

Effect of pH on Natural and Synthetic Food Colorants

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History of Food Colorants

Purple catsup and jelly bellies may make us think that food colorants are something fairly new. Actually, Egyptian tomb paintings dating back to 1500 B.C. reveal colored candies. 300 B.C. documents the use of artificial colorants in wine.

From 1850-1900, the use of synthetic food colorants became widespread. By 1900, 695 food colorants were in use throughout the world. Of which most had not been tested for their health risks. For example, pickles were colored with copper sulfate, cheese with lead oxide, candy with different compounds containing lead and mercury. Arsenic salts were also commonly used. All of which were highly toxic. Cod liver oil was adulterated with train oil mixed with iodine. Yellow tinged milk, colored with lead (II) chromate, was so common that people thought that white milk was tampered with. Today such color additives have been tested and approved for their safety.

Natural Food Colorants

Bright green spinach, ruby red strawberries, and deep orange pumpkin all add visual delight and are due to chemicals that occur naturally.

Chlorophylls are the green pigments of leafy vegetables. They also give green color to the skin of apples and other fruits. Chlorophylls a and b are the members of the chlorophyll family in food plants and serve as a functional pigment in photosynthesis. Many food processing conditions such heating and changes in pH affect this green color.

Carotenoids contribute to the red, yellow, and orange colors in many fruits and vegetables. This group of compounds includes carotenes, which are strictly hydrocarbons. Beta-carotene is one of the few carotenoids that are prepared synthetically for use as a food colorant. Its intense orange color is effective at very low concentrations (1-10 parts per million). It may be used in bakery goods, cheese, ice cream, margarine, salad dressings, and other foods. Lycopene is another carotenoid that is the red colorant in tomatoes.

Anthocyanins are responsible for the blue, pink, red, and violet colors in fruits and vegetables. This group of natural colorants is sensitive to pH, but is fairly heat stable and resist fading in daylight. This group is playing an increasingly larger colorant role for various foods. For example, pure grape pigments are being used to color canned fruit, fruit syrups, yogurt, and other products.

Synthetic Food Colorants

Foods are usually colored because they have no color or because their natural color has been altered during processing or storage. Most consumers find colorless foods unappealing, thus why colorants are added. Synthetic food colorants are regulated by the government. Currently, seven synthetic colorants are approved for use in food.

2 reds (#3 and #40)
 2 blues (#1 and #2)
 2 yellows (#5 and #6)
 1 green (#3)

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These seven colorants are grouped by the color-giving chemical functional group they contain. FD&C Red #40 and Yellow #6 both contain azo bonds (-N=N-) thus are referred to as azo colorants. FD&C Blue #1, Green #3 and Red #3 belong to the triphenylmethane group which contain three benzene rings attached to a central carbon. Just as with any substance, the chemical structure of each these colorants determine its' characteristics, for example if it is water soluble or not. Water-soluble colorants are useful in water-based foods, but not in fatty foods such as salad dressings and ice cream. Therefore a special form of colorant (called a **lake**) is prepared by attaching the water-soluble colorant to an insoluble material.

Experimental Procedure

A **quick and easy** test for the affect of pH on natural colorants: collect foods such as berries, deeply colored vegetables such as beets and red cabbage. Rub these foods on a white sheet of construction paper making a 2-3 inch streak. Dip a cotton swab in vinegar and wipe one end of each streak and record observations. Dip another cotton swab in a basic solutions or ammonia or a baking soda and wipe the other end of the streak.

These natural colorants can be extracted by either cutting up food such as beets and red cabbage and mildly boiling in distilled water, then drain. Berries can be simply crushed and filtered or concentrates may be purchased. Synthetic colorants may be purchased in the spice section of the grocery store.

Using either a microscale reaction plate, individual small beakers, or evaporating dishes, place a small amount of each colorant followed by a small amount of vinegar; repeat with base solution on a new set of colorants. Record results.

References

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