Fluoride Content and Intake From Children's Beverages

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INTRODUCTION

Fluoride is an important mineral that strengthens dental enamel against acid attack to prevent caries. Though most systemic fluoride is obtained via fluoridated water, there are measurable amounts in other foods and beverages.[1] The Food and Nutritional Board within the National Academies of Sciences, Engineering and Medicine established upper limits for fluoride intake based on age (Fig. 1).[2] If the upper limit is surpassed, dental fluorosis can occur.

Nearly 20% on US children report drinking no water at all. [5] Instead, their liquid intake consists of sugar sweetened drinks. Fluoride content in these drinks may be unknown, therefore this study aimed to measure pH and fluoride concentration of popular children's beverages to estimate the amount of fluoride consumed.

Age	Male	Female	Pregnancy	Lactation
Birth to 6 months	0.7 mg	0.7 mg		
7–12 months	0.9 mg	0.9 mg		
1–3 years	1.3 mg	1.3 mg		
4–8 years	2.2 mg	2.2 mg		
9–13 years	10 mg	10 mg		
14–18 years	10 mg	10 mg	10 mg	10 mg
19–51 years	10 mg	10 mg	10 mg	10 mg
51+ years	10 mg	10 mg		

Figure 1: Tolerable daily upper intake of fluoride based on age established by the Food and Nutritional Board.

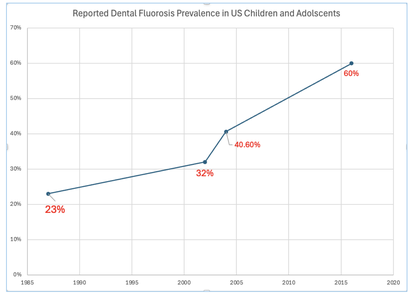

Figure 2: Reported rates of fluorosis documented by NHANES data demonstrating the increased prevalence over the last few decades.

MATERIAL AND METHODS

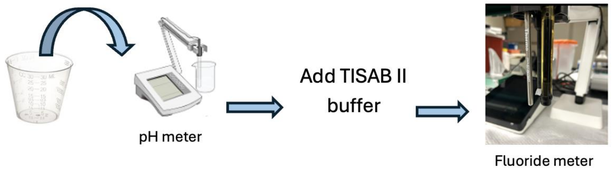

Figure 3: Schematic representation of methodology.

30 mL of each drink was obtained. The pH was measured using a pH meter, then 30 mL of TISAB II buffer solution was added (1:1 dilution). Fluoride concentrations were determined using an Orion fluoride ion-selective electrode. All measurements were performed in triplicate to ensure analytical reproducibility.

The measured fluoride concentrations were used to estimate daily intake (EDI), assuming an 8 oz (240 mL) serving size, and were compared against tolerable upper intake Levels (UL) using descriptive analysis.

RESULTS

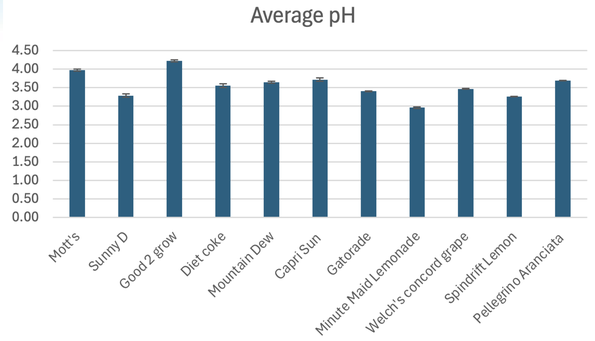

Figure 3: Average pH values. 3 samples of each beverage were used to determined the average pH.

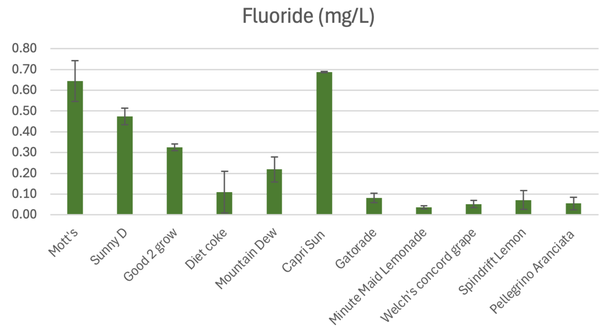

Figure 4: fluoride measurements. 3 buffered samples of each beverage were used to determined the average in mg/L.

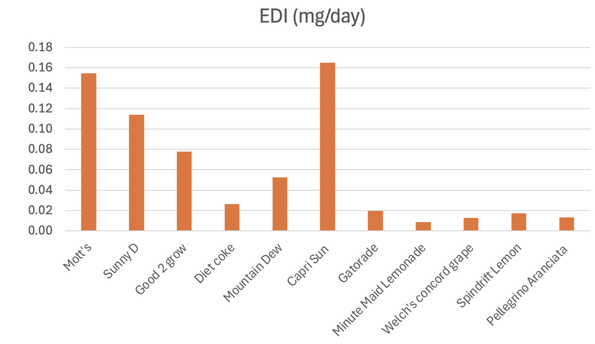

Figure 5: Estimated daily intake. Amount of fluoride ingested from 8oz of each beverage.

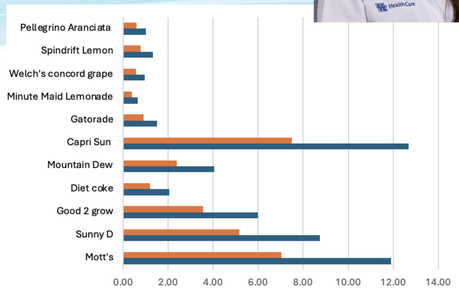

Figure 6: Contribution of beverage consumption to daily upper limit of fluoride. 1-3 (blue) and 4-8 years old (orange). Shown as percentage.

All beverages showed a pH between 3(0.03) and 4(0.03). Fluoride concentrations ranged from 0.04(0.01)–0.69(0.00) mg/L, with fruit drinks showing the highest concentrations. EDI ranged from 0.01–0.16 mg/day. %UL for children ages 1–3 years ranged from 1–13% and from 1-8% for children ages 4-8 years.

DISCUSSION

Figure 7: The 11 beverages sampled in this study.

The prevalence of dental fluorosis in the United States has significantly increased over the last several decades. This could be occurring from multiple factors including an increased reporting of fluorosis by providers or excess fluoride in drinking water, but an important factor that may easily get overlooked is dietary fluoride in beverages besides water. Toddlers and young children have the highest reported juice consumption of any age group in the US.[6] This research demonstrates the varying amounts of fluoride ingested with several popular drinks. Capri Sun had the highest available fluoride content (0.69mg/L) compared to 10 other drinks used in this study, while Minute Maid Lemonade had the lowest amount (0.04mg/L). These results demonstrate that drink preference matters and may put children at risk of developing dental fluorosis.

CONCLUSIONS

Findings showed significant variation in fluoride levels, with the highest amounts found in apple juice and Capri Sun. Although no single drink exceeded 13% to the UL, these beverages could significantly impact the total fluoride intake of frequent drinkers.

More research is needed to document the available fluoride content in other foods and beverages.

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References: 1. National Institute of Health. "The Story of Fluoridation." National Institute of Dental and Craniofacial Research, U.S. Department of Health and Human Services, Dec. 2024, www.nidcr.nih.gov/health-info/fluoride/the-story-of-fluoridation. 2. Evidence-Based Clinical Recommendations on the Prescription of Dietary Fluoride Supplements for Caries Prevention Rozier, R. Gary et al. 3. Do LG, Sawyer A, John Spencer A, et al. Early Childhood Exposures to Fluorides and Cognitive Neurodevelopment: A Population-Based Longitudinal Study. Journal of Dental Research. 2024;104(3):243-250. doi:10.1177/00220345241299352 4. Buzalaf MA, Pessan JP, Fukushima R, Dias A, Rosa HM. Fluoride content of UHT milks commercially available in Bauru, Brazil. J Appl Oral Sci. 2006 Jan;14(1):38-42. doi: 10.1590/s1678-77572006000100008. PMID: 19089028; PMCID: PMC4327169.