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Effect of Food Processing Operations on Plant Pigments

Auti M.G.[1] and Chavan V.R.[1]
[1]Assistant Professor, MGM College of Food Technology, MGM Hills, Chh. Sambhajinagar

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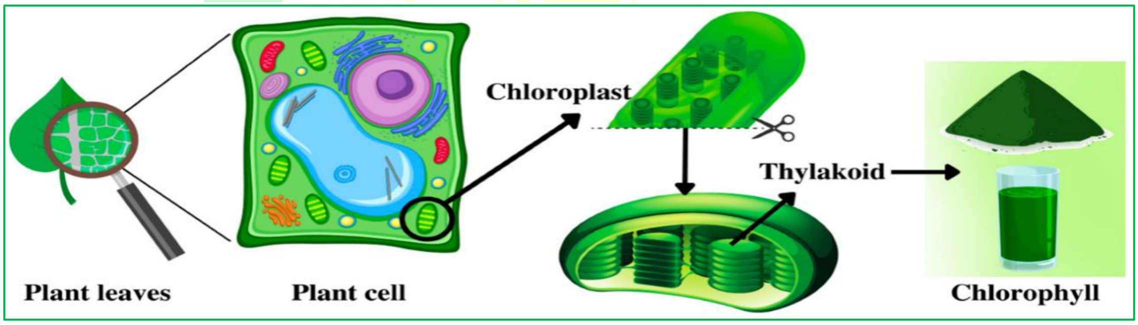
Chlorophyll

All green leaves and green-colour present vegetables like spinach, leafy vegetables, and peas contain chlorophyll. Chlorophyll molecules are primarily found in specialized structures made up of complex and conjugation of proteins which makes them very susceptible and chemical changes in cooking and consequently, the pleasant green colour is difficult to retain.



Effect of putting in hot water:

When a green vegetable is put in boiling water or in other words we can say vegetables are blanched, the green colour becomes brighter. This is due to greater translucency of plant tissue due to the expulsion of intercellular air collapse of the intercellular spaces.

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Solubility in water:

Removal of the phytyl group from the molecule of chlorophyll is catalysed by the enzyme chlorophyllase found in some vegetables. Hydrolysis of the ester linkage yields a compound chlorophyllide which iş water soluble. A limited amount of chlorophyllide produced during storage of certain green vegetables prior to cooking possibly accounts for the light green tint of the cooking water from them.

Effect of prolonged cooking and acid:

As the cooking process continues the colour of the green vegetables varies from the bright green colour of chlorophyll to the olive green. Acids are formed by the respiratory processes of the plant which are accumulated as the vegetable is warmed up, then stopped as the vegetable reaches the boiling point. Both volatile and non-volatile acids are given off during the cooking of vegetables. As cooking continues cell is disrupted, and constituents including organic acids diffuse from the vacuoles throughout the cell and into the cooking water.

Magnesium present in the structure of chlorophyll is rather easily displaced when it is heated in the presence of organic acids. A pale greenish-grey compound known as pheophytin-a or an olive-green pheophytin-b results. This combination together with pheophytins gives the vegetable a muddy olive-green colour. Green vegetables which are lower in acid retain a higher percentage of chlorophyll when they are cooked than do more acid. Since acids are present in plant tissue along with chlorophyll, the problem is how to minimise their effect during the cooking of vegetables. This may be accomplished by cooking the vegetable in an uncovered pan to eliminate volatile acids and by using enough water to cover the vegetables to dilute those acids which are not volatile. The major portion of the volatile acids is eliminated during the first few minutes when the vegetable is in contact with the boiling water. Hence greens should be cooked without a lid for the first few minutes to allow the volatile acids to escape.

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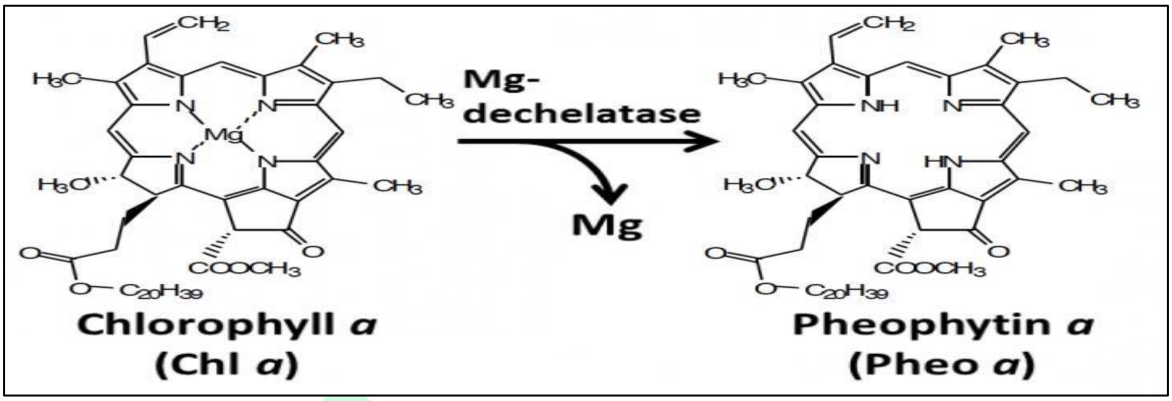

Effect of canning:

Ever wondered why canned vegetables sometimes look a little dull. It's because of high heat during canning turns the natural green pigment (chlorophyll) into something called pheophytin, which lacks that vibrant colour. But some manufacturers add a secret weapon: alkali. This reacts with the remaining chlorophyll, creating a bright green, water-soluble compound called chlorophyllin. Green colour dye made from the original pigment. So, the vibrant green colour of canned veggies might not be entirely natural, but, it looks adorable.

Effect of freezing:

The better retention of colour of frozen green vegetables is due to elimination of major part of the plant acids by blanching prior to freezing

Effect of copper:

The colour of chlorophyll is enhanced in the presence of copper and weak acid.

Effect of calcium salt:

Addition of a small amount of calcium acetate or other calcium salt prevents the mushiness by blocking the breakdown of the hemicelluloses.

Carotenoids

Ordinary cooking conditions have little effect on the colour or the nutritive value of carotenoid. The colour is little affected by acid, alkali and the volume of the water. The nutritive value is protected during cooking by the insolubility in water.


Effect of heat and oxidation:

The high degree of unsaturation of the carotenoids makes them susceptible to oxidation with the resulting loss of colour after the food containing them has been dried. The loss in intensity of colour is not only due to oxidation of the unsaturation of carotene but also shift from transform to cis form. Although the Trans form is quite stable, the heat of cooking transforms to cis configuration. . In spite of the fact that the Trans shape is very steady, the warm cooking changes to the cis setup. The tint of carotenoids with a cis arrangement is less strong than that of their partners with the trans arrangement solely. To some degree lighter colour of carrots and other carotenoid-containing vegetables that are famous after cooking is a sign that a few cis isomers have formed.

The better the vegetable is partitioned or cut and higher the temperatures that are utilized and the longer the cooking process can hurry the method of oxidation. . Blanching earlier to drying out is accommodating in decreasing the probability of oxidation. . Blanching makes lipids separate from the proteins with which they are lipoproteins.


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Effect of cooking in fat:

Appreciable amounts and enough to affect the colour will dissolve in ghee, when carrot kheer or halwa is made.

Anthocyanin

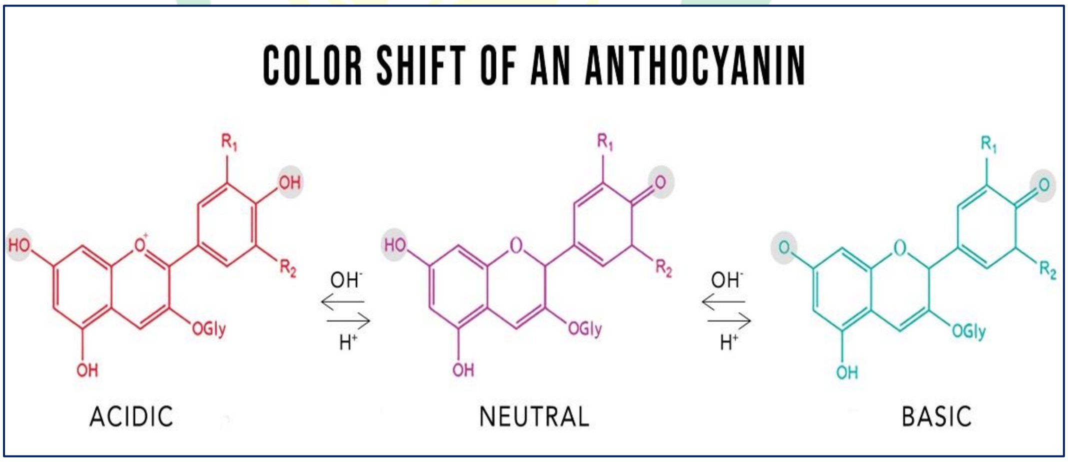
Effect of pH:

As pH changes, the colour of anthocyanin changes.

pH	3	7	8	10	12	14
Colour	Crimson	Purple	Greyish purple	Grey	Greenish grey	Bright green

Inside a plant cell, tiny molecules transform depending on the surrounding acidity. At low acidity (think lemon juice), they sport a positive charge and appear red. But as the environment gets less acidic, they shift to a violet quinone form. Finally, in alkaline conditions (like baking soda), they transform into a bright blue salt. These incredible color changes are all thanks to the fascination due to pH change.

The color show continues to the violet quinone form takes another dramatic turn when things get alkaline. It reacts to form a vibrant blue salt. This incredible transformation is due to the ever-changing environment around the molecule.



Red cabbage is a pH-changing pant model. Its vibrant color changes dramatically due to a molecule called anthocyanin. This molecule has over four hydroxyl groups that act like tiny changing swings. In acidic environments (think vinegar), anthocyanin chills out and appears red. But when adding some baking soda (alkaline), It turns to blue, making the cabbage look well, not so adorable. That's why when we cook add apples to red cabbage because Apples are acidic, and keep the anthocyanin in red.

Why Red cabbage turns green. It's all about a chemical change reaction When you add baking soda (alkaline) to red cabbage, two pigments get activated: anthocyanins (the red guys) and anthoxanthins (their yellow buddies). The anthocyanins, transform into a dark blue, while the anthoxanthins turn to yellow. These two newly colored pigments mix, creating a surprising bluish-green colour. We see in red cabbage under alkaline conditions. It's a fascinating colorful presentation with ph.

Effect of metal:

Special enamel linings in the cans are used when canning anthocyanin containing fruits and vegetables. Unusual colours ranging from green to slate blue, develop when anthocyanin's contact iron, aluminium, tin and copper ions. The presence of ascorbic acid with copper or iron accelerates the oxidation and undesirable colour changes of anthocyanin compounds. The metal iron precipitates the pigment. Iron and aluminium produce considerable discolouration iron reacts with anthocyanin's to form intense black discolouration. Red cabbage shredded with a non- stainless steel blade turns blue very rapidly from the reaction between the iron of the peeler and pigment of the cabbage.


Effect of method of cooking:

Anthocyanin are water-soluble cell sap pigments which can be leached from a vegetable by the cooking water. Cooking in a steamer or in a pressure pan which limit the contact of the vegetable with water are better methods than boiling in water. To retain the red colour in red cabbage, the cooking water should be acidified. Otherwise, the pigment will change to a dull and appetizing blue.

Effect of tap water:

Since tap water is slightly alkaline, the anthocyanin are changed to unattractive blue or grey colour.

Effect of pickling:

Pickles are usually low in pH and anthocyanin's change to deep crimson red in colour.

Betalain

Although these pigments are held tightly within cells in the raw vegetable, they diffuse rather rapidly into the cooking water resulting in the highly pigmented water associated with boiling beets. This problem is aggravated by cutting beet into small pieces and cooking leading to dull colouration in the boiled product. Since this colour is highly soluble in water, the best method of cooking beet root is to cook along with the skin, so that much of the colour does not leach out.

Effect of pH:

Betacyanins undergo colour changes parallel to anthocyanin. An acidic medium promotes a reddish colour, whereas a neutral or somewhat alkaline pH brings out brownish blue of the pigment.

Anthoxanthins

Effect of pH:

The colour of the vegetable will be whiter if little acid such as lime juice or vinegar is added during cooking. If the water in which cauliflower is cooked is slightly alkaline, it will have a distinctly yellow colour to it. They turn yellow or orange in the presence of alkali. This is used as a confirmatory test.

Effect of metal:

They cause the cooking water to turn a bit yellow, when they are cooked in aluminium pans because the flavones scavenge aluminium and form a flavone aluminium chelate. Such reactions also take place in cast iron pans.