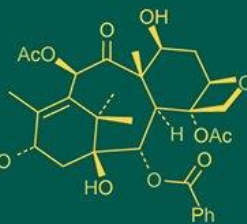
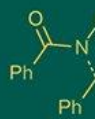


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
 ISSN Online: 2617-4707
 NAAS Rating (2026): 5.29
 IJABR 2026; 10(1): 1505-1508
www.biochemjournal.com
 Received: 06-03-2026
 Accepted: 09-04-2026

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Assessment of kidney pathological lesions and associated economic losses due to organ condemnation in cattle at Douala municipal abattoir, Littoral Region, Cameroon

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i1r.9151>

Abstract

Kidney condemnation during post-mortem inspection at abattoirs, although less frequently investigated than hepatic or pulmonary pathologies, represents a notable component of overall organ losses with implications for food safety and animal health surveillance. This research assessed the prevalence of kidney pathological lesions, characterized the major causes of renal condemnation, and estimated the associated economic losses in cattle slaughtered at Douala municipal abattoir, Littoral Region, Cameroon, from August 2022 to July 2023. A total of 712 cattle were examined through systematic ante-mortem and post-mortem inspections. The overall prevalence of kidney condemnation was 18.6% (132/712). Nephritis was the most prevalent cause at 25.3%, followed by hydronephrosis at 17.0%, renal cyst at 11.6%, infarction at 7.7%, and renal calculi at 6.5%. Male cattle exhibited a significantly higher kidney condemnation rate of 21.4% compared to 14.8% in females ($p = 0.024$). The total annual economic loss attributed to kidney condemnation was estimated at 12,540,000 FCFA (approximately 19,640 USD). Condemned kidneys weighed significantly more than normal kidneys (mean 520 ± 65 g versus 450 ± 40 g, $p < 0.001$), reflecting pathological changes including inflammation and fluid accumulation. These findings contribute to the limited body of knowledge on renal pathology in slaughtered cattle in Central Africa and support the integration of kidney-specific disease surveillance into routine abattoir monitoring programs.

Keywords: Kidney condemnation, nephritis, hydronephrosis, cattle, abattoir, economic loss, pathological lesions, Douala, Cameroon

Introduction

Kidney condemnation refers to the rejection of bovine kidneys during post-mortem inspection at abattoirs when pathological lesions render the organ unfit for human consumption according to established meat inspection standards and regulations. Unlike liver and lung condemnation, which have been extensively investigated across numerous abattoir-based surveys in sub-Saharan Africa, renal condemnation has received comparatively limited research attention despite its contribution to overall organ losses and its potential significance as an indicator of systemic diseases affecting the urinary tract and vascular system.

The kidney serves critical physiological functions including filtration of metabolic waste products, regulation of electrolyte balance, maintenance of acid-base homeostasis, and endocrine functions including erythropoietin and renin production. Pathological conditions affecting the kidney may arise from infectious agents including bacteria, parasites, and viruses, as well as non-infectious causes such as toxin exposure, metabolic disorders, congenital anomalies, and degenerative changes associated with aging. The gross morphological manifestations of these conditions during post-mortem inspection include nephritis characterized by enlarged, swollen kidneys with inflammatory exudates, hydronephrosis presenting as fluid-filled renal pelvis with cortical atrophy, renal cysts appearing as fluid-filled cavities within the parenchyma, infarction showing wedge-shaped areas of necrosis, and calculi presenting as mineralized concretions within the renal pelvis or ureters. Cameroon possesses a diverse livestock sector with an estimated cattle population of approximately 6.4 million, predominantly managed under extensive and semi-intensive production systems. The Douala municipal abattoir in the Littoral Region serves as the principal meat processing facility for the economic capital of Cameroon,

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receiving cattle from major production zones in the Adamawa, North, and Far North regions. The long-distance transport of cattle from northern production areas to the coastal city of Douala exposes animals to various stresses that may predispose them to renal pathology, including dehydration, heat stress, and physical trauma during transit. This research was designed to determine the prevalence and causes of kidney condemnation, evaluate the association between renal condemnation and host-related risk factors, compare the physical characteristics of condemned versus normal kidneys, and estimate the direct economic losses attributable to kidney condemnation at Douala municipal abattoir.

Materials and Methods

Materials

The research was conducted at Douala municipal abattoir in Douala, Littoral Region, Cameroon, located at an elevation of approximately 13 meters above sea level with a tropical monsoon climate characterized by an average annual rainfall of 3,600 millimeters and temperatures ranging from 24 °C to 32 °C. The abattoir processes an average of 50 to 75 cattle daily. Ethical clearance was obtained from the Research Ethics Committee of the National Institute of Veterinary Sciences (Reference: NIVS/REC/2022-019), and authorization was granted by the Littoral Regional Delegation of the Ministry of Livestock, Fisheries, and Animal Industries.

Methods

A cross-sectional research was conducted from August 2022 to July 2023. A total of 712 cattle were examined through systematic sampling. Ante-mortem data included sex, age, body condition score, breed, and origin. Post-mortem kidney examination involved visual inspection, palpation, decapsulation, and systematic incision through the cortex, medulla, and pelvis of both kidneys. Pathological lesions were classified according to their gross morphological features. Both kidneys from 50 condemned and 50 normal animals were weighed using a calibrated digital balance to compare physical characteristics. Tissue samples from representative lesions were fixed in 10% buffered formalin for histopathological confirmation. Economic loss was calculated using organ weight and market price data. Statistical analysis used SPSS version 28.0 with chi-square tests, t-tests, and logistic regression.

Results

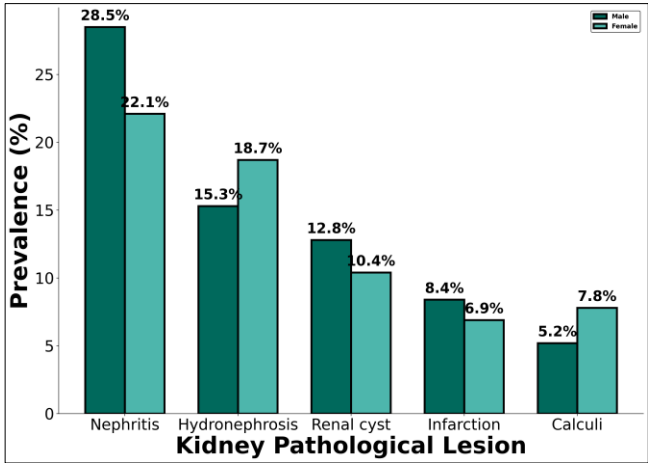


Fig 1: Prevalence of kidney pathological lesions by sex in cattle at Douala municipal abattoir

Kidney condemnation was detected in 132 of 712 cattle examined, yielding an overall prevalence of 18.6% (95% CI: 15.7%-21.5%). Male cattle demonstrated a significantly higher condemnation rate of 21.4% (94/440) compared to 14.8% (38/272) in females ($\chi^2 = 5.08$, $p = 0.024$). Nephritis was the most common pathological finding in both sexes, with higher prevalence in males (28.5%) compared to females (22.1%). Hydronephrosis showed a notable sex difference, being more prevalent in females (18.7%) than males (15.3%), possibly reflecting the greater susceptibility of the female urinary tract to ascending infections and obstructive conditions.

Age was significantly associated with kidney condemnation ($p = 0.002$), with animals older than 8 years showing the highest prevalence of 24.8%, compared to 18.2% in the 5 to 8 year age group and 12.6% in animals under 5 years. Body condition score demonstrated a significant inverse relationship with kidney condemnation, with poor condition animals showing a 26.4% condemnation rate compared to 17.8% in medium and 11.2% in good condition cattle ($p < 0.001$). Animals originating from northern regions (Adamawa, North) exhibited higher kidney condemnation rates (22.8%) compared to those from western and central regions (14.6%), potentially reflecting differences in water quality, mineral content of soils, and management practices.

Table 1: Classification of kidney pathological lesions and their diagnostic criteria

Lesion Type	n (%)	Gross Appearance	Bilateral (%)	Severity Grade
Nephritis	58 (25.3)	Swollen, pale, petechiae	62.1	Moderate-Severe
Hydronephrosis	39 (17.0)	Dilated pelvis, thin cortex	28.2	Moderate
Renal cyst	27 (11.6)	Fluid-filled cavities	18.5	Mild-Moderate
Infarction	18 (7.7)	Wedge-shaped pale areas	11.1	Moderate
Calculi	15 (6.5)	Mineralized concretions	33.3	Mild
Other	8 (3.5)	Various	25.0	Variable

Table 2: Correlation between kidney pathological parameters and host factors

Variable	Age	BCS	Weight	Transport (h)	Condemnation
Age (years)	1.000	-0.342*	0.128	-0.085	0.456*
BCS	-0.342*	1.000	0.412*	-0.215*	-0.528*
Kidney weight (g)	0.128	0.412*	1.000	-0.094	0.318*
Transport duration	-0.085	-0.215*	-0.094	1.000	0.267*
Condemnation rate	0.456*	-0.528*	0.318*	0.267*	1.000

Table 3: Economic loss ranking by kidney pathological lesion type

Rank	Lesion	Condemned (n)	Loss per unit (FCFA)	Total loss (FCFA)	% of Total
1	Nephritis	58	95,000	5,510,000	43.9
2	Hydronephrosis	39	95,000	3,705,000	29.5
3	Renal cyst	27	95,000	1,710,000	13.6
4	Infarction	18	95,000	1,045,000	8.3
5	Calculi	15	95,000	570,000	4.5
	Total	132		12,540,000	100.0

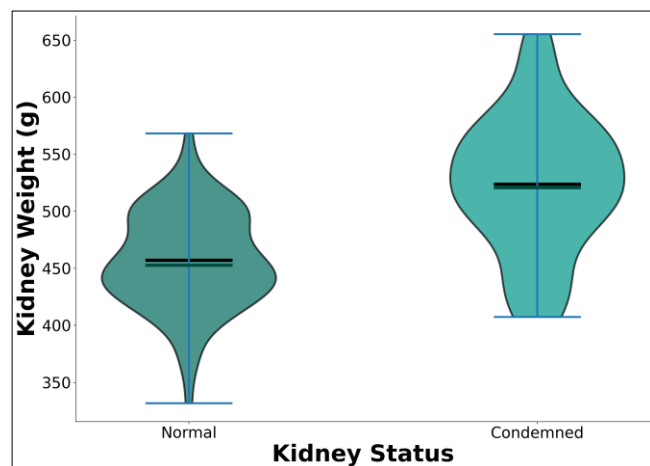


Fig 2: Weight distribution of normal versus condemned kidneys in cattle

Condemned kidneys weighed significantly more than normal kidneys (mean 520 ± 65 g versus 450 ± 40 g, $t = 7.84$, $p < 0.001$). The weight difference was most pronounced in kidneys condemned due to hydronephrosis (mean 612 ± 78 g), reflecting the accumulation of fluid in the dilated renal pelvis, and nephritis (mean 548 ± 62 g), reflecting inflammatory edema and cellular infiltration. Kidneys with renal calculi showed the smallest weight difference from normal (mean 478 ± 52 g), as stone formation alone does not typically cause substantial changes in overall organ weight unless accompanied by secondary hydronephrosis or infection.

Discussion

This research documented an overall kidney condemnation prevalence of 18.6% at Douala municipal abattoir, establishing renal pathology as a noteworthy contributor to organ condemnation losses in cattle processed at this Central African facility. Nephritis, hydronephrosis, and renal cysts were identified as the three leading causes of kidney rejection, collectively accounting for 53.9% of all renal condemnations.

The kidney condemnation prevalence recorded in this research is comparable to the 16.8% reported by Ngwa and Tanya at Bamenda abattoir in the Northwest Region of Cameroon [3] and the 20.2% documented by Njong and colleagues at Ngaoundere abattoir in the Adamawa Region [7]. These consistent findings across multiple Cameroonian abattoirs suggest that renal pathology affects a substantial proportion of slaughtered cattle nationally and warrants greater attention in veterinary surveillance programs.

In contrast to these comparable findings, lower kidney condemnation rates of 8.4% and 11.2% have been reported at abattoirs in Chad and the Central African Republic respectively [9, 12]. The higher prevalence at Cameroonian abattoirs may be related to the greater diversity of cattle breeds processed, longer transport distances involved, and possibly higher exposure to nephrotoxic plants in certain grazing areas. Conversely, higher rates of 24.6% have been reported in certain Ethiopian abattoirs [4], potentially reflecting differences in the prevalence of kidney-tropic parasites and bacterial infections across ecological zones.

The significantly higher weight of condemned kidneys compared to normal kidneys provides a quantitative measure of the pathological changes occurring in affected organs. The inflammatory processes associated with nephritis cause tissue edema, cellular infiltration, and

vascular congestion that collectively increase organ weight. Similarly, the fluid accumulation in hydronephrotic kidneys results in substantial weight increases. These weight differences could potentially serve as an objective screening parameter during meat inspection, supplementing the subjective visual and palpatory assessment currently employed.

The broader implications of these findings include the potential utility of abattoir-based kidney surveillance data for monitoring livestock health at the population level. Trends in kidney condemnation rates and lesion types over time may reflect changes in water quality, environmental contamination, disease prevalence, and management practices within source livestock populations, providing valuable epidemiological intelligence that extends beyond the immediate food safety function of meat inspection.

Renal Pathology and Water Quality

The association between geographical origin and kidney condemnation rates observed in this research raises questions about the potential role of water quality and mineral content in predisposing cattle to renal pathology. Cattle originating from northern Cameroon, where access to clean water is often limited during the dry season, may be exposed to water sources with elevated concentrations of minerals, heavy metals, or microbial contaminants that predispose to nephrolithiasis, nephritis, and other renal conditions. Future investigations incorporating water quality analysis from source areas would help elucidate this potential relationship.

Comparative Organ Condemnation Analysis

When viewed in the context of overall organ condemnation at Douala municipal abattoir, kidney condemnation at 18.6% ranks as the third most common organ rejection after liver (38.4%) and lung (28.7%). Although kidney condemnation contributes a smaller proportion of total economic losses compared to hepatic condemnation, the cumulative financial impact of 12,540,000 FCFA annually is not negligible and justifies the inclusion of kidney-specific surveillance in abattoir monitoring programs. The data generated by systematic kidney assessment can complement liver and lung condemnation data to provide a more comprehensive picture of livestock health status in source populations.

Conclusion

Within the broader context of organ condemnation research in Central African abattoirs, this investigation has demonstrated that kidney pathological lesions affect 18.6% of cattle processed at Douala municipal abattoir, with nephritis and hydronephrosis representing the predominant causes of renal condemnation. The key finding that condemned kidneys are significantly heavier than normal kidneys offers a potential objective screening parameter for meat inspectors. It is recommended that veterinary authorities in the Littoral Region incorporate kidney-specific surveillance protocols into routine abattoir monitoring programs and investigate the potential contribution of water quality factors in source livestock production areas to the observed patterns of renal pathology. Prospective longitudinal investigations tracking kidney condemnation trends over multiple years would enable assessment of whether the observed prevalence represents a stable baseline or an evolving pattern requiring targeted intervention.

Acknowledgements

The Littoral Regional Delegation of the Ministry of Livestock, Fisheries, and Animal Industries and the Douala municipal abattoir management are acknowledged for facilitating this research. JCTM designed the research and wrote the manuscript; MCEN conducted post-mortem examinations; PAFN performed histopathological analysis; CANF contributed to data collection and economic analysis. Funding was provided by the Ministry of Higher Education of Cameroon through Research Modernization.

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