ORIGINAL ARTICLE

GAS CHROMATOGRAPHY-MASS SPECTROMETRY (GC-MS) ANALYSIS OF COMMERCIALLY AVAILABLE HERBAL AND NON-HERBAL TOOTHPASTES

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KEYWORDS

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ABSTRACT

Toothpaste formulations, both herbal and non-herbal, contain a variety of components, including abrasives, sweeteners, and detergents, which influence their effectiveness and safety. This study compared the composition of commercially available herbal (*Dabur Red*, *Vicco Vajradanti*) and non-herbal (*Colgate Strong Teeth*, *Pepsodent Germicheck*) toothpastes in India using Gas Chromatography-Mass Spectrometry (GC-MS). The analysis focused on the concentration of abrasive agents, sweeteners, and other key ingredients. Results indicated that non-herbal toothpastes, particularly *Colgate Strong Teeth* and *Himalaya Complete Care*, had higher levels of calcium carbonate, hydrated silica, sorbitol, and sodium saccharine, contributing to increased abrasivity. Herbal toothpastes contained lower concentrations of these agents, suggesting a gentler formulation. Fluoride and potassium nitrate, with anti-cariogenic and anti-hypersensitivity properties, were exclusive to *Colgate*. This study highlights the need for balance between cleaning efficiency and safety in toothpaste formulations, emphasizing the distinct properties of herbal and non-herbal products.
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INTRODUCTION

Commercially available herbal and non-herbal toothpastes are containing various components such as abrasives, detergents, fluorides, flavoring, and sweetening agents. Propylene, sorbitol, glycol, and glycerin are the commonly used moisturizers and sweeteners. Hydrated Silica, Calcium Carbonate, Dicalcium Phosphate, Aluminum Oxide, and Sodium Bicarbonate are most of the abrasive agents used in toothpastes[1,2]. Relative Dentin Abrasivity (RDA) is a

standard measure of the abrasive effect of toothpaste on dentin and enamel. The effectiveness and safety of a toothpaste directly depends on the RDA value.

The abrasiveness of toothpaste not only depends on these abrasive agents, it is also influenced by the particle size and shape, its concentration, and binding agents. Abrasive particles of larger size, irregular shape are more abrasive than smaller and rounded particles. Toothpastes containing higher concentration of abrasive agents will have increased RDA value. Binding agents alter the overall abrasiveness of toothpaste by altering the interaction and dispersion of abrasive particles. It is desired to check for the balance between cleaning power and gentleness while choosing the abrasive agents for the toothpaste. The toothpaste should ensure to meet consumer needs and safety standards [3]

Gas chromatography-mass spectroscopy (GC-MS) is a hyphenated combination of two analytical techniques. Gas chromatography the individual components from a mixture and mass spectroscopy characterizes each individual components, which helps in qualitative and quantitative evaluation [3, 5, 10, 11].

With the availability of internet, people started using herbal toothpaste instead of non-herbal toothpaste, thinking herbal toothpaste has lower concentration of abrasive agents. Hence, this Gas Chromatography – Mass Spectrometry (GC-MS) analysis aimed to assess the concentration of commercially available herbal and non-herbal toothpaste in India.

MATERIALS AND METHODS

Sample Preparation

The important concept of sample preparation for GC-MS analysis is to convert a true mixture into a sample suitable for analysis by separation. The whole extract of two samples of 38 grams of non-herbal Colgate Strong Teeth toothpastes, two samples of 100 grams of Pepsodent Germicheck toothpastes and three samples of 36 grams of herbal Dabur Red toothpastes and three samples of 75 grams of Vicco Vajradanti toothpastes were analyzed using Gas Chromatography Mass Spectrometer (Agilent, USA) of 7890B model for identification and quantification of its components. In gas chromatography (GC), isolation of individual components occurred when the toothpaste sample mixtures were vaporized and injected into the head of the chromatographic column (mobile phase). The mobile phase then carries the mixture through stationary phase (chemical) in a tube called column.

Procedure

The equipment had a DB 35 -MS capillary standard non-polar column with dimensions of 30 mm x 0.25 mm ID x 0.25 µm film containing 5% phenyl and 95% dimethyl polysiloxane. The carrier gas used was Helium at low constant passage of 1.2 ml/ min. The capillary split less injector was operated at 250ºC and the oven temperature was programmed for 60ºC initially for 15 minutes and gradually increased to 280ºC at 3 minutes. Then the components of the toothpastes were identified based on Willey and National Institute of Standards and Technology (NIST) libraries with comparison of their retention indices. The components of the toothpastes were identified after comparison with those available in the computer library (Willey and NIST) attached to the GC-MS instrument. The components and their concentration in percentage were detected using mass spectrum detector of model 7000 C with a scan range of 50 m/z to 600 m/z and tabulated (Figure 1).

Figure 1: Gas Chromatography Mass Spectroscopy

RESULTS AND DISCUSSION

These tests were conducted to evaluate the components and its concentration as percentage of herbal toothpaste (Dabur Red and Vicco Vajradanti) and non-herbal toothpaste (Colgate Strong Teeth and Pepsodent Germicheck) using GC-MS analysis.

Toothpaste analysis

It has been now considered that herbal toothpastes are less abrasive than the non-herbal toothpaste whose usage has been increased recently. Although toothpastes contain flavoring, sweetening, detergents, abrasive agents are the target for this analysis. Abrasive agents cause high dentine abrasivity leading to dentine hypersensitivity. The calcium carbonate content was found to be high in Colgate Strong Teeth (38.55%) and Himalaya Complete Dental Care toothpaste (29.25%). Silica content was high in Colgate Strong Teeth (3.12%); Sodium silicate content was high in Himalaya Complete Care (2.21%). The components of herbal and non-herbal tooth paste with the percentage concentration were presented in Figure 2 to 4.

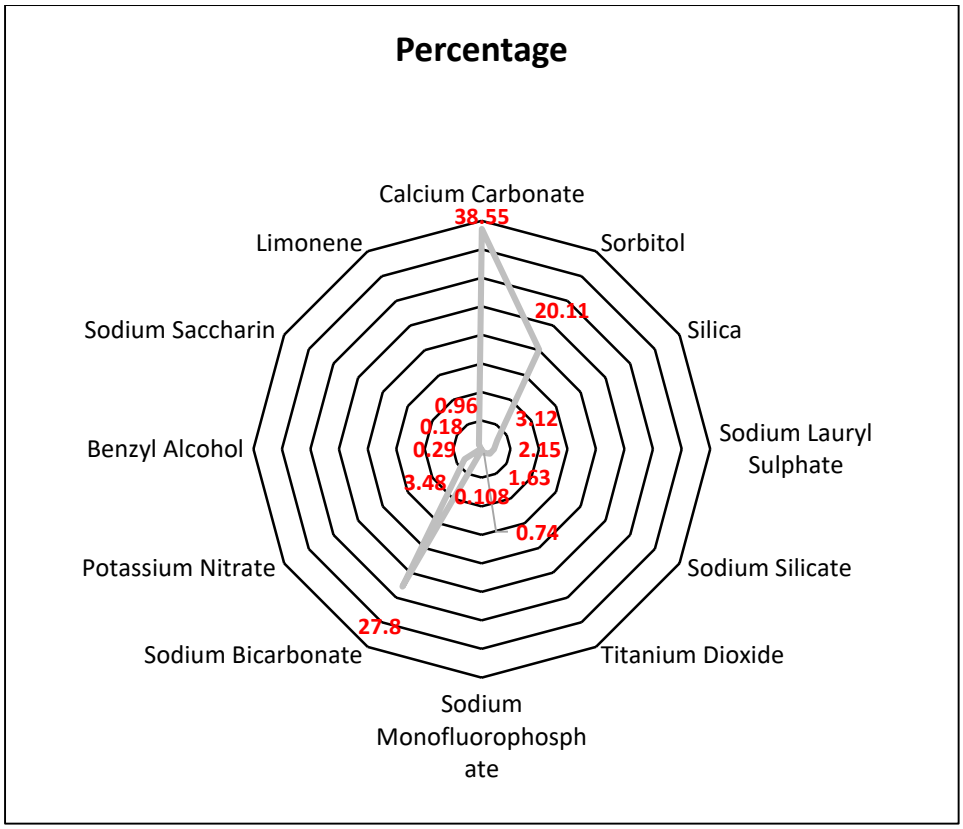

Figure 2: Components and concentration of Colgate Strong Teeth toothpaste

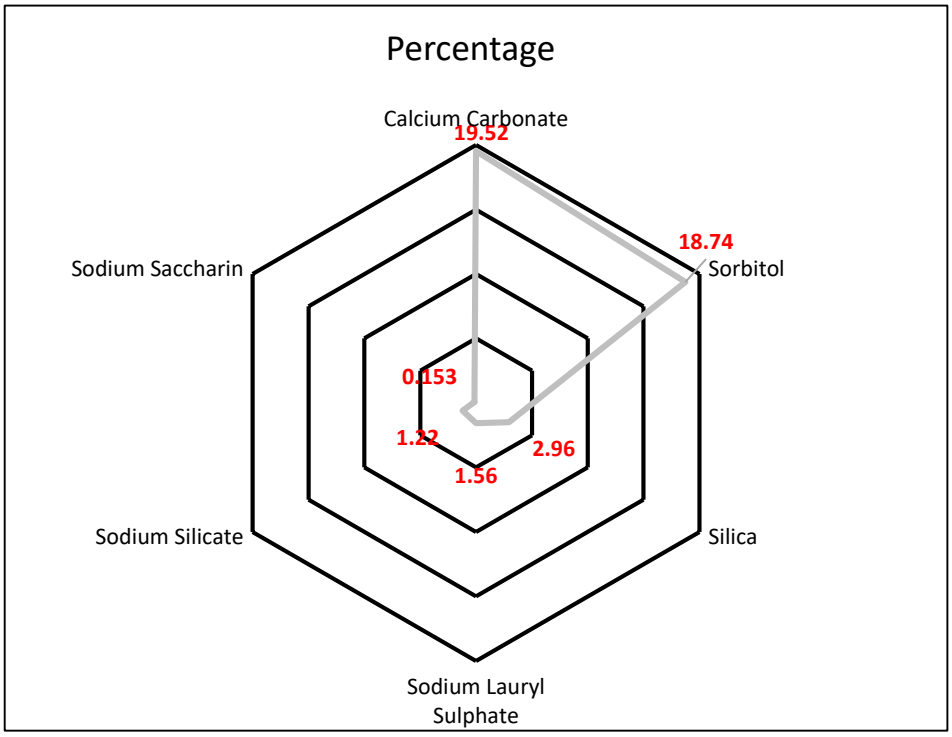

Figure 3: Components and concentration of Dabur Red and Pepsodent Germicheck toothpaste

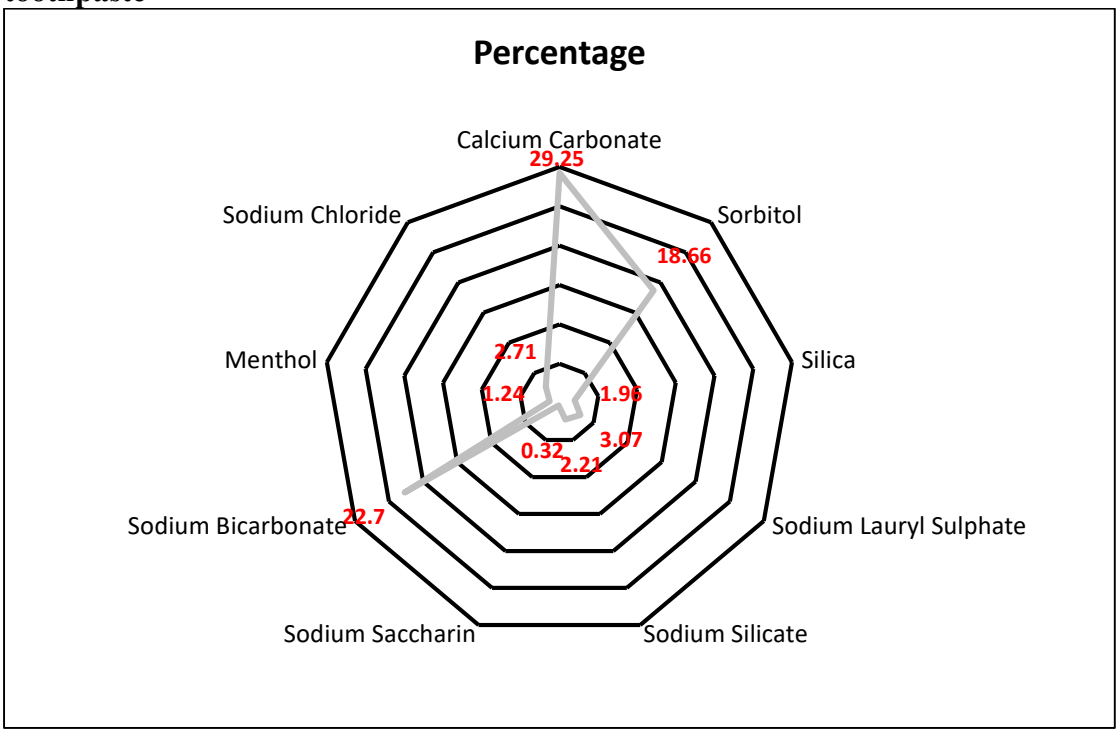

Figure 4: Components and concentration of Himalaya Complete Dental Care toothpaste

Evidences on the abrasivity of herbal and non-herbal toothpaste have reported higher abrasivity for Colgate Strong teeth and Dabur Red toothpastes[9, 12]. They are found to contain higher concentrations of abrasive agents such as hydrated silica and calcium carbonate. Sorbitol and sodium saccharine contents help in sweetening and moistening the toothpaste, they have no harmful effect. However, the sorbitol (20.11%) and sodium saccharine (0.18%) content were found to be high in Colgate Strong Teeth toothpaste. Fluoride and Potassium

Nitrate was found only in Colgate toothpaste, which has anti-cariogenic and anti-hypersensitive property. The particle sizes across all toothpastes were found to be 2-10 microns. The surfactant sodium lauryl sulphate was found to be high in Himalaya Complete Care toothpaste (3.07%).

CONCLUSION

The GC-MS analysis of herbal and non-herbal toothpaste reported a higher abrasive content in Colgate Strong and Himalaya Complete Care compared to Dabur Red and Pepsodent Germicheck toothpastes. Also, higher amount of sorbitol and Saccharine was found in Colgate Strong Teeth toothpaste.

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