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THE THERMAL ANALYSIS OF SOME NON-PRESCRIPTION ANTACIDS

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ABSTRACT

The TG and DTA (DSC) curves of the non-prescription antacids, Alka Seltzer, Bromo-Seltzer, Citrocarbonate, Phillips, Tums, Pepto-Bismol, Alkaid, Rolaids, Kolontyl, Triactin, and DiGel are described. These curves are useful for the qualitative identification of the antacids. Possible applications of these data include, among others, criminalistic investigations.

INTRODUCTION

Non-prescription antacid preparations are widely used to treat mild gastrointestinal disturbances. A large number of these preparations is commercially available, each differing in their ability to neutralize stomach acids. The active component of most antacids[1] consists of such compounds as calcium carbonate, sodium hydrogen carbonate, aluminum hydroxide, magnesium trisilicate, dihydroxy aluminum aminoacetate, and so on. Perhaps the most popular component is calcium carbonate, mainly because it is more effective than various brands of aluminum hydroxides and also because it is inexpensive and rapid in neutralization action. It is not without adverse side-effects, however, in that chronic use can cause constipation and the formation of urinary calculi.

Another antacid frequently used is sodium hydrogen carbonate ($NaHCO_3$), which is rapid in action and effective in inducing gastric emptying belching. Chronic use can be harmful in that the gastric fluids are raised to high pH values which stimulates the production of more hydrochloric acid. Also, its high basicity can cause alkalosis while the high sodium content can create problems for patients on a low salt diet.

Another antacid widely used is aluminum hydroxide, either by itself or mixed with various magnesium compounds. In addition to its antacid properties, it may be effective in the treatment of peptic ulcer due to its ability to absorb pepsin. It has more adverse side-effects than calcium carbonate if used for prolonged periods of time.

A somewhat more effective antacid than aluminum hydroxide for treatment of peptic ulcer is magnesium trisilicate, which has a greater capacity for pepsin adsorption. For short observation periods, however, this compound is less effective than the other antacids previously discussed. It will not produce alkalosis and large excesses will not raise the pH of gastric fluids much above 7.

Other effective antacids, which are used separately or with aluminum hydroxide or magnesium trisilicate, include dihydroxyaluminum aminoacetate, hydrated magnesium aluminate, dihydroxyaluminum sodium carbonate, and others. Each of these compounds have been demonstrated to be useful as antacids but they have not been as popular as calcium carbonate or aluminum hydroxide.

The purpose of this investigation is to study the identification of various solid antacid preparations by the thermal analysis techniques of thermogravimetry (TG) and differential thermal analysis (DTA). This information is potentially useful for criminalistic studies, such as was found for analgesic drugs[2], and for other uses.

EXPERIMENTAL

Antacid preparations

The antacids studied and their sources are given in Table 1. The compositional data when known, are only approximate.

TABLE 1

COMPOSITIONAL DATA AND SOURCES OF ANTACIDS

Antacids are in tablet or powder form.

Antacid	*Source*	*Approximate composition*
Alkaid	F & F Laboratories, Chicago, Ill.	Calcium carbonate, magnesium carbonate, magnesium trisilicate, and methyl salicylate
Alka Seltzer	Miles Laboratories, Elkhart, Ind.	Aspirin, 0.324 g; calcium phosphate, 0.196 g; citric acid, 1.055 g; and sodium hydrogen carbonate, 1.904 g
Bromo-Seltzer	Warner-Lambert Co., Morris Plains, N.J.	Acetaminophen, phenacetin, caffeine, sodium hydrogen carbonate, and citric acid
Citrocarbonate	Upjohn Co., Kalamazoo, Mich.	Sodium hydrogen carbonate, 20.5%; sodium citrate, 25.6%
DiGel	Plough, Inc., Memphis, Tenn.	Magnesium carbonate; methyl polysiloxane, 0.025 g; aluminum hydroxide; and magnesium hydroxide
Kolantyl	Merrell-National Lab., Richardson-Merrell, Inc., Cincinnati, Ohio	Dicyclomine hydrochloride, 0.0025 g; aluminum hydroxide, 0.180 g; and magnesium hydroxide, 0.170 g
Pepto-Bismol	Norwich Prod., Norwich, Conn.	Bismuth subsalicylate, calcium carbonate, and glycocoll

TABLE 1 *(Continued)*

Antacid	*Source*	*Approximate composition*
Phillips	Phillips Co., Sterling Drug Co., N.Y.	Magnesium hydroxide, 0.311 g
Rolaids	Warner-Lambert Co., Morris Plains, N.J.	Dihydroxyaluminum sodium carbonate, 0.330 g
Tums	Lewis/Howe Co., St. Louis, Mo.	Calcium carbonate, 0.489 g; magnesium trisilate, 0.006 g; magnesium carbonate, 0.011 g; oil of peppermint
Triactin	Norwich Pharm. Co., Norwich, N.Y.	Aluminum hydroxide, magnesium carbonate, magnesium trisiliate, and dicyclomine HCl, 2.5 mg

Thermobalance

A DuPont Model 950 thermobalance was used to record the TG curves. Sample sizes ranged in mass from 5 to 20 mg and were run under a dynamic nitrogen atmosphere at a heating rate of 10°C/min.

DTA (DSC) apparatus

A DuPont DSC cell (which is actually a DTA cell) was used in conjunction with the Model 900 DTA console. Sample sizes ranged in mass from 5 to 10 mg and were contained in small aluminum cups. All samples were heated in a dynamic nitrogen atmosphere at a heating rate of 10°C min^{-1}.

RESULTS AND DISCUSSION

DTA (DSC) results

The DTA curves for the antacids studied are given in Figs. 1 and 2. The DTA (DSC) curves are perhaps the most useful for qualitative identification of the antacid preparations. Because of the maximum temperature limitation of the DuPont DSC cell, endothermic peaks due to the thermal decomposition of calcium and magnesium carbonates are not observed. However, all other lower temperature (<500°C) transitions, such as the thermal decomposition of magnesium hydroxide (Phillips Milk of Magnesia tablets) and so on, are easily observed. Only the antacid tablets (or powders) were studied due to the necessity of solid samples for the thermal analysis techniques; liquids could perhaps also be investigated if previously dried before placing them into the TG or DTA sample holders.

It is not possible to comment on the origin of each endothermic peak (or shoulder peak) in the DTA curves due to either the complexity of the antacid mixture or (in some cases) the unknown composition. The presence of adsorbed moisture can alter the curve in the less than 100°C temperature range while aging effects can cause

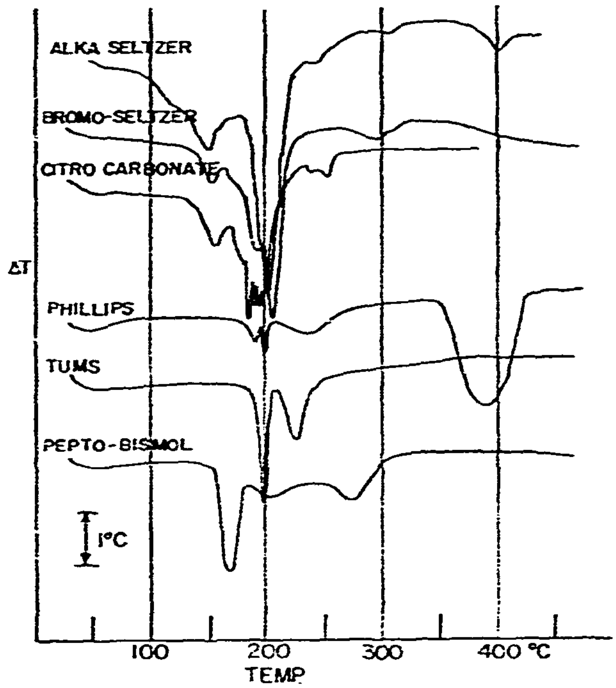

Fig. 1. DTA (DSC) Curves of non-prescription antacids.

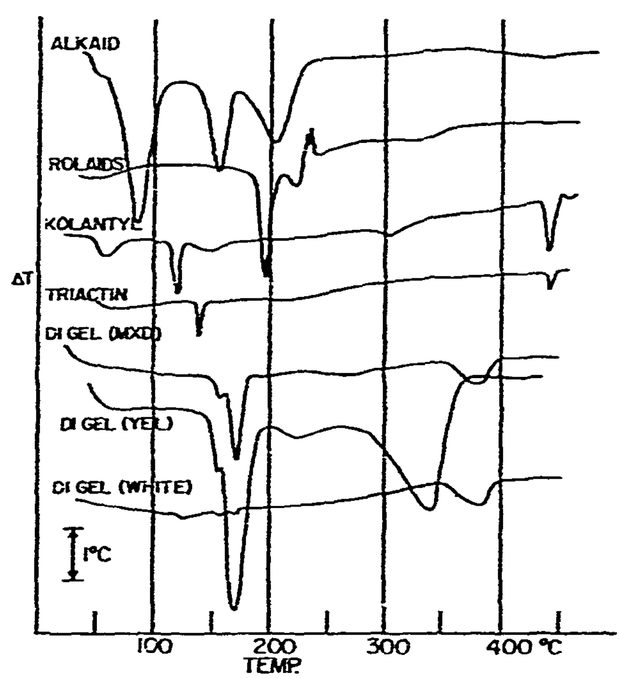

Fig. 2. DTA (DSC) Curves of non-prescription antacids.

changes in the curve at higher temperatures. In the case of antacids containing aluminum hydroxide, the latter would be especially important.

The curves for Alka Seltzer, Bromo-Seltzer and Citrocarbonate contain similar endothermic peaks and other curve features. A shoulder peak with a ΔT_m of about 150 °C is present in each of the curves as well as additional peaks in the ΔT_m range of 200–225 °C. Common compounds in these preparations include sodium hydrogen carbonate and citric acid (or sodium citrate). Alka Seltzer and Bromo-Seltzer contain analgesic compounds such as aspirin, phenacetin and acetaminophen as well, and these curves should be compared with those for other analgesics, as previously reported[2].

Phillips, Tums and Rolaids contain similar peaks in the 175 to 225 °C temperature range although there are no common components in these preparations. The broad endothermic peak with a ΔT_m of 390 °C is due to the decomposition of magnesium hydroxide. Also, Triactin and Kolantyl contain several similar features.

The DiGel antacid tablet consists of two layers, one colored yellow, the other white. If the entire tablet is pulverized, the curve, DiGel (mxd), is obtained. The other two curves, DiGel (yel) and DiGel (white), are for the yellow and white layers, respectively. As can be seen, the mixed curve has features from both the yellow and white layers.

TG results

The TG curves of the antacids studied are given in Figs. 3 and 4.

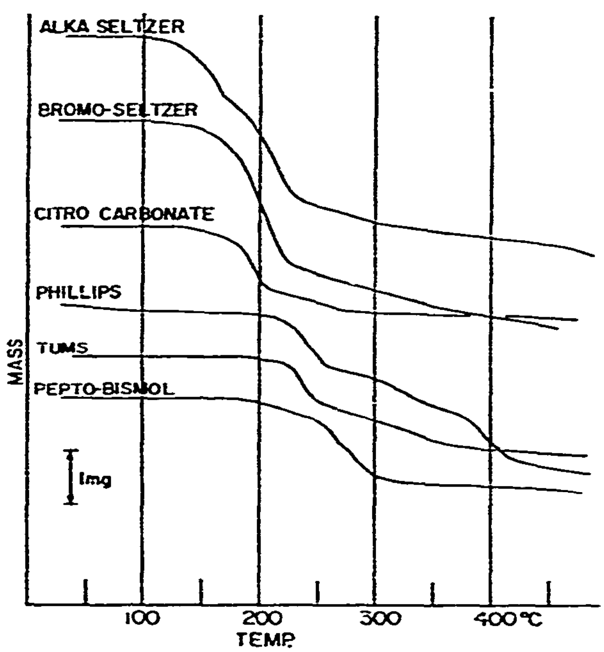

Fig. 3. TG Curves of non-prescription antacids.

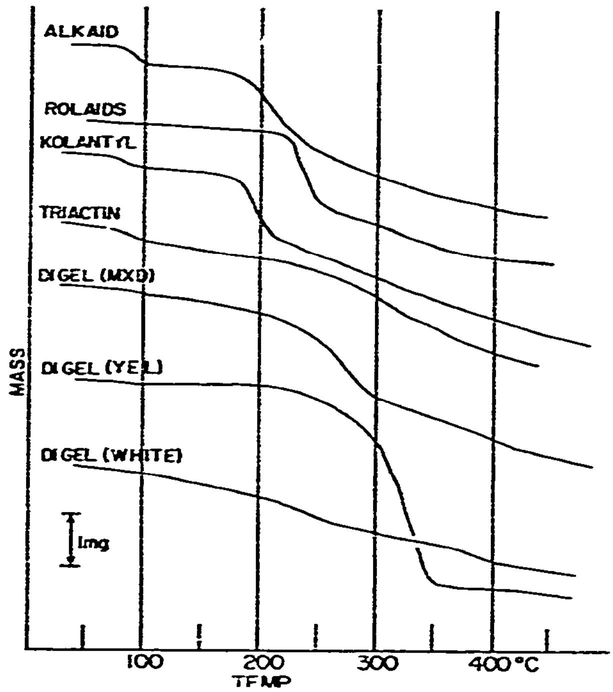

Fig. 4. TG Curves of non-prescription antacids.

As expected, the TG curves are not as useful, perhaps, as the DTA (DSC) curves for the qualitative indentification of the antacids. Similar features (initial procedural decomposition temperatures, T_i) are observed for Alka Seltzer, Bromo-Seltzer and Citrocarbonate. Likewise, T_i values for Phillips, Tums and Rolaids are similar. There are enough differences in the curves for Alkaid, Rolaids, Kolantyl and Triactin for example, to be useful for qualitative identification purposes. As in DTA (DSC) curves, the composite TG curve for DiGel (mxd) has common features with the curves for the yellow and white layers.

GENERAL

From the TG and DTA (DSC) curves, it appears possible to identify, qualitatively, the non-prescription antacids included in this brief survey. The curves are easy to obtain and the thermal analysis instrumentation is relatively inexpensive and widely available. As with all thermal analysis curves, it should be noted that they are also dependent on the instrumental variables such as heating rate, sample container geometry, furnace atmosphere, and so on. These parameters, as well as other precautions that should be observed, are discussed in detail in a book by Wendlandt[3].

ACKNOWLEDGMENT

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REFERENCES

1 R. P. Penna, *Handbook of Non-Prescription Drugs*, Amer. Pharm. Ass., Washington, D.C., 1969, p. 7.
2 W. W. Wendlandt, *Anal. Chim. Acta*, in press.
3 W. W. Wendlandt, *Thermal Methods of Analysis*, Wiley-Interscience, New York, 2nd ed., 1974.