



Fun with **milk**



Hey kids! Did you know milk is a super drink which is good for your bones to help you grow up big and strong.

Visit www.meadowfresh.co.nz to find out loads of fresh ways you can have more fun with milk!



proud to support
National Primary Science Week, May 2011

National Primary Science Week promotes and celebrates the teaching and learning of science in the primary school throughout New Zealand. Visit www.nzase.org.nz/primaryscience and see how your school can get involved and be part of the fun.

Fun with milk



NZASE NATIONAL PRIMARY SCIENCE WEEK – THE BIG MILK EXPERIMENT

Have you ever thought about what's in milk? Or why milk is white? How can liquid milk be turned into a thick, creamy yogurt? There are some really fun activities below that you can do to help you figure out the answers! You will be amazed how simple everyday materials, like good old milk, can behave in a way you've never seen before. Have fun while you are doing them and remember to handle all the equipment and materials safely to avoid accidents and spills.

The Big Milk Experiment

Exploring Meadow Fresh rainbow milk

What you need:

- Plastic plate
- Meadow Fresh full fat milk
- Food colouring (you should have four different colours)
- Cotton buds
- Detergent or dishwashing liquid

What you do:

1. Pour the milk into the plate so that it is about 5mm deep.
2. Add a few drops of each food colour around the centre of the plate.
3. Dip a cotton bud into the detergent, then dip it into the milk at the centre of the plate and watch what happens!
4. Now it is your turn to investigate. Think about things that you could change in the experiment. How does that effect the results? Think of some questions that you can explore...you can use the question starters "What would happen if...?" or "Does it matter if...?"



To find out what is contained in Meadow Fresh milk, read the label on the bottle or go to www.meadowfresh.co.nz. If you have unanswered questions, try your own investigations! If you are still stuck, you can ask Meadow Fresh research & development team directly via the National Primary Science Week Facebook page.

The secret behind the experiment

Milk contains a lot of different things, like protein, fat, carbohydrate, and minerals such as calcium. The white colour of milk is due to the way light is reflected by the protein and fat molecules found in milk. The more fat milk has, the whiter it looks. This is why cream looks much whiter than low fat milk!



You may know that fat does not mix well with water. While milk is mostly water, it also contains fat which is already stabilized. The secret of the colour 'explosion' is the chemistry behind the detergent. Detergent, or soap, has a special characteristic – the soap molecule has a water-loving (hydrophilic) end that dissolves in water, and a water-hating (hydrophobic) end that attaches to the fat molecules in the milk.

When you dip the cotton bud into the milk, the hydrophobic part of the soap immediately starts moving around, trying to move away from the water and attaches to the fat molecules in the milk. As the fat molecules get 'caught', or attached, by the soap they move around in the milk, bumping and shoving the food colouring molecules (which are attached to the water part of the milk) in the process. This is why the colours swirl around the milk without you having to move a finger!

As the soap catches all the fat molecules, the swirling motion starts to slow down and eventually stops. This is why the colour explosion does not happen if you repeat the experiment using water or low fat milk – there are no fat molecules for the soap to catch!

FACT SHEET

- **Molecules** are the smallest particles of a substance, which has a certain function. Fat and protein molecules, for example, serve different functions in milk and look different under the microscope.
- **Detergents** or **emulsifiers** allow fats to mix into water, as their molecules can attach to water molecules at one end, and oil molecules at the other
- **Emulsions** are a suspension of either fat in water (small blobs of fat in water), or water in fat (small droplets of water in oil or fat)
- **Stabilisers** have the same function as emulsifiers, but achieve this in a different way. Stabilisers help emulsion to stay together by providing a physical property, usually by making the emulsion thicker or more viscous.
- **Surface tension** is the result of the attraction between water molecules and their nearest neighbours. It results in a meniscus because the molecules at the surface are being pulled from all sides and below but not from above.
- **Detergents** reduce surface tension in water – the strong surface tension of water prevents it from creeping into the tiny spaces between fibres in clothing. Reducing the surface tension in water helps penetrate these places to remove dirt. Because detergent can form bonds with both water and fat molecules, it can take away some oily stains as well.
- **Milk** is an oil-in-water emulsion with a complex chemical make-up. It contains water, fat, proteins, carbohydrate (lactose), and minerals. Most commercially available fresh and UHT milks have been processed to standardise the fat content to a certain level – standard (3.2% or more), skim (less than 1.5%), trim (less than 1%), etc.
- **Milk fat** occurs in milk in the form of globules of varying sizes, stabilised in the emulsion by the thin membrane coating them. Since they are the largest and lightest molecules in milk, they tend to rise to the top. This is known as **creaming** and occurs when raw milk is left to stand for a while. Smaller milk fat particles will not rise as quickly.
- **Homogenisation** is a process used to break down milk fat globules into much smaller sizes, by forcing milk through a tiny hole under great pressure. As a result, creaming does not occur in homogenised milk.

What's happening?

There is a lot going on in that plate of milk. What do you think is happening? How do the colours move? Do you think the same thing would happen if you had used other liquids instead? What liquids will you try and why?

Hint: think about what is different between milk and water. Why is milk white? Does it have something in that is not found in water?



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OTHER SCIENCE ACTIVITIES FOR YOU TO TRY

Meadow Fresh Milk and juices!

What you need:

- Meadow Fresh milk (any type)
- Six clear glasses
- Cold tea (made from teabags, not ready-to-drink tea from a bottle)
- Orange juice
- Lemonade soft drink

What you do:

1. Pour the milk into three different glasses. Make sure they are only half full!
2. Pour the tea, orange juice and lemonade into the rest of the glasses. Make sure the tea is cold before you pour it.
3. Mix each drink with the glass of milk, leave for a minute and see what happens!
4. Now it is your turn to investigate. Think about things that you could change in the experiment. How does that affect the results? Think of some questions that you can explore...you can use the question starters "What would happen if..?" or "Does it matter if..?"



The secret behind the experiment

All liquids have a measure of acidity known as pH. Milk, tea, and water have a pH of about 7, which means they are 'neutral'. Lemonade and orange juice however have a lower pH, usually less than 4, and therefore they are 'acidic'. This is why orange juice tastes sour while milk tastes bland!

You already know from the previous experiment that milk contains a lot of different things like protein, fat, and carbohydrate. Milk needs to stay in its natural, neutral pH to be stable. When you mix milk and orange juice together, you are making the milk more acidic and this disturbs the balance of the milk components. As the pH of the milk decreases, the protein in milk (casein) starts to curdle and precipitates as the white stuff that you see in the glass. The same thing happens when you mix milk and lemonade, which is also acidic.

Tea is a neutral liquid like milk, and when you mix it with milk, the resulting pH will still be in the neutral range. This is why the protein does not precipitate out of the milk.

If you curdle enough of the milk protein and collect it, you will end up with a lot of guggy milk solids resembling yoghurt. This is the very basic of yoghurt and cheese making!

FACT SHEET

- **Acidity** is a measure of how 'sour' something is. Products like yoghurt, orange juice, and lemonade are examples of acidic products, while milk and water are non-acidic products.
- **pH** is a measure of the acidity of a liquid solution. Its value ranges from 1 – 14. Pure water has a pH of 7, which is the reference point for a 'neutral' liquid. Liquids with pH less than 7 are 'acidic' while liquids with pH greater than 7 are 'basic' or 'alkaline'.
- **Casein** is the major protein in milk. Cow milk typically contains about 2.5% casein. At the usual pH of milk, which is in the neutral range, casein is well stabilised in a liquid solution that is milk. If the pH of milk is brought down to 4.7 or lower, casein molecules start to clump together and precipitate into a solid form. Dairy manufacturers use this concept to make foods such as yoghurt and cheese from milk.
- **Curdling** or **precipitation** in dairy terms is a result of protein (casein) 'denaturation', in other words, the breakdown and unfolding of the casein molecules into solid forms.
- **Food acids** are a class of food additive added to processed foods and beverages to regulate and standardise their pH level. Most ready-to-drink beverages and juices contain a food acid of some kind to ensure consistent pH and therefore taste and functionality.

What's happening?

You will notice that different reactions will happen in each different glass – in the ones you have mixed with lemonade and orange juice, you may see some white solids floating around. What do you think the white stuff is? Why do they not form in the milk and tea mixture? What do you think would happen if you had used other drinks instead? Which one would you try and why?

Hint: think about the flavour of tea, lemonade, and orange juice. What is different about tea? Is it as sour as lemonade or orange juice?



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