Antioxidants: Tastes good, good for you?

Introduction

Our bodies contain billions of molecular cells that are joined together by bonds. When these bonds are broken the cells transform into harmful free radicals. Although this happens naturally in our metabolic systems it is thought that environmental factors such as pollution, stress and lack of sleep can increase the concentration of free radicals in our bodies.

These free radicals are unstable and will attack healthy molecular cells which will in turn produce even more free radicals. This chain reaction is known as oxidative stress and is thought to contribute to arthritis, premature aging, hardening of the arteries and increase the risk of cancer.

Antioxidants help to stop this chain reaction by donating their electrons to free radicals without themselves being converted into more free radicals. This is known as the oxygen radical absorbance capacity (ORAC) test. Foods can be placed in order of their ORAC rating. The larger the number the more able the antioxidants is to stop the oxidative stress of the molecular cells. [1]

This would indicate eating more of these foods would improve our health and well being and it has been reported some 40% of women and 30% of men are taking these supplements and spending over £333 million per year on them. However studies involving 230,000 women and men in 67 cases have shown that there is no convincing proof that antioxidants can make you healthier. [2]

The following practical investigation can engage pupils in the research and discussion of media items with regard to the so called “superfoods" in healthy diets and their subsequent impact on modern life.

It can be linked to the following experiences and outcomes from The Sciences in a Curriculum for Excellence : -

Local aquariums will stock brine shrimp eggs, Mikrozell, aquarium tanks and pumps and marine salt or are available online from reputable stores.

Light banks can be purchased from www.progrow.co.uk T5 Light Wave 54 W Four Tube (20000 lumen, L = 1200 mm, W = 350 mm, D = 60 mm) Ref. 4265 - £125.01 plus VAT and p+p), and www.blades-bio.co.uk Plant Grow Lighting System 55 W Four Double Tube (L = 600 mm W = 320 mm D = 100 mm, product code ACS300 £140 plus VAT and p+p).

Local DIY superstores and IKEA will stock desk lamps for illumination and clear plastic boxes which could be used as tanks.

Top tips on maintaining your populations

- Feed regularly - as described above. Maintain water temperature between 25°C - 30°C - maximises population, preferably under a light bank.
- Stir tank regularly to help circulate the nutrients and aerate the tank.
- In general, it is a case of setting up your brine shrimp system following these guidelines, but it may take a little trial and error to get a system that suits your particular school and resources available. Please get in touch with us if you have any problems with setting up your brine shrimp system.

For further information contact gordon.moore@sserc.org.uk

‘Brine shrimp bottle ecosystem’ and *‘Speedy shrimps’* are adapted from the book *Brine Shrimp Ecology* by Michael Dockery and Stephen Tomkins.

This book is full of excellent ideas for brine shrimp practicals and can be downloaded free. [4]

References

1] - www.survivalrivals.org

[2] - Brine Shrimp Ecology (2000) Dockery, M., Tomkins, S, published by the British Ecological Society. This is free to download from - http://www.britishecologicalsociety.org/educational/brine_shrimp/index.php

[3] - http://www.sciento.co.uk/catalog/item/515/

[4] - http://www.britishecologicalsociety.org/educational/brine_shrimp/index.php

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Materials - Earth's materials - Extracting useful substances - **SCN 3-17b** - I can participate in practical activities to extract useful substances from natural resources.

Topical science - Innovative research & development - **SCN 3-20a** - I have collaborated with others to find and present information on how scientists from Scotland and beyond have contributed to innovative research and development.

Topical science - Science in the media - **SCN 3-20b** - Through research and discussion, I have contributed to evaluations of media items with regard to scientific content and ethical implications.

Topical science - Current & future developments - **SCN 4-20a** - have researched new developments in science and can explain how their current or future applications might impact on modern life.

Materials - Properties & uses of substances - Researching novel materials - **SCN 4-16a** - I have carried out research into novel materials and can begin to explain the scientific basis of their properties and discuss the possible impacts they may have on society.

It is likely to feature as one of the areas in the new Higher Chemistry course.

Practical Investigation

It is possible to determine the relative levels of antioxidants present in everyday foods and drinks using the Briggs-Rauscher reaction. [3] This reaction is very complex and involves iodide ions and iodine molecules. It is thought that the colourless solution arises when I_2 is low and I^- is high; it is yellow when I_2 is high and I^- is low; and blue when I_2 and I^- concentrations are high (when both are high they form pentaiodide ions which give the blue complex with starch). The changes in the relative concentrations of the I_2 and I^- are brought about by the species hydrogenoxyiodide (HOI). As its concentration rises and falls, it triggers oscillations in the I^- and I_2 concentrations.

For this practical, 5 cm^3 of solution A (0.2M potassium iodate and 0.07M sulphuric acid) is added to 5 cm^3 of solution B (0.15M malonic acid and 0.2M manganese sulphate) in a 100 cm^3 beaker and placed on a magnetic stirrer. This is switched on and 5 cm^3 of solution C (4M hydrogen peroxide) is added to the beaker. When the sudden blue colour appears for the second time the clock is started and is stopped when it re appears for the third time. This can be seen in Figures 1 to 5. This is repeated a further two times and the average time is calculated. The average time is now the reference sample.

The experiment can then be repeated with the addition of 1.5 cm^3 of the food sample with a Pasteur pipette to the mixture of the three solutions. The preparation of the samples requires one gram to be weighed, crushed and diluted with 100 cm^3 of distilled water. This is then filtered to remove any excess solid. A Pasteur pipette is used to place 1.5 cm^3 of the sample into the 3 solution upon the second appearance of the sudden blue colour. This is repeated a further two times and the average time is calculated. The antioxidants in the food will delay the colour cycle, thus giving a greater the time interval meaning there is a relatively higher the level of antioxidant in the food.

The average times for the reference and food samples are then plotted as a bar graph (see Figures 6 and 7).

Beware of any food allergies when preparing the food samples.

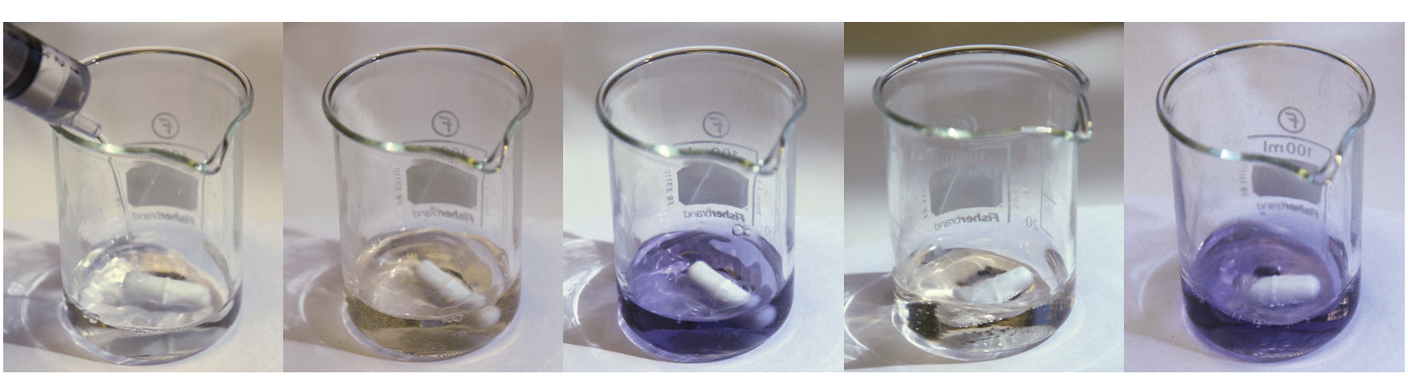
Foods recognised to be high in antioxidants

Small red beans (dried), red kidney beans, pinto beans, cranberries, artichokes, blackberries, prunes, raspberries, strawberries, Red Delicious apples, Granny Smith apples, pecans, sweet cherries, black plums, Russet potatoes, black beans (dried), plums or Gala apples. Most of these can be found in your local supermarket.

Specimen answers for superfoods

NOTE – not all these foods have been tested and some will require prior testing before using with the pupils to ensure completion of the practical within your allocated time. It may be necessary to further dilute food samples.

e.g. Compared to the foods tested in Table 1, tea samples in Table 2 had to be diluted 100 fold in order to give a viable time for completion of the experiment.



Figures 1-5 *- The colour cycle.*

Type of Superfood	Time 1 (s)	Time 2 (s)	Time 3 (s)	Average Time (s)
Reference Sample	48	62	58	56
Carrots	73	70	77	73
Raisins	80	85	81	82
Cranberry Juice	99	100	96	98
Blueberries	289	296	227	271

Table 1 *- Typical results for 'superfoods'.*

For example blueberries shows the highest relative levels of antioxidants as the colour cycle took 271 seconds compared to the reference sample of 56 seconds (Figure 6).

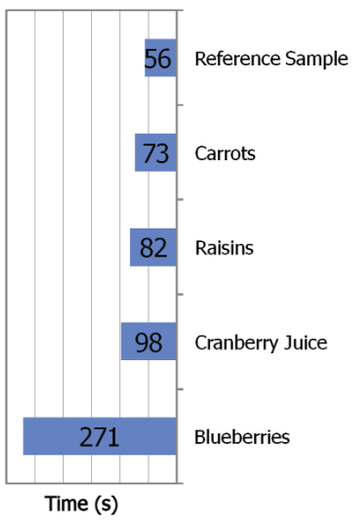


Figure 6 *- Bar graph results from Table 1*

Specimen answers for tea leaves

Type of Tea	Time 1 (s)	Time 2 (s)	Time 3 (s)	Average Time (s)
Reference Sample	40	45	49	45
Sweet Cranberry	66	69	68	68
Assam	67	75	72	71
Aromatic Earl Grey	80	77	79	79
Pure Camomile	86	84	80	83
Peppermint Punch	83	83	87	84
Tea	98	103	95	99
Green Tea Lemon	116	102	102	107
Classic Traditional English	132	116	112	123
Pure Peppermint	171	168	168	169

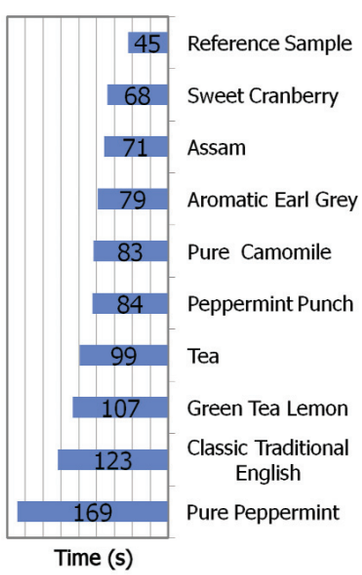


Figure 7 *- Bar graph results from Table 2*

For example Aromatic Earl Grey shows a mid range of relative levels of antioxidants as the colour cycle took 79 seconds compared to the reference sample of 45 seconds (Figure 7).

After the reactions have oscillated back and forth the solution remains as a blue-black mixture with the smell of iodine. Occasionally some purple fumes of iodine can be seen (HARMFUL & DANGEROUS FOR THE ENVIRONMENT). Therefore work in a well-ventilated area. Care should therefore be taken if the demonstration is scaled up to volumes using litres – work in a fume cupboard.

For further information on the experimental technique and on safety and disposal, contact SSERC, (andrew.boswell@sserc.org.uk)

References

[1] http://www.youtube.com/watch?v=fTBz9ipkWhE
[2] http://onlinelibrary.wiley.com/o/cochrane/clsysrev/articles/CD007176/frame.html
[3] T.S. Briggs and W.C. Rausher, Journal of Chemical Education, "An Oscillating Iodine Clock", July 1973, Ed 50, p 496. (Original paper) http://www.chem.leeds.ac.uk/delights/texts/expt_11.html (detailed descriptor of stages of reaction)