Comparative study on lesions of reproductive disorders of cows and female dromedary camels slaughtered at Addis Ababa, Adama and Akaki abbatoirs with bacterial isolation and characterization

Aynalem Mandefro (✉ anaafman@gmail.com)

Hawassa University College of Natural and Computational Science

Tilaye Demissie Ayana

Addis Ababa University

Gemechu Chala Hunderra

Hawassa University

Tadesse Gidey Gebrezihar

Addis Ababa University

Bulto Giro Boru

Addis Ababa University

Natnael Teshager Desta

National Animal Health Diagnostic and Investigation center, Sebeta, Ethiopia

Research article

Keywords: Cow, Dromedary camel, lesion, reproductive organ

Posted Date: June 25th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-35515/v1>

License: This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Version of Record: A version of this preprint was published at BMC Veterinary Research on March 29th, 2021. See the published version at <https://doi.org/10.1186/s12917-021-02822-z>.

Abstract

Background

Reproduction is a basic prerequisite to efficient livestock production. The reproductive performance depends upon the normal structure and functions of genital organs.

Methods

A cross-sectional study design was conducted from November 2016 to May 2017 to identify and compare the frequency of reproductive organ pathological lesions and to isolate bacteria associated with uterine lesions in female dromedary camels and cows slaughtered at Addis Ababa and Adama municipal abattoirs and Akaki slaughter house. Purposive sampling technique was used to collect 280 reproductive tracts from cow and female dromedary camel. Following gross inspection tissue samples with lesion were collected for histopathological and bacteriological studies and were done according to standard protocols.

Result

Various pathological lesions with different degrees of severity were observed in 34.2% (n = 48) and 36.4% (n = 51) of dromedary camel and cow, respectively. Age, species and body conditions of animals were not statistically associated with most of disorders ($P > 0.05$). The lesions encountered in dromedary camels were 21.4%, 7.14%, 1.42%, 2.85% and 1.42% uterine, ovarian, oviductal, vaginal and cervical lesions, respectively. However, 16.4%, 14.2%, 3.57%, 1.42% and 1.42%, ovarian, uterine, oviductal, vaginal and cervical lesions were seen in examined cows, respectively. The result showed that the collected uterine tissue was positive for single and/or mixed bacterial infection. Bacteria isolated includes, *Staphylococcus* species 28.5%, *Streptococci* species 19.6%, *Corynebacterium* species 8.9%, *Escherichia coli* 26.78%, *Salmonella* species 10.7% and *Klebsiella* species 5.35% were isolated from cows uteri, while in the dromedary camels, *Escherichia coli* 35.5%, *Staphylococcus* species 26.6%, *Streptococcus* species 13.3%, *Pseudomonas* species 6.6%, *Proteus* species 4.4%, *Salmonella* species 8.8% and *Klebsiella* species 4.4% were isolated. Histopathologically, endometrial glands degeneration, sloughing of epithelium, peri-glandular cuffing and infiltrations of inflammatory cells were some of characteristic changes observed in uterus.

Conclusions

Reproductive organ pathological lesions found to be an important problem in female dromedary camel and cow and it was observed that the bacteria isolated from camel's uteri were similar to those in cows. The role of each reproductive lesion incriminated as causes of reproductive failures in this livestock species needs further investigation.

Background

Reproduction is a basic prerequisite to efficient livestock production. The productivity of animal largely depends on their reproductive performance therefore; regular and successful reproduction is the key to profitable animal

production. Large animal that rarely deliver a live calf are not worth keeping [1]. Therefore, reproductive efficiency is an important facet for achieving maximum return from the animal [2]. However, the physiological process of reproduction could get disrupted or hampered due to variety of factors including; nutritional deficiencies, specific and non-specific infections, hormonal abnormalities, immunological malfunctions, environmental stress and others too [3]. Thus, identification of reproductive tract diseases is important, especially when we deal with genetically superior animals [4]. Reproductive diseases are considered as an important contributor to the decline in fertility potential in the large farm animals. Generally, in large farm animals, the highest incidence of infertility resulted in decreased milk production, treatment costs, extra labor and increased rate of culling [5].

The reproductive performance depends upon the normal structure and functions of genital organs of an animal [6]. Pathological lesions of the female genital tract are believed to be the major reason for economic loss associated with infertility, culling and slaughtering of cows [7, 8, 9] and in dromedary camels [10, 11]. In general, female animals are culled and sent to slaughterhouse either they are uneconomic to maintain or else they have diseases problems. Hence, abattoirs are a good source for studying pathological lesions of reproductive organs that are severe enough to cause infertility and even sterility [12]. Moreover, most female reproductive organ pathological lesions lack additional outward manifestation, examination of gross and microscopic lesions of genital tract play a central role in the identification of these problems. Therefore, most of these abnormalities can only be diagnosed when the animal is subjected to postmortem examination [13].

Previously abattoir-based studies on reproductive organs abnormalities of cows have been done in Bahir Dar [7], in Addis Ababa [14], in Sululta [8], in Hawassa and Tulla [9] and in Jimma [1]. According to the results of these previous studies, the reproductive organ abnormalities of cows based on the anatomical classification include; abnormalities of uterus, ovary, oviduct, cervix and vaginal were recorded. Ovariobursal adhesion, follicular cyst, luteal cyst, paraovarian cyst, ovarian hypoplasia, vaginitis, cervicitis, hydrosalpinx, pyosalpinx, hydrometra, endometritis, cervical ring hypoplasia and hypoplasia of the uterus were some of the characteristic pathological lesions recorded in most of the above studies. Apart from the above studies carried out in Ethiopia many studies [15, 16, 17] were also done in different parts of the world with almost similar findings with above mentioned lesions.

Information about female dromedary camels' reproductive organs lesions in Ethiopia is very sparse. Only single published research reports by [11] was available. However, there are several reports of female dromedary camel reproductive organ pathological conditions from other camel keeping countries like Egypt [10]; Saudi Arabia [4, 18, 19]; Nigeria [20]; Algeria [5]; Iraq [21] and Pakistan [22]. According to the findings of these above studies different reproductive pathological lesion include (lesions of uterus, ovary, oviduct and cervico-vaginal) were recorded among which lesions of the uterus was the most frequent in almost all studies. Endometritis, cystic ovarian disease, ovarian hypoplasia, hydrobursitis, ovarian tumor, uterine cysts, vaginitis, cervicitis and hydrosalpinx are some of the characteristic lesions reported in the above studies. Similar pathological lesions were also reported by [11].

The inappropriate use of broad-spectrum antibiotics and corticosteroids for the treatment of reproductive disorders or in the management of retained placenta and other obstetrical procedures in camels and cows has led to increased bacterial contamination of the vagina and subsequent invasion of the uterine environment [23, 24]. Uterine infection is a significant cause of reproductive failure and infertility in dromedary camel [4]. On the other hand, uterine infection is associated with delayed uterine involution and poor fertility in cow. Bacterial pathogens are the potential cause when cows fail to conceive on one or more cycles in the same season [25]. The most

common and economically important bacteria for uterine infection are *Actinomyces* species, *Escherichia coli*, *Fusobacterium* species, *Pasteurella* species, *Pseudomonas* species and *Staphylococcus* species. [26].

Reproductive in efficiency in animal due to observed pathological lesions of female genitalia cause huge economic loss to farmers. To circumvent these problems, isolation of bacteria from the uterus and histopathological investigations of each lesion are critical for the diagnosis and management of poor reproductive performance in animals. Most researchers reported previously were based on gross pathological lesion observation and done either on cows or female dromedary camels. Comparative study on reproductive organ pathological lesions, isolation and identifications of possible aerobic bacteria involved in uterine disorder were very few in general and some were not yet attempted in Ethiopia. Hence, the present study was conducted to narrow these gaps. Therefore, this study was aimed to identify the types and frequencies of reproductive organ pathological lesion and compare between cows and female dromedary camel; describe and characterize gross and microscopic lesions of observed abnormalities. Additionally, the study also tried to isolate and identify aerobic bacterial causing uterine lesion in both cows and female dromedary camels.

Methods

Study Area and Study Population

The study was conducted at Addis Ababa and Adama municipal abattoirs and Akaki slaughter house. Akaki slaughter house is located in the southern outskirts of Addis Ababa 20 Km away from the centre of Addis Ababa. Adama municipality abattoir is located at Adama town in Oromia regional state about 99 Km away from center of Addis Ababa. Addis Ababa municipality abattoir is located in Addis Ababa, the capital of Ethiopia. The study populations were female dromedary camels and cows slaughtered at these abattoirs. Three to seven camels were slaughtered at Akaki slaughter house, every day. Female dromedary camels were brought to this abattoir from Afar and Borana pastoral areas. All cows slaughtered at Addis Ababa and Adama municipality abattoir at the day of visit were included in the study. On average seven cross and local breed cows were slaughtered every day in each abattoir. Cows slaughtered at Addis Ababa and Adama municipality abattoirs were came from in and around Addis Ababa, Adama town, Harar town, Arsi and Bale zone. During the study period the total study animals included were 280 animals (140 female dromedary camels and 140 cows). All female dromedary camels were from Akaki slaughter house.

Study design and Sampling method

Age, body condition score and origin of animal were gathered during ante mortem examination. Age of female dromedary camels was estimated by dental examination on the basis of their dental formulas and tartar deposition on the teeth as described by [27]. However, cow's age was estimated according to [28]. The animals' body condition score (BCS) was evaluated on a scale of 0 to 5 by considering visual examination and fat cover palpation over the animal body following the description by [29]. Purposive sampling technique was used and all female camels and cows with any reproductive disorders after slaughter were sampled. Pregnant tracts were not included in the study.

Sample Collection and Transportation

During postmortem examination the entire reproductive tract was carefully removed from the carcass, taken to one corner of the abattoir, and visually examined and thoroughly palpated. Each reproductive tract was opened along its longitudinal axis starting from the vagina down to the horns using sterile scissors and was observed for any abnormalities in color, odor, consistency and morphology [30, 9]. Those with obvious gross lesions were noted based on their appearance, type, location and frequency of occurrence [31]. Tissues with grossly visible lesions were sampled for histopathological and bacteriological examinations. For histopathology, a tissue cut of 1-2 cm from lesion including some normal part was collected into a universal bottle containing 10% buffered formalin according to [32] and then transported to National Animal Health Diagnostic Investigation Centre for histopathological processing.

For bacteriological examination, the surface of the tissue with lesions were decontaminated by a flame and pieces of tissue from active lesion at the boundary were collected aseptically using sterile forceps, scissors and scalpel blade and placed into screw capped universal bottles contain sterile saline water [33], labeled and transported to the veterinary microbiology laboratory of Addis Ababa University College of Veterinary Medicine and Agriculture on ice box containing ice packs for culturing.

Sample Processing

Histopathology procedures

Tissue specimens were processed using standard procedures of tissue processing, described by [32]. Briefly, tissues were trimmed, fixed in 10% buffered neutral formalin, dehydrated in ascending grades of alcohol, cleared with xylene and impregnated with molten paraffin wax. Then tissues were sectioned at a thickness of 4-5 micrometers, spread on warm water, mounted on frosted glass slides, deparaffinized by heat (incubated at 60°C) and xylene (three changes), followed by rehydration in descending grades of alcohol and stained with hematoxylin and eosin. Stained slides were examined under microscope (at 10 x, 40x and 100x magnification) using phase contrast microscope (Nikon, Japan) and photomicrographs were taken.

Bacteriological Procedures

All bacteriological procedures were performed according to [33]. The tissue sample was cut into pieces with sterile scalpel blade and forceps then inoculated to brain heart infusion broth and aerobically incubated at 37°C for 24hrs. After 24hrs, tubes were observed for growth (turbidity) and a loop-full of sample was streaked parallel on sheep blood agar (7%) and MacConkey agars and incubated aerobically at 37°C for another 24hrs. The blood agar plates were checked for presence of growth, hemolysis (types), colony morphology, size and shape and the MacConkey agar plates were check for presence of growth, lactose fermentation or not fermenting and for colony morphology, size and shape. For primary identification, gram stain, catalase, oxidase and motility tests were conducted. Selective and differential media such as Mannitol salt agar, Edwards medium, Eosine methylene blue and Salmonella shigella agar were used for the suspected samples from the primary test results. After 24hrs of incubation, characteristic growth on selective medium was registered, a colony was then further inoculated in to nutrient broth for further biochemical tests. In general coagulase, indole, Methyl red (MR), Vogues-Prousker (VP), Citrate, Urease, Lysine and Triple Sugar Iron (TSI) tests were performed as secondary biochemical tests.

Data analysis

The data generated in this study were recorded, checked and coded on spreadsheet of Microsoft Excel and STATA version 13 statistical software was used for descriptive analysis. Chi-square test was used to determine the presence of dependency among different variables (age, species and Body condition score) with pathological lesions of the reproductive organs. Uterine bacterial isolates were compared between species by using descriptive analysis. Gross as well as histopathological lesions and findings were described using qualitative methods.

Results

During the study period, a total of 280 reproductive tracts (140 from cows and 140 from female dromedary camels) were collected and examined. Various pathological lesion with different degrees of severity were observed in 34.2 % (n=48) and 36.4% (n=51) of dromedary camels and cows, respectively. Cows and dromedary camels with lesions were observed to have one or more pathological lesion. Comparatively, the most frequently observed lesions in dromedary camels were uterine abnormalities 21.4% followed by ovarian lesions 7.14%. However, in cows, ovarian lesions 16.4% were the most frequently observed reproductive lesions followed by uterine lesions 14.2%. Vaginal lesions 2.85% were observed more frequently in dromedary camels than cow 1.42% (fig. 1). The detail of lesion types with frequencies was shown on Table 1, 2 and 3 below.

The association between frequency in occurrence of macroscopic lesions with species, age and body condition score were evaluated. There was no statistically significant association ($P>0.05$) between species, age and body condition score with frequency of occurrence of most reproductive pathological lesions (Table 1, 2, 3).

Ovarian Abnormalities and Lesion Characterization

Different ovarian abnormalities were observed in 16.4% (n=23) and 7.14% (n=10) of examined cows and female dromedary camels respectively. Follicular cyst, luteal cyst, ovarian hypoplasia, paraovarian cyst, ovarian bursal adhesion, Oopharitis and hydrobursitis were lesions observed (Table 1). Ovarian bursal adhesion and Oopharitis were the lesions observed only in examined cows whereas; hydrobursitis was seen only in dromedary camel ovary.

Follicular Cysts

Follicular cysts were seen in 4.2 % and 2.85% of examined cows and dromedary camels, respectively. The lesions were unilateral in both species. Three of them were on the right while the other three were on the left ovary in cows, but in dromedary camel only one was on the right and the rest three were on left ovary.

Macroscopically, most of the cysts were spherical in shape and were occupying ovarian cortex in both species. Their diameters were ranged from 30 mm to 55 mm and the walls of the cysts were thin, slightly opaque and had straw colored serous fluid. One follicular cyst was accompanied by ipsilateral ovarian hypoplasia and endometritis in a cow (fig. 2A). Microscopically, the follicular cysts were lined by few layers of granulosa cells, as large portion of the granulosa cells were degenerated and by pressure exerted follicular fluids. It was difficult to differentiate the theca interna from the theca externa as the cells were compressed by fluid pressure (fig. 2B). Moreover, larger cysts resulted in pressure atrophy of the adjacent ovarian tissues result in the ovum and the surrounding cells completely degenerated or absent.

Luteal cysts

Luteal cysts were observed in 2.14 % and 1.42 % of examined cows and dromedary camels, respectively. In cows, two cysts were on the right ovary and one on the left. In dromedary camels, all cysts were observed on the right ovary.

Macroscopically, the luteal cysts were thick walled, opaque and have meat like consistency. The wall of the cyst was lined by a whitish brown or yellow membrane. Furthermore, in cows, all the luteal cysts appeared as a single rounded mass on the surface of the ovary. In one camel multiple luteal cyst were observed. The diameter of the luteal cysts varies and ranged from 20- 25mm (fig. 3A). Microscopically, the wall of the luteal cysts was formed from thick layer of lutein cells and fat containing granulosa cells. They contained homogenous eosinophilic structure less substance mixed with some luteal cells in the lumens.

Paraovarian cysts and hydrobursitis

The frequency of occurrence of paraovarian cysts was all the same 1.4% (n=2) both for female camels and cows examined. Macroscopically, the cysts were detected unilaterally only on the left ovary in both species. The cysts were located either in mesovarium or in mesosalpinx ligament. These cysts were 10-20 mm in diameter and transparent, having thin wall and contained clear watery fluid.

Ovarian hydrobursitis was observed in 0.71% of examined dromedary camel but, none of this lesion was observed in examined cow. The size of the affected bursa was about 5 x 6.4 cm and the affection was unilateral. Moreover, the bursa was having about 25 ml of accumulated watery and straw color fluid indicated in (fig. 3B).

Ovarian hypoplasia/ Inactivity

The frequency of occurrence of ovarian hypoplasia was 2.85 % in cow. However, only 0.72% of dromedary camel was found with hypoplastic ovary. It was bilateral and the ovary was very small, oval in shape and measured 1 cm by 1 cm in camel. In cows all were unilateral with three of them on the right and one on the left ovary. The size varies from 1.6 cm by 1.1 cm to 1.5 cm by 1.0 cm. Macroscopically the ovaries were smaller in size, firmer in consistency and contained very small follicles on the surface of non affected part. Microscopically, excessive fibrous connective tissue proliferation with complete absence of follicular or luteal developments was seen (fig. 4).

Oophoritis

Oophoritis was observed only in a cow however, it was not seen in examined dromedary camels. This lesion might be incriminated in ovarian bursal adhesion as they accompanied each other. Macroscopically, the ovary was hyperemic and slightly swollen. Microscopically, the ovarian medulla was infiltrated by inflammatory cells (fig. 5 A and B).

Ovario-Bursal Adhesion

Ovariobursal adhesion was the most frequent 5% ovarian lesion encountered in cows. However, none was observed in dromedary camels. Except for a single adhesion which was bilateral, all examined lesions were unilateral. Four

of the adhesions were on the right and two on the left ovary. In one case ovariobursal adhesion was concomitantly occurred with oophoritis. Macroscopically, the ovaries were found adhered to the bursa and surrounded by a layer of connective tissue. The severity of adhesions varied from case to case. In five cows the adhesions were mild with sparse strands of connective tissue between the ovary and bursa. In two, the adhesions were intense in which, the ovaries were completely encapsulated in thick fibrous connective tissues.

Uterine Abnormalities and Lesion Characterization

Uterine lesions were observed at high frequency 21.4% (n=30) than other disorders in dromedary camels. However, it was the second most frequent 14.2% (n=20) in cows. Grossly the severity of uterine lesion varies between species and it was more severe in dromedary camels than cow. Microscopically, all uterine lesions, with the exception of one, which found to be leiomyoma, were inflammatory in both species. Acute endometritis, chronic endometritis and catarrhal endometritis were common in both species. However, suppurative endometritis was observed only in cow's uteri (Details of lesions were indicated under specific topics below and the frequency of occurrence each of uterine lesions was indicated in Table 2).

Acute endometritis

Acute endometritis was more frequent in dromedary camels than cows (Table 2). Acute endometritis was accompanied by luteal cyst in two of the dromedary camels. Macroscopically, the affected uteri were enlarged and the mucosa was either severely congested (red brown) or was severe reddening (fig. 6). Furthermore, thick blood tinged exudates were seen in the uterine lumen of three dromedary camels and one cow. Microscopically, endometrial epitheliums were necrotized and sloughed in most cases with either congestion or hyperemia of endometrial blood vessels especially in basilar endometrial region. Moreover, polymorphonuclear cells, mainly of neutrophils were infiltrating the endometrium. Excessive peri-glandular cuffing of cells and atrophy of endometrial glands were characteristics of acute endometritis.

Suppurative endometritis

Suppurative endometritis were observed only in cows (1.42%). Macroscopically, the endometrium was congested and covered with thick creamy white pus. The lesions were also further expanded to uterine horn but no pus observed in uterine horn. Microscopically, suppurative endometritis was characterized by infiltration of neutrophils into the endometrium with severe congestion of blood vessels and distortion of some endometrial glands.

Catarrhal endometritis

Catarrhal endometritis was observed in two dromedary camels and two cows. Macroscopically, the uterus was enlarged and its mucosa was slightly congested, edematous and was covered by thick mucoid exudates. In one camel the mucoid exudates further expanded to cervix and vaginal mucosa discharged to outside of the body. The microscopic examination showed congestion of endometrial blood vessels, lymphocytic infiltration in the mucosa and submucosa with alternative areas of epithelial desquamation and hyperplasia of lining epithelium. Degenerations of endometrial glands were also seen.

Chronic endometritis

Chronic endometritis was more frequent in dromedary camels than cows (Table 2). In One cow with chronic endometritis there was concomitant luteal cyst, vaginitis and cervicitis. Macroscopically, most of the uteri with chronic endometritis were thick, doughy, rigid, and their mucosa was severely congested. In one dromedary camel with chronic endometritis the uterus was severely congested, with corrugation of the perimetrium and dark brown hemorrhage on external surface (fig. 8 A and B).

Microscopically, the mesothelium of this uterus was hyperplastic with polypoid like projections and diffuse thickening of basal fibrous connective tissue. Most of the uteri affected by chronic endometritis were characterized by endometrial glandular degenerated, mononuclear inflammatory cells mainly of lymphocytes, macrophages and to less extent neutrophils infiltrations. In some there was hyperplasia of endometrial epithelium (fig. 8 C and D).

Uterine tumor

The only observed uterine tumor was uterine leiomyoma. It was observed only in a cow and not in female camel. Macroscopically the neoplasm was firmly attached mass, and circular in shape with a diameter of 10 cm.

Microscopically the leiomyoma was comprised of smooth muscle cells and connective tissue components. Largely composed of composed of interlacing (interweaving) bundles of smooth muscle fibers with acidophilic cytoplasm and elongated and rounded blunt ending nuclei. The fibers were usually fusiform or stellate in shape, possessed large, ovoid to elongated nuclei and sometimes multiple nucleoli. There was slight pleomorphism, and little mitotic activity was seen.

Oviductal lesions

Hemosalpix

Hemosalpix was observed in one camel and three cows. In dromedary camels, it was unilateral and was observed in the right oviduct. However, it was bilateral in one cow and unilaterally in right oviduct in two cows. Macroscopically, in both species the oviduct was slightly enlarged in size and the mucosa was hyperemic and filled with blood. Microscopically, hyperplasia of the lining epithelium and congestion of blood vessels with inflammatory cellular infiltration were noticed (fig. 10).

Pyosalpinx

Pyosalpinx was detected in one camel and two cows. Macroscopically, the affection was bilateral in both species. Moreover, the oviduct was enlarged and distended with pus. Pyosalpix was accompanied with suppurative endometritis in one cow.

Cervico-vaginal lesion

Cervicitis and Vaginitis

Cervicitis was seen in two cows and two camels. In general, cervical lesions were observed with low incidence than the rest of reproductive organ abnormalities in both species (Table 3). Macroscopically, the cervix was slightly enlarged, and the mucosa was congested, edematous and covered with whitish viscous exudates.

Vaginal lesions represented by vaginitis and vaginal lymphocytic myocytis accounted 2.85% of examined dromedary camels and it was with relatively higher frequency than the lesion observed in cows. However, vaginitis was the only lesion seen examined cow 1.42%. Macroscopically, in vaginitis the mucosa was slightly swollen and showed partial congestion and partial hyperemia on the other parts.

Vaginal lymphocytic myocytis

In dromedary camels, a hard-swelling mass which grossly looks like a kind of tumor (fig. 10) but was proved lymphocytic myositis on microscopic examination was observed in 2.14% of camels. However, lesion was not seen in cow. In one of the three camels this lesion was accompanied by chronic endometritis.

Macroscopically, in all the three camels there is single, and large sized (7-10 cm diameter) mass on the lateral side of the vagina just cranial to the lips of the vulvar commisure and on palpation the mass was soft.

Microscopically, these lesions were characterized by huge lymphocyte infiltrations into the smooth muscle fibers and some muscular degeneration. In some regions, the muscle fibers were necrotized and connective tissues were proliferated (fig. 11).

Uterine lesions of cows and camels and bacterial isolates

Fifty uterine tissue samples (30 from camels and 20 from cows) with acute, chronic, catarrhal and suppurative endometritis were cultured aerobically for bacterial isolation of which 48 yielded bacterial isolates. Except for few bacteria which were isolated as pure culture, majority of the isolates were coupled with mixed bacteria. A total of 101 isolates were recovered, of which 56 were from cows and 45 from female dromedary camels. Of the 56 bacterial pathogens isolated from cows, *Staphylococcus* species 28.5%, *Streptococci* species 19.6%, *Corynebacterium* species 8.9%, *Escherichia coli* 26.78%, *Salmonella* species 10.7% and *Klebsiella* species 5.35% were the most frequent isolates, while in the dromedary camels, the most common isolates include *E. coli* 35.5%, *Staphylococcus* species 26.6 %, *Streptococcus* species 13.3%, *Pseudomonas* species 6.6 %, *Proteus* species 4.44%, *Salmonella* species 8.8% and *Klebsiella* species 4.44%. The common bacterial isolates identified from both species include *Staphylococcus* species, *Streptococcus* species, *Escherichia coli*, *Salmonella* species and *Klebsiella* species and these accounted more than 90% of isolated bacteria. Moreover, *Pseudomonas* species and *Proteus* species were isolated only from the camel uteri whereas, *Corynebacterium* species was only isolated from cows' uterus.

Discussion

Reproductive abnormalities play an important role in animal breeding either by causing infertility or sterility, and thus inflict heavy economic losses to the livestock owners. Many animals with reproductive problems and low milk production have been sold or sent to slaughterhouse. According to [34] for minimization of these losses, the important disorder of genital organs and their incidence must be defined. There are no sufficient studies available

concerning comparative reproductive disorders in female dromedary camels and cows to be compared with the results of the present study.

According to [35] report, camels were considered to be resistant to many disease conditions. However, in the present study the occurrence of most reproductive disorders was similar between the two species. The current study supports the report by [36] and [37] who reported camels are quite as susceptible as other livestock to the common disease condition.

Unlike, the report by [38] who reported uterine lesion occur more commonly in cows 19.4% than dromedary camels 17.4%; the present study indicated that uterine lesions were a frequently observed lesion in dromedary camels 21.4% than cows 14.2%. The variation between studies might be attributed due to the differences in season, management, geographical environment, level of nutrition and health management of animals included in the study.

Among the observed reproductive lesions endometritis was the major uterine lesion observed in dromedary camels. This might be attributed to various factors one of which might be aggressive mating behavior of dromedary camel during the wrong phase of follicular developmental has been reported by [45] as a cause of severe uterine inflammation. Repeated insults of the uterus due to improper mating practices can also lead to inflammation and loss of the ability to resist infection [39]. In addition, [4] reported that postpartum complications, unsanitary gynecological manipulations and errors including breeding with a young male, overuse of males and lack of verification of intromission during copulation can cause endometritis.

In the present study occurrences of chronic endometritis varied within age group. Adult female dromedary camels and cows were positive to chronic endometritis than other age group of animals this might be due to, long time exposure, increased frequency of mating, parturitions and repeated postpartum complications. Our findings were in accordance with [40] who reported that most findings of abnormal uterine conditions were in females more than 10 years of age.

Microscopic lesions observed in the present study were those of the inflammatory uterine changes indicated by; endometrial glands degeneration, endometrial epithelial sloughing and hyperplasia of mesothelium cells in few cases, peri-glandular cuffing and infiltrations of inflammatory cells. These findings were similar to what was observed in earlier reports [41, 38, 11].

Uterine leiomyoma observed in present study was only seen in one of the examined cows. According to [42] the etiology of the uterine leiomyoma is not clearly known. The report of [43] on cellular make up of leiomyoma was in agreement with present findings in which the neoplastic cells of smooth muscle accompanied by varying quantities of connective tissue and lacks a glandular component. Also, the macroscopic finding of uterine leiomyoma noted in present study was in line to the report of camel uterine leiomyoma by [10]. Several studies [42, 44, 45] reported microscopic findings of uterine leiomyoma that were in agreement with present reports but anatomically they report from cervical, vaginal and uterus and also that was from cows.

In the present study, the ovarian lesions of cows were almost twice than that noted in dromedary camels. This might be attributed to the high production potential of the cross-breed cows that have had blood of Holstein Friesian cows that were highly selected for the production of milk. As it is reported by [46] and [47] high producing dairy cows that were exposed to negative energy balance especially at early lactation was at risk of developing

ovarian disorders. Also, it is a well recognized fact that most of dairy cows in Ethiopia were owned by small holder farmers and would not be well managed.

Even though dromedary camels ordinarily are liable to develop follicular ovarian cysts in the absence of coitus given that ovulation in these species is induced by mating [48]; the present study, showed a higher frequency of follicular cysts in cows than in dromedary camels. This might be due to various influencing factors like level of milk production; feeding, management and exercise affect the prevalence of cystic follicle in cattle [49]. Though the actual mechanism of development of cystic ovaries in dromedary camels is not completely known, the deficiency of luteinizing hormone surge may be considered as the main cause [50].

The prevalence of follicular cyst varies within body condition score. Animal with good body condition develop follicular cyst higher frequency than others. This might be due to ovarian cysts are formed by hormonal disorder it doesn't affect animal health status. The present findings agree with earlier reports by [23] who reported that camels with ovarian cysts had a general body condition fair to good. Moreover, similar finding in cattle was also reported by [7] for which the cysts were found in zebu cattle with body condition score of medium and fat. Histopathological finding of follicular cysts; degeneration of surrounding theca and granulosa cells were seen in both species. This finding was comparable to previous reports of [34, 10, 20 and 11].

In the present study the prevalence of luteal cysts was lower than that of follicular cysts in both species. This might be due the fact that luteal cysts originate from luteinization of follicular cyst, which occurred as a result of transformation of the granulosa cells into lutein cells [10]. Moreover, they are often considered to be the later form of ovarian follicular cysts and therefore the causes pertaining to follicular cysts can also be considered the original causes of luteal cysts [51]. The macroscopic and histopathological finding of present study was in line with reports by [10, 20].

Ovarian bursal adhesion in the present study was only seen cow this might be due to pregnancy complications. According to report by [52], extreme adhesions have probably resulted from pregnancy complications that include retained fetal membranes and endometritis. Furthermore, this lesion can also result from hemorrhage due to harsh manipulation of the ovaries or attempts to rupture an ovulatory hemorrhagic follicle or also may be result from oophoritis and result in ovarian hydrobursitis and peritonitis [23]. The frequency of ovarian bursal adhesion 5% in this study was in agreement with those of [7, 17, 9] who reported 5.5%, 7.27% and 6.38%, respectively, but it was higher than the report of [34] 0.27%. The variation observed might be attributed to the difference in breed, management and level of nutrition.

Comparable cases of paraovarian cysts were recorded in the examined female dromedary camels and cow's reproductive organs. Para-ovarian cysts are suspected to arise from persistent embryonal structures which are vestiges of wolffian ducts [20]. Paraovarian cyst in cows does not interfere with reproductive performance until compression of the lumen of the oviduct occurs [53, 54].

In the present study ovarian hypoplasia was observed with low frequency in dromedary camels than examined cows. This might be the optimum breeding season in which the current study was carried out and during which most camels were cyclic. The study by [55] also justified that peak sexual activity of dromedary camel ranges from November to February. Moreover, the lesions were characterized microscopically by complete absence of follicular or luteal development and excessive fibrous connective tissues proliferation. The gross and microscopic findings were in agreement with previous reports by [10, 11].

In the present study oophoritis was observed only in cow with prevalence of 0.71%. This finding was in line with the report of camel oophoritis by [20] who reported 0.17%. According to [56] oophoritis seems to be rare while perioophoritis is common pathological condition of bovine ovary. The prevalence of hydrobursitis in camel during this study was approximately similar to that of [19]. However; it was lower than the report by [18, 5]. The macroscopic finding of this lesion was in line with [5]. According to the report by [57] the incidence of hydrobursitis was relatively higher in animals with a background of reproductive failure.

The frequency of oviduct affections in the present study was low in both species. The macroscopic finding of hemosalpinx which was characterized by thickening the wall of uterine tube due to filling with bloody discharge was in agreement with [58]. However, the microscopic findings of this lesion were in accordance with that described by [59, 34, 10]. In our finding pyosalpinx was accompanied with suppurative endometritis and this supports the report by [43] who reported pyosalpinx occurs following ascending infection. Moreover, [60] considered that untreated uterine infections can lead to irreversible changes in oviducts and result in sterility.

Regarding to the detected pathological changes in the cervix, cervicitis was seen in two examined animals in both species. The low frequency of cervical affections may be due to good defense action of the mucous secreting epithelium of the cervix against bacterial invasion [61]. All observed cervicitis in the present study were associated with uterine affection or inflammation of endometrium and this finding was in line with the report by [10].

The pathological changes in the vagina of cows and camels were low compared to uterine and ovarian lesion in both species. This low frequency might be attributed to various factors. Among these, protective effect of stratified squamous epithelium of vaginal mucosa which proliferates and matures under the influence of estrogen and become more resistant to infection is of great concern. In addition to the above factor local production of lactic acid which deposit into the epithelium is also considered [61]. The relatively higher frequency of vaginal lesion in female dromedary camels 2.85% than in cow 1.42% might be due to traumatic injury during coitus especially in young females [60]. Furthermore, [4] justified that the ethno-veterinary practiced by herdsman using unusual substances, like dates, black seeds, and salts might be irritant to the mucus membrane and leads to vaginal lesions in dromedary camels.

In the current study, it was observed that the bacteria isolated from dromedary camel's uteri were similar to those in cows. This might be associated with the camels' husbandry practices in this part of the world, which allow them to graze together with other ruminants and mingling with them at watering points or market places, thereby creating conducive environment facilitating transmission of infectious pathogens circulating among livestock species cohabiting within the same ecologic zone [62]. The bacteria isolated from endometritis might be suspected the main causes of endometritis in both species. This finding supports the report by [63] who reported resistance of the uterus to infection and its ability to rid itself of microorganisms was diminished in the presence of degenerative changes in the endometrium.

Although in the present study uterine infections were observed in dromedary camels and cows, the bacterial colonizing the uterine environment in cows was more than that of the *camelids*. In postpartum cow the occurrence of ovulation prior to the expulsion of exudates and debris from the uterus has been shown to favor heavy growth of bacteria in the uterine environment which leads to the retention of the corpus luteum and consequent impairment of the ability of the uterus to secrete prostaglandin F-2 α [64]. Necrotized caruncles, blood and cell debris provide a perfect media for bacteria to grow during the immediate postpartum period [65]. There is continuous bacterial clearance and recontamination of the uterine lumen for up to seven weeks postpartum [66]; some bacteria

still persist in the uterus triggering inflammatory responses and pathological changes. This delays uterine involution thereby lowering fertility [67].

Staphylococcus species, *Streptococcus* species *Escherichia coli*, *Salmonella* species and *Klebsiella* species were the most common bacterial isolated from cow's and camels' uterine lesions and accounted for 90.8% and 88.6 % of the total isolates respectively for the two animal species. These finding were similar to the report of [38]. As it is reported by [68] most of the aforementioned bacteria attributed to most of the clinical reproductive disorders. *Proteus* species and *Pseudomonas* species were isolated only from uterine lesion of dromedary camels and *Corynebacterium* species from that of cows. Isolation of *Proteous* species from camel with endometritis in this study was in line with the report of [19, 11].

Conclusion And Recommendations

Significant number of cows and dromedary camels slaughtered at abattoirs had one or more pathological abnormalities in reproductive organs. Uterine lesions were the major pathological disorders in dromedary camels while ovarian lesions were the most frequent in cows. It was observed that two cows with luteal cysts had acute endometritis and a camel with luteal cyst had chronic endometritis, vaginitis and cervicitis. Persistent luteal cysts can be prolonged source of progesterone which might lead to uterine infection as progesterone is immunosuppressive. Many species of bacteria were isolated especially from uterine lesions. These bacterial isolates might be considered important causes of uterine disorders in these animals. Also, most of the pathological reproductive abnormalities detected in this study might be cause of infertility of these female animals which brings them to be slaughtered at these abattoirs. Therefore, strong reproductive health management that is especially, targeting the postpartum and critical period should be implemented. Nevertheless, studies that involve significant number of abattoirs and female animals, correlation between individual's reproductive lesions and hormonal disorders should be conducted to come up with more figurative results. Moreover, uterine cytobrush and uterine biopsy could be used to correlate bacterial isolates with uterine lesions. Additionally, trainings for concerned veterinarians and technicians on reproductive health and management for proper intervention mechanisms should be implemented.

Abbreviations

Not Applicable

Declarations

Ethics approval and consent to participate

Study was approved by College Review Board of Addis Ababa University college of veterinary medicine and oral consent was obtained from each abattoirs managerial board before sampling.

Consent for publication

Not applicable

Availability of data and material

All data supporting the findings of this study are available within the article.

Competing interest

We declare that there is no competing interest.

Funding

This study was financially supported by Addis Ababa University Research and Technology transfer thematic research project entitled as “Reproductive Health Management and Dairy Technology RD/LT-038/15”.

Author's contribution

Aynalem Mandefro Getahun and Tilaye Demissie Ayana generate and process the research idea and developed the proposal and analyzed the bacteriological and histopathological data and handled statistical analysis. Aynalem Mandefro Getahun and Tadesse Gidey Gebrezihar collected, processed and manipulated the samples. Bulto Giro Boru and Natnael Teshager Desta performed the histopathological investigations. Gemechu Chala Hunderra edited and organized the manuscript. All the authors read and approved the manuscript for publication.

Acknowledgements

The authors acknowledge Addis Ababa University Research and Technology transfer thematic research project entitled as “Reproductive Health Management and Dairy Technology RD/LT-038/15” for providing financial support.

We are very grateful for Mr. Tewdros Arega and Mr. Solomon Getachew in the department of veterinary pathology from National Animal Health and Diagnostic and Investigation center, for their technical assistance in the histopathology laboratory work.

We also thank Addis Ababa, Adama municipality Abattoirs and Akaki slaughter house workers for their kind reception, preparing equipment's and materials for the success of this work and good willing to use their Abattoirs.

References

- [1] Arata MA (2015) A Gross Morphological Study of Genital Organs from female Zebu Cattle in and around Jimma town (South-West Ethiopia). *International Journal for Agro Veterinary and Medical Sciences*, **9**, 300-303
- [2] Khaton R, Sarder M, Gofur M (2015) Biometrical Studies of Reproductive Organs of Dairy Cows of Different Genotypes in Bangladesh. *Asian Journal of Animal Science*, **9**, 388-395.
- [3] Khanvilkar AV, Samant SR, Ambore BN (2009) Reproduction in Camel. *Journal of Veterinary World*, **2**, 72-73.
- [4] Ali A, Al-sobayil FA, Tharwat M, Al-Hawas A, Ahmed AF (2010) Causes of infertility in female camels (*Camelus dromedarius*) in Middle of Saudi Arabia. *Journal of Agricultural Sciences and Veterinary medicine*, **2**, 59-69.
- [5] Mohammed HB, Bernard F, Rachid K (2014) Reproductive abnormalities in female camel (*camelus dromedarius*) in algeria: Relationship with age, season, breed and body condition score. *Journal of Camel Practice and Research*,

- [6] Siddiqui HU, Ahmad A, Khan MZ (2005) Biometrical studies of testes of ram. *Journal of Agriculture and Social Sciences*, **1**, 78-79.
- [7] Abalti A, Bekana M, Woldemeskel M, Lobago F (2006) Female genital tract abnormalities of Zebu cattle slaughtered at Bahir-Dar Town, North-Western Ethiopia. *Journal of Tropical Animal Health Prododuction*, **38**, 505-510
- [8] Simenew K, Bekana M, Fikre L, Tilahun Z, Wondu M (2011) Major gross reproductive tract abnormalities in female cattle slaughtered at sululta slaughterhouse in Ethiopia. *Global Veterinary Journal*, **6**, 506-513.
- [9] Mekibib B, Desta T, Tesfaye D (2013) Gross pathological changes in the reproductive tracts of cows slaughtered at two abattoirs in Southern Ethiopia. *Journal of Veterinary Medicine and Animal Health*, pp 46-50.
- [10] Shawky AM, Ahmed AT, Mona FI (2004) An abattoir survey of female genital disorders of camels (*Camelus Dromedaries*) in Kalyoubia, Egypt. 1st Annual Conference Moshtohor, 1:342-356.
- [11] Simenew K, Moa M, Ashenafi F, Tilaye D, Fekadu R et al (2015) Pathological and Bacteriological Study on Abnormalities of Female Internal Reproductive Organ of *Camelus dromedarius* Slaughtered at Akaki Abattoir, Ethiopia. *American-Eurasian Journal of Scientific Research*, **10**, 193-202
- [12] Thrusfield M (1995): Abattoir as Source of Data Veterinary Epidemiology 2nd edn. Black Well Science Ltd. Cambridge, USA, pp 146-148.
- [13] Buregelt CD (1997) Color atlas of reproductive pathology of domestic animals. Mosby, Philadelphia.
- [14] Gebrekidan B, Yilma T, Solmon F (2009) Major causes of slaughter of female cattle in Addis Ababa Abattoir enterprise, Ethiopia. *Indian Journal of Animal Research*, **43**, 271-274.
- [15] Chaudhari SU, Pau-Bakko B (2000) Reproductive status, pregnancy wastage and incidence of gross genital abnormalities in cows slaughtered at Maidughuri abattoir, Niger. *Pakistan Veterinary Journal*, **20**, 203-205.
- [16] Tafti A, Darahshiri M (2000) Studies on the uterine abnormalities of slaughtered non-pregnant adult cows. *Indian Veterinary Journal*, **77**, 1059-1062.
- [17] Ali R, Raza AM, Tabbar A, Rasool HM (2006) Pathological studies on reproductive organs of zebu cow. *Journal of Agriculture and Social Sciences*, **2**, 91-95.
- [18] Ali A, Mehana EE, Ahmed AF, El-Tookhy O, Al-Sobayil A et al. (2011) Ovarian hydrobursitis in female camels (*Camelus dromedarius*): clinical findings, histopathology and fertility after unilateral surgical ablation. *Theriogenology*, **76**, 492-499.
- [19] Al-Afaleq AI, Hegazy AA, Hussein MF, Al-Dughaym AM (2012) Pathological disorders of the female reproductive system in slaughtered camels (*Camelusdromedarius*) in Saudi Arabia. *Journal of Comparative Clinical Pathology*, **21**, 245-251.

- [20] Mahmoud MH, Fahad AA, Mostafa MH (2011) Pathologic Studies on ovarian abnormalities in Nagas (*Camelus Dromedarius*) in Al-Ahsa, Saudi Arabia. *Science Journal of King Faisal University*, 12:265-276.
- [21] Wajid SJ (2015) A Pathological Abattoir Survey of the Reproductive Tracts of non Pregnant Camels (*Camelus dromedaries*) in Iraq. *Journal of Pharmaceutical and Biological Science*, **10**, 84-90.
- [22] Mustafa MY, Chaudhry HR, Chaudhry M, Rashid HM, Khan SA (2016) Biometry and Pathology of Internal Genital Organs of Female Camel (*Camelus Dromedarius*) in Lahore, Pakistan. *Imperial Journal of Interdisciplinary Research*, **2**, 2454-1362.
- [23] Tibary A, Anouassi A (2001) Retrospective study on an unusual form of ovario-bursal pathology in the camel (*Camelus dromedarius*). *Theriogenology*, **56**, 415-424.
- [24] Gani MO, Amin MM, Alam MG, Kayesh ME, Karim MR et al (2008) Bacterial flora associated with repeats breeding and uterine infections in dairy cows. *Bangladesh Journal of Veterinary Medicine*, **6**, 79–86.
- [25] Hasan MA, Mamun AA, Uddin AA, Zakir MD, Hassan MZ et al (2015) Investigation into gynecopathological disorders and identification of associated bacteria from the genital organs of cows in Dinajpur, Bangladesh. *Journal of Advanced Veterinary and Animal Research*, **2**, 165-169.
- [26] Erin JW, Debora PF, Dirk UP, Gary CW, David EN et al. (2005) Clinical evaluation of postpartum vaginal mucus reflects uterine bacterial infection and the immune response in cattle. *Theriogenology*, **63**, 102-117.
- [27] Schwartz HJ, Dioli M (1992) The one humped camel in eastern Africa. A pictorial guide to diseases, health care and management. Verlag, Weikersheim (Germany).
- [28] Puck A, Soliame R (2004) Dairy Cattle Husbandry. 2nd edit., Agromisa foundation, Wagenineger, Netherland, pp. 70-75.
- [29] Nicholson MJ, Butterworth MH (1998) A Guide to Condition Scoring of Zebu Cattle. International Livestock Reserch Center for Africa, Addis Ababa, Ethiopia.
- [30] Feyissa T, Bekana M (2000) A gross morphological abattoir study of genital organs from female crosses breed and Zebu cattle. *Israel Journal of Veterinary Medicine*, **55**, 83-87.
- [31] Jenberie S, Awol N, Ayelet G, Gelaye E, Negussie H et al. (2012) Gross and histopathological studies on pulmonary lesions of camel (*Camelus dromedarius*) slaughtered at Addis Ababa abattoir, Ethiopia. *Journal of Tropical Animal Health and Production*, **44**, 849–854.
- [32] Talukder S (2007) Histopathology techniques, tissue processing and staining. <http://www.talukderb.com>
- [33] Quinn PJ, Markey BK, Carter ME, Donnelley WJ, Leonard FC (2004) Clinical Veterinary Microbiology disease. Black well, London, pp. 76.
- [34] Hatipoglu F, Kiran MM, Ortatatli M, Erer H, Çiftçi KM (2002) An abattoir study of genital pathology in cows: Department of Pathology Faculty of Veterinary Medicine University of Selcuk. *Revue de Médecine Vétérinaire*, **153**, 29-33.

- [35] Dalling T, Robertson A, Boddie G, Spruell J (1988) Diseases of camels. In: The international encyclopedia of veterinary medicine. W Green and Son Edinburgh, pp. 585.
- [36] Abbas B and Agab H (2002) A review of camel brucellosis. *Journal of Preventive Veterinary Medicine*, **55**, 47–56.
- [37] Gwida M, El-Gohary A, Melzer F, Khan I, Rosler U et al (2011) Brucellosis in camels. *Journal of Research on Veterinary Science*, <http://doi:10.1016/05002>
- [38] Mshelia GD, Abba Y, Voltaire YA, Akpojie G, Mohammed H et al. (2012) Comparative uterine bacteriology and pathology of camels (*Camelus dromedarius*) and cows in north-eastern Nigeria. *Journal of Comparative Clinical Pathology*, **11**, 234-261.
- [39] Tibary A, Fite C, Anouassi, Sghiri A (2006) Infectious causes of reproductive loss in camelids. *Theriogenology*, **66**, 633-647
- [40] Waheed MM, Hamouda MA, Al-Dughaym AM (2009) Uterine histopathological findings of infertile female camels (*Camelus dromedarius*). *Journal of Camel Practice and Research*, **16**, 1-7.
- [41] Ahmadi MR, Nazifi S, Ghaisari HB, Radniehr M (2005) Evaluation of reproductive cycle with cervical and uterine cytology in Iranian dromedary camels. *Journal of Comparative Clinical Pathology*, **14**, 48–55.
- [42] Sendag S, Cetina Y, Alana M, Ilhana F, Eския F et al. (2008) "Cervical leiomyoma in a dairy cattle." *Journal of Animal Reproduction Science*, **103**, 355-350.
- [43] Kennedy PC, Miller RB (1993) The Female Genital System. In: Pathology of Domestic Animals, Jubb, Kennedy, Palmer Eds., Academic Press, NewYork, pp. 349–470.
- [44] Timurkaan N, Aydin M, Yilmaz F, Cevik A (2009) Vaginal fibro-leiomyoma in a cow: a case report. *Journal of Veterinary Medicina*, **54**, 138-141.
- [45] Arvind S, Adarsh K, Sheikh I, Pankaj S, Rajesh K (2012) "Ultrasonographic, Surgical, and Histopathological Findings of a Uterine Leiomyoma in a Cow." *Case Reports in Veterinary Medicine*, **42**, 4-8.
- [46] Opsomer G, Grohn YT, Hertl J, Coryn M, Deluyker H et al. (2000) Risk factors for post-partum ovarian dysfunction in high producing dairy cows in Belgium: A field study. *Theriogenology*, **53**, 841-857.
- [47] Butler W (2003) Energy balance relationships with follicular development, ovulation and fertility in postpartum dairy cows. *Livestock Production Science*, **83**, 211-218.
- [48] Tibary A, Anouassi A (1996) Ultrasonographic changes of the reproductive tract in the female camel (*Camelus Dromedarius*) during the follicular cycle and pregnancy. *Journal of Camel Practice and Research*, **3**, 71-90.
- [49] Herenda D (1987) Abattoir survey of reproductive organ abnormalities in beef heifers. *Canada Veterinary Journal*, **28**, 33-36.
- [50] Hegazy AA, Ali A, Al-Aknah M, Ismail S (2004) Studies on pituitary- ovarian axis in the female camel with special reference to cystic and inactive ovaries. *Journal of Camel Science*, **1**, 16-24.

- [51] Vanholder T, Opsomer G, Kruif A (2006) Aetiology and pathogenesis of cystic ovarian follicles in dairy cattle: a review. *Reproduction and Nutrition Development*, **46**, 105-119.
- [52] Roberts SJ (1986) Veterinary Obstetrics and Genital Diseases. 3rd edit., Roberts SJ -Woodstock, NewYork, pp. 381–359.
- [53] Alam M G S (1984) Abattoir studies of genital diseases in cows. *Journal of Veterinary Record*, **14**, 195-196.
- [54] Peter AT, Levine H, Drost M, Bergfelt DR (2009) Compilation of classical and contemporary terminology used to describe morphological aspects of ovarian dynamics in cattle. *Theriogenology*, **71**, 1343-1357.
- [55] Monaco D, Padalino B, Lacalandra GM (2015) Distinctive features of female reproductive physiology and artificial insemination in the dromedary camel species. *Emirates Journal of Food and Agriculture*, **27**, 328-337.
- [56] Fathalla M, Hailat N, Lafi SQ (2000) An abattoir survey of gross reproductive abnormalities in the bovine genital tract in Northern Jordan. *Israel Journal of Veterinary Medicine*, **55**, 1-7.
- [57] Tibary A, Anouassi A (1997) Reproductive disorders of the female camelidae. In: Tibary A (ed) *Theriogenology in camelidae: anatomy, physiology, BSE, pathology and artificial breeding: actes editions. Reports of Agronomy and Veterinary Institute Hassan II*, 317-368.
- [58] Azawi OI (2008) Postpartum uterine infection in cattle. *Animal Reproduction Science*, **105**, 187-208.
- [59] Fetaih H (1991) Some pathological studies on the affections of genital system of she-camel. PhD Thesis, Faculty of veterinary medicine, Suez Canal University.
- [60] Tibary A, Anouassi A (2000) Reproductive disorders in the female camelid. In: Recent advances in camelid reproduction, Skidmore JA, Adams GP Eds., International Veterinary Information Service. <http://www.ivis.org/>, access 22/6/2014.
- [61] Jubb KVF, Kennedy PC, Palmer N (1993) Pathology of domestic animals. In: 4th San Diego, Eds., Academic press: California, London.
- [62] El-Yuguda AD, Abubakar MB, Baba SS, Ngangnou A (2010) Competitive ELISA rinderpest virus antibody in slaughtered camels (*Camelus dromedarius*): implication for rinderpest virus elimination from Nigeria. *African Journal of Biomedical Research*, **13**, 83–85.
- [63] Tibary A (2004) "Infertility in female Camelids." Reproductive patterns and examination technique. Large Animal Proceedings of the North American Veterinary Conference, January 17th–21st, 18:285–286.
- [64] Kaneko K, Nakamura M, Reiichiro-Sato R (2013) Influence of *Trueperella pyogenes* in uterus on corpus luteum lifespan in cycling cows. *Theriogenology*, **79**, 803–808.
- [65] Sheldon IM, Bushnell M, Montgomery J, Rycroft AN (2004) Minimum inhibitory concentration of some antimicrobial drugs against bacteria causing uterine infections in cattle. *Vet Rec* 155:383-387.
- [66] Singh J, Murray RD, Mshelia G, Woldehiwet Z (2008) The immune status of the bovine uterus during the peripartum period. *Veterinary Journal*, **175**, 301-309.

[67] Williams EJ, Fischer DP, England GC, Dobson H, Pfeiffer DU, Sheldon IM (2005) Clinical evaluation of postpartum vaginal mucus reflects uterine bacterial infection and the inflammatory response to endometritis in cattle. *Theriogenology*, **63**, 102-117.

[68] Foldi J, Kulcsar M, Pecsí A, Huyghe B, DeSa C et al. (2006) Bacterial complications of postpartum uterine involution in cattle. *Animal Reproduction Science*, **96**, 265-281.

Tables

Table 1: Frequency (%) ovarian disorders and association of ovarian lesions with putative factors

Variable		Follicular cyst	Luteal cyst	Paraovarian cyst	Hypoplasia	Ovario-bursal adhesion	Oophrotis	Ovarian hydrobursitis
Species	Cow	6(4.28)	3 (2.14)	2 (1.42)	4 (2.85)	7 (5)	1 (0.72)	0
	Camel	4 (2.85)	2 (1.42)	2 (1.42)	1(0.72)	0	0	1 (0.72)
	χ^2	0.4148	0.2036	0.0000	1.8327	7.1795	1.0036	1.0036
	P-value	0.520	0.652	1.000	0.176	0.007	0.316	0.316
Age	Adult	7 (5.34)	2 (1.57)	3 (2.3)	3 (2.29)	3 (2.29)	0	0
	Young	1 (3.44)	1 (3.57)	1 (3.44))	1 (3.44)	1(3.44)	0	0
	Old	2 (1.66)	2 (1.66)	0	1 (0.83)	3 (2.5)	1 (0.833)	1(0.833)
	χ^2	2.4600	0.5169	3.2697	1.2677	0.1307	1.3381	1.3381
	P-value	0.292	0.772	0.195	0.531	0.937	0.512	0.512
BCS	Poor	1 (0.74)	2 (2.27)	0	4 (4.54)	2 (1.42)	0	1(1.13)
	Good	8 (9.0)	2 (1.48)	1 (0.74)	1 (0.74)	4 (2.85)	0	0
	Medium	1 (1.75)	1(1.75)	3 (5.26)	0	1 (0.72)	1 (1.75)	0
	χ^2	11.4720	0.1906	7.6809	5.6984	0.2674	3.926	2.1896
	P-value	0.003	0.909	0.201	0.058	0.875	0.140	0.335

Table 2: Frequency (%) and association of uterine lesions with different variable

Variable		Acute endometritis	Chronic Endometritis	Catarrhal endometritis	Suppurative endometritis	Uterine tumor
Species	Cow	9(6.42)	7 (5)	2 (1.42)	2 (1.42)	1 (0.72)
	Camel	12(8.57)	16 (11.4)	2 (1.42)	0	0
χ^2	0.463	3.836	0.000	2.0144	1.0036	
P value	0.496	0.055	1.000	0.156	0.316	
Age	Adult	11 (8.39)	5 (3.81)	0	2 (1.52)	0
	Young	2 (6.9)	5 (17.2)	1(3.44)	0	0
	Old	8 (6.66)	13 (10.8)	3(2.5)	0	1(0.83)
	χ^2	0.2873	7.5861	3.716	2.291	1.3381
	P value	0.866	0.023	0.156	0.318	0.512
BCS	Poor	7 (7.95)	7 (7.95)	3 (3.4)	2 (2.27)	1 (0.72)
	Good	9 (6.66)	11 (8.14)	1 (0.74)	0	0
	Medium	5 (8.77)	5 (8.77)	0	0	0
	χ^2	0.2943	0.0322	3.73	4.3950	2.1896
	P value	0.863	0.984	0.155	0.111	0.335

Table 3: Frequency (%) and association of oviductal and cervico-vaginal lesion with different variable

Variable		Hemosalphix	Pyosalphix	Cervicitis	Vaginitis	Vaginal myocytis
Species	Cow	2 (1.42)	2 (1.42)	2 (1.42)	2 (1.42)	0
	Camel	1 (0.72)	1 (0.72)	2 (1.42)	1 (0.72)	3 (2.14)
	χ^2	0.3369	0.3369	0.0000	0.3369	3.0325
	P value	0.562	0.562	1.000	0.562	0.082
Age	Adult	2 (1.52)	2 (1.52)	2 (1.52)	2 (1.52)	2 (1.52)
	Young	0	0	0	0	0
	Old	2 (1.66)	1 (0.83)	2 (1.66)	1 (0.83)	1 (0.83)
	χ^2	0.4776	0.6344	0.4776	0.6344	0.6344
	P value	0.788	0.728	0.788	0.728	0.728
BCS	Poor	2 (2.27)	1 (1.13)	1 (1.13)	1 (1.13)	2 (2.27)
	Good	2 (1.48)	1 (0.74)	2 (1.48)	1 (0.74)	1 (0.74)
	Medium	0	1(1.75)	1 (1.75)	1 (1.75)	0
	χ^2	1.2741	0.3936	0.0990	5.6984	1.9547
	P value	0.529	0.821	0.952	0.058	0.376

Figures

Figure 1

Graphical presentation of bacteria isolated from uterine lesions.

Figure 2

Vaginal myositis. A cross section of swelling mass in the wall of the vagina (A) tumor like mass after removed from the wall (B) sloughed myocytes Hand E stain X40 (C) lymphocytes infiltration between myocyte. Hand E stain X 100

Figure 3

Hemosalpinx. Note the mucosa was hyperemic and the lumen filled with bloods (A) microscopically edema and inflammatory cell infiltrations (B) indicated by (red arrow). H and E stain X 40.

Figure 4

Leiomyoma. A firmly attached mass originated from body of uterus (A) showing bundles of smooth muscles running in various directions and interlaced with each other. Hand E stain X 40 (B) variation of nucleus shape (C) slight mitotic figure (red arrow) (D). Hand E stain X100.

Figure 5

Chronic endometritis. Note severe congestion visible from outside (A) and severely congested and thickened mucosa on incision (B) severely hyperplastic mesothelium indicated by (red two-sided arrow) and hemorrhage (black arrow) H and E 40x (C) lymphocytes infiltrations in endometrium (D) H and E 100x

Figure 6
 Catarrhal endometritis. Note the mucoid exudates discharged from vagina (A) microscopic endometrial gland degeneration (B) H and E 40X

Figure 7

Severely hyperemic acute endometritis with blood tinged exudates in the upper corner (A) congestion of endometrial blood vessels (B) aggregation of neutrophils H and E stain 100X (C) misshapen and atrophied endometrial gland (D). H and E 40X.

Figure 8

Oophoritis. Note hyperemic and swollen ovary (A) inflammatory cells infiltrations in ovarian medullary region (B) indicated by (red arrow). H and E stain X 40.

Figure 9

Hypoplastic ovary. Note the small size ovary (A) showing excessive fibrous connective tissues proliferation with complete absence of follicular or luteal development microscopically (B). H and E stain X 40

Figure 10

Macroscopic lesions. Thick walled luteal cyst indicated by arrow (A) unlike the thin wall follicular cysts (fig 2A) and macroscopic lesion of ovarian hydrobursitis, note straw colored fluid accumulation in ovarian bursa (B).

Figure 11

Follicular cysts. Note that the cyst occupies the entire right ovary and very thin wall due to distention by follicular fluid indicated by short thick arrow. The left ovary was hypoplastic indicated by thin arrow (A) which was microscopically characterized by extremely thin granulosa cells (black arrow) and red arrow indicate degeneration of granulosa cell (B). H and E stain X 40.

Figure 12

Anatomical distribution of reproductive organ lesions in cow and dromedary camel