Evaluation of the bacteriological flora in the vagina of postpartum anestrus cattle before and after treatment with three progesterone implants

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Abstract

Thirty postpartum (>70 days) anestrus crossbred cows were treated with three standard hormonal protocols (CIDR TRIU-B, and P₄ Sponge n=10 each) for induction of estrus and the findings were compared with a group of untreated anestrus cows (Blank Sponge n=10). 80 vaginal swabs were collected aseptically from each group just before insertion of Implants/Blank Sponge and at the time of Implant/Blank Sponge withdrawal for microbiological evaluation of vaginal mucosa. Total number of isolates obtained from all the swabs were 180. Out of 180 isolates, 72 (40.00%) isolates were Gram positive and 108 isolates were (60.00%) Gram-negative bacteria, indicating dominance of Gram-negative bacteria. Overall ratio of number of isolates per vaginal sample obtained in the present study was 2.25. The highest rate of isolation of bacteria per sample was recorded in the placebo group at the time of removal of placebo i.e. 2.6, followed by 2.5 by same group at the time of insertion, 2.3 at the time of TRIU-B removal, 2.2 at the time of TRIU-B insertion and P₄ Sponge removal, 2.1 in CIDR at the time of removal and P₄ Sponge insertion and lowest i.e. 2.0 in CIDR group at the time of insertion of implant. The frequency of single and mixed isolates observed in different groups of anestrus animals at the time of insertion and removal of implants showed predominance of mixed isolates over single isolates 63 (78.75%) vs 17 (21.25%), indicating dominance of mixed isolates over single isolates.

Keywords: Cow vaginal microflora, anestrus, estrus induction, progesterone implants

1. Introduction

The postpartum anoestrus in cattle has been identified as one of the prevalent problems affecting the reproductive efficiency which is in turn a major source of economic loss to dairy farmers in rural areas. Since the early work done by Robinson (1967) [29], intravaginal inserts/sponges impregnated with progesterone are commonly administered to postpartum dairy cows for the treatment of anoestrus and provide a very convenient method of delivering this steroid hormone for prolonged periods (Rhodes et al., 1998) [28]. Under natural conditions, the environment of the bovine vagina is stable and does not allow excessive growth of pathogenic, potentially pathogenic or saprophytic organisms (Hafez and Hafez, 2002 and Otero et al., 2000) [15, 22]. Vaginal microorganisms can invade the uterus through the cervix, which is partly open due to the action of estrogens released during estrus or during parturition (Foldi et al., 2006) [11]. Thus, the presence of microorganisms in the cervical vaginal secretions poses a potential threat to fertility of the cows (Dabas et al., 1995) [7]. There is a lack of information about the effects of prostegsten impregnated sponges/implants on the bacterial microflora in the vaginal microbiota. Therefore, the purpose of the current experiment was to conduct the qualitative analysis of bacteria from vagina associated with the use of different intravaginal implants in cows subjected to estrus induction protocols.

2. Materials and methods

The present study was carried out on 40 anestrus cattle with more than 70 days postpartum period. The animals were selected from various villages of Jammu and Samba districts of J&K. The animals were then randomly allocated to four groups, three treatment (n=10) and one untreated anestrus control (n=10) and were managed with three different hormonal regimens. In 10 true anestrus cattle, CIDR was inserted intra-vaginally on day 0.
removed on day 9 together with 600 IU i/m injection of PMSG+eCG and AI was performed on day 11 and 12 at detected heat. Same protocol as that of for CIDR group was followed in TRIU-B and P4 Sponge group while as in control group blank sponge was inserted intra-vaginally on day 0 and was removed on day 9 together with injection of normal saline (10 ml) intramuscularly.

2.1 Collection of vaginal swab samples
80 vaginal swabs were collected on day 0 (insertion of implants) and day 9 (removal of implants). The vulvar area was washed with water followed by surgical spirit and then then a sterile pressed cotton swabs (1cm²), moistened with saline (0.9% NaCl; w/v) swab was inserted along the dorsal vaginal wall to approximately 10 cm cranial to the vulva, kept there for at least 30 seconds (Fig. 1). Upon collection, samples were placed individually into sterile tubes containing 10 ml of saline solution, which were kept in ice until arrival at the Public Health Laboratory at Faculty of Veterinary Sciences and Animal Husbandry SKUAST J, R.S. Pura, Jammu.

2.2 Bacterial isolation and identification
The vaginal swabs were cultured using different media for isolation and purification of bacteria which included: Blood agar, MacConkey agar, Nutrient agar, Edward blood agar, Eosin-Methylene-Blue agar (EMB), Simmon’s citrate agar and Mannitol salt agar. The commercial media were prepared according to the direction of the manufacturer (Hi-Media, India). Plates were incubated at 37°C, and examined daily for bacterial growth, for a period of 3 days for bacterial isolation (Quinn et al., 2011[26]). All bacterial genera isolated were identified on the basis of colony characteristics, Gram staining, and biochemical reactions, including: urease test; citrate test; indole test, motility test, nitrate test, catalase activity tests, the fermentation of carbohydrates; and triple sugar iron (TSI) (Fig. 2) Genera were classified according to Cruickshank et al. (1980)[6] (Fig. 3).

Fig 1: (A) Perineal region following cleaning with water followed by surgical spirit. (B) Moisten Cotton Swab inserted along the dorsal vaginal wall to approximately 10 cm cranial to the vulva.

Fig 2: IMViC tests for identification of bacteria: (A) IMViC tests for Pseudomonas (-, -, -, +); (B) IMViC tests for E. coli (+, +, -, -)
3. Results
Total number of vaginal swabs obtained for bacterial isolation was 40 at the time of insertion and 40 at the time of implant removal, in total 80 vaginal swabs were obtained. All (100%) the vaginal swabs (Insertion/removal) in all the groups of animals using different protocols yielded growth of bacteria in all the vaginal swabs. Number of bacterial isolates obtained in each group of anestrus cattle at the time of insertion and removal of CIDR, TRIU-B, P₄ Sponge and Placebo Sponge were: 20, 21; 22, 23; 21, 22 and 25, 26 respectively with total sum of 180 isolates. The highest rate of isolation of bacteria per sample was recorded in the placebo group at the time of removal of placebo (2.60), followed by (2.50) same group and TRIU-B group (insertion), at the time of insertion in CIDR and P₄ Sponge groups (2.2) and lowest in (2) CIDR, TRIU-B and P₄ Sponge groups at the time of removal of implants. In most of the groups the bacterial isolation showed predominance of mixed isolates over single isolates 63 (78.75%) vs 17 (21.25%), indicating that in most of the cow vagina harbours mixed bacteria than single isolates (Fig. 4, Table-1).

![Fig 3: Selective Media for Identification of bacteria: (A) Growth of S. aureus on Mannitol Salt Aggar; (B) Pink colour colonies of E. coli on Mac Conky Agar; (C) Green colour discolouration of nutrient agar by Pseudomomas spp; (D) Streptoccus spp. on Blood agar with Haemolysis; (E) Metallic sheen appearance of E. coli on EMB (F) Growth of Klebsiella spp. on MacConkey agar.](image)

![Fig 4: Bar diagram showing recovery of isolates from vaginal swabs as single or mixed cultures](image)

**Table 1:** Recovery of isolates from vaginal swabs of postpartum anestrus cows in different estrus induction protocols as single or mixed cultures

| Group            | Day    | No. of single cultures | No. of mixed cultures | Total no. of swabs |
|------------------|--------|------------------------|-----------------------|--------------------|
| CIDR Protocol    | Insertion | 2                      | 8                     | 10                 |
|                  | Removal  | 3                      | 7                     | 10                 |
| TRIU-B Protocol  | Insertion | 1                      | 9                     | 10                 |
|                  | Removal  | 1                      | 9                     | 10                 |
| P₄ Sponge Protocol | Insertion | 2                      | 8                     | 10                 |
|                  | Removal  | 3                      | 7                     | 10                 |
| Placebo          | Insertion | 2                      | 8                     | 10                 |
|                  | Removal  | 3                      | 7                     | 10                 |
| Total            | No.     | 17                     | 63                    | 80                 |
|                  | %       | 21.25                  | 78.75                 | 100                |

Out of the 180 bacterial isolates, Gram positive organisms isolated were (72 isolates) 40.00% and Gram-negative bacteria were (108 isolates) 60.00%, indicating dominance of Gram- negative bacteria (Fig. 5, Table -2).
Table 2: Recovery of isolates from vaginal swabs of postpartum anestrus cows in different estrus induction protocol based on Grams reaction.

| Group             | Day   | No. of Gram +ive isolates | No. of Gram -ive isolates | Total no. of isolates |
|-------------------|-------|---------------------------|---------------------------|-----------------------|
| CIDR Protocol     | Insertion | 8                        | 12                        | 20                    |
|                   | Removal  | 8                        | 13                        | 21                    |
| TRIU-B Protocol   | Insertion | 8                        | 14                        | 22                    |
|                   | Removal  | 8                        | 15                        | 23                    |
| Pt Sponge Protocol| Insertion | 9                        | 12                        | 21                    |
|                   | Removal  | 9                        | 13                        | 22                    |
| Placebo           | Insertion | 11                       | 14                        | 25                    |
|                   | Removal  | 11                       | 15                        | 26                    |
| Total             | No.     | 72                       | 108                       | 180                   |
|                   | %       | 40                       | 60                        | 100                   |

Fig. 5: Bar diagram showing recovery of isolates from vaginal swabs based on Grams reaction.

E. coli, Staphylococcus, Proteus spp and Bacillus spp were the commonest isolates obtained before and after insertion of CIDR, TRIU-B, Pt Sponge protocols and placebo sponge in postpartum anestrus cattle. These organisms could, therefore, be considered as a part of the normal vaginal bacterial flora of the cow. The implant used and time/period of isolation did not alter the types of bacteria isolated. From the quantitative study of the organisms from postpartum anestrus cattle before and after insertion of Crestar, CIDR, TRIU-B, Pt Sponge protocols and placebo sponge it was observed that 8 out of 8 types of bacterial isolates are common before and after insertion of implants. Upon comparing each species of bacteria between before and after insertion of implants it is observed that there was no remarkable difference in the frequency of occurrence of the different species. This signifies that there is a "normal" bacterial population resident in the vaginal mucus of postpartum anestrus animals. However, Pseudomonas spp, was not recovered before and after insertion of TRIU-B implant but it was recovered from vaginal samples before and after insertion of all other vaginal implants including placebo implant in placebo group. Likewise, Klebsiella, Streptococcus and Coagulase Negative Staphylococcus (CNS) was not recovered before and after insertion of Placebo group, CIDR and Pt Sponge and TRIU-B implants respectively (Table 3).

Table 3: Prevalence of various bacterial genera in vaginal swabs of postpartum anestrus cows during different estrus induction protocols

| Protocol         | Day   | E. coli | Prot. | Pseud. | Kleb. | Staph. | Strept. | Bacil. | CNS | Total no. of isolates |
|------------------|-------|---------|-------|--------|-------|--------|---------|--------|-----|-----------------------|
| CIDR Protocol    | Insertion | 7(35.0) | 3(15) | 1(5) | 1(5) | 5(25) | 0(0.0) | 1(5) | 2(10) | 20                    |
|                  | Removal | 7(33.3) | 4(19.05) | 1(4.7) | 1(4.7) | 5(23.8) | 0(0.0) | 1(4.7) | 2(9.4) | 21                    |
| TRIU-B Protocol  | Insertion | 7(31.8) | 5(22.7) | 0(0.0) | 2(9.1) | 6(27.3) | 1(4.5) | 1(4.5) | 0(0.0) | 22                    |
|                  | Removal | 8(34.8) | 5(21.7) | 0(0.0) | 2(8.7) | 6(26.1) | 1(4.3) | 1(4.3) | 0(0.0) | 23                    |
| Pt Sponge Protocol | Insertion | 6(28.6) | 3(14.3) | 2(9.4) | 1(4.7) | 5(23.8) | 0(0.0) | 2(9.4) | 2(9.4) | 21                    |
|                  | Removal | 7(31.8) | 3(13.6) | 2(9.1) | 1(4.5) | 5(22.7) | 0(0.0) | 2(9.1) | 2(9.1) | 22                    |
| Placebo          | Insertion | 7(28.0) | 5(20.0) | 2(8.0) | 0(0.0) | 7(28.0) | 1(4.0) | 2(8.0) | 1(4.0) | 25                    |
|                  | Removal | 8(30.7) | 5(19.2) | 2(7.7) | 0(0.0) | 7(26.9) | 1(3.8) | 2(7.7) | 1(3.8) | 26                    |
| Total            | No.     | 57(31.7) | 33(18.3) | 10(5.0) | 8(4.0) | 46(25.6) | 4(2.0) | 12(6.7) | 10(5.0) | 180                   |

The number in parenthesis indicate percentage of bacterial species obtained from vagina out of total number of isolates obtained at the time of insertion or removal of implant/sponge. Prot = Proteus, Pseud. = Pseudomonas, Kleb. = Klebsiella, Staph. = Staphylococcus, Strept. = Streptococcus, CNS = Coagulase Negative Staphylococcus.
4. Discussion

The extent of Vaginal samples found positive (100%, 40/40) for the presence of bacterial isolates in vaginal swabs in the present study closely corroborated with the observations reported by Kavvashree (2013) [18] and Husted (2003) [16] who reported 100% bacterial culture from the vaginal samples. While these findings are comparatively higher than previous reports varying from 64 to 99 % by Bulman et al. (1978) [4], and Dholakia et al. (1987) [10]. However, the results obtained in the present study are very high than those varying from 3.79 to 60 % as reported by Khasatiya et al. (1999) [19], Patel et al. (2005) [24] and Ocando et al. (2010) [20]. The overall ratio of number of isolates per vaginal sample obtained in the present study was 2.25. The highest rate of isolation of bacteria per sample was recorded in the placebo group at the time of removal of placebo (2.60), followed by - (2.50) same group at the time of insertion, (2.3) at the time of TRIU-B removal, (2.2) at the time of TRIU-B insertion and P2 Sponge removal, (2.1) in CIDR at the time of removal and P2 Sponge insertion and lowest in (2) CIDR group at the time of insertion of implant. The rate of bacterial isolation per sample reported in the previous studies were 1.30 (Decun and Rosu, 1973) [8], 1.90 (Heist and Tanabe, 1974) [14] and (Panangula et al., 1978) [23] 2.89 while Kavvashree (2013) [18] obtained 2.2 isolates per vaginal samples of normal fertile cows.

The frequency of single and mixed isolates observed in different groups of anestrous animals at the time of insertion and removal of implants in the present study revealed predominance of mixed isolates over single isolates 63 (78.75%) vs 17 (21.25%), indicating dominance of mixed isolates over single isolates (Table 1 and Fig.4). This is in corroboration with the findings of Panangula et al. (1978) [23] who also recovered 93.10% and 6.90% of mixed and single bacterial isolates respectively. However, the present findings are contrary to those of Shah and Dholakia (1983) [30], Sharma et al. (2008) [31] and Ocando et al. (2010) [20] who recorded 34.18%, 11.43% and 25.49% of mixed isolates as compared to 65.82%, 88.57% and 28.43% of single isolates respectively.

Out of the 180 bacterial isolates, Gram positive organisms isolated were (72 isolates) 40.00% and Gram-negative bacteria were (108 isolates) 60.00%, indicating dominance of Gram- negative bacteria. This confirms the findings of Deka et al. (1979) [9] who also reported the predominance of gram-negative bacteria isolated from cervico vaginal mucus of cows. Sharma et al. (2008) [31], reported 38.71% and 61.29% respectively gram positive and gram-negative organisms. However, several other studies reported the dominance of Gram-positive organisms being isolated more frequently than gram negative bacteria (Shah and Dholakia, 1983; Petit et al., 2009 and Ocando et al., 2010) [30]. However, Ramaswamy et al. (1998) [27] and Azawi et al. (2008) [3] reported that prevalence of gram positive and Gram-negative organisms was almost equal.

E. coli, Staphylococcus, Proteus spp and Bacillus spp were the commonest isolates obtained before and after insertion of CIDR, TRIU-B, P2 Sponge protocols and Blank sponge in post-partum anestrous cows. These organisms could, therefore, be considered as a part of the normal vaginal bacterial flora of the cow. Kather et al. (2012) [17] observed that in multiparous cows E. coli was the most prevalent bacteria with an isolation rate (38.3%), followed by S. aureus (20.0%) and Proteus spp. (10.0%). Other bacteria in order and frequency were Pseudomonas spp., Klebsiella spp., Bacillus spp, which is in close agreement with the present study. Further, some workers (Kather et al., 2012; Ata et al., 2010; Hella (2014)] [17, 1, 13] observed that E. coli and Staphylococcus were the predominant isolates from intact vagina which is in agreement with the present findings. However, present results are in disagreement with other previous studies (Gani et al., 2008) [12], where Staphylococcus was predominant 37.8%. Also, the main source of vaginal bacteria is variable according to species including contamination from environment, skin or faecal materials (Torres et al., 1994) [32]. Carmona et al. (1993) [3] mentioned that the differences of the microflora between clinically healthy and sick cows, between cows with normal or abnormal deliveries or between cows and heifers were not significant. A few studies have been conducted, however, that evaluated the normal flora in healthy cattle (Amin et al., 1996; Otero et al., 1999, and Otero et al., 2000) [2, 21, 22]. These studies demonstrated that the dominant bacteria were Streptococcus spp. followed by coagulase-negative Staphylococcus spp. (White et al., 1989 and Otero et al., 2000) [33,22], Enterobacteriaceae (in particular, Escherichia coli), members of the genus Lactobacillus were consistently present but in much lower numbers (Otero et al., 2000) [22].

4. Conclusion

It could be concluded that the use of intravaginal devices, regardless of their composition, may generate changes in the normal vaginal bacterial flora of the vaginal mucus, the implant used and time/period of isolation did not alter the types of bacteria isolated. These organisms could, therefore, be considered as a part of the normal vaginal bacterial flora of the cow and did not reflect on the subsequent fertility.

5. Acknowledgments

The authors are responsible for all the content.

6. Conflict of interest.

The authors declare that they have no conflict of interest.

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8. References

1. Ata A, Türütoğlu H, Kale M, Gülay MS, Pehlivanoğlu F. Microbial flora of normal and abnormal cervical mucus discharge associated with reproductive performance of cows and heifers in estrus. Asian-Aust. J Anim. Sci. 2010; 23(8):1007-1012.
2. Amin JD, Zaria LT, Malgwi RM. Vaginal aerobic flora of apparently healthy cattle in various stages of the reproductive cycle in the Sahel region of Nigeria. Bulletin of Animal Health and Production in Africa. 1996; 44:15-18.
3. Azawi OI, Omran SN, Hadad JJ. A study on repeat breeding of Iraqi buffalo cows. Buffalo Bulletin. 2008; 27(4):274-283.
4. Bulman DC, Mc Kibbin PE, Appleyard WT, Lamming GE. Effect of a progesterone-releasing intravaginal device on the milk progesterone levels, vaginal flora, milk yield and fertility of cyclic and non-cyclic dairy cows. J Reprod. Fert. 1978; 53:289-296.
5. Carmona RR, Cotayo BG, Ahmed T, Habtamu A. Cervical and vaginal microbial flora in recently calved...
6. Cruickshank K, Duguid JP, Marmion BP. Test for sensitivity to antimicrobial agents. Medical Microbiology. Churchill Livingstone, 1980, 190-209.

7. Dahas YPS, Verma MC, Gupta RS. Bacteriological studies of cervical secretions of repeat breeder cows. Indian J Anim. Reprod. 1995(1): 6(1):77.

8. Decun M, ROSU M. Investigation of the microflora of normal and pathological cervical secretions in cows. Revta Zooteh. Med. Vet. Bucuresti. 1973; 23:39-46.

9. Deka AK, Chakrabarty AK, Bora BR, Nath KC. Studies on microflora in the cervico-vaginal mucus of the repeat breeder cows. J Coll. Vety. Sci. Assam Agri. Univ. 1979; 19:40-46.

10. Dholakia PM, Shah NM, Purohit JH, Kher HN. Bacteriological study on non – specific genital infection and its antibiotic spectra in repeat breeders. Indian Vet. J. 1987; 64:637-640.

11. Foldi J, Kulcsar M, Pecsi A, Huygheb B, De Sa C, Lohuis JACM et al. Bacterial complications of postpartum uterine involution in cattle. Anim. Reprod. Sci. 2006; 96:265-281.

12. Gani MO, Amin MM, Alam MGS, Kayesh MEH, Karim MR, Samad MA et al. Bacterial flora associated with repeat breeding and uterine infections in dairy cows. Bangl. J Vet. Med. 2008; 6(1):79-86.

13. Hella Al-Fatlawy J. Isolation and identification of aerobic vaginal bacteria and fungi from adult cows in AL-Kufa district/AlNajaf province-Iraq. MRSVA. 2014; 3(2):19-23.

14. Heist CE, Tanabe TY. Prevalence and types of uterine microflora, the nature of subfertility in dairy heifers. Pennsylvania State Univ. Agr. Exp. Sta. Bull, 1974, 794.

15. Hafez ESE, Hafez B. Reproduction and Artificial Insemination in Animals. Edn 7, Mc Graw-Hill Publishers, 2002, 519.

16. Husted JR. Bacterial and fungal organisms in the vagina of normal cows and cows with vaginitis. Master’s Thesis. Office of Graduate Studies of Texas A and M University, 2003.

17. Kather NY, Hasan ASH, Dawood WS, Mohammed SN. Bacterial flora isolated from genital tract of cows submitted for artificial insemination in Balad district. Kufa Journal for Veterinary Medical Sciences. 2012; 3(1):92-97.

18. Kavyashree S. Vaginal microbial flora of normal, repeat breeding and endometritis dairy cows. Master’s Thesis, Department of Veterinary Gynaecology and Obstetrics, Veterinary College, Hebbal, Bengaluru, Karnataka, 2013, 1-98.

19. Khasatiya T, Kavani FS, Dhami AJ, Panchal MT, Shah RG. Fallopian tube patency testing and therapeutic measures in repeat breeding bovines. Bioscience in Animal Production and Thai Buffalo Association. 1999; 1:69-79.

20. Ocando JB, Nava SZ, Nava J, Martínez GP. Profile of Vaginal Bacterial Flora: A potential risk for reproduction in Criollo limonero cows. Revista científica. 2010; 20(3):227-234.

21. Otero C, Silva de Ruiz C, Wilde OP, de Ruiz Holgado A, Nader Macô As ME. Lactobacilli and Enterococci isolated from vaginal cows during the estrous cycle. Anaerobe. 1999; 5:305-307.

22. Otero C, Saavedra L, Silva de ruiz C, Wilde O, Holgado AR, Nader-Macias ME. Vaginal bacterial microflora modifications during the growth of healthy cows. Lett Appl Microbiol. 2000; 31:251-254.

23. Panangala VS, Fish NA, Barnum DA. Microflora of the cervico-vaginal mucus of repeat breeder cows. The Canadian Vet. J. 1978; 19:83-89.

24. Patel JA, Dhami AJ, Kavani FS, Jani RG. Effect of hormonal therapies at breeding on conception rates and plasma biochemical profiles in repeat breeding HF cows. A paper presented in XXI Annual Convention of ISSAR and National Symposium on recent trends and innovations in animal reproduction held at Jammu. Nov. 23-25, 2005. Abstr. FIM-27. 2005, 127.

25. Petit T, Spergser J, Rosengarten R, Aurich J. Prevalence of potentially pathogenic bacteria as genital pathogens in dairy cattle. Reprod. in Domestic Animals. 2009; 44(1):88-91.

26. Quinn PJ, Carter ME, Markey BK, Carter GR. Clinical veterinary microbiology. London: Mosby, 2011, 22-91.

27. Ramaswamy V, Latha N, Gnanasubramanian T, Jesudass JA, Manickam R. Multiple drug resistant bacteria in repeat breeder bovines. Indian J Anim. Reprod. 1998; 19(2):123-125.

28. Rhodes FM, Clark BA, Nation DP et al. Treatment of postpartum anoestrus in New Zealand dairy cows with progesterone and estradiol benzoate. In XX World Buiatrics Congress. Sydney, Australia: Australian Association of Cattle Veterinarians, 1998.

29. Robinson TJ. The Control of the Ovarian Cycle in the Sheep. 1st Ed. 1University Press, Sydney, 1967.

30. Shah NM, Dholakia PM. Microflora of the cervico vaginal mucus of Surti buffaloes and their drug-resistance pattern. Indian J. Anim. Sci. 1983; 53(2):147-150.

31. Sharma S, Sharma H, Dhami AJ Bhong CD. Physico microbial properties of cervico-vaginal mucus and its antibiotic sensitivity pattern in repeat breeding buffaloes. Indian J. Anim. Reprod. 2008; 29(1): 19-26

32. Torres EB, Enriquez J, Vizmanos MF. Bacteriological profile of the Vagina and Uterus of postpartum Dairy Cows. Philosophical Journal of Veterinary Medicine and Research. 1994; 31:14.

33. White DG, Harmon RJ, Mato JES, Langlois BE. Isolation and identification of coagulase-negative Staphylococcus species from bovine body sites and streak canals of nulliparous heifers. J Dairy Science. 1989; 72:1886-1892.