HEALTHY DRINKS AND TASTY TOOTHPASTE

A science investigation pack for teachers of 7-9 year olds

CENTRE *for* INDUSTRY EDUCATION COLLABORATION

Supported by the Gatsby Charitable Foundation

Contents

Introduction

AGE RANGE

The activities in this book provide an opportunity for lower Key Stage 2 children to understand how to keep teeth and gums healthy, and the dangers of tooth decay. It can be modified for use in upper Key Stage 2.

The suggested activities can be adapted to suit the needs of the children, staff and the planning requirements of the school.

CONTEXT

The activities use the real life context of a toothpaste manufacturer who wants to develop, in consultation with a drinks' manufacturer, a toothpaste that will provide maximum protection against sugar in drinks. The children take on the role of toothpaste researchers to investigate the ingredients and properties of toothpaste in order to suggest a toothpaste that will provide maximum protection against sugar in drinks.

Children test a variety of different types of toothpaste and then make their own. The drinks' manufacturers also want to provide an appropriate dental hygiene recommendation on the drink cartons.

ALTERNATIVE INDUSTRIAL LINKS

The fictional company in this pack is a toothpaste manufacturer. However, other links may be made, as indicated in the table below.

Industry	Activity[1]	Possible industrial site visit
Food and drinks' manufacturers.	Sugary drinks	Visit a food or drink manufacturer and see how they make and test their product.
Toothpaste or other dental health product manufacturers.	Tantalizing toothpaste	Children observe the manufacturing process and scientific testing of commercial toothpaste. Alternatively, arrange a visit from a suitable company
Dental associations	Making toothpaste	Children visit a dentist or arrange a visit from a dental association representative. They can find out what dentists use to clean our teeth more effectively than we can at home.

1 See table overleaf for activity description.

ACTIVITIES

The activities should take about 7 hours to complete and can be covered in 3-4 ½ day sessions. The activities should be completed in the order given, as they develop an investigation from identification and investigation of a problem through to a solution. However, each activity can be adapted to suit the needs of the children or the school.

It is advised that children work in mixed ability groups of 4 children. Some of the sessions (particularly activities 2 and 3) would benefit from additional adult support such as teaching assistants or parent helpers.

ACTIVITY SUMMARY

Title	Description	Timing
1. Sugary drinks	Children take on the role of a toothpaste manufacturer liaising with a drinks manufacturer to produce a juice drink that does not increase the risk of tooth decay. The children test the effect of plaque acid on teeth, using egg shells in different concentrations of vinegar left over night.	2 hours
2. Tantalizing toothpaste	Children test a range of toothpaste types for abrasion, taste, colour, consistency and smell. They establish what is necessary in toothpaste and which ingredients help to achieve this.	2 hours
3. Making toothpaste	Children make their own types of toothpaste following a range of recipes. They choose the flavours and colours. They then test their toothpaste and come up with an ultimate toothpaste recipe.	2 hours
4. Report back to company	Children report back to the company via e-mail. They then design a poster to advertise their toothpaste, showing the active ingredients and their function in the toothpaste. This provides an ideal assessment opportunity.	1 hour

Resource requirements

Quantities are given per group of 4 children, unless otherwise stated:

ACTIVITY 1

- Activity sheets 1a-b
- Activity sheets 1c-f (per child)
- 3 containers, e.g. 250 ml beakers or yoghurt pots or Petri dishes
- 75 ml white vinegar
- 75 ml water
- Eggshell (one egg for 3-4 groups)
- 2-4 magnifying glasses (optional)
- Drinks packaging detailing sugar content – optional (children collect)
- 1 plastic teaspoon
- latex /disposable plastic gloves.

ACTIVITY 2

- Activity sheet 2a and 2b
- Activity sheet 2c (optional - extension/homework)
- 3 large tubes of different types of toothpaste for the class, e.g. whitening, tartar control, paste or gel, different colours/flavours
- 3 small white ceramic tiles[1]
- 1 permanent marker for the class
- 2 new toothbrushes
- Stop watch

1 These can be bought cheaply as 'seconds' from DIY stores.

ACTIVITY 3

- Teaspoon
- Small container (e.g. 250 ml beaker or yoghurt pot)
- Either:
- Activity sheet 3a
- 3 teaspoons of baking soda
- ½ teaspoon of salt
- 3 teaspoons of glycerine
- 1-2 teaspoons of peppermint flavouring
- ½ teaspoon of food colouring (optional)
- 2-3 teaspoons of water
- Or:
- Activity sheet 3b
- 3 teaspoons of mixed gelatine
- 3-5 teaspoons of baking soda
- 1-2 teaspoons of peppermint flavouring
- Oil of liquorice, fennel or anise (optional)
- ½ teaspoon of food colouring (optional)

ACTIVITY 4

- Activity sheet 1a

1. Sugary drinks

2 hours

Children take on the role of a toothpaste manufacturer liaising with a drinks manufacturer to produce a juice drink that does not increase the risk of tooth decay. The children test the effect of plaque acid on teeth, using egg shells in different concentrations of vinegar left over night.

OBJECTIVES

- Identify the different types of teeth in humans and their simple functions
- To understand that sugar can cause tooth decay.
- To understand that plaque produces a corrosive substance.
- To understand the effect of plaque acid on teeth.

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 1a-b
- Activity sheet 1c-e (per child)
- 3 containers, e.g. 250 ml beakers or yoghurt pots
- 75ml white vinegar
- 75ml water
- Eggshell (one egg for 3 – 4 groups)
- 2-4 Magnifying glasses (optional)
- Drinks packaging - detailing sugar content – optional (children collect)
- 1 plastic teaspoon
- Latex/disposable plastic gloves.

Safety note

The eggs must be boiled and the membrane removed. Check for children's allergies.

ADVANCE PREPARATION

To prepare the egg shell, either boil and shell the eggs for each group, removing the membrane, or, shell raw eggs and then boil the shells.

Break the shells into roughly 3 equal sized pieces (approximately 1 cm2) for each group.

Each group requires three containers of liquid (approximately 50 ml). The first contains water, the second, half water and half vinegar, and the third undiluted vinegar. Depending on the class and time available, either prepare the vinegar solutions for each group beforehand, or allow the children to measure them out during the activity.

INTRODUCING THE ACTIVITY

Show the children the toothpaste manufacturer's e-mail (Activity sheet 1a), asking for advice on developing a toothpaste that will clean off the sugar left on teeth after contact with a sugary drink. Read the newspaper cuttings (Activity sheet 1b) that refer to the effect of some soft drinks on children's teeth. (Information in the cuttings is from www.bbc.co.uk)

Discuss how sugary foods and drinks cause tooth decay (see Appendix 1 for background information about tooth decay).

This is an opportunity to highlight, define and discuss vocabulary to do with dental hygiene and tooth decay such as:

plaque, tooth decay, cavity, hygiene, bacteria, gum disease, tartar.

As an optional extension or homework activity, the children could complete a flow chart (Activity sheet 1c) showing the process of tooth decay using words or labelled pictures.

MAIN ACTIVITY

Ask the children to suggest how they could test the effects of sugary drinks on teeth. If they suggest dropping teeth into different kinds of drinks, ask them where they will get the teeth from. Tell them that eggshells are made of similar material to our teeth. Explain that, to make the test fair, vinegar will be used. This is not meant to be like the drink, but like the substance that is made when plaque and sugar mix together; this is called 'plaque acid'. Continue to remind the children of the connection between the effects of vinegar on eggshell, and the effect of plaque acid on teeth.

Use Activity sheet 1d to go through the investigative process and the plan to observe the effects of different strengths of vinegar on eggshell.

Children can observe the eggshells using magnifying glasses to describe their colour, texture and hardness before the investigation. They then read the plan and think about what they are going to do.

Safety note

The children should either wear plastic gloves or manipulate the eggshell with a spoon without touching it.

Children set up an investigation with the same amount of liquid in each of three containers (approximately 50 ml). The first contains water, the second, half water and half vinegar, and the third undiluted vinegar.

The children predict what they think will happen to each of the eggshells and why. Encourage them to think about the colour, texture and hardness. They could draw and label a prediction picture on the back of the sheet.

After the eggshells have been in the solutions for a few minutes, the children should be able to notice bubbles appearing on those in the vinegar solutions (more in the highest concentration of vinegar) and no bubbles on the eggshell in the water. Ask the children:

- *Why do you think bubbles are appearing on the eggshells in vinegar?*

The vinegar is doing something to the eggshell. It is changing the eggshell in some way.

After leaving for at least 1 hour (perhaps over lunch), the children observe the eggshells in the solutions. They should see that the eggshell in both concentrations of vinegar should be floating and covered in small bubbles of gas (more bubbles on the eggshell in the concentrated vinegar). However, the eggshell in the water should have no bubbles and should still be at the bottom of the container.

The children remove the eggshell samples to observe any changes in colour, hardness or texture by gently prodding, scratching and feeling the samples. This could be a discussion point, or the children record their observations on Activity Sheet 1e. They should notice that eggshells in both the vinegar solutions are weaker, more brittle (snap-able), rougher, and crumbly and that the colour can be scratched off. The eggshell in water should have no change to its colour, texture or hardness.

They then return the eggshells to their solutions and leave them overnight before the final observation where the eggshells left in the vinegar solution should be floppy and begin to disintegrate when removed from the container.

PLENARY

Draw a conclusion with the children, discussing the effect the vinegar had on the eggshell. The shell should have weakened and be much more brittle.

Make it explicit that the vinegar has damaged the eggshell in a similar way to plaque acid damaging teeth.

EXTENSION

Children examine the ingredients on the drinks packaging that they have collected to identify the sugar content in different drinks and fill in the chart on Activity sheet 1f. If the amount of sugar is not listed, they could examine the ingredients that are usually listed in order of amount; largest to smallest.

Ask the question:

- *Should we never drink sugary drinks even if we really enjoy them?*

We can still eat or drink sugary foods or drinks in moderation, as long as we clean our teeth regularly after drinking them.

Re-read the e-mail and ask the children if they have found an answer to any of the problems.

Compose a brief whole-class e-mail to send to a drinks manufacturer with the children's recommendations relating to sugary drinks, by asking the children to come up with suggestions about what drinks' manufacturers should do to reduce the tooth decay caused by their fruity drinks. They could recommend that manufacturers cut down on the amount of sugar in drinks; find an alternative sweetener; show clear health warnings on the labels; or provide advice on the label for keeping teeth healthy, e.g. advising children to clean their teeth after a drink.

The issue may be raised that pure fruit juice contains no added sugar (it only contains naturally occurring sugars), yet it is acidic. The more sugar a drink contains, the more tooth decay it can cause.

From: "Sparkle plc" <Simmonds@sparkleplc.com>
To: "Oral health research group" <research@healthrp.co.uk>
Subject: Healthy Teeth

Dear Research Group,

We at Sparkle Toothpaste plc have been asked by Bubble Drinks plc to create a toothpaste ideal for cleaning teeth after a sugary drink. They want to keep their drinks tasty and sweet without rotting people's teeth.

Please find attached some recent newspaper articles that explain how sugary drinks damage teeth.

We need you to:

1. Find out how sugary drinks can damage teeth.
2. Explain how toothpaste helps fight tooth decay.
3. Investigate what taste, smell and colour of toothpastes people like best.
4. Find out what the main ingredients of toothpaste are, and what they do.

We look forward to hearing from you with your results.

Mike Simmonds
Research Manager
Sparkle plc
Simmonds@sparkleplc.com

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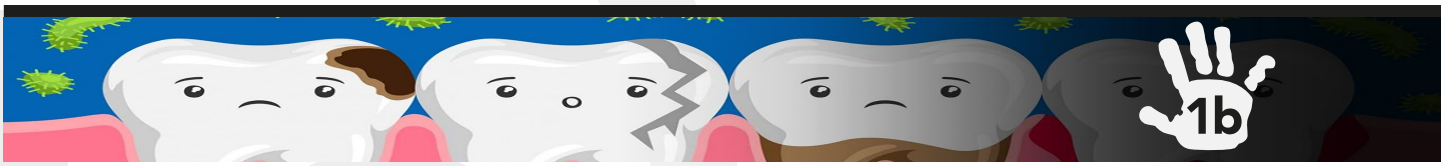
Disclaimer

This email transmission is confidential and intended solely for the organisation to whom it is addressed.

Activity Sheet 1b: Newspaper Cuttings



Some of the UK's most popular brands of juice drink contain more sugar than cola, increasing the risk of damage to children's teeth!

Tooth decay warning over soft drinks

Some soft drinks manufacturers are producing juice drinks that are pretending to be healthy, but

...or with...

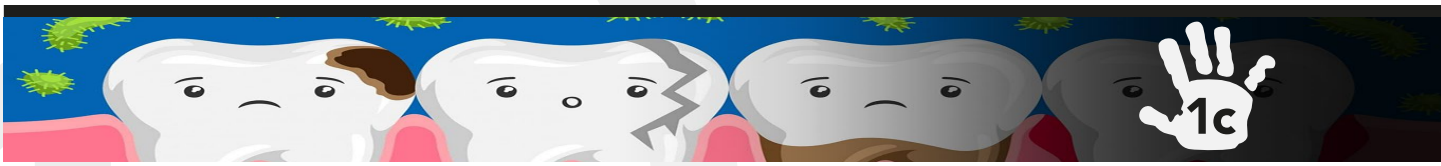
Even some drinks that claim to be kind to teeth can still cause tooth decay.

...caus...

Juice Drinks fall short of healthy image

Some drinks tested had less than 5% real fruit juice, others had so much sugar that they were 60% sweeter than pure fruit juice.

Activity Sheet 1c: Tooth Decay Flow Chart



Make a flow chart to show how sugar can cause tooth decay remember to use words and pictures. You could start by showing someone drinking a sugary drink like Cola.

1.

2.

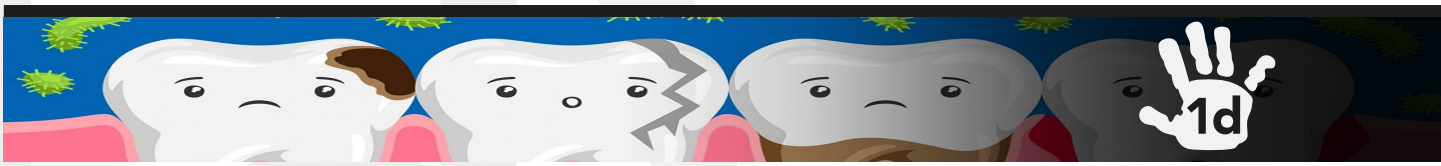
3.

4.

5.

Useful Words: plaque, decay, tooth, cavity, eats away, bacteria, sugary drink, gum disease, toothpaste, toothbrush, rot.

Activity Sheet 1d: What does plaque acid do to our teeth?



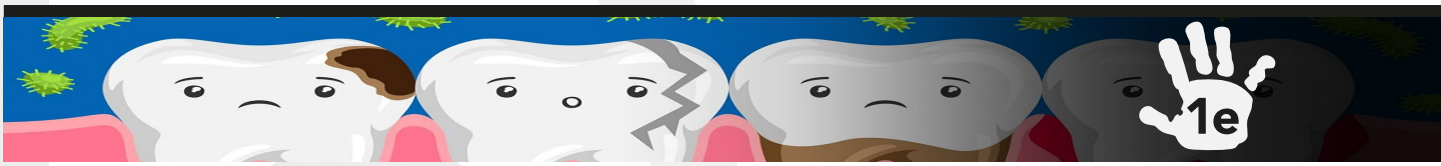
When we eat sugary food, the sugar mixes with germs (bacteria) in our mouths and this then makes plaque. This makes plaque acid that eats away at our teeth.

We are using egg shell because

We are using vinegar because

What do you think will happen to the eggshell in the each pot?	
Pot	**Prediction** e.g. shape, colour, texture (smoothness), hardness
A: Water	
B: Water and Vinegar	
C: Vinegar	

Activity Sheet 1e: Results



Start

Draw and label pictures in boxes 1, 2 and 3.

After 1-2 hours

Describe shape, colour, feel and hardness.

Water	Water and vinegar	Vinegar

After being left overnight

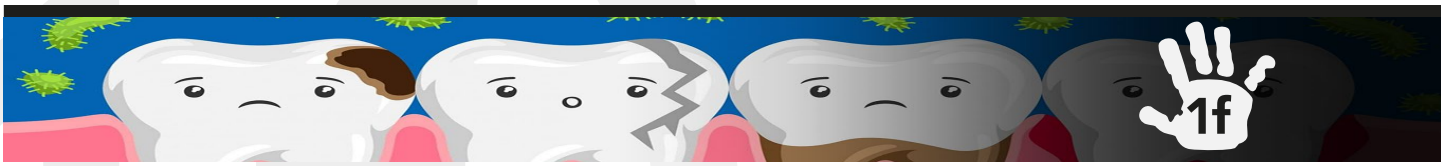
Water	Water and vinegar	Vinegar

Conclusion

What does vinegar do to the eggshells?

What do you think plaque acid does to our teeth?

Activity Sheet 1f: Results



Look at the labels on different drink packages.

Fill in the table below.

Name of drink	Amount of sugar (%)	How do you think it will affect our teeth? ☹☹☹ = very bad (very sugary) ☹☹ = bad (fairly sugary) ☹ = fairly bad (some sugar) ☺ = healthy (very little sugar)

Which drink is probably the best for your teeth?

Why?

Which drink is probably the worst for your teeth?

Why?

2. Tantalizing toothpaste

2 hours

Children test a range of toothpaste types for abrasion, taste, colour, consistency and smell. They establish what is necessary in toothpaste and which ingredients help to achieve this.

OBJECTIVES

- To understand the function of toothpaste.
- To undertake tests to find the most effective toothpaste.
- To compare different toothpastes by analysing their effectiveness.

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheet 2a-c
- Activity sheet 2d (optional - extension/homework)
- 3 large tubes of different types of toothpaste for the class, e.g. whitening, tartar control, paste or gel, different colours/flavours
- 3 small white ceramic tiles[1]
- 1 permanent marker for the class
- 2 new toothbrushes
- Stop clock or watch, or the second hand of the class clock

ADVANCE PREPARATION

Coat or colour a small patch on each ceramic tile with the permanent marker pen.

There are four mini-activities for Activity 2 with implications for classroom organisation. Here are some options:

1. A circus of investigations set up around the room, which the children visit in turn.
2. Each group carries out a different test and shares them.
3. Each child in a group is given the responsibility to carry out a different test on toothpaste.
4. The whole class works through each activity sequentially.

1 These can be bought cheaply as 'seconds' from DIY stores.

INTRODUCING THE ACTIVITY

Look at the concept cartoons (Activity sheet 2a-b). The children discuss the cartoon statements in their groups, ticking the ones they agree with and crossing out the ones they do not. Lead a discussion about which statements the children agree with and importantly, why they agree. Discuss the last activity; explaining how cleaning our teeth helps make our teeth and gums healthier.

MAIN ACTIVITY

Introduce the following tests to compare types of toothpaste, in order to find out what the children consider is the best toothpaste and find out how it fights tooth decay. Discuss key vocabulary, e.g. abrasive (scratchy, grating, gritty, rough), consistency (firmness, thickness). Display these in the classroom.

Activity sheet 2c provides a table for the children to record their measurements, observations and preferences. Differentiate between scientific observations such as carefully describing the smell, and expressing opinions such as their favourite taste is mint. Explain that the toothpaste manufacturers would have to do similar tests.

Colour observation: The children describe the toothpaste colours and which they prefer. Do any colours put them off?

Smell observation: They select 1-2 words to best describe each smell, and add a ☺ or ☹ to show preference.

The children then establish which of the three toothpastes smell the best. Discuss how important smell is to toothpaste. What would the children like toothpaste to smell like?

Scratch test: The children test each toothpaste type by timing how long it takes to remove the permanent marker from the ceramic tile. Establish that the permanent marker represents plaque. The toothpaste that removes the marker the quickest will be the most abrasive.

Discuss the ideal circular motion for cleaning teeth and why it is better for your teeth than scrubbing.

Thickness test: The children put some toothpaste on a toothbrush and try and shake it off into a container. The higher the number of shakes, the thicker the consistency. Establish that consistency is important for the toothpaste to stay on the brush and to evenly spread over the teeth. This can be quite a messy test.

Safety note

The children should wear goggles to prevent toothpaste getting into their eyes. They may prefer to wear aprons to protect their clothes.

PLENARY

The children then draw a conclusion by considering all the properties of each toothpaste.

The class then pool all their choices, and discuss the toothpastes to find out whether the class can select one preferred toothpaste.

Remind the children that preferred smells and tastes can differ from one person to another.

Toothpaste manufacturers could be asked how they select new flavours/smells, e.g. do they ask 10, 100 or 1,000 people for their preferences?

Look back at the concept cartoons to establish that brushing our teeth has several different purposes, e.g. brushing scrapes some of the plaque from the surface of our teeth.

EXTENSION/ HOMEWORK

Toothpastes contain different ingredients to make them work successfully. The children could use Activity sheet 2c to match the function to the active ingredient. The table below shows some active ingredients and their function.

Type of ingredient	Function
Fluoride	Strengthens tooth enamel against decay.
Abrasive substance (such as silica)	Helps scrape off plaque from the smaller nooks and crannies that the toothbrush alone cannot reach.
Stain remover	To help to whiten teeth.
Thickening agent (such as cellulose)	So that it forms a paste, stays on the toothbrush and can be easily applied to our teeth.
Flavouring	To mask the flavours of other ingredients and to make our mouths feel fresh and clean.

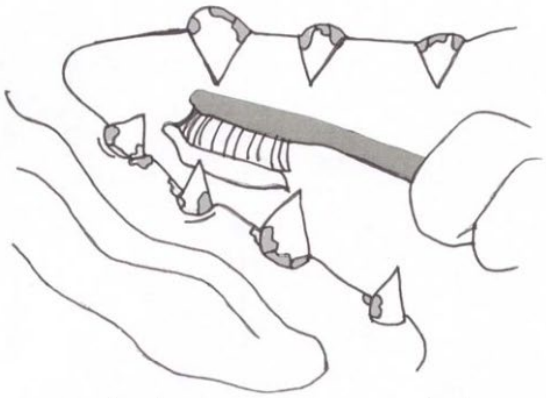
Appendix 2 provides a more comprehensive explanation and table as well as the features and functions of different types of toothbrush.

Activity Sheet 2a

How does brushing our teeth help to keep them healthy?

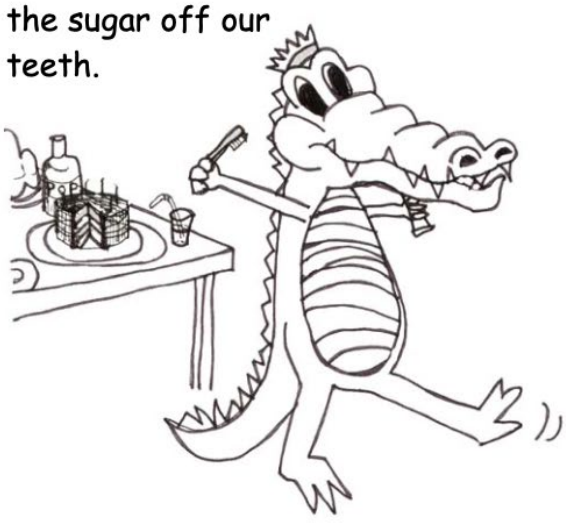
Tick the statements you agree with.

I think the toothpaste kills all the germs in our mouths.



I think the toothpaste helps to scrape off the plaque from tiny nooks and crannies.

I think brushing our teeth cleans the sugar off our teeth.



I think the toothpaste makes our teeth stronger.

Activity Sheet 2b

2b

I think the toothpaste scrapes off the plaque from our teeth when we brush them.

I think toothpaste kills the germs on our teeth.

I think toothpaste gets rid of stains on our teeth.

I think the toothpaste makes our mouth taste fresh and clean!

Activity Sheet 2c: Toothpaste observations and results

Toothpaste Brand Name	Colour Tick the box if you like it.		Smell ☺ = nice smell ☹ = nasty smell	Cleaning time (Scratchiness) (seconds)	Shake time (seconds)

Conclusion

Circle the toothpaste that has the best:

- colour
- smell
- scratchiness
- thickness

The best overall toothpaste was _____

Activity Sheet 2d: The ingredients of toothpaste

Type of ingredient	Function
Fluoride	
Scratchy ingredient (abrasive)	
Stain remover	
Something to make the toothpaste thicker	
Flavouring	

Cut out these statements and fit them into the correct box.

To make a paste that stays on the toothbrush and spreads on our teeth.

To scrape off plaque from parts of our teeth that a toothbrush cannot reach.

To make our teeth stronger against decay.

To help to make our teeth whiter.

To make our mouths feel fresh and clean and hide the taste of other ingredients.

3. Making toothpaste

2 hours

Children make their own types of toothpaste following a range of recipes. They choose the flavours and colours. They then test their toothpaste and come up with an ultimate toothpaste recipe.

OBJECTIVES

- To make a toothpaste, considering the necessary ingredients.
- To further understand the function of the different ingredients in toothpaste.

RESOURCES

(Per group of 4 children unless otherwise stated)

- Teaspoon
- Small container, e.g. 250 ml beaker or yoghurt pot
- Activity sheet 2c
- Either:
- Activity sheet 3a
- 3 teaspoons of baking soda
- 1/2 teaspoon of salt
- 3 teaspoons of glycerine
- 1-2 teaspoons of peppermint flavouring or crushed peppermints
- 1/2 teaspoon of food colouring (optional)
- 2-3 teaspoons of water
- Or:
- Activity sheet 3b
- 3 teaspoons of mixed gelatine
- 3-5 teaspoons of baking soda
- 1-2 teaspoons of peppermint flavouring or crushed peppermints
- Oil of liquorice, fennel or anise (optional)
- 1/2 teaspoon of food colouring (optional)

ADVANCE PREPARATION

For Toothpaste Recipe B (Activity sheet 3b), mix 10 ml of gelatine with 500 ml of hot water and leave to stand for at least 20-30 minutes.

INTRODUCING THE ACTIVITY

Remind the class of the different functions of key toothpaste ingredients using the completed extension/homework activity (Activity sheet 2d).

Explain that they are going to use recipes[1] to make different types of toothpaste and test their effectiveness. Use one of the recipes from Activity sheet 3a or 3b to demonstrate how to make toothpaste, talking through the functions of the different active ingredients as you add them.

MAIN ACTIVITY

Children make their own toothpaste using one of the recipe choices. Different groups could follow different recipes. They then test their toothpaste by carrying out tests from Activity 2 recording observations and results on Activity sheet 2c.

PLENARY

Discuss the children's results to establish the best recipe and why (use success criteria from Activity 2). As a class, create a recipe for the perfect toothpaste on the board, checking that it has all the necessary active ingredients and functions. Ask why the children think mint is the most common toothpaste flavour, e.g. it has a strong flavour to hide the taste of the other ingredients and it makes our mouths feel clean and fresh.

1 These recipes have been adapted from recipes on www.industryinet.com/~ruby/toothpaste.html and www.new- sng.com/tooth.cfm

Activity Sheet 3a: Toothpaste Recipe A

Ingredients	Equipment
3 teaspoons of baking soda 1/2 teaspoon of salt 3 teaspoons of glycerine 1-2 teaspoons of peppermint flavouring 1/2 teaspoon of food colouring (optional) 2-3 teaspoons of water	Teaspoon Yogurt pot, or 250 ml beaker

Method

1. Mix together the baking soda and salt in the container.
2. Add the glycerine, peppermint flavouring and colouring (if using) and mix to form a thick paste.
3. Add a few drops of water at a time until it is at the correct thickness.

What the ingredients do:

Ingredient	Job
Baking soda	Cleans
Salt	Makes it abrasive or scratchy
Peppermint	Freshens
Glycerine	Thickens
Water	Loosens the toothpaste

Activity Sheet 3b: Toothpaste Recipe B

Ingredients	Equipment
3 teaspoons of mixed gelatine 3-5 teaspoons of baking soda 1 -2 teaspoons of peppermint flavouring Oil of liquorice, fennel or anise (optional) 1/2 teaspoon of food colouring (optional)	Teaspoon Yogurt pot, or 250 ml beaker

Method

1. Put the gelatine in the container and add the baking soda a spoonful at a time until the mixture is pasty.
2. Mix in the remaining ingredients.

What the ingredients do:

Ingredient	Job
Baking soda	Cleans and makes it abrasive or scratchy
Peppermint	Freshens
Liquorice, fennel/anise	Hides the flavour of the baking soda
Gelatine	Thickens

4. Report back to the company

1 hour

Children report back to the company via e-mail. They then design a poster to advertise their toothpaste, showing the active ingredients and their function in the toothpaste. This provides an ideal assessment opportunity.

OBJECTIVES

- Reporting on findings from enquiries including oral and written explanations, displays or presentations of results and conclusions.

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheet 1a

INTRODUCING THE ACTIVITY

Look back at the company e-mail (Activity sheet 1a) from the toothpaste manufacturer and discuss whether all their questions have been answered. Establish a suitable way of feeding back the information discovered to the company, e.g. e-mail, poster, cartoon or letter, etc.

MAIN ACTIVITY

The children reply to the e-mail by their chosen means answering the questions and providing their recommendations on how to make drinks healthier. They could also outline their ideas about toothpaste and include a good toothpaste recipe for people who regularly drink sugary drinks.

EXTENSION ACTIVITY

The children could create a poster to advertise their toothpaste, including the ingredients and different functions of toothpaste.

These activities provide an ideal opportunity to assess the understanding of the children.

PLENARY

Ask the children how they think the activities they have done might compare to how toothpastes are commercially manufactured or tested.

Compile a list of questions that children would like to find out about the manufacturing or testing of toothpaste or other oral health products, or what drinks' manufacturers try to do to reduce tooth decay for people using their products.

A site visit could be arranged to a toothpaste manufacturer or a company related to oral health care. Here the children could observe the manufacturing process, find out what the scientists do in the company and compare these to the activities they did in the classroom. The children could try and find the answers to the questions. Or, if this is not possible, a representative from a company could visit the school to describe the manufacturing and testing of toothpaste and the role of scientists. Some of the children's work could be passed on to the company.

If a link with an industry is not possible, the children could research answers to their questions on the internet or in the library.

The PSEP support video, section 5 – Virtual Site Tour, shows children visiting a site where toothpaste is made.

Appendix 1: Tooth decay

Tooth decay is damage to the enamel of your teeth. It occurs when acids produced by bacteria in dental plaque eat away at the tooth.

HOW DO SUGARY FOODS AND DRINKS CAUSE TOOTH DECAY?

A number of micro-organisms are present in our mouths. Bacteria are the most common among them. Enzymes produced by these bacteria convert all food, especially sugar and starch, into acids. Bacteria, acid, food debris, and saliva combine in the mouth to form a sticky colourless film called plaque that adheres to the teeth.

The bacteria in the plaque consumes sugar in our mouths and produce an acidic substance as a waste product, which damages teeth, gums, and surrounding bone. Plaque forms constantly, but it can be controlled by proper brushing and flossing.

Plaque that is not removed from the teeth becomes a hard substance called tartar. Plaque and tartar irritate the gums. The acids in plaque can dissolve the enamel surface of the tooth and create holes in the tooth (cavities). Cavities are usually painless until they grow very large inside the internal structures of the tooth (the dentine and the pulp at the core) and can cause death of the nerve and blood vessels in the tooth, leading to the formation of abscess. Untreated tooth decay can result in death of the internal structures of the tooth with eventual loss of the tooth.

A dentist or physician may prescribe fluoride tablets to be taken while the teeth are developing in a young child. Daily intake of refined carbohydrates or sugars should be minimised since they promote tooth decay. If a cavity is found, the decayed tissue is removed from the tooth and replaced by a filling. A crown is used if decay of a tooth is severe. Crowns cover the tooth and minimise the risk of the tooth breaking.

HOW DOES SALIVA AFFECT TOOTH DECAY?

A primary factor in the rate of tooth decay is the chemical structure of saliva. Acid saliva causes tooth decay; and alkaline saliva causes gum disease. Acid saliva and sugar in dental plaque causes the enamel on the tooth to soften which leads to cavity formation. Alkaline saliva and sugar in dental plaque causes the plaque at the gum line to harden into calculus (tarter) causing gum disease.

Therefore, two children in the same family can eat the same amount of sugar and one child may have a lot of cavities and the other child may have no or few cavities because of the different saliva. As people get older their saliva becomes more alkaline with age. That is one reason adults have more gum disease and fewer cavities.

Thus it is important for children to brush the gums and teeth on a regular basis even though the child is not cavity prone. The gums are important too.

Appendix 2: The active ingredients of toothpaste

WHAT IS IN TOOTHPASTE?

Almost all commercial toothpastes start with mild abrasives and detergents, as well as the near-universal ingredient, fluoride. After that, toothpastes vary significantly.

Here is a list of active ingredients in toothpaste:

- Fluoride
- Antibacterial agents, are used to control plaque (Triclosan)
- Desensitising agents (potassium nitrate)
- Anti-tartar agents (pyrophosphate)
- Sodium bicarbonate (baking soda)
- Enzymes, to enhance the antibacterial properties of saliva
- Xylitol, a non-sugar sweetener, which reduces levels of cariogenic (decay causing) bacteria in the mouth and enhances remineralization.

Natural toothpastes may contain a variety of ingredients - anything from oil of ginger to seaweed extract.

Inactive ingredients:

- Water
- Detergents, to make the toothpaste foam
- Binding agents
- Humectants to retain moisture
- Flavouring, sweetening, and colouring agents like peppermint, spearmint, cinnamon, wintergreen, and menthol
- Preservatives
- Abrasives for cleaning and polishing.

Toothpaste is regularly being improved. Currently available are anti-cavity toothpastes, extra- whitening toothpastes, toothpastes with mouthwash, toothpastes for sensitive teeth, toothpastes with stripes, clear toothpaste, even liver flavoured toothpaste for dogs.

HOW DOES TOOTHPASTE WORK?

There are several different types of toothpaste being commercially manufactured today. All of these are based on some sort of abrasive, intended to scour off plaque, rotting food, and various other substances from the teeth and surrounding area. However, there are several fundamental differences between different toothpaste types, depending on specific ingredients that have been added.

Fluoride toothpaste is by far the most popular toothpaste. Manufactured by the major toothpaste companies, this toothpaste's active ingredient is a type of sodium fluoride. Sodium fluoride creates a chemical bond with the teeth and hardens the enamel against decay.

Sodium bicarbonate (baking soda) is added for taste and feel in the mouth. It combines with acids to release carbon dioxide gas, adding to the foam produced by brushing. It is a mild abrasive. It may reduce the numbers of acid loving bacteria in the mouth, although this effect lasts only as long as the mouth stays alkaline.

Sweeteners such as sodium saccharin are added for taste. Other flavours are usually strong essential oils found in the mint family. It must have a strong enough flavour to hide the bad tastes of decaying bits of previous meals, and the awful taste of some of the other ingredients, such as detergents and phosphates.

Toothpaste must have thickeners to enable it to stay on the toothbrush, squeeze out of the tube, but also retain moisture so the toothpaste does not dry out if the top is not replaced. It must have detergents to remove fatty films, water softeners to make the detergents work better, and sweeteners, preferably non-nutritive, so bacteria are not encouraged.

Sodium carbonate peroxide is added as a whitener. It breaks down into sodium carbonate (washing soda) and hydrogen peroxide. The hydrogen peroxide bleaches the teeth, and kills germs.

The anti-bacterial agent triclosan is added to kill plaque-forming microbes.

SUMMARY OF TOOTHPASTE INGREDIENTS AND THEIR FUNCTIONS.

The following table shows the different components of toothpaste, their functions and examples of ingredients that serve that purpose.

Component	Function	Examples
Polishing agent	Abrasive which helps in the removal of plaque and surface tooth stains without scratching the tooth enamel or dentine.	Calcium carbonate (chalk), hydrated silicas, dicalcium phosphate, alumina.
Humectant	Holds water in the toothpaste, helps dissolve some of the other ingredients, provides gloss to the paste, also imparts some sweetness and 'mouthfeel' to the product.	Glycerine, sorbitol.
Gum thickeners	Controls consistency, making toothpaste flow onto brush and disperse easily into the mouth. Gums also bind the solid and liquid matter together to maintain the integrity of the paste.	Sodium carboxymethylcellulose, carrageenan, xanthan.
Foaming agent	Detergent; provides foam that eases the removal of food debris and improves dispersion of the paste in the mouth.	Sodium lauryl sulphate, sodium methyl cocyl taurate.
Flavour systems	Important: makes product pleasant to use, fresh tasting. A solubiliser emulsifies the flavour into the aqueous base.	Commonly peppermint and spearmint, and a sweetener.
Active ingredients	Protect against tooth decay, gum disease, tartar and treat sensitivity.	Very diverse, e.g. fluoride systems (sodium fluoride, sodium monofluorophosphate), antimicrobials (Triclosan, zinc citrate), tartar agents (sodium and potassium pyrophosphates), sensitivity agents (potassium nitrate, strontium acetate and strontium chloride).
Preservatives	To preserve the product and ensure a long-life.	Sodium propyl paraben, sodium methyl hydroxybenzoate, potassium sorbate, benzoic acid.
Colouring	Important for visual appeal.	Various dyes.
Water	Solubilize and carry some of the active ingredients, and make up liquid phase of toothpaste.	

Table to show the features of different types of toothbrush:

Toothbrush characteristics	Function
Firm, medium or soft bristles	They are harsher or gentler on the teeth and gums. Firm bristles remove more plaque but can damage the tooth surface and gums.
Flexible/rigid handles	Some are flexible to reach awkward parts of the mouth
Compact heads, larger heads	Compact heads often can reach into more awkward parts of the mouth. Larger heads brush more plaque off and last longer.
Indicator	Some toothbrushes have an indicator that changes colour to show when it is time to change toothbrushes.
Different sized and types bristles	The different bristles have different functions in tooth cleaning. Some clean the tooth, the others reach into spaces between teeth.

Table taken from the GlaxoSmithKlein Oral Information Pack.

Appendix 3: The History of Toothpaste

When people first started taking the conscious decision to maintain their teeth, the methods were rather crude and instead of keeping them healthy may have caused more damage.

First attempts at tooth cleaning included using abrasives such as crushed bone, crushed egg and oyster shells, which were used to clean debris from teeth.

Tooth powders were the first noticeable advance and were made up of ingredients such as powdered charcoal, powdered bark and flavouring agents. This would be applied to teeth using a simple stick.

By the early 1900s, consumers were recognising the importance of clean teeth and as a result, many chemists began using special ingredients which made the powder into a cream. This was eventually put into tubes to make it more convenient to use.

As a result of this, the market grew and new brands were developed to accommodate consumer preferences, including Macleans which was launched in 1923.

The 1960s saw the introduction of fluoride into toothpaste. This development was followed in the 1980s with the addition of soluble calcium fluoride to fluoride toothpastes to strengthen teeth. Both calcium and fluoride are two of the most important ingredients in modern toothpaste.

In 1995 Whitening toothpastes were launched onto the market, the first time toothpaste was proven to whiten teeth safely.

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