

Beetroot pigment essay sample



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These pigments are betalain pigments (not, as often thought, anthocyanins), which they replace in some organisms.

They are named after the Beet family of plants (Beta) but are also found in fungi (Fly Agaric - the red, spotted one!). In petals they presumably attract pollinating insects and may be present in seeds/fruits to encourage birds to eat them and so disperse the seeds.

Man has selected for colour in beetroot, both because it is more attractive but also because it may well be linked to genes for flavour too. There is no indication that they have any protective function (e. g. against UV light or insect/fungal/viral attack). Unlike anthocyanins, they are not pH indicators - their colour is stable over a wide range of pH. They are oxidised over time (going brown) and this may be prevented by 0.1% ascorbic acid (= Vit. C); they are sometimes used as food colourants.

They are found in the vacuole and thus are used as markers for scientists who wish to extract intact vacuoles from plants for research. To extract the pigment, the membranes must be disrupted. This can be done by heat shock, by detergents or by solvents (e. g. ethanol or acidified methanol).

Thin slices have a larger surface area and so leak more pigment; freezing the beetroot first bursts the cell membranes and kills the cells, thus allowing the pigment to be extracted much more quickly.

Effect of Heat:

When you heat a beetroot, you disrupt the cell membranes. A biological membrane is made of a so-called phospholipid bilayer. These are formed

because the phospholipids that make it up have a polar “ water-loving” (hydrophilic) head and a “ water-hating” (hydrophobic) tail. The tails pack together, exposing only the polar heads to the water. The most effective way of doing this is to create two blankets one atop the other, with the fatty acid tails towards each other. This is the phospholipid bilayer.

In a cell they form sacks. One goes all around the cell (the plasma membrane), others may form vacuoles (such as the tonoplast). Yet others may be like stacks of half empty bags (the endoplasmic reticulum, which is also continuous with the nuclear envelope. In these lipid seas, there will be a number of proteins in various degrees of submersion. Some span all the bilayer, thus being exposed on both sides. Others just drift on either of its surfaces. Typically, you will find that about 70% of a cell membrane is protein. The water around and within the compartments formed by the phospholipid bilayers is also crammed with protein (= cytoplasm).

So what happens when you heat this? When you heat something you give it energy. Molecules start to spin and vibrate faster. The water will expand too. This will have a disruptive effect on any membrane in its way. To make things worse, lipids become more fluid as temperature goes up (think of what happens when you heat butter) so the membranes become more fragile.

Proteins are remarkable machines: they're formed of coiled and folded strings of amino-acids, held together by hydrogen bonds and disulphide bridges. If you heat them too much, they will untangle and break apart (vibrations again). When this happens to the proteins spanning a lipid

membrane, they will form holes that will destroy the delicate structure. Now, any pigments in the innermost compartment will spill out.

Half-life:

The half-life of beetroot pigment is 413 mins at 250C but only 83.5 mins at 600C. These values are doubled in 0.1% ascorbic acid. Metal ions speed up the breakdown - iron is particularly effective.

They are stable between pH 4.0 and 7.0 - indeed, at high temperatures they are most stable in a pH between 4.0 and 5.0 - and most fruits and vegetables are acidic!

Effect of organic solvents

If you want to dissolve lipid-embedded pigments, place a beetroot in an organic solvent such as acetone and see what you get. You break down the structure between the phospholipids, not the phospholipids themselves that much. The proteins on the other hand, are truly destroyed.

The basic structure of the tonoplast is the same as the plasma membrane (as described above). In this respect, they're similar, though with a higher proportion of protein in the plasma membrane than in the tonoplast. (why?)

Pigments in Plants

1. The anthocyanins are common plant pigments. They are water-soluble glycosides with some or all of the sugar groups removed. The colour comes from a positive charge distributed over the chemical ring system. The

colours of the charged anthocyanin pigments are dependent on the pH of the intracellular medium containing these pigments.

2. Many leaves frequently develop red coloration during development, at maturity, and during senescence. Most plants produce anthocyanins (usually cyanidin glycosides) as the basis of this colour, but members of the Caryophyllales produce nitrogenous pigments, betacyanins.

3. The betacyanin pigment of beetroot is normally sequestered in the vacuole of the beet root cells. Of course, if the beetroot is cut, cells are sliced open and the pigment spills out. However, if the membrane is altered (phospholipid bilayer + proteins) more subtly, leakage (diffusion) of betacyanin is induced.

Betalains: What are betalains?

Betalains are alkaloid pigments that are found in some families of plants belonging to the order Caryophyllales, but in no other plants. Little is known about the role of betalains. Betalains are not found in plants containing anthocyanin pigments - structurally they are

unrelated They have also been found in some fungi e. g. Fly Agaric

They can be divided into betacyanins and betaxanthins based upon their molecular structure. Betacyanins generally appear red to red violet in colour - they absorb in the 535-550nm range - hence our choice of filter in the colorimeter)

Betaxanthins generally appear yellow in colour (absorb in the 475-480nm range) They cause colour in both flowers, fruits and sometimes vegetative organs They are found in the vacuole and they are water-soluble.

Beetroot contains 2 Betacyanins - Betanin and a derivative

The basic structure of betacyanins

Commercial uses:

Beetroot pigment is used commercially as a food dye. It changes colour when heated so can only be used in ice-cream, sweets and other confectionary, but it is both cheap and has no known allergic side-effects. Beetroot itself, of course, is a common salad ingredient - when cooked, vinegar is added to the water to lower the pH. If you read all the above notes, you will see why!