Asian Journal of Research in Medical and Pharmaceutical Sciences

9(2): 10-15, 2020; Article no.AJRIMPS.60771
ISSN: 2457-0745

Acid Neutralizing Capacity of Selected Antacid Suspensions Available in the Ghanaian Market

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Authors' contributions

This work was carried out in collaboration among all authors. Authors CDKA and OFWA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. All authors managed the analysis of the study. Author JK managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJRIMPS/2020/v9i230148
Editor(s):
(1) Dr. Davina Hijam, Regional Institute of Medical Sciences, India.
Reviewers:
(1) Supriya Bhandage, Rajiv Gandhi University, India.
(2) Naveed Muhammad, Abdul Wali Khan Univeristy Mardan, Pakistan.
(3) Antonio dos Santos Silva, Universidade Federal do Pará (UFPA), Brazil.
Complete Peer review History: http://www.sdiarticle4.com/review-history/60771

Original Research Article

Received 27 June 2020
Accepted 02 September 2020
Published 08 September 2020

ABSTRACT

Antacids are substances commonly used by patients to obtain fast symptomatic relief from dyspepsia. They are weak bases which neutralize excess gastric acid and subsequently raise the pH of the gastric contents. The potency of the antacids depends mainly on their acid neutralization capacity (ANC) and this can vary from one brand to another. Several dosage forms of antacids are available for use by patients. However, In Ghana, suspensions are the commonest dosage form of antacids which is preferred by patients.

The objective of this study was to determine the acid neutralizing capacity of six (6) randomly selected brands of antacid suspensions on the Ghanaian market using potentiometric acid-base titration. The samples were coded A-F to avoid any bias in the study. All the sampled brands had more than one year to expiry as indicated on their label.

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Brand D had the highest ANC of 29.70 mEq/dose whiles brand A had the lowest ANC of 11.25 mEq/dose. From the results obtained, it can be inferred that acid neutralization can be more effective and rapidly achieved with liquid antacids containing a high amount of magnesium hydroxide and aluminium Hydroxide. Hence, for acute symptomatic relief from dyspepsia, antacids containing a higher concentration of magnesium hydroxide and aluminium hydroxide would be most beneficial to patients.

Keywords: Antacids; suspensions; Acid Neutralizing Capacity (ANC); potentiometry; acid-base titrations.

1. INTRODUCTION

Acid reflux disorder such as gastroesophageal reflux disease (GERD), heartburns (acid indigestion), hyperacidity, gastric distress, peptic ulcer and dyspepsia are common conditions worldwide. These have resulted in increasing popularity of antacid therapy and marketing of a large number of brands based on the principle of neutralization of excess gastric acid [1]. Gastroesophageal reflux disease causes gastric acid to move into the esophagus as a result of an increment in stomach acid and weakening of the esophageal sphincter muscle [2]. Dyspepsia is a generalized term for upper abdominal (Chest) discomfort. It is often described as a feeling of having gas, of fullness or burning pain [3]. Heartburns (acid indigestion) is a burning pain or discomfort that moves up from the stomach to the middle of the abdomen and chest. These disorders are all due to excess of the acid in the stomach [4]. Antacids are bases that are usually taken to react with and neutralize the acid in the stomach or to absorb acid in the stomach and by so doing, they relieve the pain and irritation being experienced by the patient. They are generally used for peptic ulcer irritation, acid indigestion, gastroesophageal reflux disease and dyspepsia [1].

Antacids can be classified into two major types; systemic antacids and non-systemic antacids. Systemic antacids are those that undergo complete systemic absorption following oral ingestion. The non-systemic antacids are those that do not undergo systemic absorption following the oral ingestion. The systemic antacids have a rapid onset with a transient duration of action. The systemic antacids, on prolong use causes systemic alkalosis for instance sodium bicarbonate. Non-systemic antacids have slow onset but a protracted duration of action including magnesium carbonate, magnesium hydroxide and aluminum [5].

The food and drug administration (FDA) has introduced various *in vitro* tests such as acid neutralizing capacity, buffering capacity, onset and duration of action to assess the activity of antacids [6]. According to FDA, although in vitro test can approximate *in vivo* conditions with respect to acid-consuming capacity, the speed of action, duration of action and maximum buffering capacity of antacid, it cannot account for variations in antacid activity due to gastric emptying, changes in acid secretion rate in fasted and non-fasted state, interaction of antacids with glycoprotein and mucoproteins of gastric juice, coating of gastric mucosa by antacids, and the effects of antacid on the endogenous control of acid secretion [7].

The important features of antacid preparation are rapid onset of action and effective neutralization of acid [7]. Measurement of acid neutralizing capacity is one of the widely used tests that evaluate the efficacy of antacids. There are several ways of assessing the acid neutralizing capacity of an antacid but one of the simplest and most accurate methods is potentiometric acid-base titrations.

A large number of antacid preparations are available on the Ghanaian market and day in day out many more keep on entering the market. Antacids are available in different formulations like tablets, effervescent, powders, and suspensions. The suspension formulations are more preferred as they have the fastest onset of action [6]. There is a high possibility of misuse and adulteration of these antacids due to the fact that they are common on the market and can be purchased over the counter without any prescription. Thus, from health care providers and patients' point of view, it is very essential to have information regarding the efficacy and cost effectiveness of various antacid preparations on the Ghanaian market [6]. Currently, there is little data regarding the ANC of antacids on the Ghanaian market. This research therefore, seeks to provide more data and information regarding the efficacy of antacids on the Ghanaian market by assessing their ANC using potentiometric acid-base titrations.

2. MATERIALS AND METHODS

2.1 Materials and Reagents

Six liquid antacids were randomly sampled and purchased from community pharmacies in the Kumasi Metropolis of Ghana. Hydrochloric acid (HCl, 37% w/v, Fischer Scientific, United Kingdom) and Sodium Hydroxide (98% w/w, NaOH, Fisher Scientific, U.K) were supplied by Pharmaceutics department, Royal Ann College of health, Kumasi. Sulphamic acid (Fisher scientific (98% w/w) and sodium bicarbonate (Fisher Scientific, U.K) were supplied by Pharmaceutics department, KNUST, Kumasi. All other reagents used for the analysis were of analytical grade. Teflon-coated Magnetic stirrer (5.08 x 0.95 cm, Thomas Scientific) and pH meter (Jenway 3510 bench pH/mV Meter, U.K) were also employed in the titration procedure.

2.2 Methodology

The procedures described below were carried out partly at the pharmaceutical technology lab of the department of Pharmaceutics, KNUST and the dispensing lab of Royal Ann College of Health all located in Kumasi, Ghana within the month of February in 2019.

2.2.1 Preparation and standardization of solutions

2.2.1.1 Preparation of mol L^{-1} hydrochloric acid solution

Hydrochloric acid (37% w/v, 84 ml) was measured with a measuring cylinder and transferred into a volumetric flask (1 L) half-filled with distilled water and made to the mark with the same solvent. The flask was stoppered, shaken and labelled appropriately.

2.2.1.2 Preparation 0.5 mol L^{-1} sodium hydroxide solution

NaOH pellets (98%w/w, 20.40 g) was weighed into a beaker and dissolved in distilled water (100 ml). The contents and washings were transferred quantitatively into a volumetric flask (1 L). The mixture was allowed to cool and the volume was made to the mark with distilled water. The flask was stoppered, shaken and labelled appropriately.

2.2.1.3 Preparation of sulphamic acid to standardize 0.5 mol L^{-1} NaOH solution

Sulphamic acid (98% w/w, 4.95 g) was weighed into a beaker and dissolved in distilled water (50 ml). The mixture was stirred and allowed to cool after which it was quantitatively transferred into a volumetric flask (100 mL). The volume was made to the mark with distilled water. The flask was stoppered, shaken and labelled appropriately.

2.2.1.4 Preparation of sodium bicarbonate to standardize 1 mol L^{-1} HCl solution

Sodium bicarbonate (99.7%, 4.22 g) was weighed into a beaker and dissolved in distilled water (50 ml). The mixture was stirred and allowed cool after which it was quantitatively transferred into a 100 ml volumetric flask. The volume was made to the mark with distilled water. The flask was stoppered, shaken and labelled appropriately.

2.3 Determination of Acid Neutralizing Capacity of Antacid Suspensions (Ph Meter Method)

The liquid antacid bottles were well shaken for one minute and 10ml of each preparation was transferred quantitatively into a glass beaker (250 mL). Distilled water (70 mL) was added to the antacid formulation in the beaker and mixed well with a magnetic stirrer for 15 minutes.

1 mol L^{-1} HCl (30 ml) was pipetted into the resulting mixture with continuous stirring for 15 minutes. The excess HCl was titrated with NaOH (0.5 mol L^{-1}) to attain a stable pH of 3.5 within a period of five (5) minutes [8,9].

The number of mEq of the acid consumed by the suspensions was calculated using the formula: Total mEq = (30 × N HCl) – (V NaOH × N NaOH); Where N HCl and N NaOH are the normality's of the hydrochloric acid and the sodium hydroxide, respectively; and V NaOH is the volume of sodium hydroxide used for the titration. The results were expressed in terms of mEq of acid consumed per ml of the substance tested [8,10].

3. RESULTS AND DISCUSSION

The acid neutralizing capacity which represents a vital pharmacological factor in antacid preparations and the rapid onset of drug action which is a worldwide admired quality of antacid formulations was determined in this study. A total of six (6) antacid suspension from six different manufacturers were obtained for the study. These samples were analyzed by back titration using pH meter for their acid neutralizing capacity. All antacids were white or off-white in colour except Brand E, Brand D and Brand C (Table 1).

Table 1. Data of antacids used

Name of drug	Compo sition	Batch No.	Man. date	Expiry date	Dosage form
Brand A	Magnesium Hydroxide USP 250 mg	14085	August, 2016	August,2019	Suspension
Brand B	Dried Aluminum Hydroxide gel BP 200 mg. Magnesium Hydroxide BP 200 mg. Simethicone USP 25 mg.	17007	February, 2017	February, 2020	Suspension
Brand C	Dried Aluminum Hydroxide gel BP 200 mg. Magnesium Hydroxide BP 250 mg. Activated Dimethicone BP50 mg	T48765	June 2017	June 2020	Suspension
Brand D	Dried Aluminum Hydroxide gel UBP 250 mg. Magnesium Hydroxide BP 250 mg Simethicone USP 50 mg	G6099	November 2016	October 2019	Suspension
Brand E	Dried Aluminum Hydroxide gel BP 200 mg Magnesium Hydroxide BP 200 mg Simethicone USP 25 mg	I8021	September 2018	September 2021	Suspension
Brand F	Dried Aluminum Hydroxide gel BP 250 mg Magnesium Hydroxide BP 250 mg Simethicone BP 25 mg Oxethazaine BP 30 mg Alginic Acid BP 200 mg	F72672	May 2018	May 2021	Suspension

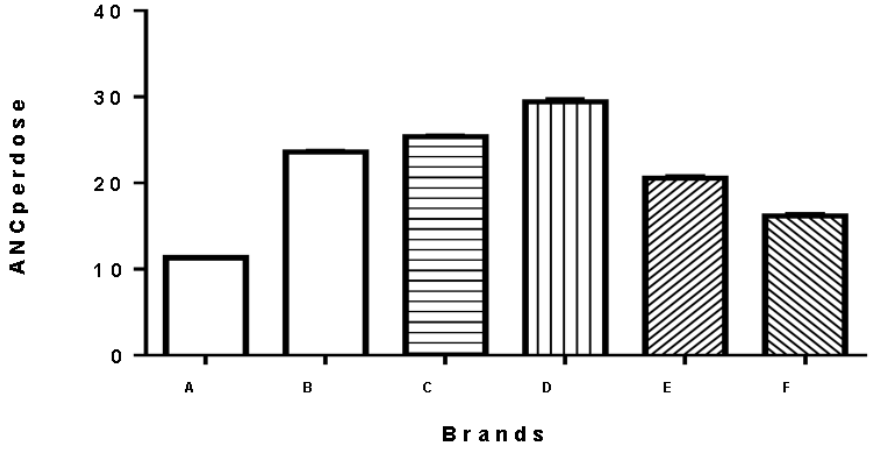

Fig. 1. Acid neutralizing capacity of sampled brands

Table 2. Parameters tested for the antacids

Brand name	Dosage form	Parameters tested		
		Volume of 1 mol L-1 HCl added (mL)	Volume of 0.5 mol L-1 NaOH that reacted (mL)	ANC per dose (mEq/10 mL)
A	Suspension	30	37.50	11.25±0.02
B	Suspension	30	12.70	23.65±0.06
C	Suspension	30	8.40	25.20±0.05
D	Suspension	30	0.60	29.70±0.03
E	Suspension	30	18.50	20.75±0.08
F	Suspension	30	28.00	16.00±0.01

Acid Neutralizing Capacity (ANC) is an important quality assessment tool for evaluating effectiveness of antacid, as it gives information about the ability of the brand to react and neutralize gastric acid. For an antacid suspension to have adequate activity, it must have at least ANC of five milliequivalents (5 mEq) per dose [11]. From the results, all the brands have adequate ANC. However, the sampled antacids could be classified into three groups according to their ANCs; those with high ANC (29.70 -20.75 mEq/dose), those with intermediate ANC (16.00 mEq/dose) and those with a low ANC (11.25 mEq/dose) [11] (Table 2).

All the antacids with high and intermediate ANC values contained at least two active ingredients (magnesium hydroxide and aluminium hydroxide) whiles brand A which had the lowest ANC value contained only magnesium hydroxide. Moreover, the difference in the ANC could be due to the difference in excipients used in the preparation, method of preparation and difference in the quantity of the active ingredients. The duration of action of antacids also correlate with ANC. This implies that, the higher the ANC, the longer the duration of action [12]. It can therefore be inferred that the antacid with the highest ANC (brand D) exhibited a longer duration of action hence would provide the patient the needed therapeutic response for a longer period of time. However, the opposite response was observed for brand A (Fig. 1).

A standard dose of antacid does not exist due to variable response by patients. The dose of antacids is determined by the manufacturer based on the ANC of the brand. Thus, patients taking brand A are likely to take an overdose of the suspension due to short relief time from their gastric pain or irritation. Overdose of antacids may cause diarrhea, constipation, alkalosis and acidosis depending on the composition [13].

4. CONCLUSION

The high ANC of brand D makes it the antacid of choice in treating various acid mediated gastro-intestinal problems. Brand A however recorded the least value of acid neutralizing capacity, and is the least preferred antacid formulation according to the study.

DATA AVAILABILITY

The data used to support the findings of this study are available at the Department of Pharmaceutical Sciences, Royal Ann College of Health, Kumasi.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENTS

The authors are grateful to the staff of Royal Ann College of Health, Kumasi. The technical expertise of Mr. Clement Attor and Mr. Prosper Adzormahe, both at the Department of Pharmaceutics, KNUST, Ghana is greatly appreciated.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/60771