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Research Article

Unveiling the Hidden Epidemic: A Multidimensional Study of Lameness, Haematological Biomarkers, and Lesion Topography in Cattle of Nigeria's Federal Capital Territory

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Abstract
Lameness has been a significant problem in the livestock industry, particularly the dairy industry of cattle production, with significant negative effects on both animal welfare and the economy of production. This study aims to evaluate and analyse the population of cattle affected by lameness, as this is the first of its kind, with little or no documentation on the condition in the Federal Capital Territory. The study involves taking data from farms, markets and abattoirs, sampling cattle in those areas and taking blood samples from both the affected and the apparently healthy ones. From the analysis, the prevalent cause of lameness was traumatic injury, especially at the hind limb, from slips and falls, as well as petty fights among the animals. The haematological parameters of the lame animals, as compared to those of the apparently healthy, do not differ much, as there could be other underlying causes of the slight changes and not necessarily lameness as a primary cause. In conclusion, cattle owners and animal handlers were advised to adequately and properly floor the stalls of these animals with concrete aggregates to prevent subsequent falls and also evacuation of dungs to tackle slips. Bulls should be separated from the cows and properly spaced between them to prevent any form of fights among them. Butchers were also educated to properly handle the cattle when evacuating them from their transport trucks to minimise any impact that might result in injury, which can reduce the carcass quality after slaughtering.
Keywords: Lameness, Haematology, Biomarkers, Lesion, Cattle.

Introduction

With an astounding 71.61 million metric tonnes of beef produced worldwide in 2018, beef cattle, including buffaloes, are the third most common livestock species in the world, behind pigs and poultry (Ritchie, 2017). At the same time, the European Union produced 10.64 million metric tonnes of beef, which made a substantial contribution to this statistic. The number of cows worldwide is predicted to increase from 1.5 billion in 2000 to 2.6 billion in 2050 (Thornton, 2010). Techniques for raising cattle vary greatly throughout the world, ranging from extensive to intense methods and using a variety of breeds (Endres *et al.,* 2018). Animal welfare presents distinct challenges for each management system (Endres *et al.,* 2018). While best practice information is available for some of the issues identified, there are still knowledge gaps in other areas, such as illness control and monitoring live transport optimization, environmental feature usage, and enrichments (Endres *et al.,* 2018). Lameness is a major concern when it comes to the care, handling, and growing of cattle in the dairy industry. Lameness is one of the biggest issues regarding the welfare of high-yielding dairy cows in North America (Vermunt, 2007) and the second most costly management condition in the dairy industry, behind mastitis (Vermunt, 2007).

Lameness in cow herds continues to be a significant issue that has a detrimental impact on animal welfare, farm economics, and milk production worldwide. Lameness is the term used to describe any foot or limb ailment that affects a cow's movement, posture, and gait, whether or not it is infectious (Archer *et al.,* 2010). There are numerous potential causes of lameness, thus both infectious and non-infectious variables may contribute to its incidence (Ranjbar *et al.,* 2016). The main cause of lameness in dairy cows is claw lesions, which can be non-infectious (white line disease, sole ulcer, sole hemorrhage, interdigital hyperplasia) or

infectious (digital dermatitis, interdigital dermatitis, heel erosion, and interdigital phlegmon, or foot rot) (Van Nuffel *et al.,* 2015). These infections typically cause discomfort, inflammation, and lameness in the hooves and surrounding structures. Foot rot is a common ailment that is linked to overcrowding, muddy and wet conditions, and poor hoof hygiene (Nelson *et al.,* 2017). From a different angle, inadequate hygiene, slatted floors, and poorly maintained footbaths are linked to digital dermatitis, which is more common in intensive agricultural systems (Angell *et al.,* 2015).

Nutritional imbalances, genetics, aberrant hoof conformation, severe traumas, and excessive hoof wear can all cause lameness. Lameness can result from nutritional deficits, particularly in the micronutrients copper and zinc (Nansen *et al.,* 2018). The importance of early identification is highlighted by the fact that milk supply may begin to decline in preclinical cases of disease, even though lameness may not always be apparent (Langova *et al.,* 2020). Similar to how some cow breeds may be more prone to lameness for genetic reasons, such as the predominance of poor hoof conformation features (Heringstad *et al.,* 2017), acute lameness can be caused by traumatic injury, such as sprains or fractures, but severe hoof wear can occur in animals kept on abrasive surfaces without proper hoof protection or in those who walk long distances. Furthermore, the prevalence of lameness in cattle might be influenced by environmental factors. Hooves can become softer under wet and muddy environments, increasing the risk of bacterial infections. On the other hand, excessive wear and tear on hooves due to abrasive or solid surfaces can lead to lameness. The impact of environmental factors on the occurrence of lameness in cattle can be mitigated by adhering to suitable housing and management techniques (Telezhenko *et al.*, 2009). Early detection and prompt treatment are necessary to reduce the negative effects of lameness on cattle's health and production, which include pain, discomfort, and reduced mobility (Whay *et al.,* 2003). The periodic incidence of lameness can be prevented and treated with good hoof maintenance and trimming, according to research by O'Connell *et al.,* (2019). Cattle lameness can also be reduced by improving housing conditions, improving nutrition, and implementing appropriate herd health management techniques.

Materials and Methods

Study Area

This study was conducted at various farms, markets and abattoir in 4 area councils of the FCT (Abuja Municipal, Kuje, Gwagwalada and Bwari). Federal Capital Territory lies between latitude 8° 35' and 9° 25' North of the equator and longitude 6° 45'' and 7° 45" East of the Greenwich Meridian with a land area of 8000 square kilometers. It has a Guinea Savannah type of vegetation; with annual rain-fall ranges from 1100 to 1600mm. There are two major types of seasons: dry season (November–April) and rainy season (May-October) in each year. The maximum temperature is 37 °C and the minimum 30 °C. Cattle kept in those farms and markets and those slaughtered in the abattoir were mostly sourced from different cattle-rearing regions mainly from northern Nigeria.

Study Design and Study Period

The study design was conducted from October to November, 2023 by visiting 2 farms and an abattoir as well as some notable cattle markets in each area council aforementioned. The study involved visiting those identified places taking note of the management systems especially in the farms, relating with the owners and veterinarians and observing the gait of each of the cattle present.

Sample Size and Population

A total of 200 cattle were sampled with an average of 50 cattle sampled per area council visited.

Data and Sample Collection Process

Between October and November 2023, about 2 markets, 5 farms and 3 abattoirs were visited and 200 cattle sampled cumulatively in those area councils of the FCT. The process involves close observation and monitoring of each cattle gait checking for signs of lameness or limping. A total of 4 lame cattle were observed from all cattle sampled and relevant signalment taken about each one with each lame cattle restrained and blood sample collected from each of them as well as from 3 other random apparently healthy ones. The blood sampled were then carefully kept in the cooler with ice pack and taken for complete blood count.

Data Analysis

Data and results obtained were analyzed using a simple method such as percentage. The haematology results were arranged in a tabular form comparing that of the lame with that of apparently normal with the distribution of lesions in the lame cattle.

Ethical Statement

The Institutional Animal Care and Use Committee (IACUC) of the University of Abuja, Nigeria, authorized the study protocol before its start via the number SP00375800_79, ensuring that it adhered to the standards of studies involving animals.

Results

Prevalence of Lameness Within the Cattle Population Sampled in the FCT

A total of 4 lame cattle were obtained from the study out of a population of 200 cattle.

$$\text{Incidence rate} = \frac{number\ of\ new\ cases}{Total\ number\ of\ population} \times 100$$

$$= \frac{4}{200} \times 100 = 2\%$$

Therefore, the incidence of lameness in cattle population in the FCT is 2%.

Table 1. Area councils and number of cases found in each.

Area council	Number of cattle sampled	Number of lame cattle
Gwagwalada	50	3
Kuje	50	1
Bwari	50	0
Abuja Municipal	50	0

Table 2. Haematological results of the sampled cattle.

Parameters	Values of lame cattle				Reference range	Interpretation	Values of non-lame			Reference range	Interpretation
	1	2	3	4			1	2	3		
PCV (%)	18	28	33	20	24-46	Low 2/4	32	22	28	24-46	Normal 2/3
HGB (g/dL)	6.70	9.30	9.80	7.40	8-15	Low 2/4	9.3	7.3	8.5	8-15	Low 1/3
RBC (x 10^6)	5.3	10.7	8.3	6.5	5-10	Normal ¾	6.3	6.8	8.5	5-10	Normal
MCV (fL)	37.4	46.5	43.3	46.8	40-60	Normal ¾	46.4	38.3	43.0	40-60	Low 1/3
MCH (pg)	10.3	14.1	15.7	9.6	11-17	Low 2/4	10.2	12.8	16.3	11-17	Low 1/3
MCHC (g/dL)	28.5	32.9	27.3	35.6	30-36	Low 2/4	32.8	35.3	33.5	30-36	Normal 3/3
WBC (x 10^3/µL)	13.6	12.4	8.3	10.7	4-12	High 2/4	6.9	8.0	13.6	4-12	High 1/3
GRAN (x 10^3/µL)	76	73	61	63	50-70	High 2/4	55	62	74	50-70	High 1/3
LYM (x 10^3/µL)	49	53	67	71	45-75	Normal 4/4	72	56	50	45-75	Normal 3/3
MON (x 10^3/µL)	6	6	7	4	0-8	Normal 4/4	6	4	5	0-8	Normal 3/3
PLT (x 10^3/µL)	347	836	552	758	100-800	Normal ¾	635	478	755	100-800	Normal 3/3

*SUSAN 2023; PVC = Packed cell volume; HGB = Hemoglobin; RBC = Red blood cell; MCV = Mean corpuscular volume; MCH = Mean corpuscular hemoglobin; MCHC = Mean corpuscular hemoglobin concentration; WBC = White blood cells; GRAN = Granulocyte; LYM = Lymphocytes; MON = Monocytes; PLT= Platelets

Table 3. Distribution of lesions in the lame cattle sampled.

Breed	Age	Gender	Cause of lameness	Location of lesion	Part of the body affected
Cameroon Brown	3 years	Female	Trauma/injury	Left hind limb	Lateral tibia
White Fulani	20 months	Male	Injury	Left hind limb	Lateral femur
White Fulani	18 months	Male	Trauma	Right hind limb	Medial thigh
White Fulani	22 months	Male	Trauma	Left hind limb	Hoof

The prevalent cause of lameness in the sampled cattle were predominantly trauma or injury due to slips or falls during offloading from transport vehicle, accidents or fights with fellow animals; thus, extra care must be taken during offloading of animals and proper spacing of animals to prevent fighting in order to eradicate possible traumatic experiences for the animals.

Discussion

This study represents an effort to evaluate the incidence of lameness among the cattle population in the FCT by visual observation of the gait and posture of individual animals noting the location of the various lesions as well as comparing the haematology of the lame cattle with those of the apparently healthy ones. The study revealed that lameness was more prevalent in the bulls than the cows and that the predominant cause of the condition in the population sampled was trauma resulting to injury either due to falls or slips or probably due to regular fights among the bulls. This finding was in accord to the study conducted by (Booth *et al.,* 2004; Shearer *et al.,* 2017) as a result of lameness which is a major issue encountered in the livestock industry and is second only to mastitis in terms of its detrimental effect on herd productivity in dairy cows, as it has significant negative effects on both animal welfare and the economy of production. Similarly, lameness has a detrimental effect as a result of drop in milk production (Green *et al*., 2002) and reproductive efficiency (Alawneh *et al.,* 2011) higher replacement costs and rates of culling and increased medication and man power costs (Cha *et al.,* 2010; Ettema and Østergaard S 2006).

Although new and efficient methods of lameness detection have been developed, the manual visual observation seems to be the mostly used method in this part of the world due to the fact that it is quick and straight forward through the help of an experienced field veterinarian. The present study was conducted on some randomly selected farms, cattle markets and abattoir which does not really give the full statistics of the indebt population of cattle in the FCT as well as possible lame ones among them and thus only offering little information about the condition in the Capital. The findings in the current study were similar to the findings of (Whay and Shearer, 2013) which showed that among dairy cattle's most excruciating ailments is lameness resulting from lesions on the hooves or claws. Changes in posture and gait are noticeable when walking and standing in order to alleviate this kind of pain. Similarly, digital dermatitis is an established disease of the claw that affects the hindlimb of cattle (Sogstad *et al.,* 2005). It is an infectious disease spread by the environment and caused by a combination of bacteria with the most incriminated bacteria being spirochetes of the genus *Treponema* spp (Rutherford *et al.,* 2009). Animals with cloven hooves, such as cattle, are the main hosts of foot and mouth disease (Arzt *et al.,* 2011). The condition known as toe tip necrosis typically affects the lateral claw of the hind feet of beef cattle that are 10 to 12 months old. It usually appears a few days to a few weeks after the cattle are processed, weaned, and transported to a feedlot. Although the epidemiology and pathophysiology of TTN have never been thoroughly investigated as stated by (Greenough, 2007; Paetsch and Jelinski, 2013).

Laminitis is an acute or persistent inflammation of the laminae which is the tissue directly beneath the foot's outer horny wall. A metabolic insult lowers the pH of the rumen and systemic pH, which is the cause of lameness. As the pH drops, the circulatory system becomes more active, resulting in an increase in pulse and blood flow. Additionally, ruminal acidosis and laminitis are frequently linked, despite the fact that they are distinct disorders with a similar etiology namely, highly fermentable diets they are not co-dependent syndromes, an immunosuppression frequently coexists with a joint infection, making treatment particularly challenging as stated by (Nuss *et al.,* 2009), and is in accord with the finding of the current study. Sole ulcers are the most common foot condition which usually affects the outer claw of the hind foot. The pedal bone may drop as a result of conditions like laminitis, harming the horn of the sole underneath. Sole ulcer has a strong correlation with abnormal claw shape as found in their study (Manske *et al.,* 2002; Amory *et al.,* 2008). In the current study, lameness was found to be caused by improper flooring, such as extremely wet or hard concrete floors. It may harm hooves and put stress on legs and joints. The general health of the hoof can be affected by climatic conditions, including extreme heat or cold. Soft hooves can result from heat stress, and tissue damage can occur from extended exposure to cold or moisture (Shearer *et al.,* 2017). In the present

study, nutritional factors have been linked to lameness in cattle. Nutritional deficiencies or imbalances can lead to improper bone development and structural integrity, which can increase the risk of lameness as stated by (Van Marle-Köster *et al.,* 2019).

Traumatic injuries is a physical injuries resulting from slips, falls and contact with hard surfaces can induce sprains, breaks, fractures, dislocations, sand cracks, and frostbite which commonly occur in beef cattle in the present study. This finding is similar to the study conducted by (Telezhenko *et al.,* 2009) which showed that structural imbalances in the hooves could affect weight distribution thus inducing discomfort in cattle. The haematology results of the lame cattle as compared to the apparently healthy ones does not really differ much in the figures obtained as there might be other underlying causes inducing those changes in the haemogram and probably not as a result of the lame conditions of the affected animals.

Conclusion

The findings of this study revealed only a small fraction of the cattle population in the FCT were examined and sampled which could only provide little understanding of the prevalence of lameness among the cattle population putting various factors into consideration. This study to the best of our knowledge is the first of its kind to document on lameness in cattle in the FCT and from the study it was gathered that trauma was the prevalent cause among herds with foot rot and foot and mouth disease accounting for a small fraction.

Declarations

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Institutional Review Board Statement: This study involved animal subjects and was conducted in accordance with accepted ethical standards for the use and care of animals in research. Ethical approval for the study was obtained from the Department of Veterinary Medicine, Faculty of Veterinary Medicine, University of Abuja, Nigeria.

Informed Consent Statement: Not applicable, as this study did not involve human participants.

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