Betalains

Betalains—betacyanins and betaxanthins—are vegetable pigments characteristic of some fungi (particularly the toadstool or fly agaric, and the royal agaric or Caesar's amanita), and of nine of the eleven families of Centrospermae in which they replace anthocyanins in flowers, leaves, fruits, or colored subterranean parts.

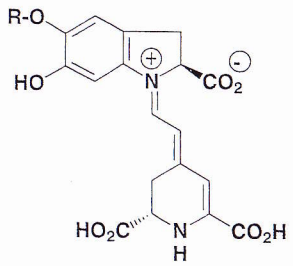
Betacyanins are red or violet pigments which occur as water-soluble glycosides, whose aglycone is a zwitterion comprising a dihydroindole and a dihydropyran nucleus. Betaxanthins have a close structure, but they are yellow (they are found especially in Cactaceae). Biogenetically, betalains arise from the metabolism of phenylalanine, *via* dihydroxyphenylalanine which may either cyclize (to cyclodopa) or degrade to betalamic acid (see figure p. 214). Betacyanins result from the condensation of cyclodopa and betalamic acid, whereas betaxanthins arise from the reaction of betalamic acid with various amino acids and amines.

These substances decompose readily, and are difficult to isolate and purify. They separate well by chromatography on polyamide-type stationary phases.

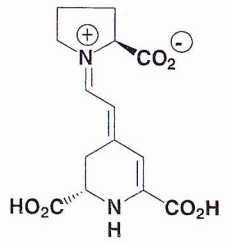
Betalains are of no therapeutic interest. Pharmaceutical technology and food technology take advantage of their coloring properties: beet red (Eur. id. code E162) is a coloring stable from pH 3.5 to 7; it is marketed as a concentrated juice or as a fermented juice spray adsorbed on gelatin.

The beet (see also p. 29) has recently become valuable as a source of D-galacturonic acid: one hectare of sugar beet produces (in theory) 600 kg of D-galacturonic

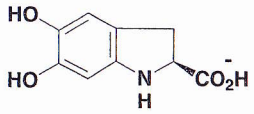
surfactants. It can also be converted to mucic acid, a tetrahydroxylated diacid capable of forming stable complexes with metal ions. This sequestering agent is sometimes described as a possible alternative to phosphates; it is biodegradable.



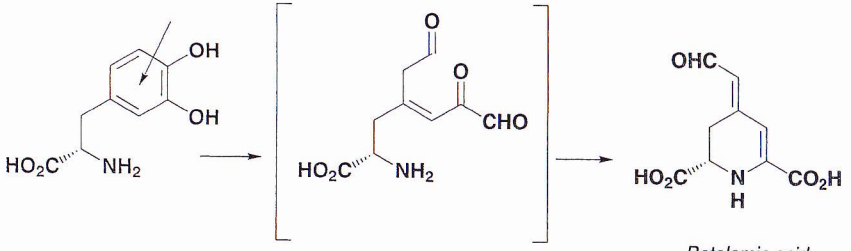
R = H : Betanidin
R = glc : Betanin



Indicaxanthin



Cclodopa



Betalamic acid

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Strack, D., Steglich, W. and Wray, V. (1993). Betalains, *in* "Methods in Biochemistry, vol. 8, Alkaloids and Sulphur Compounds", (Waterman, P.G., Ed.), p.421-450, Academic Press, London.

Proteins

Protein Sweeteners

• THAUMATIN

Thaumatin was initially marketed in the United States and in Japan (Talin®), and it is now on the European Union list of approved additives (E957). It is a mixture of proteins isolated from the fruit of an African Marantaceae, *Thaumatococcus danielli* Benth.

The Plant. *T. danielli* is a species with large leaves on a long petiole, with purplish pink flower spikes, and a fleshy trigonal fruit, which ripens to a glowing red and contains 1-3 black seeds surrounded by a fleshy aril. The species is abundant in Ghana, the Ivory Coast, Togo, and Sierra Leone, and the sweetness of its arils has been described as early as the middle of the nineteenth century: it is due to proteins.

Composition. The frozen fruits undergo an aqueous extraction and the protein fraction is resolved by physical techniques (ultrafiltration). The extract contains two chief proteins (thaumatin I and II) which are each composed of 207 amino acids and differ from one another only in five positions; their structure includes eight disulfide bridges. Thaumatin is readily soluble in water and soluble in dilute alcohols. Its stability is maximal at pH 2.7-3 (the sweet taste turns acidic at pH<2) and the sweetening power does not disappear upon heating. Solutions may be pasteurized, but prolonged treatment (sterilization) destroys the sweet taste.

Properties. Thaumatin is a potent sweetener: its activity can be detected at a concentration of 10^{-8} M. The sweet sensation induced by thaumatin is slightly