

Comparison of The Histology of Goblet Cells the Intestinal Mucosa Colon Induced by Cayenne Pepper at Doses of 45 mg, 90 mg, 135 mg, 180 mg

Sherly Usman

Department of Histology, Faculty of Medicine and Health Science, Universitas Muhammadiyah Yogyakarta

Received : 01 January 2026
Revised : 05 January 2026
Accepted : 10 January 2026
Published : 20 February 2026

Corresponding author*:
sherlyusman@umy.ac.id

DOI:
<https://doi.org/10.56127/ijml.v5i1.2604>

Abstract: This study aimed to analyze the effect of cayenne pepper (*Capsicum frutescens* L.) juice on the histological structure of colonic mucosal crypts and the number of goblet cells in Wistar rats. Cayenne pepper contains capsaicin, flavonoids, and vitamin C, which exhibit both pro-inflammatory and anti-inflammatory properties. Goblet cells play an essential role in maintaining intestinal homeostasis by producing mucin that protects the mucosa from inflammation. This quasi-experimental study employed a post-test only control group design using 20 male Wistar rats divided into one control group and four treatment groups receiving cayenne pepper juice at doses of 45 mg, 90 mg, 135 mg, and 180 mg daily for seven days. On day seven, the rats were terminated, and colon tissues were processed for histological examination using hematoxylin-eosin staining. Observations were conducted under 40× magnification to measure crypt length and count goblet cells. Data were analyzed using the Shapiro–Wilk normality test followed by one-way ANOVA. The results showed significant differences among groups ($p < 0.05$). The 90 mg group exhibited the shortest mean crypt length, while the 135 mg group had the lowest number of goblet cells, indicating greater mucosal damage. In contrast, the 180 mg group demonstrated the longest crypt length and highest goblet cell count, suggesting mucosal repair. These findings indicate that cayenne pepper induces dose-dependent effects on colonic mucosa, with higher doses potentially promoting mucosal regeneration.

Keywords: Cayenne Pepper Juice, Large Intestine, Crypts, Goblet Cells.

INTRODUCTION

Cayenne pepper is a food ingredient that is widely used by almost the entire population in the world, including Indonesia. Chili is a plant of the *Capsicum* genus which acts as the most widely used spice in the world. Chili is an important horticultural commodity in Indonesia which is consumed by the majority of the population regardless of social level. Indonesian people can be said to be the biggest chili fans in the world. According to data from the Central Statistics Agency (BPS), the average per capita chili consumption is 3.05 kg/capita. Indonesia needs 118,800 tons of chilies per year with a population of 237.6 million (2010 census). Many foods use cayenne pepper. Cayenne pepper in food causes a spicy sensation when consumed, but in some people this spicy taste sensation is felt to increase appetite (With this taste, cayenne pepper has become a popular food ingredient) [1]. The nutritional content of cayenne pepper is quite complete, namely fat, protein, carbohydrates, calcium, phosphorus, iron, vitamins A, B1, B2, C and alkaloid compounds such as capsaicin, flavonoids, oleoresin and essential oils [2]. Cayenne pepper contains capsaicin, vitamin A and vitamin C which function as antioxidants. Vitamin A also functions to reepithelialize the skin, and vitamin C functions to stimulate collagen synthesis. Based on previous research, it shows that the ingredients in cayenne pepper have 2 opposite effects, namely as a pro-inflammatory agent and at the same time as an anti-

inflammatory. This spicy and hot sensation causes an inflammatory effect on the gastric mucosal walls. Chili (*Capsicum annum L*) is a type of plant from the eggplant group with an average of 7.5% per protein, carbohydrate, calcium, phosphorus, iron, vitamins A, B1, B12, C and alkaloid compounds such as capsaicin oleoresin, flavonoids and essential oils. Capsaicin (8methyl-N-vanillyl-6- contains a special compound, namely capsaicin, which gives a hot, burning sensation when consumed [3]. The level of spiciness of chilies varies depending on the capsaicin content. Cayenne pepper contains nutrients, namely fat, In research conducted [4], [5], it was discovered that cayenne pepper at varying doses showed different levels of erosion of the gastric and large intestinal mucosa. This study will further examine the effects of damage to the mucosa of large intestine by looking at the cytological picture of the mucosal components as well as the structure of the crypts and goblet cells with a variety of higher dose levels. Goblet cells are one of the barrier components in the intestinal lining to maintain intestinal homeostasis [6]. Goblet cells produce mucus which plays a role in preventing direct contact between enterocytes and pathogenic microorganisms that trigger damage or inflammation. Inflammatory conditions can trigger changes in the structure of goblet cells and affect mucin production [7]. This research will add information regarding the mechanism of intestinal inflammation caused by cayenne pepper and will be useful in developing the management of digestive disorders. Cayenne pepper (*Capsicum frutescens L.*) has long been known as a cooking spice that provides a spicy taste to various dishes. Cayenne pepper production in Indonesia has increased over the last 5 years [8]. Antioxidants play a role in preventing more serious damage. beta karoten dan beta cryptoxanchin has the ability as an antioxidant that can overcome free radicals. Chilies generally contain carbohydrates, protein, fat, vitamins (vitamin B, vitamin C, and vitamin E), flavonoids, capsaicin, minerals, water, and fiber. Chili also contains antioxidant compounds including vitamin C, vitamin E, vitamin K, phytosterols, causes pain in the stomach [9]. The other side of the flavonoids and vitamin C in cayenne pepper Transient receptor potential vanilloid-1 (TRPV1) on blood vessel walls so that high economy because it is an export commodity and food industry. The national level of chili productivity over the last 5 years is around 6 tons/ha. The need for chilies in large cities in Indonesia with a population of one million or more is around 800,000 tonnes/year or 66,000 tonnes/month. Chili is used as a food flavoring and Capsaicin has the ability to irritate and cause a burning sensation in the affected tissue [4]. On the gastric mucosal wall, capsaicin is able to stimulate receptors.

RESEARCH METHOD

This research is an experimental research with a post test only control group research design. The research was carried out at the Integrated Research and Testing Institute (LPPT). Unit 4 UGM and in the Biomedical Building on the UMY medical faculty campus started in November until completed. This study used 20 adult Wistar rats, consisting of a control group (A) and a treatment group that were given a standard pellet diet for 6 days. The treatment group was divided into four groups, namely group B which was given cayenne pepper at a dose of 45mg/day, group C which was given cayenne pepper at a dose of 90mg/day, group D which was given cayenne pepper at a dose of 135mg/day, and group E which was given cayenne pepper. with a dose of 180mg/day. These five groups will be terminated simultaneously on the 7th day. The cayenne pepper used is fresh cayenne pepper which can be found in the market. Cayenne pepper that has been made into juice is given to test animals orally (nasogastric tube) at doses of 45 mg/day, 90 mg/day, 135 mg/day and 180 mg/day.

Animals All mice were acclimatized in the integrated research and testing institute (LPPT) building Unit IV of Gajah Mada University (UGM) in the environment for keeping experimental animals by giving them food and water. Cayenne pepper that has been made into juice is given to test animals orally (nasogastric tube) at doses of 45 mg/day, 90 mg/day, 135 mg/day and 180 mg/day. The room was set with certain conditions, namely a temperature of 25-30 C, humidity of 50-60%, and a light-dark cycle of 12 hours each. All treatment groups were given intervention by administering cayenne pepper juice with a gastric tube according to the dose for each group for 7 days in the integrated research and testing institute (LPPT) Unit IV UGM building. This study used 20 adult Wistar rats, consisting of a control group (K) and a treatment group that was given a standard pellet diet for 6 days. All experimental animals were treated with cayenne pepper juice according to their group division by administering it through a gastric tube. This activity was carried out in the Integrated Research and Testing (LPPT) Unit IV UGM building. Necropsy Animals try to be terminated using ether. Intestinal organs were removed by laying the rat on its back and cutting open the abdominal wall until the abdominal cavity was visible, then the intestinal organs were removed. The abdominal cavity is closed again. The intestinal organs that have been removed are cleaned with NaCl and placed in a container containing formalin solution. The clean intestinal organs were then fixed by spreading them over solid paraffin using a needle, and observing macroscopic mucosal damage. Assessment Macroscopic damage to the intestinal mucosa is assessed based on the appearance of changes in mucosal color, the presence of ulcer stains, or bleeding. After observing the level of mucosal damage macroscopically, the intestine was sliced transversely with a thickness of ± 1 cm. Mucosal slices were then processed for microscopic examination using a paraffin embedding procedure using HE staining. The crypt structure will be assessed for changes in crypt size, namely shortening if damaged. In goblet cells, the number of goblet cells will be assessed. Data in the form of quantitative data in the form of scoring data from microscopic observations. Data will be tested for normality using the Shapiro-Wilk test. If the data distribution is normal, then use parametric test analysis with two-way analysis of variance (two-way ANOVA). If the distribution of the data is not normal then use the non-parametric test using the Kruskal-Wallis non-parametric test.

RESULT AND DISCUSSION

The research entitled The Effect of Cayenne Pepper Juice on the Image of Cryptos and Goblet Cells of the Rat Colon Mucosa, began with the stage of obtaining a research ethical permit at the Health Research Ethics Committee (KEPK) of the Faculty of Medicine and Health Sciences, UMY with the issuance of a certificate of ethical suitability on May 10 2024. Stages Next, prepare the test animals using 20 male white rats (*Rattus Norvegicus*) with an average weight of 200-250 grams, aged 3-4 months, divided into 5 groups consisting of 1 control group and 4 treatment groups (table 1).

Table 1. Treatment Groups

No.	Group	Treatment
1	K	Standard feed and drink
2	C45	Cayenne pepper 45 mg, standard feed, and drink
3	C90	Cayenne pepper 90 mg, standard feed, and drink
4	C135	Cayenne pepper 135 mg, standard feed, and drink
5	C180	Cayenne pepper 180 mg, standard feed, and drink

The test animals went through the stages of adapting to the rearing environment in the test animal cage of the FKIK UMY biomedical building for 7 days. The next stage begins the treatment process for 7 days by giving standard food and drink to the control group as well as cayenne pepper juice according to the dosage and distribution in table 1 via a gastric probe. After the treatment stage is complete, it continues with the termination process for all groups and the process of taking large intestine organs for the process of making histological preparations. From the results of microscopic observations of the colon mucosa with a light microscope with 40x magnification (figure 3), the results of the average number of goblet cells and crypt length for each group were obtained according to table 2 and table 3.

Table 2. Mean Result Goblet Cells
Number of Goblet Cells

Number of Goblet Cells	Kelompok		Statistic
	Control	Mean	
Std. Deviation			13.12065
45mg	Mean		34.9167
	Std. Deviation		6.48717
90mg	Mean		27.1667
	Std. Deviation		6.88653
135mg	Mean		20.2500
	Std. Deviation		6.86394
180mg	Mean		41.4167
	Std. Deviation		10.45734

Table 3. Crypt Length For Each Group
Crypt Length

Crypt Length (x10 ⁴ um)	Group		Statistic
	Control	Mean	
Std. Deviation			10.01665
45mg	Mean		43.4167
	Std. Deviation		7.54933
90mg	Mean		39.7500
	Std. Deviation		8.61421
135mg	Mean		44.9167
	Std. Deviation		8.38243
180mg	Mean		62.5000
	Std. Deviation		11.53256

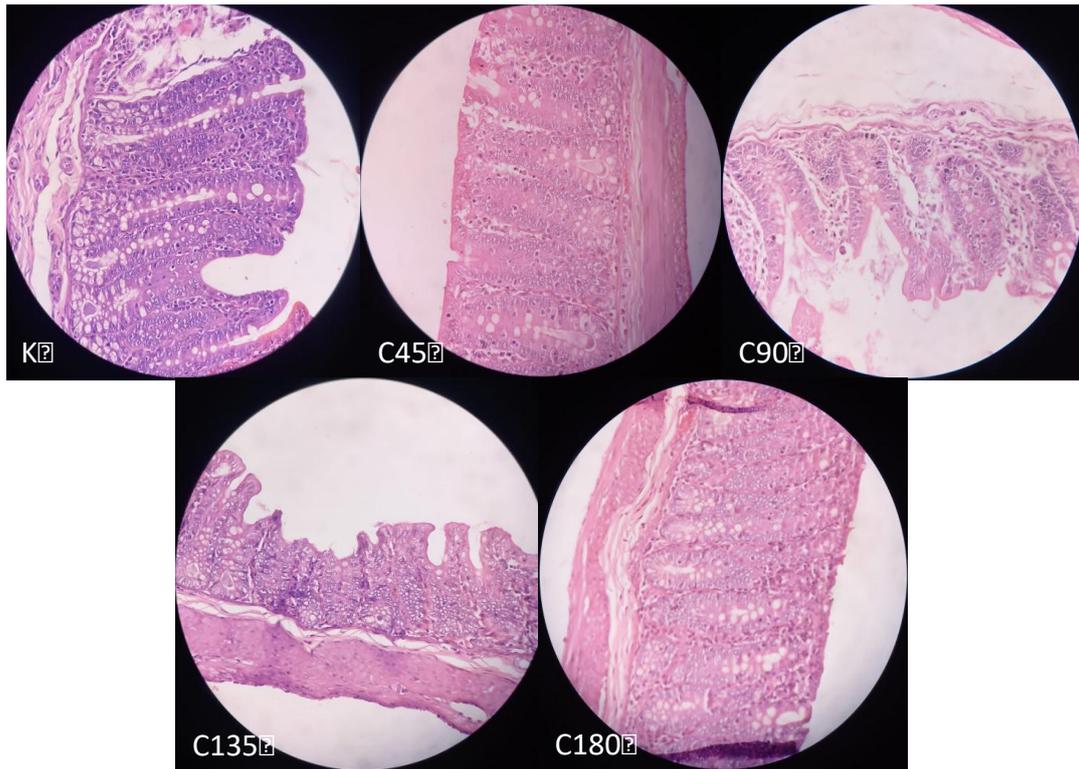


Figure 3. Microscopic Image of Intestinal Mucosa; K. Control group, C45. Cayenne pepper dose 45mg, C.90. Cayenne pepper dose 90mg, C.135. Cayenne pepper dose 135mg. C.180 Cayenne pepper dose 180mg

The results obtained are in line with research which states that colon mucosa that is inflamed will experience functional disruption of goblet cells and changes in the normal structure of colon mucosal crypts [10]. Goblet cells are structures in the intestinal mucosa layer that play a role in producing mucin. The mucin produced is able to prevent bacterial invasion which causes a continuous inflammatory process. The inflammatory process of the large mucosa will cause various forms of damage, including erosion and desquamation processes to ulceration of the large intestinal mucosa. In the mucosal crypts of the large intestine that undergo changes, their size will shorten due to the occurrence of scar tissue due to the continuing process of inflammation. From the results of this study, the C180 group had the highest number of goblet cells and the longest crypt length compared to the other groups, so it can be seen that the process of repair of the colon mucosa occurred in the group given a dose of 180 mg of cayenne pepper.

The repair of the colon mucosa that occurred in the C.180 group is in accordance with Sherly Usman's 2022 research which states that the mucosal repair process occurs as part of from the stages of the inflammatory process. The inflammatory process is divided into inflammatory, proliferative and remodeling. In the proliferation phase, the healing process occurs, characterized by formation new connective tissue produced by fibroblasts [11]. Formation of collagen and epithelial cells regenerates new tissue to repair the mucosal layer. This mucosal repair process can also be done induced due to the presence of vitamin C [12] and cayenne pepper as an antioxidant and anti-inflammatory. The vitamin C content in 100 grams of cayenne pepper reaches 125 mg. As for from Previous research shows that vitamin C compounds provide antioxidant effects on 0.0313 mg cayenne pepper preparation. Based on this, it can be assumed that the cayenne pepper content of 180 mg in this study provides a vitamin C content of 0.225 mg and is thought to be able to provided

an antioxidant effect on mucosal erosion that occurred in the C180 group in this study. Another ingredient, namely flavonoids in cayenne pepper, is thought to play an inhibitory role accumulation of leukocytes in the inflammatory process and reducing the effects of acute inflammation. In the inflammatory process, leukocytes play a role in phagocytosis of microorganisms. Antioxidants from flavonoids and vitamin C are able to inhibit free radicals which trigger damage to cells normal. Free radicals in infectious and inflammatory processes cause cell incompetence in maintaining the cell defense system including the proliferation process for mucosal repair who are inflamed [13].

CONCLUSION

Administration of cayenne pepper triggers the effect of mucosal damage and at the same time the repair process of the colon mucosa. Mucosal damage began at doses of 45 mg, 90 mg, and was most severe at a dose of 130 mg of cayenne pepper, characterized by the minimum number of goblet cells. Improvement of the intestinal mucosa occurred when administering a dose of 180 mg cayenne pepper, which was characterized by the highest number of goblet cells and maximum long crypt structure. We would like to thank the Research and Innovation Institute of Muhammadiyah University of Yogyakarta for providing support in carrying out this research.

REFERENCES

- T. Bariroh and S. Siska, "The Effect of Chilli Extract on Gastroprotective Function in Male," *Indones. J. Pharm. Sci. Technol.*, vol. 8, no. 1, pp. 1–7, 2021.
- M. Dianawati and E. Sujitno, "Kajian berbagai varietas unggul terhadap serangan wereng batang coklat dan produksi padi di lahan sawah Kabupaten Garut, Jawa Barat," in *Prosiding Seminar Nasional Masyarakat Biodiversity Indonesia*, 2015, vol. 1, no. 14, pp. 868–873.
- N. Nurbaiti and D. Artileristiana, "Pengaruh Ekstrak Cabai Rawit (*Capsicum Frutescens* L) terhadap Jumlah Leukosit pada Tikus Putih Jantan," *Tunas Med. J. Kedokt. Kesehat.*, vol. 3, no. 4, 2016.
- P. Teng, C. Kairupan, and L. Loho, "Gambaran Histopatologi Lambung Tikus Wistar Yang Diberi Cabe Rawit (*Capsicum Frutescens*)," *J. e-Biomedik*, vol. 1, no. 3, pp. 1109–1113, 2013, doi: <https://doi.org/10.35790/ebm.v1i3.3268>.
- S. Usman, "DOSIS TERTINGGI PERLAKUAN JUS CABE RAWIT MENYEBABKAN TERJADINYA EROSI MUKOSA KOLON YANG LEBIH MINIMAL DIBANDING DOSIS PERLAKUAN YANG LEBIH RENDAH LAINNYA," *Biomedika*, vol. 14, no. 2, pp. 170–177.
- R. Nowarski *et al.*, "Epithelial IL-18 equilibrium controls barrier function in colitis," *Cell*, vol. 163, no. 6, pp. 1444–1456, 2015, doi: [doi:10.1016/j.cell.2015.10.072](https://doi.org/10.1016/j.cell.2015.10.072).
- G. M. H. Birchenough, M. E. V Johansson, J. K. Gustafsson, J. H. Bergström, and G. Hansson, "New developments in goblet cell mucus secretion and function," *Mucosal Immunol.*, vol. 8, no. 4, pp. 712–719, 2015, doi: [doi:10.1038/mi.2015.32](https://doi.org/10.1038/mi.2015.32).
- N. Gurnani, M. Gupta, R. Shrivastava, D. Mehta, and B. K. Mehta, "Effect of extraction methods on yield, phytochemical constituents, antibacterial and antifungal activity of *Capsicum frutescens* L," *Indian J. Nat. Prod. Resour.*, vol. 7, no. 1, pp. 32–39, 2016.
- J. Kusnadi, D. W. Andayani, E. Zubaidah, and E. L. Arumingtyas, "Ekstraksi senyawa bioaktif cabai rawit (*Capsicum frutescens* L.) menggunakan metode ekstraksi

- gelombang ultrasonik,” *J. Teknol. Pertan.*, vol. 20, no. 2, pp. 79–84, 2019.
- C. Chairani, F. Wahyuni, T. Tofrizal, and S. Salsabila, “STRUKTUR HISTOLOGI DAN JUMLAH SEL GOBLET PADA SEDIAAN HISTOPATOLOGIS RADANG USUS BESAR DENGAN PEWARNAAN HEMATOXYLIN-EOSIN (HE) DAN PERIODIC ACID-SCHIFF (PAS),” *Ensiklopedia J.*, vol. 4, no. 3, pp. 182–186, 2022.
- A. Ito, B. Iizuka, T. Omori, S. Nakamura, and K. Tokushige, “Development and improvement of simple colonic mucosal ulcer during treatment of severe ulcerative colitis with tacrolimus,” *Case Rep. Gastroenterol.*, vol. 11, no. 1, pp. 168–177, 2017.
- J. Jubahar, Y. Astuti, and N. Suharti, “Penetapan kadar vitamin C dari buah cabe rawit (*Capsicum frutescens* L.) dengan metode Kromatografi cair kinerja tinggi (KCKT),” *J. Farm. Higea*, vol. 7, no. 2, pp. 208–217, 2015.
- A. P. Lestari, A. Rosyid, and I. Wahyudin, “Aktivitas Ekstrak Daun Cabe Rawit (*Capsicum Frutescens* L.) terhadap Penghambatan Pertumbuhan Bakteri *Escherichia coli* Secara Invitro,” *J. Farm. Sains dan Prakt.*, vol. 1, no. 2, pp. 1–5, 2016.