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Analysis of Fluoride Content in Ayurvedic Toothpaste Using Spadns Reagent Method

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ABSTRACT
This study aims to determine fluoride content in Ayurveda toothpaste using spadns reagent method. It is essential to maintain fluoride concentration between 0.8 - 1.0 mg/L**.** Intake of excessive fluoride is generally marked with white and brown patches in children's teeth. Excessive fluoride intake can cause a person suffering from dental fluorosis, the fragility of the bones (osteoporosis), liver and kidney damage. In this study, Fluoride is extracted from the toothpaste using the centrifugation method and the absorbance was measured using UV spectroscopy. The amount of fluoride in the toothpaste was calculated by the UltraViolet Spectroscopy method.

KEYWORDS: Ayurvedic toothpaste, spadns reagent, UV spectroscopy, Dental fluorosis.

1. INTRODUCTION

To promote attractiveness and to maintain healthy and clean teeth, toothpaste is used. The primary function of toothpaste is to remove food particles, reduce superficial plaque or stain, polish the tooth surface. Therapeutic and cosmetic functions of toothpaste are whitening, bleaching, desensitizing, inhibition of plaque formation, and protection against periodontal problems.[1] Fluoride is an important ingredient in dental care products used in world while. Fluoride protects teeth both systemically and topically. Systemic fluoride is what we ingest, it is found in fluoridated water, fluoride/tablet/drops, and in food beverages. The consumed fluoride help in the formation of teeth becomes part of the tooth structure. After teeth have completely developed in the mouth fluoride is incorporated into one's oral cavity topically. Topical applications of fluoride include application from various kinds of toothpaste, mouth rinses, and fluoride foams .Topical fluoride is used after proper cleaning of teeth. [2

2. ROLE OF FLUORIDE IN TOOTHPASTE

The mechanism of fluoride in dental caries prevention is reduction of enamel solubility caused by acid, lowering the enamel surface permeability, and inhibition of fermentation of carbohydrates by microorganisms of the oral cavity. The need for fluoride is between 0.8 - 1.0 mg/L. Therefore the fluoride in toothpaste should not be exaggerated beyond this limit . Excess fluoride can cause cells to die and the teeth become brittle.The degree of dental fluorosis depends on the amount of fluoride exposure up to the

age of 8 - 10 yrs. The fact that an adult shows no signs of dental fluorosis does not mean that his or her fluoride intake is within the safety limit. Excessive fluoride in children's teeth is generally marked with white and brown patches.[3,4]

2.1. PROBLEMS CAUSED BY EXCESSIVE FLUORIDE

2.1.1. Dental fluorosis

It is characterized by hypomineralization of tooth enamel caused by ingestion of excessive fluoride during enamel formation. It appears as a range of visual changes in enamel causing degrees of intrinsic tooth discoloration and in some cases, physical damage to the teeth.

2.1.2. Skeletal fluorosis

Skeletal fluorosis is defined as skeletal changes due to long-term ingestion of excessive and it may include hyperostosis and osteoporosis.

- **Cancer**
- **Bone fractures**
- **Neurological impairment**

3. METHODS USED FOR DETERMINATION OF FLUORIDE)[5,6]

Many methods were adopted to determine the content of fluoride in toothpaste. several forms of fluoride have been incorporated in dental products. Example are stannous fluoride, sodium fluoride, amine fluoride, and sodium mono fluorophosphate, all of which are biologically and chemically unique.

3.1. SPADNS Method

Under acidic conditions fluorides (HF) react with zirconium SPADNS solution and the lake (color of SPADNS reagent) gets bleached due to the formation of ZrF6. Since bleaching is a function of fluoride ions, it is directly proportional to the concentration of fluoride. It obeys Beers law in a reverse manner

3.2. Ion Selective Electrode Method

The fluoride-sensitive electrode is of the solid-state type, consisting of a lanthanum fluoride crystal, in use, it forms a cell in combination with a reference electrode, normally the calomel electrode. The crystal contacts the sample solution at one face and an internal reference solution at the other. A potential is established by the presence of fluoride ions across the crystal which is measured by a device called an ion meter or by any modern pH meter having an expanded millivolt scale.

3.3. Ion chromatography

Ion chromatography method used for the determination of fluoride ions in sample.In this method the sample should not have any particle it should be filtered by the use of 0.15-0.45 micrometer filter. Lower conductivity detection is highly recommended for ion chromatography because the ion is weak and the matrix components such as bicarbonate can cause disturbances and produce a large peak. [7-9]

SPADNS REAGENT

1. MOLECULAR FORMULA

$C_{16}H_9N_2Na_3O_{11}S_3$

2. IUPAC NAME

Trisodium;4,5-dihydroxy-3-[(4-sulfonatophenyl) diazenyl] naphthalene-2,7-disulfonate

3. STRUCTURE

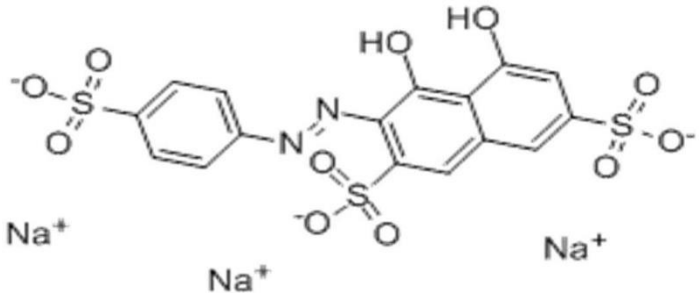

Figure:1 Structural formulae of Spadns Reagent

4. MECHANISM

The SPADNS Method for fluoride determination involves the reaction of fluoride with a red zirconium-dye solution. The fluoride combines with part of the zirconium to form a colorless complex, thus bleaching the red color in an amount proportional to the fluoride concentration.[10,11]

The reaction is as follows:

4. MATERIALS AND METHODS:

4.1. Collection of Sample:

The various marketed ayurvedic toothpaste were purchased from Market and Sample Id gave as AY.F1 to AY.F5

4.2. PREPARATION OF SPADNS REAGENT

Dissolve 0.960 ±0.010 g of SPADNS reagent [4,5 Dihydroxyl-3-(p-Sulfophenylazo)-2,7- Naphthalene-Disulfonic Acid Trisodium Salt] in 500 ml water.

4.3. PREPARATION Of ZIRCONYL CHLORIDE SOLUTION

Dissolve 0.135 ±0.005 g of zirconyl chloride octahydrate (ZrOCl28H2O) in 25 ml of water. Add 350 ml of concentrated HCl, and dilute to 500 ml with deionized, distilled water. Mix equal volumes of zirconyl chloride solution and SPADNS solution to form a single reagent.[10,11]

4.4. DETERMINATION OF MAXIMUM WAVELENGTH

100mg of anhydrous sodium fluoride is dissolved in water and makes up to 100ml with water. From the above solution pipette out 1ml and dilute to 100ml with water. Add few drops of SPADNS reagent. Scanning is performed using a UV spectrophotometer. 507nm is fixed as the maximum wavelength after scanning.

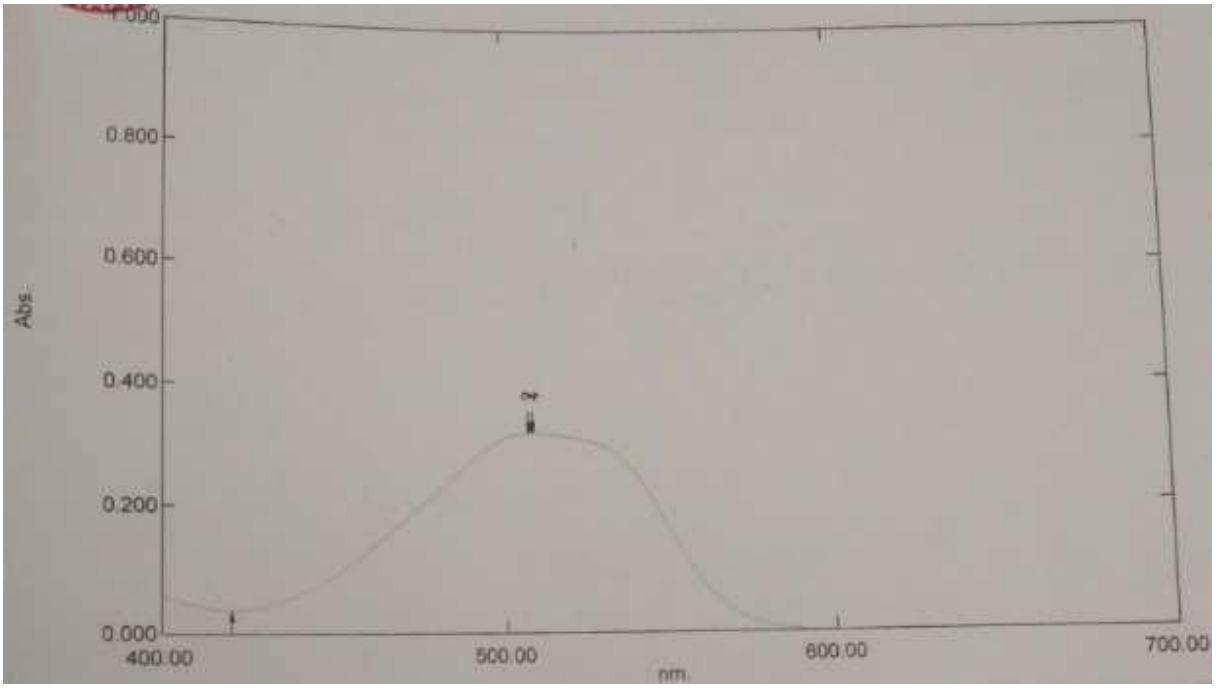

Figure:2 . λ max of standard sodium fluoride

4.5. PREPARATION OF STANDARD SOLUTION

Weigh 10mg of anhydrous sodium fluoride is dissolved in water & made up to the required quantity up to 10ml with distilled water (1000µg/ml). From the above solution pipette out 5ml and dilute to 50ml with water (100µg/ml). From the above solution prepare a calibration graph using standard solution 10-50µg/ml add a few drops of SPADNS reagent. Measure the absorbance at 507 nm.[12]

CONCENTRATION	ABSORBANCE
10ug	0.341
20ug	0.358
30ug	0.388
40ug	0.391
50ug	0.395

Table No :1 Absorbance Of Standard Fluoride

4.6 PREPARATION OF SAMPLE SOLUTION

Weigh 1g of sample (Tooth paste) and immersed in 50 ml of distilled water for 24 hours in a porcelain dish. The mixture was filtered and centrifuged at 1500 rpm. From this 15ml of the supernatant solution was taken and made up to 100ml with water. Measure the absorbance at 507nm.[13]

Table 2: FLUORIDE CONTENT PRESENT IN TOOTHPASTE SAMPLES

S.NO	SAMPLE ID	ACTIVE INGREDIENT	AMOUNT OF FLUORIDE PRESENT (g)
1	AY.F1	NAF	0.793
2	AY.F2	NAF	0.581

3	AY.F3	NAF	0.803
4	AY.F4	NAF	0.631
5	AY.F5	NAF	0.636

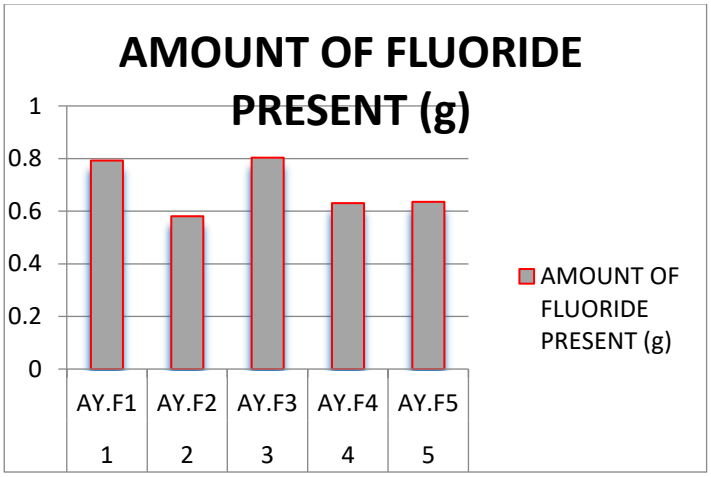

FIGURE:3. AMOUNT OF FLUORIDE PRESENT IN SAMPLE

5. Qualitative test for Fluoride: (TEST FOR FLUORIDE)[14]

Table No :3 Qualitative test for Fluoride

TEST	OBSERVATION	REPORT
Add 5ml of water to sample and stir well. Add few drops of silver nitrate and dilute nitric acid.	No precipitate formed	Presence of fluoride
Warm a solid fluoride with concentrated Sulphuric acid and hold in the fumes, a glass rod with a drop of water on the end.	Look for the etching effect on the surface of the glass rod.	Presence of fluoride

FIGURE:4. CHEMICAL TEST FOR OF FLUORIDE PRESENT IN SAMPLE

6. PRELIMINARY EVALUATION OF TOOTHPASTE:

6.1. DETERMINATION OF pH:

Weighed 5 gm of the sample was transferred in a clean beaker. To this freshly boiled and cooled water was added and stirred well to get a uniform suspension. The pH was determined within 5 min by using a pH meter.[15]

S.NO	NAME OF THE TOOTHPASTE	pH
1	AY.F1	9.80
2	AY.F2	9.85
3	AY.F3	8.60
4	AY.F4	9.98
5	AY.F5	8.36

TABLE:4. CHEMICAL TEST FOR OF FLUORIDE PRESENT IN SAMPLE

6.2. ORGANOLEPTIC CHARACTERS

All the toothpaste was also evaluated for their organoleptic characters.[16]

TOOTHPASTE	TEXTURE	COLOUR	APPEARANCE	EXTRUD ABILITY
AY.F1	Smooth	Light brown	Paste - like	Easy
AY.F2	Smooth	Light red	Paste - like	Easy
AY.F3	Smooth	Light brown	Paste - like	Easy
AY.F4	Smooth	Creamy white	Paste - like	Easy
AY.F5	Smooth	Light green	Gel-like	Easy

TABLE:5. CHEMICAL TEST FOR OF FLUORIDE PRESENT IN SAMPLE

7. CONCLUSION

In this experiement, The UV method was developed for extraction of Flouride from toothpaste using the centrifugation method. The results showed that the wavelength of maximum absorption was at a wavelength of 507 nm. Determination of fluoride was done by using the UV spectrophotometric method and it was based on metal displacement from a colored complex or the formation of a mixed-ligand complex, Zr (IV)-F-SPADNS. Fluoride addition will bleach SPADNS-Zirconyl chloride and degrade the red-colored complex. The degree of bleaching was determined with a spectrophotometer, and the concentration of fluoride ions was assessed by comparison with standard solutions. The colorless was measured at a wavelength on maximum absorption of the mixed-ligand complex.

The red color observed (as seen by the eye) is the color of the reagent SPADNS. As an indication of the content of fluoride, the red color of the reagent SPADNS will be degraded, and if the higher fluoride content, the red color will fade (degradation increases) so that the smaller absorbance.[17,18]

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