**EAS Journal of Nutrition and Food Sciences**
*Abbreviated Key Title: EAS J Nutr Food Sci*
ISSN: 2663-1873 (Print) & ISSN: 2663-7308 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-6 | Issue-4 | Jul-Aug; 2024 | DOI: https://doi.org/10.36349/easjnfs.2024.v06i04.004

**Original Research Article**

# Effects of Red, Green and Black Pepper on Intestinal Motility and Post-Prandial Bicarbonate Concentration in Guinea Pigs

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**Article History**
Received: 14.06.2024
Accepted: 22.07.2024
Published: 12.08.2024

**Journal homepage:**
https://www.easpublisher.com

**Quick Response Code**

**Abstract:** Pepper is one of the most commonly used spices in most food cultures because of its many dietary and medicinal uses. The aim of the present study was to investigate and compare the effects of different varieties of pepper on intestinal motility and post-prandial serum bicarbonate concentration in guinea pigs. The study was carried out using 50 adult guinea pigs weighing 800-1000g, separated into groups of 5 each including group 1 which served as control. The experimental groups received respectively black, green and red pepper extracts in concentrations of 25mg/kg, 50mg/kg and 75mg/kg. For each experimental group, pepper was administered together with a mixture of Evans blue dye and Arabic gum and allowed for one hour. Each animal was thereafter, anesthetized and the intestines dissected out. For each animal, the total length of the intestine as well as the distance travelled by the test meal from the pyloric sphincter were measured and recorded. Intestinal transit was expressed as the percentage of the distance travelled by the test meal to the total length of the intestine. Concomitantly, blood samples were collected to determine the post-prandial bicarbonate concentration. The result showed that all three varieties of pepper caused significant rise in percentage intestinal transit (in 1hr) and by implication reduction in the intestinal transit time. However, a significant dose-dependent effect was observed in the groups receiving black and green pepper respectively but not in the red category. This suggests an inverse relationship between the concentrations of black and green pepper with the intestinal transit time. Pepper did not cause any significant change in the plasma post-prandial bicarbonate concentrations. Conclusively, the results suggest that black, green and red pepper respectively increased intestinal motility without possibly causing any significant effect on gastric acid secretion.

**Keyword:** Pepper, intestinal motility, post-prandial bicarbonate.



## INTRODUCTION

The characteristic 'hot' taste of pepper makes it a commonly consumed food spice globally. It has been used over the years for its enormous dietary and medicinal benefits [1, 2]. Although pepper exists in different forms, the red, green and black varieties are the most commonly consumed. However, amongst these three varieties, the preferred type will depend on individual, family and cultural choices. The primary bioactive substance in red and green pepper (*Capsisum annuum*) is capsaicin [3, 4] while that of black pepper (*piper nigrum*) is piperine [5-7]. These bioactive substances are responsible for the pungent taste of pepper and its biological effects including antioxidant [8, 9], anti-inflammatory and analgesic effects. Animal studies suggest that the bioactive constituents of pepper may improve memory and overall brain function, lower plasma cholesterol levels and improve the bioavailability of certain nutrients in the gut [10-12]. Pepper, either in its raw form or as a food spice has over the years gained acceptability in home care of persons with some gastrointestinal disorders. It can either be given to suit the stomach or discontinued as a means of management. The effect of pepper on gastric acidity and intestinal motility is not well established [13] but a few studies have shown that it may have laxative effect [1, 14]. The

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aim of the present study was to investigate and compare the effect of three varieties of pepper (red, green and black) on intestinal motility and post-prandial serum bicarbonate in guinea pigs. Due to the changing dietary patterns especially in the most urban settings, the prevalence of disorders of gastrointestinal transit and motility (including constipation and diarrheal diseases) is rising [15, 16]. The results of this study will be useful in the development of agents that have the capacity of modulating the activities of the gastrointestinal tract. Since pepper is a constituent of virtually every meal, results from this study will be useful in determining the type of pepper to be added as part of nutritional support for persons suffering from constipation, diarrheal diseases or other forms of gastrointestinal disorders.

## MATERIALS AND METHODS

This experiment was carried out at the animal house of the department of Human Physiology, University of Port Harcourt, Nigeria. The Three varieties of pepper fruit (black, green and red) used for the study were purchased from the mile 1 market, Port Harcourt, Rivers State, Nigeria and identified/authenticated in the Department of Plant Science and Biotechnology, University of Port Harcourt. Ethical approval for this study was obtained from the Research Ethics and management Committee of the University of Port Harcourt with approval number; UPH/CEREMAD/REC/MM81/035. The fruits were first chopped into tiny bits before sun-drying for a period of four weeks, after which they were grinded into powder with a mechanical grinding machine and prepared for extraction.

A total of 50 adult guinea pigs weighing 800-1000g were used. These animals were first acclimatized for one week and for the period they were maintained in standard conditions and allowed access to water and standard feeds *ad libitum*. The animals were separated into groups of 5 each as follows; The control group was given distilled water. The experimental groups were divided into three different categories according to the different varieties of pepper. That is Black, Green and Red categories with the respective colours inscribed on their skin. Each category comprised of three groups which respectively received pepper extracts in concentrations of 25mg/kg, 50mg/kg and 75mg/kg. After acclimatization, the guinea pigs were starved for 24 hours prior to the experiment.

For each experimental group, pepper was administered together with a mixture of Evans blue dye and Arabic gum using an oral gavage and allowed for one hour. Each animal was thereafter, anesthetized and the intestines dissected out; the total length of the intestine as well as the distance travelled by the test meal from the pyloric sphincter were measured and recorded. Intestinal transit was expressed as the percentage of the distance travelled by the test meal to the total length of the intestine. Concomitantly, blood samples were collected via cardiac puncture to determine the post-prandial bicarbonate concentration which is an indirect measure of gastric acidity in animals [17].

## RESULTS AND DISCUSSION

**Table 1: Percentage Intestinal transit in 1 hour following the administration different doses of three varieties of pepper**

| Group | Black pepper | Green pepper | Red pepper |
|---|---|---|---|
| Control | 40.98 ± 3.68 | 40.98 ± 3.68 | 40.98 ± 3.68 |
| 25mg/kg | 58.58 ± 4.12* | 66.61 ± 5.06* | 73.05 ± 6.91* |
| 50mg/kg | 60.51 ± 4.20* | 69.03 ± 5.42* | 59.68 ± 4.19* |
| 75mg/kg | 62.38 ± 3.66* | 73.36 ± 2.46* | 63.30 ± 2.58* |

Data are expressed as mean ± SEM. * Significantly higher compared with the control group.

All three concentrations of black, green and red pepper caused significant increases in the percentage intestinal transit (in 1hr) compared to their control group. For the black and green pepper, the increase in intestinal motility was in a dose-dependent fashion whereas that of red pepper did not follow a dose-dependent pattern.

**Table 2: Post-prandial bicarbonate concentration (mmol/l) following administration of different doses of black, green and red pepper**

| Group | Black pepper | Green pepper | Red pepper |
|---|---|---|---|
| Control | 29.60 ± 0.75 | 29.60 ± 0.75 | 29.60 ± 0.75 |
| 25mg/kg | 25.80 ± 1.59 | 27.20 ± 1.98 | 28.60 ± 3.28 |
| 50mg/kg | 24.20 ± 1.28 | 24.40 ± 1.43 | 25.80 ± 1.43 |
| 75mg/kg | 26.80 ± 1.98 | 27.60 ± 1.29 | 28.60 ± 1.63 |

No significant differences in post-prandial plasma bicarbonate concentrations were observed in the test groups compared to their control.

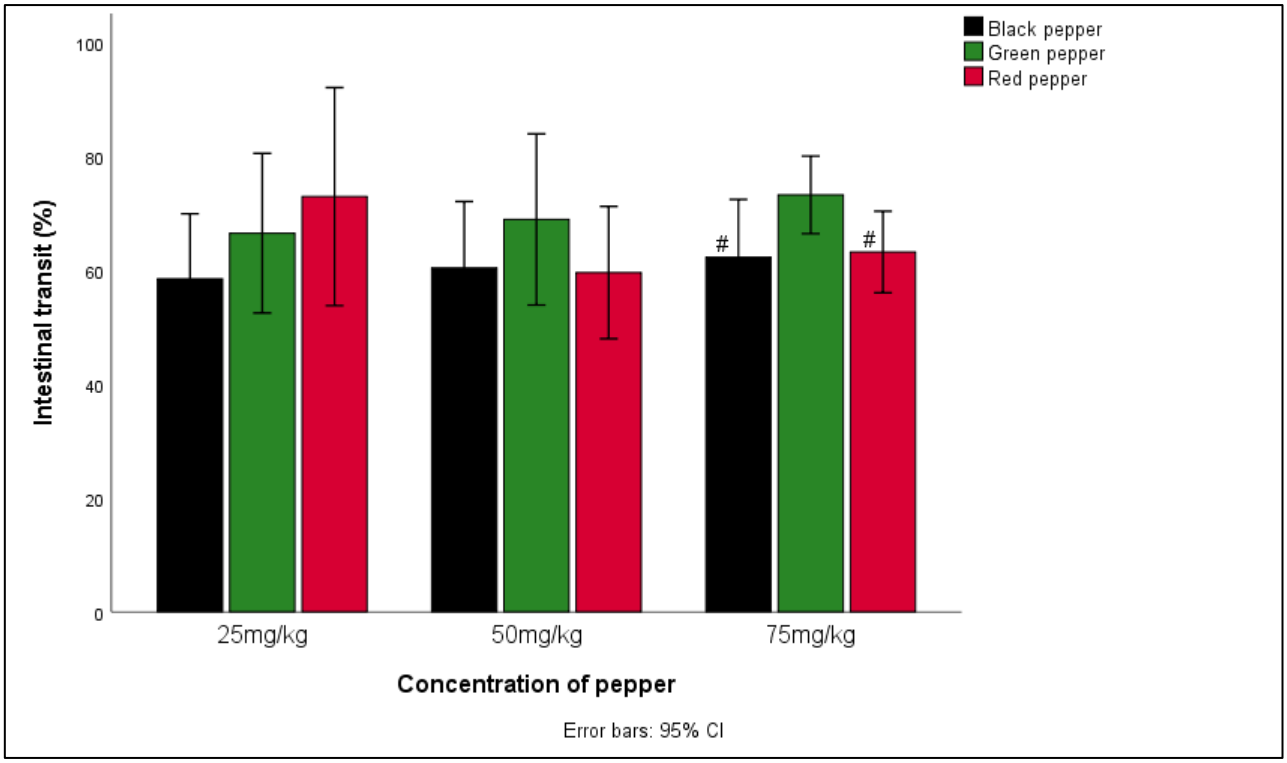


**Fig 1: Comparing the percentage intestinal transit in 1 hour in following administration of the three varieties of pepper**

[#] Significantly lower compared to green pepper (*Dunnett* t-test).

Comparing the percentage intestinal transit (in 1hr) using the three varieties of pepper at the 25mg/kg and 50mg/kg concentrations, no significant differences were observed in the animals that received black, green and red pepper. However, at 75mg/kg, green pepper had significantly higher intestinal transit compared to black and red pepper.

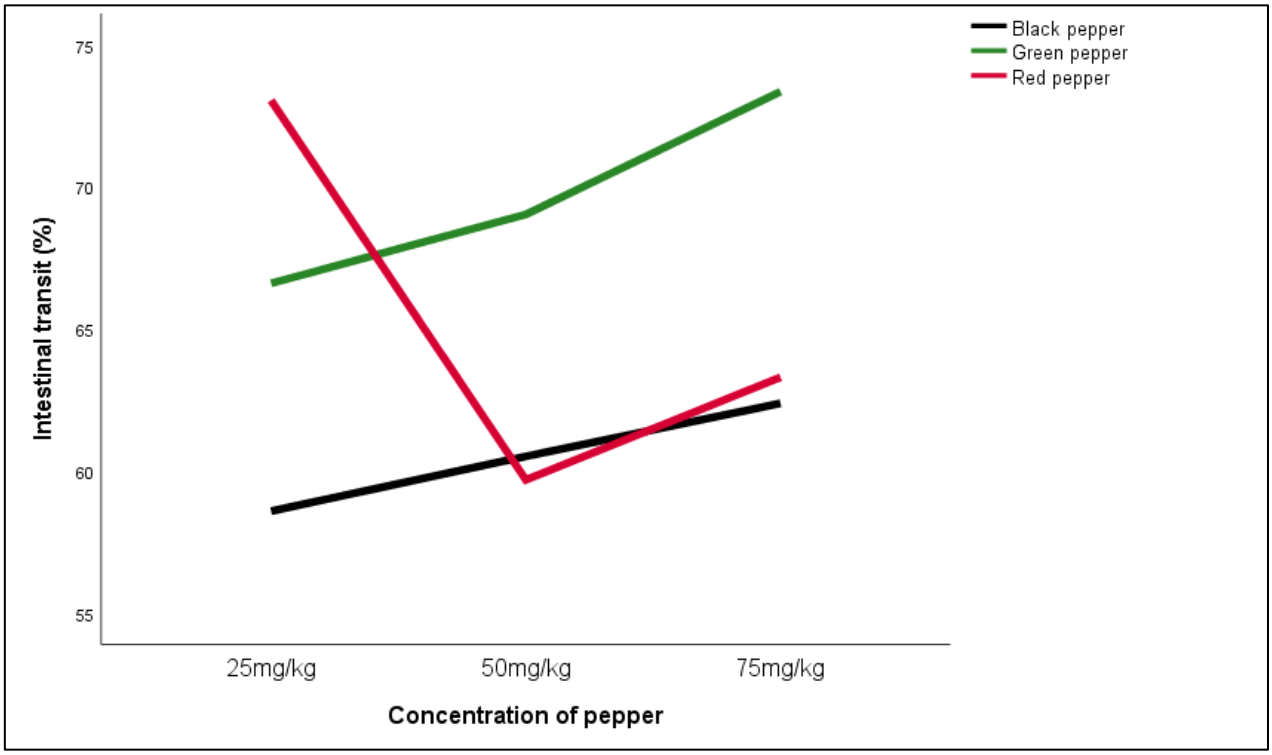


**Fig 2: Relationship between intestinal transit in 1 hr (%) and the concentration of pepper**

The present study showed that all three pepper varieties significantly increased intestinal transit, indicating that both capsaicin and piperine has significant effects on intestinal motility. Previous studies in human subjects suggests that capsaicin which is the active agent in both green and red pepper had profound effect on upper gastrointestinal motility and therefore facilitates secondary peristaltic contractility [18, 19]. This is probably possible by stimulation of capsaicin-sensitive afferents in the gastrointestinal tract [20]. Despite causing a significant dose-dependent increase in the intestinal transit of guinea pigs, the piperine content of black pepper has been shown in previous studies to improve the intestinal absorption of certain oral drugs and nutrients [21, 22] by stimulating both the pancreatic digestive enzymes and also the ultrastructure of the intestinal brush border [23]. This effect is essential in enhancing the bioavailability of orally administered substances especially in any emergency situation where parenteral administration is contraindicated or not available. There is a direct relationship between the concentrations of both the black and green pepper with their intestinal transit as shown in the present study, so that increasing the dosage of these pepper varieties increases intestinal transit and by implication reduces intestinal transit time. The present study could therefore suggest an inverse relationship between the concentrations of pepper (black and green) and intestinal transit time such that increasing the concentrations of these varieties will be associated with shorter intestinal transit time. The significant dose-dependent reduction in gastrointestinal transit time following administration of black and green pepper could be beneficial in the dietary management of persons with gastrointestinal disorders. Thus, increasing the dosage of these pepper varieties will further reduce intestinal transit time which could improve bowel opening in patients with constipation whereas reducing the dosages will increase the intestinal transit time and by implication reduce bowel opening which is beneficial in management of diarrheal diseases. The increase in intestinal transit following administration of red pepper was not dose-dependent so that increasing the dosage did not cause further change in the intestinal transit. Comparative assessment of the effects of the three varieties of pepper on intestinal transit showed that there were no significant differences following oral administration of 25mg/kg and 50mg/kg. However, with the 75mg/kg dose, green pepper had significantly higher intestinal transit compared to the black and red varieties. Therefore, in conditions where higher concentrations of pepper are required to reduce intestinal transit time, green pepper should be preferred over the black and red varieties.

In many cultures, people believed that gastric ulcerations are either caused by spices or worsened by these. This is still not very clear because some patients with gastric ulcerations would have their symptoms worsened when they consume pepper even moderately. It is well known that factors that either increase gastric acid secretion or reduce the amount of mucus in the stomach would worsen gastric ulcerations. Some studies have proven that pepper potentially suppressed gastric ulcers [24] even when the mechanism of action is yet unknown. Results of the present study showed that all three varieties of pepper did not cause any significant change in the plasma post-prandial bicarbonate concentrations (which is an indirect measure of gastric acidity). This study suggests that in persons with peptic ulceration, it is the intestinal motility (spasm) associated with consumption of pepper spices that triggers their ulcer pain and probably not increase in gastric acidity. Intense spasms associated with eating pepper has even been reported by a researcher to cause perforations in the stomach [25]. Conclusively, the results suggest that all three varieties of pepper increased intestinal motility without causing any possible significant effects on gastric acidity in guinea pigs.

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**Cite This Article:** Christian Charles, Onyebuchi Obia, Furo Dawari Emmanuel, Azubuike Ogba, Sunday Ogbu Ojeka (2024). Effects of Red, Green and Black Pepper on Intestinal Motility and Post-Prandial Bicarbonate Concentration in Guinea Pigs. *EAS J Nutr Food Sci*, *6*(4), 125-129.