ARTICLE

Taste Test

Children Rate Flavoring Agents Used With Activated Charcoal

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Objective: To compare flavoring agents added to activated charcoal (AC) to determine which mixture is most palatable to children.

Design: Healthy volunteers between the ages of 3 and 17 years participated in a prospective masked trial. Five identical pitchers were prepared containing AC alone, AC with chocolate milk, AC with Coca-Cola (Coca-Cola Corp, Atlanta, Ga), AC with cherry-flavored syrup, and AC with sorbitol. Subjects tasted all 5 substances in random order. Children younger than 8 years rated taste on a 10-point Faces Scale. Children 8 years and older used a 100-point visual analog scale to rate taste and, separately, ease of swallowing. All children were asked which mixture was best. Ratings were compared using 1-way analysis of variance, and comparisons for all pairs were made using the Tukey test. $P<.05$ was considered significant.

Results: Mean age among the 53 children enrolled was 8.3 years; 23 children were younger than 8 years. Girls made up 52% of the group. Taste scores for chocolate milk, Coca-Cola, and cherry-flavored syrup were significantly better than those for no flavoring agent. The scores for ease of swallowing for Coca-Cola, chocolate milk, and cherry-flavored syrup were significantly better than those for either no flavoring agent or sorbitol. When asked to choose a single best flavoring agent, 39% chose chocolate milk, 23% picked Coca-Cola, and 23% chose cherry-flavored syrup.

Conclusion: The addition of chocolate milk, Coca-Cola, or cherry-flavored syrup to AC improves palatability for children and is favored over no flavoring agent or sorbitol.

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ACCIDENTAL and intentional toxic ingestions are an important problem involving children and adolescents. In 1990, the American Association of Poison Control Centers (Washington, DC) noted that activated charcoal (AC) had surpassed syrup of ipecac as the gastrointestinal decontaminant of choice. Activated charcoal is now the first-line therapeutic intervention recommended for pediatric poisonings.[1,2]

Despite its success in absorbing toxic substances from the intestinum, the palatability of AC is problematic. It forms a thick, gritty slurry that must be swallowed or administered enterally by a nasogastric tube. Children often refuse to drink AC. Nasogastric tube placement is invasive and aversive. This procedure also has several potential complications, including incorrect tube placement, esophageal injury, and the induction of emesis with possible aspiration risk.[2-4] Studies of AC found that the addition of sorbitol seemed to improve its palatability for adults, and this mixture is commonly used in the emergency department setting.[5-7] Unfortunately, the addition of sorbitol to AC has been found to have an increased incidence of adverse effects, particularly in children, including induction of emesis as well as fluid and electrolyte abnormalities.[6,8-10] Studies of adults have demonstrated increased AC palatability with the addition of other flavoring agents.[11-13] It is difficult to extrapolate these findings to children, however, and there have been no studies of flavoring agents in the pediatric population.

The objective of this study was to compare several flavoring agents added to AC to determine which mixture was most palatable to children.

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RESULTS

Fifty-five children were considered for enrollment in the study. One child, an oncology patient who was receiving chemotherapy, was excluded from participation prior to data collection. Of the 54 enrolled children, all were able to complete

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METHODS

A prospective double-blind study was conducted among a convenience sample of healthy volunteers between the ages of 3 and 17 years who came to a tasting booth at a hospital-sponsored bicycle fair in May 1999. Mixtures were given to participants by a small group of pediatric emergency physicians. Participants were told that this was a study of a substance used to absorb poisonous substances from the stomach and intestines. The risks and benefits of participation in the study were explained to both parents and participants. Parental consent (and subject assent if ≥ age 8 years) was obtained. Participation was rewarded with an inexpensive toy or water bottle upon completion of the taste test.

Exclusion criteria included abnormalities of the airway or cardiorespiratory, hepatic, renal, or central nervous systems; a history of adverse reactions to AC; or lactose intolerance. Children taking any medications were also excluded. The institutional review board of Primary Children's Medical Center (Salt Lake City, Utah) reviewed and approved this study.

Five AC mixtures were prepared in identical pitchers. A commercially available formulation of AC (Liqui-Char; Jones Pharma Inc, St Louis, Mo) with an adsorption power of 99%[14] was used for 4 of the preparations. This consists of 25 g of AC, 1.5 g of carboxymethylcellulose, and 75 mL of distilled water. The flavoring agents selected are typically available in the emergency department. Most had been shown to have little effect on the adsorptive capacities of AC.[11,12,14,15] The following 4 flavoring agents were used: (1) chocolate milk, (2) Coca-Cola (Coca-Cola Corp, Atlanta, Ga), (3) cherry-flavored syrup, and (4) sorbitol. The fifth preparation consisted of AC alone. Chocolate milk was added to AC in 1:1 volume equivalents, as was Coca-Cola. Cherry-flavored syrup was obtained from the hospital pharmacy and mixed per pharmacy recommendations as 5 mL of syrup per 30 mL of AC. A commercially available preparation of AC with sorbitol (Liqui-Char) consisting of 25 g of AC, 27 g of sorbitol, and 118.3 mL of distilled water was used for the fourth preparation.

Children and researchers were blinded to the AC preparations. Enrolled study subjects tasted 5 mL each of all 5 mixtures once, in random order, separated by sips of water. Randomization was achieved by forming 4 tasting stations and allowing participants to line up in front of each station. Children younger than 8 years rated the taste of each mixture on a 10-point Faces Scale.[16,17] These children were told that a score of 0 meant "great" and a score of 10 meant "horrible." Children 8 years and older used a 100-mm visual analog scale for taste and, separately, ease of swallowing.[18] Here, 0 signified "great" and 100, "horrible." Investigators also recorded the subject's age, sex, and any adverse events.

Ratings were compared using a 1-way analysis of variance, with comparison of all pairs using the Tukey test. Taste scores for the 2 age groups were analyzed separately and then together. For the pooled analysis, taste scores from the Faces Scale were multiplied by a factor of 10 to standardize these with the scores from the 100-mm visual analog scale. Because only children 8 years and older ranked ease of swallowing, these scores were analyzed as a single group. All scores were inverted for ease of ranking, so higher scores reflected increased preference. Statistical significance was defined as $P<.05$. An a priori power analysis showed that 50 subjects would yield 80% power to detect a significant difference of 20 points on a 100-point scale.

the tasting with the exception of a 3-year-old girl who became upset and was excused from completing the study. Her scores were not included in this analysis. Therefore, final data were available for 53 children. Participants ranged in age from 3 to 17 years, with a mean age of 8.3 years. Twenty-two subjects were younger than 8 years, and 31 children were 8 years or older. Girls constituted 52% of the group.

Taste scores for the 2 age groups were analyzed separately and pooled. Because the results of the separate analyses did not differ from the pooled results, only the pooled results are presented here. The mean scores for taste and ease of swallowing by flavoring agent are shown in the **Table**. In all-pairs comparisons for taste, chocolate milk, Coca-Cola, and cherry-flavored syrup scored significantly better than no flavoring agent. Chocolate milk also scored significantly better than sorbitol. No other flavoring agents achieved statistically significant differences for taste. **Figure 1** graphically depicts the mean scores for taste among all children. Regarding ease of swallowing, chocolate milk, Coca-Cola, and cherry-flavored syrup all achieved significantly higher mean scores than either sorbitol or no flavoring agent. **Figure 2** shows mean scores for taste among children 8 years and older.

Thirty-nine percent of the children (95% confidence interval, 29%-51%) rated chocolate milk the best flavor. Twenty-three percent of the children each rated Coca-Cola and cherry-flavored syrup the best. All 3 supplemental flavors (chocolate milk, Coca-Cola, and cherry-flavored syrup) were rated best significantly more often than were sorbitol (15%) or no flavor (6%).

COMMENT

To our knowledge, this study is the first to examine the effect of the addition of flavoring substances to AC and the resulting palatability to children. The addition of chocolate milk, Coca-Cola, or cherry-flavored syrup to AC resulted in a significantly better score for both taste and, separately, ease of swallowing.

A review of the literature verifies the poor palatability of AC. As early as 1976, recommendations were made to flavor AC preparations.[19] In 1994, Scharman and Krenzelok[20] found that the primary perceived problem with AC administration among emergency department nurses was its poor palatability. Follow-up recommendations by the authors included the addition of a flavoring agent to AC.

Studies of flavoring agents, however, have been limited to adults. Cooney and Roach[15] found that a 1:1 mixture of sucrose and AC provided sufficient flavor without substantial loss of adsorbance. Cooney[13] also compared

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Scores for Taste and Ease of Swallowing by Flavoring Agent

Flavoring Agent	Taste Score, Mean: Age <8 y* (n = 25)	Taste Score, Mean: Age ≥8 y† (n = 28)	Taste Score, Mean: Pooled Results‡ (n = 53)	Swallowing Score, Mean: Age ≥8 y§ (n = 28)
Chocolate milk	66	82	74	70
Coca-Cola‖	62	74	68	62
Cherry-flavored syrup	56	70	63	62
Sorbitol	42	58	50	28
None	31	45	38	27

*Children younger than 8 years completed a 10-point Faces Scale score, shown here multiplied by 10 for ease of comparison.

†Children 8 years or older completed a 100-mm visual analog scale.

‡There was no statistically significant difference between results in the 2 age groups.

§Only children 8 years or older rated ease of swallowing on a 100-mm visual analog scale.

‖Coca-Cola Company, Atlanta, Ga.

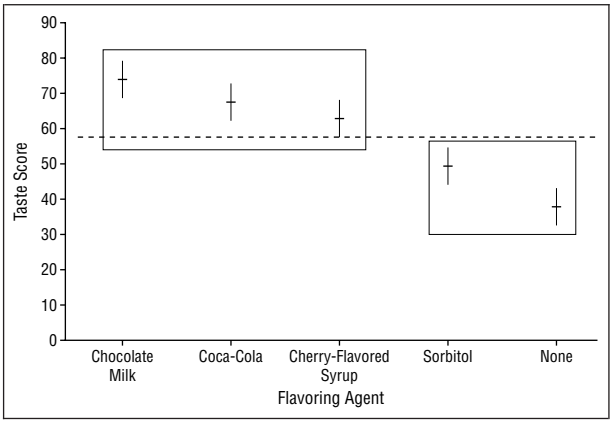

Figure 1. *Mean scores for taste among all children (N=53). Daggers represent the SEM. The dashed line denotes the grand mean. Boxes are drawn around groups of means that do not differ significantly (P >.05). Coca-Cola is manufactured by the Cola-Cola Company, Atlanta, Ga.*

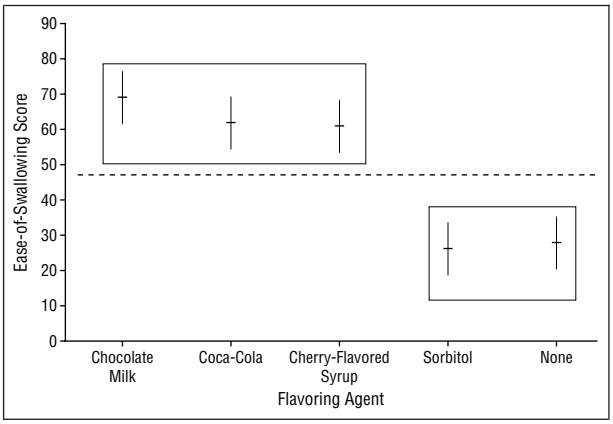

Figure 2. *Mean scores for ease of swallowing among children 8 years and older (n=28). Daggers represent the SEM. The dashed line denotes the grand mean. Boxes are drawn around groups of means that do not differ significantly (P >.05). Coca-Cola is manufactured by the Coca-Cola Company, Atlanta, Ga.*

the palatabilities of AC formulations flavored with sucrose, sorbitol, or saccharin with regard to taste, texture, ease of swallowing, and overall impression. No significant differences were noted among the flavored mixtures, but all 3 flavored formulations were significantly more acceptable than the unflavored mixture ($P < .005$). In a review, Katona et al[21] recommended the addition of carboxymethylcellulose, sucrose, saccharin, chocolate syrup, or sorbitol to increase the palatability of charcoal. No similar studies of AC and various flavoring agents were performed in the pediatric population.

This study looked specifically at children. As per a priori power calculations, a total of 53 participants completed the series of different flavoring agents. Interestingly, no significant differences were noted among the mixtures flavored with chocolate milk, Coca-Cola, or cherry-flavored syrup. However, these 3 flavored formulations were significantly more acceptable to children than the unflavored mixture ($P < .05$). Although subject order effect could not be analyzed because of randomization, it should not affect the results.

This study had several limitations. The concentration of AC was not identical for each mixture; the mixtures containing chocolate milk and Coca-Cola were half as concentrated as the other 3. Children would need to drink twice the volume of these mixtures to receive the same dose of AC as in the others. However, if AC is significantly more palatable in this formulation, a larger quantity of liquid might be taken more readily. In addition, the concentration, and therefore the consistency of AC with cherry-flavored syrup, was similar to that of AC with no flavoring agent. For both taste and ease of swallowing, AC with cherry-flavored syrup was rated significantly better than no flavoring agent. Therefore, it was probably not dilution of AC alone that was responsible for the ratings difference. Another possible limitation is that tasting trials were conducted in full view of other study participants and parents. Parental presence may have led to interference, such as encouraging children to complete the trial. Finally, this was a convenience sample, which may have led to biased results. As an aside, caution should be exercised when giving chocolate milk as a flavoring agent to children with potential allergies to cow's milk.

In conclusion, we found that the addition of chocolate milk, Coca-Cola, or cherry-flavored syrup to AC significantly improved both the taste and the ease of swallowing for children when compared with no added flavoring agent or sorbitol. It would require further study to determine if the use of these flavoring agents may decrease the need for nasogastric tube placement. Further studies should also address the acceptance of flavoring agents, including the more diluted mixtures used in our study, in clinical practice.

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REFERENCES

1. Chyka PA, Seger D. Position statement: single-dose activated charcoal [review]. American Academy of Clinical Toxicology, European Association of Poisons Centres and Clinical Toxicologists; *J Toxicol Clin Toxicol.* 1997;35:721-741.
2. Burns MM. Activated charcoal as the sole intervention for treatment after childhood poisoning. *Curr Opin Pediatr.* 2000;12:166-171.
3. Harris CR, Filandrinos D. Accidental administration of activated charcoal into the lung: aspiration by proxy. *Ann Emerg Med.* 1993;22:1470-1473.
4. Fatal pulmonary aspiration of oral activated charcoal. *BMJ.* 1988;297:918-919.
5. Minocha A, Krenzelok EP, Spyker DA. Dosage recommendations for activated charcoal-sorbitol treatment. *J Toxicol Clin Toxicol.* 1985-1986;23:579-587.
6. James LP, Nichols MH, King WD. A comparison of cathartics in pediatric ingestions. *Pediatrics.* 1995;96(suppl 2, pt 1):235-238.
7. McFarland AK III, Chyka PA. Selection of activated charcoal products for the treatment of poisonings. *Ann Pharmacother.* 1993;27:358-361.
8. Barceloux D, McGuigan M, Hartigan-Go K. Position statement: cathartics [review]. American Academy of Clinical Toxicology, European Association of Poisons Centres and Clinical Toxicologists. *J Toxicol Clin Toxicol.* 1997;35:743-752.
9. Moore CM. Hypernatremia after the use of an activated charcoal-sorbitol suspension [letter]. *J Pediatr.* 1988;112:333.
10. Mauro LS, Nawarskas JJ, Mauro VF. Misadventures with activated charcoal and recommendations for safe use. *Ann Pharmacother.* 1994;28:915-924.
11. Scholtz EC, Jaffe JM, Colaizzi JL. Evaluation of five activated charcoal formulations for inhibition of aspirin absorption and palatability in man. *Am J Hosp Pharm.* 1978;35:1355-1359.
12. Navarro RP. Relative efficacy and palatability of three activated charcoal mixtures. *Vet Hum Toxicol.* 1980;22:6-9.
13. Cooney DO. Palatability of sucrose-, sorbitol-, and saccharin-sweetened activated charcoal formulations. *Am J Hosp Pharm.* 1980;37:237-239.
14. Eisen TF. The adsorption of salicylates by a milk chocolate-charcoal mixture. *Ann Emerg Med.* 1991;20:143-146.
15. Cooney DO, Roach M. Sucrose as a sweetener for activated charcoal. *Am J Hosp Pharm.* 1979;36:797-798.
16. Chambers CT, Giesbrecht K, Craig KD, Bennet SM, Huntsman E. A comparison of faces scales for the measurement of pediatric pain: children's and parents' ratings. *Pain.* 1999;83:25-35.
17. Terai T, Yukioka H, Asada A. Pain evaluation in the intensive care unit: observer-reported faces scale compared with self-reported visual analog scale. *Reg Anesth Pain Med.* 1998;23:147-151.
18. Jensen MP, Miller L, Fisher LD. Assessment of pain during medical procedures: a comparison of three scales. *Clin J Pain.* 1998;14:343-349.
19. Gwilt PR, Perrier D. Influence of "thickening" agents on the antidotal efficacy of activated charcoal. *Clin Toxicol.* 1976;9:89-92.
20. Scharman EJ, Krenzelok EP. Nursing attitudes towards charcoal administration: impact on patient care. *Vet Hum Toxicol.* 1994;36:472-474.
21. Katona BG, Siegel EG, Cluxton RJ Jr. The new black magic: activated charcoal and new therapeutic uses [review]. *J Emerg Med.* 1987;5:9-18.

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