

Evaluation of *invitro* antacid properties of a porridge powder mixture

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Abstract- Commercial availability of dry powders of porridge for convenient consumption is currently a trend due to the lifestyle changes of people. The porridge prepared with the porridge powder used in this study which is composed of many traditional rice varieties and grains exhibited many health benefits to the consumers. This study analyzed *in vitro* antacid properties of the porridge powder mixture composed of seven types of Sri Lankan traditional rice varieties (*Kuruluthuda*, *Suwadel*, *Kalu heenati*, *Sudu heenati*, *Beheth heenati*, *Sudu mawee*, *Rathu mawee*) and four types of grams (*Kollu*, *Meneri*, *Kurakkan* and *Mung*) with spices (Curry powder and coriander). The porridge (PR) was prepared as instructed by the producer using porridge powder and coconut milk. Coconut milk (CM) itself used as a sample. *In vitro* antacid properties of the PR was evaluated using acid neutralization effect with artificial gastric juice, Fordtran's titration method and Vatie's artificial stomach model. PR and CM exhibited significant acid-neutralization properties demonstrated by the acid neutralizing effect, neutralizing capacity and duration compared to distilled water ($p < 0.05$). CM exhibited better acid-neutralizing capacity and duration compared to PR. In conclusion PR exhibited significant acid- neutralizing properties compared to distilled water and thus could be consider as a beneficial food.

Keywords: Antacid, artificial stomach model, porridge, porridge powder

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1. Introduction

Porridge is a dish made primarily of cooked whole grains, cereal or legumes, which is used as a staple in many communities around the world (Khoury, 2023). *Kanda* or *kola kanda* is the Sri Lankan version of porridge which is a nutritious semi solid food. Traditionally this herbal porridge is prepared with locally available rice varieties, green leaves (herbs) and spices with medicinal value and usually consumed as an appetizer or breakfast. It is a nutritionally wholesome food- preparation, which is usually less in fat and rich in micro nutrients and phytochemicals when leaves are added (Wickramage *et al.*, 2018; Hewavissenti, 2021). Apart from being a wholesome meal, it is also considered as a nutraceutical. It is widely used by traditional medical practitioners in Ayurvedic medicine as a remedy for many disease conditions such as non-communicable diseases including diabetes mellitus (Wickramage *et al.*, 2018; Hewavissenti, 2021). Although preparation of these porridges appears to be easy, busy and competitive life styles of people have led to fast disappearance of consumption of home-made herbal porridge due to difficulties in collecting the preferred leaves and complications in the traditional preparation method. In spite of the constraints in preparation, instant herbal porridge made up of medicinally important herbs, rice varieties and spices are widely available commercially now mainly because of its demanding nutritional and medicinal values along with ability of convenient usage in their complex day-today life. These are usually available as powder products and feasible advanced technologies such as extrusion cooking and drum drying widely are used for the commercial manufacturing of these instant products (Thushara *et al.*, 2019; Medagama and Senadhira, 2015; Wickramage *et al.*, 2018).

In this study, the porridge powder used to prepare the porridge is composed of traditional rice varieties of Sri Lanka (*Kuruluthuda*, *Suwadel*, *Kalu heenati*, *Sudu heenati*, *Beheth heenati*, *Sudu mawee*, *Rathu mawee*) and grams (*Kollu*, *Meneri*, *Kurakkan* and *Mung*) with spices (Curry powder and coriander). Sri Lanka was known to have about 2000 traditional rice varieties during its long rice cultivation history. However, demand for the many of these traditional rice varieties were reduced with the introduction of newly enhanced rice varieties to the rice market (Abeysekera, Premakumara, Chandrasekharan, 2017; Achchige *et al.*, 2019). Most of the varieties were known to have medicinal properties and those health claims have been scientifically proven in many of recent studies (Samaranayake, Yathursan, Abeysekera, 2017; Abeysekera, Premakumara and Chandrasekharan, 2017).

Hyperacidity results from the excessive production of acid in the stomach and occurs in various conditions ranging from gastritis and peptic ulcers to acid reflux disease. A gastric ulcer is a disease condition in which the inner lining of the stomach becomes irritated and inflamed leading to breakdown of the protective mucosal layer. It occurs because of several aggravating factors such as chronic alcohol consumption, long-term use of non-steroidal anti-inflammatory drugs (NSAIDs), and infection with *Helicobacter pylori*. The aim of the medications used for this condition is to reduce the acid secretion in the stomach which lowers the acidity inside the gastric lumen and promotes the healing of gastric ulcers. The most commonly used medications include antibiotics to eradicate *H. pylori*, acid blockers to reduce acid secretion over an extended period, proton pump inhibitors, and agents that protect the stomach lining. Currently there is a growing demand for traditional medicines worldwide for hyperacidity and related complications due to their advantages and benefits including lesser side effects compared to synthetic drugs (Panda, Khambhat and Kundnani, 2013; Jayasuriya *et al.*, 2022).

As the synthetic antacid therapies are often associated with significant side effects and drug interactions, there is a worldwide growing acceptance of the natural healing properties of plants and their products in various traditional forms due to its lesser side effects (Panda and Shinde, 2016). As gastritis is an inflammatory condition, herbs with natural antioxidants may help in managing inflammation in the stomach. When considering dietary remedies, porridge dishes

also can be used to minimize gastritis symptoms as its ability to quickly swell, split and digest allows porridge not to irritate the stomach, reducing internal pressure and pain. It is usually well absorbed by an inflamed stomach, protecting the walls of the organ from additional injuries and also does not cause sensation of heaviness after consuming the porridge. Examples of different porridge types for these purposes include millet porridge, wheat porridge, oatmeal porridge, buckwheat porridge, lentil porridge, rice porridge and barley porridge (Richards, 2018). Consumers of the porridge powder used in this study was known to have many health benefits. However, no scientific study has been done to prove such claims. Therefore, the present study evaluated the antacid properties of this porridge powder mixture.

2. Methods

Preparation of the porridge

The porridge powder was obtained for the research study from the suppliers. The porridge (PR) was prepared using the porridge powder and coconut milk as instructed by the producer. An amount of 100 g of the dry powder was mixed well in 1000 ml of water. Then 500 ml of first extraction of coconut milk (CM) and 4 g of salt were added. The mixture was then boiled for 15 minutes while stirring. CM was prepared by squeezing 500 g of grated coconut kernel with 500 ml water.

Preparation of artificial gastric juice

An amount of 3.2 mg of pepsin enzyme and 2.0 g of sodium chloride were dissolved in 500 mL of distilled water in a 1 L volumetric flask followed by dropwise addition of 7.0 ml of hydrochloric. Final volume was brought up to 1 L with distilled water and the pH was adjusted to 1.2 (Jayasuriya *et al.*, 2022)

Assessment of neutralizing effect

Neutralizing effect was assessed according to method reported by Jayasuriya *et al.*, 2022. PR and CM were used as the samples. ENO (5 g / 150 ml) and Belcid were used as the positive controls while distilled water was used as the negative control. An amount of 30 ml from each sample / control was mixed well with 30 ml of artificial gastric juice at room temperature. Initial pH of the sample/ control and pH after adding artificial gastric juice at 30-minute intervals until two hour were measured. The pH drop was calculated as follows which was the measure of the acid-neutralizing effect (Jayasuriya *et al.*, 2022).

$$pH \text{ drop} = (\text{Initial pH}) - (\text{pH after adding gastric juice}) \quad (01)$$

Assessment of neutralizing capacity

Neutralizing capacity was determined using modified Fordtran's titration method. PR and CM were used as the samples. ENO (5 g / 150 ml) and distilled water were used as the positive control and the negative control respectively. An amount of 30 ml of each sample / control was preheated to 37°C and stirred constantly using a magnetic bar at 50 rpm to imitate the stomach movements. While maintaining at 37°C and stirring, it was titrated with artificial gastric juice. End point was pH 3 and final consumed artificial gastric juice volume to reach the end point was measured (Jayasuriya *et al.*, 2022).

Assessment of consistency of duration of neutralizing effect

A modified artificial stomach model consisting gastric juice reservoir, stomach compartment and discarding compartment which was built according to Vatie's artificial stomach model was used according to method described in Jayasuriya *et al*, 2022. PR and CM were used as the samples while ENO (5 g / 150ml) was used as the positive control and distilled water was used as the negative control. The stomach compartment was maintained at 37°C stirring constantly at 50 rpm which mimics the natural stomach conditions. A volume of 30 ml of sample / control was added to the stomach compartment and gastric juice was pumped at a constant rate (3 ml / minute) and the contents are pumped out at the same rate simultaneously. Time taken to reach pH 3.0 was measured (Vatie, and Lionnet, 1988; Wu *et al*, 2010; Jayasuriya *et al.*, 2022)

Statistical Analysis

All the experiments were conducted in triplicate ($n = 3$) and results were presented as mean \pm standard deviation (SD). The data were statistically analyzed using the SPSS 26.0 software. One-way analysis of variance (ANOVA) was used to determine the differences among the sample means. p value of less than 0.05 ($p < 0.05$) was regarded as significant.

3. Results

Assessment of neutralizing effect

The initial pH, pH after adding artificial gastric juice and calculated pH drop for samples and controls are mentioned in table 1. The PR, CM, ENO, Belcid and distilled water resulted in initial pH drop (0 min) of 4.28 ± 0.01 , 4.65 ± 0.02 , 0.73 ± 0.05 , 0.91 ± 0.03 and 6.05 ± 0.01 respectively with artificial gastric juice. According to mean pH drop of each sample with artificial gastric juice at 30 minute intervals until two hour shown in table 1, no significant change was observed in pH drop of PR, CM and distilled water compared to initial pH drop at 0 min (The pH drop remained approximately the same). However, the pH drop of ENO decreased slightly after 30 minutes onwards whereas Belcid showed both slight increases and decreases.

Neutralizing effect refers to the overall ability of a substance to neutralize the given amount of acid. The pH drop indicates the measure of the neutralizing effect. According to that both PR and CM demonstrated statistically significant neutralizing effect compared to the distilled water which was the negative control ($p < 0.05$). PR showed statistically significant neutralizing effect ($p < 0.05$) compared to the CM. However, the neutralizing effect of both PR and CM were not significant ($p > 0.05$) compared to ENO and Belcid which were the positive controls.

Assessment of neutralizing capacity

The volumes of artificial gastric juice consumed to titrate to pH 3 for PR, CM, ENO and distilled water were 7.97 ± 0.06 , 9.5 ± 0.00 , 90.17 ± 0.29 and 0.5 ± 0.00 ml respectively (Table 2). The neutralizing capacity quantifies the amount of acid that the sample can neutralize and it reflects the maximum amount of acid that can be countered by a given quantity of the sample. Both PR and CM demonstrated significant neutralizing capacity ($p < 0.05$) compared to

distilled water while CM exhibited better neutralizing capacity compared to PR. However, the neutralizing capacity of both PR and CM were not significant ($p > 0.05$) compared to ENO.

Table 1

Mean pH drop of samples with artificial gastric juice at 30-minute intervals

Sample	Initial pH	pH after adding artificial gastric juice				
		0 min	30 min	60 min	90 min	120 min
PR	5.98±0.00	1.70±0.01	1.71±0.01	1.71±0.01	1.70±0.01	1.70±0.00
	pH drop	4.28±0.01*	4.27±0.01*	4.27±0.01*	4.28±0.01*	4.28 ±0.00*
CM	6.41±0.02	1.76±0.01	1.76±0.01	1.77±0.01	1.77±0.02	1.77±0.02
	pH drop	4.65±0.02*	4.65±0.02*	4.64±0.01*	4.65±0.01*	4.65 ±0.01*
ENO (5 g/150 mL)	6.42±0.02	5.68±0.04	5.78±0.03	5.80±0.03	5.88±0.03	5.92±0.03
	pH drop	0.73 ± 0.05	0.64 ± 0.05	0.61 ± 0.05	0.54 ± 0.04	0.49 ± 0.05
Belcid	7.57±0.01	6.66±0.02	6.08±0.01	6.20±0.01	6.37±0.01	6.43±0.02
	pH drop	0.91 ± 0.03	1.5 ± 0.01	1.38 ± 0.01	1.2 ± 0.00	1.15 ± 0.01
Distilled water	7.57±0.01	1.52±0.01	1.51±0.01	1.52±0.00	1.52±0.00	1.52±0.00
	pH drop	6.05 ± 0.01	6.05 ± 0.01	6.05 ± 0.01	6.05 ± 0.01	6.05 ± 0.01

Table 2

The volumes of artificial gastric juice consumed to titrate to pH 3

Sample	Volume of artificial gastric juice (ml)
PR	7.97±0.06*
CM	9.5±0.00*
ENO (5g / 150ml)	90.17±0.29
Distilled water	0.5±0.00

Significant * $p < 0.05$ compared to distilled water. Values are reported as mean ± SD (n=3)

Assessment of consistency of duration of neutralizing effect

The duration of consistent neutralization effect of PR, CM, ENO and distilled water on artificial gastric juice were found to be

192±10.55, 255.20±3.67, 895±12.48 and 15.33±0.58 seconds respectively (Table 3). The consistency of neutralizing duration refers to how reliably a substance maintain its acid neutralizing properties overtime. It is assessed by measuring the time it takes for each substance to reach pH 3 where longer durations indicate a more sustained neutralizing effect. According

to that ENO exhibited the longest duration while distilled water exhibited the shortest duration. Both PR and CM exhibited significant duration of neutralization effect ($p < 0.05$) compared to distilled water. Also, the duration of neutralization effect of PR was not significant ($p > 0.05$) compared to CM and CM exhibited better duration of neutralization effect. However, the duration of neutralization effect of both PR and CM were lesser compared to ENO.

Table 3

Duration of consistent neutralization effect on artificial gastric juice

Sample	Time (seconds)
PR	192±10.55*
CM	255.20±3.67*
ENO (5g / 150ml)	895±12.48
Distilled water	15.33±0.58

Significant * $p < 0.05$ compared to distilled water. Values are reported as mean \pm SD (n=3)

4. Discussion

In vitro antacid effects of the PR were evaluated in this study. Acid-neutralizing activities of both PR and CM were significantly higher compared to the negative control (distilled water). CM exhibited better acid neutralizing capacity and duration than PR. Antacid properties of this PR and CM could be due to different phytochemicals that possess the ability to neutralize gastric acid (Jayasuriya *et al.*, 2022). PR was prepared using the porridge powder and coconut milk. This porridge powder consists of many traditional rice varieties and other grains. Traditional rice varieties are rich sources of phytochemicals such as phenolic acids, flavonoids, anthocyanins, proanthocyanidins, tocopherols, tocotrienols, γ -oryzanol, and phytic acid (Priyanthi and Sivakanesan, 2021). Coconut milk also is a source of phenolic compounds such as gallic acid, chlorogenic acid, parahydroxybenzoic acid, caffeic acid, vanillic acid, syringic acid, and ferulic acid (Karunasiri *et al.*, 2020) and flavonoids. Usually most of the phenolic compounds and flavonoids possess alkaline properties due to hydroxyl groups present in their molecular structure which can serve as sites that either donate or accept electrons depending on the pH of the reaction medium (Jayasuriya *et al.*, 2022). The acid neutralizing effect estimation is considered as a preliminary test which emphasizes the overall ability of the sample to neutralize acid irrespective of the time taken or how consistently it maintains the neutralization. The acid neutralizing capacity reflects the quantity of acid that can be effectively neutralized by the sample providing information on its total neutralizing potential. The consistency of duration of neutralizing effect focuses on the duration of neutralization indicating how consistently the sample can sustain its acid neutralizing properties. The observed difference of antacid properties between PR and CM could be due to the ingredients and their composition. The better acid neutralizing properties of CM could be due to the stronger acid neutralizing compounds present in CM compared to those present in porridge powder used. Further, cooking process could affect the acid neutralizing capacity of PR as it could alter or break down certain components. Also the thickness or consistency of PR could affect its acid neutralizing properties. PR exhibited a thicker consistency than CM. Therefore the thicker PR might have a lower surface area exposed to acid and influence the overall contact with acid potentially affecting the capacity and duration of neutralization. In contrast, CM might provide a larger surface area contributing to its higher acid neutralizing capacity and duration. ENO was selected over Belcid as the positive control in acid neutralizing capacity

and duration assays as Belcid exhibited more than 250 ml capacity with artificial gastric juice during the trial of the assay to reach the end point of pH 3. Also the exact volume could not determine as the pH value did not change after pH 4 even the consumed volume exceeded 250 ml. As Belcid could result in much longer duration than ENO, where the stomach model apparatus also would not efficiently work for such an extended duration, ENO was used as the positive control for those two assays.

5. Conclusion

Based on the findings of this study, the prepared PR from the porridge powder mixture exhibited noteworthy acid-neutralizing capabilities and sustained effectiveness surpassing distilled water. Although its efficacy fell short compared to commercially available antacid (ENO and Belcid), its status as a wholesome meal suggests that it could be beneficial as a food for individuals suffering with hyperacidity.

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Abbreviations: Porridge (PR), hydrochloric acid (HCl), gram (g), milliliter (ml)