation, morphometric measurements and representative portions were fixed in 10% buffered formaline for histological examination.

3.3 Gross Observations

Immediately following slaughter and exteriorization of the genital tract, symmetry, tonicity and turgidity or oedema of the uterine horns were appraised and recorded. After dissecting the genital tract free of ligament and fat, each uterine horn was incised close to the external bifurcation, and the colour and shape of the caruncles were observed.

The presence of uterine fluid was also appraised and recorded. The cervix was incised open and the presence of locia and/or mucus were appraised and recorded. These observations were recorded as either absent (-), low (+), moderate (++), or high (+++).

3.3.1 Gross Measurements

The technique used was largely adopted from Eduvie et al. (1984). Each genitalia consisting of the uterine horns and the uterine body were weighed after the cervix had been resected.The length of each uterine horn from the external bifurcation (i.e., the site where both horns were externally joined by the intercornual ligament) to the uterotubal junction was measured, using a measuring tape. The length of each uterine horn from the internal bifurcation to the uterotubal junction was also measured. The diameter of each horn at the external bifurcation was measured and each horn then weighed after severing at the internal bifurcation. Subsequently, an incision was made on each horn as close to the external bifurcation as possible and the thickness of the wall was measured from the serosa to the endometrium. The diameter of the caruncle close to the external bifurcation was also measured. The distance

between two caruncles near the external bifurcation and in the uterine body was measured as the intercaruncular distance.

3.3.2 Ovaries and ovarian structures

The technique was adopted largely from Eduvie et al.(1985). The length, breadth and height of the ovaries were measured after dissecting them free of all ligaments, using a measuring tape. The distance between the anterior and posterior surfaces of the ovary was measured as the length of the ovary. The distance between the medial and lateral poles of the ovary and that between the attached and free borders of the ovary were measured as breadth and height of the ovary, respectively. The intact ovaries with or without ovarian structures were weighed to the nearest gram.

Follicles on each ovary were counted and the diameter of the largest follicle, taken along the longest axis, was measured. The follicular fluid from the largest follicle and the fluid from all follicles were aspirated with a hypodermic syringe and the volume was recorded. The weight of the follicular fluid from all follicles in each ovary

was determined by subtracting the ovarian weight without the follicular fluid from the weight of the intact ovary. The number of corpora lutea, corpora haemorrhagicum and corpora albicans of the ovaries were counted.

3.3.3 Histological Samples

3.4.1 Genital tract

Uterine samples for histology were taken from the dorsal surface of the uterus close to the external bifurcation. Portions of the caruncle plus uterine wall, intercaruncular wall and caruncle only were obtained from each horn.Sections of the internal os, external os and mid-cervix were collected from the cervix. Sections of the uterine body were taken at a point mid-way between the internal bifurcation of the uterus and the internal os of the cervix. All samples including the oviduct were fixed in buffered 10% formalin. The tissues were then trimmed and subjected to routine histological processing of dehydration and embedding, (paraffin waxing). Representative portions were sectioned at 3 microns and stained with haematoxylin and eosin (Lee, 1968). Serial sections were examined with light microscope and representative parts photographed.

3.4.2 Ovaries and Ovarian Structures

The ovaries were fixed for a minimum of 24 hours in Bouin's solution and processed routinely as described in section 3.4.1. Representative portions were then sectioned at 6 microns before staining with haematoxylin and eosin (Lee, 1968). Serial sections were examined with light microscope and representative parts were photographed.

3.4.3 Postpartum Interval to Resumption of Ovarian Activities and Conception

3.5.1 Postpartum Oestrus and Conception

Five of the 40 goats described in section 3.1.2 were used to determine postpartum oestrus and conception. Oestrus detection using an aproned mature buck began from d1 pp and lasted until d60 pp. Animals that showed heat by standing to be mounted were isolated and allowed to be mated by a fertile buck continuously until the end of heat. The pp period (in days) to first overt oestrus and breeding was recorded. Animals that exhibited a second pp oestrus were rebred. Animals were assumed to have conceived after a 60-day non-return period.

3.5.2 Postpartum Progesterone Profile

Postpartum serum progestrone (P_4) levels were measured using 20 of 40 goats described in section 3.1.2 above. All the 20 does were bled via jugular venipuncture begining from d1 pp and thereafter at 4 days interval until d60pp. At each bleeding, 10 ml of blood was collected. Blood samples collected were immediately refrigerated and later centrifuged at 3000 rpm. The serum was then harvested and stored at -20 °C until assayed for progestrone.

3.5.3 Radioimmunoassay (RIA) for Progesterone

A 'Coat-A-Count' Progesterone (P_4) Kit (Diagnostic Corporation, Los Angeles, U.S.A.) Supplied by FAO/IAEA. Vienna, Austria, was used to measure serum P_4. The procedure involved the addition of 100 microlitre of sample or standard to antibody coated tubes. Then 1 ml (1000 μL) of the tracer solution (^{125}I-Progesterone solution) was added to the same tubes. The tubes were then incubated for 4 hours at room temperature. Thereafter, the tubes were decanted and the bound radioactivity counted for 60 seconds, using a gamma counter. The sensitivity of the assay, defined as twice the standard deviation from the

zero standard, was 0.14 ng/ml.The intra- and interassay coefficients of variation were 6.7% and 7.1%, respectively. Progesterone concentration equal to or greater than 0.1 ng/ml was used as evidence of luteal activity (Fasanya et al., 1992a).

3.6.1 Effect of Time of Oestrus Synchronization on Rebreeding

Following parturition, 15 out of the 40 goats described in section 3.1.2were randomly alloted to 3 groups of 5 animals each for synchronization on days 21, 28, and 35 postpartum. Oestrus synchronization was carried out using the agent SYNCROMATE-B (SMB) (ceva)(R). The SMB cattle dose consisted of a 2 cm length plastic ear implant containing norgestomet (a synthetic progestin), and a 2 ml injectable solution of norgestomet and oestradiol valerate in sesame oil with 10% benzyle alcohol as preservative. Each implant contained 6.0 mg norgestomet and each 2 ml of the injectable solution contained 3.0 mg norgestomet and 5.0 mg oestradiol valerate. For the purpose of this study, half the cattle dose was used for the goats, i.e., the 2 cm ear implant was cut in half (1 cm in length) containing approximately 3.0 mg norgestomet and 1.0 ml of the injectable solution

containing approximately 1.5 mg norgestomet and 2.5 mg oestradiol valerate.

3.6.2 Implanting Procedure

Using a special implanting plunger and needle, the plastic ear implant was placed subcutaneosly on the outer surface of the ear, about midway between the tip and the base of the ear. Prior to implanting, the site was disinfected with 70% alcohol. Implant was left in place for 9 days (day of implant as day 0). On the 9th day of synchronization, the implant site was pricked open with a disinfected scalpel blade and the implant squeezed out through the point of entry. The site was then disinfected again with 70% alcohol.

3.6.3 Oestrus Detection and Breeding after Synchronization

After removing the implant on d9 post-synchronization, an aproned buck was used for heat detection immediately afterwards. Animals were observed for oestrus (when they stood to be mounted) twice daily (9:00a.m. and 5:00p.m.).This exercise was carried for 72 hours. Animals detected on heat were separated from the flock and

presented to a fertile buck for breeding until the end of heat. Animals that did not show heat in 72 hours after implant removal were checked again 17-25 days later and bred if they exhibited heat. Animals that responded to synchronization and were bred, were again checked 17 - 25 days later and those exhibiting a second post-synchronization oestrus were rebred.

3.7.1 Data Analysis

All morphometric data of the genitalia were subjected to ANOVA and correlation analysis. Duncan's multiple range test was used to compare differences in the observed means between groups (Steel and Torrie, 1960). The percentage of animals that exhibited oestrus and conception were calculated and Chi-square was used to determine the differences. The Student's t-test was used to determine differences in rebreeding intervals between synchronization groups (Snedecor and Cochran, 1967). The data were expressed as mean and standard error of the mean ($\pm$SEM). Values of $P < 0.05$ were considered significant.

CHAPTER 4

RESULTS

4.1 Gross and Histological Changes in the Uterus and Ovaries Between Day 24 and 32 Postpartum.

4.2 Genital Tract.

4.3 Gross observations

The uterine horns were observed to be closely uniform in size and shape, i.e., there was symmetry of horns between d24 and 32 pp (Table 4.1; Plate 4.1A-D). Tonicity, oedema and copious uterine fluid were observed more between d28 and 32 pp than at d24 to d26pp. The caruncles were convex-shaped with 3 out of the 8 animals (38%) showing a few blood-tinged caruncles mainly between d24 and 26 pp. By d28 and 32 pp, the caruncles had resumed a normal light brown colour. In the cervix, small amounts of blood-tinged mucus was observed in 3 out of the 8 animals and mainly between d24 and 26 pp. Between d28 and 32 pp, cervical mucus was clear and glassy (Table 4.1).

4.3.1 Gross measurements

There was no significant difference in the overall mean ($\pm$SEM) weight, length, diameter, circumference, and

thickness of the uterine horns between d24 and 32 pp ($P > 0.05$). That is, symmetry of uterine horns morphometry was recorded between d24 and 32 pp. However, there were significant increases in some of these uterine parameters when comparison was made between the different slaughter dates.

The mean weight of the entire uterus decreased between d24 and 28 pp (30.20 $\pm$ 9.93g versus 27.35 $\pm$ 3.69g; $P > 0.05$). (Table 4.2). Thereafter the weight of the uterus increased to 36.75 $\pm$ 7.73g at d30-32 pp. The mean weight of the cervix was slightly higher at d24 and d30 to 32 pp than at d26 and 28 pp. While the mean weight of the oviducts remained essentially the same, that of the uterine body showed a slight decrease during the study period. There was a slight increase in the mean lengths of the uterine horns and oviducts from d24 to 32 pp with the left oviduct being significantly longer ($P < 0.05$) at d30 to 32 pp than in the other days. (Table 4.3). The mean lengths of the uterine horns and cervix remained relatively the same during the study period. The mean diameter of the uterine horns was slighly wider at d24 and d30 to 32 pp than at d26

and 28 pp (Table 4.4). Also the mean circumference and thickness of the uterine horns did not change appreciably during the study period (Table 4.5 and 4.6) However, the mean intercaruncular distance for both uterine horns at d30 to 32 pp was significantly longer ($P < 0.05$) than at d24 pp (Table 4.7).

4.3.2 Ovaries and ovarian structures

The mean (SEM) weight of the right ovary at d28 pp was significantly greater ($P < 0.05$) than at d24 and 26 pp. (Table 4.8). A similar though insignicant increase in weight was observed for the left ovary between d24 and 32 pp. There was no significant difference in the mean length, breadth and height of the ovaries between the groups (Table 4.9). The number of tertiary and secondary follicles (≥0.30cm in diameter) in the right ovary at d30 to 32 pp were significantly more ($P < 0.05$) than at d26 pp (Table 4.9.1). Similarly, the diameter of the largest follicle in the right ovary at d28 pp was significantly greater ($P < 0.05$) than at d26 pp. There were more primary follicles (<0.30cm diameter) in both ovaries at d24 and 26 pp than at d30 to 32 pp. The weight of fluid in all follicles of both

ovaries at d28pp was significantly more ($P<0.05$) at d28 pp than in the other study groups(Table 4.9.2)

At d26 pp, 1 and 2 corpora lutea respectively were recorded in the left and right ovaries of each animal in the group (Table 4.9.3). One corpus albicans each was recorded in 1 doe at d28 and d30 to 32 pp. In the rest of the animals studied, corpora lutea, corpora haemorrhagicum and corpora albicans were not identifiable on their ovaries.

4.3.3 Histological Observations

4.4.1 Genital tract

Re-epithelialization of the uterine caruncle was complete at d24pp (Plate 4.2A). Between d24 and 32 pp, complete regeneration of the caruncular, intercaruncular, and maternal crypts epithelium had occured (Plate 4.2 A-D). Similarly the characteristic tall columnar epithelium of the cervix was observed to be near intact between d24 and 32 pp (Plate 4.3 A-D). Greater numbers of maternal crypts were also observed at d30 to 32 pp than in the other study groups (Plate 4.2 D).

4.4.2 Ovaries and Ovarian Structures

The histological features of the ovaries between d24 and 32 pp indicated the presence of growing and tertiary follicles in all the interval days studied (Plate 4.3.1 A and B). Large numbers of primary follicles were also observed.

4.4.3 Postpartum Interval to Resumption of Ovarian Activities and Conception.

4.5.1 Postpartum Oestrus and Conception

Only 2 (40%) of the 5 animals used for this study exhibited first pp oestrus at a mean (SEM) interval of 19.50 ± 2.50 days. A second pp oestrus was exhibited by both does approximately 21 days later (Table 4.10.1). None of the remaining 3 animals showed heat during the 60-day period of the study. Of the 2 animals that exhibited oestrus, none conceived at the first pp oestrus, while both conceived to the second pp oestrus with a mean rebreeding interval of 40.50 ± 1.50 days and conception rate of 100%.

4.5.2 Postpartum progesterone profile

The progestrone (P_4) levels of the SB goat were observed to rise gradually from d1 pp (0.23 ± 0.44 ng/ml) to a moderate increase at d5 pp (0.24 ± 0.06 ng/ml) (Fig4.2). Thereafter,

a decrease in the P_4 level was recorded between d5 and 9pp (0.19 $\pm$ 0.09 ng/ml).A gradual rise in the P_4 level was again observed from d9 pp to another slight increase at around d17 pp (0.21 0.06 ng/ml). Subsequently, an immediate and drastic decrease in the P_4 level was again recorded up to d25 pp (0.07 $\pm$ 0.02 ng/ml). This was followed by another increase in the P_4 level at d29 pp (0.12 $\pm$ 0.12 ng/ml). From d41 to d60 pp the P_4 levels fluctuated at basal levels (i.e., lower than the minimum sentivity value (0.14 ng/ml) for this assay as indicated in section 3.5.3). The mean P_4 concentrations were not statistically different between the sampling days within d1 to d37 pp ($P > 0.05$).

4.5.3. Effect of Time of Oestrus Synchronization on Rebreeding

4.6.1 Rebreeding Interval.

Fourteen of the 15 animals that were synchronized at d21, 28 and 35 pp, exhibited oestrus within 24.0-33.6 hours after synchronization (Table 4.10.2). The 22-day interval between the first and second post-synchronization oestrus in the d35 pp group was about 5 days longer than was recorded for d21 and d28 pp groups (17.33days). The

parturition to conception interval (rebreeding interval) was about 47 days in the d28 pp group and 48 and 53 days, respectively for the d21 and 35 pp groups. This means that the 47 days rebreeding interval for d28 pp synchronization group was 1 day and 5 days shorter than the intervals recorded for d21 and d35 pp groups, respectively. The 48-day rebreeding interval recorded in the d21 group was significantly different ($P < 0.05$) when compared to the other groups. This may be due to the fact that one animal in the d21 pp group died during the course of the study. This affected the sample size for the group (from n=5 to n=4), and possibly the statistical analysis too.

4.6.2 Oestrus Response Rate

Following the 9-day synchronization period with SMB, oestrus response rates at 1-2 days (24-33.6 hours) post-synchronization was 100% in both d28 and 35 pp groups. This was 20% higher than in the d21 pp group. (Table 4.10.3) . While one animal in the d21 pp group did not respond to synchronization, all the animals in d28 and 35 pp groups exhibited oestrus within 1-2 days (24-33.6 hours) and/or 17-25 days post-synchronization. The difference in oestrus

response rates between the groups was not statistically significant ($P > 0.05$).

4.6.3 Conception rate

There was no conception at breeding to first post-synchronization oestrus in the d21 pp group, while conception rates for d28 and d35 pp groups were 40% (2/5) and 60% (3/5), respectively (Table 4.10.3). At the second post-synchronization oestrus, conception rate was 100% for both d21 and 35 pp groups, while it was 66.7% (2/3) for d28 pp group. One animal in the d28 pp group did not conceive to either the first or second post-synchronization oestrus. The overall conception rates for the first and second post-synchronization oestrus were 75% (3/4), 80% (4/5), and 100% (5/5) for d21, d28, and d35 pp groups, respectively. Increase in conception rates with increasing pp interval to the commencement of synchronization was apparent in the study (i.e., d21 pp:75%;d28pp:80%; and d35pp; 100%) (Table 4.10.3). The difference in conception rates between groups was not statistically significant ($P > 0.05$).

Table 4.1: **Gross Observations of the Tubular Genitalia of Savanna Brown Goats Between d24 and d32 Postpartum**

Genital Portion/ Observations	Days Postpartum			
	24	26	28	30-32
Uterine Horns:				
Symmetry	+++	+++	+++	+++
Oedema	++	++	+++	+++
Tonicity	++	++	+++	+++
Uterine fluid	++	++	+++	+++
Caruncle:				
Shape	Convex	Convex	Convex	Convex
Blood-tinged surface	+	+	-	-
Cervix:				
Blood-tinged mucus	+	+	-	-

\+ = Low
++ = Moderate
+++ = High
\- = Absent

Table 4.2: **Mean (SEM) weights of the genitalia of Savanna Brown goats between d24 and d32 postpartum**

Days Postpartum	n	Entire Uterus	Uterine Horns (g)		Oviducts (g)		Uterine Body (g)	Cervix (g)
			R	L	R	L		
24	2	30.20±9.93	12.45±6.05	11.70±3.60	1.20±0.50	1.05±0.65	6.05±0.25	8.85±3.65
26	2	27.35±0.65	12.60±0.40	11.95±0.05	0.55±0.05	0.45±0.05	2.80±0.30	7.90±0.80
28	2	27.35±3.69	10.70±2.30	10.95±2.35	1.05±0.35	1.00±0.20	5.75±1.75	7.05±2.05
30-32	2	36.75±7.73	15.65±5.65	17.55±7.45	1.25±0.45	1.20±0.40	3.55±0.95	9.60±3.60
Mean(SEM)		30.41±3.76	12.90±1.76	13.04±1.91	1.01±0.18	0.93±0.18	4.53±0.64	8.35±1.12

n = Number of animals per group
R = Right
L = Left

Table 4.3: **Mean (SEM) length of the genitalia of Savanna Brown goats between d24 and d32 Postpartum**

Days Postpartum	n	Uterine Horns (cm)		Oviducts (cm)		Uterine Body (cm)	Cervix
		R	L	R	L		
24	2	9.50±3.00	10.65±2.65	13.50±1.00	14.00±0.50^{ab}	2.00±1.00	3.50±0.50
26	2	10.25±1.25	10.15±1.15	15.00±0.50	12.00±1.00^{a}	1.50±0.50	3.75±0.75
28	2	10.40±0.10	9.25±0.25	13.75±1.75	13.75±0.25^{ab}	1.85±0.35	3.50±1.00
30-32	2	11.35±3.35	12.00±3.00	15.00±0.50	15.75±1.25^{b}	2.05±1.05	3.60±2.40
Mean (SEM)		10.38±0.92	10.51±0.87	14.31±0.48	13.88±0.60	1.84±0.31	3.59±0.52

n = Number of animals per group
R = Right
L = Left
a,b = Means with different superscripts within columns differ significantly ($P < 0.05$)

Table 4.4: **Mean (SEM) diameter of the tubular genitalia of Savanna Brown goats between d24 and d32 Postpartum**

Days Postpartum	n	Uterine Horns (cm) R	Uterine Horns (cm) L	Uterine Body (cm)	Cervix (cm)
24	2	2.00±0.00	2.00±0.00	1.75±0.25	1.50±0.59
26	2	1.65±0.15	1.65±0.15	1.50±0.00	1.40±0.10
28	2	1.70±0.10	1.65±0.15	1.25±0.25	1.20±0.00
30 - 32	2	2.00±0.00	2.00±0.00	2.05±0.45	1.80±0.20
Mean(SEM)		1.84±0.07	1.83±0.08	1.64±0.16	1.48±0.13

n = Number of animals per group
R = Right
L = Left

Table 4.5: **Mean (SEM) circumference of the tubular genitalia of Savanna Brown goats between d24 and d32 Postpartum**

Days Postpartum	n	Uterine Horns (cm)		Uterine Body (cm)	Cervix (cm)
		R	L		
24	2	4.75±0.75	5.20±0.30	5.75±0.25	6.05±0.05
26	2	4.85±0.15	5.05±0.15	5.10±0.70	5.15±0.15
28	2	4.85±0.15	4.70±0.20	4.70±0.20	4.85±0.35
30 - 32	2	5.10±0.90	5.25±0.75	5.75±0.75	6.60±1.60
Mean(SEM)		4.89±0.23	5.05±0.18	5.32±0.26	5.35±0.36

n = Number of animals per group
R = Right
L = Left

Table 4.6: **Mean (SEM) thickness of uterine horns of Savanna Brown goats between d24 and d32 Postpartum**

Days Postpartum	n	Right Uterine Horn (cm)	Left Uterine Horn (cm
24	2	0.25±0.05	0.25±0.05
26	2	0.40±0.10	0.30±0.00
28	2	0.30±0.00	0.20±0.00
30 - 32	2	0.35±0.05	0.40±0.10
Mean(SEM)		0.33±0.03	0.29±0.04

n = Number of animals per group.

Table 4.7: **Mean (SEM) caruncular dimensions of Savanna Brown goats between d24 and d32 Postpartum**

Mean caruncular diameter (cm)				Mean distance between Caruncles (cm)			
Days Postpartum		Uterine Horns (g)		Uterine Body	Uterine Horns		Uterine Body
	n	R	L		R	L	
24	2	0.45±0.50	0.45±0.05	0.40±0.00	0.30±0.00^{a}	0.25±0.05^{a}	0.45±0.50
26	2	0.50±0.00	0.50±0.00	0.40±0.00	0.60±0.20^{ab}	0.65±0.05^{b}	0.55±0.05
28	2	0.35±0.05	0.40±0.09	0.30±0.10	0.50±0.10^{ab}	0.55±0.15^{ab}	0.50±0.00
30-32	2	0.40±0.10	0.45±0.05	0.30±0.00	0.90±0.00^{b}	0.90±0.10^{b}	0.80±0.20
Mean(SEM)		0.43±0.03	0.45±0.03	0.35±0.03	0.58±0.09	0.59±0.10	0.58±0.08

± = SEM
n = Number of Animals Per Groups
R = Right
L = Left
a, b = Means with different superscripts within columns differ significantly ($P < 0.05$)

Table 4.3: Mean(SEM) Weight and Volume of Ovaries of Savanna Brown Goats Between d24 and d32 Postpartum

Days Postpartum	n	Mean Ovarian Weight (g) R	Mean Ovarian Weight (g) L	Mean Ovarian Volume (ml) R	Mean Ovarian Volume (ml) L
24	2	1.00±0.10[a]	1.05±0.15	0.85±0.15	0.85±0.15
26	2	0.95±0.05[a]	1.00±0.00	0.70±0.10	0.95±0.05
28	2	1.90±0.40[b]	1.95±0.25	1.45±0.35	1.30±0.30
30 - 32	2	1.20±0.00[ab]	2.25±0.75	0.85±0.25	1.75±1.15
Mean(SEM)		1.26±0.16	1.56±0.26	0.96±0.40	1.21±0.26

± = SEM
n = Number of Animals per group
R = Right
L = Left
a, b = Means with different superscripts within columns differ significantly (P<0.05)

Table 4.9 : Mean(SEM) Ovarian dimensions of Savanna Brown Goats Between d24 and d32 Postpartum

Days Postpartum	n	Mean Ovarian Length (cm) R	Mean Ovarian Length (cm) L	Mean Ovarian Breadth (cm) R	Mean Ovarian Breadth (cm) L	Mean Ovarian Height (cm) R	Mean Ovarian Height (cm) L
24	2	1.75±0.25	1.65±0.35	0.40±0.10	0.30±0.00	1.00±0.00	1.00±0.00
26	2	1.70±0.25	1.80±0.20	0.35±0.05	0.50±0.20	0.85±0.05	0.90±0.10
28	2	1.90±0.10	1.90±0.10	0.50±0.00	0.65±0.25	1.10±0.00	1.15±0.05
30-32	2	1.80±0.30	2.30±0.70	0.55±0.15	0.55±0.25	0.90±0.05	0.90±0.10
Mean(SEM)		1.79±0.08	1.89±0.19	0.45±0.05	0.50±0.09	0.96±0.05	0.99±0.05

± = SEM
n = Number of Animals per group
R = Right
L = Left

Table 4.9.1: **Mean(SEM) dimensions of follicular activity of Savanna Brown Goats Between d24 and d32 Postpartum**

Days Postpartum	n	Number of follicles ≥0.30cm in diameter R	Number of follicles ≥0.30cm in diameter L	Number of follicles < 0.30cm in diameter R	Number of follicles < 0.30cm in diameter L	Diameter of the largest follicle (cm) R	Diameter of the largest follicle (cm) L
24	2	1.50±0.50^{ab}	2.00±1.00	14.50±2.50	17.50±1.50	0.40±0.00^{ac}	0.50±0.10
26	2	0.50±0.50^{a}	2.50±0.50	13.55±4.50	9.50±4.50	0.25±0.05^{a}	0.45±0.15
28	2	2.50±1.50^{ab}	4.00±0.00	18.00±10.0	25.00±10.0	0.60±0.10^{b}	0.45±0.05
30-32	2	5.50±1.50^{b}	3.00±1.00	10.00±0.00	12.00±2.00	0.45±0.50^{ac}	0.55±0.15
Mean(SEM)		2.50±0.82	2.88±0.40	14.00±2.38	16.00±3.09	0.43±0.05	0.49±0.05

n = Number of animals per group
R = Right ovary
L = Left ovary
a, b = Means with different superscripts within columns differ significantly (P<0.05)

Table 4.9.2: Mean(SEM) dimensions of follicular activity of Savanna Brown Goats Between d24 and d32 Postpartum

Days Postpartum	n	Volume of fluid in the largest follicle (mL) R	Volume of fluid in the largest follicle (mL) L	Volume of fluid in all follicles (mL) R	Volume of fluid in all follicles (mL) L	Weight of fluid in all follicles (gm) R	Weight of fluid in all follicles (gm) L
24	2	0.02±0.00	0.48±0.42	0.09±0.05	1.01±0.89	0.15±0.05[a]	0.30±0.00[a]
26	2	0.02±0.00	0.06±0.02	0.20±0.10	0.16±0.04	0.15±0.05[a]	0.30±0.10[a]
28	2	0.09±0.03	0.08±0.02	0.24±0.06	0.31±0.11	0.75±0.15[b]	1.20±0.20[b]
30-32	2	0.04±0.02	0.06±0.02	0.17±0.05	0.10±0.20	0.20±0.10[a]	0.20±0.10[a]
Mean(SEM)		0.04±0.01	0.17±0.10	0.18±0.03	0.40±0.22	0.31±0.10	0.49±0.16

± = SEM
n = Number of animals per group
R = Right Ovary
L = Left Ovary
a, b = Means with different superscripts within columns differ significantly (P<0.05)

Table 4.9.3: **Corpus luteum activity in Savanna Brown Goats Between d24 and d32 Postpartum**

Days Postpartum		Number of corpus haemorrhagicum		Number of corpus luteum		Number of corpus albicans	
	n	R	L	R	L	R	L
24	2	NI	NI	NI	NI	NI	NI
26	2	NI	NI	2.0*	1.0*	NI	NI
28	2	NI	NI	NI	NI	1.0*	NI
30 - 32	2	NI	NI	NI	NI	NI	1.0*

R = Right ovary
L = Left ovary
NI = Not identifiable
* = Single values, not means

Table 4.10.1 : Mean(SEM) intervals to postpartum oestrus and conception in Savanna Brown Goats

Postpartum Oestrus	n	Postpartum Interval			
		To First Oestrus	Second Oestrus(RI)	Between first and second Oestrus	Conception rate (%)
Exhibited	2	19.50 ± 2.50d	40.50 ± 1.50d	21.00 ± 4.00d	100
Not exhibited	3	0.0	0.0	0.0	0.0

± = SEM

RI = Rebreeding interval

d = Days Postpartum

Table 4.10.2: **Mean(SEM) interval to oestrus and rebreeding following postpartum oestrus synchronisation in Savanna Brown Goats**

	Synchronised		
Postpartum interval	d21 5(4)	d28 5(5)	d35 5(5)
To first post-synchronization(hours)	24.00±0.00	33.60±5.88	24.00±0.00
Between first and second Post-synchronization oestrus(days)	17.33±0.33[a]	17.33±1.45[a]	22.00±4.00[a]
To breeding and conception (Rebreeding interval)(days)	48.33±0.33[a]	47.27±5.12[b]	53.80±5.53[b]
Overall conception rate (%)	75.00	80.00	100.00

± = SEM
d = Day of commencement of oestrus synchronisation postpartum.
( ) = Number of animals bred within each group
a, b = Means with different superscripts within rows differ significantly (P<0.05)
Number of animals per group = 5

Table 4.10.3: **Oestrus response and conception rates following postpartum synchronisation in Savanna Brown Goats**

Postpartum activity	Synchronisation days d21	d28	d35
Oestrus by 1-2 days Post-synchronisation	80.0(4/5)	100.0(5/5)	100.0(5/5)
Oestrus by 17-25 days Post-synchronisation	75.0(3/4)*	60.0(3/5)	40.0(2/5)
Not in Oestrus by 17-25 days Post-synchronisation	25.0(1/4)	0.0	0.0
Conception rate to first Post-synchronisation oestrus(%)	0.0(0/4)	40.0(2/5)	60.0(3/5)
Conception rate to second Post-synchronisation oestrus(%)	100.0(3/3)	66.7(2/3)	100.0(2/2)
Overall group conception rate (%)	75.0(3/4)	80.0(4/5)	100.0(5/5)

( ) = Number of animals responding divided by the number of animals in the group at the time of observation

* = One animal died 48 hours after the first post-synchronisation oestrus.

d = Day of commencement of oestrus synchronisation postpartum.

Number of animals per group = 5

PLATE 4.1:

Photographs of gross appearance of uterus of the Savanna Brown Goat slaughtered between d24 and d32 postpartum (A-D).



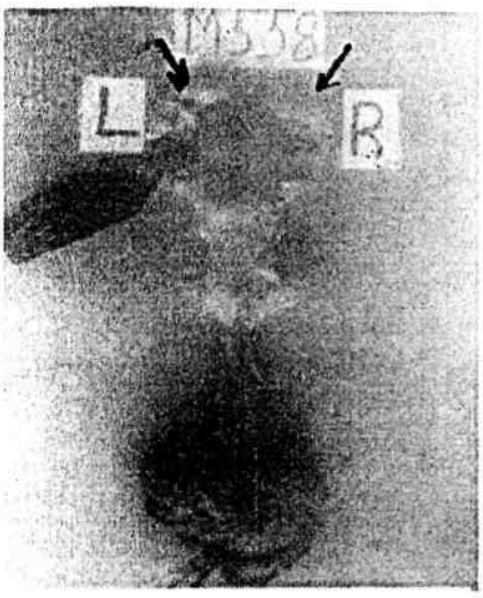
A: Uterus at d24 postpartum. Note the symmetry of the uterine horns (arrow).



B: Uterus at d26 postpartum. Note the reduced size of the convex - shaped caruncles (arrow).



C: Uterus at d28 postpartum. Note the smooth caruncular surfaces and the gross distortion in the shape of the ovaries due to the presence of large preovulatory follicles (arrow).



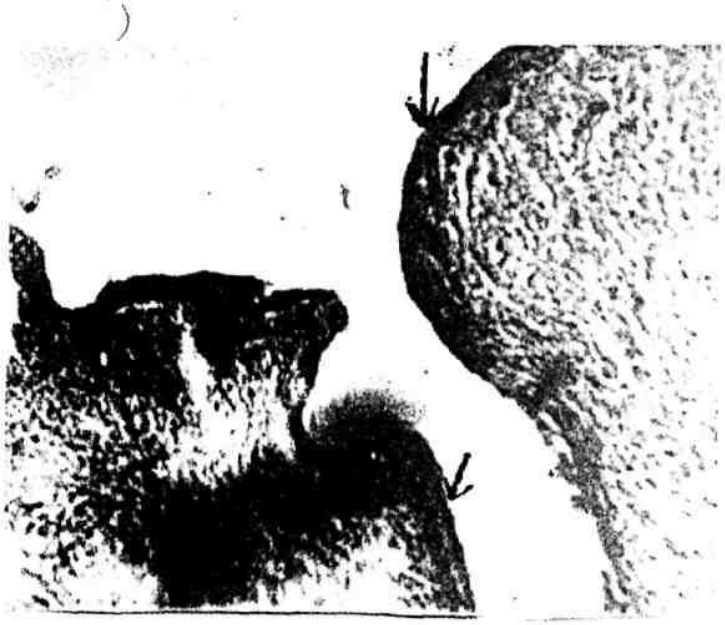
D: Uterus at d32 postpartum. Note the bulging of both uterine horns due to the high tone and oedema of the uterus at that stage (arrow).

PLATE 4.2:

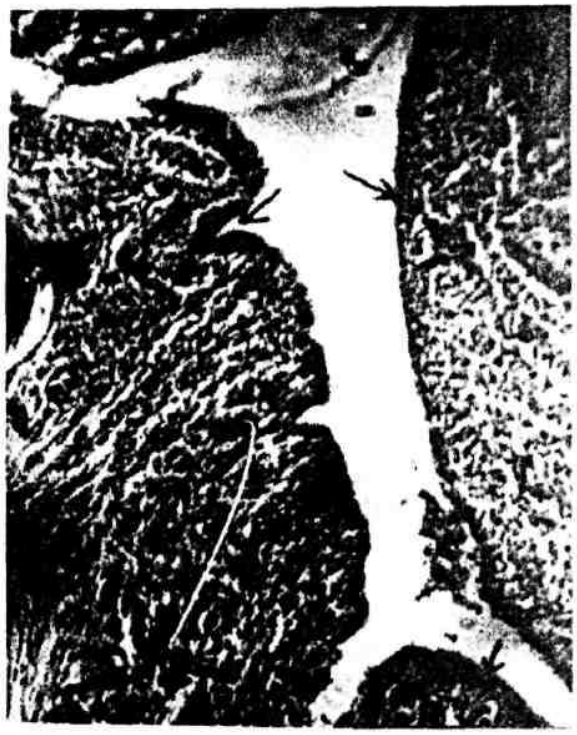
Histological features of the uterus of Savanna Brown goats slaughtered between d24 and 32 postpartum(A-D).



A: Photomicrograph of a cross section of a caruncle at d24 postpartum showing epithelial regeneration from glandular epithelium (arrow) (x150).



B: Photomicrograph of a cross section of intercaruncular epithelium at d26 postpartum showing re- epithelialization of the caruncular and intercaruncular mucosa (arrow) (x150).



C: Photomicrograph of a cross section of a caruncle at d28 postpartum showing caruncular, intercaruncular and glandular epithelial regeneration (arrow) (x150).



D: Photomicrograph of a cross section of caruncles at d32 postpartum showing epithelial regeneration from the edge of the caruncles and maternal crypts within the lamina propria (arrow) (x150).

PLATE 4.3:

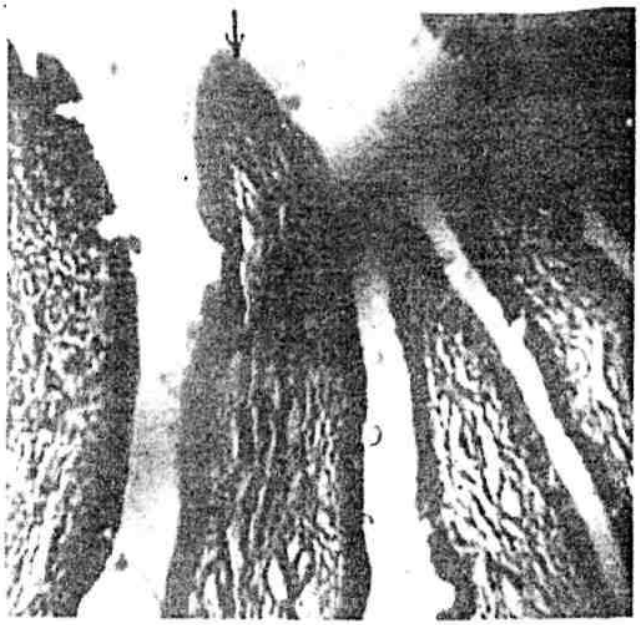
Historical features of cervix of the Savanna Brown goat slaughtered between d24 and d32 postpart um showing near intact characteristic tall columnar epithelium (arrow) (A-D).



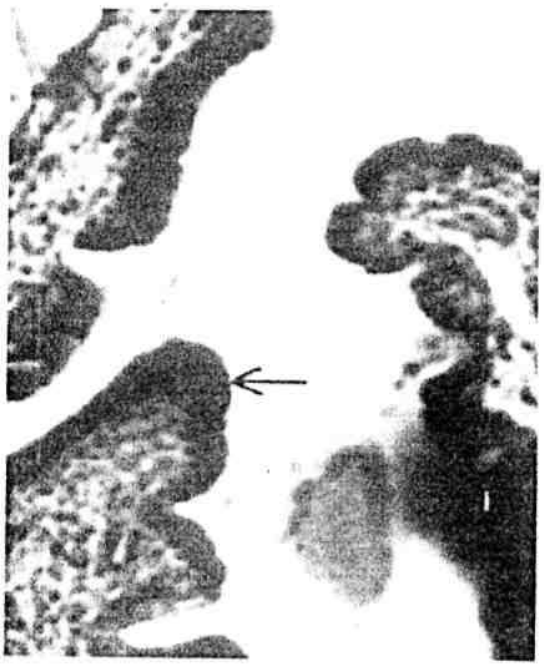
A: Photomicrograph of a cross section of a cervix at d24 postpartum (x150).



B: Photomicrograph of a cross section of the cervix at d26 postpartum (x150).



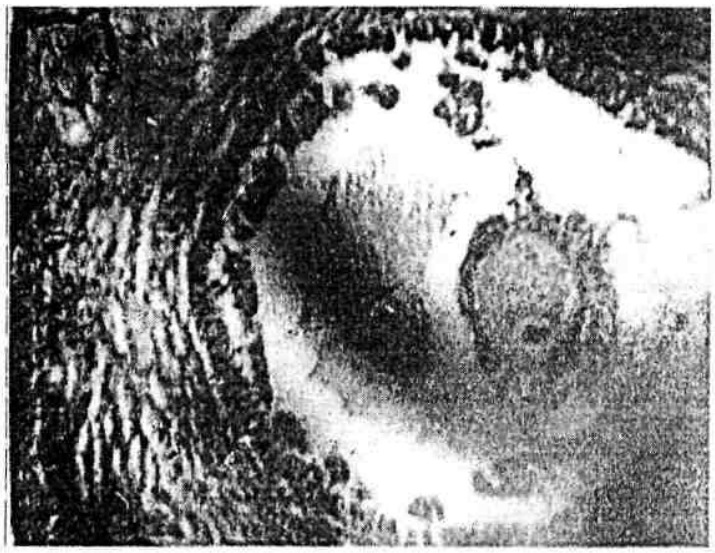
C: Photomicrograph of a cross section of a cervix at d28 postpartum (x150).



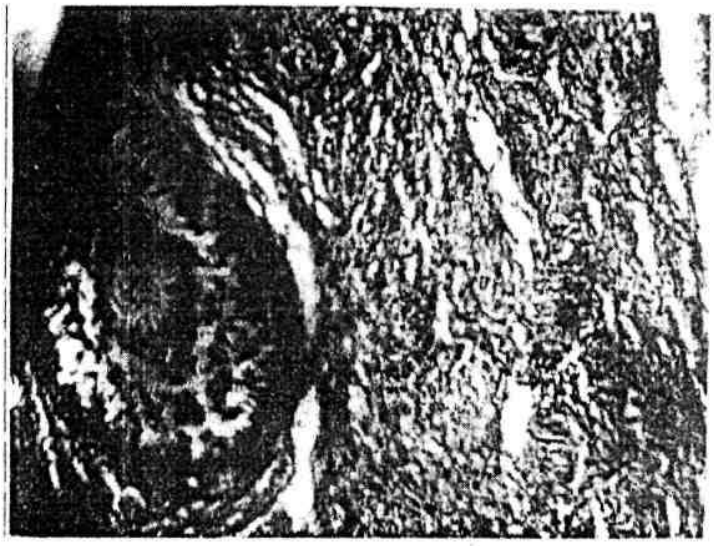
D: Photomicrograph of a cross section of the cervix at d32 postpartum (x150).

PLATE 4.3.1:

Photomicrographs of cross sections of ovaries of the Savanna Brown Goat slaughtered between d24 and d32 postpartum (A and B).

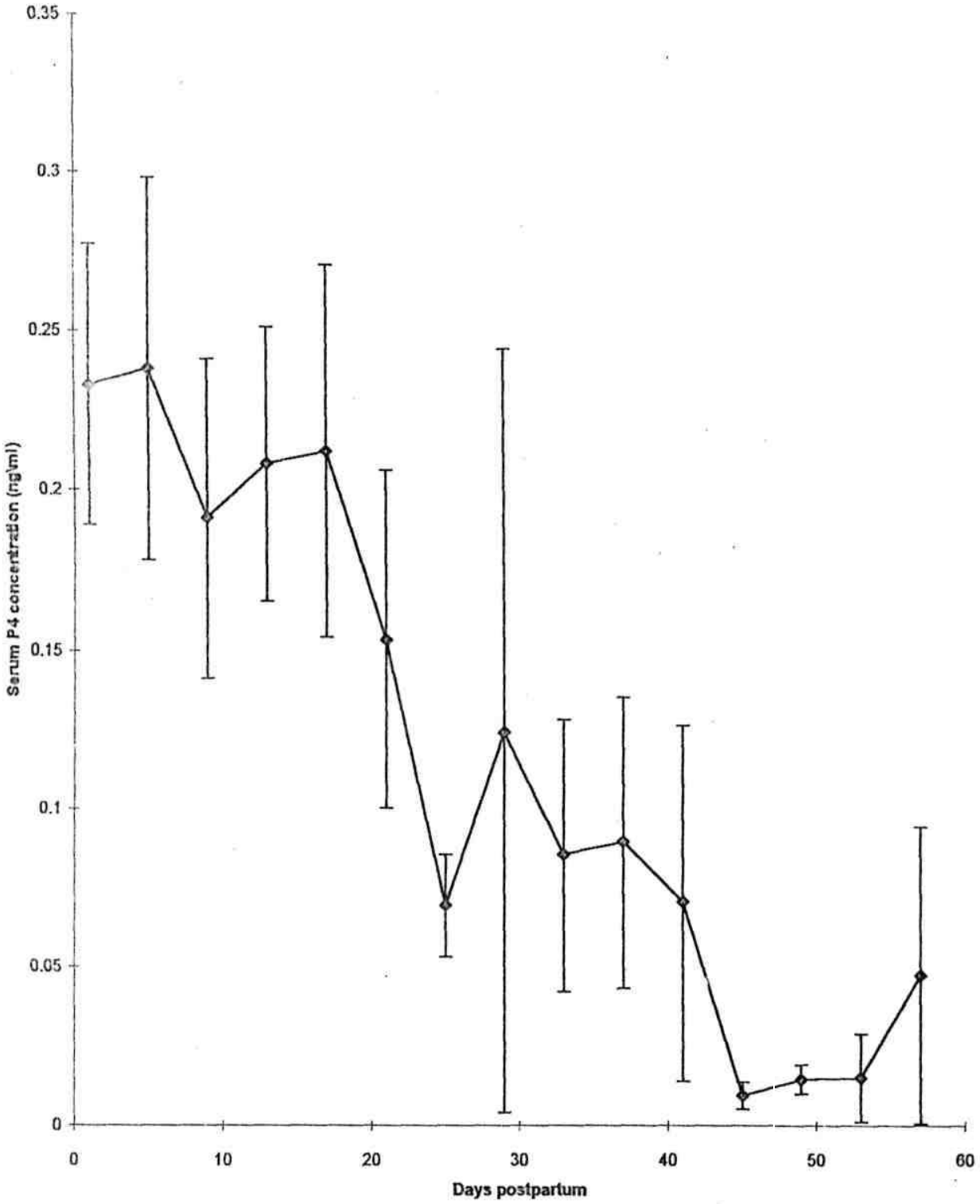


A: Photomicrograph of a tertiary (graafian) follicle at d24 postpartum (x150).



B: Photomicrograph of a growing (secondary) follicle at d28 postpartum (x150).

Fig. 4.2. Progesterone profile of Savanna Brown goats between day 1 to 60 postpartum (n=20)



CHAPTER 5

DISCUSSION

5.1 Gross sand Histological Changes in the Uterus and Ovaries Between Day 24 and 32 Postpartum.

5.2 Genital tract

The symmetry of the uterine horn length , the convexity of the caruncles and the scarcity of locia in the uterus between d24 and 32 pp indicate that gross uterine involution in the SB goat is complete by day 24 pp. This finding agrees with that of Fasanya et al (1987), who reported that most locia discharge in SB goats occurred within 48 hours, and by d16 to 24 pp, the caruncles appeared as smooth round elevations on the surface of the endometrium. The increase in uterine weight at d30 to 32 pp agrees with an earlier report in non-suckled Zebu cattle (Eduvie et al., 1984), but contrasts with an earlier observation that indicated a continuous decrease in weight during the same period (Fasanya et al., 1987). The increase in uterine weight at d30 to 32 pp may be due to the stimulatory effect of high levels of ovarian hormones, especially oestrogens on the size and secretory activity of

uterine glands (Eduvie et al., 1984). The relatively large numbers of growing and tertiary follicles observed between d28 and 32 pp of this study is indicative of enhanced follicular activity, and hence increased levels of circulating oestrogens during that period. Similar increase in uterine weight has been reported in this breed at d16 pp (Fasanya et al., 1987).The stimulatory effect of progestrone (P_4) and oestrogen on the uterus has also been reported in pp mares and sheep (Sexton and Bristol, 1985; Rubianes et al., 1996). Significant follicular activity has also been reported in the early pp period of the cow (Eduvie et al., 1985; Peters and Lamming, 1986). The increase in intercaruncular distance in both horns at d26 and d30-32 pp and the slight increase in the length, diameter and circumference of the horns between d24-32pp could also be attributed to this oestrogenic effect.

The period of re-epithelialization of the caruncular, intercaruncular and maternal crypt mucosa observed in this study agrees with the earlier report by Fasanya et al. (1987), who observed that uterine endometrial re-epithelialization and uterine involution were complete by d24-28pp. This implies that pregnancy, implantation and

placental formation may be viable from d24 to 32 pp in the SB goat. This viability is mainly dependent on the return of the pp uterus to its pregravid status, grossly and histologically (Hunter, 1968; Fasanya et al., 1987). The relatively larger numbers of maternal crypts observed between d30 to 32pp in this study could be due to the increased follicular activity observed during that period. Fasanya et al.(1987) also suggested that the slight increase in uterine parameters of the SB goat at d16 pp may be due to this increased endometrial gland activity.

5.3 Ovaries and ovarian structures

The occurrence of more tertiary and secondary follicles and higher ovarian and follicular fluid weight observed between d28 and 32 pp of this study does imply greater ovarian follicular activity around that period than at d24 and 26 pp. The relatively higher number of primordial follicles observed between d24 and 26 pp also lends more credence to the later assertion. Rubianes et al. (1996) reported a similar pattern of follicular activity in Corriedale ewes at d17 and d30 pp. In contrast to the findings of the present study, Fasanya et al. (1987) observed no significant differences in ovarian parameters between d1

and 32 pp. This may be due to the delay in resumption of ovarian activity in primiparous than in multiparous animals (Eduvie, 1985; Dawuda et al., 1988).

The significantly larger values of ovarian weight, number of secondary and tertiary follicles, diameter of the largest follicle and volume of fluid in all follicles associated with the right ovary between d28 and 32 pp are suggestive of higher follicular activity in the right than the left ovary of the SB goat pp. This may be due to a genetic predisposition. The greater prominence of ovarian activity in the right ovary agrees with earlier reports in sheep, goat and cattle which indicate that the right ovary is more active (Pathiraja and Oyedipe, 1985; Alaku et al., 1986; Donkin, 1980a). The greater dominance of follicular activity in the right ovary relative to the left suggests a higher possibility of pp ovulation occurring in the right than the left ovary of the SB goat between d28 and 32 pp. The moderately large number of growing and tertiary follicles recorded in both ovaries between d28 and 32 pp is indicative of an early reactivation of the hypothalamo-pituitary-ovarian axis of the SB goat pp.

The near absence of CL grossly in the ovaries of most of the animals during this study agrees with earlier reports in SB goats and Corriedale sheep (Fasanya et al., 1987; Rubianes et al., 1996). However, the absence of CL recorded grossly during the study period does not necessarily imply the complete absence of luteal activity during this period. It may be due to the short life span and deficient activity of most corpora lutea in the early pp period.

In lactating sheep, this inadequate pp luteal function has been attributed to the reduced capacity of the hypothalamo-pituitary axis to release LH and inappropriate LH stimulation of the ovary prior to the LH surge (Cognie and Pelletier, 1976; Kann et al., 1976; Wright et al., 1983). In turn, this would result in too low and infrequent LH pulses to initiate effective CL development and function. This eventually results in early regression of corpora lutea in the early pp period and thus a short luteal phase.

5.3.1 Postpartum Interval to Resumption of Ovarian Activities and Conception

5.3.2 Postpartum Oestrus and Conception

The pp interval to first oestrus of 19.5 days recorded for the SB goat in this study is close to an earlier report of 20.1 days by Molokwu (1982). Fasanya et al.(1992b) had also reported an interval of 21 days in 1 out of 5 SB does whose grazing was supplemented with maize. The fact that only 2 of the 5 does showed a first pp oestrus during the 60-day observation period of this study implies subnormal luteal activity and consequently low fertility in the early pp period of the SB goat. The rebreeding interval of 40.5 days observed in this study is lower than the 48 days reported by Fasanya et al.(1992b) in primiparous goats, but higher than the 23 days observed by Molokwu (1983). It is also 7 days more than the ideal 33 days interval required to achieve twice-yearly kidding.

The 100% conception rate recorded at the second pp oestrus, as opposed to zero conception at the first pp oestrus, implies that fertility is compromised in the early pp period of the SB doe, with fertility increasing with

advancing pp interval. A Similar trend of improved fertility with advancing pp interval has been reported in sheep (Lamming, 1962; Thimonier et al.,. 1968; Hulet and Stormshak, 1972; Osinowo and Ekpe, 1985). Poor fertility associated with early pp breeding has been attributed to poor uterine environment due to incomplete uterine involution, low pituitary LH release and ovarian activity (Lamming, 1962; Gordon, 1963; Thimonier et al., 1968; Pelletier and Thimonier, 1973; Dawe and Fletcher, 1976).

5.3.3 Postpartum Progestrone Profile

Since the first increase in circulating progestrone (P_4) was recorded at d5 pp, this may signify that the first pp ovulation in multiparous SB goats may occur as early as d5 pp. In other words, ovarian activity in the SB goat could resume by d5pp. Fasanya (1985) had also recorded a peak P_4 level of 0.6ng/ml at d4 pp during sampling between d1 to 32 pp. A similar report of an immediate pp ovulation in cattle has been made by Callahan et al. (1971.) Since the level of circulating P_4 in goats is almost entirely attributed to the corpora lutea (Gordon, 1997), the increase in P_4 concentration recorded at d5 pp could have been produced

mainly by a functional CL at that time. The immediate fall in the P_4 level after d5 and d17 pp could be attributed to the short life span of the early pp corpora lutea (Donaldson et al., 1970; Odde et al., 1980; Troxel et al., 1984). The short life span of the early pp corpora lutea has been attributed to premature luteolysis caused by prostaglandin $F_{2\alpha}$ and its metabolite, PGFM which are produced by caruncular uterine tissue after parturition (Troxel et al., 1984, Troxel and Kesler, 1984). In addition, a short GnRH-induced LH surge and low number of LH receptors and granulosa cells of an early pp ovary have also been linked to the short life span of the early pp CL (Troxel et al., 1980; Channing et al., 1981).

5.4.1 Effect of Time of Oestrus Synchronization on Rebreeding

5.4.2 Oestrus Response

The fact that 14 of the 15 animals synchronized exhibited oestrus within 24.0-33.6 hours pp is indicative of good precision in SMB-induced oestrus synchronization in the SB goat. This precision is repeated in the 17-22 days interval to the second post-synchronization oestrus in all groups.

This means that facilities and manpower can be optimally utilized within 2 days post-synchronization and again within 17-22 days at the second post-synchronization. Similar results have been reported in cattle, sheep and goats with SMB in conjuction with FSH, GnRH, PMSG and/or prostaglandin $F_{2\alpha}$ (Smith and Vincent, 1972; Wiltbank and Mares, 1977; Senn and Richardson, 1992; Twagiramunga et al., 1992; Krisher et al.,(1994). High oestrus response rates, ranging from 60-75% have also been recorded for SB goats synchronized with PMSG in conjunction with prostaglandin $F_{2\alpha}$ (Ogunbiyi et al., 1980; Alemede and Fasanya, 1996). However, the interval of 24-33.6 hours from synchronization to first oestrus observed in this study is much shorter than in the previous reports. The relatively shorter interval to first post-synchronization oestrus and the high oestrus response rate associated with SMB has been attributed to both the oestradiol component, which remains sufficiently high enough to induce oestrus after implant removal; and the progestin implant which induces the secretion of more endogenous oestradiol, thus enhancing SMB - induced oestrus (Kojima et al., 1992; Larson and Kiracofe, 1995; Tanaka et al., 1995).

5.4.3 Conception Rate

The high oestrus response rate for SMB synchronization in this study was equally translated into good conception rates (75-100%) in all groups. Previous studies in cattle and Nubian goats have also reported high ovulation and conception rates following pre-treatment with SMB augmented with FSH or GnRH and/or prostaglndin $F_{2\alpha}$ (Spitzer et al., 1978; McGowan et al., 1992; Senn and Richardson, 1992; Krisher et al., 1994) Oestrus synchronization in SB goats with 2 doses of prostaglandin $F_{2\alpha}$ has also been reported to yield conception rates of up to 90% (Ogunbiyi et al., 1980). The high conception rate attributed to SMB synchronization may not be unconnected to the immediate release of preovulatory follicles and/or the fast development of antral follicles, that usually occur immediately after the implant removal (Smith et al., 1983; Kojima et al., 1992; Taylor et al., 1993).

The zero conception at the first post-synchronization oestrus in the d21 pp group coupled with an increase in conception rate with advancing interval to the commencement

of the synchronization implies that fertility was compromised at the first oestrus following synchronization with SMB in SB goats, but improves with increase in pp interval. A Similar trend of increasing fertility with advancing pp interval has been reported in lactating sheep (Gordon, 1958; Lamming, 1962; Thimonier et al., 1968; Hulet and Stormshak, 1972; Warren, Jr et al.,1989). However, the high fertility associated with breeding at the second post-synchronization oestrus is usually accompanied by a longer rebreeding interval (Osinowo, 1982). The poor fertility observed in the d21 pp group at the first post-synchronization oestrus could be attributed to inadequate P_4 support and thus early embryonic mortality at the time of breeding(Lamming, 1962; Gordon, 1963; Thimonier et al., Pelletier and Thimanier, 1973; Dawe and Fletcher, 1976). The inadequate progestational support is due to the short life span of the early pp corpora lutea (Donaldson et al., 1977; Odde et al., 1980)

5.5.1 Rebreeding interval

The rebreeding interval range of 47 to 53 days recorded in this study with SMB synchronization agrees with a similar

observation made in Yankasa sheep synchronized with progestrone intravaginal device at d28pp (Osinowo,1982). However, the 47 to 53 days interval achieved with the SMB could be further shortened if majority of the animals could be made to conceive at the first oestrus after synchronization. This has been achieved in lactating sheep and cattle by either augmenting SMB with gonadotropins after implant removal or by increasing circulating P_4 through injection of exogenous P_4 or HCG after the first pp mating (Wiltbank and Mares, 1977; Alifakiotis, 1982; Kitock et al., 1983; Twagiramunga et al., 1992). But this type of intervention could eventually escalate the cost of sunchronization, especially in Nigeria, where these hormone inputs are imported.

The good conception rates recorded with SMB in this study implies that oestrus synchronization could be economically viable for the intensive goat farmer. In addition assuming a gestation length of 150 days and considering the rebreeding intervals of 47 to 53 days recorded in this study, a kidding interval of about 200 days or less is achievable. This is less than the kidding interval of 222

days earlier reported for this breed (Molokwu and Igono, 1978). Hence, the rebreeding interval range of 47 to 53 days recorded with the SMB synchronization could ensure at least a kid crop of 1.5 per year or 3 kiddings in 2 years.

The findings of this study further suggests that rebreeding the SB goat at the first postpartum (pp) or post-synchronization oestrus prior to d40 pp would result in lower fertility. The decreased fertility is not unconnected with low levels of circulating P_4 and short luteal phases observed during the early pp period. The low levels of circulating P_4 and short luteal phases are not sufficient to maintain pregnancy occurring prior to d40 pp. Since better fertility was obtained by rebreeding around d40 pp or by commencing synchronization at d28 or d35 pp, it means that the completion of uterine involution occurring between d24 and d32 pp would not be a hinderance to successful rebreeding in the SB goat.

CONCLUSION

From the general and specific findings of this study, the following conclusions were drawn:

i. Uterine involution in multiparous SB goat is complete by d24pp. Thereafter an increase in most uterine parameters occurred between d24 and 32 pp. Postpartum ovarian activity occur more in the right than the left ovary in SB goat between d24 and 32 pp.

ii. The first pp oestrus in multiparous SB goats could occur as early as 19.5 days pp, while the rebreeding interval averages 40.5 days. Fertility at the first pp oestrus is compromised, but improved at the second pp oestrus. Based on P_4 profile, resumption of ovarian activity in multiparous SB goats could occur as early as d5 pp.

iii. The rebreeding interval of 47 to 53 days achievable with SMB synchronization is capable of reducing the kidding interval from 222 days to 200 days. Postpartum synchronization with SMB is capable of achieving good oestrus and conception rates. Fertility following SMB synchronization increases with increasing pp interval from the commencement of the synchronization.

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APPENDIX

A: Progesterone concentrations (ng\ml) in the serum of Savanna Brown Goats between day 1 to 60 postpartum

S/N No	Tag No	Sampling Periods PP (days) 1	5	9	13	17	21	25	29	33	37	41	45	49	53	57	60
1	M361	0.681	0.067	0.249	0.485	0.819	0.183										
2	M369	0.397	0.208	0.254	0.682	0.279	0.035										
3	M378	0.100	0.047	0.237	0.176	0.014	0.086										
4	M379	0.166	0.163	0.014	0.182	0.547	0.815										
5	NN	0.086	0.241	0.139	0.239	0.007	0.008										
6	M557	0.070	0.097	0.772	0.373	0.174	0.281	NA	NA								
7	1313	0.113	0.169	0.082	0.006	0.796	0.043	0.079	0.415								
8	1324	0.042	0.367	0.055	0.044	0.017	0.028	0.023	0.051								
9	1049	0.249	0.104	0.281	0.108	0.213	0.037	0.122	0.042								
10	1349	0.199	0.018	0.009	0.118	0.058	0.650	0.039	0.181								
11	1883	0.052	1.044	0.753	0.429	0.020	0.058	0.068	0.146	0.040	0.287						
12	2310	0.122	0.064	0.069	0.078	0.565	0.050	0.055	0.124	NA	NA						
13	2313	0.065	0.605	0.384	0.047	0.075	0.174	0.050	0.305	0.029	0.003						
14	1318	0.163	0.397	0.029	0.157	0.164	0.100	0.043	0.069	0.113	0.111						
15	45	0.226	0.122	0.092	0.029	0.149	0.029	0.200	0.035	0.285	NA						
16	1704	0.326	0.079	0.080	0.086	0.120	0.019	0.042	0.022	0.010	0.014	**0.126**	**0.106**	**0.019**	**0.286**	*	*
17	1706	0.137	0.038	0.193	0.00	0.111 (d17)**											
18	M359	0.751	0.029	0.059	0.110	0.054	NA	0.008 (d22)**									
19	1734	0.330	0.700	0.030	0.390	0.020	0.020	0.150	0.100	0.030	**0.060**	0.014	0.013	NA	0.011	0.093	**0.014**
20	32	0.381	0.195	0.030	0.429	0.035	0.132	0.020	0.000	NA	NA	NA	0.190	0.010	NA	0.000	*

NA = Unacceptable value
( ) = Date of last blood sampling
( )** = Date of first postpartum oestrus and breeding and last b ood **sampling**.
* = Samp e not assayed.

B: Uterine dimensions and weights of Savanna Brown Goats between d24 and d32 postpartum (Uterine horns)

S/N	Animal Tag No.	PP slaughter interval (days)	Length (cm)				Diam. (cm)		Circum. (cm)		Thickness (cm)		Weight (gm)	
			RH(I)	LH(I)	RH(E)	LH(E)	RH	LH	RH	LH	RH	LH	RH	LH
1	M552	24	12.5	G13.3	9.5	G9.5	2.0	2.0	5.5	5.5	0.3	0.3	16.5	G15.3
2	M457		6.5	G 8.0	5.0	G6.5	2.0	2.0	4.0	4.9	0.2	0.2	6.4	G 8.1
3	M557	26	G11.5	G11.3	G7.5	G7.2	1.8	1.8	4.7	4.9	0.5	0.3	13.0	11.9
4	M166		G 9.0	G 9.0	G7.0	G7.0	1.5	1.5	5.0	5.2	0.3	0.3	12.2	12.0
5	M554	28	G10.3	G 9.0	G9.0	G7.5	1.8	1.8	4.7	4.9	0.3	0.2	13.0	13.3
6	M383		10.5	9.5	8.5	7.5	1.6	1.5	5.0	4.5	0.3	0.2	8.4	8.6
7	M377	30-32	G 8.0	9.0	G6.0	7.0	2.0	2.0	4.2	4.5	0.3	0.3	10.0	10.1
8	M558		14.7	15.0	13.2	10.0	2.0	2.0	6.0	6.0	0.4	0.5	21.3	25.0

RH=Right horn
LH=Left horn
(I)=Distance from the uterotubal junction to the internal bifurcation
(E)=Distance from the uterotubal junction to the external bifurcation.
Diam.=Diameter
Circum.=Circumference.
G = Gravid horn.

C: Uterine dimensions and weights of Savanna Brown Goats between d24 and d32 postpartum (Uterine body and horns)

			Uterine Body				Uterine Horns			
S/N	Animal Tag No.	PP slaughter interval (days)	Weight (gm)	Diam. (cm)	Circum. (cm)	Length (cm)	Diam. (cm)		Ave. distance between caruncles (cm)	
							RH	LH	RH	LH
1	M552		6.3	1.5	6.0	3.0	0.5	G0.5	0.3	G0.2
2	M457		5.8	2.0	5.5	1.0	0.4	G0.4	0.3	G0.3
3	M557		3.1	1.5	4.4	2.0	G0.5	G0.5	G0.4	G0.7
4	M166		2.5	1.5	5.8	1.0	G0.5	G0.5	G0.8	G0.6
5	M554		7.4	1.0	4.9	2.2	G0.4	G0.5	G0.4	G0.7
6	M383		4.0	1.5	4.5	1.5	0.3	0.3	0.6	0.4
7	M377		2.6	2.5	5.0	1.0	0.3	0.4	0.9	1.0
8	M558		4.5	1.6	6.5	3.1	0.5	0.5	0.9	0.8

RH=Right horn
LH=Left horn
Diam=Diameter
Circum=Circumference
PP = Postpartum.

D: **Uterine dimensions and weights of Savanna Brown Goats between d24 and d32 postpartum (Cervix and oviduct)**

			Cervix							
	Animal Tag No.	PP slaughter interval (days)	Weight (gm)	Length (cm)	Diam. (cm)	Circum. (cm)	Length (cm)		Weight (gm)	
							ROV	LOV	ROV	LOV
1	M382	24	12.5	4.0	1.0		14.5	G13.5	1.7	1.7
2	M457		5.2	3.0	2.0		12.5	G14.5	0.7	0.4
3	M357	26	8.7	4.5	1.3		G15.5	G11.0	0.5	0.4
4	M166		7.1	3.0	1.5		G14.5	G13.0	0.6	0.5
5	M354	28	9.1	4.5	1.2		G12.0	G13.5	1.4	1.2
6	M383		5.0	2.5	1.2		15.5	14.0	0.7	0.8
7	M377	30-32	6.0	1.2	2.0		G15.5	G17.0	1.7	1.6
8	M358		13.2	6.0	1.6		14.5	14.5	0.8	0.8

RH=Right oviduct
LH=Left oviduct
Diam=Diameter
Circum=Circumference

E: Ovarian dimensions and weights of Savanna Brown Goats between d24 and d32 postpartum

S/N	Animal Tag No.	PP slaughter interval (days)	Right ovary						Left ovary					
			L	H	B	W(+)	W(-)	V	L	H	B	W(+)	W(-)	V
1	M552	24	2.0	1.0	0.5	1.1	0.9	1.0	2.0	1.1	0.3	1.2	0.9	1.0
2	M457		1.5	1.0	0.3	0.9	0.8	0.7	1.3	0.9	0.3	0.9	0.6	0.7
3	M557	26	1.8	0.9	0.4	0.9	0.8	0.6	2.0	1.0	0.7	1.0	0.6	1.0
4	M166		1.6	0.8	0.3	1.0	0.8	0.8	1.6	0.8	0.3	1.0	0.8	0.9
5	M554	28	1.8	1.1	0.5	2.3	1.4	1.8	2.0	1.1	0.9	2.2	0.9	1.6
6	M383		2.0	1.1	0.5	1.5	0.9	1.1	1.8	1.2	0.4	1.7	0.7	1.0
7	M377	30-32	1.5	0.7	0.4	1.2	1.1	0.6	1.6	0.8	0.3	1.5	1.1	0.6
8	M558		2.1	1.1	0.7	1.2	0.9	1.1	3.0	1.0	0.8	3.0	2.9	2.9

L=Length (cm)
H=Height (cm)
B=Breadth (cm)
W(+)=Weight of intact ovary
W(-)=Weight of ovary after removal of follicular fluid
V =Volume (mL)

F: Ovarian follicular activity in the right ovary of the Savanna Brown Goat between d24 and d32 postpartum

S/N	Animal Tag No.	PP slaughter interval (days)	No. of follicles >=0.30cm	No. of follicles <0.30cm	Diam. of the largest follicle (cm)	Vol. of fluid in the largest follicle (ml)	Vol. of fluid in all follicles (ml)	Weight of fluid from all follicle (gm)
1	M552	24	1.0	17.0	0.4	0.02	0.1	0.2
2	M457		2.0	12.0	0.4	0.02	0.09	0.1
3	M557	26	1.0	9.0	0.3	0.02	0.3	0.1
4	M166		0.0	18.0	0.2	0.02	0.1	0.2
5	M554	28	1.0	28.0	0.5	0.06	0.18	0.9
6	M383		4.0	8.0	0.7	0.12	0.3	0.6
7	M377	30-32	4.0	10.0	0.4	0.06	0.12	0.1
8	M558		7.0	10.0	0.5	0.02	0.22	0.3

Diam. = Diameter
Vol. = Volume
PP = Postpartum

G: Ovarian follicular activity in the left ovary of the Savanna Brown Goat between d24 and d32 postpartum

S/N	Animal Tag No.	PP slaughter interval (days)	No. of follicles >=0.30cm	No. of follicles <0.30cm	Diam. of the largest follicle (cm)	Vol. of fluid in the largest follicle (ml)	Vol. of fluid in all follicles (ml)	Weight of fluid from all follicle (gm)
1	M552	24	1.0	16.0	0.4	0.9	0.12	0.3
2	M457		3.0	19.0	0.6	0.06	1.9	0.3
3	M557	26	3.0	5.0	0.6	0.08	0.21	0.4
4	M166		2.0	14.0	0.3	0.04	0.12	0.2
5	M554	28	4.0	35.0	0.5	0.1	0.42	1.35
6	M383		4.0	15.0	0.4	0.06	0.2	1.0
7	M377	30-32	2.0	11.0	0.4	0.04	0.08	0.3
8	M558		4.0	10.0	0.7	0.08	0.12	0.1

Diam. = Diameter
Vol. = Volume
PP = Postpartum

E: Corpus luteum activity of Savanna Brown Goats between d24 and d32 postpartum

S/N	Animal Tag No.	PP slaughter interval (days)	Right ovary			Left ovary		
			CL	CH	CA	CL	CH	CA
1	M552	24	NI	NI	NI	NI	NI	NI
2	M457		NI	NI	NI	NI	NI	NI
3	M557	26	NI	NI	NI	NI	NI	NI
4	M166		2.0	NI	NI	1.0	NI	NI
5	M554	28	NI	NI	1.0	NI	NI	NI
6	M383		NI	NI	NI	NI	NI	NI
7	M377	30-32	NI	NI	NI	NI	NI	1.0
8	M558		NI	NI	NI	NI	NI	NI

CL=Corpus luteum
CH=Corpus haemorrhagicum
CA=Corpus albicans
NI=Not identifiable

I: Reproductive performance of Savanna Brown Goats under observation between day 1 and 60 postpartum

S/N	Animal Tag No.	Interval to the first PP oestrus (days)	Interval from first to second PP oestrus (days)	Day-60 No n-return rate (conception)	Rebreeding interval (days)
1	1704	NI0	NI0	-	-
2	1706	17.0a	25.0	+	42.0
3	M359	22.0a	17.0	+	39.0
4	1734	N10	NI0	-	-
5	32	N10	NI0	-	-

NI0= Not in oestrus
+= Conceived
-= Did not conceive
*= Died 48hrs after the first post-synchronisation oestrus.
PP= Postpartum

J: **Reproductive performance following synchronization of Savanna Brown Goats postpartum**

S/N	Animal Tag No.	PP treatment group (days)	Interval from the end of Rx to the first PRx oestrus (days)	Interval from first to second PRx oestrus (days)	Day-60 No n-return rate (conception)	Rebreeding interval (days)
1	M361		1.0	Nd	Nd	Nd
2	M369		1.0	17.0	+	48.0
3	M378	21	1.0	18.0	+	49.0
4	M379		NIO	NIO	-	-
5	NN		1.0	17.0	+	48.0
6	M557		2.0	Nd	+	39.0
7	1313		1.0	Nd	+	38.0
8	1324	28	1.0	20.0	+	58.0
9	1049		1.0	17.0	-	-
10	1349		2.0	15.0	+	54.0
11	1883		1.0	Nd	+	45.0
12	2310		1.0	18.0	+	63.0
13	2313		1.0	Nd	+	45.0
14	1318		1.0	Nd	+	45.0
15	45	35	1.0	26.0	+	71.0

Rx= Synchronised
PRx= Post-synchronisation
Nd= Not determinable
NIO= Not in oestrus
+= Conceived
-= Did not conceive
*= Died 48hrs after the first post-synchronisation oestrus.
PP= Postpartum