Plant pigments in functional foods developments

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ABSTRACT

Food colour influences food acceptance. Previously, food colours were sourced from artificial sources or chemicals. However, there is a progressive change in the supply of food colouring components from synthetic to natural pigments. This was intended to take advantage of functional qualities in natural pigments such as bioactive activities, anticancer potentials, vitamins A synthesis, and so on, while also increasing consumer appeal. Polyphenols, anthocyanins, chlorophyll a and b, carotenoids, and other useful chemicals are found in natural pigments. These chemicals are powerful antioxidants, anti-diabetics, vasoprotective, anti-inflammatory, anti-cancer, chemoprotective, and anti-neoplastic agents. Carotenes act as a precursor to vitamin A. The isolation and use of natural pigments will eliminate the adverse effects seen in artificial colouring agents, as well as reduce the prevalence of various diseases.

Key Words: *Antioxidants; Carotenoids; Food colors; Functional properties*

INTRODUCTION

Food pigments are substances found in food that determine the color of the food and/or can be used to color it. The color of food influences customer acceptance of a specific food. The first coloring agent was created from natural sources. For example, beet root pigments, but was eventually abandoned due to high manufacturing costs and color volatility. However, natural sources of color additives are gaining popularity due to a number of health concerns associated with the usage of synthetic coloring chemicals. Natural pigments have been shown to contribute to total antioxidant capacity in a dose-dependent and compound-specific manner. Polyphenols are plant secondary metabolites that are often classed as non-flavonoids or flavonoids based on their structure. Non-flavonoids are typically colorless and do not contribute to plant pigmentation, whereas the majority of flavonoids do. Flavonols, flavones, and anthocyanin are the main flavonoids that contribute to pigment. Flavonols and flavones are yellow in colour, whereas anthocyanins might be orange, red, blue, or purple. Flavonols and flavones have a lower solubility in water than anthocyanins, which limits their contribution to food colouring. Flavonoids such as xanthones and quinones are found in plants as minor pigments [1].

Anthocyanins are pigments that give many fruits, vegetables, and flowers their red, purple, blue, and pink hues. They also play a role in several physiological processes such as photosynthesis and pollination by attracting pollinators. Anthocyanins are anthocyanidin glycosides and acylglycosides. There are approximately 250 naturally occurring anthocyanins in the form of delphinidin, cyanidin, pelargonidin, marvidin, and peonidin, all of which are o-glycosylated with various sugar substitutes. Anthocyanins are commonly 3- or 3,5-glycosylated.

Chlorophylls are green pigments that are found in all higher plants and participate in photosynthesis [2]. Chlorophyll is a macrocyclic tetrapyrrole that contains coordinated magnesium in the middle. Green plants contain two forms of chlorophyll (chlorophyll a and b). Chlorophylls a and b have methyl groups (CH3) and formyl groups (CHO) on carbon C-3 of the chlorophyll structure's tetrapyrrole ring, respectively. Chlorophyll an appears blue-green, whereas chlorophyll b appears yellow-green [3].

Pheophytin (formed by replacing the magnesium atom with hydrogen), pyrophophytin (formed by replacing the carboxymethoxy group at C-10 with hydrogen), chlorophyllide (formed by removing the phytol at C-7), pheophorbide (removal of phytol and magnesium), pyropheophorbide (removal of phytol, magnesium, and carboxymethyl group) are derivatives of chlorophyll a and b due. The loss of chlorophyll pigment in thermally processed green vegetables has been attributed to the creation of pheophytin and pyropheophytin chlorophyll derivatives, which give olive brown colour. It has been found that chlorophyll b is more heat stable than chlorophyll a. The electron-withdrawing property of its C-3 formyl group was linked to its stability [4].

Carotenoids, nature's most abundant pigments, are also involved in the photosynthetic process. Carotenoids, which are most commonly associated with the yellow-orange colour of many plants, act as secondary pigments in all chlorophyll-containing tissues, harvesting light energy. Some carotenoids are bound with chlorophyll, resulting in a variety of appealing colours in plants, fruits, and vegetables. Carotenoids are classified into two types: carotenes, which contain only carbon and hydrogen, and xanthopyll, which contains carbon, hydrogen, and oxygen. Carotenoids found in plants include-carotene, -carotene, capsanthin, lutein, lycopene, and zeaxanthin. Carotenoid was received by animals from plants; the human body cannot synthesise carotenoid, although it is collected in specific organs and tissues [5].

FUNCTIONAL FOODS

Functional foods (nutraceuticals) are whole, fortified, or improved foods that have the potential to give health advantages in addition to necessary nutrients (vitamins and minerals) when consumed. They not only improve customer well-being, but they also minimize disease risks. Beyond basic nutrition, functional foods may have a positive impact on health. The inclusion of bioactive substances in functional foods contributes to their functionality. Bioactive chemicals (also known as nutraceuticals) are dietary compounds that exist naturally and have an influence on human health (carotenoids, essential oils, antioxidants, flavors, pigments, vitamins, polyphenols). One critical advantage of nutraceuticals is that they are linked to a lower risk of chronic diseases [6].

Fruits, vegetables, vegetable oils, essential oils, plant by-products, and plants have been discovered to be rich sources of natural bioactive chemicals. Other sources include peels, stems, seeds, shells, bran, and residues left over after juice, oil, starch, and sugar extraction [7].

PLANT PIGMENTS AND FUNCTIONALITIES

Anthocyanins pigments

Anthocyanins are known as natural dye substitutes, yet commercial application as a dye may be prohibitively expensive. Anthocyanins have been found to be employed as useful chemicals for food colouring as well as a powerful antioxidant. It prevented cell lipid peroxidation. Anthocyanins have been shown in studies to exhibit vasoprotective, anti-inflammatory, anti-cancer, chemoprotective, and anti-neoplastic activities, indicating a protective impact against cardiovascular disorders. Natural anthocyanin-based pigments isolated from black-chokeberry (623 g/mg), black-thorn (151 g/mg), strawberry (54.8 g/mg), and elderberry (5 g/mg) function as colourants while also possessing antiradical qualities, according to researchers [8].

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Carotenoids pigments

Carotenoid is a vitamin A precursor, with carotenoids containing rings having the highest provitamin A activity. Provitamin A carotenoids are transformed into retinol and other related retinols in mammals, where they serve crucial roles in the visual cycle and gene regulation. A high intake of carotenoids has been linked to improved cognitive performance, a stronger immune system, and a lower chance of acquiring cardiovascular and degenerative chronic diseases like cancer and macular degeneration. The capacity of carotenoids to scavenge free radicals that produce oxidative damage as a result of illnesses has been attributed to their anti-disease action. Carotenoids have also been linked to non-antioxidant mechanisms such as retinoid-dependent signalling, carcinogen metabolism modulation, cell growth regulation, and DNA repair mechanisms modulation.

Chlorophyll

Chlorophyllin, an artificial chlorophyll pigment, is extensively used as a food colouring additive in sugar confectionaries, sweets, sauces and condiments, cheese, and soft beverages. Chlorophyll derived from plants has been shown to be effective in the treatment of wounds and inflammation. Chlorophyll forms complexes with some chemicals that cause cancer, and the complex structure generated interferes with gastrointestinal absorption of potential carcinogens, reducing the amount of carcinogen compounds in vulnerable tissue. Several studies have found that chlorophyll and its derivatives support antioxidants; however, other studies have found that chlorophyll's antioxidant activity is light dependent, since it exhibits pro-oxidant effects in the presence of light.

A study found that utilizing the -carotene bleaching method, chlorophyll derivatives, pheophorbide b and pheophytin b, were more efficient against linoleic acid than BHT. However, using the DPPH assay, all chlorophyll derivatives were found to have minimal antioxidant activity when compared to Trolox. The antioxidant activity of chlorophyll a pigment was the lowest of all the greenish pigments studied by the researchers. Other health benefits of chlorophyll include its capacity to renew and energise the body, detoxify the liver, clear the colon, normalise blood pressure, and counteract foul odours, bad breath, and body odour thanks to the magnesium it contains [9].

Betalains pigments

Betalains pigments are water soluble and have been observed to retain their colour over a wide pH range of 3 to 7, making them acceptable for use in food colouring in the pH range of 3 to 7. Betalains are classified into several types, including betanin, betacyanin, amaranthine, betacyanin, betaxanthin, vulgasanthin, and gomphrenin. Betanin has been used to colour foods such as yoghurt, confectionary, ice cream, syrups, and so on, but its application is limited due to its distinctive earthy flavour. The major chemical related with the red colour displayed by flowers, fruits, and other plant tissue is betacyanins, a kind of betalains. Betacyanin's structure is built up of glycosides of the aglycones betanidin/isobetanidin.

Pigments in sweet potato

There were more than 15 anthocyanin pigments isolated from sweet potato, the majority of which were peonidin, cyanidin, and pelargonidin derivatives. Because purple skinned sweet potatoes contain acylated anthocyanins, they can be used as colourants. Sweet potato anthocyanin pigments had no off-flavors and could be utilised in place of red cabbage. Sweet potato antioxidant action has been claimed to be attributable to the plant's anthocyanin content. Anthocyanins from sweet potatoes have been shown to have prebiotic-like effect through the modification of microbiota in the intestine. Anthocyanin from purple potatoes has been shown to suppress tyrosine kinase activity, making it effective against colon cancer cells [9].

Pigments in black sorghum

Sorghum is a cereal that has a considerable quantity of anthocyanin pigment, which is comparable to that found in fruits and vegetables. The bran of black sorghum has a significant quantity of anthocyanin colouring. Anthocyanin levels in the bran were observed to be three to four times greater than anthocyanin levels obtained from numerous commercial sources (typically fruits), with the exception of Elderberry, which was practically in the same range as sorghum. Several anthocyanins have been identified from sorghum, including apigeninidin, apigeninidin-5-glucoside, luteolinidin, luteolinidin-5-glucoside, cyanidin, and pelargonidin. The most frequent anthocyanin identified in black sorghum is 3-deoxyanthocynidins, which exist in nature as aglycones composed of luteolinidin and apigeninidin [10].

Pigments in pomegranate fruit

Pomegranate's main anthocyanin pigments are delphinidin, cyanidin, and pelargonidin. The major anthocyanin in the juice is delphinidin-3,5-diglucoside, although other anthocyanins identified in the seed coat include cyanidin, pelargonidin, and even delphinidin 3 and 3,5-glycosylated. Pomegranate extract was reported to have potent radical scavenging activity against superoxide, which was attributed largely to the presence of delphinidin, a major component of pomegranate juice, and partly to cyanidin, which is present in the seed coat. Scientists also reported that superoxide radical scavenging activity and H2O2-induced lipid peroxidation in rat brain homogenate of anthocyanin were highest in delphini. Although anthocyanidin did not directly scavenge hydroxyl radicals, it did demonstrate apparent hydroxyl radical scavenging properties [11].

Pigments in tomatoes

Tomato pigments include chlorophyll, carotene, and lycopene, though the amount of each depends on the maturity of the tomato. Tomatoes have been found to be the best source of lycopene, which appears orange in solution. Lycopene has been shown to be one of the most powerful antioxidants, with double the antioxidant activity of -carotene. Lycopene-fed rats have a high blood lycopene level and a lower incidence of prostate cancer death when fed tomato powder. This could imply that consuming lycopene and tomato products may have a positive effect on oxidative stress markers, prostate specific antigen, or tissue biomarkers. Lycopene has also been proven in studies to reduce the risk of chronic degenerative disease and cardiovascular disease [12].

CONCLUSION

Some of the origins and advantages of natural pigments were discussed. Natural pigments have the important advantage of being widely available locally at low prices. Sweet potato, black sorghum, pomegranate fruits, tomatoes, beet roots, and palm fruits were among the raw resources emphasised. Polyphenols (flavonoids, flavonones), antocyanins (glycosides, acylglycosides), chlorophyll a and b, carotenoids (carotenes, xanthophyll), and betalains are abundant. These chemicals have powerful antihypertensive, antidiabetic, anticancer, anti-inflammatory, and vasoprotective properties, making them useful in the treatment of cardiovascular disorders.

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