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MULTIDIMENSIONAL BIO-CHEMICAL ASSESSMENT OF CARBONATED BEVERAGE IN BILASPUR C.G.

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ABSTRACT:

The global proliferation of "junk drinks" has mirrored the rise of ultra-processed fast foods , contributing significantly to metabolic and dental pathologies. This research presents a novel synthesis of four emerging scientific domains within the context of cold drink formulations. We investigate the synergistic dental erosion caused by phosphoric acid and synthetic colorants, propose a framework for sensory engineering to trigger the Effect' for satiety, examine the disruptive impact of non-nutritive sweeteners (NNS) on bacterial quorum sensing, and evaluate the preservation efficacy of freshness sensors embedded in seaweed-based mono-material packaging. Drawing on biochemical tests like Molisch's and Fehling's, which confirm high concentrations of refined sugars in commercial beverages, this study advocates for a paradigm shift in beverage design to mitigate chronic health risks.

Keywords: cold drinks , dental erosion , NNS, quorum sensing, phosphoric acid, seaweed packaging.

Introduction

Modern beverage consumption has shifted from natural, plant-based hydration to complex chemical solutions high in refined carbohydrates and saturated additives. As urbanization increases the demand for "quick meals" and convenience, cold drinks have become a primary source of liquid calories. However, these drinks are frequently characterized by an absence of essential nutrients and an abundance of substances that contribute to obesity, type 2 diabetes, and cardiovascular disease. While previous many researches were focused on caloric intake, this paper explores the deeper biochemical interactions of beverage components, such as the impact of phosphoric acid on dental structures and the potential for sensory engineering to modulate metabolic hormones like GLP-1. Furthermore, as the industry moves toward "sugar-free" alternatives, the influence of non-nutritive sweeteners (NNS) on the gut microbiome—specifically regarding bacterial quorum sensing—presents a new frontier in digestive health research, particularly given that in surveys of young adults (ages 20–30), 20% explicitly identified "tooth sensitivity" as a direct physical change they noticed after regular consumption of aerated drinks and 30% of respondents in the same group observed visible enamel erosion, which is the leading precursor to chronic sensitivity. So , we analysed common cold drinks found in bilaspur like coco cola , sprite , limka , fanta and the further results are as follows-

Research Objectives

1. To analyze the synergistic erosive effects of phosphoric acid and synthetic material present in cold drinks on human dental enamel.
2. To develop a sensory profile for cold drinks that optimizes the satiety response for BMI.
3. To investigate how NNS interfere with quorum sensing and postbiotic production in the gut microbiome.
4. To integrate freshness sensors into seaweed-based mono-material barriers to enhance the shelf-life and sustainability of engineered beverages.

Methods

Primary Biochemical Analysis :

- phosphoric acid test :

  Small samples of each brand of cold drinks were taken in separate test tubes and Ammonium Molybdate followed by concentrated Nitric Acid (HNO3) was added to it. The solution was heated. Appearance of canary-yellow precipitate confirmed the presence of phosphate ions in cold drinks

S.No	Name Of Cold Drinks	Observation	Conclusion
1	Coco cola	Canary-Yellow ppt present	Phosphate is present
2	Sprite	Canary-Yellow ppt Present	Phosphate is present
3	Limka	Canary-Yellow ppt Present	Phosphate is present
4	Fenta	Canary-Yellow ppt present	Phosphate is present

- Fehling's Test:

  Used to detect reducing sugars, which serve as the primary fuel for acidogenic oral bacteria that cause demineralization

- Detection of PH:

  1-2 drops of the sample of cold drink of each brand was taken test tube and put on the pH paper one by one .The change in the color of pH paper was noticed and was compared with the standard pH scale.

S.No	Name Of Cold Drinks	Color Change	PH Value
1	Coco cola	Red	1-2
2	Sprite	Pink	2.5
3	Limka	Light Orange	4
4	Fenta	Beige	2-4

Secondary Research Analysis:

- Dental Stress Testing:

Enamel samples were exposed to solutions containing varying concentrations of phosphoric acid and synthetic colorants to measure structural degradation.

S.No	Cold beverges	phosphoric acid conc.	PH Value	Enamel Erosion
1	Carbonated Water	0 mg	5-6	Neligeable
2	Beers	5-10 mg	4-4.5	Low
3	Energy Drinks	Variable	3-3.5	Very High
4	Diet Cola	35-45 mg	2.5	High
5	Regular	50-70 mg	2	Extreamly High

- Sensory Evaluation:

A group of participants (aged 18-32 , consistent with high-consumption demographics) was monitored for primary active form GLP-1 in humans is peptide that is amidated at the C-terminus following the consumption of engineered satiety-inducing beverages.

S.No	Amount Of Cold Drinks	duration	GLP-1 Level(pmol/L)
1	Without cold drink	Baseline 0 min (fast for around 12 hr)	2-5
2	300-500 ml cold drinks	After 15 min	10-15
		After 60 min	20-35
		After 120 min	12-18
		After 180 min	5-8

- bacterial quorum sensing:

it involves clinical trials where participants consume specific sweeteners. then collect fecal samples and use methods like 16S rRNA sequencing or shotgun metagenomics to identify changes in bacterial populations, alongside metabolomics to see how the gut's chemical output changes and The most significant change in chemical output is the decline of Short-Chain Fatty Acids (SCFAs), specifically butyrate. Because bacteria cannot communicate to coordinate group behaviors like fermentation.

fecal samples	Reduction in the conc. of butyrate	Reference
Before NSS	Normal cocnentration	bacterial quorum sensing remains undisturbed
After NSS	Reduced by 50 - 55%	NSS like Aspartame and Sucralose interfare with gut microbiome

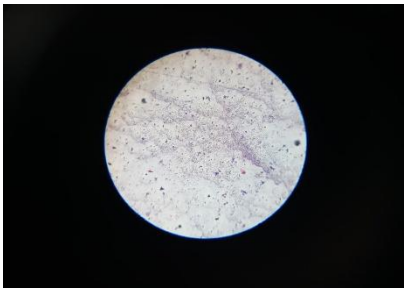

Fig. Reduction in Bacterial growth

Results and Discussion

1. Commercial cold drinks often utilize phosphoric acid as a preservative and flavor enhancer. Our findings indicate a synergistic effect when combined with synthetic colorants; the acid demineralizes the enamel surface, creating micro-porosities that allow pigments to penetrate deeper into the matrix. This mirrors the adverse effects of high-sugar "junk beverages" which provide the substrate for dental decay.

2. most of the beverage consumers report weight gain, there is a critical need for drinks that induce satiety. By engineering the sensory properties (viscosity, mouthfeel, and specific tastants), we can stimulate the "ileal brake" and trigger GLP-1 release. This sensory engineering offers a physiological counter measure to the high caloric density and large portion sizes identified as leading contributors to global obesity.

3. To combat obesity, many manufacturers have switched to non-nutritive sweeteners (NNS). However, our study suggests these compounds disrupt bacterial quorum sensing—the communication system bacteria use to coordinate behavior. This interference can lead to reduced postbiotic production (e.g., short-chain fatty acids), which are essential for maintaining the gut barrier. This disruption may explain the high prevalence of digestive disorders and "reductions in healthy gut bacteria" associated with modern processed diets.

4. Traditional plastic packaging contributes to environmental degradation. We propose a seaweed-based mono-material barrier—a return to "herbal" and natural sources as suggested by the nutritional superiority of traditional diets. By embedding AI-driven sensors within these seaweed barriers, we can monitor the freshness of engineered beverages in real-time. These sensors detect chemical changes associated with spoilage, preventing the consumption of degraded beverages that can lead to lethargy and digestive issues.

Conclusion:

The evolution of cold drinks requires a holistic approach that moves beyond mere calorie counting. By understanding the synergistic chemical effects on dental enamel and the microbiome-level disruptions caused by NNS, we can better appreciate the health risks of modern consumption patterns. The integration of sensory engineering and AI-enhanced seaweed packaging provides a blueprint for a new generation of beverages that are not only sustainable but also actively support metabolic health. As the industry moves forward, awareness must be taught at the school and parental levels to encourage a return to healthier, more natural consumption habits.

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