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Secondary Metabolites Tressure to Pharma and Food Industry – A Review

Premalatha S.J.

Department of Studies in Biochemistry, Government Science College, Chitradurga-577501, Karnataka, India.

ABSTRACT

Secondary metabolites used in food industry majorly as a food additives and food preservatives. Food additives are substances added to food to preserve flavor or enhance its taste, appearance, or other qualities. secondary metabolites are organic compounds that are largely obtained by extraction from plants or tissues. They are primarily used in the biopharmaceutical industry due to their capability to reduce infectious diseases in human beings and animals and thus increase the life expectancy. Many secondary metabolites have important antibacterial or antifungal agents, anticancer drugs, cholesterol lowering agents, antiparasitic agents, herbicides, antibiotics, bacterial pigment and plant terpenoids are also found to have anti-HIV, antitumor, antiaging, immunosuppressants, antiprotozoal and anthelmintic activities. Secondary metabolites that have complicated chemical structure are used as medicine raw material in pharmaceutical industry, food additives in food industry. Products contain secondary metabolites are known as herbal drugs or phytochemicals are widely demanded. Well known sources of secondary metabolites are plants, bacteria, algae, microalgae, fungi and marine organisms such as sponges, tunicates and corals. Many different classifications are present in literature, it is possible to classify secondary metabolites as terpene, phenolic compound (such as anthocyanin, flavonoids, coumarin and lignin) and alkaloids.

Keywords: Secondary Metabolites, Phytochemicals, Infectious Diseases, Biopharmaceutical, Compounds.

Correspondence
Premalatha S.J.
Department of Studies in Biochemistry, Government Science College, Chitradurga-577501, Karnataka, India.

Email address: premalathasj@gmail.com

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INTRODUCTION

Food Additives from the plant cell cultures are the reason for the use of metabolites synthesized by the plant cell cultures as food additives is not only that they are difficult or impossible to synthesize chemically, but consumers also more easily accept a natural product than an artificially produced one. Food additives contribute to making food [(1)].

Smetanska in 2008 also reported a palatable stuff and attractive by enhancing or improving their flavor, color, and texture. Food technologies try to respond to these criteria especially with regard to the texture, taste, and aroma of the foodstuff. The need to have the same taste and aroma in order to suit the consumer tastes makes it compulsory to use additional natural or artificial aromas [(1)].

Since the late 1950s, many food additives have been questioned mainly by national and international regulatory authorities about their safety for long-term use and consumption. At the same time, the consumer associations, aware of the inclusion of additives in foodstuffs, have been exerting pressure on governmental bodies to have chemical or artificial additives replaced by natural additives from plant tissues, or additives synthesized by plant cell cultures [(2)].

The most valuable food additives that can be obtained from the plant cell cultures are food colorants (anthocyanins and betalaines), flavors (saffron and vanillin), sweeteners (steviosides), pungent food additives (capsaicin), and anti-bacterial food preservatives (thiophene). Some food additives obtained from plant cell cultures are listed in [(3)].

Aromas and fragrances natural aromas are a mixture of numerous compounds; more than 500 have been identified in roasted coffee beans and 200 in apples. Natural aromas are susceptible to the conservation processes of foodstuffs, such as sterilization, pasteurization, freezing, etc. Some aromas are altered by enzymatic or chemical reactions and usually disappear if stored for a long period [(4)]. This is why their substitutes have been sought since the end of the 19th century. Artificial aromas used to be manufactured from coal or oil derivatives, and they used to be added in very low concentrations (10–6–10–9). The present trends are either to produce synthetic molecules, which are identical to natural molecules, or to use plant cell cultures. Aromas from the cell cultures have an advantage of a constant composition and are independent on the season. Thus, the characteristic aromas of cocoa and coffee have been produced by cell cultures of *Tlaeobroma cacao* and *Coffea arabica*, respectively [(5-9)].

Pigments The use of additional pigments was strongly criticized by the associations of consumers in the 1970s, because most of the colors are produced by chemical synthesis and they are unrelated to any naturally occurring material. The biotechnological methods used for producing natural food colorants consist of growing higher plant cells [(10-12)].

Terpenes and Terpenoids: These are the largest group of secondary metabolites and are classified according to their five carbon units (monoterpenes, sequiterpenes, diterpenes, triterpenes etc.) [(13)]

Phenolic Compounds: These are present in plants are divided into two groups as phenolic acids (hydroxibenzoic, hydroxicynamic acids) and flavonoids (anthocyanidin, flavon). Phenolic compounds can contribute the taste and aroma of plant originated foods and are also source of astringency and bitterness. A wide group of flavonoids are also responsible from colours of foods. Anthrocyanin is also a flavonoid and is natural colour substances. It is responsible

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pink, red, blue and purple colours of vegetables, fruits, fruit juices and wine [14].

Alkaloids: Alkaloids are the secondary metabolites have been used as nutrient supplement, encolouring compounds (anthocyanin, betalain, Carotenoid), acidulant, flavour enhancer such as aromas (saphrane, vanilin), sweeteners (steviosides), embittered taste substance (capsaicin), texturizer, preservative such as antibacterial food preservatives(tiyofen), emulsifier, surfactants or thickener in food industry. Examples of commercially useful plant secondary metabolites are carotenoids, terpenoids, alkaloids, phenyalpropanoids and more specific compounds such as corilagin, ellagic acid, vincristine [15].

Shikonin Compounds: Such as shikonin and its derivatives acetyl and isobutyl shikonin, accumulated in roots of *Lithospermum erythrorhizon*. Because of a shortage of this plant, the mass cultivation of Lithospermum erythrorhizon cells to produce shikonin compounds has been successfully established [16].

Anthocyanins: These are the large group of water-soluble pigments responsible for many of the bright colors in flowers and fruit. They change color over the pH range due to the existence of four pH-dependent forms: at low pH they are red and at pH over six they turn blue. They are commonly used in acidic solutions in order to impart a red color to soft drinks, sugar confectionary, jams, and bakery toppings. Many researchers describe the production of anthocyanins using cultured cells of various plant species; most of them seem to use an anthocyanin-producing cell line as a model system for secondary product production because of their color, which allows production to be easily visualized [17, 18].

Crocin: These are the main pigment of *Crocus sativus* stigma, is used extensively as yellow food colorant. Commercial production of saffron pigment is restricted by its high price and limited availability. The major components in the pigment are alizarin, purpurine, and its glycoside, ruberythric acid. Pure alizarin is an orange crystal and is soluble in boiling water and in other solvents. Alizarin shows a yellow color in acidic to neutral pH and tends to be reddish with increasing pH. It is highly resistant to heat and light, which is favorable to the food industry. Through the selection of high-producing cell lines and elicitor application, yellow-pigment-producing cells of Rubia tinctorum were obtained [19-21].

Capsaicin: Capsaicin an alkaloid is used mainly as a pungent food additive in formulated food. It is obtained from fruits of green pepper (capsicum spp.). Capsaicin is also used in pharmaceutical preparations as a digestive stimulant and for rheumatic disorders [22].

Saponins: Saponins are a group of compounds which attract attention. Structurally, they can be divided into triterpenoids or steroids [23].
Saponins from *Yucca* show an inhibition of food-spoilage yeast *Debaryomyces hansenii*, *Pichia nakazawae*, *Zygosaccharomyces rouxii* [24],
Y. schidigera are commonly used in Japan as an additive against yeasts contaminating cooked rice, pickled vegetables or fish meat. Moreover, it was found that yeast treated with saponin extract from *Q. saponaria* showed increased cell membrane permeability, as a result facilitating the preparation of yeast salt-free lysates much easier [25].

Carotenoids: Such as β-carotene, lutein, lycopene or zeaxanthin, are lipid-soluble colour pigments occurring in vegetables and fruits, giving them a yellow, orange

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and even a red colour. On the other hand, some terpenes are toxins and play important defensive roles against many insects and mammals [26].

Pyrethroids and monoterpene esters: These are from *Chrysanthemum* spp., show strong insecticidal activities. However, it is believed that the most important from all of the terpenes are volatile monoterpenes and sesquiterpenes known as essential oils (EOs). They occur mainly in herbs and spices, as well as some fruit, giving them a characteristic aroma. Peppermint (*M. piperita*), lemon (*Citrus limon*), basil (*O. basilicum*), cinnamon (*C. zeylanicum*) and rosemary (*R. officinalis*) are the examples of plants that are rich sources of essential oils. EOs are well-known bioactive compounds used in aromatherapy [27,].

Microbiology and Agroindustry: It has been shown that terpenes exhibit various pharmacological properties such as anti-inflammatory, anticarcinogenic, antitumor, antibacterial, antimalarial, antiviral, antibacterial as well as hepatoprotective. B- carotene is produced by a range of mucorales. This can be added to a variety of foods. Natural sources fermentation of *Monascus purpureus*_on rice to prepare "koji" Or "ang-kak" (Red rice) has been as a traditional cheese food and medicine [28-30].

Fig 1: List of main secondary metabolites of natural products

Production of Secondary Metabolites and Recent Improvements of Production Process

For improving production of plant secondary metabolites was mainly focused on the following aspects:

Manipulation of plant cell cultures to improve productivity of target compounds, by improving chemical processing and bioreactor performance or employing elicitors, a biotic stress, and other approaches, regardless of their mechanisms

1. Studying signal transduction pathways underlying various effective strategies leading to biosynthesis of target secondary metabolites
2. Studying transcription factors and their regulation mechanisms, includes genetic manipulation of regulator genes to improve production of target secondary metabolites
3. Cloning of secondary metabolite biosynthetic genes, and genetic modification of key genes to engineer the metabolic flux to target compounds.
4. Studying metabolic flux and profiling metabolic intermediates to understand whole pathways and overall regulation and accumulation of target compound.
5. Studying gene transcripts for plant secondary metabolism by profiling and analyzing global gene expression under different conditions to make sure the regulation of plant secondary metabolism in a whole sense.

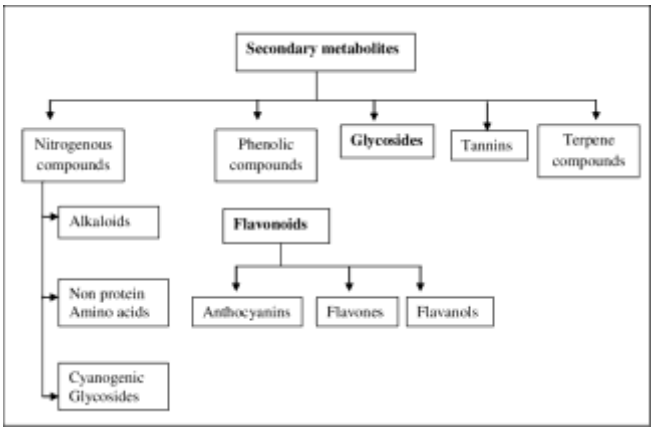

Fig 2: Shows the secondary metabolites and their derivatives

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CONCLUSION

Consumers are looking for safe food with natural ingredients and great taste. They are asking for ingredients they can understand, simple labeling, balanced nutrition panels, and trustworthy sourcing."In terms of health claims, consumers are also demanding a 'clean label' product, meaning no additives and/or preservatives, which is seeing strong growth within the food sector.To sum up, there is great potential that plants and their extracts be used as effective naturally occurring food preservatives that perform similar functions as their chemical counterparts.

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