THE STABILIZATION OF MILK OF MAGNESIA BY CITRIC ACID.*

BY E. C. BILLHEIMER AND F. W. NITARDY.[1]

An investigation has been made of the stability of milk of magnesia on long aging at elevated temperatures in containers of various types of glass. It has been determined that if milk of magnesia is stored in an ordinary glass bottle at temperatures approximating summer heat, it will develop excessive alkalinity and a bitter, unpleasant taste. The change may be retarded by using a harder, more resistant glass for the container, and can be almost entirely prevented within practical limits by the use of a pyrex glass container. However, because of the excessive cost of pyrex glass bottles for use as market containers for milk of magnesia, it became necessary to investigate other means of stabilizing the product against deterioration, even when packaged in the ordinary glass bottle.

It has been determined that the increase in alkalinity of milk of magnesia when stored under these conditions, and the development of a bitter taste, are due to reaction of the product with the glass bottle. This is shown by the fact that when a non-soluble glass is used, the changes are greatly retarded or entirely prevented. The same result can be accomplished, however, by adding a very small percentage of citric acid to the milk of magnesia, which appears to interfere with the action of the milk of magnesia on glass, possibly because of its buffering action, and greatly extends the period during which milk of magnesia will remain in its original state of alkalinity and taste, even when stored in an ordinary glass bottle. Milk of magnesia to which has been added 0.15% citric acid develops no bitter taste and no increase in alkalinity even after exposure to a temperature of 100° C. for over 250 hours, whereas uncitrated milk of magnesia turns excessively alkaline and quite unpalatable and bitter in 75 hours under the same treatment; 0.1% of citric acid seems to be sufficient for practical purposes.

A standardized testing procedure was developed whereby measurement could be made of the comparative stability of samples of milk of magnesia in glass bottles when exposed at elevated temperatures for long periods of time. This consisted of filling the bottle with the milk of magnesia, attaching a reflux condenser so that no loss of water would occur by evaporation, and immersing the bottle up to the shoulder in a bath at 100° C. Samples of the milk of magnesia were then removed at intervals for tasting and for measurement of change in alkalinity. This testing procedure was found on repeated trials to give quite reproducible results and was used entirely throughout this comparative study. A temperature of 100° C. is, of course, higher than would ever be encountered in the market, but since the deterioration of the milk of magnesia occurs through the reaction between it and the glass, and the speed of the reaction is greatly influenced by temperature, this elevated temperature was chosen to accelerate the rate of change. It produces the same effect which would otherwise occur much more slowly at ordinary temperature.

Tests were made on a large series of compounds, including various organic acids and salts, to determine their value for the stabilization of milk of magnesia.

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Several of them gave some protection, others either had little or no stabilizing effect or were unsatisfactory for other reasons, such as imparting an objectionable taste to the product or otherwise influencing its physical properties. Citric acid in suitable quantity, which of course forms and is present as magnesium citrate, seemed definitely superior to the others, had no appreciable effect in itself on the taste of milk of magnesia, and gave very decided stabilization even at high temperature. Samples of milk of magnesia were prepared which contained 0.5 Gm., 1.0 Gm., 1.5 Gm. and 2.0 Gm., respectively, of citric acid per liter, and exposed to a temperature of 100° C. under the conditions of the test previously described. A control sample of the same milk of magnesia without citric acid was included. It was found that the uncitrated milk of magnesia developed an incipient bitter taste after forty hours' exposure to this temperature, and a pronounced bitterness after 75 hours. The sample containing 0.5 Gm. of citric acid per liter had a slight bitter taste after 94 hours' heating and a pronounced bitterness after 135 hours. The use of 1.0 Gm. citric acid per liter gave somewhat more protection, as incipient bitterness was not observed until 195 hours and pronounced bitterness until 255 hours of heating. However, the presence of 1.5 Gm. of citric acid per liter, as well as 2.0 Gm., apparently stabilizes the milk of magnesia against development of bitter taste. Only a faint trace of bitterness was noticeable after 275 hours, and after 370 hours of heating at 100° C., the product containing 1.5 Gm. per liter was still practically free from bitter taste. The milk of magnesia containing 2.0 Gm. per liter did not develop a trace of bitter taste even after 370 hours of heating. However, since exposure at 100° C. for 250 hours is a more severe test than exposure to summer temperature for a year or more, 1.0 Gm. per liter, or 0.1% citric acid, in milk of magnesia is apparently all that is required for practical purposes to protect the product under conditions encountered in national marketing operations, as no deterioration was observed in extended marketing tests covering several years with milk of magnesia containing even slightly less than 0.1% of citric acid. Measurements on the alkalinity of these samples of milk of magnesia showed also that the citric acid, in addition to preventing the development of bitter taste, greatly retarded increase in alkalinity through reaction with the glass bottle. This method of stabilization of milk of magnesia with citric acid has been offered to, and accepted by the U. S. Pharmacopœia.

CONCLUSIONS.

1. Milk of magnesia on storage at summer temperature in ordinary glass bottles will undergo deterioration through reaction of the product with the glass. This results in a considerable increase in alkalinity and the development of an unpleasant bitter taste.

2. The increase in alkalinity and development of a bitter taste can be produced in a much shorter time by exposure to a higher temperature, such as 100° C., and a testing procedure has been developed for comparing the stability of variously treated samples of milk of magnesia.

3. The composition of the glass bottle definitely influences the change which occurs in the milk of magnesia on prolonged storage or at high temperatures. The change can be retarded by using a harder, less soluble glass, and practically eliminated by using pyrex glass bottles.

4. The addition of citric acid to milk of magnesia will stabilize it against development of bitter taste and increase in alkalinity in an ordinary glass bottle even on storage at elevated temperatures; 0.1% of citric acid seems to be sufficient for all practical purposes.

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WILLIAM WITHERING AND THE INTRODUCTION OF DIGITALIS INTO MEDICAL PRACTICE.*

BY LOUIS H. RODDIS.[1]

"The Botanical Professor gives annually a gold medal to such of his pupils se are most industrious in that branch of science. . . .It will hardly have charm enough to banish the disagreeable ideas I have formed of the study of botany." This is the view of the "Gentle Science" held by one, when a medical student at the University of Edinburgh, who was to be one of the greatest of English botanists and, perhaps, the greatest medical botanist.

William Withering, the discoverer of the use of digitalis, was born in Shropshire, England, on March 17, 1741. Shropshire is one of the most beautiful counties of England, and its position adjacent to Wales gives it a record of historical tradition similar to the counties on the Scottish border. The English call tha county Salop and its residents Salopians. The highest point in the county, near Withering's birthplace, is a small mountain called the Wrekin, and the local toast is "To all around the Wrekin." The oaks of Shropshire are so celebrated that that tree is often referred to as the "Shropshire weed." A plant that also grew like a weed around every cottage and along every path was the foxglove (*Digitalis purpurea*).

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At Edinburgh, Withering had among his professors such men as Cullen, the author of the celebrated "Practice of Medicine" and the famous anatomist, Alexander Monro, who was distinguished from his equally famous son by the title of Monro *primus*. This son, Monro *secundis*, was succeeded by *his* son, Monro *tertius*. The professorship in anatomy was held at Edinburgh by these three Monros for over 125 years, an example of a real medical dynasty.

After graduating in 1766, Withering went to the little town of Stafford, where he remained for nearly ten years as a country doctor. His practice here was not so large but that he had plenty of opportunity to study botany and mineralogy.

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* Section on Historical Pharmacy, A. PH. A., Portland, meeting, 1935.

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