

Effects of ingestion of plastic bags on the forestomachs and liver tissue of cattle

Efectos de la ingestión de bolsas de plástico sobre el tejido de los preestómagos y del hígado del ganado vacuno

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ABSTRACT

The objective of the current study was to evaluate histopathological changes in the liver and the macroscopic and microscopic modifications caused by the presence of plastic bags in the forestomachs of cattle. To reveal this problem, a study was undertaken at the slaughterhouse, involving sixty (60) animals in total, which included 44 males and 16 females, selected without any prior selection process. After slaughter, emptying, and washing of the rumen-reticulum, foreign bodies and macroscopic lesions were investigated. Histopathological analysis was performed on samples of the liver and rumen. Macroscopic examination of the forestomachs with plastic bags revealed congestion, hemorrhage, stunting, sagging, atrophy, and thinning of the papillae. Areas of erosion and ulceration in forestomachs of all cattle harboring a large quantity of plastic bags. Ulcerations and nodular formations were also present. The forestomachs walls were thinner than normal and had a light mottled wall and compressed papillae. The microscopic examination revealed a wide variety of lesions. Destruction, degeneration, necrosis, focal hyperplasia of the keratinized epithelium, and especially lesions of fragmentary or segmental ruptures were observed. The papillae are atrophied, compressed, shortened, folded, besides the buds' length was shortened. These microscopic changes can be attributed to the pressure exerted on the rumen wall and mechanical irritation induced by plastic impaction or released chemicals by these plastic bags. Microscopic examination of the liver of cattle with plastic bags in the rumen did not reveal the presence of histopathological changes. The identified pathological alterations played a role in the clinical manifestations and could disrupt nutrient absorption, leading to compromised animal health and diminished production and reproduction.

Key words: Foreign body; forestomachs; lesions; liver; histopathology

RESUMEN

El objetivo del presente estudio fue evaluar los cambios histopatológicos hepáticos y modificaciones macroscópicas y microscópicas causadas por la presencia de bolsas de plástico en los preestómagos del ganado. Para identificar este problema, se realizó un estudio en el matadero con un total de sesenta (60) animales, 44 machos y 16 hembras, seleccionados sin un proceso de selección previo. Tras el sacrificio, el vaciado y el lavado ruminal, se investigaron cuerpos extraños y lesiones macroscópicas. Se realizó un análisis histopatológico en muestras de hígado y rumen. El examen macroscópico de los preestómagos con bolsas de plástico reveló congestión, hemorragia, retraso del crecimiento, flacidez, atrofia y adelgazamiento de las papilas. Se observaron áreas de erosión y ulceración en los estómagos anteriores de todos los bovinos que albergaban una gran cantidad de bolsas de plástico. También se observaron ulceraciones y formaciones nodulares. Las paredes de los preestómagos eran más delgadas de lo normal, con una pared ligeramente moteada y papilas comprimidas. El examen microscópico reveló una amplia variedad de lesiones. Se observó destrucción, degeneración, necrosis, hiperplasia focal del epitelio queratinizado y, especialmente, lesiones por rupturas fragmentarias o segmentarias. Las papilas se encuentran atrofiadas, comprimidas, acortadas, plegadas y agrandadas; además, la longitud de los brotes se redujo. Estos cambios microscópicos pueden atribuirse a la presión ejercida sobre la pared ruminal y a la irritación mecánica inducida por la impactación del plástico o las sustancias químicas liberadas por estas bolsas. El examen microscópico del hígado de bovinos con bolsas de plástico en el rumen no reveló la presencia de cambios histopatológicos. Las alteraciones patológicas identificadas influyeron en las manifestaciones clínicas y podrían alterar la absorción de nutrientes, comprometiendo la salud del animal y disminuyendo la producción y la reproducción.

Palabras clave: Cuerpo extraño; preestómagos; lesiones; hígado; histopatología

INTRODUCTION

Ingestion of plastic bags is common in ruminants, especially cattle (*Bos taurus*), due to their particular feeding and digestive behavior. However, adult cattle have a non-selective and non-discriminatory food prehension mode and a summary and rapid initial chewing that can lead to the ingestion of foreign bodies of a very varied nature [1], mainly non-food foreign bodies, which are most often non-biodegradable objects such as plastic bags. This is regarded as one of the most frequent reasons why ruminants develop digestive problems. The forestomachs becomes overloaded due to the presence of large quantities of plastic bags that accumulate over a long period [2]. This creates a barrier that impedes the transfer of forestomach contents into the following segments of the digestive tract, thereby causing digestive complications. These bags are commonly found lodged in the forestomach, invading the ruminal area and interfering with the animal's normal physiological operations [3].

Clinical symptoms of plastic bag accumulation in the forestomachs include emaciation, anorexia, weight loss, frothy salivation, abdominal distension and asymmetry, lack of rectum excretion, and a tendency for the animal to lie down [4].

Many varied macroscopic lesions, including hemorrhage, congestion, sagging, stunting, atrophy and thinning papillae, were found in the stomachs inspected during the abattoir survey [5]. Ulceration and erosion were observed in the forestomachs of all cattle that contained a significant amount of plastic bags. Scars and nodular lesions were also present [6].

The forestomachs wall was thinner than normal and had a light and marbled appearance and compressed papillae. Microscopic sections of samples taken from the forestomachs containing plastic bags showed a wide variety of lesions [7].

Plastic bags are the most predominant indigestible materials found in the rumen of cattle at slaughter. However, macroscopic and microscopic changes in cattle due to plastic bags in the rumen-reticulum have not been previously evaluated as has been done for goats and sheep. The current study was aimed at evaluating the effects of ingestion of plastic bags on the forestomachs and liver tissue of cattle.

MATERIALS AND METHODS

Animals

The study was conducted on 60 cattle (44 males and 16 females) of different breeds and ages without any previous selection and apparently healthy. The animals slaughtered at the Batna Municipal Abattoir were raised in different locations of Batna City and other surrounding municipalities. Batna City is located in the eastern part of Algeria between 4° and 7° of eastern longitude and 35° and 36° of north latitude, with an area of 12,038.76 km². The region of Batna City is primarily situated within the physical framework established by the intersection of the Tellien and Saharan Atlases, which serves as a defining feature of the city and influences its climatic conditions. As a semi-arid area, it places considerable emphasis on livestock farming as a vital component of its agricultural practices [7, 8, 9].

Macroscopic examination

After the slaughtered animal was eviscerated, a visual inspection and palpation of the forestomachs were conducted to evaluate the shape and amount of foreign bodies (such as plastic bags) and to check for any visible lesions. The forestomachs were carefully washed to allow for a more detailed examination of the walls, mucosa, papillae, and pillars for any irregularities. Any macroscopic lesions found were documented with photographs identified and photographed with the smartphone Samsung Galaxy S22 (made in Malaysia).

Microscopic examination

Samples were collected from ten (10) animals from both areas with visible lesions in the forestomachs and areas without any apparent changes. Liver tissue samples, measuring 1 to 2 cm in thickness, were also taken at the same time and immediately fixed in 10% neutral buffered formalin. Five-micron sections were prepared and stained with hematoxylin and eosin, following the methods outlined by Bancroft and Stevens [10]. These sections were then examined under a light microscope (Optika B-350, Italy) [11, 12] using 40× and 100× objective lenses. The findings were documented, and photomicrographs were captured as needed using a photomicroscope (Leica DM1000 LED microscope, Olympus CXSF1, Olympus Corporation, Tokyo, Japan) [7].

RESULTS AND DISCUSSION

This study demonstrated macroscopic and microscopic changes linked to the accumulation of plastic bags in the forestomach of cattle, but no histopathological alterations in the liver.

Macroscopic examination

The different types of foreign bodies found in the forestomach of animals during this study were very varied (21.66%). They most often consisted of household objects and packaging, such as pieces of cloth and leather, ropes, stones, nails, and wires of different lengths; however, plastic bags dominated (78.33%) (FIG. 1).

The examination of the forestomachs at the Batna slaughterhouse during this investigation showed that the animals' reticulum-rumen wall had macroscopic lesions resulting from ingestion of plastic bags. Several distinct macroscopic lesions, including hemorrhages and congestion, papillae thinning, shrinking, bending, and atrophy like shown in FIG. 2a. Erosion and ulceration areas



FIGURE 1. Different undigested foreign bodies were found in the forestomachs of cattle after slaughtering. 1a: Plastic material from the rumen. 1b: Mixed undigestible foreign bodies (plastics, ropes, and plastic bags)

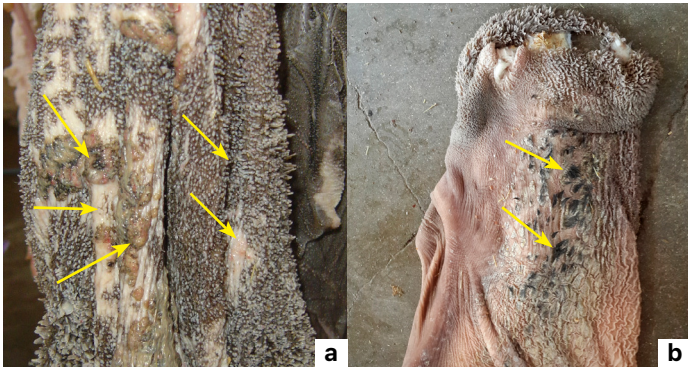


FIGURE 2. Necropsy findings of affected rumen show stunted and sloughed ruminal papillae (2a), nodular elevation, and necrotic areas (2b)

have additionally been noted in every cattle's forestomach, which is harboring a sizable amount of plastic bags. Lesions with nodules, necrotic areas, and scars were visible as well (FIG. 2b).

The rumen–reticulum's wall was thinner than normal and had a light, marbled appearance and compressed papillae, with growth retardation, curvature of papillae, irritation of rumen papillae, and desquamation of rumen papillae (FIG. 3a, 3b).

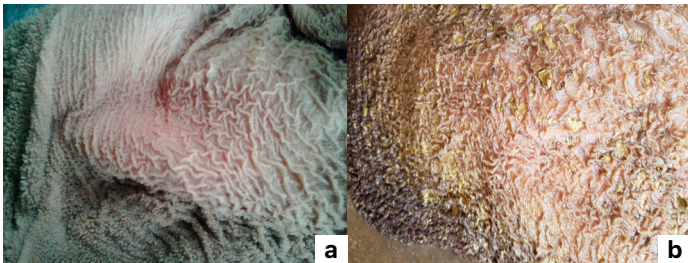


FIGURE 3. Stunting, bending of papillae (3a), irritation of rumen papillae, desquamation of ruminal papillae (3b)

Microscopic examination

Histological sections of samples taken from the forestomach containing plastic bags (FIG. 4) showed a wide variety of lesions. Lesions of fragmentary or segmental ruptures, destruction, necrosis, degeneration and focal hyperplasia (or even metaplasia) of the keratinized epithelium were observed (4a). The papillae are compressed, atrophied, enlarged, shortened, folded and the papillae length was reduced (4b, 4c).

Histological sections of the liver of cattle with a foreign body in the forestomachs also show normal architecture of the hepatic parenchyma and do not reveal any microscopic lesions, as shown in the (FIG. 5).

This investigation revealed that plastic waste is the primary type of foreign body commonly observed in the forestomachs of cattle (FIG. 1). This finding agrees with Kahn *et al.* [13] who reported that the major portion of foreign bodies found in the rumen of buffaloes is plastic waste. Singh [2] showed that 95% of urban

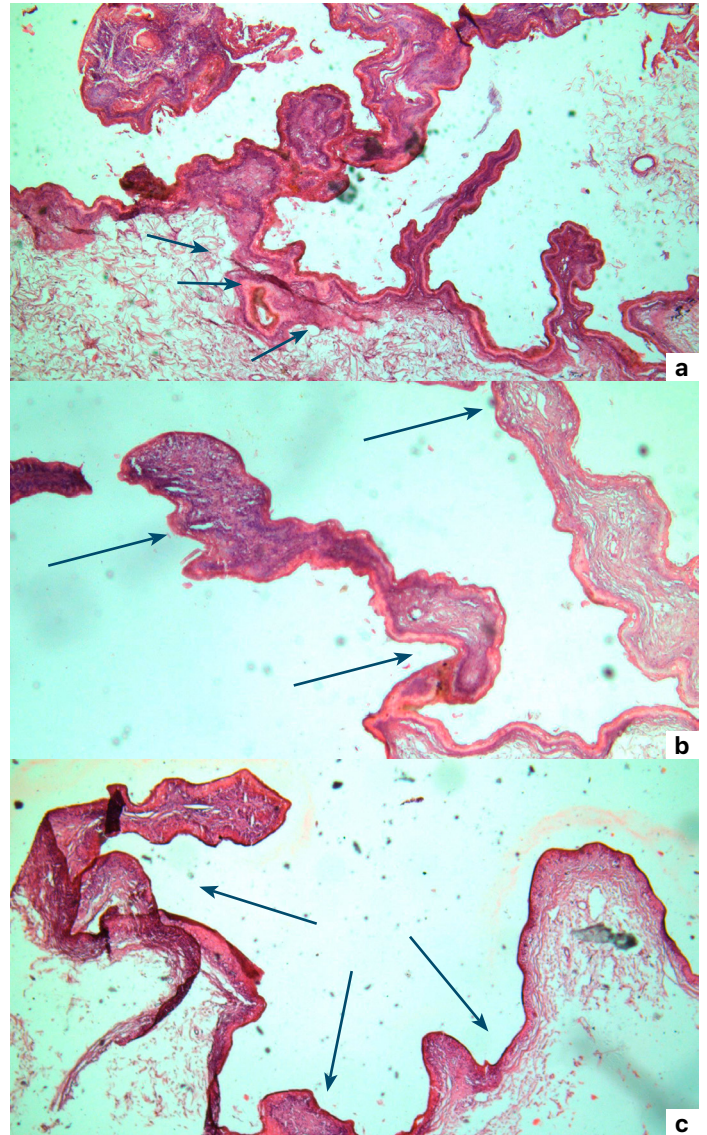


FIGURE 4. Irregular, disrupted epithelium (4a) and flattened papillae (4b) atrophied and destroyed papillae (4c) (H&E, 400×)

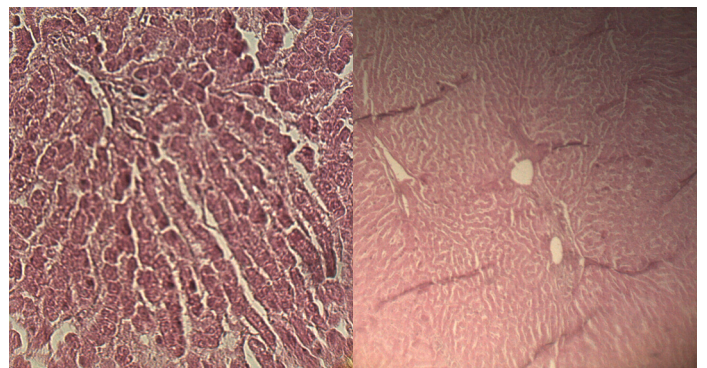


FIGURE 5. Liver parenchyma and trabeculae in cattle with plastic bags in the forestomachs (H&E, 40× and 100×)

stray cattle in India suffer from various affections due to foreign materials in their reticulum–rumen, 90% of which are plastic bags. He attributed this to the materials used for waste storage, shopping bags and food items that are ingested by free–grazing animals, especially in cities and towns.

Bakhiet [12], also noted that plastic bags are the most frequently encountered foreign bodies in ruminants in Sudan, and cleaning the environment would significantly reduce foreign body syndrome. Tiruneh and Yesuwork [14] also came to the same conclusion.

Multiple and varied macroscopic lesions, including congestion, hemorrhage, stunting, sagging, atrophy, and a reduction in papillary thickness, were observed. Moreover, ulceration and erosion were noted in the rumen–reticulum of all cattle that had ingested a considerable amount of plastic bags, as shown in (FIG. 2). Nodular lesions and scars were also present. The forestomach wall was thinner than normal and had a light, mottled appearance and compressed papillae (FIG. 3). These lesions can be attributed to the persistent irritation of the rumen–reticulum wall, which results from the pressure applied by the continuous movement of the plastic bags, a consequence of their substantial volume and weight. They would most often cause compressive, obstructive or downright abrasive actions.

This process leads to the erosion of papillae and the rumen mucosa, particularly at the rumen pillars, accompanied by hyperplastic alterations in the epithelial mucosa and the presence of inflammation. It is also possible that some lesions could result from chronic frictional micro–trauma caused by the plastic bags, as reported by [7, 14].

Abdelaal and El–Maghawry [15], reported that the accumulation of plastic bags and other indigestible materials weighing 1.5 to 4.5 kg, mixed with rumen contents, resulted in partial occlusion of the rumen. Macroscopic examination showed that the physical effect of a relatively large weight of foreign bodies led to the stripping and stunting of the ruminal papillae.

The intensity of macroscopic changes was found to be proportional to the quantity of plastic substances detected in the rumens, which varied from a few small pieces (g) to 10 kg (FIG. 1). Singh [2], reported that animals suffering from ruminal impaction due to plastic bags exhibited pathological conditions such as impaction, indigestion, tympany, chemical leaching, traumatic reticulopericarditis, polybezoars, and immunosuppression. Kahn *et al.* [13] indicated that in some instances, the plastic materials were particularly stiff.

Tiruneh and Yesuwork, Abdelaal and El–Maghawry, and Calfee and Manning [14, 15, 16] suggest that the severity of the pathological changes is influenced by the characteristics of the foreign body, the duration it remains in the rumen, and the extent of obstruction it creates.

The microscopic examination of samples taken from the forestomachs containing plastic bags (FIG. 4) showed a wide variety of lesions. Lesions of fragmentary or segmental ruptures, destruction, necrosis, degeneration and focal hyperplasia (or even metaplasia) of the keratinized epithelium were observed. The papillae are shortened, atrophied, folded and compressed. The length of the papillae was reduced. The histopathological changes observed can be explained by the mechanical irritation produced

by plastic bags, along with the chemical compounds released from these non–biodegradable bodies [12, 17, 18].

According to Otsyina *et al.* [18], the ruminal mucosa of animals free from plastic foreign bodies exhibited fully developed and well–structured papillae of varying lengths; long, intermediate, and short. The stratified epithelial layer of the papillae appeared thin, continuous, and without any structural disruptions.

The mucosal surface was smooth and intact, showing no projections into the submucosa. The submucosal layer contained dense connective tissue with only a few lymphatic channels, while both the muscular and serosal layers appeared normal, showing no pathological alterations.

On the other hand, some authors have found that microscopic examination of the plastic–overloaded rumen revealed extensive or superficial coagulative necrotic lesions affecting the mucosa and submucosa, sometimes erosive and occasionally ulcerative [5, 11, 19, 20, 21]. Marked and inflammatory hyperemia with cellular infiltration mainly of neutrophilic granulocytes in the mucosa and sometimes extending into the submucosa. The presence of focal epithelial hyperplasia was significant, affecting the mucosal surfaces in multiple areas. This condition was characterized by finger–like projections of varying lengths that extended into the lamina propria and the submucosa beneath, with some reaching the muscularis.

Furthermore, several mitotic figures and cells with more than one nucleolus were observed in the hyperplastic regions. Most of the lesions observed in the present study are very close to those described by these different authors.

Histological sections of the liver of cattle with a foreign body in the forestomachs show a normal architecture of the hepatic parenchyma and do not reveal any microscopic lesions as shown in FIG. 5. Contrary to these results, Abu–Seida and Al–Abbadi [22] reported the presence of a necrotic center infiltrated by plasma cells, as well as the presence of macrophages and epithelioid cells.

Moreover, according to Costa de Sousa *et al.* [23] the histopathological evaluation of the liver showed that 85% of the hepatic parenchyma was impacted. The lesions were defined by a diffuse inflammatory response affecting the hepatocytes, with the presence of some discrete and clear vacuoles on the sides of the nucleus (lipid degeneration).

These modifications arise from the partial blockage of the reticulo–omasal orifice, which is due to the presence of a considerable quantity of foreign objects in the rumen. This condition restricts the flow of rumen contents through the reticulo–omasal orifice and diminishes the absorption of nutrients that are advantageous to the animal. As a result, this restriction causes a substantial mobilization of adipose tissue and, in turn, leads to an accumulation of triglycerides in the liver.

CONCLUSION

From the present study, it is concluded that the extent of overloading cattle stomachs with foreign bodies (plastic bags) is quite significant. Histological examination of the rumen wall showed several distinct tissue changes caused by mechanical

irritation induced by plastic bags. Histological sections of the liver of cattle with foreign bodies in the forestomachs did not reveal the presence of histological lesions. Despite the presence of different types of foreign bodies in the forestomachs, no animals were observed with symptoms of traumatic reticulo-pericarditis (or pericarditis), which is a common pathology in cattle.

Conflict of interest statement

None of the authors of the paper has any financial or personal relationships that could inappropriately influence or bias the content of the paper.

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