PHARMACEUTICAL CHEMISTRY

Dental Products

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Introduction

The teeth are accessory digestive organs. People use their teeth to bite and chew food, the first step in the digestion of food. The long, sharp canine teeth tear up food (like meat). The wide, flat molars grind and mash up food. While we chew food, the tongue pushes the food to the teeth and saliva helps digestion and wets the food.

A number of inorganic compounds are used in maintaining the oral and dental hygiene. Most of them are over the counter (OTC) products. Dental products include anticaries agents (dentifrices and fluoride salts), polishing agents, and desensitizing agents.

Tooth Anatomy

A typical tooth has three major external regions: the crown, root, and neck.

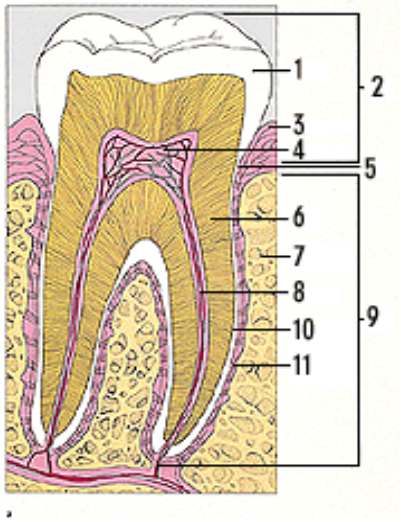

Figure of a tooth and surrounding structures

1 Enamel: Hard calcified (consists primarily of calcium phosphate and calcium carbonate) tissue covering dentin of the crown of tooth.

2 Crown: The crown is the visible portion of tooth above the level of the gums.

3 Gingiva (gums): Soft tissues overlying the crowns of unerupted teeth and encircling the necks of those that have erupted.

4 Pulp Chamber: The space occupied by the pulp.

5 Neck: The area where the crown joins the root.

6 Dentin: That part of the tooth that is beneath enamel and cementum.

7 Alveolar Bone (jawbone) : The part of the jaw that surround the roots of the teeth.

8 Root Canal: The portion of the pulp cavity inside the root of a tooth; the chamber within the root of the tooth that contains the pulp.

9 Root: Embeded in the socket are one to three roots.

10 Cementum: Hard connective tissue covering the tooth root, giving attachment to the periodontal ligament.

11 Periodontal Ligament: A system of collagenous connective tissue fibers that connect the root of a tooth to its alveolus.

Anticaries Agents

Dental caries, or tooth decay, involves a gradual demineralization (softening) of the enamel and dentin. If it is not treated then microorganisms may invade the pulp, causing inflammation and infection, with subsequent death of the pulp and abscess of the alveolar bone surrounding the root's apex, requiring root canal therapy.

Dental caries (i.e. cavities) are formed by the growth and implantation of cariogenic microorganisms. Bacteria (primarily streptococcus mutans and lactobacillaceae) produce acids, mostly lactic acid that demineralize the enamel. The demineralized enamel initially appears as a white, chalky area and eventually becomes brown or yellow. Diet is another factor in the development of dental caries. Diet with a high concentration of fermentable carbohydrates increases the risk of dental caries. Masses of bacterial cells, sticky polysaccharide (produced from sucrose) and other debris adhering to teeth constitute dental plaque. Fermentable sugar such as sucrose is converted by bacterial plaque into volatile acids that destroy the hydroxyapatite. The formation of bacterial plaque also helps the decay process by forming pockets or crevices on the tooth surface in which the food particles can stick and be decayed by the bacteria. If plaque is not removed it calcifies into calculus when calcium salt precipitates from the saliva. Brushing the teeth helps in removing the material from the tooth surface before it hardens into calculus.

Dental caries can be prevented and oral and dental hygiene can be maintained with the help of dentifrices. These are the products that enhance the removal of stain and dental plaque by the toothbrush. The most accepted approach to prevent caries includes flossing and brushing accompanied by administration of fluoride either internally or topically to the teeth.

Fluoride is anticariogenic as it replaces the hydroxyl ion in hydroxyapatite with the fluoride ion to form fluorapatite in the outer surface of the enamel. Fluorapatite hardens the enamel and makes it more acid resistant. Fluorapatite has also shown antibacterial activity. Fluoride is most beneficial upto an age of 12 or 13 because unerupted permanent teeth are mineralizing during that time.

Fluoride can be administered by two routes, orally and topically. The fluoridation of the public water supply is the most convenient and effective may of oral administration. This can be achieved by adding sodium fluoride, giving a fluoride concentration of 0.7-1.0 ppm. Fluoride can also be administered orally as sodium fluoride tablets or drops added in water or fruit juice. Fluoride in solution or in rapidly soluble salts when administered internally is readily absorbed from the gastrointestinal tract, partially deposited in the bone or developing teeth and the remainder gets excreted by the kidneys.It is not always feasible to administer fluoride internally and in post-adolescent individuals, it is not beneficial. In such cases, fluoride can be administered topically. A 2% aqueous solution of sodium fluoride is widely used topically. A freshly prepared 8% solution of stannous fluoride is also extensively used for topical application of fluoride.

Inorganic phosphate salts can also be useful in the prevention of dental caries. It has been shown that soluble salts of phosphates (e.g., calcium sucrose phosphate, sodium dihydrogen phosphate, sodium monohydrogen phosphate etc.) can cause caries reduction in men.

Polishing Agents
Dentifrices contain agents for cleaning tooth surfaces and providing polishing effect on the cleaned teeth. These agents are abrasive in nature. They are responsible for physically removing plaque and debris. Examples include dicalcium phosphate, sodium metaphosphate, calcium pyrophosphate, calcium carbonate and calcium monohydrogen phosphate. Pumice is too abrasive for daily use in a dentifrice.

Desensitizing Agents
Desensitizing agents reduce the pain in sensitive teeth caused by cold, heat or touch. These products should be non-abrasive and should not be used on a regular basis unless directed by a dentist. Examples include strontium chloride and zinc chloride.

1. Sodium Fluoride: NaF Mol. Wt. 41.99
It contains not less than 98.5 percent and not more than 100.5 percent of NaF, calculated with reference to the dried substance.

Preparation: It is prepared by reacting hydrofluoric acid with sodium carbonate. Sodium fluoride being not very soluble precipitates out.

$$2HF + Na_2CO_3 \rightarrow 2NaF + H_2O + CO_2\uparrow$$

The precipitate is contaminated with fluorosilicate and the acid salt. It is made alkaline to phenolphthalein with sodium carbonate and then heated to neutralize the acid salt and decompose the fluorosilicate.

$$Na_2SiF_6 + 2H_2O \rightarrow 2NaF + 4HF + SiO_2$$

Identification Tests: Sodium fluoride is an ionic salt and gives reactions for fluoride ion and sodium ion.

1. Calcium chloride gives a white gelatinous precipitate of CaF_2 with fluoride ions. The precipitate dissolves in ferric chloride solution.

   $$CaCl_2 + 2NaF \rightarrow 2NaCl + CaF_2\downarrow$$

   2.5 g is dissolved in sufficient carbon dioxide free water without heating to make 100 ml **(solution A)**. To 2 ml of solution A, 0.5 ml of calcium chloride solution is added. A white gelatinous precipitate is produced which dissolves on adding 5 ml of ferric chloride solution.

2. In another test for fluoride, an alizarin-zirconium lake is prepared having a red colour. This red colour changes to yellow colour of alizarin-sulphonic acid by the fluoride ions due to the formation of colourless hexafluorozirconate (IV) ion $[ZnF_6]^{2-}$.

Add about 4 mg to a mixture of 0.1 ml of alizarin red S solution and 0.1 ml of zirconyl nitrate solution and mix. The red colour changes the yellow.

3. Sodium salts react with an alkaline solution of potassium antimonite, $KsbO_3.3H_2O$ to give white precipitate of sodium antimonite $NaSbO_3.xH_2O$, which rapidly changes to the crystalline sodium pyroantimonate, $Na_2H_2Sb_2O_7.\ 6H_2O$.

   0.1 g is dissolved in 2 ml of water. To this add 2 ml of 15% w/v solution of potassium carbonate and heat to boiling. No precipitate is formed. 4 ml of a freshly prepared potassium antimonite solution is added and heat to boiling. On cooling in ice a dense white precipitate is formed.

Test for purity: It has to be tested for acidity or alkalinity; fluorosilicate; clarity and colour of solution; chloride; sulphate and loss on drying.

Acidity or Alkalinity: From the method of preparation described above, sodium fluoride may be contaminated with sodium hydrogen fluoride or sodium carbonate leading to acidity or alkalinity respectively. Titration with 0.1M sodium hydroxide or hydrochloric acid using phenolphthalein as indicator gives a limit for these impurities. 2.5 g of potassium nitrate is dissolve in 40 ml of solution A and the volume is made to 50 ml with carbon dioxide-free water. Cool to 0° and then add 0.2 ml of dilute phenolphthalein solution. If the solution is colourless, not more than 1.0 ml of 0.1M sodium hydroxide is required to produce a red colour that persists for at least 15 seconds. If the solution is red, not more than 0.25 ml of 0.1M hydrochloric is required to change the colour of the solution. Keep the neutralized solution for the test for fluorosilicate.

Fluorosilicate: When the neutralized solution is heated to boiling, it results in hydrolysis of any fluorosilicate present to give free hydrofluoric acid, which is then titrated with 0.1M sodium hydroxide.

The neutralized solution reserved in the test for acidity or alkalinity is heated to boiling and then titrated while hot with 0.1M sodium hydroxide until a red colour is produced. Not more than 1.5 ml of 0.1M sodium hydroxide is required to produce the red colour.

$$Na_2SiF_6 + 2H_2O \longrightarrow 4HF + 2NaF + SiO_2$$

Loss on drying: It should not be more than 0.5%, determined on 1 g by drying in an oven at 130° for 3 hours.

Assay: It is assayed by non-aqueous titration method.
Weigh accurately about 80 mg and add a mixture of 5 ml of acetic anhydride and 20 ml of anhydrous glacial acetic acid to it. Heat to dissolve, cool, add 20 ml of dioxan and titrate with 0.1M perchloric acid using crystal violet solution as indicator until a green colour is produced. Carry out a blank determination and make any necessary correction.
Each ml of 0.1M perchloric acid is equivalent to 0.004199 of NaF

Uses: It is used as preventive for dental caries because of its fluoride ion content.

Usual dose:2.2 mg (equivalent to 1 mg of fluoride ion)

Application: 1.5-3.0 ppm (equivalent to 0.7-1.3 ppm of fluoride ion) in drinking water; topically, as 2% solution to the teeth.

Formulations: Sodium fluoride is administrated as solution, tablet, oral gel for systemic use or as mouth wash for local use.

2. Stannous Fluoride: SnF_2 Mol. Wt. 156.69
It contains not less than 71.2 percent of stannous (Sn^{2+}) ions and not less than 22.3 percent and not more than 22.5 percent of fluoride, calculated with reference to the dried substance.

Preparation: Stannous fluoride is prepared by heating stannous oxide with gaseous hydrofluoric acid in the absence of oxygen

$$SnO + 2HF \rightarrow SnF_2 + H_2O$$

Identification Tests:

1. Calcium chloride gives a white precipitate of CaF_2 with fluoride ions. Take 5 ml of solution (1 in 100) in a test tube and add 2 ml of calcium chloride solution to it. A fine, white precipitate of calcium fluoride is formed.

$$CaCl_2 + SnF_2 \longrightarrow CaF_2\downarrow + SnCl_2$$

2. Mix 2 drops of solution (1 in 100) with 2 drops of silver nitrate solution on a spot plate. A brown-black precipitate is produced.

$$2AgNO_3 + SnF_2 \longrightarrow 2AgF_2 + Sn(NO_3)_2$$

3. One drop of solution (1 in 100) is added to 2 drops of mercuric chloride solution. There is formation of white, silky precipitate. A brown-black precipitate is formed on further addition of the solution (1 in 100).

Test for purity: It has to be tested for pH, loss on drying and water insoluble substances

pH: A freshly prepared 0.4% solution has pH between 2.8 and 3.5

Loss and drying: When it is dried at 105° for 4 hours, the loss should not be more than 0.5% of its weight.

Water-Insoluble substances: About 10 g of accurately weighed in taken in a 400 ml plastic beaker. To this add 20 ml of water and stir with a plastic rod for 3 minutes, or until no more solid dissolves. Then filter through a tared filtering crucible and wash thoroughly first with ammonium fluoride solution (1 in 100) and then with water. The residue is dried at 105° for 4 hours, cooled and weighed. The weight of the residue should not be more than 0.2%.

Antimony:
Standard Preparation: 55.0 mg of accurately weighed antimony potassium tartrate is transferred to a 200 ml volumetric flask, dissolved in water, diluted with water to make up the volume and mixed. 5 ml of this solution is transferred to a 500 ml volumetric flask and to this 6N hydrochloric acid is added to the volume and mixed.

Test Preparation: 1.0 g of accurately weighed stannous fluoride is transferred to a 50 ml volumetric flask. To this 6N hydrochloric acid is added to the volume and mixed.

Method: 5 ml each of the standard preparation and the test preparation is taken into separate 125 ml separators. Then, 15 ml of hydrochloric acid and 1 g of ceric sulphate are added and allowed to stand for 5 minutes, with occasional shaking 500 ml of hydroxylamine hydrochloride is added and shaken for 1 minute. 15 ml of isopropyl either is pippeted into the mixture, shaken for 30 seconds followed by addition of 7 ml of water and mixed. Then, cooled in a water bath at room temperature for 10 minutes, shaken for 30 seconds, allowed the layers to separate and aqueous phase is discarded. 20 ml of rhodamine B solution is added, shaken for 30 seconds and the aqueous layer is discarded. The either layer is decanted from the top of the separator and centrifuged to obtain a clear solution. The absorbances of the either solution from the test preparation and the standard preparation are concomitantly determined at the wavelength of maximum absorbance at about 550 nm, with a suitable spectrophotometer, using water as the blank. The absorbance of the test preparation should not exceed that of the standard preparation (0.005%).

Assay:
Assay for Stannous Ion: Transfer about 250 mg of accurately weighed stannous fluoride to a 500 ml conical flask. To this flask, add 300 ml of hot, recently boiled 3N hydrochloric acid. Swirl the flask to dissolve the stannous fluoride and cool to room temperature. Add 5 ml of potassium iodine and titrate with 0.1N potassium iodine-iodate using 3 ml of the starch as indicator added towards the end point.
Each ml of 0.1N potassium iodine-iodate is equivalent to 5.935 mg Sn^{2+}.

Assay for Fluoride
Buffer solution: Dissolve 5.7 ml of glacial acetic acid, 58 g of sodium chloride and 4 g of (1,2-cyclohexylenedinitrilo)tetraacetic acid in 500 ml of water. Adjust the pH to 5.25 $\pm$ 0.25 with 5N Sodium hydroxide, dilute with water to 1000 ml and mix.

Standard Preparation: Dissolve the accurately weight quantity of sodium fluoride so as to obtain a solution in water containing 420 µg per ml **(Standard preparation A)**. Each ml of this solution contains 190 µg of fluoride ion. Transfer 25.0 ml of standard preparation A to a 250 ml volumetric flask, make up the volume with water and mix **(Standard preparation B)**. Transfer 25.0 ml of standard preparation B to a 250 ml volumetric flask, make up the volume with water and mix **(Standard preparation C)**. This solution contains 1.9 µg of fluoride ion.

Assay Preparation: Transfer about 10 mg of accurately weighed stannous fluoride to a 250 ml volumetric flask. Add 50 ml of water, mix vigorously for 5 minutes, make up the volume with

water and mix. Transfer 10.0 ml of this solution to a 50 ml volumetric flask, make up the volume with water and mix.

Method: Pipette 20 ml of each standard preparation and the assay preparation into separate plastic beakers. Add 20 ml of butter solution into each beaker. Concomitantly measure the potential of the solutions from the standard preparations and assay preparation using a pH meter equipped with a fluoride specific. Ion indicating electrode and a calomel reference electrode.

Plot the logarithms of the fluoride ion concentrations, in μg per ml of the standard preparations versus potential, in mV. Determine the concentration, C, in μg per ml, of fluoride ion in the assay preparation from the measured potential of the assay preparation. Calculate the percentage of fluoride by the formula.

$$125\ C/W$$

Where C is the concentration of fluoride determined in assay preparation and W is the weight of the stannous fluoride taken.

Uses: It is used as a preventive for dental caries. A freshly prepared 8% solution is used at 6 to 12 month intervals.

Formulations: It is administered as solution, gel, mouth wash or dentifrice. It is for topical use only.

Disinfectants

Disinfectants are antimicrobial agents that are applied to non-living objects to destroy microorganisms. The process is known as disinfection. Disinfectants are different from antibiotics and antiseptics in that, antibiotics, destroy microorganisms within the body, and antiseptics, destroy microorganisms on living tissue. Bacterial endospores are most resistant to disinfectants, however some bacteria and viruses also possess some tolerance. A perfect disinfectant produces complete sterilisation, without causing any harm to other forms of life, is inexpensive, and non-corrosive. Unfortunately there is no ideal disinfectant. Most disinfectants are also, by their very nature, potentially harmful (even toxic) to human beings. They should be treated with appropriate care. Most of them come with safety instructions printed on the packaging, which should be read completely before using the disinfectant.

They are frequently used in hospitals and dental surgeries, to kill infectious organisms.The selection of the disinfectant to be used is made according to the particular situation. Some disinfectants kill a wide range (kill nearly all microorganisms), while others kill a smaller range of disease-causing organisms but are preferred for other properties (that may be non-corrosive, non-toxic, or inexpensive).

1. Zinc chloride: $ZnCl_2$ Mol. Wt. 136.29

It contains not les than 95 percent and not more than 100.5 percent of $ZnCl_2$.

Preparation: It is prepared by heating granulated zinc with hydrochloric acid. When evolution of hydrogen ceases, the solution is filtered and evapourated to dryness

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$$Zn + 2\,HCl \rightarrow ZnCl_2 + H_2\uparrow$$

Identification Tests: 1. To 2 g, add 38 ml of carbon dioxide–free water prepared from distilled water. Add 2 M hydrochloride acid drop wise until solution is complete and make up the volume to 40 ml with carbon dioxide–free water prepared from distilled water **(Solution A)**. Solution A gives the following reactions of Zinc salts.

(A) A solution of zinc salts when treated with dilute sodium hydroxide solution forms a white precipitate of zinc hydroxide which dissolve in excess of sodium hydroxide solution (forms zincate which is soluble). The solution remains clear on addition of ammonium chloride. On addition of a few drops of sodium sulphide solution, a white precipitate of zinc sulphide is formed.

$$ZnCl_2 + 2NaOH \rightarrow 2NaCl + Zn(OH)_2 \downarrow$$
$$Zn(OH)_2 + 2NaOH \rightarrow Na_2ZnO_2 + 2H_2O$$
$$Na_2ZnO_2 + Na_2S + 2H_2O \rightarrow 4NaOH + ZnS \downarrow$$

Take 5 ml of solution A and add 0.2 ml of sodium hydroxide solution to it. A white precipitate is formed. Further, add 2 ml of sodium hydroxide solution to dissolve the precipitate. The solution remains clear on addition of 10 ml of ammonium chloride solution. Add 0.1 ml of sodium sulphide solution. A flocculent white precipitate is formed.

(B) When solution of zinc salts is acidified with dilute sulphuric acid and treated with one drop of copper sulphate solution followed by addition of ammonium mercurithiocyanate solution, a violet precipitate is obtained due to complexation of zinc ion.
Acidify 5 ml of the solution A with dilute sulphuric acid. Add one drop of a 0.1% w/v solution of cupric sulphate and 2 ml of ammonium mercurithiocyanate solution. A violet colour precipitate is produced.

(C) Solution of zinc salts when treated with potassium ferrocyanide solution forms a white precipitate of zinc ferrocyanide which is insoluble in dilute hydrochloric acid.

$$2\,Zn^{2+} + [Fe(CN)_6]^{4-} \rightarrow Zn_2\,[Fe(CN)_6]$$

Zinc ferrocyanide

To 5 ml of solution A, add 2 ml of potassium ferrocyanide solution. A white preparation is formed which is insoluble in dilute hydrochloric acid.

2. A 5% w/v solution in 2M nitric acid **(Solution B)** gives the following reactions of chloride.

(A) An aqueous solution of chloride on acidification with dilute nitric acid followed by treatment with silver nitrate solution forms a curdy white precipitate of silver chloride which is insoluble in dilute nitric acid but soluble in dilute ammonia solution. The precipitate reappears on addition of dilute nitric acid.

$$NaCl + AgNO_3 \rightarrow AgCl \downarrow + NaNO_3$$

$$AgCl + 2NH_3 \rightarrow [Ag(NH_3)_2]^+Cl^-$$

$[Ag(NH_3)_2]^+Cl^- + HNO_3 \rightarrow AgCl\downarrow + (NH_4)_2NO_3$

Acidify 2 ml of the solution B with dilute nitric acid, add 0.5 ml of silver nitrate solution, shake and allow to stand for some time. A white curdy precipitate is produced, which in insoluble in nitric acid but soluble in dilute ammonia solution after being well washed with water. The reprecipitation occurs on addition of dilute nitric acid.

(B) Sample containing chloride ion on treatment with potassium dichromate and sulphuric acid gives volatile chromylchloride which reacts with diphenylcarbazide solution to produce a violet colour.

$$4Cl^- + K_2Cr_2O_7 + 3K_2SO_4 \rightarrow 2CrO_2Cl_2\,(g) + K_2SO_4 + 2SO_4^{2-} + 3H_2O$$

Take in test tube the quantity equivalent to 10 mg of chloride ion, add 0.2 g of potassium dichromate and 1 ml of sulphuric acid. Place a filter paper moistened with 0.1 ml of diphenylcarbazide solution over the month of the test tube. The paper turns to violet red in colour.

Test for Purity: It has to be tested for ammonium salts; alkalis and alkaline earths; oxychloride; sulphate and heavy metals.

(i)Ammonium Salts: Ammonium salts are detected by warming a solution of zinc chloride with sodium hydroxide. No odour of ammonia should be perceptible.

$$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$$

To 5 ml of a 10% w/v solution, add 1M sodium hydroxide until the precipitate first formed is redissolved and then warm the solution. No odour of ammonia is perceptible.

(ii)Alkalis and Alkaline Earths: When sample is dissolved in dilute hydrochloric acid followed by addition of ammoniacal ammonium sulphide, zinc gets precipitation as ZnS. The ZnS is filtered off and an aliquot of the filtrate is acidified with sulphuric acid, evapourated to dryness and ignited. The residue obtained after ignition is weighted. The residue should not be more than 1%.

(iii)Oxychloride: Aqueous solution of zinc chloride is acid to litmus due to hydrolysis to hydrogen chloride and on evaporation it gives a residue containing varying proportions of the Oxychloride, Zn(OH)Cl.

$$ZnCl_2 + H_2O \rightarrow HCl + Zn(OH)Cl$$

Dissolve 1.5 g in 1.5 ml of carbon dioxide-free water. To this solution, which should be clear, is added 7.5 ml of 95% ethanol. The solution may become cloudy within 10 minutes but becomes clear on the addition of 0.2 ml of 2M hydrochloride acid.

(iv)Sulphate: 15 ml of solution A complies with the limit test for sulphates.

Assay: It is assayed by complexometry using strong ammonia–ammonium chloride solution as buffer, eriochrome black T solution as indicator and titrating with 0.1M disodium edetate.

$ZnCl_2$ + $C_{10}H_{14}N_2Na_2O_8$ → $C_{10}H_{14}N_2O_8Zn$ + 2NaCl

Disodium edetat Zinc edetate

Weight accurately about 3 g, dissolve in 125 ml of water add 3 g of ammonium chloride and make up the volume to 250 ml with water. To 25 ml of the resulting solution add 100 ml of water and 10 ml of strong ammonia-ammonium chloride solution. Titrate with 0.1M disodium edetate using eriochrome black T solution as indicator until a deep blue colour is produced.

Each ml of 0.1 M disodium edetate is equivalent to 0.01363 g of $ZnCl_2$

Uses: It is used as an antiseptic astringent to the skin and mucous membrane as a 0.5–2.0% solution. It ranks very low among disinfectants.
It is used as an active ingredient to prepare magnesia cements for dental fillings and certain mouthwashes.
It is also used as dentin desensitizer, topically as a 10% solution to the teeth.

Formulation: It is for topical use only and is administered as solution and mouthwash.

2. Zinc-Eugenol Cement
Preparation: Zinc-Eugenol cement consists of two parts and is prepared as follows

Part A. The Powder:

Zinc Acetate	0.5 g
Zinc Stearate	1 g
Zinc Oxide	70 g
Rosin	27.5 g

Rosin is powdered and mixed with about an equal weight of zinc oxide. The mixture is sifted through a sieve of not less than 100–mesh. The material retained on the sieve is regrinded with additional zinc oxide, and sifted again. The process of regrinding and sifting is repeated until all of the material passes readily through the sieve and the two mixtures are then mixed with the remainder of the zinc oxide.

Part B. The Liquid:

Eugenol	85 ml
Cottonseed Oil	15 ml

The liquids are mixed together in the proportion specified.

Zinc-Eugenol cement is prepared by mixing 10 parts of the powder with 1 part of the liquid to a thick paste immediately before use. For obtaining any desired consistency the amount of the liquid may be varied.

The Powder
Identification Tests:
1. 10 parts of the powder is mixed with 1 part of the liquid and the resulting mixture is transferred to a beaker containing water at 25^{o}. The mixture hardens in not more than 20 minutes.

2. 1 g of the powder is triturated with 10 ml of solvent hexane. The mixture is filtered and to the filtrate 10 ml of freshly prepared cupric acetate solution (1 in 200) is added, shaken for a few minutes, and allowed the liquid layers to separate. The solvent hexane layer is green.

3. The residue obtained in the assay for total zinc as zinc oxide, dissolved in a slight excess of hydrochloric acid, gives reactions for zinc.

4. 5 g of the powder is triturated with 25 ml of water, the triturate is filtered and to 10 ml of the clear filtrate, 1 ml of ferric chloride TS is added in a colour-comparison tube. A standard is prepared by adding 1 ml of ferric chloride TS to 10 ml of water in a matched colour-comparison tube. The intensity of the colour produced in the filtrate is more than that of standard colour when viewed downwards against a white surface.

Assay for Rosin: About 1 g of the accurately weighed powder is placed in a beaker, to this 50 ml of chloroform is added, and stirred for several minutes. The resultant is filtered through a tared porcelain filtering crucible and the insoluble material is transferred as completely as possible with additional portions of chloroform. The crucible is washed with chloroform, dried in an oven at 80°C, cooled, and weighed. The loss in weight of the powder taken should not be less than 300 mg.

Assay for total Zinc as Zinc oxide: Ignite the residue obtained in the assay of rosin to constant weight, cool, and weigh. The weight of the ZnO so obtained is not less than 680 mg and not more than 720 mg.

The Liquid
Identification Test: 1 ml of the liquid is shaken with 20 ml of water, filtered, and to 5 ml of the clear filtrate, 1 drop of ferric chloride TS is added. A transient pale yellow-green colour is produced.

Specific Gravity: Between 1.043 and 1.048.

Refractive Index: Between 1.528 and 1.531 at 20°

Uses: It is a temporary cement with a zinc oxide eugenol base for crown and bridge procedures**.**
It can be used in dentistry as a filling or cement material. It is used in temporary restorations ,in managing dental caries as a temporary filling .
It is also used as an impression material during construction of complete dentures.
Zinc-Eugenol cement has anaesthetic and antimicrobial effect due to the eugenol content and is used in painful conditions of dental pulp.

Pumice

Pumice is a substance of volcanic origin, produced when lava with a very high content of water and gases is thrown out of a volcano. As the gas bubbles escape from the lava, it becomes frothy. When this lava cools and hardens, it results in a very light rock material filled with tiny bubbles of gas. It consists mainly of complex silicates of aluminum, potassium, and sodium. It is very light, hard, rough, porous, greyish mass. It is odorless and stable in air

Labeling: Powdered pumice is labeled to indicate the fineness of the powder. Powdered pumice shall meet the following requirements:

"Pumice Flour" or "Superfine Pumice": not less than 97.0 percent of pumice flour or superfine pumice passes through a No.200 standard mash sieve. **"Fine Pumice":** not less than 95.0percent of the fine pumice passes through a No.150 standard mash sieve and not more than 75.0 percent passes through a No.200 mash sieve.

"Coarse Pumice": not less than 95.0 percent of coarse pumice passes through a No.60 standard mash sieve and not more than 50 percent passes through a No.200 standard mash sieve.

Test for purity: It has to be tested for water soluble substances, acid soluble substances and iron.

Water-soluble substances: 10 g is boiled with 50 ml of water 30 minutes, adding water from time to time to maintain approximately the original volume, then filter; the filtrate is neutral to litmus, and one-half of this filtrate, when evapourated and dried at 105° for 1 hour, yields not more than

It has to be tested for water-soluble substances, acid 10 mg of residue (0.20%)

Acid-soluble substances: Boil 1 g of pumice with 25 ml of 3N hydrochloric acid for 30 minutes, adding water from time to time to maintains approximately the original volume, then filter the liquid. Add 5 drops of sulphuric acid to the filtrate, evapourate to dryness, ignite, and weigh the residue; not more than 60 mg of residue is obtained (6.0%).

Iron: Acidify the remaining half of the filtrate from the test for water-soluble substances with hydrochloric acid, and add a few drops of potassium ferrocyanide TS. No blue colour is produced.

Uses: It is used as an abrasive.Finely ground pumice is added to some toothpastes and heavy-duty hand cleaners as a mild abrasive.

It is prepared in various grits and is used for finishing and polishing in dentistry. It is used in the polishing of natural teeth during a prophylaxis but is being replaced by less abrasive synthetic particles in some polishing pastes.

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