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Evaluation of the Effectiveness of the Acid-Neutralizing Contents of Selected Palestinian Folk Medicinal Herbs

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Abstract – Various herbal plants have been used worldwide to remedy various diseases. The healing aspect of herbal plants have been accepted in many cultures and have been known as alternative medicine. Some herbs may consist of pharmaceutical ingredients suitable to treat certain cases such as stomach acidity or ulcers. Our aim was to verify the claim that some herbal "folk" plants can be used as an alternative for neutralizing the stomach acidity. Therefore, the purpose of this research was to test selected herbal plants for anti acid efficacy and estimate the acid-neutralizing capacity by addition of excess acid, followed by back-titration of the excess acid with sodium hydroxide. The anti acid capacity of the herbs was compared with that of anti acid tablets containing magnesium hydroxide and calcium carbonate as the active ingredient.

Keywords – Herbal plants; Antacid capacity; Back-titration; Anti-ulcer medicine

1. Introduction

Excessive secretion of gastric acid or stomach acid, which is mostly hydrochloric acid (HCl), inflames the stomach lining and produces ulceration. Some common causes might be an infection with a bacterium called Helicobacter pylori, or long-term use of non-steroidal anti-inflammatory medicines (NSAIDs) such as aspirin and ibuprofen, and other factors that make heartburn worse such as stress and spicy foods [1]. Antacids relieve the effects of the ulcer by neutralizing small amounts of excess stomach acid. Several antacid tablets are available over the counter and sold under various commercial names such as Maalox, Mylanta, Rolaids, Tums, Gaviscon, Alka-Seltzer, and Rennie, among others[2].

The main common active ingredients in these tablet consists of one or combination of magnesium hydroxide, aluminum hydroxide , calcium carbonates, magnesium carbonate, and Sodium bicarbonate[3]. Alternative to such tablets is the use of natural plant extracts to combat stomach acidity in what has become known as "folk" or traditional medicine[6]. Recent literature indicated that extracts from herbal plants are being used worldwide for treatment of peptic ulcer[4-7]. The market of herbal plant products, which contain flavonoids, terpenoids and tannins as the active substances, has flourished significantly [8]. In Palestine, many people, especially the elderly, use alternative medicine to remedy various diseases [9]. These traditional herbal remedies have been passed on and used from generation to generation based on personal experience rather than scientific experiments. The aim of this work is to experimentally determine the antacid capacity of some of these herbal medicines to verify the claim. Quantitative determination will be carried out by titration with standardized sodium hydroxide solution. In aqueous solutions, a the acidic H+ ions the herbs may produce will be titrated with OH– ions from the standardized NaOH base. The reaction of an acid and base is a neutralization reaction, the products of which are a salt and water. In an aqueous solution, virtually all of the OH– ions present will react with all of the H^+ ions which are present:

$$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$$

Because this reaction is essentially quantitative, it is pos-sible to determine the concentration of an acid in an aque-ous solution with high accuracy. When a solution of hydro-chloric acid, HCl, is exactly neutralized with a solution of sodium hydroxide, NaOH, the number of moles of NaOH used will equal the number of moles of HCl originally pre-sent. The following relationship then holds true:

Moles NaOH = moles HCl

(Molarity of NaOH) (Volume NaOH in liters) = (Molarity HCl) (Volume HCl in liters)

In order to determine when a solution has been exactly neutralized, phenolphthalein indicator is used. At the end point of the titration, its color changes from colorless to pink and can be used to determine when the correct amount of base has been added to an acidic solution to exactly neutralize it. Therefore, the exact antacid capacity can be calculated using the back-titration technique.

2. Experimental

2.1 Standardization of a Sodium Hydroxide Solution

Because sodium hydroxide is hygroscopic (absorbs water readily from air), it was standardized using potassium acid phthalate, KHPh, primary standard. In our experiments, a solution of NaOH, which has an approximate concentration of 1.0 M, was standardized

using potassium acid phthalate, KHPh. The molecular weight of KHPh is 204.23 g/mole, and it has one acidic proton, which will react

quantitatively with OH^-:

$$OH^-_{(aq)} + KHPh_{(aq)} \rightarrow H_2O_{(l)} + KPh^-_{(aq)}$$

For the highest accuracy, a sample size is chosen such that it will consume as large a volume of the base as possible without exceeding the capacity of the buret. The 50 mL buret was used, and the amount of KHPh was chosen such that it required approximately 20 mL of 1.14 M NaOH solution to reach the endpoint. Thus, about 0.0228 moles, or 4.656 g, of KHPh was weighed and used. At the endpoint, the number of moles of NaOH equals the number of moles of KHPh used:

Moles NaOH = moles KHPh / Volume NaOH in liters

or

Moles NaOH = (g, KHPh) / (204.23 g/mole) x (1000 mL/L)/(mL, NaOH)

Once the NaOH solution was standardized, it was used for titrating the herbal plants.

2.2. Sample preparation

About 1.0 gram of each sample was crushed using a mortar and pestle. The crushed samples were weighed to the nearest 0.001 g as shown in the tables, and transferred to a 250-mL Erlenmeyer flask. Exactly 25 mL of 0.521 M HCl was added to each of the flasks and gently swirled. The flasks were heated gently to boil for exactly 5 minutes to remove any interference from the dissolved carbonic acid that may have come from the CO2 air and dissolved in water. The CO2 was driven off by heating the contents of the flask just to boiling:

$$H_2CO_{3\,(aq)} + \text{heat} \rightarrow CO_{2\,(g)} + H_2O_{(l)}$$

after this, the flask were removed from the heat and allowed to cool until it is comfortable to hold. Then, about 2-3 drops of phenolphthalein indicator solution to the flask. Then, 75 ml of distilled water was added to the flask and swirled. Then, the exact antacid capacity was calculated using the back-titration technique.

3. Results and discussion

Antacids relieve the effects of heartburn by neutralizing small amounts of excess stomach acid. Stomach acid is mostly hydrochloric acid (HCl). The active ingredients in commercial antacids are usually either insoluble metal car-bonates, such as calcium carbonate ($CaCO_3$), or insoluble metal hydroxides, such as magnesium hydroxide, $Mg(OH)_2$. These substances are mixed with a variety of inert materials that serve as binders. Table I shows some the most common active ingredients in these tablet. These compounds neu-tralize stomach acid to produce salts and water.

The acid neutralizing capacity of a herbs is the amount of hydrochloric acid that it can neutralize. It is the quantity which can "neutralizes x times its weight in stomach acid". This capacity was determined by a back-titration. The known amount of the herbal sample was mixed the excess of HCl, and then the excess acid is back titrated with standardized NaOH solution. When the endpoint was reached, the number of moles of acid, which was added to the herbal sample, is equal to the number of moles of base present, NaOH plus the antacid present in the herb.

Table 1. Common antacid ingredient

Compound	Chemical formula	Chemical Reaction
Aluminum hydroxide	$Al(OH)_3$	$Al(OH)_{3\,(s)} + 3\,HCl_{(aq)} \rightarrow AlCl_{3(aq)} + 3\,(H_2O)_{(l)}$
Calcium carbonate	$CaCO_3$	$CaCO_{3\,(s)} + 2\,HCl_{(aq)} \rightarrow CaCl_{2\,(aq)} + H_2O_{(l)} + CO_{2\,(g)}$
Magnesium carbonate	$MgCO_3$	$MgCO_{3\,(s)} + 2\,HCl_{(aq)} \rightarrow MgCl_{2\,(aq)} + H_2O_{(1)} + CO_{2\,(g)}$
Magnesium hydroxide	$Mg(OH)_2$	$Mg(OH)_{2\,(s)} + 2\,HCl_{(aq)} \rightarrow MgCl_{2\,(aq)} + 2\,H_2O_{(1)}$
Sodium bicarbonate	$NaHCO_3$	$NaHCO_{3(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + CO_{2\,(g)}$

Therefore, the number of moles of HCl which was neutralized by the herbal plants is equal to the total number of moles of HCl added minus the number of moles which were neutralized by the NaOH:

moles acid neutralized = (moles of HCl added) – (moles of NaOH required for back-titration)

= (Molarity of HCl x Volume HCl) – (Molarity NaOH x Volume NaOH)

Table 2 shows the average mass of each sample (triplicates) in grams and the corresponding moles of acid or ant-acid it may contain. As shown in **Figure 1**, the commercially available pills such as rennie and acidex have on average about 0.0140 -0.0160 moles of antacid capacity. Contrary to what has been reported[1], the herbal plants in this study showed little to none acid

fighting composition. In fact, some of the herbs showed little bit of acid composition such as ginger, cucumber, almond and potato. On the other hand, curcuma (aka, turmeric) showed a negligible amount of antacid capacity as shown in **Table 2**. Nonetheless, these herbal plant continue to have wide acceptance and use among local people. It is possible that the acid fighting power of such herbs may take different form such as having biological blockers that prevent the stomach from releasing acid [10].

Table 2. Antacid of herbs in moles of NaOH

Sample name	Mass (g)	Mole of antacid	Mole of acid
Ginger	1.315	0	0.0017
Cucumber	1.059	0	0.0013
Almond	1.040	0	0.0005
Potato	1.094	0	0.0013
Curcuma	1.002	2.9E-05	0.0000
Rennie pill	1.217	0.0145	0.0000
Acidex pill	1.830	0.0167	0.0000

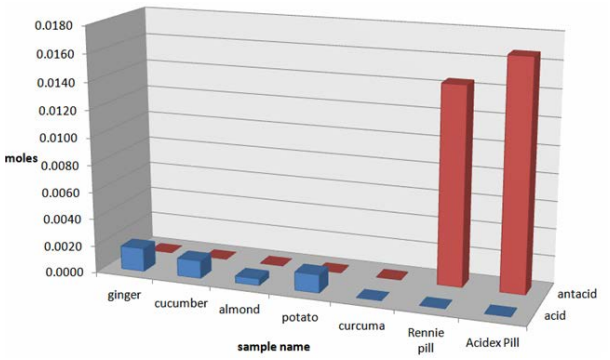

Figure 1. Comparison of acid and antacid contents from data in Table 2.

3. Conclusions

People with excessive secretion of gastric acid should consult medical doctors before taking any herbal treatments. As shown from the experiments, some of these herbal remedies may not contain the antacid outcome sought. With the tools and techniques of back-titration, the research suggests that the herbal plants in this study contained zero to little antacid fighting power compared with commercially available tablets from chemistry point of view. Further investigation from a biological and physiological perspectives would be also valuable.

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