Effect of Ginger on Lower Esophageal Sphincter Pressure

Supatra Lohsiriwat MD*, Mayurat Rukkiat BSc*,
Reawika Chaikomin MD, PhD*, Somchai Leelakusolvong MD**

** Department of Physiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand*
*** Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand*

Objective: *Ginger has been traditionally used to reduce intestinal gas and flatulence. The present study examined the effects of ginger on the esophagus and lower esophageal sphincter (LES) function by esophageal manometry.*
Study design: *A randomized controlled trial.*
Setting: *Departments of Physiology and Medicine, Faculty of Medicine Siriraj Hospital.*
Subjects: *Fourteen healthy young male volunteers.*
Material and Method: *The effect of ginger (1 gram of dried powder suspended in 100 ml water) on LES and esophageal peristalsis were studied by manometry in 14 healthy young men. Subjects drank 100 ml of water as a control, then performed five wet swallows at 30 minutes after the drink, followed by drinking a ginger suspension and performed five wet swallows at every 30 minutes thereafter for 180 minutes. The esophageal manometry was performed throughout 180 minutes after ginger consumption. The manometric parameters before and after water and ginger intake were compared.*
Results: *The present study showed that after 1 gram-ginger consumption, the LES resting pressures remained unchanged but the percent relaxation at swallowing was increased throughout the 180 minutes with statistical significance at 90, 150 and 180 minutes. The amplitude and duration of esophageal contraction were not changed, while the velocity of contraction waves was decreased at 30, 120, 150 and 180 minutes after the drinks.*
Conclusion: *Ginger did not affect LES pressure at rest or esophageal contractile amplitude and duration when swallowing, but caused more relaxation of the LES and decreased the esophageal contraction velocity, which may cause more chance of gastric gas expel or antiflatulant effect.*

Keywords: *Ginger, Zingiber officinale, Lower esophageal sphincter, Esophageal manometry, Wet swallowing, Dyspepsia*

J Med Assoc Thai 2010; 93 (3): 366-72
Full text. e-Journal: *http://www.mat.or.th/journal*

Ginger (*Zingiber officinale* Roscoe, Zingiberaceae) is a medicinal plant that has been traditionally used both as a popular food ingredient and a medicinal herb all over the world. Its multisystemic effects have been claimed and reviewed from time to time[1-10]. In recent years, clinical trials and research have shown that ginger can be used successfully in the treatment of a number of conditions, both gastrointestinal and non-gastrointestinal. Ginger has been used for a wide array of unrelated ailments such as arthritis, rheumatism, sprain, muscular ache, pain, sore throat, cramp, constipation, indigestion, vomiting, hypertension, dementia, fever, infection and helminthiasis[1]. The National Center for Complementary and Alternative Medicine (NCCAM) in United States has evaluated the results of available studies on ginger and classified them as "suggestive" (for short-term use of ginger in pregnant related nausea and vomiting), "mixed" (for nausea caused by motion sickness, chemotherapy, or surgery), and "unclear" (for treating rheumatoid arthritis, osteosrthritis, or joint and muscle pain)[4].

As a favorite food ingredient, ginger has long been widely used as a folk remedy in functional

Correspondence to: Lohsiriwat S, Department of Physiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand. Phone: 08-1427-9474, Fax: 0-2411-5009. E-mail: sislr@mahidol.ac.th

gastrointestinal disorders particularly dyspepsia[6], nausea and vomiting[11]. However, little is known about the physiological response of the upper gastrointestinal tract to ginger consumption. The present study examined the effects of ginger on the upper part of the gastrointestinal tract, the esophagus and lower esophagus sphincter function, by esophageal manometry technique.

Material and Method

Study subjects

The present study included fourteen healthy male volunteers aged 18-40 years, with no history of symptoms such as tachycardia, palpitation, nausea or skin rash after ginger consumption and no prior gastrointestinal surgery. Subjects with underlying medical conditions, heavy smokers (more than 20 cigarettes/day) or regular alcohol consumers (more than twice a week) were excluded. The present study protocol was approved by the Siriraj ethics committee for human experiment and a written informed consent was obtained from each subject.

Ginger powder

The ginger powder was prepared by a pharmacist from the Center of Applied Thai Traditional Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University. Briefly, dried ginger rhizomes were desiccated by 60 degree Celcius heat for 6-8 hours, chopped into small pieces, and then ground into powder. One gram of ginger powder was suspended in 100 ml of distilled water to be consumed by each subject.

Esophageal manometric equipments

Esophageal motility was recorded using an 8-channel hydraulically perfused manometric catheter system (Dent sleeve, Arndorfer Medical System, Greendale, WI, USA). The pressure tips were located at 5, 10, 15, 20, 25, 30, 35 and 40 cm from the distal end of the catheter. The catheter was then connected to the low compliance pneumohydraulic manometry system (Mui scientific, Mississauga, Ontario, Canada, serial No. MS4-2401). The pressure transducers were calibrated before introducing to each subject. A stationary MS-DOS computer served as the online display and retrieval system. The manometric data were analyzed both visually and semi-automatically.

Study protocol

The present study was performed as a cross-sectional placebo-controlled study, starting after an overnight fast. Each experiment consisted of three consecutive esophageal manometric recording periods with subjects in the recumbent position. The first period was performed before consumption of any solution, the second after water consumption lasting about 30-60 minutes, and the third with ginger suspension consumption lasting about 180 minutes. The lower esophageal sphincter (LES) pressure was studied using the slow pull-through technique.

Control before any solution drink

After 10 minutes of resting LES pressure recording, the subject did five wet-swallows (5 ml of water for each swallow) with LES pressure and esophageal waves recorded.

Consumption of water

The subject drank 100 ml of water at room temperature (approximately 25°C). LES pressure was continuously recorded for 30 minutes, then the subject did another five wet-swallows with LES pressure and esophageal waves recorded.

Consumption of ginger suspension

The subject drank a ginger suspension (1 gram of ginger powder suspended in 100 ml distilled water) at room temperature. The continuous LES pressure measurement was carried on for another 180 minutes. The subject did a set of five wet-swallows at 30, 60, 90 and 120 minutes after ginger consumption.

The recorded results were automatically transferred to a computer and the tracing displayed on the screen. After adjustment of the esophageal baseline, the pressures were analyzed for the LES relaxation and esophageal body peristalsis after swallowing. The pharyngeal wave was used as the onset of swallowing.

Perception of bloating, nausea, abdominal discomfort, hunger, and satiety were subjectively scored by each volunteer for totally nine episodes consisting of the time before water consumption, 30 minutes after water, before ginger 30, 60, 90, 120, 150 and 180 minutes after ginger consumption, using 10 centimeter visual analog scales.

Statistical analysis

Results were expressed as mean $\pm$ standard error of mean (SEM). Kolmogorov-Smirnov test was used to test the data distribution. Data relating to LES resting pressure, percent relaxation, amplitude, duration and velocity were evaluated, using analysis

of variance (ANOVA) with repeated measures (SPSS for windows 10.0). Statistical significance was set at p-value < 0.05.

Results

This present study evaluated the effect of drinking a 100 ml suspension, containing 1 g of dried fine ginger powder, on lower esophageal sphincter (LES) and esophageal body peristalsis measured by esophageal manometry. The average age of the 14 volunteers was 25.2 ± 1.9 (range 21 to 29) years and BMI 20.9 ± 1.8 (range 18.2 to 25.3) kg/m^2. The height of the volunteers was 163-174 cm and the pull-through technique revealed the location of LES at 41-49 cm from the incisors. Each volunteer drank 100 ml of water as a control. The mean temperature of control drink (distilled water) and ginger solution was 22 to 25 degree Celcius (Table 1).

The experiment demonstrated that drinking 100 ml of water caused no change in LES resting pressure compared to that before water consumption. The ginger consumption also caused no significant change in the LES resting pressures throughout the 3-hour period (Fig. 1), while the percentage of relaxation at swallowing was increased throughout the 180 minutes after ginger with a significantly statistical difference at 90, 150 and 180 minutes compared to those before ginger consumption (Fig. 2). Table 2 shows the LES resting pressure and percent LES relaxation after swallowing.

The amplitude and duration of esophageal body peristaltic waves did not show any significant change after ginger consumption (Table 3).

The velocity of esophageal body peristaltic waves was decreased with statistical significance at 30, 120, 150 and 180 minutes (Table 4, Fig. 3).

Sensation of bloating, nausea and discomfort were low throughout the experiment (0-2 out of 10). Sense of hunger was slightly increased during the latter half of the experiment (1-2 out of 10, increasing to 2-3 out of 10). Sense of satiety was minimal throughout the 4-hour experiment (0-1 out of 10).

Table 1. Characteristics of all male volunteers (n = 14) and LES location

Variable	Mean ± SD	Range
Age (yr)	25.21 ± 1.89	21-29
Weight (kg)	59.96 ± 6.47	51.6-73.1
Height (cm)	169.21 ± 4.34	163-174
BMI (kg/m^2)	20.92 ± 1.84	18.2-25.29
LES location (cm)	45.15 ± 2.38	41-49

BMI = body mass index, LES = lower esophageal sphincter

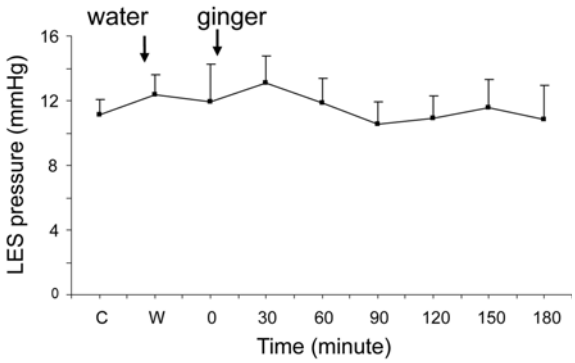

Fig. 1 LES resting pressures (mean ± SEM, n = 14) before and after water consumption, then ginger consumption and every 30 minutes until 180 minutes after ginger consumption. No statistically significant difference was found comparing the valves after to before each drink. (C = control, before water consumption, W = 30 minutes after water consumption, 0 = just before ginger consumption 30, 60, 90, 120, 150, 180 = minutes after ginger consumption)

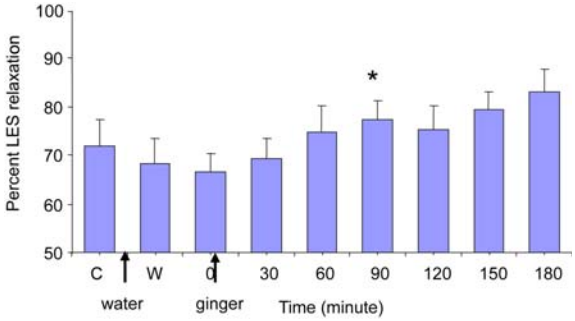

Fig. 2 The percentage of LES relaxation before and after water consumption, then ginger consumption and every 30 minutes until 180 minutes after ginger consumption. The percent relaxation was significantly increased at 90, 150 and 180 minutes after ginger consumption compared to the relaxation before the drink. (C = control, before water consumption, W = 30 minutes after water consumption, 0 = just before ginger consumption 30, 60, 90, 120, 150, 180 = minutes after ginger consumption, * = p < 0.05 when compared to zero time before ginger consumption)

Table 2. LES resting pressure and percent LES relaxation at swallowing (n = 14, mean ± SEM)

Time (min)	Resting pressure (mmHg)	p-value	Percent relaxation	p-value
C	11.12 ± 0.94	0.743	71.93 ± 5.28	0.309
W	12.40 ± 1.23	0.810	68.26 ± 5.09	0.725
	(p-value = 0.240)#		(p-value = 0.349)#	
0	11.91 ± 2.38		66.59 ± 3.84	
30	13.08 ± 1.66	0.355	69.25 ± 4.10	0.567
60	11.83 ± 1.55	0.969	74.68 ± 5.62	0.144
90	10.54 ± 1.37	0.468	77.27 ± 4.00	0.049*
120	10.93 ± 1.37	0.584	75.31 ± 4.78	0.092
150	11.56 ± 1.77	0.847	79.35 ± 3.75	0.007*
180	10.87 ± 2.09	0.583	82.96 ± 4.72	0.003*

(C = control, before water consumption, W = 30 minutes after water consumption, 0 = just before ginger consumption 30, 60, 90, 120, 150, 180 = minutes after ginger consumption, * = $p < 0.05$ when compared to zero time before ginger consumption, # = p-value comparing between after and before water consumption or W and C)

Table 3. The amplitude and duration of esophageal body peristaltic waves before and after ginger consumption (mean ± SEM, n = 14)

Time	Amplitude (mmHg)	p-value	Duration (second)	p-value
C	77.79 ± 7.93	0.413	3.01 ± 0.14	0.542
W	72.99 ± 6.85	0.972	3.04 ± 0.16	0.657
	(p-value = 0.258)#		(p-value = 0.804)#	
0	73.17 ± 7.48		3.11 ± 0.19	
30	70.46 ± 7.19	0.536	3.13 ± 0.17	0.906
60	65.64 ± 6.66	0.080	3.23 ± 0.18	0.448
90	66.56 ± 5.59	0.288	3.21 ± 0.17	0.607
120	69.50 ± 8.21	0.512	3.14 ± 0.21	0.874
150	70.66 ± 7.17	0.691	3.03 ± 0.18	0.663
180	70.34 ± 6.45	0.653	3.18 ± 0.17	0.751

(C = control, before water consumption, W = 30 minutes after water consumption, 0 = just before ginger consumption 30, 60, 90, 120, 150, 180 = minutes after ginger consumption, # = p value comparing between after and before water consumption or W and C)

Immediately after drinking 100 ml of 1 gram-ginger suspension, every subject reported a sense of chilly hot in the mouth, the pharynx and upper esophagus. This was subsided within 10-30 minutes. No symptom of heart burn was a complaint. All subjects tolerated the 4-5 hour experiment very well.

Discussion

This present study showed that after drinking 100 ml of 1 gram-ginger suspension, the percent relaxation of LES was increased at 90-180 minutes and the esophageal body peristaltic velocity was also increased, while no change in resting LES pressure or esophageal body peristaltic contraction amplitude and duration was found.

It is well known that ginger has a beneficial effect in people with dyspepsia, nausea and vomiting. In functional bowel disorders, ginger is also reported to be one of the most common complementary and alternative medicines[12]. Many scientists are interested in proving its effect and action on upper gastrointestinal motility. Ghayur et al reported that ginger not only had a direct cholinergic agonistic effect on the post-synaptic M3 receptors, but also produced a possible inhibitory effect on pre-synaptic muscarinic autoreceptors in rat stomach fundus strip preparation[13]. This

Table 4. The velocity of esophageal body peristalsis before and after ginger consumption (mean ± SEM, n = 14)

Time	Velocity (cm/sec)	p-value
C	3.01 ± 0.12	0.111
W	2.82 ± 0.14	0.036
	(p-value = 0.122)#	
0	3.47 ± 0.24	
30	2.71 ± 0.18	0.031*
60	2.88 ± 0.14	0.070
90	3.09 ± 0.32	0.310
120	2.76 ± 0.14	0.016*
150	2.85 ± 0.16	0.038*
180	2.85 ± 0.12	0.018*

(C = control, before water consumption, W = 30 minutes after water consumption, 0 = just before ginger consumption 30, 60, 90, 120, 150, 180 = minutes after ginger consumption, * = $p < 0.05$ when compared to zero time before ginger consumption, # = p value comparing between after and before water consumption or W and C)

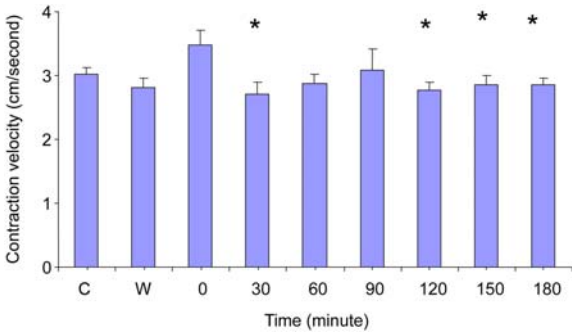

Fig. 3 After ginger consumption, the velocity of esophageal body peristaltic waves was decreased with statistical significance at 30, 120, 150 and 180 minutes. (C = control, before water consumption, W = 30 minutes after water consumption, 0 = just before ginger consumption 30, 60, 90, 120, 150, 180 = minutes after ginger consumption, * = $p < 0.05$ when compared to zero time before ginger consumption)

supports the prokinetic activity of ginger on proximal stomach in *in vitro* animal study.

In a human study, Wu et al found that 1,200 mg of encapsulated ginger accelerated gastric emptying and stimulated antral contraction in healthy males evaluated by ultrasonographic scanning[14]. In patients with chemotherapy-induced delayed nausea, high protein meals with ginger reduced nausea symptoms, minimized the requirement of antiemetic medications, and caused a significant decrease in gastric dysrhythmia when the gastric myoelectrical activity was recorded[15]. However, in another phase II trial of 1-2 gram encapsulated ginger as a treatment for chemotherapy-induced nausea and vomiting, Zick et al reported that ginger provided no additional benefit for reduction of the prevalence or severity of acute or delayed nausea and vomiting, when given with 5-HT3 receptor antagonists[16].

In the present study, 1 gram of ginger caused no change in resting LES pressure, so it should not bother those people with gastroesophageal reflux tendency. Meanwhile as the ginger solution induced more relaxation of the LES during swallowing, this would be beneficial to those people who have gaseous distension of the stomach as in dyspepsia, gastroparesis, and functional bowel disorders. The exact mechanism of ginger effect on smooth muscle relaxation remains to be examined. Buddhakala et al investigated the effects of ginger oil on rat myometrial contractility. They found that ginger oil is a potent inhibitor of phasic activity in rat uterus and could be via inhibition of L-type calcium channels[17].

Ginger has the potential to offer not only a cheaper natural alternative to conventional agents, but also one with significant lower side effects[1-2,11]. Regarding dyspepsia in childhood and adolescence, Parez and Youssef have suggested multidisciplinary approaches including dietary manipulation and use of nutraceuticals such as ginger[18].

In summary, the present study demonstrated that consumption of 1 gram dried ginger suspended in water can affect the LES function in healthy young males. It produced an increase in relaxation of the LES during swallowing without affecting the basal LES pressure. This evidence in humans supports the use of ginger in people with gaseous distension of the stomach as in dyspepsia, or gastroparesis. It also suggests that ginger may not do more harm to people with gastroesophageal reflux disorders.

Acknowledgements

The authors wish to thank the Center of Applied Thai Traditional Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, for supplying the ginger powder freshly prepared.

References

1. Ali BH, Blunden G, Tanira MO, Nemmar A. Some phytochemical, pharmacological and toxicological properties of ginger (Zingiber officinale Roscoe):

a review of recent research. Food Chem Toxicol 2008; 46: 409-20.
2. Nicoll R, Henein MY. Ginger (Zingiber officinale Roscoe): a hot remedy for cardiovascular disease? Int J Cardiol 2009; 131: 408-9.
3. Najm W, Lie D. Dietary supplements commonly used for prevention. Prim Care 2008; 35: 749-67.
4. Hoffman T. Ginger: an ancient remedy and modern miracle drug. Hawaii Med J 2007; 66: 326-7.
5. Imanishi N, Andoh T, Mantani N, Sakai S, Terasawa K, Shimada Y, et al. Macrophage-mediated inhibitory effect of Zingiber officinale Rosc, a traditional oriental herbal medicine, on the growth of influenza A/Aichi/2/68 virus. Am J Chin Med 2006; 34: 157-69.
6. Ghayur MN, Gilani AH. Pharmacological basis for the medicinal use of ginger in gastrointestinal disorders. Dig Dis Sci 2005; 50: 1889-97.
7. Ojewole JA. Analgesic, antiinflammatory and hypoglycaemic effects of ethanol extract of Zingiber officinale (Roscoe) rhizomes (Zingiberaceae) in mice and rats. Phytother Res 2006; 20: 764-72.
8. Mehrdad M, Messripour M, Ghobadipour M. The effect of ginger extract on blood urea nitrogen and creatinine in mice. Pak J Biol Sci 2007; 10: 2968-71.
9. Chen JC, Huang LJ, Wu SL, Kuo SC, Ho TY, Hsiang CY. Ginger and its bioactive component inhibit enterotoxigenic Escherichia coli heat-labile enterotoxin-induced diarrhea in mice. J Agric Food Chem 2007; 55: 8390-7.
10. Brown AC, Shah C, Liu J, Pham JT, Zhang JG, Jadus MR. Ginger's (Zingiber officinale Roscoe) inhibition of rat colonic adenocarcinoma cells proliferation and angiogenesis in vitro. Phytother Res 2009; 23: 640-5.
11. Chrubasik S, Pittler MH, Roufogalis BD. Zingiberis rhizoma: a comprehensive review on the ginger effect and efficacy profiles. Phytomedicine 2005; 12: 684-701.
12. van Tilburg MA, Palsson OS, Levy RL, Feld AD, Turner MJ, Drossman DA, et al. Complementary and alternative medicine use and cost in functional bowel disorders: a six month prospective study in a large HMO. BMC Complement Altern Med 2008; 8: 46.
13. Ghayur MN, Khan AH, Gilani AH. Ginger facilitates cholinergic activity possibly due to blockade of muscarinic autoreceptors in rat stomach fundus. Pak J Pharm Sci 2007; 20: 231-5.
14. Wu KL, Rayner CK, Chuah SK, Changchien CS, Lu SN, Chiu YC, et al. Effects of ginger on gastric emptying and motility in healthy humans. Eur J Gastroenterol Hepatol 2008; 20: 436-40.
15. Levine ME, Gillis MG, Koch SY, Voss AC, Stern RM, Koch KL. Protein and ginger for the treatment of chemotherapy-induced delayed nausea. J Altern Complement Med 2008; 14: 545-51.
16. Zick SM, Ruffin MT, Lee J, Normolle DP, Siden R, Alrawi S, et al. Phase II trial of encapsulated ginger as a treatment for chemotherapy-induced nausea and vomiting. Support Care Cancer 2009; 17: 563-72.
17. Buddhakala N, Talubmook C, Sriyotha P, Wray S, Kupittayanant S. Inhibitory effects of ginger oil on spontaneous and PGF2alpha-induced contraction of rat myometrium. Planta Med 2008; 74: 385-91.
18. Perez ME, Youssef NN. Dyspepsia in childhood and adolescence: insights and treatment considerations. Curr Gastroenterol Rep 2007; 9: 447-55.

ผลของขิงต่อความดันหูรูดอันล่างของหลอดอาหาร

สุพัตรา โล่ห์สิริวัฒน์, มยุรัตน์ รักเกียรติ์, เรวิกา ชัยโกมินทร์, สมชาย ลีลากุศลวงศ์

วัตถุประสงค์: *มีธรรมเนียมพื้นบ้านในการใช้ขิงเพื่อลดอาการท้องอืดแน่นท้องกันมานานแล้ว การศึกษาครั้งนี้ต้องการประเมินผลของขิงต่อการทำงานของหลอดอาหารและกล้ามเนื้อหูรูดอันล่างของหลอดอาหาร โดยวิธีวัดความดันภายในหลอดอาหาร*

วัสดุและวิธีการ: *ศึกษาในอาสาสมัครชายสุขภาพดี 14 คน ดูผลของการดื่มสารละลายของขิงผงแห้ง 1 กรัม ละลายในน้ำ 100 มิลลิลิตร ต่อการบีบตัวของหลอดอาหารที่วัดโดยวิธีวัดความดันภายในหลอดอาหารที่ตำแหน่งต่าง ๆ โดยเริ่มจากอาสาสมัครดื่มน้ำเปล่า 100 มิลลิลิตรก่อน เป็นเครื่องดื่มควบคุม บันทึกความดันในหลอดอาหาร 30 นาที แล้วจิบและกลืนน้ำ 5 ครั้งเพื่อดูการบีบตัวของหลอดอาหารและการคลายตัวของหูรูด แล้วจึงดื่มสารละลายขิง และกลืน 5 ครั้งทุก 30 นาทีนาน 180 นาที เปรียบเทียบค่าบันทึกต่าง ๆ ก่อนและหลังดื่มน้ำและดื่มน้ำขิง*

ผลการศึกษา: *หลังจากดื่มสารละลายขิง ความดันของหูรูดอันล่างของหลอดอาหารขณะพัก ไม่เปลี่ยนแปลง แต่เมื่อมีการกลืนจะมีการคลายตัวได้มากขึ้น ตลอด 180 นาที โดยมีความดันลดลงอย่างมีนัยสำคัญที่ 90, 150 และ 180 นาที ความแรงและช่วงเวลาของการบีบตัวของหลอดอาหารไม่เปลี่ยนแปลง ความเร็วของการบีบตัวลดลงที่เวลา 30, 120, 150 และ 180 นาทีหลังได้รับขิง*

สรุป: *ขิงไม่มีผลต่อความดันที่หูรูดอันล่างของหลอดอาหารขณะพัก และไม่มีผลต่อการบีบตัวของหลอดอาหารขณะกลืน แต่ทำให้หูรูดอันล่างของหลอดอาหารคลายตัวได้ดีขึ้นขณะกลืน พร้อมกับลดความเร็วในการบีบตัวของหลอดอาหาร ซึ่งบ่งชี้ว่าก๊าซในกระเพาะอาหารน่าจะย้อนกลับออกมาได้ง่ายขึ้นขณะกลืนหรือเรอ สนับสนุนฤทธิ์ขับลมของขิง*