

Effects of extract from Castor oil seed on the Stomach of Adult Wistar Rats

Adesanya Olayioye¹, Odunayo J. Gbadegesin^{1,2} and Oladele A. Olaniran^{1,3}

¹Department of Crop and Environmental Protection, Faculty of Agricultural Science, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Oyo State, Nigeria

²Department of Crop Science, College of Plant of Science and Crop Production, Federal University of Agriculture and Technology Okeho, Oyo State, Nigeria

³Department of Crop Science, Faculty of Agriculture and Renewable Natural Resources, Federal University of Agriculture and Development Studies, Iragbiji, Osun State, Nigeria

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CORRESPONDING AUTHOR

Adesanya Olayioye

Department of Crop and Environmental Protection, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo State, Nigeria
aolayioye@lautech.edu.ng
+234-803-261-6191

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Abstract

Rats rank among the most destructive rodent pests, contaminating stored food grains, causing structural and properties damage and spreading diseases including Lassa fever to both humans and animals. Because rodenticides carry harmful environmental consequences, there's a clear need to explore alternative control methods that are less damaging to the ecosystem, supporting human safety and protecting food supplies. This study assessed the rodenticidal effects of castor oil seeds on rat stomach histology to control stored product rodent populations. Thirty albino rats (9-10 weeks old) were divided into three replicated groups, each with varying doses of Dichloromethane extract from castor seeds mixed with commercial rat feed. Thirty 9–10-week-old albino rats were divided into three replicated groups with five treatments in each replicate, housing two rats of both sexes per treatment. The rats had unlimited access to food and water. Castor oil seeds were crushed and soaked in Dichloromethane for 24 hours, then extracted and air-dried. The extract was mixed with rat feed in varying doses (200 mg/g, 400 mg/g, 600 mg/g and 800 mg/g of extract to feed) administered to the rats. A control group received only commercial rat feed. The results showed a slight increase in stomach weight (7.12 - 7.50 g) with increasing doses, but no significant difference compared to the control group (6.67). However, histological analysis revealed severe tissue damage in rats treated with the extract, indicating the potential of castor oil seed extract to induce stomach damage in living organisms.

Keywords: Albino rat, Castor oil seed, Dichloromethane extract, Gastric ulceration, Histology of stomach, Ricin poison

Introduction

Globally, rodents remain one of the major threats to stored food grains, with post harvest losses increasingly recognized as a critical challenge to national and global food security (Tadese & Ali 2021; FAO, 2023). Their wide geographic distribution and high population densities are largely driven by their flexible habitat preferences, behavioural plasticity, and strong ecological adaptability, which allow them to thrive in diverse storage environments (Ruscoe et al., 2022). Rodents are exceptionally prolific breeders, and storage structures offer nearly ideal conditions-ample food, stable microclimates, and shelter from natural predators that enable year round reproduction and rapid population growth (Prasad et al., 2025). Once established, they reduce both the quantity and quality of grain stocks through direct consumption, spoilage from spillage, and contamination with urine, faeces, hair, and even carcasses (Scobie et al., 2024; Doddabematti et al., 2025). Study estimates that rodents consume 8-15% of their body weight daily, and when combined with the grain they render inedible, total post harvest losses can be substantial (Prasad et al., 2025). Beyond grain damage, rodents compromise storage infrastructure by burrowing and gnawing on building foundations, walls, and packaging materials (Ahmed et al., 2021). Jute or polypropylene bags are fre-

quently torn, leading to grain spillage and further exposure to moisture, mould, and insects (Okori et al., 2022). Because contamination is nearly impossible to reverse, heavily infested lots are often rejected by procurement agencies and commercial buyers, resulting in significant economic losses for farmers and heightened food losses along the supply chain (Binge et al., 2023; Huitu et al., 2026). Effective rodent management in storage systems is therefore essential not only for protecting grain reserves but also for sustaining rural livelihoods and reducing food losses, the need for safer, more sustainable control methods become increasingly urgent, a key target under SDG 12.3 (Tutar et al., 2025).

The use of plants with pesticidal properties has long been a traditional practice among smallholder farmers across Africa and other parts of the world. Historically, these indigenous pest management strategies received little attention from the academic and scientific community. However, in recent years, there has been a paradigm shift, with growing recognition of the value embedded in local ecological knowledge. This renewed interest has spurred systematic research into the bioactive potential of various plant species for pest control (Saikumar et al., 2025; Soares et al., 2026).

Subsistence farmers, who often operate under severe financial constraints, stand to benefit considerably from botanical pesticides. Unlike synthetic alternatives, plant-based formulations can be prepared from locally available materials, reducing dependency on expensive imported inputs and enhancing farm self-sufficiency (Isman, 2020; Mkenda et al., 2022). Furthermore, a substantial body of evidence indicates that plant extracts are generally biodegradable, exhibit low mammalian toxicity, and pose fewer risks to non-target organisms and the environment compared to conventional synthetic chemicals (Saikumar et al., 2005; Acheuk et al., 2022). These attributes make botanical pesticides particularly attractive for integration into sustainable and climate-smart agricultural systems, especially in resource-limited settings (FAO, 2023; Oluseun et al., 2026). This experiment evaluated the rodenticidal potentials of castor bean seeds on rat stomach histology to control stored-product rodent populations.

Castor oil plant (*Ricinus communis*) seeds contain a complex phytochemical profile, with ricin as the primary bioactive compound (constituting 85–90% of extracted oil). While traditionally employed as a laxative, emerging evidence indicates significant dose-dependent effects on gastric mucosa, ranging from cytoprotection to ulcerogenic responses. In rodent

models, the stomach exhibits particular sensitivity to castor seed derivatives due to ricin dual action as a prostaglandin agonist and irritant to epithelial barriers (Abomughaid et al., 2024; Gupta & Sharma, 2024; Ramothloa et al., 2025). Castor oil administration is a well-established method to induce diarrhoea and study secretory mechanisms, but its direct effects on gastric integrity are contentious. Bari et al. (2021) observed that acute exposure to *Ricinus communis* extract triggered oxidative stress and histopathological alterations in the rat stomach, including erosion and neutrophil infiltration.

Acute administration of *R. communis* seed extract induces neutrophil infiltration, submucosal edema, and oxidative stress in Wistar rat stomachs, mediated by NF- κ B pathway activation and depletion of glutathione (GSH) reserves (Mendes et al., 2019). Conversely, Rincel et al. (2017), McQueen (2017), and Canivenc-Laviern & Bennetau-Pelissero (2023) recorded that low-dose ricin stimulated mucus secretion, potentially enhancing gastric barrier function. These paradoxical outcomes suggest dose-dependent and time-contingent actions, necessitating further mechanistic investigation.

Ricin works by blocking cell protein synthesis, which causes cell death and multiple organ failure (Audi et al., 2005). Furthermore, it is readily accessible, and its relative ease of extraction from the castor bean plant, as well as its stability in both hot and cold conditions (Schep et al., 2009),

Materials and Methods

The study was conducted at the Toxicology Laboratory, Department of Crop and Environmental Protection, Ladoke Akintola University of Technology (LAUTECH), Ogbomosho.

Animal and experimental design

National Institute of Health's Guide for the Care and Use of Laboratory Animals was followed throughout this investigation and the protocol for this investigation was approved by the Ethical Research Committee of the Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, Nigeria (ERC Approval Number: ERCFASLAUTECH: 017/01/2026). The experimental animals consisted of thirty 9 to 10-week-old albino rats of mixed sex, obtained from the Virology Department of the University College Hospital (UCH), Ibadan. The animals were housed in cages under standard laboratory conditions and provided with a commercial rat feed (Growers mash from Bova Jay Livestock Feeds). For the experimental

design, the rats were distributed into three replicate groups, with each group comprising five treatments housing two rats per each treatment.

Preparation of castor oil seed extract

Mature castor oil seeds were collected from the Botanical Garden of Ladoke Akintola University of Technology, Ogbomosho. A 1000 g sample of the seeds was crushed into a coarse meal and soaked in 2000 mL of Dichloromethane for 24 hours. The mixture was then filtered through a muslin cloth. The resulting Dichloromethane extract was left to air-dry completely. Dichloromethane extract from 1000 g of castor seeds dissolved in 2000 mL yielded **541 g**. For the experiment, four doses of the extract (200 mg/g, 400 mg/g, 600 mg/g and 800 mg/g of extract were each mixed thoroughly to commercial rat feed. A fifth group of plain commercial rats feed served as the control.

The groups were treated as follows:

1. Treatment I: 200 mg/g of extract to commercial rat feed
2. Treatment II: 400 mg/g of extract to commercial rat feed
3. Treatment III: 600 mg/g of extract to commercial rat feed
4. Treatment IV: 800 mg/g of extract to commercial rat feed
5. Treatment V (Control): 50 g commercial rat feed only

Each treatment was replicated three times and lasted for 5 days. The rats had unlimited access to food and fresh water daily. After sacrifice, the stomachs were removed, preserved in 10% neutral buffered formalin, and sent to the Histopathology Laboratory at the University of Ilorin Teaching Hospital for analysis. The photomicrographs of the tissue samples aimed to determine the effects of the castor oil seed extract and identify potential causes of death.

Histopathological examination - This process involves studying tissues microscopically to identify morphological changes. It examined the microanatomy of tissues, particularly those affected by injury or disease. The examination typically began with healthy tissue samples for comparison, followed by analysis of tissues from infected animals to identify infection-related changes

Data Collection

The following data were collected:

1. Body weight before treatment
2. Body weight (24 hours interval)
3. Stomach weight of treated rats
4. Stomach weight of untreated (control) rats

Data analyses

Data collected were subjected to analyses of variance (ANOVA) and mean were separated with Duncan Multiple Range Test (DMRT) at 5% level of probability using SPSS.

Results and Discussion

Impact of castor oil seed extract on the body weight and the stomach weight organ of the experimental rat.

The least body weight was recorded on the rats fed with the highest concentration of 600 mg/g extract of castor oil seed (Table 1). However, the rat fed with the control feed had the higher body weight when compared with 200 mg/g extract of castor oil seed, significant ($P < 0.05$) higher weight was recorded in rat fed with the control feed than the rats fed with 400 mg/g, 600 mg/g and 800 mg/g extract of castor oil seed. No significant difference was observed among the rat fed with 400 mg/g, 600 mg/g and 800 mg/g extract of castor oil seed irrespective of the concentration, and no significant difference was observed with the control group (Rats fed with the normal feed) and the rat fed with 200 mg/g extract of castor oil seed (Table 1).

At initial body weight measurement, all groups share the superscript letter “a” meaning indicating no significant difference among them at the start of the study but when compared with final body weight measurement of rats fed with 600 mg/g and 800 mg/g groups is about roughly the same as or even lower compared to their initial weight (e.g., 600 mg/g: 145.67 g → 144.38 g). This means that the control group gaining more weight while rats fed with 600 mg/g failed to gain weight coupled with physiological abnormalities like watery fluid of their faecal droppings (diarrhoea), dizziness, abdominal cramp and impaired vision, which were observed on rat fed with 600 mg/g and 800 mg/g Dichloromethane extract from castor oil seed over the study period. This is a strong sign of toxicity at higher doses.

There is a clear inverse dose-response relationship as the amount of castor oil seed extract increases from 0 g to 600 mg/g, body weight gain was reversed into weight loss. This strongly suggests the extract has a growth inhibiting or toxic effect that became more severe with increasing dose, up to 600 mg/g. (Table 1).

The stomach weights of all treated group fed with castor oil seed extract-treated feed showed no statistically significant difference including those fed with commercial rat feed only (control group). However, a minor increase in the stomach weight organ was observed in the extract-treated groups (400 mg/g – 800 mg/g castor oil seed extract) compared to those fed with commercial rat feed only (Table 1). This effect was more pronounced in the mid-dose (400 mg/g extract of castor oil seed) and highest-dose (800 mg/g extract of castor oil seed) groups, where the absolute stomach weight was a little bit increase ($p < 0.01$) than

both the control and low-dose groups (200 mg/g castor oil seed extract). The control group, which received only Commercial rats feed only showed no changes in stomach weight throughout the study. Note, no group carries superscript “b” alone, and no treatment level was isolated as statistically distinct only in the middle category rather superscript “b” only functions as a linking destination between the high weight superscript “a” and lower weight superscript “c” groups, this indicating a gradual, dose dependent decline in final body weight.

Table 1: Impact of castor oil seed extract on body weights and the stomach weight organ of the experimental rat.

Treatment	Initial body weight (g)	Final body weight (g)	Stomach weight (g)
Control	175.83 ± 27.915 ^a	218.18 ± 31.129 ^a	6.67 ± 1.329 ^a
200 mg/g	174.43 ± 24.851 ^a	199.16 ± 36.093 ^{ab}	7.12 ± 1.021 ^a
400 mg/g	160.17 ± 32.321 ^a	163.83 ± 39.491 ^{bc}	7.50 ± 1.262 ^a
600 mg/g	145.67 ± 22.831 ^a	144.38 ± 14.716 ^c	7.42 ± .475 ^a
800 mg/g	142.50 ± 22.634 ^a	152.43 ± 23.444 ^c	7.50 ± 1.049 ^a

Means followed by the same letters within the same column are not significantly different at $p \leq 0.05$,

Mortality of the Albino rats fed with Dichloromethane extract derived from castor oil seed

No rats died in either the control rats fed with commercial rat feed only or the rat fed with 200 mg/g Dichloromethane extracts group across all three replicates. Often pre-test shows no mortality in rats fed with commercial rat feed soaked in Dichloromethane after left to air-dry completely, meaning full survival in all. In the rat fed with 400 mg/g Dichloromethane extracts group, only a single death occurred and which was observed in Rep 3 at the 96 hours. The rat fed with 600 mg/g Dichloromethane extracts group recorded one mortality in each of the three replicates, though the timing differed (72 hours in Rep 1, 96 hours in Rep 2, and 96 hours in Rep 3 as well), bringing its total to three deaths. The rat fed with 800 mg/g Dichloromethane extracts group recorded heaviest losses, with at least one death in every replicate, and Rep 2 alone accounted for both of its rats dying, one at the 96-hour check and the other at 120 hours, leaving no survivors in that particular pair,

Histopathological analysis of tissue section of stomach of rats

Figure 1 show muscular layer (ML), the submucosa (SM), muscularis mucosae (MM), the glandular layer

(GL) as well as the gastric pit (GP). Features agree with healthy/ normal stomach histology. The severe mucosal erosion occurs at the muscular layer (ML). The ulceration also affects the lamina propria (LP) and the epithelial lining (EL). Features agree with minimal / mild damage of the stomach because of barely noticeable morphology, i.e. less than 5% changes were observed in tissues section (Figure 2). There is extensive necrosis of the muscularis external (ME) structure and submucosa (SM). Also, severe histological damage was observed, characterized by loss of glandular layer and distorted tissue architecture. Features are in keeping with complete necrosis of the stomach (Figure 3). The histological effects of castor oil seed on albino rat tissues shows lysis and there is enlargement of epithelia muscle (EM). The submucosa (SM), the muscularis mucosae (MM) were also damaged. There was ulceration / severe mucosal erosion at the gastric pit (GP). The gland of the mucosa was also affected changing epithelia structure. Implies loss of normal tissue architecture, typically affect above 50% of the section (Figure 4). Figure 5 shows the affected muscularis external (ME) and the muscularis mucosae (MM). There is total ulceration of lamina propria (LP) showing that the tissue section is marked above 50% of the section / very severe.

Table 2: Mortality of the Albino rats fed with Dichloromethane extract derived from castor oil seed

Treatment	Total rats	Total deaths	Survivors	Mortality rate
Control	6	0	6	0%
200 mg/g	6	0	6	0%
400 mg/g	6	1	5	~17%
600 mg/g	6	3	3	50%
800 mg/g	6	4	2	~67%

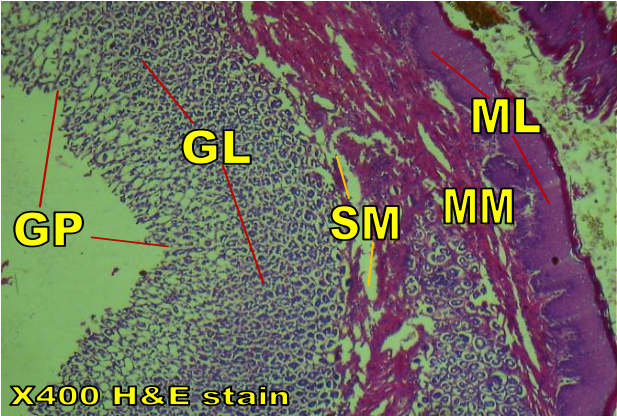


Figure 1: Microscopic image (X400 magnification, H&E stain) of a normal stomach tissue from an albino Wistar rat (control group)

LEGEND
ML - Muscular Layer
SM – Submucosa
MM – Muscularis mucosae
GL - Glandular Layer
GP - Gastric Pit
LP - Lamina propria
EL - Epithelial lining
ME - Muscularis external

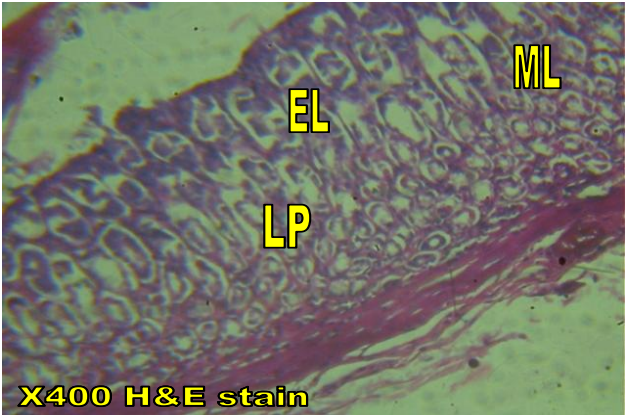


Figure 2: Microscopic image (X400 magnification, H&E stain) stomach tissue from an albino rat treated with 200 mg/g castor oil seed extract.



Figure 3: Microscopic image (X400 magnification, H&E stain) of stomach tissue from an albino rat treated with 400 mg/g castor oil seed extract.

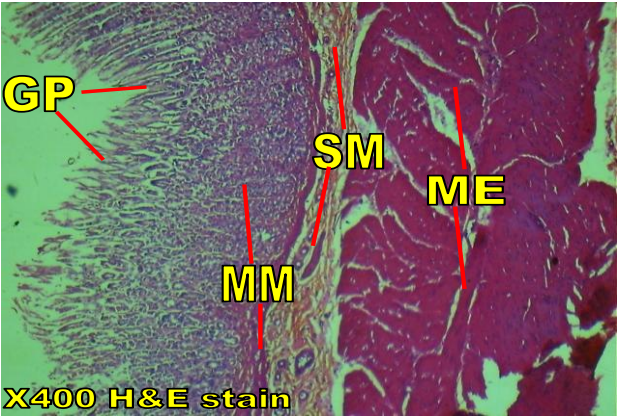


Figure 4: Microscopic image (X400 magnification, H&E stain) stomach tissue from an albino rat treated with 600 mg/g castor oil seed extract.

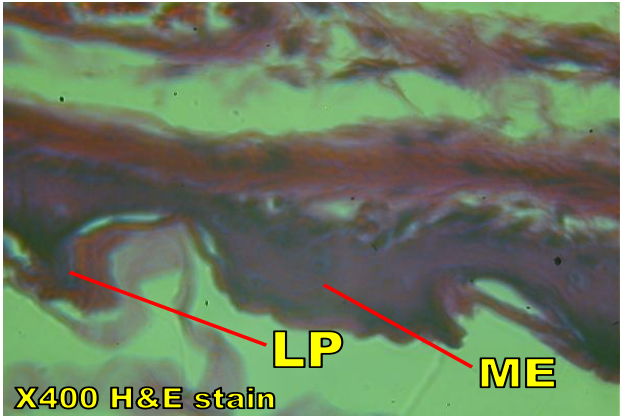


Figure 5: Microscopic image (X400 magnification, H&E of stain) of stomach tissue from an albino rat treated with 800 mg/g castor oil seed extract.

The observation revealed that the extract from castor oil seed caused decrease in the body weight of test rats compared to the control rats which were fed with normal feed ration. Response to decrease in weight depends on the level of concentration applied (Table 1).

This shows that the botanical pesticide toxicity as rodenticide like conventional pesticides depends majorly on the concentration. The data suggest that extract from castor oil seed has no significant effect on the stomach weight, however. The negative effect depends on the concentrations applied that is why rats fed with highest concentration of 600 mg/g and 800 mg/g has the least body weight (144.38 g and 152.43 g).

The stomach plays several critical roles in the digestive process. It continues the enzymatic breakdown of carbohydrates that began in the mouth with salivary amylase. Through vigorous muscular contractions and the secretion of hydrochloric acid (HCl), the stomach physically and chemically processes the ingested food into a semi-fluid substance called chyme. A key function is the initiation of protein digestion; the stomach lining releases pepsinogen, an inactive enzyme that transforms into pepsin when exposed to stomach acid. Pepsin then breaks down proteins into smaller peptides. Furthermore, the stomach contributes to fat digestion by secreting gastric lipase, which works in conjunction with lingual lipase from the mouth to begin the hydrolysis of triglycerides (Widmaier et al., 2022).

The marked elevation in both absolute and relative stomach mass is a well-established hallmark of toxic insult and pathology. This observed hypertrophy is pathological, resulting from severe irritation, inflammation, edema, and hemorrhage caused by ricin which is the principal toxic constituents of the castor oil seed extract (Polito et al., 2019; Stoll et al., 2023). The infiltration of inflammatory cells and associated edema are direct contributors to the increase in organ weight (Robbins et al., 2010). The fact that higher doses caused worse damage confirms that the castor oil seed extract was directly responsible for the gastric injury (Felter et al., 2021).

The histology of the normal stomach (control group) of Albino (wistar rats) show normal muscular layer, the submucosa, muscularis mucosae, the glandular layer as well as the gastric pit (Figure 1). The stomach shows extensive necrosis of the muscularis externa structure and submucosa. Also show glandular disruption in histological architecture as evidenced by loss of glandular layer (Figure 2 – 5). The findings of this

study demonstrate that oral administration of extract from castor oil seeds induces significant and dose-dependent pathological changes in the gastric mucosa of adult Wistar rats. The observed effects, including severe mucosal erosion, occurrence of lysis led to hemorrhage into the gastric lumen results in bloody stools, glandular disruption and necrotic cell death, provide a clear histopathological basis for the well-known purgative action of castor oil, which has traditionally been attributed primarily to its effects on the intestines. The primary mechanism underlying these gastric lesions is likely the local action of ricin, which is the main toxic protein in castor oil seed by pancreatic lipases in the duodenum (Tunaru et al., 2012). While its main cathartic effect is mediated through the activation of prostaglandin EP3 receptors in the intestinal smooth muscle, leading to vigorous peristalsis (Vieira et al., 2000). Our results suggest that even during gastric transit, ricin can directly injure the gastric mucosal blockage. This disruption compromises the mucosal layer's integrity, allowing back-spread of hydrogen ions (H⁺) from the gastric lumen into the mucosal tissue, leading to cellular injury, inflammation, and the observed erosions. This mechanism is consistent with the pathology induced by other irritants like ethanol and non-steroidal anti-inflammatory drugs (NSAIDs) (Doğan et al., 2026). The dose-response relationship observed in this study is critical. The low-dose group showed only mild erythema and slight inflammatory infiltration, indicating that the gastric mucosa possesses a certain capacity to tolerate mild irritants. However, as the dose increased, the defensive mechanisms were overwhelmed, leading to extensive hemorrhagic lesions and glandular atrophy in the high-dose group. This progression underscores the importance of dosage in the toxicity profile of castor oil. The significant increase in the ulcer index in the medium and high-dose groups aligns with findings from other studies that have used castor oil to induce gastropathy in experimental models (Edem et al., 2025).

In addition, the study findings indicate a clear dose-dependent increase in mortality rates among rats exposed to varying concentrations of dichloromethane extracts. While control rats and those receiving 200 mg/g of the extract showed full survival, higher doses led to increased mortality, with the 800 mg/g group experiencing the heaviest losses. This suggests that dichloromethane extracts can exhibit toxic effects in a dose dependent manner (Osano et al., 2016; kumara et al., 2024).

In summary, all test organs histologically showed castor oil seed extract caused lethal tissue damage in all treated rats, but no mortality was recorded in rats fed with lower doses of 200 mg/g and 400 mg/g while control group tissues appeared normal.

Conclusions

The results of this study provide compelling histopathological evidence that extract from *Ricinus communis* seeds exerts a direct damaging effect on the gastric mucosa of adult Wistar rats. The severity of erosion and lysis occur is directly proportional to protein synthesis-inhibiting action of ricin. This analysis underscores the critical effect of consuming castor seeds, and it serves as a stark morphological confirmation of the extract's potent gastro-toxicity. The gastropathy is primarily attributed to the irritant action of ricin poison on the gastric mucosal barrier.

Recommendation

Based on the findings of this study, the following recommendations are proposed:

- There is need to encourage the use of extract from castor oil seed in controlling rats by the farmers because of its relative advantages
- Locally made and readily available.
- No technicalities in application.
- It is cost effective.
- No effect on ecosystem.

Further research directions on safety and regulatory considerations

1. Field trials

Controlled field trials in actual grain storage facilities are recommended to validate laboratory findings under natural conditions, accounting for variables such as rodent species diversity, competing food sources,

2. Policy and extension support

Given the low-cost, locally-sourced nature of castor oil seeds, agricultural extension programs should consider promoting this botanical alternative to smallholder farmers as part of sustainable, low-toxicity rodent management. In Addition, educating farmers and storage managers on the toxic potential of castor seeds. Provide clear guidelines on safe preparation and handling of botanical pesticides.

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Ethical approval

The National Institute of Health's Guide for the Care and Use of Laboratory Animals was followed throughout this investigation and the protocol for this investigation was approved by the Ethical Research Committee of the Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, Nigeria (ERC Approval Number: ERCFASLAUTECH: 017/01/2026).

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