POSTPARTUM PHYSIOLOGY AND BACTERIOLOGY OF THE GENITALIA OF THE SAVANNA BROWN GOAT

BY

OMOTUNDEE OLUSEYI ADEMUYIWA FASANYA
D.V.M., Ahmadu Hello University, Zaria, 1980

A
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Department of Physiology and Pharmacology
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SEPTEMBER, 1985

DIGITIZED

THESIS APPROVAL

This thesis by Omotunde Oluseyi Ademuyiwa, Fasanya meets the regulations governing the degree of Master of Science of Ahmadu Bello University and is approved for its contribution to scientific knowledge and literary presentation.

Internal Examiners

Dr. E. C. I. Molokwu
Dept. of Physiology and Pharmacology, Faculty of Veterinary Medicine, A.B.U., Zaria.

Professor D. S. Adegboye
Dept. of Veterinary Pathology and Microbiology, A.B.U., Zaria.

Dr. N. I. Dim,
Animal Science Department,
Faculty of Agriculture,
A.B.U., Zaria.

External Examiner

Dr. Oyewole Adeyemo
Dept. of Anatomy
Faculty of Veterinary Medicine, University of Ibadan

Dean,
Postgraduate School,
A.B.U., Zaria

Date: September 21, 1985.

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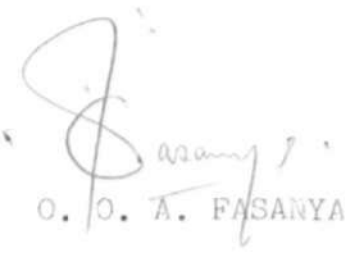
Dean,
Postgraduate School,
A.B.U., Zaria

Dr. N. I. Dim,
Animal Science Department,
Faculty of Agriculture,
A.B.U., Zaria.

Date: September 21, 1985

DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my research work. The 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.



O. O. A. FASANYA

Date: 21/9/85

DEDICATION

This thesis is dedicated to my son Opeoluwa Olusọla Babayemi, my daughter, Oluyinka Omolabake Ayọọla Morọmọkẹ, and my wife Marie Oluremi Fasanya.

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ABSTRACT

The gross and histologic changes of the postpartum uterus of primigravid Savanna Brown (SB) goats was studied. The peripheral blood progesterone levels at various postpartum interval was determined in these goats. Finally, the bacteriology of the tubular genitalia during the pre-breeding and postpartum period was also studied.

The weight of the entire postpartum uterus decreased markedly from a mean value of 432.0 gm to 191.121 gm between days zero and four. This reduction progressed steadily but more slowly to day 12 postpartum after which there was a slight increase by day 16. Thereafter, there was further decrease such that by day 32 postpartum, the mean value was 14.498 gm a value comparable to the weights of the non-gravid 3-day postoestrus uterus. The weight and circumference of the individual uterine horns follow this regression pattern.

The regression curves for weight and circumference of the involuting gravid and non-gravid uterine horns showed rapid reduction until day 18 postpartum. These parameters, which were higher for the gravid horn initially, decreased in such a

fashion that by day 18 both horns had attained the same values. After this time, both horns continued to regress more slowly at about the same rate until day 24 when these parameters began to increase.

Histologically, the maternal crypts were present until 8 days postpartum after which they disappeared. Trophoblastic cells were present in large numbers during the first 4 days postpartum after which their number decreased progressively. Leukocytes particularly small lymphocytes and some neutrophils were present in some of the uterine sections. By day 20 postpartum, areas of caruncular re-epithelization were observed and this appeared more regularly by day 24 postpartum.

The number of follicles on the left ovary ranged from 1 to 12, while that of the right ovary ranged from 1 to 18. The sizes of the follicles on both left and right ovaries ranged from less than 1 mm to greater than 3 mm in all the animals. Corpus luteum was present on the left ovary of six animals and on the right ovary of three animals. The peripheral progesterone level was either not detectable or reached a maximum level of 0.6 ng/ml in those goats which their ovaries carried visible corpus luteum.

The prebreeding vagina of nulliparous SE goats was not bacteria-free. Using prebreeding vaginal swabs taken from 29 goats, Staphylococcus sp. was isolated from 20 goats, Streptococcus sp. from 15 goats, and Micrococcus sp. from 4 goats. All the Staphylococcus sp. were coagulase positive and were identified as Staphylococcus aureus; all the Streptococcus sp. were identified as Streptococcus agalactiae except one identified as Streptococcus faecalis. A glucose-utilizing Mycoplasma sp. identified as Mycoplasma agalactiae was isolated from 5 goats, while Ureaplasma sp. was isolated from 3 goats. No commonly isolated Gram-negative organism was encountered in the prebreeding vagina swabs.

For the postpartum specimens, uterine swabs from the goats killed on day 2 yielded E. coli, on day 12, Micrococcus sp., on day 16, Staph. aureus, Micrococcus sp. and E. coli and on day 24, Staph. aureus. Concurrent infection with all three organisms was encountered in one of the goats killed on day 16 postpartum.

Strept. agalactiae was isolated from the cervix in one of the goats killed on day 4 postpartum, while E. coli was obtained from the cervix in a goat killed on day 16 postpartum. Furthermore, Staph. aureus was isolated from the cervix of a goat killed 24 days

postpartum while M. agalactiae was isolated from the cervix of a goat killed 8 days postpartum.

Based on gross and histologic changes in the tubular genitalia, it is concluded that the uterine involution in the SB goat is complete by day 24-28 postpartum and that it might be possible to re-breed the goat soon after since ovarian function is re-established as early as day 16 postpartum or before. The microbial flora of the vagina of the unbred nulliparous goats does not change much with pregnancy and parturition and there appears to be no specific pattern of colonisation of this tract with the microbial agents encountered. Histopathological examination of the uterus suggests that the bacterial agents merely colonized the epithelial surface of the genitalia without provoking any severe inflammatory reaction, hence they probably did not influence the uterine involution process remarkably.

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Chapter 1

GENERAL INTRODUCTION

GENERAL INTRODUCTION

Recent studies in Nigeria, show that goats are the second most important livestock next to cattle (Adu, Buvanendra and Lakpini, 1979). The importance of goat in livestock industry in Nigeria is also highlighted by an F.A.O. Report (1966). According to this report, the 1979/80 target for meat supply for Nigeria in tons was 300,000, 180,000 and 70,000 respectively. Goats play an important role in the economic and socio-cultural life of Nigerians since they serve as a quick source of income and are used in ceremonies and ritual sacrifices (Adu et al., 1979).

Goats are second highest in livestock population amongst tropical and subtropical countries (Devendra and Burns, 1970; Akerejola, 1982). Their relatively small body size signifies a low expenditure on the animal unit, and their high reproductive capacity brings a short term capital return. On the basis of their relatively small size, goat and sheep are suited to meet the meat requirements of families in rural areas where refrigerator is not commonly available (Molokwu and Umunna, 1980).

Gefu (1982) reported that goats represent close to 49% of the total grazing domestic livestock in Nigeria and they have a great disease tolerance, high fertility, favourable cost-yield ratio and they are more acceptable to a vast majority of rural inhabitants.

The estimated livestock population in Nigeria is presented in Table 1.1 and Table 1.2 shows information on goat distribution according to states. A projection production target for goats in 1985 is put at 38.8 million compared with a population of 12.1 million and 11.7 million for cattle and sheep respectively (Anon, 1974). This population projection is based on the assumption of a growth rate of 3% and it is expected that substantial increases in meat prices will eventually precipitate increases in off take and thus stimulate large scale holdings of ranches and an improved package of management and feeding practices in goat production (Molokwu, 1984).

Calving interval, lambing interval, kidding interval, and farrowing interval are terms commonly used in animal production to indicate periods between successive deliveries by a female animal. The duration of this period is a measure of reproductive

Table 1.1: LIVESTOCK POPULATION ESTIMATES OF NIGERIA ('000) - Gefu (1982)

Livestock	*NLDC	**FAO	***Devendra and Burns
Cattle	9,619	12,000	-
Sheep	6,025	8,500	-
Goats	17,000	24,000	29,000
Pigs	300	1,000	-
Poultry	38,000	110,000	-

* NLDC - National Livestock Development Committee (1974)

** FAO - Food and Agricultural Organisation (1980)

*** Devendra and Burns (1970).

Table 1.2: GOAT DISTRIBUTION ACCORDING TO STATES AND LAND AREA - Ngere et al. (1984).

State	Number ('000)	Area (Km^2)	Goat Density Head/km^2	Head/100 inhabitants
Anambra	400	17,360	23.0	11.1
Bauchi	1,500	67,282	22.2	61.7
Bendel	450	38,653	11.6	18.3
Benue	900	46,096	18.7	37.1
Borno	2,250	107,506	20.9	75.1
Cross River	450	35,570	12.6	12.9
Gongola	850	96,909	8.8	32.6
Imo	300	12,557	23.9	8.2
Kaduna	2,600	70,233	37.0	63.4
Kano	4,050	43,083	94.0	70.1
Kwara	600	61,373	9.8	35.0
Lagos	50	3,575	14.0	3.5
Niger	750	66,233	11.3	62.8
Ogun	450	17,414	23.0	25.8
Ondo	450	21,145	21.3	18.5
Oyo	1,100	36,829	29.9	21.2
Plateau	1,600	53,971	29.6	78.9
Rivers	150	18,160	8.3	8.7
Sokoto	1,950	102,531	19.0	43.0

efficiency and it is economically desirable that this period be short. One factor limiting reproductive rate in the goat is kidding interval which has been put at 222 days for the Savanna Brown (SB) goats (Molokwu and Igono, 1978). There is a well established gestation period in all species, although breed variation occurs in some species. The component of the kidding interval that seems logically open to manipulation would be the period from delivery to reconception.

An attempt to manipulate this period to the benefit of mankind, requires a precise knowledge of what goes on in the reproductive system at this time. The process of genital involution has to run to completion before pre-implantation changes can occur; so that this involution may be the most important limiting factor in an intensive breeding program.

An attempt to successfully manipulate the postpartum interval to obtain the maximum reproductive efficiency in goats would require an understanding of problems associated with postpartum infertility. This is of great economic concern in livestock and the causes are many. Among the most common causes is that due to infectious agents such as bacteria,

viruses, fungi and protozoa, which may directly or indirectly affect the genital tract and its product, the fetus. Among bacteria infectious agents alone are several species such as Brucella ovis, Streptococcus agalactiae, etc. capable of causing abortion and other reproductive problems (Carter, 1979).

A number of studies have been carried out on postpartum involution of the genitalia of some species. In indigenous cattle, the bacterial flora of the female genitalia has been studied (Eduvie et al., 1984) and similar study has been done in sheep (Koomson, 1980). Such study of the bacterial flora has been carried out on goat respiratory tract in Nigeria (Ojo, 1976) but one is not aware of similar studies on goat genital flora.

The objectives of the present study were, therefore to:

1. Provide fundamental data on postpartum changes in the genitalia of the SB goat of Nigeria;

2. Study the bacterial (including mycoplasmal) flora of the genitalia of the SB goat both during the prebreeding and postpartum

periods, in case this plays some role in rate of uterine involution.

Chapter 2

A REVIEW OF LITERATURE

I. THE SAVANNA BROWN GOAT

The Savanna Brown (SB) goat (Plate I) accounts for 60% of the total goat population in Nigeria which presently stands at approximately 21 million (Ngere et al., 1984). With the present distribution of goat in Nigeria particularly in the Northern states, this brown coloured goats appear to be more widely spread than any other group. This classification would include the Sokoto Red that have left their original geographical location and so have lost their purity as a result of cross-breeding with other strains. It would also include the Kano Brown and all the cross-breeds that have resulted from the Kano Brown and the Sokoto Red interbreeding with the more Southern breeds. Their common characteristics is the uniform brown colour of varying shades. It would be difficult to defend classifying these animals under the Sokoto Red (Maradi) as is proposed by Ngere, et al. (1984). The purity of the Sokoto Red in Nigeria could only be maintained by restricting the movement of goats into or out of the old Sokoto province, the original geographical location of this breed (Devendra and Burns, 1970). This would imply that any relaxation of this policy could no longer guarantee

that one is dealing with this breed.

The SB goat is highly prolific with very high twinning rate (Molokwu, 1984). According to this author, the twinning rates are 53.56% and 55.0% for the West African Dwarf goats, 35.14% for the Sokoto Red, and 42.9% for the SB goat. The author also gave the summary of the other types of birth as 19.18% and 35.0% singles for the West African Dwarf goats, 48.65% for the Sokoto Red, and 55.4% for the SB goats. The triplet rates have also been summarized by the author as 27.36 and 10.0% for the West African Dwarf, 16.22% for the Sokoto Red and 1.8% for the SB goats.

Other reproductive traits of the SB goat which have been reported include the age at first kidding which is estimated to be 14 months and the birth weight which is put at 1.7 kg for single males, 1.6 kg for twin males, 1.6 kg for single females and 1.5 kg for twin females (Molokwu and Igono, 1978).

The greatest attribute of these animals is their ability to reproduce throughout the year, with three kidding peaks (Molokwu and Igono, 1978). Unfortunately these authors reported these animals to have a long kidding interval of 222 days. To

maximise the breeding performance of this breed the kidding interval has to be shortened. To do this calls for a knowledge of the postpartum reproductive physiology from kidding to reconception.

II. THE POSTPARTUM OVARY

Early resumption of activities of the ovary following parturition would be extremely beneficial since it determines when the next ovulation can occur. There are reports on a number of factors that would readily affect postpartum ovarian activity. Such factors include age, nutrition, season and suckling.

Age has been found to significantly increase or decrease the interval from parturition to first oestrus in cattle (Herman and Edmondson, 1950). Their observation agreed with that of Hammond and Sander (1923) who found that the interval from parturition to first oestrus in cattle became shorter with age until after the third or fourth calving. The interval became longer again in those cows after the sixth, seventh and eight calving. In the observation of Herman and Edmondson (1950) the interval from parturition to first oestrus for cows between the ages of less than 2-3 years was between 60-75 days. The interval decreased

to 50-60 days for cows between 3-10 years while those between ages 13-14 years showed an interval of 90 days.

Reports on the effect of nutrition on ovarian activity vary particularly in respect of postpartum oestrus. Van Niekerk and Mulder (1965) noted that differencies in feeding levels and the method of feeding may be a source of variation of postpartum interval to oestrus in a particular breed of sheep even when lambing occurs the same time each year. Hunter and Lishman (1967) did not find any significant effect of feeding a supplementary ration of one pound maize per ewe daily for 25 days after lambing on the postpartum interval to ovulation or oestrus in ewes. Other workers such as Wagner and Veenhuizen (1968), Whiteman et al. (1972) did not observe any significant difference between early and late weaned ewes with respect to the first postpartum oestrus when on a high plain of nutrition.

However in the cow reports show that nutrition plays a significant role in the occurence of first postpartum oestrus. Wiltbank et al. (1962) did observe that occurence of oestrus may be influenced by the level of feeding. They showed that the intervals from calving to first oestrus in mature

Hereford cows fed different levels of energy pre-and postpartum were 48 days for the high-high level group, 43 days for the high-low level, 65 days for the low-high level and 62 days for the low-low level of feeding. The conception rates reported for the different feed levels were 95, 77, 95, and 20% respectively.

For pos partum beef cows at different levels of feeding, Wiltbank et al. (1964) noted that cows given 16.5 Ib total digestible nutrients (TDN) had a significantly shorter interval from calving to first oestrus ($P<0.01$) than those given 12.5 and 2 25.0 TDN during the first five weeks postpartum and 16.4 Ib thereafter (49 days vs 73 and 77 days). These reports suggest that high level of plain of nutrition will tend to shorten the postpartum interval to first oestrus while low level of plain of nutrition will increase this interval.

El-Sheikh and Mohammed (1976) in buffaloes reported that the season of calving had a marked effect on postpartum heat interval. In their observation the longest interval from calving to first heat was 163.03 days in autumn, while it was shorter in summer 79.42 days.

Clapp (1937) noted that the interval between calving and first oestrus for cows milked four times a day was 69.4 days, 46.4 days for cows milked twice daily, while that for nursing cows was 71.8 days. He suggested that the frequency of suckling or handling of the teats in milking might be the main cause of the difference in the length of the postpartum interval to first oestrus between cows milked twice daily and those milked four times daily or suckled.

Lactation in the ewe has a pronounced effect on the expression of postpartum heat and subsequent conception (Hafez, 1952b). It was also concluded that lactation seems to defer postpartum oestrus. In his study with the suffolk ewes, (Hafez, 1952b), postpartum heat was experienced in 56% of the ewes, while a second lambing only occurred in 50% of the mated ewes. Ewes which do not show any heat may have a short breeding season and either experience a few silent heats or have quiescent ovaries during lactation period (February and March). He noted that the length of lactation anoestrus after the first lambing (January and February) is shorter than that after the second lambing (July and August). In the later case, the period of lactation anoestrus was infact partly lactation anoestrus and partly

true anoestrus. He also reported a 100% post-partum conception rate in the non-suckling ewes while this was low in suckling ewes.

Miller and Wiggins (1964) showed that lactating ewes have one or more quiet ovulation before the first oestrus after lambing. They observed that in 39 out of 40 cases, the range of the interval from quiet ovulation to first oestrus was 16 to 19 days and infact, Mauleon and Dauzier (1965) and Hunter and Lishman (1967), showed that most of the ewes in their experiment ovulated well before the first postpartum heat and that lactation did not appear to suppress ovulation in ewes which had lambed in the autumn months.

Lactation and or milking have a definite effect on reproduction and in several species of livestock such as cow, pig and sheep, lactation and milking prevents maturation and ovulation of ovarian follicles (Wagner and Oxenreider, 1971). They also noted that because of the interference of season in many of the studies so far reported, the evidence of the effect of lactation and or milking in the ewe is not very clear and that suckling or lactation does not prevent cyclic ovarian activity in the postpartum mare. In the cow Wiltbank and Cook (1958) showed

that dairy cows milked twice a day had a shorter interval from calving to ovulation than those suckling calves. Also Oxenreider (1968) noted that the time interval between parturition and ovulation was shortened by treatment with gonadotropins and by preventing calves from suckling. He reported that cows which were suckled by 2 calves required a longer time for ovulation than the controls and concluded from his result that suckling had an inhibitory effect on ovulation.

Minaquchi and Meites (1967) observed that suckling reduced pituitary and ovarian weights at 18 days postpartum and that pituitary and [illegible] luteinizing hormone (LH) decreased while prolactin increased. Also, Van Niekerk and Mulder (1965) [illegible] noted that additional nutritive requirements imposed by lactation as opposed to the hormonal side effects of lactation, play a role in inhibiting the occurence of postpartum oestrus in lactating ewes. These reports show that suckling and milking might cause a delay in the resumption of postpartum ovarian activity.

Hutchinson and Robertson (1965) observed that the ovarian follicles in sheep increased in size during the immediate pre-and post-ovulatory phase

of the cycle. This observation was in partial agreement with the findings of Quinlan and Mare (1931) who suggested that there was rapid enlargement of the follicles destined to rupture at the next oestrus shortly after ovulation, and that the follicles continue to grow very slowly during the remainder of the interoestrus period.

Barker and Wiggins (1964a & b) observed that 9% of the 240 Rambouillet ewes they studied exhibited oestrus between 15 and 27 hours after parturition but laparatomy showed that ovulation did not accompany it. The average interval from parturition to the establishment of a regular cyclic pattern of oestrual behaviour in this study was also observed to be 73 days (range 12 to 293) and 86 days (range 8 to 253) for grade Rambouillets and 39 days (range 14 to 77) and 66 days (range of 28 to 103) for pre-Dorset ewes for the years 1957-58 and 1958-59, respectively.

In their study, Mauleon and Dauzier (1965) found that 60% of the ewes they studied by laparatomy had their first ovulation within 25 days of lambing.

Gould and Whiteman (1973) evaluating the postpartum oestral activity and subsequent reproductive performance of 80 mature early weaned spring lambing ewes (lambs weaned at 30 days of age), 77 mature control lambing ewes (lambs weaned at 70 days of age) observed that a larger percentage ($P<0.05$) of the early weaned ewes mated postpartum had shorter interval to first oestrus.

Ovarian changes were detectable at 5 to 7 days postpartum by follicle growth progressing until first ovulation which occurred frequently in normal cows as early as 10-15 days (mean 15.0 ± 3.9) postpartum (Morrow et al., 1966). In the same study, they observed that normal cows had two ovulations during the first 30-35 days after parturition while abnormal cows, had one ovulation (mean 34.4 ± 30.3 days) after parturition. They equally observed that the occurence of silent or unobserved oestrus and ovulation in experimentally normal cows decreased in frequency with each oestrus cycle i.e. 79.0% frequency of silent oestrus at first oestrus decreased to 55.0% at the second oestrus period in experimentally normal cows ($P<0.005$).

Also, Morrow et al. (1966) noted that the mean interval from parturition to first oestrus is 15 days and normal corpora lutea occurred 62.5% of the 357 postpartum period studied. Furthermore, the corpora lutea (CL) of pregnancy regressed early in the postpartum period and did not prevent the onset of first postpartum oestrus.

There are also reports indicating wide ranges in the period of oestrus after parturition in other species. Chapman and Casida (1937), reported that rabbits, rats, guinea pigs and mice came into oestrus a few hours postpartum, but that they did not resume the periodicity of oestrus when suckling in a normal size litter. A range of 3 to 100 days have been indicated as the period of coming into oestrus in the mare but 92% of the cases studied were shown to fall between the limits of 5 and 12 days with a shorter interval in older animals (Satō and Hoshi, 1934). In sow, this period is given as 4 to 9 days postpartum (Quinlan and Mare, 1931).

Ovulation usually takes place on the first, second and in exceptional cases, the third day of oestrus. It is noted that during active season, ovulations follow each other at regular intervals

as do the oestral periods, whereas during inactive season, ovulation does not take place (Kupfer, 1928).

Lee (1926) showed that cold tends to lengthen the oestrus cycle of rats. Similarly, in guinea pig Stockard and Panicolaou (1917) found slightly longer cycle in winter. Duncan (1883) noted that menstrual cycle of women in Lapland and Greenland is longer than those of hot countries, and Engle and Shelesnyak (1934) noted that long menstrual intervals in puberal girls are most frequently initiated in July when it is fairly warm.

Progesterone levels generally decline in all animals before parturition except the human where plasma progesterone concentration remains constant or increases slightly as parturition approaches (Llauro et al., 1968, Csapo et al., 1971). Stabenfeldt et al. (1970) and Henricks et al. (1972) in the cow reported that peripheral plasma progesterone level was found to decrease from 6.8 ng/ml on day 250 of gestation to approximately 4 ng/ml during the final week of gestation, and this was followed by a further abrupt decline to less than 1 ng/ml about 24 hours prior to parturition. The decline was observed to continue postpartum. Also,

Echternkamp and Hansel (1973) noted that after parturition the progesterone levels in bovine declined to low undetectable levels until the initiation of corpus luteum formation following the first ovulation. In another study Smith et al. (1973) noted a marked fall in plasma level of progesterone from 7.6 ng/ml at 2 days prepartum to 0.6 ng/ml at parturition. During the early postpartum period, serum progesterone concentration remained low, averaging 0.6 ng/ml from day 0-9 postpartum.

Molokwu and Wagner (1973) indicated that the progesterone level in the sow begins to decline about 4 or 5 days before farrowing and then decreases abruptly during the last 48 hours. The levels of progesterone in the peripheral plasma at the time of farrowing for all the animals were below 1 ng/ml. The decline recorded in that study was from 11 ng/ml on day 4 prepartum to 0.5 ng/ml on day 1 postpartum. This study showed that the low level of peripheral plasma progesterone in the sow was maintained till about day 7 postpartum.

The above studies show that postpartum peripheral plasma progesterone levels in most domestic animals appear quite low at the early postpartum

period. This might be due to the fact that the corpus luteum of pregnancy might have undergone regression and that the placental source of progesterone if it existed had significantly declined.

III. UTERINE INVOLUTION

Rasbech (1950) defined uterine involution as the return to normal oestrual secretory cycles. It comprises of the reduction in size of the uterine mass and the re-establishment of normal uterine morphology (Wagner, 1968). In animals with cotyledonary placentation such as the cow and the ewe, this process of repair and regeneration is usually quite extensive (Wagner, 1968) and takes from 25 to 50 days (Duch et al., 1955, Morrow et al., 1966). Gier and Marion (1968) put the changes occurring during uterine involution as involving three overlapping processes: (1) reduction in size; (2) loss of tissue and (3) the repair,

Cows

Foote et al. (1960) investigated the influence of delayed uterine involution on subsequent fertility. In cattle the maintenance of yearly reproductive cycle is greatly dependent upon the

rapid return of the female genital organs to its non-gravid size and function following parturition. Informations available on the rate of uterine involution in cattle is based on clinical involution as shown by the return to normal tone, position and size of the genitalia as determined by rectal palpation, on gross measurements of weights, diameter, length of uterine horns or on histological studies on caruncular changes in slaughtered cows or ewes (Morrow et al., 1966, Tennant et al., 1967).

Casida and Venzke (1936) based on rectal palpation, found that the bovine uterus involuted to normal position, size and form within 26.2 ± 0.1 days following parturition. Using the same method Tennant et al. (1967) observed that for the 2,338 genital organs examined, the rate of uterine involution was rapid and constant during the period 10-30 days postparturition. They found that changes in the diameter of the uterine horns of these animals thereafter occurred slowly with no changes taking place after 40 days postpartum. These findings were however not in agreement with the reports by Casida and Venzke (1936) who suggested that the bovine uterus involuted to normal position, form and size within 26.2 ± 0.1 days following parturition; and Rasbech (1950) who on the basis of rectal examinations

as well as gross and microscopic studies of the postpartum uterus concluded that the postpartum uterus of primiparous cow appear to involute completely within 18 to 20 days while that of the multiparous cow involutes within 20 to 25 days following parturition.

Observations by Morrow et al (1966) showed that the size of the uterus decreased slowly during the first 4 to 9 days after parturition and that there was a marked decrease in uterine tone from days 10 to 14 postpartum. In this study, the rapid involution was associated with a concomittant discharge of uterine lochia. They also observed that the main decrease in size of the pregnant horn was complete by 25 days postpartum in normal cows and by 30 days in abnormal cows.

Oyedipe et al (1980) found that in the Bunaji and Friesian-Bunaji cross cows, involution was complete in 17 and 16 to 30 days respectively.

Wagner and Hansel (1969) observed that exudates on the uterine mucosal surface appeared to begin at a point basal to the maternal crypts. By day 12 to 14 postpartum, the necrotic tissue had sloughed from the surface of the caruncle and epithelial regeneration was beginning from the edge of the

caruncles. Complete uterine mucosal epithelium was re-established by day 30 postpartum.

Detailed studies on the progression of uterine involution based on histological findings have been reported by a number of workers. Gier and Marion (1968) observed that although the necrosis of the septal mass had begun; organizational structure of the septum and crypts containing remnants of villi was maintained to the end of the *second day after parturition in the cow.* The necrosis of the septal mass progressed steadily and sloughed off leaving a mass of leukocytic laden necrotic layer 1 to 2 mm thick over the stratum compactum. Also in the cow, Wagner (1968) observed that the line marking the limit of necrosis and sloughing of caruncle is quite evident by day 7 postpartum. They showed that loss of cellular organisation was complete by day 5, except for the persisting blood vessels and clumping of leukocytes.

In a bovine caruncular section, Archbald et al. (1972), observed remnants of chorioallantoic cells in the maternal crypts on day 1 postpartum. These cells underwent necrosis and mineralization and were phagocytized by macrophages or were expelled with lochia by day 11 postpartum. Gier and Marion (1968)

also reported the presence of chorioallantoic cells in the lumen of the maternal crypts at day 2 postpartum.

Progressive vascular changes in the medium sized and smaller arteries of the caruncular stratum compactum have been observed during day 1 - 19 postpartum in the cow (Archbald et al., 1972). These changes consisted of hydropic degeneration of the cytoplasm and pyknosis of the smooth muscle fibre cells of the tunica media and fibrinoid necrosis of the tunica media. With these progressive vascular changes, necrosis and sloughing of the superficial area of the caruncles were observed at days 6 - 7 postpartum and by day 15 postpartum, the stratum compactum was reduced to the level of the intercaruncular area.

These authors also reported the presence of both degenerated and regenerated epithelial cells in the intercaruncular epithelium on day 1 post-partum. The degenerated cells were confined to the basal areas of the epithelium and were characterised by pyknosis and cytoplasmic vacuolation, while the regenerated cells were interspersed amongst the degenerated epithelial cells and were characterised by large hyperchromatic nuclei and

granular cytoplasm. They noted that the process of regeneration and degeneration continued simultaneously until day 15 postpartum and that the endometrial glands exhibited a pattern of simultaneous degeneration and regeneration similar to that observed for the intercaruncular epithelium. They also observed that at no time during the process of uterine involution was the intercaruncular area devoid of an epithelial layer.

Ewes

Information from slaughtered ewes showed that three quarters of the uterine weight (excluding its contents) was lost during the first week postpartum and the uterine weight was restored to the level of the non-pregnant uterus by four weeks after parturition (Basset, 1963).

Lactation and suckling play a major role in the process of involution in this species. Foote and call (1969) recorded mean uterine weights of 1,256; 1,089; 261; 106 and 96 for days 0, 3, 10, 17 and 24 postpartum respectively in lactating ewes. They noted that the process of involution was essentially complete by day 17 postpartum based on the reduction in the uterine parameter. The mean

weight for day 24 postpartum in non-lactating ewes in their study was 67 gm. The breed of lactating ewes used in the study was however not stated.

Uterine involution in sheep based on macroscopic finding was complete between 20 and 24 days postpartum (Van Wyk et al, 1972b). There was also a rapid reduction in the weight of the uterus in the first eight days postpartum. The greatest reduction occurred during the first 12 days postpartum. In this study, the authors observed that even though the recently gravid uterine horns had undergone maximum reduction in length by day 20 postpartum, the diameters of the uterine horns had not yet done so by this time.

Van Wyk et al., 1972a) also studied histologically the postpartum involuting uterus of the ewe from 3 hours postpartum to 28 days postpartum and observed that at 3 hours postpartum, the fetal villi had been withdrawn together with the fetal membrane and the parallel spaces they occupied were easily discernible. Fetal cells such as trophoblast cells, binucleate giant cells and symplasma cells could be seen in these places. By 12 hours postpartum, the maternal villi began to collapse and the regular parallel arrangements were

no longer discernible and degenerative changes such as pyknosis were seen. The entire tissue had degenerated into an amorphous mass with the cells undergoing pyknosis, karyorrhexis and karyolysis by 48 hours postpartum. By day 16 postpartum and thereafter, the upper part of the caruncle was a brown necrotic plaque which was later lost leaving a naked connective tissue surface over which the epithelium will begin to extend from the sides. The epithelium was noted to have completely covered the caruncles by day 28 postpartum. These workers remarked that the very sparse infilteration by leukocytes into the caruncle during involution indicated the relative insignificance of the role played by these cells.

Sow

In the sow, Palmer et al (1965a) noted that the length of the postpartum uterus decreased markedly from approximately 240 cm on day 1 to 120 cm on day 28 of lactation and then remained relatively unchanged for the rest of the lactation period. They also observed some increase in the length of the uterus following weaning, after the effect of lactation or suckling was removed. Also,

a rapid decline in the uterine weight from day 1 to 28 of lactation was observed. The authors showed from the data on the weights and length of the uterus of the sow that involution had been completed by day 21-28 after parturition. Their observation was contrary to that of Rumjancev (1954) who believed that postpartum involution was complete by day 18 after farrowing. This report was not supported by any gross measurements.

Detailed microscopic study of the early post-partum uterus of the sow showed that hypertrophy of the uterine musculature occurred during pregnancy and that the uterine gland epithelium appear to degenerate during the immediate postpartum period and that regeneration began at 7 days postpartum and was complete by 21 days postpartum (Palmer et al., 1965b).

Does

Based on the weights, lengths and dimensions of the goat genital tract, Teilgy et al. (1982) concluded that these organs returned to the initial non-gravid state within a period of 28 days after kidding. They showed that decrease in the weight of the uterus occurred during the first 14 days

followed by a gradual decrease in the next two weeks. A decrease in lengths and diameters of the pregnant horns were gradual as shown by the correlation regression between the dimensions and postpartum intervals of -1.524, -0.257 and -0.190 respectively. They also observed a great variation in different dimensions of the non-gravid horn as indicated by the correlation regressions -0.890, -0.229, and -0.359 respectively and noted that by day 28 postpartum, the gravid horns were similar to the non-gravid horn.

IV. BACTERIOLOGY OF THE FEMALE REPRODUCTIVE TRACT

Infertility in livestock is of great economic concern and the causes are many. Among the most common causes, is that due to infectious agents such as bacteria, viruses, fungi and protozoa which may directly affect the genital tract and its product, the fetus. Among bacterial infectious agents alone, are several species, capable of causing abortion and other reproductive problems (Carter, 1979).

Quinlivan (1970), Adams (1975) and Sawyer (1977), reported the isolation of a large number of infectious organisms from the reproductive tract of

the sheep. Large numbers of bacterial organisms were present in progestagen impregnated sponges used for synchronisation (Robinson, 1964). In their own work, Moore and Robinson (1967) observed the presence of large numbers of bacteria organism when various bactericides were being tested using intravaginal sponges. They demonstrated that the prevailing species, present in the sponges after withdrawal, include Corynebacterium sp. and gram negative bacilli (Enterobacteriaceae). In those sponges inserted without any bactericide, a great number of bacteria were noted, while a gram positive bacteria (diphtheroids), gram negative bacilli, streptococci and other miscellaneous bacteria were observed in vaginal smears taken at the time of sponge withdrawal.

Adams (1975) isolated a number of bacterial organism from the uterus of 59 of the 217 ewes he studied. In that study, the following bacteria genera were isolated in order of occurence: Corynebacterium, Escherichia, Streptococcus, Bacillus, Proteus Staphylococcus, Micrococcus, Enterobacter, Pasteurella and some unidentified gram negative and gram positive organisms. In the case of Sawyer (1977), more than one organism was isolated from broth

samples from the cervix of ewes. The predominant isolates obtained were Achromobacter sp., Alkaligenes sp., Corynebacterium sp., Bacillus sp. and Escherichia coli. Potentially pathogenic bacteria such as Pasteurella multocida, Corynebacterium pyogenes, Staphylococcus sp. and Streptococcus sp. increased after developing embryos were experimentally killed with colchicine.

The presence of subclinical infections in the uterus during the breeding season, may contribute to reproductive failure in the ewe, especially when a close association has been shown between the presence of bacteria and the occurence of endometritis and cyst of the cervix (Adams, 1975). In that study, E. coli and Streptococcus sp. were the most common bacteria organisms associated with endometritis.

Several infectious agents have been noted as causes of abortion, prenatal mortality and infertility in sheep (Hindmarsh and Blumer, 1932; Stamp, 1950; Paulsen, 1953; Henning, 1956; Watson, 1962a; 1962b; 1962c; Gorrie, 1962; Smith, 1962; Dennis, 1967; Watson, 1973). Such infectious agents include Brucella sp., Blue tongue virus, Clostridium chauvoei, Corynebacterium sp., Campylobacter fetus var

intestinalis, Chlamydia sp. (causing enzootic abortion of ewes) Leptospira sp., Listeria monocytogenes, Salmonella sp. etc. Protozoans such as Toxo plasma gondii and rickettsia organisms such as Ehrlichia sp. are also included.

Hindmarsh and Blumer (1932) recovered organisms that appeared to be irregularly shaped cocci or bacilli in short chains, and a few large bacilli from smears of the genital organs from the sheep they studied. In the uterine smears, the irregularly shaped cocci or bacilli and some small gram positive organisms were very abundant. Some of the colonies they obtained showed the presence of staphylococcus organism. They however did not indicate the details of the organisms isolated, but they proved that these organisms would cause rapid abortion in quinea pigs.

Quinlivan (1970) showed that bacterial examination of cervical mucus from ewes at the first and second oestrus following synchronisation with "cronolene" impregnated intravaginal sponges showed a decrease in the incidence of miscellaneous organisms such as Corynebacteria, Micrococci and Streptococci and a slightly higher incidence of mixed growths of predominantly gram negative organisms of the coliform

type and of the potential pathogens such as E. coli and C. pyogenes. It was also noted that the particular environment prior to or at first oestrus favoured the growth of particular species of bacteria and that continued contamination may be effected, in part, by faeces and urine on the string of the sponge used.

Zaki and Saber (1963) and Quinlivan (1970) noted that the normal pattern of bacterial populations of the cervical mucus of ewes is that of a dominance of gram positive bacteria with anthracoids, Micrococci, Corynebacteria, E. coli and Streptococcus. Animals with normal breeding history have been shown to have mixed bacterial population e.g. goats (Bhaskaran and Bastrain, 1963), cattle (Rawson et al. 1953; Shalka and Svojanovska, 1963; Zaki et al., 1963), and in buffaloes (Zaki et al., 1961).

In humans, the bacterial flora of the cervical canal varies within any one individual within relatively brief periods of time (Matthews and Buxton 1951, Oliver et al., 1965) due to various sources of contamination such as coitus, environment, hormonal status, and drug therapy in an area with an abundant microbial population mainly due to contamination from the intestinal tract.

The genital site from which samples for bacteriological isolations are obtained, greatly affects the number of organisms found. Weitz (1947) from studies of the bacteria present in the posterior vagina of normal cows, noted the presence of non-hemolytic Streptococcus, Staphylococcus, E. coli, B. subtilis and various diphtheroids, including C. renale and C. pyogenes. Laing (1955), reports a similar finding but noted that the organisms seem to be present in large numbers in the vestibule and posterior vagina and decreases in the anterior vagina with the cervix showing the least population.

In human, considerable evidence has been placed on the distribution and effect of microorganisms in the cervical mucus as a possible cause of infertility (Matthew and Buxton, 1951; Sobrero, 1962; Oliver et al., 1965), but the significance of these findings is debatable because of the ability of the genital tract to overcome infection. The higher incidence of organisms, particularly potential pathogens and the high probability of an associated increase in polymorphonuclear leukocytes, could be a factor involved in the relatively low fertility commonly observed following insemination at first oestrus shown by Quinlivan and Robinson (1967) and

and (1969), to be associated with an altered pattern of sperm transport.

Moorthy and Singh (1982) reported that 82 of 86 live sheep and all 9 dead sheep they examined harboured different species of bacteria in the genital tract. Corynebacterium sp. were predominant in the anterior vagina and cervix of live sheep (77.9%) followed by Escherichia sp. (46.5%), Staphylococcus sp. (39.4%) and Streptococcus sp. (38.4%). The uteri of dead sheep yielded mostly Corynebacterium and Staphylococcus species. They also isolated three strains of B. melitensis from apparently normal, non-pregnant and normal gravid uteri of sheep and noted that other species of the various genera such as Micrococcus, Neisseria, Bacillus, Alkaligenes, Flavobacterium and unidentified diphtheroids may contribute to the normal flora as saprophytes or may be associated with genital infections of ewes together with other pathogens.

At parturition, it is usually believed that the uterus is sterile and that normal involution proceeds aseptically, because the lochia discharge is bacteria free. However, Rasbech (1950), in his investigation revealed that the uteri of a number of cows become infected by a number of non-specific

bacteria during the puerperium.

Varying reports of the bacteria flora of the genitalia of clinically normal cows are available. Clark and Stevenson (1948) reported a 0% uterine infection in the cow, while Wulf and Dracy (1952) recorded 100% infection. Hartigan (1978) indicated the role of non-specific uterine infection in the infertility of clinically normal repeat breeder cows and stated that majority of reports on the incidence of infection for both fertile and repeat breeder cows fall within the range of 20 to 40%.

In the report of Rasbech (1950), puerperal uterine infections in clinically normal cows occurred with a frequency of 25 to 30% in a herd of 203 cows. In that study, Corynebacterium pyogenes in pure cultures was common (28.3%) followed by Escherichia coli (26.7%). Staphylococcus sp. in pure culture was demonstrated in 16.7% of the cases while infection of group B - Streptococci was demonstrated in two cases.

Eduvie et al. (1984) reported that the incidence of uterine contamination from both suckled and non-suckled cows sampled on different days post-calving was 29.2%. This fell within the range of

20 to 40% reported by Hartigan (1978) for both fertile and repeat breeder cows. In the same study, Eduvie et al. (1984) noted that the pattern of contamination indicates a rise between day 10 and 12 postpartum followed by a decline thereafter. The rise coincided with the beginning of massive sloughing of caruncular tissue along with increased discharge of lochia. He noted that Staphylococcus sp. was the commonest organism.

Gourlay (1974), Livingston and Gauer (1975), and Ogata et al. (1978), isolated ureaplasmas from the urogenital tracts of goats in England, United States and Japan, respectively. In addition to other parts of the animal surveyed, Kotani et al., (1980), also isolated Acholeplasmas from the urogenital tracts of the goats.

Gourlay et al. (1977) also isolated ureaplasmas from the genito-urinary tracts of goats and successfully produced an experimental sub-clinical mastitis in lactating does using human ureaplasmal isolates. Ureaplasma sp. serotype 1202, (a serotype of ovine origin) has also been isolated from the reproductive tracts of goats (Kotani et al., 1980) and has been associated with uterine infection in sheep, and was isolated from the vagina of does and

semen of bucks in a flock experiencing reproductive problems (Livingston Jr. et al., 1978).

In Nigeria, Ureaplasma sp. (T-mycoplasma) has been reported from the vagina of clinically healthy cows in this environment (Adegboye and Hassan, 1976), while this mycoplasma-related microorganisms and typical mycoplasmas such as M. bovigenitalium have also been cultured from the genital tract of apparently healthy cows and bulls in the environment (Fasanya, 1980; Adegboye, Fasanya, Bwala and Hassan, 1982). Similarly in goats, Chima, Ezeugwu, Onoviran and Adewuyi (1981) isolated M. agalactiae from goats and they suspect it might be a cause of vulvovaginitis in Nigerian goats, a condition which interferes with mating process. These authors also studied the vagina flora of vulvovaginitis-free goats as controls and reported the isolation of Staphylococcus sp., Streptococcus sp., Corynebacterium sp., Pasteurella sp. and Klebsiella from some goats.

In his study Quinlivan (1970), concluded that there is an increase in the coliform organisms, specifically E. coli, Alkaligenes sp. and other gram negative bacteria and C. pyogenes probably

through contamination of the string by faeces and urine. Hartigan et al (1974), noted that a persistent infection by C. pyogenes caused severe endometritis, delayed uterine involution, induced anoestrus and caused prolonged infertility or even sterility.

These studies indicate that a knowledge of resident bacteria in an involuting genital tract especially the uterus in a host is desirable as this may influence involution process.

Chapter 3

SERUM PROGESTERONE LEVELS AND OVARIAN STRUCTURES DURING THE POSTPARTUM PERIOD IN THE SAVANNA BROWN GOATS

INTRODUCTION

The concentration of progesterone in the peripheral blood in non-pregnant female farm animals, is an accurate index of the presence of functional corpus luteum (CL) Perera and Abeyraine (1982). Oestrus manifestation is also an indication of ovarian activity. Serum concentrations of reproductive hormones such as progesterone are also useful in monitoring ovarian activity.

There are reports on follicle size at various times postpartum. In cattle, Casida and Venzke (1936) stated that the interval from calving to the presence of a 12mm follicle was 12 days. Also, Labsetwar et al (1964) noted that mature follicles were present in the cow by 21 days postpartum. The largest follicle present in the ovary of milked cows averaged 9.6mm on day 7, 11.3mm on day 14 and 13.1mm on day 30 postpartum (Wagner and Hansel, 1969).

This study was carried out to examine the postpartum ovarian structures in Savanna Brown (SB) goats and relate the findings to the postpartum manifestation of oestrus and the peripheral progesterone levels.

MATERIALS AND METHODS

Twenty nulliparous SB does were purchased from local markets in Zaria Environs. Their ages ranged from 6 months to one year and they weighed between 13-20kg. The animals were first kept in the pen for a 6 week observation period during which they were fed ad libitum with hay and wheat offal. They were also observed for any clinical manifestation of illness.

One animal each was slaughtered on days 0, 1, 2 and 8 postpartum while two animals each were slaughtered 4, 12, 16, 20, 24, 28 and 32 days postpartum. Two animals were slaughtered 3 days post-oestrus to obtain baseline data. Prior to slaughter of any doe postpartum, they were observed for oestrus using vasectomized and intack bucks. Also, 10mls of blood was obtained via the jugular vein. This was kept in an ice pack compartment and taken to the laboratory. The blood was refrigerated for 10 minutes and serum separated. The serum was then stored at $-4.0^{o}C$ until assay for progesterone.

At the time of slaughter, the entire tubular genitalia was removed. The ovary was neatly trimmed by removing all attached connective tissues. The

corpus hemorrhagicum and corpus luteum on the ovaries were noted, while the follicles were counted and sizes measured. Each ovary was then weighed and the volume was determined by the water displacement method: distrilled water was put into a measuring cylinder, each ovary was then dropped and the new water level recorded. The volume of each ovary was taken as the difference in volume.

Progesterone Assay

The serum was thawed just before the assay at room temperature prior to use. The radioimmunoassay procedure used for the progesterone assay is similar to that described by Pathiraja et al (1985) using a commercially available progesterone kit, (Diagnostic Products Cooperation, California, 90045).

The Procedure is as follows:

To antibody coated tube, 100 µl of standard (0.1 to 40ng/ml) or sample and 1 ml of buffered I^{125}-labelled progesterone solution were added. This mixture was incubated for 3 hours at room temperature. The liquid phase was discarded (no centrifugation was required), and the radioactivity bound to the antibody coated tube was counted. The immunogen used to raise

the antibody and to produce radioiodinated progesterone (Tyrosine methyl ester) are 11 alpha linked conjugates. The sensitivity of the assay technique defined as twice the standard deviations of blank values was 0.081ng/ml. Assay values were calculated by using a linear logit-log dose response curve of the standard concentrations added and I^{125} progesterone displaced.

RESULTS

Oestrus manifestation was observed in one animal on the 16th day postpartum. However, this was not followed by a standing oestrus. Further oestrus which resulted into mounting by the bucks were observed in two animals by day 24 postpartum.

The number of follicles on each ovary varied from one ovary to the other. They ranged from 1 to 12 on the left and ranged from 1 to 18 on the right ovary (Table 3.1). Corpus luteum was present on the left ovary of six animals. It was also present on the right ovary of three animals but one for day 4 postpartum was regressing (Table 3.2). The diameter of the follicles on both left and right ovaries ranged from less than 1mm to greater than 3mm in all the animals (Table 3.1). All through the postpartum

period studied, the individual weights and volumes of the left and right ovaries were not significant different P>0.05 (Table (3.3).

The serum progesterone levels ranged from non-detectable to 0.6ng/ml (Table 3.2) in the goats studied.

DISCUSSION

The fact that there is no significant difference (P>0.05) in the individual weights and volume of the left and right ovaries, might suggest that throughout the observation period both ovaries maintained a relatively similar level of activity. This could be supported by the fact that numerous distinct follicles were present in both ovaries at the same periods postpartum. This could also explain the postpartum oestrus observed on day 16 and 24 postpartum.

Most of these animals whose ovaries had corpus luteum showed detectable amount of serum progesterone. Serum progesterone levels were not determined in seven animals because of storage defects. Three of such animals had corpus luteum on their ovaries (Table 3.2). The levels of progesterone observed in 3 animals on day 4, 12 and 20 postpartum were quite

close to the values for the baseline animals 0.5 and 0.6 ng/ml, which had corpus haemorrhagicum.

The postpartum peripheral progesterone level of the SB goats relates to the presence of corpus luteum during the early postpartum period. However, there were animals without corpus luteum or corpus hemorrhagicum which had detectable progesterone levels. The reason for this is uncertain, but it is unlikely that this progesterone would be of ovarian source. In sheep Robertson (1974) indicated that basal progesterone concentration of 0.2ng/ml presumably arises from the adrenal cortex since similar levels are found in ovariectomised ewes and in intact ewes during seasonal anoestrus. On the basis of this view, it could be that the progesterone detected in the SB goats without corpus luteum was released by the adrenal cortex.

SUMMARY

The postpartum peripheral progesterone level of 20 Savanna Brown goats were assayed. The weights and volumes of the postpartum ovary were also determined for the same goats.

The number of follicles on each ovary ranged from 1 to 12 on the left and from 1 to 18 on the right. The diameters of follicles on both left and right ovaries ranged from less than 1mm to greater than 3mm in all the animals. Corpus luteum (cl) was present on the right ovary of three animals but that on day 4 postpartum was regressing. CL was also present on the left ovary of six of the animals. The weights and volume of the left and right ovaries did not show much difference throughout the postpartum period studied. Postpartum serum progesterone level was either undetectable or reached a maximum detectable level of 0.6ng/ml.

The fact that there was no difference ($P>0.05$) in the individual weight and volume of the left and right ovaries of these animals might suggest that they maintained a relatively identical level of function throughout the postpartum period. Also the postpartum serum progesterone level of the Savanna Brown goats relates to the presence of corpus luteum.

Table 3.1: Postpartum ovarian follicles: number and sizes

Identification No.	Days postpartum	No. of follicles on ovary left	No. of follicles on ovary right	Sizes of follicles (mm) Left <1mm	Left 1-3mm	Left >3mm	Right <1mm	Right 1-3mm	Right >3mm
1	0	1	2	-	1	-	-	2	-
2	1	-	1	-	-	-	-	1	-
3	2	1	[illegible]	1	-	-	9	-	-
4	4	4	8	4	-	-	8	-	-
5	4	1	1	-	-	1	-	1	-
6	8	8	7	8	-	-	-	7	-
7	12	2	5	2	-	-	-	5	-
8	12	3	2	-	3	-	2	-	-
9	16	7	4	-	7	-	3	-	1
10	16	6	10	-	4	2	0	1	-
11	20	1	10	-	1	-	6	-	4
12	20	9	7	-	8	1	-	7	-
13	24	4	6	-	4	-	6	-	-
14	24	12	18	10	-	2	17	-	1
15	28	4	6	-	-	4	6	-	-
16	28	2	6	-	-	2	6	-	-
17	32	6	4	5	-	1	4	-	-
18	32	4	5	-	4	-	-	5	-
19	NPD	-	2	-	-	-	-	2	-
20	NPD	4	-	-	-	2	-	-	4

NPD = Non-pregnant does

Table 3.2: Serum progesterone levels in relation to structures on the ovary

Identification No.	Day post-partum	Structure on ovary Left f	cl	CH	Right f	cl	CH	Progesterone level ng/ml
1	0	1	1	-	2	-	-	ND
2	1	-	1	-	1	-	-	*
3	2	1	-	-	9	-	-	ND
4	4	4	-	-	4	-	-	0.14
5	4	1	-	-	1	rcl	-	0.6
6	8	8	-	-	7	-	-	0.19
7	12	2	1	-	5	-	-	0.55
8	12	3	1	-	2	1	-	*
9	16	7	-	-	4	1	-	0.19
10	16	6	1	-	10	-	-	*
11	20	1	1	-	10	-	-	0.58
12	20	9	-	-	7	-	-	0.1
13	24	4	-	-	6	-	-	*
14	24	12	-	-	18	-	-	ND
15	28	4	-	-	6	-	-	*
16	28	2	-	-	6	-	-	*
17	32	6	-	-	4	-	-	*
18	32	4	-	-	5	-	-	0.065
19	NPD	-	-	1	2	-	-	0.5
20	NPD	2	-	-	4	-	1	0.6

rcl = regressing corpus luteum
ND = not detectable
F = follicle
cl = corpus luteum
CH = corpus hemorrhagicum
* = samples not assayed

Table 3.3: Weights and volumes of the ovaries of the SB goats at various intervals postpartum

Identification No.	Day Postpartum	Wt. of ovaries (gm)		Vol. of ovaries (cc)	
		Left	Right	Left	Right
1	0	1.0	1.5	0.9	1.4
2	1	0.9	0.8	1.5	0.9
3	2	0.8	0.6	0.7	0.6
4	3	1.0	0.8	0.9	0.8
5	4	0.6	1.2	0.6	1.0
6	5	1.0	1.0	0.9	1.0
7	12	1.2	1.1	1.2	1.0
8	12	0.9	0.9	0.9	0.9
9	16	0.7	0.7	0.7	1.0
10	16	1.2	1.0	1.0	0.8
11	20	0.8	0.8	0.8	0.8
12	20	0.6	0.6	0.6	0.6
13	24	0.7	0.6	0.6	0.5
14	24	1.1	1.2	0.9	1.0
15	28	0.9	0.9	0.9	0.9
16	28	0.5	0.4	0.3	0.2
17	32	0.5	0.4	0.5	0.5
18	32	0.7	0.7	0.7	0.7
19	NPD	0.4	0.8	0.4	0.8
20	NPD	0.3	0.3	0.3	0.3

P > 0.05

NPD = Non pregnant does

Chapter 4

GROSS AND HISTOLOGICAL CHANGES OF THE POSTPARTUM UTERUS OF THE SAVANNA BROWN GOAT

INTRODUCTION

The physiological and histological changes in the genital organs during the puerperium when these organs return to normal oestrual and secretory cycles are known as the process of involution (Rasbech, 1950).

A number of factors are known to influence the rate of uterine involution and the resumption of postpartum ovarian activity. Among these factors are nutrition, season, suckling and parity. The relative rates at which these various factors influence reproductive activity in Nigerian goats, especially the Savanna Brown (SB) goat have not been well studied. The duration of kidding intervals in the goat is a measure of the reproductive efficiency and it is economically desirable that the period be short. This interval consists of the period from the previous delivery to reconception and one gestation period. The process of genital involution has to run to completion before pre-implantation changes can occur. Thus the involution process is one of the most important factors governing successful breeding programme and it should be well understood for the breed of animal involved.

This study was designed to study this important reproductive process in the SB goat of Nigeria.

MATERIALS AND METHODS

Goats

The same goats whose postpartum ovarian activity was studied were used in this investigation. During the six-week observation period, no buck was allowed to run with the does.

Following the six-week observation period, two vasectomised bucks were allowed to run with the does for the purposes of oestrus detection. Oestrus detection was done twice a day at 9.00 a.m. and 5.00 a.m. After the morning heat detection the animals were taken out for grazing and returned before the evening observation. Throughout the period of the study, the animals relied on grazing alone, with no concentrate feeding.

Animals that were observed to be on heat were taken to an intact buck for breeding. Each doe observed on heat was bred to two intact bucks each time until it was out of oestrus. All animals carried their pregnancy to term and had natural

deliveries. Only animals with single pregnancy were included in the postpartum study and were allowed to nurse their kids until time of slaughter.

One animal each was slaughtered on days 0, 1, 2 and 8 postpartum while two animals each were slaughtered 4, 12, 16, 20, 24, 28 and 32 days postpartum. Two nulliparous animals were slaughtered 3 days post-oestrus to obtain baseline data. The day zero slaughter was done immediately after the expulsion of the placenta which occurred 3 hours postpartum.

Uterine Parameters

Immediately after slaughter, the entire tubular genitalia from the ovary to the vulva was removed, dissected free of extraneous tissues and the following data were recorded: (1) circumference of the uterine horns at the level of the external bifurcation, (2) circumference of the middle portion of the body of the uterus, (3) weight of each uterine horn, (4) weight of the body of the uterus, (5) size of the largest caruncle in each horn, (6) total number of caruncles, (7) amount of lochia content and (8) circumference of the cervix.

A cross section of the uterine tissue about 15-25 mm long containing at least a caruncle was taken from each uterine horn at the level of the bifurcation and fixed in 10% neutral buffered formalin. They were later section at 10 μ and stained with hematoxylin and eosin stain.

Statistical analysis

The effect of various postpartum intervals on the weight and circumference of the left and right uterine horns, gravid and non-gravid uterine horns and the body of the uterus were tested statistically using a regression analysis programme of Steel and Torrie (1960). This yielded a student T-test analysis for these parameters and guadratic. analysis used to determine the regression curve f for the uterine measurements against days postpartum. Correlation matrix analysis was performed of the various uterine parameter and of the day postpartum against one another.

RESULTS

Gross Observations

Fetal membranes were expelled within three hours postpartum. Lochia discharge was generally not observed. Within 48 hours postpartum, a brick red, clotted bloody discharge was observed. Between day 0-2, the entire tubular genitalia appeared as large organs containing bloody lochia. By days 4 and 8 postpartum, the uterus still appeared as a large bag with its size and weight yet to be greatly reduced when compared with the uterus of day 16 postpartum (Plates 2A and 2B). By day 24 postpartum, the size of the uterus had been greatly reduced approaching the pre-gravid size (Plates 2C and 2D). The caruncle during the early postpartum period upto day 8 were quite prominent and maintained visible "stalks" upto day 4 (Plates 3A and 3B). By days 16-24 postpartum, the caruncles appeared as smooth round elevation from the surface of the endometrium showing clear 4-row arrangement (Plate 4A and 4B). The total number of caruncles in the entire uterus ranged from 41 - 156 with a mean of 108. (Appendix C).

Uterine and Cervical Measurements

The summary of the measurements of the uterine and cervical dimensions is shown in Tables 4.1 and 4.2.

There was a rapid reduction from a mean value of 432.0 gm to 191.121 gm in the weight of the entire uterus from Day 0 to 4 postpartum. By the 16th day postpartum, the weight of the uterus increased slightly, after which it further decreased progressively such that the mean weight was 14.498 gm by day 32 postpartum (Table 4.2).

Similar pattern of regression or decrease in weight was noted with both the right and left uterine horns between day 0 to 32 postpartum (Tables 4.1 and 4.2).

The reduction in the circumference of the gravid and non-gravid uterine horns from Day 0-8 postpartum was very rapid: 21.5 cm to 8.3 cm and 14.8 cm to 7.8 cm. respectively. Further decreases were observed in these parameters on day 12 post-partum. On day 16, a slight increase in the circumference of the gravid and non-gravid uterine horns was observed. Thereafter, the regression pattern was more gradual than in the earlier postpartum period (Table 4.2).

As for the cervix, the circumference decreased markedly between day 0-8 postpartum (12.0 cm - 6.0 cm), after which the regression was not marked.

Table 4.3 compares the means of the uterine parameters of the postpartum animals with those of the nulliparous baseline animals. It shows that by Day 32 postpartum the parameters were close to the values of the baseline uterus.

Both the gravid and non-gravid uterine horns showed rapid reduction in weight during the early days postpartum which for the gravid horn continued after day 18 (Fig. 1). The circumferences of the gravid and non-gravid horns also regressed rapidly until day 20 and more slowly to day 24. By day 28 postpartum they began to decrease (Fig. 3). Fig. 2 shows the regression curves for the circumference of the left and right uterine horns and for the mean of the left and right means. The correlation matrix for the various uterine parameters is shown in Table 4.4. The values show that there is a very high correlation between the uterine parameters and the various days postpartum. Table 4.5 shows the prediction equations for the circumference and weights of the uterus from days postpartum.

Histological findings

A summary of the histological features of the uterus is presented in Table 4.6. On day 0, 1, 2 and 4 postpartum, maternal crypts were visible in a mass of caruncular tissue (Plate 5). The lamina propria on days 0, 1 and 2 showed some disorganisation. The tunica muscularis did not however show any disorganisation but the blood vessels were congested. Trophoblastic cells were very distinct and present in large numbers. On days 4 and 8 postpartum, maternal crypts were still present and the uterine glands showed distinct epithelium. The intercaruncular epithelium was distinctly present on day 4 postpartum (Plate 6). Leukocytic infilteration particularly small lymphocytes were present inside and around the uterine glands (Plate 7). By day 12 and thereafter, the maternal crypts were no longer present and had been replaced by a distinct area of stratum compactum.

A typical uterine gland (Plate 8a) on day 20 postpartum shows an area where the gland opens to the outside, indicating a possible area where re-epithelization begins. By day 24 postpartum the epithelium of the endometrium show a fairly regular

arrangement (Plate 8B). The uterine glands were prolific throughout the period studied (Table 4.6).

On days 12 - 24 postpartum, lymphocytes and neutrophils were still present in appreciable numbers in the endometrium around the uterine glands and in the stroma. The muscularis layer show regular arrangements.

Distinct cervical epithelium was present in sections of the cervix regardless of the day postpartum (Plate 9). Some of the epithelial cells showed vacuolation. Also the cervical epithelium cells appeared stretched in some areas but slightly taller in others.

DISCUSSION

In this study, it was observed that the SB goats expel their fetal membranes within three hours postpartum. The inability to observe a reasonable amount of lochia from these animals raises a question as to the rate and extent to which lochia is persistent. The brick red, clotted, bloody discharge from the vagina of these animals within 48 hours postpartum agrees with the observation of Teilgy et al (1982) who reported the discharge of mucoid fluid mixed with clotted blood and some fetal membrane debris from the vulva. This can be attributed to uterine contraction as suggested by Jordon (1952).

The entire weight of the uterus in this study decreased from day 0 until day 16 when it increased slightly and thereafter regressed progressively to day 32 postpartum. The reduction in the entire weight of the uterus to almost one half of its day 0 weight by day 4 postpartum, is in agreement with the reports of Gier and Marion (1968) in the cow. The more gradual decrease in the entire weight of the uterus from day 4 to 12 postpartum also agrees with this report. However, the slight increase in

the uterine parameters by day 16 has not been previously reported and may suggest that glandular secretion had commenced by that day. This view is supported by the fact that well developed follicles or corpus luteum was present in the ovary on this day and so must have stimulated glandular secretion by the uterus.

The observation that the gravid uterus showed a marked reduction in size upto day 18 postpartum when compared with the non-gravid horn, may be due to the fact that the former had to undergo a more substantial degree of tissue repair as a result of massive sloughing occurring during the recovery process.

The mean values of the circumference (4.6 cm) and weight (6.105 gm) of the postpartum uterus by day 32 postpartum was close to the mean values 3.70 cm and 6.924 gm of the circumference and weights respectively of the nulliparous uterus. This indicates that by day 32 postpartum the uterus is completely involuted. The gravid uterus would appear to approach the pre-pregnancy size by day 28 - 32 postpartum.

On the basis of gross and histologic changes observed in this study, the process of uterine involution can be said to be complete in the SB goats by day 28 - 32 postpartum. The presence of distinct intercaruncular epithelium on day 4 postpartum tends to support the contention by Archbald et al (1972) that this area is not involved in the entire process of implantation. This area of active intercaruncular epithelization and the areas where the uterine gland epithelium opens to the outside, would represent areas where the process of caruncular re-epithelization would progress steadily until it reaches the surface of the caruncles as suggested in the cow by Eduvie (1982).

The histological features of the tissues also indicate that there is a dynamic re-organisation of the various sections postpartum. Maternal crypts were observable until day 4 postpartum following which there was a complete hyalinization and a layer of leukocytic-laden necrotic layer of the caruncles. Such observation had been made in the cow by Gier and Marion (1968). The leukocytic cells also observed were also observable in most cases to day 4 postpartum following which they were absent.

Along with the epithelial regeneration is an increased muscular contraction as indicated by the decline in the measured uterine parameters by day 12 postpartum. The combined effect of the muscular contraction, necrotic tissue loss and epithelial regeneration eventually returns the uterus to its non-gravid state.

No attempt was made to determine the significance of the leukocytic infilteration observed in the uterine tissue sections. However, it may be associated with the normal process of necrosis, clearing and sloughing of caruncular tissues. Van Wyk *et al* (1972b) noted similar leukocytic infilteration in the postpartum uterus of the ewe, and concluded that the very sparse infilteration of these cells into the caruncle during involution indicates the relative insignificance of the role they play.

The presence of leukocytic foci in some sections may suggest the presence of some mild chronic non-specific uterine infection. This was similar to the findings of Gier and Marion (1968) and Wagner and Hansel (1969).

The cervix regressed considerably in a similar pattern to the uterus and the uterine horns. Apparently not much damage was done to the cervical epithelium as a result of pregnancy and parturition. The only change observed was that the cervical columnar epithelium appeared stretched in some areas but retained their tall appearance in other areas.

SUMMARY

Gross and histologic changes in the tubular genitalia of the SB goat during the postpartum period were studied. One goat each was killed on days 0, 1, 2 and 8 postpartum while two each were killed on days 4, 12, 16, 20, 24, 28, and 32 to assess these changes. Two goats killed 3 days post-oestrus provided the baseline data. Gross measurements of uterus, uterine horns, caruncles and cervix were made, and appropriate tissues were taken, fixed in 10% neutral, buffered formalin, processed and stained with hematoxylin and eosin for histological examination.

There was a high degree of correlation between the uterine parameters measured and the days

postpartum: r = 0.872 and 0.865 for weights of the gravid and non-gravid horns versus days postpartum; r = 0.852 and 0.856 for the circumference of the gravid and non-gravid uterine horns; and r = 0.864 and 0.858 for the circumference of the left and right uterine horns. The gravid and non-gravid horns regressed steadily until about day 18 after which the non-gravid horn regressed much more steadily than the gravid horn which regressed much slowly. The sizes of both horns were comparable to the horns of the baseline uterus by day 32 postpartum.

Histologically, maternal crypts were present till day 4 postpartum while glandular development was prolific throughout the post-partum period covered by the study. Sloughing of caruncular tissue was noticed to be complete by day 8 postpartum and initiation of caruncular re-epithelization was noticed by day 20. Caruncular re-epithelization which began from the edges of the intercaruncular area and from the uterine glands, was noted to have been more widely spread by day 24 postpartum.

On the basis of these gross and histologic observations, it is concluded that uterine involution in the SB does is complete by 24 - 28 days postpartum.

Table 4.1: Individual means of the uterine parameters measured at various intervals postpartum

Days Post-partum	No. of Animals	Circumference of left uterine horn (cm)	Circumference of right uterine horn (cm)	Circumference of body of uterus (cm)	Circumference of cervix (cm)	Weights of left uterine horns (gm)	Weights of right uterine horns (gm)
0	1	14.8	21.5	12.5	12.0	162.0	250.0
1	1	19.0	15.0	11.5	9.5	190.0	150.8
2	1	13.0	13.6	8.5	6.5	103.7	149.8
4	2	10.55±.07	11.05±3.47	8.05±0.21	6.65±.57	80.404±0.15	100.657±10.03
8	1	8.3	7.8	6.5	5.0	57.667	38.122
12	2	5.25±1.06	5.1±.85	5.25±1.06	5.45±.07	13.646±3.77	14.836±4.48
16	2	6.9±0.28	6.75±1.06	5.4±0.8	5.55±0.21	22.359±6.23	19.961±2.70
20	2	5.0±0.71	4.7±.71	4.55±0.07	5.05±0.49	13.757±1.84	11.522±.35
24	2	5.35±.57	5.6±.57	5.15±.57	5.35±0.21	10.229±2.52	11.728±1.66
28	2	4.6±0.14	4.85±.07	4.95±0.16	4.95±.07	8.331±4.84	8.291±3.55
32	2	4.75±0.78	4.45±0.16	4.2±0.57	5.2±0.71	6.280±0.24	5.929±0.64

Table 4.2: Means of Gravid and Non-Gravid uterine parameters* measured at various intervals post-partum

Days post-partum	n	Entire wt. of uterus (gm)	Wt. of Gravid horn (gm)	Wt. of Non-gravid horn (gm)	Circumference of gravid horn (cm)	Circumference of non-gravid horn (cm)
0	1	432.0	250.0	162.0	21.5±0	14.8±0
1	1	352.82	190.0	150.8	19.0±0	15.0±0
2	1	263.5	149.8	103.7	13.6±0	13.0±0
4	2	191.211±65.18	113.35±45.04	68.70±11.592	12.05±2.50	9.95±1.48
8	1	101.789	57.667	38.122	8.3±0	7.8±0
12	2	30.35±0.67	17.152±1.2	11.33±0.48	5.85±0.2	4.75±0.35
16	2	47.212±3.6	24.317±3.46	18.00±0.067	7.1±0.57	6.55±0.78
20	2	27.209±2.27	13.757±1.84	11.522±0.36	5.0±0.71	4.7±0.71
24	2	23.754±4.4	11.725±1.52	10.479±2.23	5.0±0.28	4.7±0.28
28	2	18.188±9.37	8.291±3.06	8.3315±4.07	4.85±0.07	4.6±0.41
32	2	14.498±0.7	6.415±0.05	5.793±0.45	4.95±0.49	4.25±0.07
Baseline Animals	2	15.4105±0.4	7.174±.15	6.719±0.5	3.95±0.07	3.45±0.64

* = The values are means ± standard deviation where more than one observation were made.

n = number of animals

Table 4.3: Mean values of the circumference and weight of uterus, postpartum and 3 days post-estrus in SB goats

Days Postpartum	Circumference of uterine horns* (cm)	Weights of uterine horns* (gm)
0	18.15	206.0
1	17.0	170.4
2	13.3	126.45
4	18.80	90.535
8	7.15	36.440
12	5.175	14.207
16	6.825	21.161
20	4.85	12.64
24	5.475	10.979
28	4.725	8.311
32	4.6	6.105
Baseline 3 days post-estrus	3.70	6.924

* = mean values for the left and right horns

n = 2 for each observation

Table 4.4: Correlation matrix of various uterine parameters measured

	1	2	3	4	5	6
1. Days post-partum	1					
2. Entire Wt of Uterus	-.783	1				
3. Wt. of pregnant horn	-.734	.998	1			
4. Wt. of non-pregnant horn	-.774	.995	.989	1		
5. Circumference of pregnant horn	-.792	.992	.999	.99	1	
6. Circumference of non-pregnant horn	-.807	.977	.971	.981	.978	1

Table 4.5: Regression Equations for predicting the circumference and the weights of uterine horns from the days post-partum (x)

Predictor	Df[a]	Prediction Equations	S.E.[b]	S.F.E.[c]	T
X	8	$Y_1=16.438-1.1x+0.024x^2$	0.005	1.727	4.24
X	8	$Y_2=172.78-16.295x+0.366x^2$	0.078	23.802	4.674
X	10	$Y_3=340.587-31.287x+0.695x^2$	0.12	47.729	5.773

a = degrees of freedom
b = standard error of slope
c = standard error of estimate
Y_1 = mean circumference of uterine horns (cm)
Y_2 = mean weight of uterine horns (gm)
Y_3 = entire weight of the uterus (gm)
T = Students' T-test

Table 4.6: Histological features of the uterine sections of goats killed at different intervals postpartum

Histologic features	3 Days post-estrus	0	1	2	4	8	12	16	20	24	28	32
Maternal crypts	A	P	P	P	P	A	A	A	A	A	NE	NE
Caruncular epithelium	P	A	P	A	A	A	A	I	I	P	NE	NE
Intercaruncular epithelium	P	NS	NS	NS	P	NS	NS	I	I	I	NE	NE
Uterine gland epithelium	P	P	P	P	P	P	P	P	P	P	NE	NE
Glandular development	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	NE	NE
Re-epithelization	NA	A	A	A	A	A	A	A	P	P	NE	NE
Cell Types												
Trophoblastic cells	NA	P	P	P	P (Slightly)	A	A	A	A	A	NE	NE
Lymphocytes	P	P	P	P	P	P	P	P	P	P	NE	NE
Plasma cells	A	A	A	A	A	A	A	A	A	A	NE	NE
Macrophages	A	A	A	A	A	A	A	A	A	A	NE	NE
*Neutrophils	P	P	P	P	P	P	P	P	P	P	NE	NE
Eosinophils	A	A	A	A	A	A	A	A	A	A	NE	NE
Arrangement of muscle fibres in the myometrium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NE	NE

A = Absent
P = Present
I = Incomplete
Pr = Prolific
ND = Not disturbed

* Few neutrophils
NS Not seen
NA Not application
NE Not examined

FIGURES AND PLATES

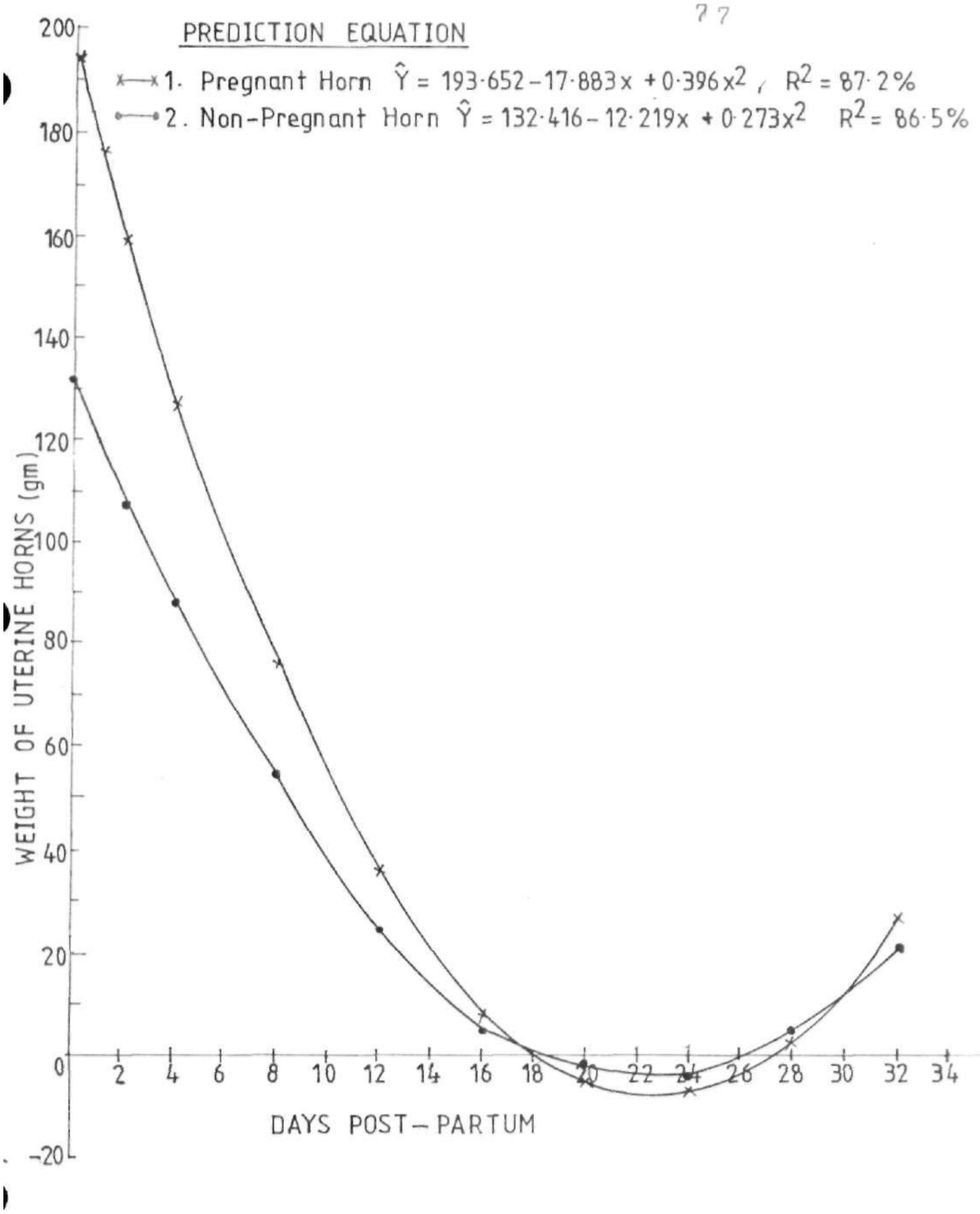


Fig. 1. Regression curve of weights of gravid and non-gravid horns versus day post-partum.

PREDICTION EQUATION

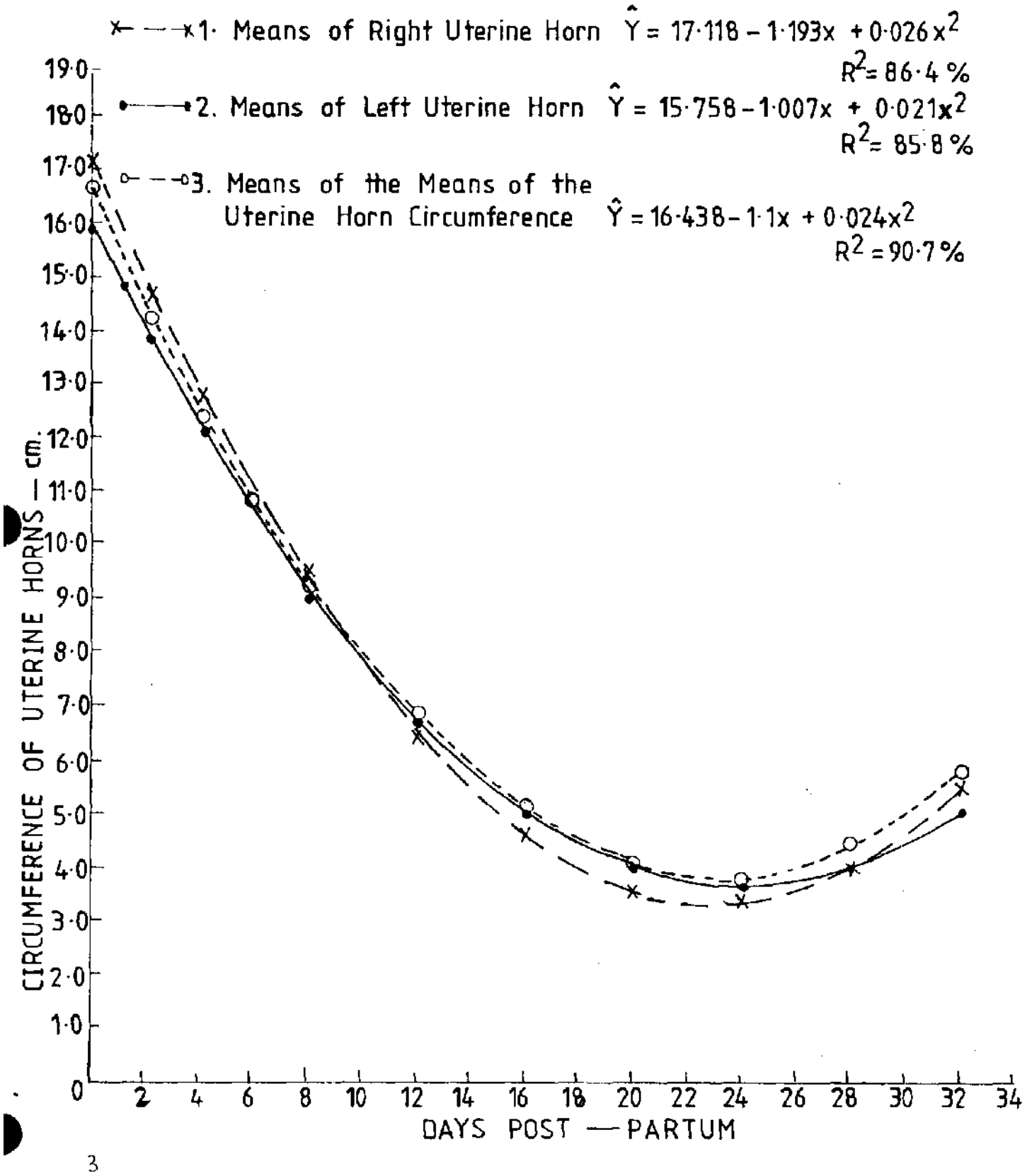


Fig. 2 . Regression curves of circumference of uterine horns against days post — partum.

PREDICTION EQUATION

1. Pregnant Horn $\hat{Y} = 17{\cdot}69 - 1{\cdot}184x + 0{\cdot}025x^2$ $R^2 = 85{\cdot}2\%$
2. Non-Pregnant Horn $\hat{Y} = 13{\cdot}763 - 0{\cdot}824x + 0{\cdot}017x^2$ $R^2 = 85{\cdot}6\%$

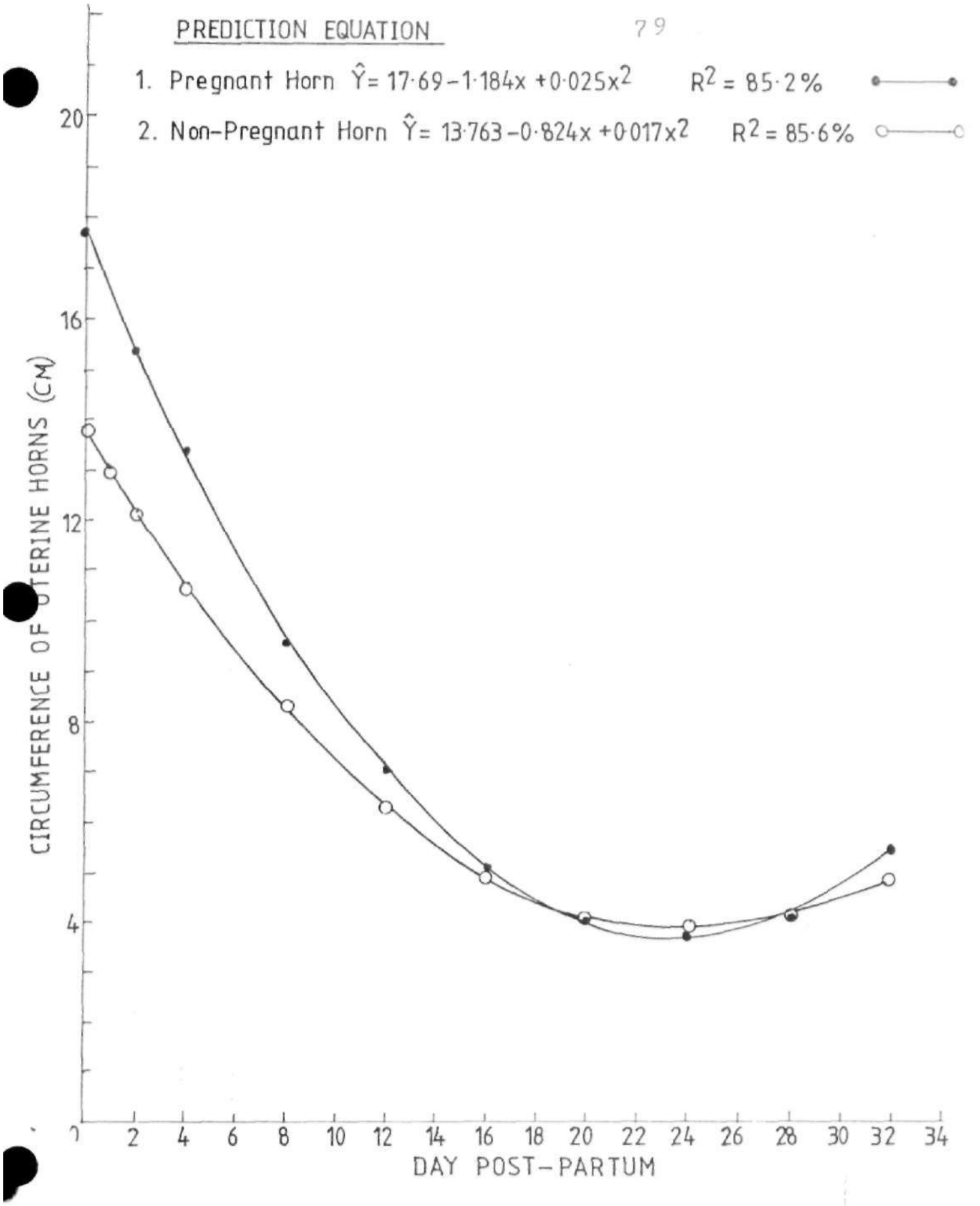


Fig. 3. Regression curves of circumference of gravid and non-gravid horns versus days post-partum.

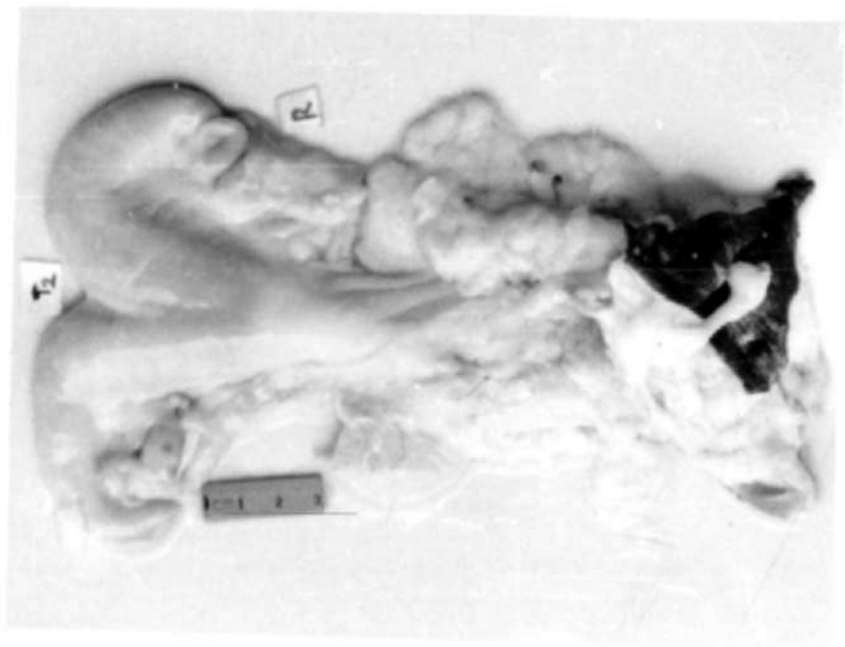
PLATE 1



THE SAVANNA BROWN GOATS WITH THEIR
TYPICAL BROWN COAT



A



B

PLATE 2 (CONT.)

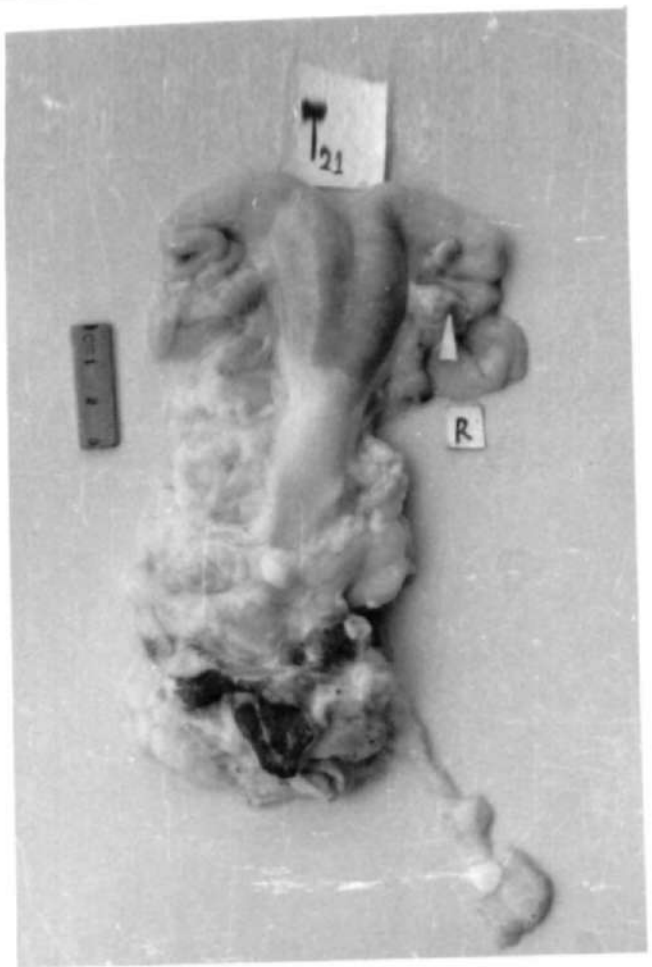
C

UTERUS OF A GOAT KILLED 24 DAYS POSTPARTUM. THE UTERUS IS FIRMER AND MUCH REDUCED IN SIZE. ARROW POINTS TO OVARY WITH A FOLLICLE.

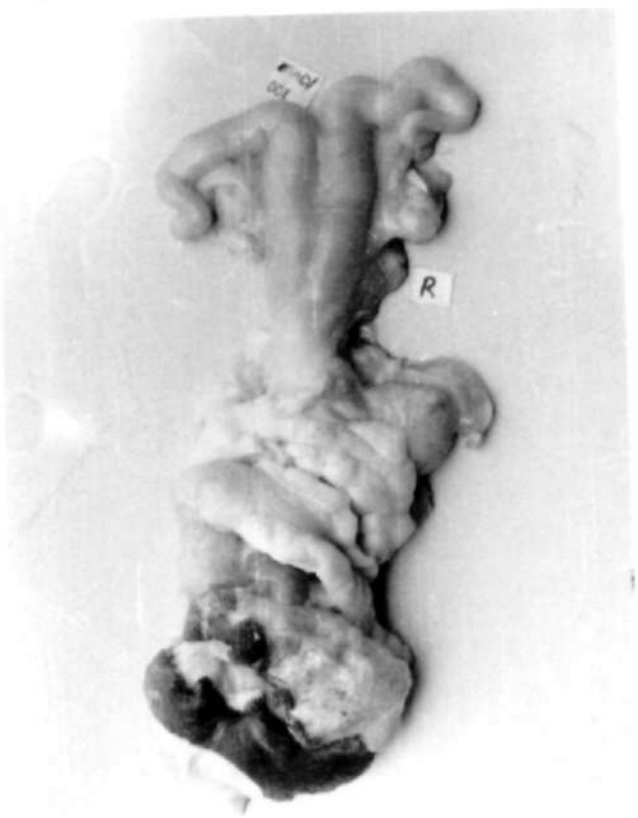
D

UTERUS OF A GOAT KILLED 3 DAYS POST-OESTRUS. THE UTERUS IS MUCH SMALLER AND IT IS TONIC.

C



D





B

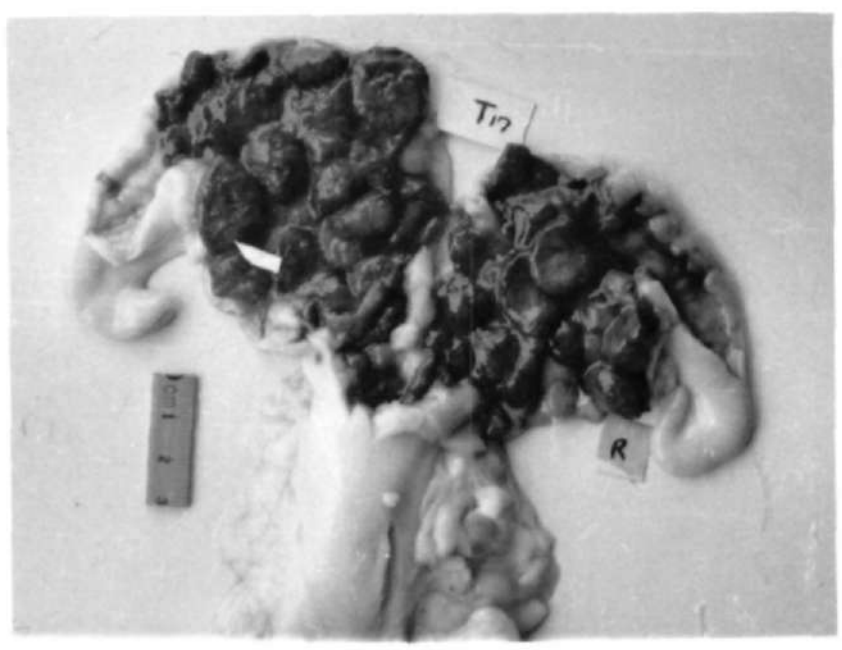


PLATE 4

A

OPENED UP UTERUS OF A GOAT KILLED 16 DAYS POSTPARTUM SHOWING SMOOTH ROUND CARUNCULAR ELEVATIONS FROM THE SURFACE OF THE ENDOMETRIUM.

B

OPENED UP UTERUS OF A GOAT KILLED 24 DAYS POSTPARTUM SHOWING DISTINCT ROWS OF CARUNCLES THAT ARE GREATLY REDUCED IN SIZE COMPARED WITH EARLIER DAYS POSTPARTUM.


T2
R

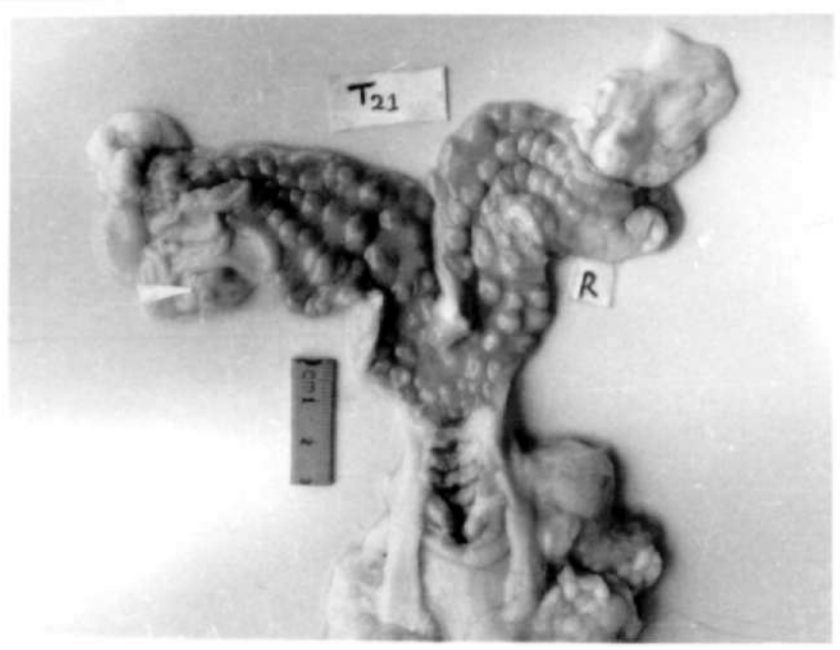

T21
R

PLATE 5

SECTION OF THE UTERUS OF A GOAT KILLED 4 DAYS POSTPARTUM SHOWING AREA OF MATERNAL CRYPTS IN THE CARUNCLES x 200 (ARROW).

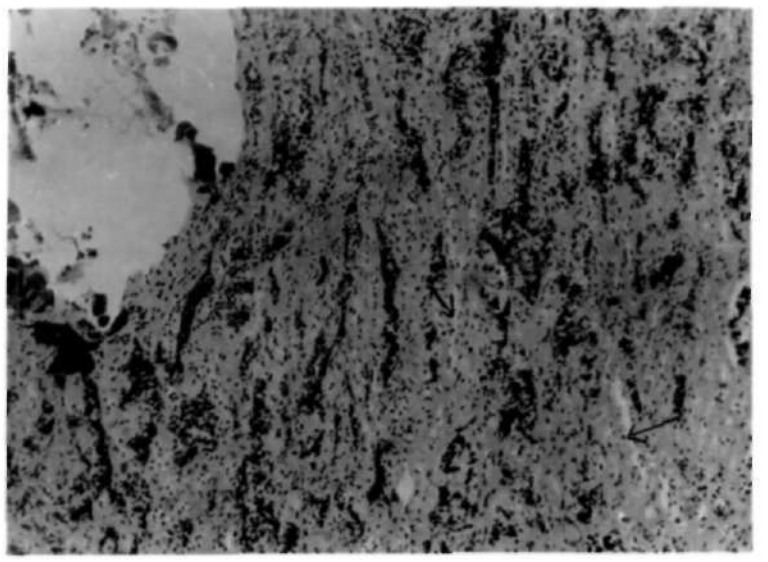


PLATE 6

SECTION OF THE UTERUS OF A GOAT KILLED 4 DAYS POSTPARTUM SHOWING DISTINCT INTERCARUNCULAR EPITHELIUM x 200 (ARROW).

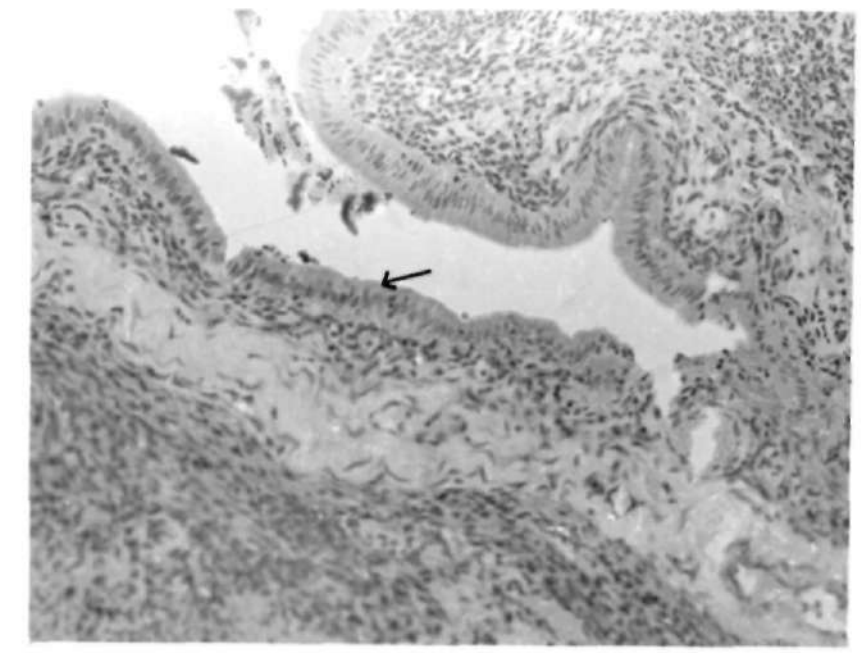


PLATE 7

SECTION OF THE UTERUS OF A GOAT KILLED 16 DAYS POSTPARTUM SHOWING LEUKOCYTIC INFILTERATION IN THE MYOMETRIUM AND AROUND THE UTERINE GLAND x 200 (ARROW).

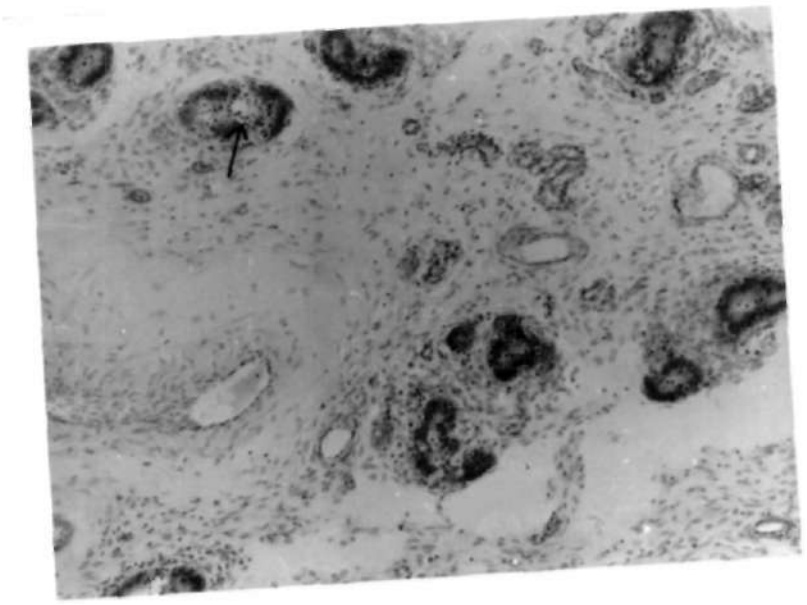
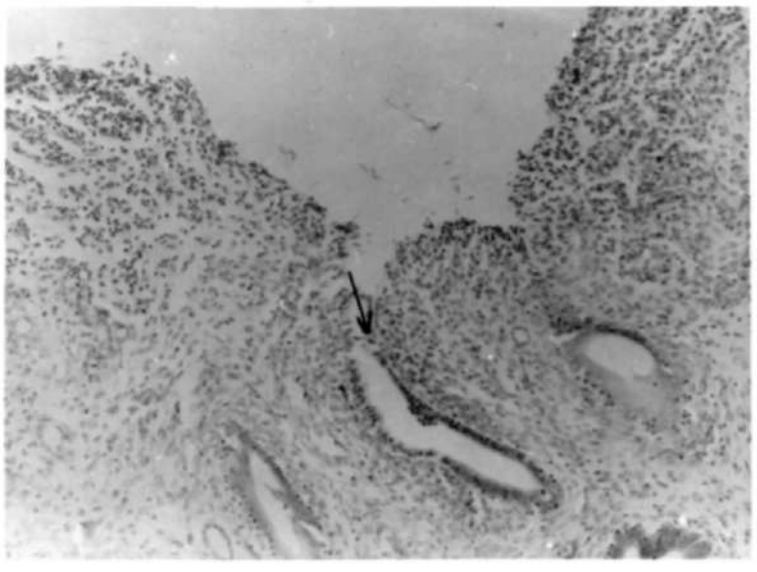


PLATE 8

A SECTION OF THE UTERUS OF A GOAT KILLED 20 DAYS POSTPARTUM SHOWING AN AREA WHERE THE UTERINE GLAND OPENS TO THE OUTSIDE x 200 (ARROW).

B SECTION OF THE UTERUS OF A GOAT KILLED 24 DAYS POSTPARTUM SHOWING AREA OF DISTINCT CARUNCULAR RE-EPITHELIZATION X 400 (ARROW).



B

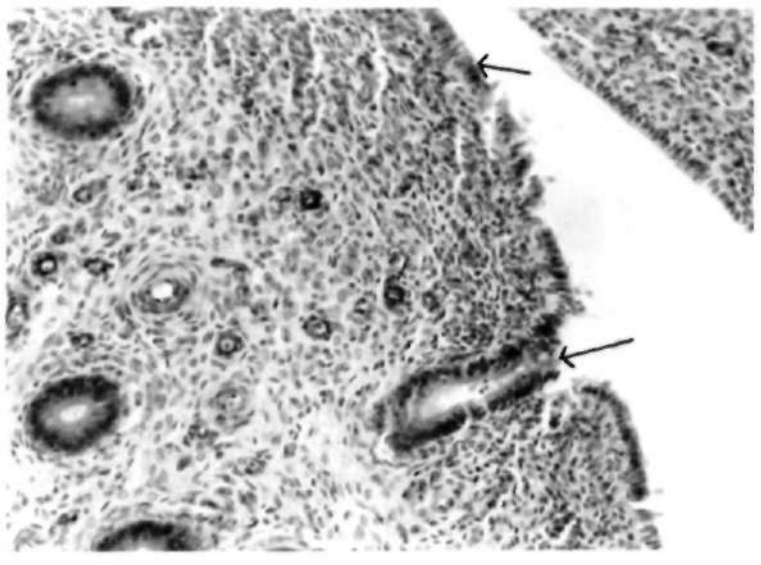
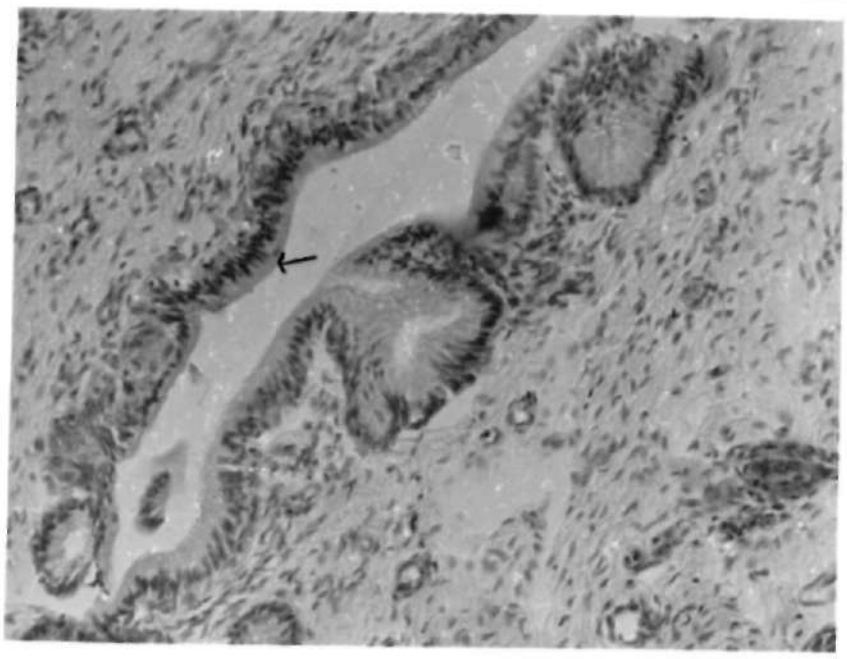


PLATE 9

SECTION OF THE CERVIX OF A GOAT KILLED 12 DAYS POSTPARTUM SHOWING CERVICAL EPITHELIUM x 200 (ARROW).



Chapter 5

STUDIES ON THE BACTERIAL FLORA OF PREBREEDING AND POSTPARTUM TUBULAR GENITALIA OF THE SAVANNA BROWN (SB) GOATS

INTRODUCTION

Because of its anatomical disposition, the vagina of all domesticated animals is predisposed to a number of infectious organisms which could adversely affect the reproductive performance of an animal.

Available information on the microbial flora of the tubular genitalia in goats is scanty while, comparatively, similar information for other species such as the sheep and cow are quite numerous.

Uterine involution is expected to proceed aseptically, but a number of animals have been found to be infected by different types of bacteria especially during early postpartum period (Rasbech, 1950). Postpartum uterine infections have been classified as specific or non-specific. Roberts (1971) indicated that Brucella sp., Trichomonas sp. and Vibrio sp. are important in causing specific uterine infections while Staphylococcus, Streptococcus, Corynebacterium, Escherichia coli and other unclassified gram negative rods have been identified as causes of non-specific uterine infection (Sagartz and Hardenbrook, 1971).

A systematic study of the bacteriology of the respiratory tract of Nigerian goats has been carried out (Ojo, 1976). Such a systematic study on the microbial flora of the genitalia of SP goats has not yet been done. This study was designed to determine the prebreeding bacterial flora of the vagina of nulliparous SP goats and to determine if the flora will change with pregnancy and parturition.

MATERIALS AND METHODS

Goats: The study was carried out on the same goats used for the physiological studies. During the period of acclamatization, earlier reported, their genitalia was examined for pathological conditions such as vulvovaginitis, vaginal discharge etc. All the 29 goats used in this study were clinically fit.

Specimen: After the six-week observation period, before the goats were bred, four swabs were taken from the anterior end of the vagina close to the cervix in each goat. The swabs were immediately taken to the laboratory nearby for bacterial cultures. For postpartum specimens, four swabs each were taken at slaughter from the right uterine

horn, left uterine horn, body of the uterus and the cervix. These sets of swabs were obtained by making a small incision over the collection sites with a flamed scapel blade, after which a sterile swab was inserted into the lumen.

Cultures: One set of swabs was cultured for bacteria while others were cultured for mycoplasmas and related agents as follows: one set was routinely inoculated onto 10% defibrinated sheep blood agar and MacConkey agar and examined for bacteria by standard procedure (Cowan and Steel, 1970). The other three sets of swabs were examined for a glucose and arginine utilizing large colony producing mycoplasmas and ureaplasmas (T-mycoplasmas) as previously described (Adegboye, 1981; Adegboye, Fasanya, Bwala and Hassan, 1982). The techniques are routine for mycoplasma and ureaplasmas. Bacterial identification was based on necessary biochemical tests (Cowan and Steel, 1970), while mycoplasmas and ureaplasma identification were also based on standard techniques (Razin and Tully, 1983).

RESULTS

Pre-breeding Swabs

The results are summarized in Table 5.1. Staphylococcus sp. was isolated from 20 goats, Streptococcus sp. from 15 goats and Micrococcus sp. from 4 goats. A glucose utilizing Mycoplasma sp. identified as Mycoplasma agalactiae was isolated from 5 goats while Ureaplasma sp. was isolated from 3 goats. No commonly isolated Gram negative bacteria was encountered. The Staphylococcus sp. were identified as Staphylococcus aureus, while all the Streptococcus sp. were identified as Streptococcus agalactiae with one as Streptococcus faecalis.

None of the goats was completely free of a bacterial or mycoplasmal agent, and in fact, concurrent infection with these agents did occur in some of the goats (Table 5.2).

Post-partum Swabs

The postpartum vaginal flora did not show much difference from the prebreeding samples (Table 5.4). However, in two animals E. coli was

isolated. As in the pre-breeding vaginal specimens, Staphylococcus sp. and Streptococcus sp. were the predominant organisms encountered and they occurred concurrently with others such as Micrococcus sp. and Mycoplasma sp. No Ureaplasma sp. was encountered in the postpartum vagina specimens.

Uterine swabs from goats killed on Day 2 yielded E. coli, Day 12, Micrococcus sp., Day 16, Staph. aureus, Micrococcus sp. and E. coli, and Day 24, Staph. aureus (Table 5.3). Concurrent infection with all three organisms was encountered in one of the goats killed on Day 16 postpartum. Strep. agalactiae was isolated from the cervix in one of the goats killed on day 4 postpartum, while E. coli was obtained from the cervix of a goat killed on day 16 postpartum. Also, Staph. aureus was isolated from the cervix of a goat killed 24 days postpartum while M. agalactiae was isolated from the cervix of a goat killed 8 days postpartum (Table 5.3).

There was no gross observable pathology in the uterine sections and leukocytic cells mainly lymphocytes were sparsely distributed in the uterine sections.

DISCUSSION

The study shows that the vagina of unbred nulliparous SR goats is not bacteria free. Even though highly pathogenic abortifacient bacteria such as Brucella sp. or Corynebacterium sp. were not encountered, some potential pathogens such as Staphylococcus sp., Streptococcus sp., Mycoplasma sp. and Ureaplasma sp. were encountered. The Gram positive coccoid organisms encountered are common skin and environmental contaminants which could have gained access easily to the site studied.

The postpartum uterus appear to be sparsely colonized with microbial organisms. However, the presence of E. coli, Micrococcus sp. and Staphylococcus aureus in some of the uterine sites may not be overlooked. Though the gross and histologic observations of these organs did not show any pathologic disturbance, they are potential pathogens that could adversely affect uterine involution - under appropriate conditions.

The presence of Streptococcus sp. concurrently with other bacterial organisms have been known to cause pyometra and endometritis (Adams, 1975),

which would usually cause a delay in uterine involution. Also Azizzudin (1948), ruggested that the isolation of Staphylococcus sp. under experimental conditions in the genital tract reveal that they may be natural inhabitants of these organs but that under conditions of stress such as abortion or parturition, they may cause metritis and infertility.

None of the agents cultured was yet associated with any disease of the genitalia in the goats studied. The fact that very few organisms were encountered in the uterus and no corresponding leukocytic foci or histological evidence in this study, shows that the organisms can be present in the mucosa or uterine fluid without necessarily invading the endometrium. Thus, it is felt that none of the agents cultured affected the involution pattern significantly.

SUMMARY

A study of the bacteria flora of the genitalia of nulliparous SB goats was carried out both before breeding and at different intervals postpartum, to investigate the type of microbial organism that could be present in the vagina, uterus and the

cervix during a reproductive cycle.

Of 29 pre-breeding vaginal swabs, Staphylococcus sp. was isolated from 20 goats, Streptococcus sp. from 15 goats, and Micrococcus sp. from 4 goats. Mycoplasma agalactiae was isolated from 5 goats, while Ureaplasma sp. was isolated from 3 goats.

The postpartum vagina did not show any appreciable change in the microbial flora, except that Escherichia coli was encountered in 2 cases. The uterus yielded E. coli from the goat slaughtered 2 days postpartum; Micrococcus sp. from goats slaughtered 12 days postpartum; Staph. aureus, Micrococcus sp. and E. coli from goats slaughtered 16 days postpartum; and Staph. aureus from goats slaughtered 24 days postpartum.

Table 5.1: Pre-breeding bacterial and Mycoplasmal flora of vagina of nulliparous Savanna Brown goats.

	MICROORGANISMS CULTURES				
	Staphylococcus aureus	Streptococcus agalactiae*	Micrococcus sp.	Ureaplasma sp.**	Mycoplasma agalactiae
No. of goats harbouring organisms	20(68.7%)[a]	15(51.7%)	4(13.8%)	3(10.3%)	5(17.2%)

a. % total goats examined

* All identified as Strept. agalactie except one identified as Strept. faecalis

** Ureaplasma from goats not yet speciated (Adegboye, Personal Communication).

Table 5.2: Distribution of the microbial infection of the pre-breeding vagina of nulliparous SE goats

Types of Organisms	No. of Animals	% of total No. of goats
Staphylococcus aureus	11	37.9
Streptococcus agalactiae	5	17.24
Streptococcus faecalis	1	3.45
Streptococcus agalactiae and Staphylococcus aureus	4	13.79
Streptococcus agalactiae, Staphylococcus aureus and Micrococcus sp.	1	3.45
Streptococcus agalactiae, Staphylococcus aureus and Mycoplasma agalactiae	1	3.45
Streptococcus agalactiae, Staphylococcus aureus, Mycoplasma agalactiae and Ureaplasma sp.	2	6.90
Streptococcus agalactiae, Staphylococcus aureus and Ureaplasma sp.	1	3.45
Mycoplasma agalactiae and Micrococcus sp.	2	6.70
Micrococcus sp. only	1	3.45

Table 5.3: Summary of Postpartum Genital Bacterial isolations from Primigravid Savanna Brown goats

No. of Animals Killed	Day post-partum	Isolates at various sites		
		Vagina	Uterus	Cervix
1	0	Staph. aureus	-	-
1	1	Staph. aureus and Strept. agalactiae	-	-
1	2	E. coli, Staph. aureus and Strept. agalatiae	E. coli	-
2	4	Strept. agalactiae and Micrococcus sp.	-	Strept. agalactiae
3	8	Strept. agalactiae and Staph. aureus	-	Mycoplasma agalactiae
2	12	Strept. agalactiae	Micrococcus sp.	-
2	16	Strept. agalactiae and E. coli	Staph. aureus Micrococcus sp. and E. coli	E. coli
2	20	Strept. agalactiae and Staph. aureus	-	-
2	2 4	Strept. agalactiae and Staph. aureus	Staph. aureus	Staph. aureus
2	28	Strept. agalactiae	-	-
2	32	Staph. aureus, Strept. agalactiae and Micrococcus sp.	-	-
2	Non Pregnant Does	Micrococcus sp, Mycoplasma agalactiae and Staph. aureus	-	-

Table 5.4: Comparative prebreeding and postpartum vaginal flora of Savanna Brown Goats

Animal Number	Prebreeding Vaginal Isolation	Postpartum Vaginal Isolations
1	Staphylococcus aureus	Staphylococcus aureus (0)
2	Streptococcus agalactiae and Staphylococcus aureus	Streptococcus agalactiae and Staphylococcus aureus (1)
3	Staphylococcus aureus and Streptococcus agalactiae	E. coli, Streptococcus agalactiae and Staphylococcus aureus (2)
4	Staphylococcus aureus, Streptococcus agalactiae Mycoplasma agalactiae and Ureaplasma sp.	NI (4)
5	Streptococcus agalactiae and Staphylococcus aureus	Streptococcus agalactiae and Micrococcus sp. (4)
6	Streptococcus agalactiae	Staphylococcus aureus (8)
7	Staphylococcus aureus	Staphylococcus aureus and Streptococcus agalactiae (8)
8	Streptococcus agalactiae	Staphylococcus aureus (8)
9	Streptococcus agalactiae Staphylococcus aureus and Micrococcus sp.	NI (12)
10	NI	Streptococcus agalactiae (12)
11	Streptococcus agalactiae	Streptococcus agalactiae (16)

Table 5.4 (Cont.)

12	Streptococcus agalactiae	E. coli (16)
13	Staphylococcus aureus	Staphylococcus aureus and Streptococcus agalactiae (20)
14	Staphylococcus aureus	NI (20)
15	Micrococcus sp. and Mycoplasma agalactiae	Streptococcus agalactiae and Staphylococcus aureus (24)
16	Staphylococcus aureus	Staphylococcus aureus (24)
17	Streptococcus faecalis	Streptococcus agalactiae (28).
18	Staphylococcus aureus	Streptococcus agalactiae (28)
19	Micrococcus sp.	Staphylococcus aureus, Streptococcus agalactiae and Micrococcus sp. (32)
20	Staphylococcus aureus, Streptococcus agalactiae, Mycoplasma agalactiae and Ureaplasma sp.	NI (32)
21	Micrococcus sp. and Mycoplasma agalactiae	Micrococcus sp. and Mycoplasma agalactiae (3-post-estrus)
22	Staphylococcus aureus Streptococcus agalactiae and Mycoplasma agalactiae	Staphylococcus aureus, Streptococcus agalactiae and Mycoplasma agalactiae (3-post-estrus)
23	Streptococcus agalactiae and Staphylococcus aureus	had twin pregnancy
24	Staphylococcus aureus	Died

Table 5.4 (Cont.)

25	Staphylococcus aureus	Died
26	Staphylococcus aureus	Aborted
27	Staphylococcus aureus	Twin pregnancy
28	Staphylococcus aureus, Streptococcus agalactiae and Ureaplasma sp.	Died
29	Staphylococcus aureus	Died

( ) Days of slaughter in bracket.

Chapter 6

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSIONS

The work presented in this thesis was designed to investigate some aspects of the postpartum physiology of the Savanna Brown (SB) goats of Nigeria. It was also intended to provide basic information on the bacteriology of the prebreeding vagina, and the postpartum vagina and uterus of these goats. To achieve these objectives 29 nulliparous SB goats purchased from Zaria environ were used for this study. Data from 20 of these animals which had single kids were eventually utilized in the reproductive physiology studies.

The general results show that the SB goats expelled their fetal membranes within three hours after parturition and that the postpartum uterus regressed rapidly in the first 8 days following parturition. Thereafter, the process of uterine regression was slower but progressive. A striking observation is that on day 16 postpartum, the uterine parameters measured increased slightly. This finding corresponds to the occurrence of follicles or corpus luteum in the ovary. Nevertheless the uterus is unlikely to be ready for implantation at this time since re-epithelization of the endometrium

had not yet taken place. Consequently any ovulation during this early postpartum period is not likely to result in successful conception. Serum progesterone concentrations and the presence of ovarian follicles suggest that the postpartum ovary in the SB goat maintained some level of activity during the period of involution.

The rate of puerperal uterine infection by specific bacterial and mycoplasmal agent in these goats was not quite significant as there was no evidence that their presence affected the process of uterine involution.

It is noted that the kidding interval of 222 days reported in literature for these goats is quite long and constitutes a reproductive wastage. This study shows that uterine involution is complete by 24-28 days postpartum as indicated by gross and histologic changes in the uterus, such that the uterus could be ready for the implantation of fertilized ovum anytime thereafter. Since the study also show that postpartum ovarian activity resumes as early as 16 days postpartum or before, it appears logical that the above kidding interval could be drastically reduced. However, the practicality of accomplishing this needs to be tested in breeding programmes, and

this is an area of suggested further studies.

Based on the finding from this study that uterine involution is complete by days 28-32 post-partum, a kidding interval of 182 days is proposed for the SB goats for maximum reproductive utilization. Also a tentative breeding programmes such that animals are monitored and bred by 32 days postpartum is recommended. This should be combined with proper nutrition and health management programmes.

REFERENCES

Adams, N. R. (1975). "A pathological and bacteriological abattoir survey of the reproductive tracts of Merino ewes in Western Australia". Australian Veterinary Journal. 51: 351-354.

Adegboye, D. S. (1981). "An outline of techniques for the isolation and identification of Mycoplasmas". A lecture note delivered at the College of Veterinary Medicine, Kansas State University, Manhattan, U. S. A. pp. 1-8.

Adegboye, D. S. and M. K. J. Hassan (1976). "Preliminary studies on genital mycoplasmosis in Nigeria: Occurence of Ureaplasma (T-mycoplasmas) in Urogenital tracts of cattle in Zaria". Journal of Nigerian Veterinary Medical Association. 5: 62-64.

Adegboye, D. S., Fasanya, O. O. A., Bwala, M. S. and M. K. J. Hassan (1982). "Preliminary studies on Urogenital mycoplasmosis in Nigeria". Bulletin of Animal Health Production in Africa. 30(2): 95-99.

Adu, I. F., Buvanendra, V. and C. A. M. Lakpini (1979). "The reproductive performance of Red Sokoto goats in Nigeria". Journal of Agricultural Science (Cambridge) 93:563-566.

Akerejola, O. (1982). "Management of diseases affecting goat production under the intensive system in Nigeria". In: Proceedings of the third international conference on goat production and disease. Tucson Arizona. January 10-15, Pg. 289.

Anon (1974). "Agricultural Development in Nigeria 1973-75". Federal Ministry of Agriculture and Natural Resources Joint Planning Committee.

Archbald, L. H., Schultz, R. H., Fahing, M. L., Kurtz, H. J. and R. Zenjamis (1972). "A sequential histological study of the postpartum bovine uterus". Journal of Reproduction and Fertility. 29: 133-138.

Azizzudin, I. M. (1948). Thesis - University Edinburgh. Cited by Moorthy, A. R. S. and S. P. Singh (1982) "Studies on the bacterial flora of the female genital tract of sheep". Bulletin of Animal Health Production in Africa. 30(1) 15-18.

Barker, H. B. and W. L. Wiggins (1964a). "Occurence of postpartum estrus in fall-lambing ewes", Journal of Animal Science. 23: 967-972.

Barker, H. B. and W. L. Wiggins (1964b). "Estrual activity in lactating ewes". Journal of Animal Science. 23: 973-980.

Basset, E. G. (1963). "Some effects of endogenous hormones on muscle and connective tissue with special reference to the ewe. New Zealand, Society for Animal Production. 23: 107-120.

Bhaskaran, R. and T. Bastrain (1963). Cited by Moorthy A. R. S. and S. P. Singh (1982) "Studies on the bacterial flora of the female genital tract of sheep". Bulletin of Animal Health Production in Africa. 30(1): 15-18.

Buch, M. C., Tyler, W. J. and L. E. Casida (1955). "Postpartum estrus and involution of the uterus in an experimental herd of Holstein-Friesian cows". Journal of Dairy Science. 38: 73-79.

Carter, G. R. (1979). "Diagnostic procedure in Veterinary Bacteriology and Mycology". 3rd Edition. Charles C. Thomas Publisher, Springfield Illinois, U. S. A.

Casida, L. E. and W. G. Venzke (1936). "Observations on reproductive processes in dairy cattle and their relation to breed efficiency". Proceeding American Society Animal Production. P. 221.

Chapman, A. B. and L. E. Casida (1937). "Analysis of variation in the sexual cycle and some of the component phases with special reference to cattle". Journal of Agricultural Research. 54: 417-435.

Chima, J. C., Ezeugwu, E. U., Onoviran, V., Agba, M. I. and O. A. Adewuyi (1981). "Isolation of Mycoplasma agalactiae from caprine vulvovaginitis". Nigerian Veterinary Journal 10(1): 26-30.

Clapp, H. (1937). "A factor in breeding efficiency of dairy cattle". Proceedings of American Society for Animal Production. 30th Annual Meeting. p. 259-264.

Clark, W. A. and W. G. Stevenson (1948). "The bacterial flora of the normal gravid bovine uterus". Canadian Journal of Comparative Medicine, 13: 92-93.

Cowan, S. T. and K. J. Steel (1970). Manual for identification of Medical bacteria. Cambridge, University Press, Cambridge, U. K.

Csapo, A. I., Knobial, E., Van der Molen, H. J. and W. J. Wiest (1971). "Peripheral plasma progesterone levels during human pregnancy and labor". American Journal of Obstetrics and Gynecology. 110:630.

Dennis, S. M. (1967). "An ovine abortion outbreak associated three pathogens". Australian Veterinary Journal. 43: 597.

Devendra, C. and M. Burns (1970). "Goat production in the tropics". Commonwealth Agricultural Bureau Farham Royal, Bucks England. pp. 69-86.

Duncan, J. M. (1883). "The gulstonian lectures on the sterility of women". Lecture II. British Medical Journal. 1: 443-445.

Echternkamp, S. E. and W. Hansel (1973). "Concurrent changes in bovine plasma hormone levels prior to and during the first postpartum estrous cycle". Journal of Animal Science. 37(6): 1362-1370.

Eduvie, L. O. (1982). "Uterine involution, ovarian activity and bacteriological studies of the postpartum period in indigenous Nigerian cattle". Ahmadu Bello University, Ph.D. Thesis.

Eduvie, L. O., Osori, D. I. K., Addo, P. E. and C. O. Njoku (1984). "Bacteriological investigation of the postpartum uterus: Relationship to involution and histopathological findings". Theriogenology 21(5): 733-735.

EL-Sheikh, A. S. and A. A. Mohammed (1976). "First postpartum oestrus in buffaloes". Indian Journal Animal Science. 46: 580-583.

Engle, E. T. and M. C. Shelesnyak (1934). "First menstruation and subsequent menstrual cycle in pubertal girls". Human Biology 6: 431-453.

Fasanya, O. O. A. (1980). "Cultural examination of semen and preputial swabs from breeding bulls in Zaria area for Mycoplasmas and Ureaplasmas". D.V.M. V Research Project.

Foote, W. D., Hauser, E. R. and L. E. Casida (1960). "Some causes of variation in postpartum reproductive activity in hereford cows". Journal of Animal Science. 19: 238-241.

Foote, W. D. and J. W. Call (1969). "Postpartum changes in the uterus and blood of ewe during the anaestrus season". Journal of Animal Science, 29: 190 (Abstract No. 343).

Gefu, O. J. (1982). "Socio-economic characteristics of goat producers and their husbandary practices in Northern Nigeria". In: Proceedings of the third international conference on goat production and disease. Jan. 10-15. Tucson, Arizona.

Gier, H. J. and G. B. Marion (1968). "Uterus of the cow after parturition: Involutional changes". American Journal of Veterinary Research. 29(1): 83-96.

Gorrie, C. J. R. (1962). "Ovine abortion in Victoria". Australian Veterinary Journal. 138-142.

Gould, M. D. and J. V. Whiteman (1973). "Postpartum reproductive performance of early weaned spring lambing ewes". Journal of Animal Science. 36: 1041-1043.

Gourlay, R. N. (1974). "Pathogenicity of T-mycoplasmas in animals". INSERM. 33: 365-374.

Gourlay, R. N., Brownlie, J. and C. J. Howard (1977). "Isolation of T-mycoplasmas from goats and the production of subclinical mastitis in goats by intramammary inoculation of human T-mycoplasmas". Journal of General Microbiology. 76: 251-254.

Hafez, E. S. E. (1952b). "Studies on the breeding season and reproduction of ewe. Pt. IV. Studies on reproduction of the ewe". Journal of Agricultural Research (Cambridge) 42: 241-255.

Hammond, J. and H. G. Sander (1923). "Some factors affecting milk yield". Journal of Agricultural Science. 12: 74.

[illegible]

Hartigan, P. J., Griffin, J. F. T. and W. R. Hunn (1974). "Some observation on Corynebacterium pyogenes infection of the bovine uterus". Theriogenology. 1: 153-167.

Hartigan, P. J. (1978). "The role of non-specific uterine infection in the fertility of clinically normal repeat breeder cows". Veterinary Science Communication. 1: 310-321.

Henning, M. W. (1956). Animal diseases in South Africa. 3rd Edition. Central News Agency LTD. South Africa. p. 1176.

Henricks, D. M., Dickey, J. F., Hill, J. R. and W. E. Johnston (1972). "Plasma estrogen levels after mating and during late pregnancy and postpartum in cows". Endocrinology, 90: 1336-1342.

Herman, H. A. and J. H. Edmondson (1950). "Factors affecting interval between parturition and first estrus in dairy cattle". Missouri Agricultural Experimental Station Research Bulletin. 462.

Hindmarsh, W. L. and C. C. Blumer (1932) "Infectious abortion of sheep Preliminary report". Australian Veterinary Journal. 149-151.

Hunter, G. L. and A. W. Lishman (1967). "Post-partum ovulation and estrus in spring lambing ewes". Journal of Reproduction and Fertility. 14: 473-475.

Hutchinson, J. S. M. and H. A. Robertson (1965). "The growth of the follicle and corpus luteum in the ovary of the sheep". Research in Veterinary Science. 7: 17-24.

Jordon, W. J. (1952). "The puerperium of the sow, a study of uterine motility". Journal of Comparative Pathology. 62: 54-68.

Koomson, T. O. M. (1980). "Studies on the female Reproductive tract of indigenous sheep and goats". M.Sc. Thesis, Ahmadu Bello University.

Kotani, H., Nagatono, H. and M. Ogata (1980). "Isolation and serological comparism of ureaplasmas from goats and sheep". Japanese Journal of Veterinary Science. 42: 31-40.

Kupfer, M. (1928). "The sexual cycle of female domesticated mammals". 13th and 14th Report of the Division of Veterinary Education and Research. October, 1928. p. 1212-1270.

Laing, J. A. (1955). Fertility and Sterility in Domestic Animals. Balliere. Tindall and Cox, London.

Labhsetwar, A. P., Collins, W. E., Tyler, W. J. and L. E. Casida (1964). "Some pituitary ovarian relationships in the peripar-turient cows". Journal of Reproduction and Fertility. 8: 85-90.

Llauro, J. L., Runnebaum, B. and J. Zander (1968). "Progesterone in human peripheral blood before, during and after labor". American Journal of Obstetrics and Gynecology. 101: 857.

Lee, M. O. (1926). "Studies on the oestrus cycle in rat. III. The effects of low environmental temperatures. American Journal of Physiology, 78: 246-253.

Livingston, W. Jr. and B. B. Gauer (1975). "Isolation of T-strain mycoplasmas from sheep and goats in Texas". American Journal of Veterinary Research. 36: 1699-1701.

Livingston, W. Jr., Gauer, B. B. and M. Shelton (1978). "Non-specific Ureaplasma serotype associated with bovine uterine infection". American Journal of Veterinary Research. 39: 1699-1701.

Matthew, C. S. and C. L. Buxton (1951). "Bacteriology of the cervix in cases of infertility". Fertility and Sterility. 2(1): 45.

Mauleon. P. and L. Dauzier (1965). "Variation in the duration of lactation and oestrus in ewes of the Ile-de France breed". Annals of Biological Biochemistry and Biophysics. 5: 131-143.

Minaquchi, H. and J. Meites (1967). "Effect of suckling on hypothalamus releasing factor, prolactin inhibiting factors and on pituitary Luteinizing hormone and prolactin". Endocrinology. 80: 603.

Miller, W. W. (III) and E. L. Wiggins (1972) "Ovarian activity and fertility in lactating ewes". Journal of Animal Science. 34: 981-983.

Molokwu, E. C. I. and W. C. Wagner (1973). "Endocrine physiology of the puerperal sow". Journal of Animal Science. 36: 1158-1163.

Molokwu, E. C. I. and M. O. Igono (1978). "Reproductive performance and pattern in the brown goats of Nigeria Savanna zone". In: Proceeding of IV World Conference on Animal Production Buenos Aires Argentina.

Molokwu, E. C. I. and N. N. Umunna (1980). "Reproductive performance of Yankassa sheep of Nigeria". Theriogenology. 14(4): 239-248.

Molokwu, E. C. I. (1984). "Goat production in Nigeria - Prospect and Problems". International sheep and goat research (In Press).

Moore, N. W. and T. J. Robinson (1967). "Control of the ovarian cycle in the sheep". Ed. Robinson T. J. Sydney University Press, Sydney.

Moorthy, A. R. S. and S. D. Singh (1982). "Studies on the bacterial flora of the female genital tract of sheep". Bulletin of Animal Health Production in Africa 30(1): 15-18.

Morrow, D. A., Roberts, S. J., McEntee, K. and H. G. Gray (1966). "Postpartum ovarian activity and uterine involution in dairy cattle". Journal of American Veterinary Medical Association. 14(2): 1596-1609.

Ngere, L. O., Adu, I. F. and I. O. Okubanjo (1984). "Indigenous goats of Nigeria". Animal Genetic Resource Information. 3: 1-9

Ogata, M., Nolani, H., Yamamota, K. and R. Harasawa (1978). "Serological typing of Ureaplasmas isolated from cattle, dogs, and cats". Senlralbl. Balcteriol. Parasitenlcal. Infertionskv. H. D. D. Orig. A. 241-277.

Ojo, M. O. (1976). "Caprine pneumonia in Nigeria. I. Epidemiology and bacterial floral of normal and diseased respiratory tracts". Tropical Animal Health Production. 8: 85-89.

Oliver, R. J., Henderson, D. G. H. and D. G. Brynes (1965). "Microbiology of the cervix: An anaerobic study". American Journal of Obstetrics and Gynecology 92: 970-972.

Oxenreider, S. L. (1968). "Effect of suckling and ovarian functions on postpartum reproductive activity in beef cows". American Journal of Veterinary Research 29: 2099-2102.

Oyedipe, E. O., Osori, D. I. K., Jagun, A. G., Ntunde, B. and L. O. Eduvie (1980). "Postpartum uterine involution and resumption of ovarian activity in white Fulani and Friesian/Bunaji cross cows determined by rectal palpation". Nigerian Journal of Animal Production. 7(1): 112-116.

Palmer, W. M., Teague, H. S. and W. G. Venzke (1965a). "Macroscopic observations on the reproductive tract of the sow during lactation and early post weaning". Journal of Animal Science. 24(2): 541-545.

Palmer, W. M., Teague, H. S. and W. G. Venzke (1965b). "Histological changes in the reproductive tract of the sow during lactation and early weaning". Journal of Animal Science. 24(4): 1117-1125.

Pathiraja, N., Oyedipe, E. O., Voh, A. A. Jr. and P. M. Dawuda. (1985). "Accuracy of rectal palpation in the diagnosis of corpus luteum in Zebu cows". British Veterinary Journal (In Press).

Paulser M. (1953). "Infectious ovine abortion". Australian Veterinary Journal. 29: 133-139.

Perera, B. M. A. O. and A. S. Abeyraine (1982). "The use of nuclear techniques in improving reproductive performance of farm animals". World Animal Review. 32: 2-8.

Quinlivan, T. D. (1970). "The bacteriology of cervical mucus of ewe at oestrus following treatment with fluoroprogestagen impregnated intravaginal sponges". Australian Veterinary Journal. 6: 11-16.

Quinlivan, T. D. and T. J. Robinson (1967). "Control of ovarian cycle in sheep". Ed. T. J. Robinson, Sydney University Press.

Quinlivan, T. D. and T. J. Robinson (1969). "Numbers of spermatozoa in the genital tract after artificial insemination of progestagen treated ewes". Journal of Reproduction and Fertility. 19: 73-86. (A.B.A. 3756)

Quinlan, J. and G. S. Mare (1931). "The physiological changes in the ovary of the Merino sheep in South Africa and their practical application in breeding. Union South Africa. Division of Veterinary Service and Animal Industry Report. 17: 661-704.

Rasbech, N. O. (1950). "The normal involution of the cow". Nordisk Veterinary Medicine. 2: 655-687

Rawson, L. E. A., Laming, G. M. and R. N. Fry (1953). "The relationship between ovarian hormones and uterine infection". Veterinary Record. 65: 335-340.

Razin, S. and J. G. Tully (1983). "Methods in mycoplasmology". Volume I. Mycoplasma characterization. Academic Press.

Robertson, A. H. (1974). "Reproduction in the Ewe and Goat". In Reproduction in Domestic Animals. Academic Press, New York. p. 484.

Roberts, S. J. (1971). Veterinary Obstetrics and Genital Diseases. 2nd Edition. Ithaca, New York.

Robinson, F. R. (1964). "Diseases of sub-human primates of importance to the Veterinary Practitioner". 5th Western Veterinarian 17: 273-275.

Rumjancev, T. V. (1954). "The postpartum period in sows and possibility of reducing the farrowing internal". Veterinariya 3(1): 52.

Sagartz, W. J. and J. J. Hardenbrook (1971). "A clinical bacteriology and histological survey of infertile cows". Journal of American Veterinary Medical Association, 158: 619-622.

Sawyer, G. T. (1977). "Observations on the bacterial population of the Os cervix of the ewe before and after embryo death". Australian Veterinary Journal. 53: 233-235.

Satō, S. and S. Hoshi (1934). "Studies on the reproduction in the Mare. III. The oestrus duration and oestrus cycle". Journal of Japanese Society of Veterinary Science. 13: 237-250.

Shalka, B. and M. Svojanovska (1963). Cited by Quinlivan, T. D. (1970). The bacteriology of cervical mucus of ewes at oestrus following treatment with fluoro-progestagen impregnated intravaginal sponges". Australian Veterinary Journal. 46: 1-16.

Smith, I. D. (1962). "Observation on ovine abortion with particular reference to Toxoplasmosis and virus abortion". Australian Veterinary Journal. 38: 143-146.

Smith, V. G., Edgerton, C. A., Hafs, H. D. and E. M. Convey (1973). "Bovine serum estrogens, progestins and glucocorticoids during late pregnancy, parturition and early lactation". Journal of Animal Science. 36: 391-396.

Stabenfeldt, G. H., Osburn, B. I. and L. L. Ewing (1970). "Peripheral plasma progesterone levels in the cow during pregnancy and parturition". American Journal of Physiology. 218: 517-575.

Stamp, J. T. (1950). "Abortion in sheep". Veterinary Record. 50: 778-780.

Steel, R. G. D. and J. H. Torrie (1960). "Principles and procedure of statistics". McGraw-Hill Incorporation, New York.

Sobrero A. J. (1962). Cited by Quinlan T. D. (1970). "The bacteriology of cervical mucus of ewes of oestrus following treatment with fluco-progestagen impregnanted Intravaginal sponges". Australian Veterinary Journal. 46: 11-16.

Stockard, C. R. and G. N. Panicolaou (1917): "The existence of a typical oestrus cycle in the guinea pig with a study of its histological and physiological changes". American Journal of Anatomy. 22: 275-280.

Teilgy, A. H., Fathalia, M., Omar, M. A. and S. AL-dahesh (1982). "The clinical and morphological characteristics of the uterus of the goat during the period of involution". Canadian Veterinary Journal. 23: 138-140.

Tennant, B. W., Kendrick, J. W. and R. G. Peddicord (1967). "Uterine involution and ovarian function in the postpartum cow. A restrospective analysis of 2,338 genital organ examinations". Cornell Veterinarian 57: 543-558.

Van Niekerk, B. D. H. and A. M. Mulder (1965) "Duration of pregnancy and of postpartum anaestrus in autumn mated Dorper, Dohme Merino and Merino ewes". Proceedings of South African Society for Animal Production. 4: 205-212. A.B.A. 36 No. 1593.

Van Wyk, I. C., Van Niekerk, C. H. and P. C. Belonge (1972a). "Involution of the postpartum uterus of the ewe". Journal of South African Veterinary Association. 43(1): 19-26.

Van Wyk, L. C., Van Niekerk, C. H. and P. C. Belonge (1972b). "Further observations on the involution of the postpartum uterus of the ewe". Journal of South African Veterinary Association. 43(1): 29-33.

Wagner, W. C. (1968). "Physiology of the postpartum female". Iowa State University Veterinarian. 30(3): 75-77.

Wagner, J. F. and E. L. Veenhuizen (1968). "Effect of lactation on reproductive performance in the ewe". Journal of Animal Science 27: 1198 (Abstract No. 312).

Wagner, J. C. and W. Hansel (1969). "Reproductive physiology of the postpartum cow (1). Clinical and histological finding". Journal of Reproductive Fertility. 18: 493-500.

Wagner, W. C. (1970). "Plasma corticoids in the cow". Journal of Animal Science 31:233, (Abstract No. 305).

Wagner, W. C. and S. L. Oxenreider (1971). "Endocrine physiology following parturition". Journal of Animal Science. 32. Suppliment p. 1-15.

Wagner, W. C. and S. L. Oxenreider (1972). "Adrenal function in the cow. Diuonal changes and the effects of lactation and neurohypophyseal hormone." Journal of Animal Science. 34: 630-635.

Watson, W. A. (1962a). "Ovine abortion". Veterinary Record. 24: 1403-1408.

Watson, W. A. (1962b). I. "Abortion and still birth in sheep". Veterinary Bulletin. 32: 259-264.

Watson, W. A. (1962c). II. "Abortion and still birth in sheep". Veterinary Bulletin. 32: 335-341.

Watson, W. A. (1973). "Clinical problems of preventive medicine. The prevention and control of infectious ovine abortion". Britist Veterinary Journal. 129: 309-341.

Weitz, B. (1947). "The bacterial flora found in the vagina of dairy cows with special reference to corynebacteriosis". Journal of Comparative Therapeutics. 57: 191-195.

Whiteman, J. V., Zollinger, W. A., Thrift, F. A. and M. B. Gould (1972). "Postpartum mating performance of ewes involved in a twice yearly lambing program" Journal of Animal Science. 35: 836-842.

Wiltbank, J. M. and A. C. Cook (1958). "The comparative reproductive performance of nursed cows and milked cows". Journal of Animal Science. 29: 602-605.

Wiltbank, J. N., Rowden, W. W., Ingalls, J.E., Gregory, K. E. and J. M. Kock (1962). "Effect of energy level on reproductive phenomena of mature Hereford cows". Journal of Animal Science. 21: 219-225.

Wiltbank, J. N., Rowden, W. W., Ingalls, J. E. and D. R. Zimmerman (1964). "Influence of postpartum energy level on reproductive performance of Hereford cows restricted in energy intake prior to calving". Journal of Animal Science. 23: 1049-1053.

Wulf, J. J. nd A. E. Dracy (1952). "A survey of the microflora obtained by flushing the normal bovine uterus". Proceedings of South Dakota Academy of Science. 116-122.

Zaki, K., bdel-Raouf, M. and M. A. Siam. (1963). 'The bacterial flora of the external os of Friesian cattle". Cairo Veterinary Medical Journal. 8: 225-229.

Zaki, K., M. Abdel-Raouf, and M. A. Siam (1961). "The bacterial flora of the external ox os in the buffaloes". Journal of Arabian Veterinary Medical Association 21, 427-431. (Abstract, Veterinary Bulletin 32, 4418).

Zaki, K. nd M. S. Saber (1963). "The bacterial flora of the external os and prepuce of Merino sheep". Veterinary Medical Journal Cairo, 8: 17

A P P E N D I X

Table A: Summary of the individual gravid and non-gravid uterine parameters against days post-partum

Animal No.	Days post partum	*Entire wt. of uterus (G)	Wt. of pregnant Horn (G)	Wt. of non pregnant horn (G)	Circumference of pregnant Horn (cm)	Circumference of non pregnant Horn (cm)
1.	0	432.0	250.0	162.0	21.5	14.8
2.	1	352.82	190.0	150.8	19.0	15.0
3.	2	263.5	149.8	103.7	13.6	13.0
4.	4	145.121	80.508	57.115	10.6	8.6
5.	4	237.3	144.2	80.3	13.5	10.5
**6.	8	54.671	28.471	21.600	6.5	6.0
7.	8	101.789	57.667	39.122	8.3	7.8
8.	12	29.8766	16.3050	11.671	6.0	4.5
9.	12	30.826	18.0	10.985	5.7	5.0
10.	15	44.667	21.8722	17.955	7.5	7.1
11.	16	49.757	26.763	18.050	6.7	6.0
12.	20	25.607	12.456	11.271	5.5	5.2
13.	20	28.811	15.058	11.778	4.5	4.2
14.	24	20.649	10.649	8.9	5.2	4.9
15.	24	26.858	12.8	12.058	4.8	4.5
16.	28	23.619	10.458	11.752	4.9	4.7
17.	28	12.765	6.124	4.911	4.8	4.5
18.	32	14.006	6.451	5.477	5.3	4.3
19.	32	14.990	6.380	6.110	4.6	4.2

* Obtained by adding weights of both horns and body
* * Not utilized in statistical analysis

Table b: Individual left and right uterine parameter used for statistical analysis

Animal No.	Days Post Partum	Circumference of Uterine Horn (cm) Left	Right	Circumference of Body of Uterus (cm)	Circumference of cervix (cm)	Wt. of Uterine Horns (gm). Left	Right
1	0	14.8	21.5	12.5	12.0	162.0	250.0
2	1(24hrs)	19.0	15.0	11.5	9.5	190.0	150.8
3	2(48hrs)	13.0	13.6	8.5	6.5	103.7	149.8
4	4	10.6	8.6	8.2	7.0	80.508	57.113
5	4	10.5	13.5	7.9	6.2	80.3	144.2
6	8	7.0	6.5	5.8	5.7	21.600	28.471
7	8	8.3	7.8	6.5	6.0	57.607	38.122
*8	8	12.1	11.8	8.0	7.8	123.564	108.4
9	12	6.0	4.5	4.5	5.4	16.3056	11.671
10	12	4.5	5.7	6.0	5.5	10.986	18.00
11	16	7.1	7.5	5.0	5.4	17.955	21.872
12	16	6.7	6.0	5.8	5.7	26.763	18.050
13	20	5.5	5.2	4.6	4.7	12.456	11.271
14	20	4.5	4.2	4.5	5.4	15.058	11.773
15	24	4.9	5.2	4.8	5.2	8.5	10.649
16	24	5.7	6.0	5.5	5.5	12.058	12.8
17	28	4.7	4.9	4.8	5.0	11.752	10.458
18	28	4.5	4.8	5.0	4.9	4.911	6.124
19	32	5.3	4.3	4.6	5.7	6.451	5.477
20	32	4.2	4.6	3.8	4.7	6.110	6.380
21	NP 3 days post heat	3.9	3.9	3.8	4.0	7.248	6.367
22	NP 3 days post estrus	4.0	3.0	3.5	4.0	7.07	7.1

* - Not utilized in analysis

Table C: The number of caruncles in each uterine section and the size of the larges caruncles in the left and right uterine horns

Animal No.	Days Post Partum	Left Horn	Right Horn	Body	Total	Diameter of the largest caruncle in cm Left	Right
1	0	39	42	8	89	2.8/3.2	2.8/3.0
2.	1(24hrs)	45	51	6	102	1.7/2.8	1.8/2.4
3	2(48hrs)	48	55	11	114	1.4/2.4	1.0/2.3
4	4	45	39	3	87	1.3/1.4	1.4/1.9
5	4	51	59	4	117	0.95/1.1	0.80/0.85
6	8	18	20	3	41	1.9/2.2	1.1/1.7
7	12	63.0	57.0	3	123	0.45/0.70	0.40/0.50
8	12	41	59	7	107	0.30/0.45	0.4/0.5
9	16	45	54	4	103	0.6/0.7	0.7/0.9
10	16	64	51	8	113	0.65/0.8	0.6/1.0
11	20	52	49	4	105	0.4/0.7	0.4/0.5
12	20	80	72	4	156	0.5/0.8	0.5/0.8
13	24	60	52	6	120	0.5/0.8	0.6/1.0
14	24	57	49	6	112	0.6/0.7	0.6/1.0
15	28	57	37	10	104	0.4/0.7	0.5/0.5
16	28	48	50	5	103	0.5/0.6	0.6/0.7
17	32	57	52	7	116	0.5/0.6	0.6/0.7
18	32	49	44	7	100	0.4/0.5	0.4/0.5
19	Baseline	61	67	7	135	0.4/0.4	0.3/0.45
20	Baseline	57	52	8	117	0.3/04	0.2/0.2
Total		1037	1086	121.0	2164		
Average		51.	54.3	6.1	108.2		