

## FLAVORING BARIUM SULFATE\*

By ROSCOE E. MILLER, M.D.†  
INDIANAPOLIS, INDIANA

**M**OST patients no longer expect barium sulfate suspensions to taste chalky or unpleasant. Many radiologists and hospital pharmacists can easily improve this aspect of gastrointestinal examinations.

Oral suspensions should be sufficiently palatable so that they will be taken readily by the patient. Disagreeable suspensions often tempt the patient to hesitate and not take the suspension as requested. This prolongs the examination and increases the radiation exposure to both doctor and patient. If the suspension is too obnoxious it may cause nausea, retching, or vomiting and complete refusal by the patient. Spoiled suspensions are particularly prone to do this. Often children cannot be induced to take a second swallow of a repulsive suspension and it is not quite reasonable to insult sick children's taste buds.

The first and most important principle is to eliminate the chalk or mud-like texture that makes the suspension unpalatable. This is easily accomplished by the addition of a good suspending agent such as sodium carboxymethylcellulose or some of the many vegetable "gums" such as pectin, acacia and tragacanth. Because of the great variety and types of these agents available, almost any viscosity level can be obtained; but too thick or excessively paste-like textures, similar to thick cream or butter, will severely limit the amount of suspension that the patient will willingly swallow. Almost all of the present day barium contrast products have such suspending aids already in them whether listed on the container labels or not. Therefore, one must be extremely cautious in adding another suspending aid to these preparations since their viscosity can increase quite rapidly with extremely small additions.

The second principle to follow is to tailor the suspension flavor for the in-

tended consumer. Is it to be taken by adults, children or both? Children usually like a decidedly sweet flavor, but the average adult does not. One of the most popular flavors for children is sweet cherry. Raspberry and sweet orange are also well liked. Wright<sup>21</sup> flavor tested over 600 adults. Their choices, purely for taste alone in descending order, were the syrups of cocoa, raspberry, orange, cherry, sasparilla, citric acid and aromatic syrup of eriodictyon.

The all-around efficient flavoring agents for disguising bitter, salty and other unpleasant tastes, such as occurs with some preservative agents, were the syrups of cocoa, raspberry and aromatic syrup of eriodictyon.

A basic barium suspension with a mild sweet cherry or raspberry flavor can be made for general use and other flavors added as they are chosen by the child or adult patient. A 10 to 1 or higher mixture of cherry with wild cherry is usually better liked than either alone. Some "Kool-aid" or other instant drink flavor can then be added just before the patient drinks the suspension. The radiologist or his pharmacist must decide what brand and type flavors he wants to use and then make some experiments to see if they are compatible with the other substances or additives present and to determine the quantity of sweetening agents that must be added to the basic suspension. A noncaloric type is best and a 1 to 10 mixture of saccharin and sodium cyclamate has proved satisfactory. Sugar and true syrups are generally to be avoided, because barium suspensions are often given to diabetic patients. Chocolate or cocoa should usually be avoided also because some people do not like it, some are allergic to it, and it can always be added at the last moment if desired.

The third principle often followed by

\* From the Department of Radiology, Indiana University Medical Center, Indianapolis, Indiana.

† Associate Professor of Radiology.

flavor experts is to use mixtures. Experience has shown the author that a mild mixture of flavors is best if the radiologist wants to avoid the trouble of regularly adding another flavor at the time of the examination. A mild mixture of three or four flavors such as sweet cherry, wild cherry, raspberry and orange with some vanilla and then a little of a more sharp flavor such as peppermint, lime, apricot, or citric acid has been quite satisfactory. A moderate mixture of various flavors allows the person swallowing the barium suspension to "selectively taste" and pick out the flavor he likes best—if no one flavor, sweetness or texture is predominant. Aromatic powder N.F. containing cinnamon, ginger, cardamom seed and nutmeg is a pleasant flavoring powder with the mixture principle that also can be used by adding 3 gm. of the finely powdered mixture to each kilogram of barium sulfate and mixing thoroughly.

The flavors chosen for a suspension must also disguise the other ingredients of the suspension such as preservative and suspending agents. Masking these additives may even determine some of the flavors.

The location of the radiological laboratory where the suspension is to be used may also influence the choice of flavors since local tastes and customs vary. A strong anise or licorice flavor may be fine in Ankara, Turkey, but not so well received in Kokomo, Indiana. From personal experience, the author can testify that an otherwise fine flavor is not well tolerated if the patients associate its accompanying aroma with a similar one found in the local popular toilet bowl cleanser. A mild but agreeable aroma is pleasant and quite often is a by-product of the flavoring agents. A pleasant odor is particularly desirable in suspensions that are used for barium enemas.

The radiologist, his pharmacist, or the manufacturer must decide whether to use liquid or powdered flavors. This choice is usually made to conform to local mixing or other processing equipment, convenience and cost. Either type flavor can be satisfactory, but a word of caution is necessary.

Fine powders adhere to coarser particles when they are mixed together. This can have an effect on taste because the finer material adsorbed on the coarser may cause a change in flavor.<sup>4</sup> For example, when paprika and sugar are mixed, if the sugar is extra fine and the paprika relatively coarse, the first taste of this mixture will be sweet. When the sugar is coarse and the paprika extra fine, the mixture will not have the sweet taste. The finer powder in each case has coated the coarser and determined the taste.

Relative small amounts of liquid flavors can be sprayed into the powdered barium and then mixed well to form a "dry" product. This is sometimes desired for prolonged storage, convenient packaging or shipment.

Some pharmaceutical manufacturers have "taste panels" of several people to taste test their products. These people are carefully recruited from employees and their children. In most commercial concerns, the flavoring of their product is a "top trade secret" known only to a few individuals and jealously guarded. "Coca-Cola" is an example and, of course, is a mixture. If the radiologist will try some mixtures and test only two or three at a time, he should soon be quite successful. He can recruit or draft a taste panel from x-ray technicians, students, or employees and develop a highly acceptable taste for his locality. The taste panel, however, should not be a haphazard selection, but should follow rational rules such as those given by Moir.<sup>19</sup>

The radiologist should realize that the popularity of flavors changes from time to time, and that there are many reasons for a variance in an individual's taste ability and choice of flavors. For example, some people are "nontasters" and some tastes are different partly because of different solubilities in different salivas. Taste thresholds also vary. They have been correlated by Griffin and Fischer<sup>8,12</sup> with salivary oxidation rates and inversely correlated with salivary catalase activity.

Kaplan and his co-workers<sup>15</sup> tested 121

subjects with duodenal and stomach ulcers and found that taste differed and was more sensitive in those patients who had the duodenal ulcers than in those with the stomach ulcers.

Henkin and Powell<sup>14</sup> found that patients with cystic fibrosis were much more sensitive to taste. They could detect all substances at concentrations 40 to 13,000 times more dilute than the concentrations at which the same substances could be detected by normal volunteers. On the other hand, there is a significantly higher percentage of nontasters among persons with nodular goiter than normal controls.<sup>13</sup> Fallis *et al.*<sup>7</sup> reported decreased acuity for sodium chloride in hypertensive patients.

There is also a relationship between nontasters and parents of Mongols, and between taste thresholds and the amount of cigarettes smoked.<sup>8</sup>

There is also a variation in tastes and a relationship between nontasters and race. Among Brazilian Indians, only 1.2 per cent, and among Navahoes, Cree and Beaver Indians only 2.0 per cent are nontasters; but Bombay Indians reach a high of 42.5 per cent. The rate of nontasters is less than 2 per cent for some American Negroes, 7 per cent among Japanese, 17 per cent for Welsh and 30 per cent for Western Europeans and Caucasians in general.<sup>2,17</sup> Taste sensitivity also varies with age and sex for different sweet, sour, salty and bitter substances.<sup>11</sup> Females are more sensitive tasters in all ages. Taste sensitivity in both sexes gradually rises from infancy to a peak at the ages of 16 to 20 years and thereafter declines. The decline is much more rapid for males. Cooper, Bilash and Zubek<sup>6</sup> have shown that apparently some individuals have a delayed peak for sour, sweet and bitter substances. These sensitivities declined only after reaching peaks in the 30 to 34 year age groups. Sensitivity for all modalities declined after 50 years in both male and females. Sensitivity to common table salt, however, was found to decline consistently with increasing age.

Taste may also vary because of a difference in anatomy. The taste receptors for

bitter occur on the upper surface at the back of the tongue, and those for sour occur primarily at the sides. Anatomic investigations have shown that the gustatory papillae reach full development at puberty,<sup>1</sup> and several studies have demonstrated that in adult life the number of taste buds tend to decrease with age.<sup>3,18</sup> Children have taste buds studding the hard palate, walls of the throat, and the central upper surface of the tongue. By maturity, however, most of the taste buds are lost from these areas. During normal aging, many of the remaining taste buds disappear.

Many of these taste differences can be explained on the basis of heredity. Blakeslee<sup>5</sup> and Fox<sup>10</sup> demonstrated that the ability of persons to taste phenylthiocarbamide and other substances is heritable as a mendelian recessive. Even those who get any taste at all from the phenylthiocarbamide describe it variously as bitter, sweet, salty or sour.

Fallis, Lasagna and Tétreault<sup>7</sup> taste tested thresholds in 20 subjects for sodium chloride dissolved in distilled water and found some subjects identifying the solutions as "quinine water," "Epsom salts" and other substances. Moir<sup>19</sup> tested 60 persons as to their ability to recognize by taste 4 simple flavors—orange, lemon, lime and vanilla. Only 1 person had a perfect score. Five had records of over 75 per cent, but 48 failed to reach 50 per cent. Vanilla was variously identified as black currant, lime, apricot, greengage, damson, lemon, pineapple, orange, tangerine, almond, red currant and strawberry.

It is not only taste ability and sensitivity that influence food and flavor likes and aversions, but these are further influenced by cultural, social and idiosyncratic variables. Smith, Powell and Ross<sup>20</sup> found that there are more food dislikes among neurotic and anxious individuals than among more normal people. Those individuals with siblings, especially older siblings, have more food dislikes as well as those who do not attend church regularly. Also females have more food dislikes than males.

Some of the idiosyncratic variations that

occur in taste thresholds are due to hormone therapy, the ingestion of aspirin, the first 3 days of menstruation, stressful situations and pregnancy.<sup>9,16</sup>

## SUMMARY

Because of many variations in different people, flavor likes and dislikes are apt to differ. It is quite evident, then, that the radiologist will never find a flavor or combination that will please everyone. Nevertheless, he should not be discouraged from flavoring his barium suspensions and trying to find better flavor combinations. By doing this, through some of the methods suggested here, the radiologist can succeed in making gastrointestinal examinations much more pleasant for the great majority of his patients.

The main principles to follow in flavoring barium sulfate suspensions are:

1. Eliminate the chalk-like texture by the addition of a good suspending or dispersing agent.
2. Do not make the suspension too viscous.
3. Use a mixture of flavors so that no one flavor, sweetness or texture predominates.
4. Test a few different mixtures on several carefully selected sensitive tasters chosen from the local laboratory.

Department of Radiology  
Indiana University Medical Center  
1100 West Michigan Street  
Indianapolis, Indiana 46207

## REFERENCES

1. ALLARA, E. Recherche sull'organo del gusto dell'uomo. *Arch. ital. anat. e embriol.*, 1939, 42, 506-564.
2. ALLISON, A. C., and BLUMBERG, B. S. Ability to taste phenylthiocarbamide among Alaskan Eskimos and other populations. *Human Biol.*, 1959, 31, 352-359.
3. AREY, L. B., TREMAINE, M. J., and MONZINGO, F. L. Numerical and topographical relations of taste buds to human circumvallate papillae throughout life span. *Anat. Rec.*, 1935, 64, 9-25.
4. BANCROFT, W. D. Applied Colloid Chemistry. McGraw-Hill Book Company, Inc., New York, 1926.
5. BLAKESLEE, A. F. Genetics of sensory thresholds: taste for phenyl thio carbamide. *Proc. Nat. Acad. Sc.*, 1932, 18, 120-130.
6. COOPER, R. M., BILASH, I., and ZUBEK, J. P. Effect of age on taste sensitivity. *J. Gerontol.*, 1959, 14, 56-58.
7. FALLIS, N., LASAGNA, L., and TÉTREAU, L. Gustatory thresholds in patients with hypertension. *Nature*, 1962, 196, 74-75.
8. FISCHER, R., and GRIFFIN, E. Pharmacogenetic aspects of gustation. *Arzneimittel-Forsch.*, 1964, 14, 673-686.
9. FISCHER, R., and GRIFFIN, F. "Taste-blindness" and variations in taste-threshold in relation to thyroid metabolism. *J. Neuropsychiat.*, 1961, 3, 98-104.
10. FOX, A. L. Relationship between chemical constitution and taste. *Proc. Nat. Acad. Sc.*, 1932, 18, 115-120.
11. GLANVILLE, E. V., KAPLAN, A. R., and FISCHER, R. Aging, sex, and taste sensitivity. *J. Gerontol.*, 1964, 19, 474-478.
12. GRIFFIN, F., and FISCHER, R. Differential reactivity of saliva from "tasters" and "non-tasters" of 6-n-propylthiouracil. *Nature*, 1960, 187, 417-419.
13. HARRIS, H., KALMUS, H., and TROTTER, W. R. Taste sensitivity to phenylthiourea in goitre and diabetes. *Lancet*, 1949, 2, 1038-1039.
14. HENKIN, R. I., and POWELL, G. F. Increased sensitivity of taste and smell in cystic fibrosis. *Science*, 1962, 138, 1107-1108.
15. KAPLAN, A. R., FISCHER, R., GLANVILLE, E., POWELL, W., KAMIONKOWSKI, M., and FLESHLER, B. Differential taste sensitivities in duodenal and gastric ulcer patients. *Gastroenterology*, 1964, 47, 604-609.
16. KAPLAN, A. R., POWELL, W., FISCHER, R., and MARSTERS, R. Re-examination of genetic aspects of taste thresholds for thiourea-type compounds. Abstract in Genetics Today. Edited by S. J. Geerts. Pergamon Press, London, 1963.
17. LEE, B. F. Genetic analysis of taste deficiency in American Negro. *Ohio J. Sc.*, 1934, 34, 337-342.
18. MOCHIZUKI, Y. Studies on papilla foliata of Japanese. *Okajimas Folia anat. japon.*, 1939, 18, 337-369.
19. MOIR, H. C. Some observations on appreciation of flavor in foodstuffs. *Chem. & Indust.*, 1936, 55, 145-148.
20. SMITH, W., POWELL, E. K., and ROSS, S. Manifest anxiety and food aversions. *J. Abnorm. & Social Psychol.*, 1955, 50, 101-104.
21. WRIGHT, H. N. Comparative efficiency of commonly used flavoring agents. *J.A.M.A.*, 1937, 108, 959-961.