Advances in Environmental Health Sciences and Toxicology (AEHST)

A publication of the University of Medical Sciences, Ondo City, Ondo State, Nigeria

URL: https://journals.unimed.edu.ng/index.php/JEMT/index

Vol. 1 No 1, September 2024, Pp. 1 - 10

PROXIMATE ANALYSIS AND MODULATORY EFFECTS OF GINGER-AND-HONEY DRINK ON GASTRIC EMPTYING AND GASTRIC ACID SECRETION IN MALE ALBINO RATS

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Submitted 25 January, 2024

Accepted 05 July, 2024

ABSTRACT

Background: It is known that using ginger and honey individually has contrasting effects on gastric emptying and residual volume. There have been few reports on the effects of products containing both ginger and honey on gastric functions and standard drugs relevant in gastric disorders.
Objectives: The study investigated the effect of ginger-and-honey drink (GHD) on gastric emptying and gastric acid secretion and its pharmacological interaction with standard drugs used in the management of gastric disorders.
Methods: Proximate analysis was carried out on ginger, GHD and honey using standard methods of the Association of Official Analytical Chemists. Physiological study was done in four experimental phases, The first phase examined GHD relative effect at optimal dose on gastric emptying , Groups I, II, III, IV, V, VI and VII were given distilled water, GHD (0.25 g/kg BW.), Ginger extract (0.25 g/kg BW), Honey (2.5 g/kg BW.), Honey (5 g/kg BW), Metoclopramide (1 mg/kg BW) and Loperamide (0.5 mg/kg BW) respectively. Phase two examined graded doses of GHD on gastric empying; Group I (10 ml/kg of distilled water), group II,III,IV and V received GHD in increasing dosages of 0.25, 0.50, 2.50 and 5 g/kg BW respectively. The next phase examined GHD and loperamide interaction with gastric emptying, Control group (0.25 g/kg of GHD). Group II received Loperamide (5 mg/kg BW) + ginger-and-honey drink (0.25 g/kg BW). Group III received loperamide (5 mg/kg). The last phase on gastric acid secretion has group I received normal saline (10 ml/kg BW), groups II, III, IV, V and VI received 2.5 g/kg honey, 0.25 g/kg GHD, 0.25 g/kg ginger extract, 5 mg/kg histamine, and 100 mg/kg cimetidine respectively.
Results: GHD contained carbohydrate, mineral contents, protein and fats in different proportions; ginger, GHD significantly increased gastric emptying. Also, ginger extract and GHD significantly enhanced gastric emptying, increased gastric acid secretion and interfered with the actions of the Loperamide.
Conclusion: The study shows that ginger-and-honey drink enhanced gastric emptying and gastric acid secretion and attenuated the inhibitory action of Loperamide on gastric emptying.

Keywords: Gastrointestinal Motility, Loperamide, Pharmacological Interaction, Gastric Disorders, Residual Volume

INTRODUCTION

Gastrointestinal ailments are a challenge to overall well-being of humans. Of particular interest are problems of constipation and indigestion, treatment of which may require use of drugs with the attendant challenges of side effects. Honey is a natural substance containing at least 181 components, primarily consisting of a supersaturated sugar solution with fructose (38%) and glucose (31%) as its main constituents (Alvarez-Suarez *et al*., 2013). The application of honey for prevention and treatment of gastrointestinal disorders such as peptic ulcers, gastritis (inflammation of stomach lining), and gastroenteritis (stomach and intestinal inflammation) has been reported (Ajibola *et al*., 2012; Almasaudi *et al*., 2016). It has been reported that consuming honey a few hours before surgery can increase residual gastric volume and prevent post-operative nausea and vomiting (Gumuskaya *et al.*, 2022). Furthermore, Shaaban *et al*. (2010) found that supplementing with honey has been shown to increase gastric emptying time in patients with protein-energy malnutrition. In both adult rats and humans, the rate of gastric emptying is influenced by dietary properties, such as caloric content and osmotic characteristics (Mackie *et al.* 2013).

On the other hand, Ginger (*Zingiber officinale*) has abeen utilized in the treatment of various diseases, particularly those impacting the digestive system (Shariatpanahi *et al*., 2010; Hu *et al*., 2011). It has long been a common household remedy for dyspepsia, flatulence, and diarrhea, and is also commonly used as a spice in foods. The pharmacological effects of ginger on the gastrointestinal tract, including the stimulation of gastrointestinal motility, have been widely documented (Nikkhah *et al*., 2018 Foshati *et al*., 2023). Ginger accelerated gastric emptying in healthy volunteers (Hu *et al.,* 2011) and in patients with dyspepsia (Wu *et al*., 2008). Ginger extract has also been demonstrated to reduce gastric residual volume in patients on mechanical ventilation in intensive care units (Arazberdi *et al*., 2013).

It is known however that using ginger and honey individually has contrasting effects on gastric emptying and residual volume. Ginger accelerates gastric emptying, thus reducing gastric residual volume, whereas honey slows down gastric emptying and increases residual volume (Mackie *et al.* 2013; Resk and Abulfadle, 2013). Also, gastric motility which leads to gastric emptying may be increased by gastric acid secretion but the role of in-take of Ginger-and-Honey Drink on gastric acid secretion is not known.

Ginger-and-honey drink may prove to be a useful natural agent capable of preventing or ameliorating constipation and indigestion if found to stimulate gastric emptying and gastric acid secretion. This would reduce the economic burden associated with cost of drugs and problems of drug side effects. With the evident-based knowledge and growing market for Ginger-and-Honey Drink in Nigeria, It was therefore imperative to investigate in this present study the proximate analysis and effects of Ginger-and-Honey Drink on gastric emptying and gastric acid secretion and its possible influence on the actions of standard drug used in the treatment of gastric disorders.

2.0 Materials and Methods

2.1 Experimental animal care

A total of 126 healthy male Sprague Dawley rats, weighing between 150g and 200g, were sourced from the Laboratory Animal Centre at the College of Medicine, University of Lagos, Lagos State, Nigeria. The animals were kept in clean plastic cages under a controlled environment with a 12-hour light/dark cycle at room temperature (25–27°C). All groups had free access to standard laboratory rat chow and water. All experimental procedures adhered to the guidelines established by the National Research Council (US) Committee for the Update of the Guide for the Care and Use of Laboratory Animals (2011).

Experimental design

The animals were used in the different phases of the study as follows. For the first phase of gastric emptying, forty-two (42) male rats were divided into seven groups of 6 rats per group. Group one (control) received distilled water (10 ml/kg BW.) orally. Group two received Ginger-and-honey drink (0.25 g/kg BW.) orally. Group three received Ginger extract (0.25 g/kg BW.) orally. Group four received Honey (2.5 g/kg BW.) orally. Group five was administered Honey (5g/kg BW.) orally. Group six received Metoclopramide (1 mg/kg BW) intra-peritoneally. Group seven received Loperamide (5 mg/kg BW.) orally.

The second phase investigated the effect of graded doses ginger-and-honey drink on gastric emptying. Thirty (30) male rats (150g-200g) randomly gathered in five groups (n=6/group). First group was given water orally with the aid of oral cannula (10 ml/kg) and considered as control and each of the other four (4) groups were treated with ginger-and-honey drink in increasing dosages of 0.25, 0.50, 2.50 and 0.5 g/kg BW. Maximum volume of extract administered to rats was kept below 2 ml.

The next phase which investigated the effect of ginger-and honey drink on loperamide actions has another set of eighteen (18) male rats divided into three groups (6 rats per group). Group I (Control) received 0.25 g/kg (BW) of ginger-and-honey drink.

Loperamide group received loperamide (5 mg/kg BW) orally. The Loperamide+GHD recieved Loperamide (5 mg/kg BW) then ginger-and-honey drink (0.25 g/kg BW) orally.

The last phase on gastric acid secretion studiee, thirty-six (36) male rats were divided into six groups (n=6) as well. control group received normal saline (10 ml/kg BW), groups two, three, four, five and six received 2.5 g/kg honey, 0.25 g/kg ginger-and-honey drink, 0.25 g/kg ginger extract, 5 mg/kg histamine, and 100 mg/kg cimetidine respectively.

Honey and Ginger-and-honey Drink

A bottle of natural honey and a pack of Ginger-and-honey drink were obtaine from a known and accredited Supermarket within the premises of College of Medicine, University of Lagos, Idi-Araba, Lagos, Nigeria and kept in cool dry place in Physiology Teaching Laboratory, Department of Physiology, College of Medicine, University of Lagos during the period of the experiment.

Preparation of Ginger Extract

Fresh ginger rhizomes were obtained from Ojuwoye Market, Mushin Local Government, Lagos State, Nigeria. The ginger was thoroughly washed under running water, the light outer skin of the rhizomes was peeled off, and the rhizomes were then cut into small pieces. The pieces of ginger were air-dried and ground to powder. The ground sample of ginger (500g) was soaked in methanol-water mixture (ratio 4:1) for 72 hours and filtered. The filtrate collected was then concentrated to dryness to obtain the crude extracts labeled as ginger extract. The 500 g of dried ginger rhizome yielded 74 g extract (14.8%).

Standard drugs

Loperamide (used for treating short-term diarrhea), Metoclopramide (used to relieve heartburn and promote the healing of ulcers and esophageal sores), Cimetidine (used to treat heartburn, stomach ulcers, reflux disease, and conditions causing excess stomach acid), and Histamine (which stimulates gastric gland secretion, leading to increased secretion of highly acidic gastric juice) were all purchased from a reputable pharmaceutical store in Lagos.

2.2 Proximate analysis

Standard methods of the Association of Official Analytical Chemists (*Official Methods of Analysis of AOAC INTERNATIONAL, 1999*) were used to determine the moisture, crude protein, crude fat, total ash and crude fibre contents of honey, ginger extract and ginger and-honey drink. The moisture content of each fresh sample was determined by heating 2.0 g in a crucible placed in an oven maintained at 105°C until a constant weight was achieved. The dry matter obtained was used for the subsequent analyses. Crude protein content (% total nitrogen × 6.25) was determined using the Kjeldahl method with 2.0 g samples. Crude fat was extracted from 5.0 g of each sample using a Soxhlet apparatus and petroleum ether (boiling point range 40-60°C) as the solvent. Ash content was determined by incinerating 10.0 g samples in a muffle furnace at 550°C for 5 hours. Crude fiber was obtained by digesting 2.0 g of sample with H_2SO_4 and NaOH, followed by incineration of the residue in a muffle furnace at 550°C for 5 hours. Each analysis was performed in triplicate.

2.3 Determination of Rate of Gastric Emptying

Rats were administered with distilled water, Ginger-and-honey drink, Ginger extract, Honey, Metoclopramide, and Loperamide depending on their group. Distilled water, Ginger-and-honey drink, Ginger extract, Honey and Loperamide were given by oral cannula while Metoclopramide was injected intraperitoneally. Each administration was given 1 hour. before the introduction of feeds. Measurement of percentage of gastric emptying was done by disemboweling method described by Rezk and Abdufadle (2013) and as modified in this study. Fasted rats after one hour of treatment were fed for one hour (30 minutes feeds and 30 minutes water). Then food and water were withdrawn. After another one hour, rats were sacrificed by applying blow on the head. A midline laparotomy was performed, and the stomach was excised, clamped at both ends, and weighed.

Then, the stomach was opened at the greater curvature, its contents were washed out with tap water, and then the gastric wall was weighed. The amount of food in the stomach (in grams) was determined by subtracting the weight of the empty stomach from the weight of the stomach with its contents. The amount of food ingested by the rats during a one-hour feeding period was calculated by subtracting the weight of the food container before feeding from its weight after one hour. Similarly, the amount of water consumed was measured before and after drinking, and each rat's water intake was measured and added to the food intake. The percentage of gastric emptying during the one-hour experimental period was calculated using the method described by Barrachina et al. (1997) as follows:

Gastric emptying (%) = [1 – (wet weight of food recovered from the stomach/weight of food intake)] × 100.

2.4 Determination of Gastric acid secretion

Rats were fasted for 24 hours to empty the stomach of all ingested food materials. Acid secretion was measured using a modified continuous flow method as described by Ghosh and Schild (1955). Each rat was anaesthetized with 0.25 mg/ml urethane at a dose of 0.6 ml/100g body weight. Esophageal cannula from the normal saline reservoir was inserted through the mouth of the anaesthetized rat into the stomach. Another cannula was inserted into the duodenal end of the stomach. Effluents were collected in aliquots of 10 ml at every 15 minutes interval for 60 minutes and acid secretion was determined by titrating each sample of gastric effluent against 0.0025 N NaOH using 1 % Phenolpthalein as indicator. The level of acidity in each sample was calculated in Meq/L.

2.5 Statistical analysis

Data analysis was performed using one-way ANOVA followed by Newman-Keuls post-tests. Statistical analyses were conducted with GraphPad Prism 9 (Version 9.01, GraphPad Software, USA). A significance level of $P < 0.05$ was considered statistically significant.

3 Results

3.1 Proximate analysis

The results of the proximate analysis of ginger and honey drinks, honey and ginger extracts are presented in figures 1a,1b,1c,1d,1e and 1f. Figure 1a shows the carbohydrate contents of ginger-and-honey drink, honey and ginger extract. There was no significant difference in the carbohydrate contents of honey and that of ginger extracts in comparison with ginger-and-honey drink. Figure 1b shows the protein contents of ginger-and-honey drink, honey and ginger extract. There was no significant difference between the protein contents of ginger-and-honey drink, and honey. However, ginger extract showed significantly higher protein content compared to ginger-and-honey drink.

3.2 Gastric emptying after consumption of ginger and honey

The results of percentage of gastric emptying in rats given different treatments are presented in figure 2. There was no significant difference in the percentage of gastric emptying in the groups treated with 2.5 g honey/kg BW compared with the control group, whereas the percentage of gastric emptying was significantly decreased ($p<0.05$) in group given honey 5 g / kg BW compared with the control group. Also, there was a significant decrease ($p<0.05$) in the percentage of gastric emptying of the group given Loperamide compared with control. The percentage of gastric emptying in the group given honey 5g /kg BW was significantly lower ($p< 0.05$) than those of the group administered Loperamide. The percentage of gastric emptying in groups given ginger extract, ginger-and-honey drink or metoclopramide were significantly higher ($p<0.05$) compared with control group.

3.3 Effects of Graded Doses of ginger-and-honey drink on the rate of gastric emptying

The results of the effects of different doses of ginger-and-honey drink on the rate of gastric emptying in rats are presented in figure 3. There was no significant difference in the rates of gastric emptying of the four different graded doses of ginger-and-honey drink (0.25g/kg, 0.5g/kg, 2.5g/kg and 5.0g/kg.). However, gastric emptying in all the rats fed with ginger-and -honey drink was significantly higher ($p<0.05$) than the rats in the control group.

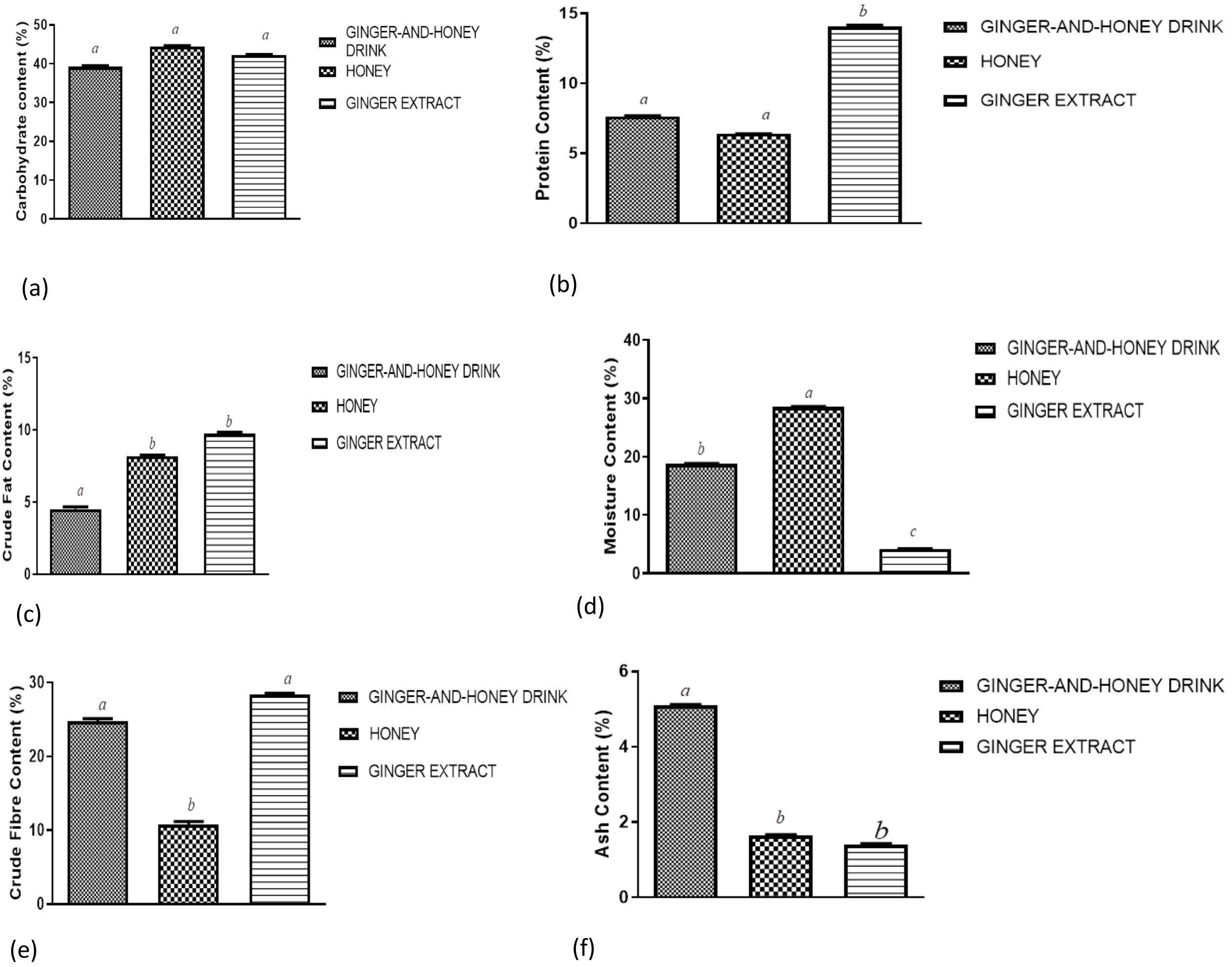

Fig. 1. Percentage composition (%) in proximate analysis of ginger-and-honey drink, Honey and ginger extract. Values are mean ± SEM (n = 3, where 'n' is the number of observations made). Values bearing the same superscript letter are not significantly different: $p > 0.05$, One way ANOVA followed by Newman keuls post-tests

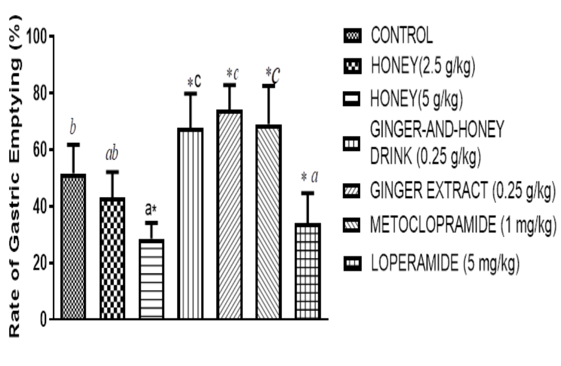

Fig. 2. Percentage of rate of Gastric Emptying in Rats in Different Treatment Groups. Values are mean ± SEM (n = 6/group).*$P < 0.05$; significant difference compared to control. Values bearing the same superscript letter are not significantly different: $p > 0.05$. One way ANOVA followed by Newman keuls post-tests

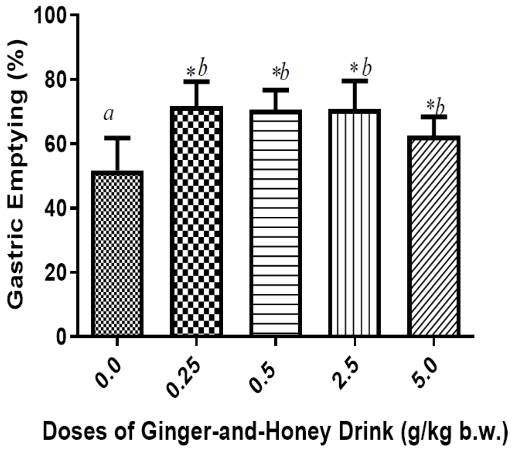

Fig. 3. Gastric emptying in rats fed with different doses of ginger-and-honey drink Groups. Values are mean ± SEM (n = 6/group).*$P < 0.05$; significant difference compared to 0.0 g/kg, Values bearing the same superscript letter are not significantly different: $p > 0.05$ One way ANOVA followed by Newman keuls post-tests.

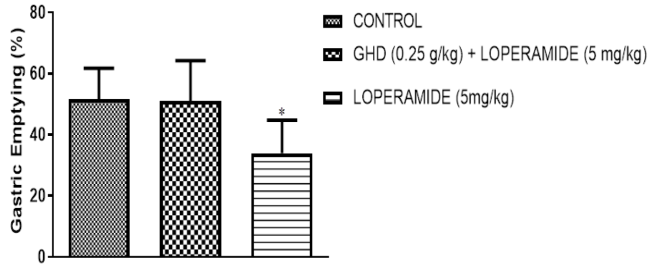

Fig. 4. Effects of ginger-and-honey drink on gastric emptying after Loperamide administration. Values are mean ± SEM (n = 6/group). *$P < 0.05$; significant difference compared to control. One way ANOVA followed by Newman keuls post-tests

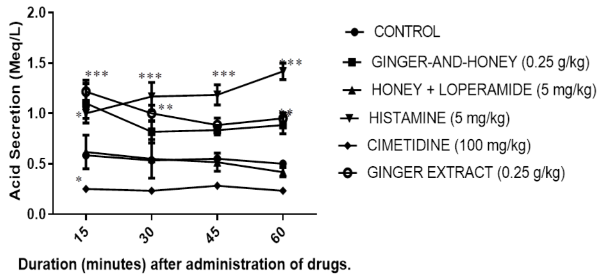

Fig. 5. Gastric acid secretions in rats after consumption/administration of ginger, ginger-and-honey, honey, histamine and cimetidine. Values are mean ± SEM (n = 6/group). *$p<0.05$; **$P<0.005$; ***$p<0.0005$, significant differences from control group. One way ANOVA followed by Newman keuls post-tests

3.4 Effects of ginger-and-honey drink on gastric emptying after Loperamide administration

The results of the effect of ginger-and-honey drink on gastric emptying in rats pre-treated with Loperamide are presented in figure 4. There was no statistically significant difference in the rates of gastric emptying in rats given ginger-and-honey drink following pre-treatment with Loperamide compared with the control group. However, Loperamide alone significantly lowered ($p<0.05$) the rate of gastric emptying than in control rats.

3.5 Acid Secretion after Consumption of ginger and honey

Acid secretions in rats of various groups at different time intervals are presented in figure 5. In comparison with control groups, gastric acid secretion in rats treated with histamine was significantly increased at 15 min ($p<0.05$), 30 min ($p<0.05$) 45 min ($p<0.05$) and 60 min ($p<0.05$) post-administration. The groups given Ginger extract and Ginger-and-honey Drink, also showed significant increase in gastric acid secretion after 15 min. ($p<0.05$) when compared with the control group. There was no significant difference between the gastric acid secretion of the rat group given 2.5g/kg honey and those of the control. However gastric acid secretion in the group administered cimetidine were significantly decreased ($p<0.05$) compared to those of the control group only at 15 min of post-administration.

DISCUSSION

Knowledge of the gastrointestinal effects of drugs, foods and other consumables is very important in order to reduce the risk that such substances may pose to gastrointestinal health and the attendant gastrointestinal disorders. To this end, many studies have been conducted on food substances in relation to their effects on gastric functions. Some of these studies have reported effects of ginger extract and natural honey on gastric empting (Shaaban *et al*., 2010; Rezk and Abdulfadle, 2013). However, there has been no report on the effect of product containing both honey and ginger on gastric emptying and gastric acid secretion in healthy animals. Therefore, the present study was carried out to investigate the effects of ginger-and-honey drink on gastric empting and gastric acid secretion. In addition, comparative proximate analysis was carried out on natural honey, ginger extract, and ginger-and-honey drink to unravel health benefits or otherwise, of these consumables. The results of this study revealed that ginger-and-honey drink enhanced gastric emptying in healthy rats. Ginger content of the ginger-and-honey drink might be responsible for the stimulating effect on gastric emptying. This is because pure honey (large dose, 2.5 kg BW) inhibited gastric emptying in rats (Rezk and Abdulfadle, 2013) whereas ginger extract enhanced gastric emptying in rats. Further, the rate of gastric emptying is influenced by dietary factors such as caloric content and osmotic properties (Mackie et al., 2013). Both glucose and fructose have been observed to slow gastric emptying by interacting with the small intestine. Their presence in the small intestine induces relaxation of the proximal stomach, suppresses antral motility, and stimulates both phasic and tonic contractions (Steven *et al*., 2009). Honey, which is a constituent of ginger and-honey drink, is majorly composed of glucose and fructose

(Alvarez-Suarez *et al*., 2013).

Proximate analysis of ginger extract and ginger-and-honey drink revealed that they are very rich in carbohydrates. It might be expected that this would make ginger-and-honey drink to lower the rate of gastric emptying but contrary was the case. Stimulating effects of ginger-and-honey drink on gastric emptying in this study was therefore probably caused by some pharmacological agents such as gingerol in the ginger and-honey drinks which is capable of ameliorating the effects of dietary properties and caloric content of the drink and also potentiate gastric emptying. This view is consistent with the reports that ginger elicited pharmacological effects on gastrointestinal tract which include stimulation of gastrointestinal motility (Arazberdi *et al.,* 2013). A phytochemical analysis of ginger-and-honey drink would further substantiate this view.

Rezk and Abdulfadle (2013) reported that a small dose of honey (0.312g/kg BW) did not have effects on gastric emptying in rats while a large dose (2.5g/kg BW) decreased percentage of gastric emptying. However, in the present study, the same large dose (2.5g/kg BW) produced no effects on gastric emptying whereas, a larger dose (5g/kg BW) significantly decreased percentage of gastric emptying compared with the control group. Our study employed the same experimental procedure used by Rezk and Abdulfadle (2013) but extended the time of re-feeding from 30 minutes to 60 minutes. It may therefore be inferred that the lowering effects of pure honey on gastric emptying rate/percentage are dose-dependent and the longer the time of re-feeding after pure honey was administered the lower the decreasing effects of the pure honey on gastric emptying.

Loperamide is one of the most effective and commonly used antidiarrheal medications, it operates through multiple mechanisms: it has an antisecretory effect, inhibits peristalsis, blocks the calcium-binding protein calmodulin, and directly affects the gastrointestinal wall by interacting with local neuronal mechanisms (Lee *et al*., 2013). In this present study, loperamide decreased gastric emptying time significantly. This result is consistent with the report that loperamide at doses 2 and 8mg/kg per body weight prolonged gastric residence time in humans (Kirby *et al.,* 1989). However, ginger-and-honey drink attenuated the inhibitory effect of loperamide on gastric emptying in this present study. Acute toxicity test of ginger-and-honey drink in this study revealed that it is non-toxic up to the dosage of 10g/kg BW Ginger-and-honey drink in Nigerian markets is usually packaged in a sachet of 18g net weight. This implies that if an adult (about 70kg body weight) drinks a sachet it is equivalent to 0.25g/kg BW In fact, the choice of dosage in this study was suggested by the way people take the drink though toxicity test also supported this decision. Invariably, a dose of 5g/kg body weight is equivalent to taking 20 sachets of the drink. Our finding in the present study shows that ginger-and-honey drink is not dose dependent in its stimulatory effects on gastric emptying as there was not significant increase in the percentage of gastric emptying with increase in dosage.

In this present study, ginger-and-honey drink and ginger extract which increased percentage gastric emptying also increased gastric acid secretion. It is not clear however, whether the stimulation of gastric acid secretion by ginger-and-honey drink actually contributed to the observed increase in gastric emptying. Studies on mechanisms of action would tend to reveal if ginger-and-honey drink increased rate of gastric emptying by increasing rate of acid secretion.

The most comprehensive data on food composition is derived from the proximate analysis system, developed over a century ago by German scientists Henneberg and Stohmann. This analytical method categorizes food into six components: carbohydrates, proteins, crude fats, crude fiber, ash, and moisture (Shurson *et al*., 2021). Proximate measurements are essential in the analysis of biological materials, breaking down consumable goods into their primary constituents. They provide a reliable approximation of the contents of packaged food products and serve to verify nutritional information panels (Shurson *et al*., 2021). In this study, natural honey, ginger extract, and ginger-and-honey drink were found to be very rich in carbohydrate. The results obtained in the present study were similar to those reported by Ugwoke and Nzekwe (2010) indicating that ginger contains mainly carbohydrate. This shows that ginger-and-honey drink is an excellent food drink and a rich source of metabolic fuel.

Ginger-and-honey drink was found to contain protein in the present study. That the protein level of the ginger extract was higher than that of the ginger-and-honey drink suggested that some of the protein originally present in ginger might have been lost to high temperature during processing. Ene-Obong and Carnovale (1992) reported that diet is nutritionally satisfactory if it contains high calorie values and sufficient amount of protein. Ali (1995) also noted that foods providing approximately 12% of their caloric value from protein are considered to be good sources of protein. Ginger-and -honey drink did not meet this requirement though one of the raw materials, that is, ginger extract did. A better technology is required therefore in the production of ginger-and-honey drink which would preserve its protein content as much as possible. For example, freeze-drying may be used to concentrate ginger extract rather than the use of oven-drying. Findings from this study revealed that the crude fat content in ginger-and-honey drink is low compared with that of ginger extract. It is well known that oils contained in ginger are very volatile. They are responsible for the aroma of the plant (Suekawa *et al.,* 1984; Tang and Eisenbrand, 1992; Kikuzaki and Nakatani, 1991;). Some of these oil fractions therefore might have been lost during industrial processing accounting for the low crude fat content in the ginger-and-honey tea. However, the value of crude fat reported for ginger and-honey drink in this study is similar to that reported by Odebunmi and colleagues in powdered ginger (Odebunmi, *et al.,* 2009). The nutritive value of fat and oil cannot be overemphasised. It is an important nutrient for heat regulation, body metabolism and solvent for fat-soluble vitamins (Amoo and Agunbiade, 2009). Consumption of fat in large quantity is not advisable especially in lipid related disease conditions such as hyperlipidemia. Thus low crude fat recorded from this study in comparison to protein suggests that ginger-and-honey tea could be recommended as a beneficial dietary supplement for patients with cardiac issues or at risk of lipid-related disorders. The moisture content of food serves as an indicator of its water activity (Zambrano *et al*., 2019) and is utilized to assess its stability and susceptibility to microbial contamination (Davey, 1989). Foods with high moisture content are more prone to microbial spoilage and degradation (Desai and Salunkhe, 1991). High moisture content of ginger-and-honey drink observed in this study requires that the products be stored in cool and dry condition if they would be kept for too long. Further dehydration of the product would improve its shelf-life and relative concentration of food nutrients in it.

High ash content observed in ginger-and-honey drink from this study is very desirable. The proportion of ash content reflects the mineral content present in the food materials (Omotoso, 2005; Nnamani *et al*., 2009). Since the ash content of ginger extract recorded from this study and that of ginger powder reported by Odebunmi *et al.* (2009) are significantly lower than that of the ginger-and-honey drink, it is not improbable that the product might have been fortified with extra minerals during production. Ginger-and-honey drink is rich in crude fibre according to the findings from this study. Crude fiber is the portion of food that remains undigested by humans, yet the normal function of the intestinal tract relies on sufficient fiber presence. Fiber increases stool bulk and reduces the duration waste materials remain in the gastrointestinal tract (Bello *et al.,* 2008). Fiber plays a crucial role in maintaining human health and has been shown to lower cholesterol levels in the body (Bello *et al*., 2008). Diets low in fiber have been linked to various health conditions such as heart disease, colon and rectal cancer, varicose veins, phlebitis (vein inflammation), obesity, appendicitis, diabetes, and constipation (Saldanha, 1995). Therefore, based on its relatively high fiber content, ginger-and-honey drink could be recommended as a valuable source of dietary fiber.

Conclusion

The study demonstrates that ginger-and-honey drink enhances gastric emptying and gastric acid secretion, while also reducing the inhibitory effect of Loperamide on gastric emptying. These findings suggest that ginger-and-honey could serve as a natural adjunct therapy for alleviating indigestion, bloating, and discomfort caused by delayed gastric emptying. Further research is needed to elucidate the mechanisms by which ginger-and-honey affects gastric functions and its interactions with different medications.

Acknowledgment

The authors express their gratitude to the technical personnel of the Department of Physiology, University of Lagos, Akoka, Lagos, Nigeria.

Competing interests

The authors declare no conflict of interest.

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