



Review Paper

Natural food grade dye extraction techniques

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Abstract

Natural food grade colors demand is increasing progressively because of consumer awareness as they are eco-friendly as well as have various pharmacological benefits for human health. It is need of the day to develop viable technologies as well as they should be cost effective to extract food grade colors from natural sources especially utilizing waste of organic compounds. The purpose of this review article is purely for consumers and manufacturers to attain knowledge about the extraction techniques either conventional or recent technologies of food colors with respect to natural color application.

Keywords: Natural dye, food grade, pigments, extraction and advance techniques.

Introduction

Consumer judge every food product on the basis of appearance especially color is an important attribute as it provide information on food safety, organoleptic attributes and also freshness for acceptance. Now day natural dyes are preferred over synthetic dyes by consumer and food industry¹. Natural dyes show harmony with environment because of its potential for renewal and lack of toxic nature they were extracted from minerals, animals or plants with or without use of food grade solvents²⁻⁴. Currently organizations (Ecological and Toxicological Associations Dyes, Food and Agriculture Organization, the Organic Global Textile Standards, Organic Manufacturer and Environmental Potential Agency) enforced the researchers, traders and consumers to use natural dyes rather than synthetic dyes⁵.

Dyes are colorful material and are named as colorants that are able to color variety of substances such as food and fabrics. Food grade dyes extraction from natural sources is a need of this era to fulfill these requirement scientists has developed effective and efficient techniques for extraction and their applications⁶. Researchers are now developing innovative techniques to improve the dye extraction methods from natural sources⁷.

Natural dyes have magnificent advantages because they are blessing of nature due to their exquisite and naturopathic values also they have ability to inhibit hemolysis, inflammation, oxidation as well as viral and microbial activity and also have numerous benefits for humans and environment⁸.

Methods of Dye extraction

To extract food grade pigments from natural source such as plants and animals scientists have develop different techniques. In this review both conventional and advanced

techniques are discussed as well as techniques in combinations to get maximum yield.

Table-1: Some sources of natural dyes.

Pigment	Color	Sources	Ref.
Chlorophyll	Green	Avocado and spinach	9, 10
Lycopene	Red	Beet, watermelon and tomato,	11, 12, 13
Anthocyanin	Purple	Sweet potatoes, black carrot, Saskatoon berry, Black chuck and berry	14, 15, 16, 17
Anthoxanthin	White	Banana and black rice bran	18, 19, 20

Conventional methods: Conventional methods for dye extraction are usually followed by solvents, flocculation and filtration but these methods results in poor quality and yield as well as plenty of time for a single step but there importance cannot be negligible as these methods the root cause of advance technologies. The conventional techniques that are followed are solvent extraction, column chromatography and solid liquid extraction.

Solvent extraction: The most important step is selection of solvent in solvent extraction although for the extraction of natural dyes organic solvents are preferred²¹. After extraction solvents were separated via vacuum or other purification steps²². Water bath was used to extract pigments from homogenized sample in a sealed vessel for 30 minutes at different temperatures. The extract was cooled followed by centrifuge to separate remains for 5 minutes at 3000 rpm²³.

Advanced methods: Usage of organic solvent to extract dye is harmful for human and nature in order to avoid these hurdles advancements were made in the field of pigment extraction procedures. Innovative techniques were developed by scientists such as gamma irradiation, Sonication, enzyme and microwave assisted extraction and so others.

Gamma Irradiation: Electrons are removed from sample using gamma radiation (high energy ionizing radiation) and create highly reactive free radicals²⁴. It can also be used as a pretreatment for the samples to extract dyes because it makes cell wall more permeable that revealed in maximum yield²⁵.

Sonication: Most effective among recent advancements is sonication method. Sonication mechanism is easy as it exert pressure on plant tissue by generating bubbles that explosively rupture the membrane of cell and release all inner cell material in solvent.

Bath type sonication assisted extraction

Bath type sonicators are frequently utilized as method for micro component extraction. These extractors usually constitute as dual mantle coating on the stainless steel with water circulation. The heating systems usually set at 25kHz to control the temperature. These types of sonicators are easily available and can treat many samples at same time²⁶.

Probe Type Sonication: As compared to batch type these sonicator operate less number of samples because lesser power of ultrasound waves are delivered to samples.

Enzyme assisted extraction: Cell wall degrading enzymes used successfully reduces amount of solvent to be used for extraction and increases solvent effectiveness²⁷. These enzyme assisted extraction methods are helpful to extract pigments like β carotene, chlorophyll lycopene and anthocyanin²⁸.

Microwave-Assisted Extraction: An innovative technology such as microwave-assisted extraction is used to extract dyes²⁹. Microwave-assisted extraction results in higher yield (almost 50-500% more than conventional methods) and reduction in time and solvent consumption³⁰.

Membrane Technology

Among emerging techniques membrane processing is rapid technique in food processing and biotechnology for separation and concentration on the basis of shape and size of molecule. Beside this, it is ecofriendly as it consumes less energy and no harmful solvents. There are many advantages of membrane processing that include pH-sensitive products, higher yields and quality products and use of by-products, which can be easily extracted without alterations³¹.

Supercritical Fluid Extraction: Super critical fluid extraction is effective for extracting variety of dyes and gained much attention because it uses carbon dioxide as a solvent. To avoid

biological product degradation this technique work under mild conditions. It is necessary to add polar co-solvent to maximize solubility of a compound because carbon dioxide solubility is less and it limits the application²³.

Ohmic Heating Assisted Extraction: Ohmic heating assisted method for extraction purposes were also termed electro-conductive heat system. Food innately electrically charged energy is transferred into thermal energy to utilize for heat generation without using heating medium. It is a promising technique for foods containing ionic constituents (acids and salts) also for extracting anthocyanin from rice bran. Ohmic heating is better than conventional methods as it reduces thermal damage of heat sensitive substances for example dyes, vitamins and phenols³².

Pressurized Liquid Extraction: Pressurized liquid extraction modify properties of extraction solvents by elevating temperature and pressure simultaneously this allows selection of extracted metabolites according to polarity. This technique can be used in many analytical approaches as it uses less volume of solvent and provide automatic identification of subsequent compounds on the basis of polarity of solvent³³.

Combination of Techniques

Combination of two or more techniques could be used for efficient extraction of the food grade dye from natural sources. This includes many techniques but in this review paper sono-soxhlet extraction was discussed.

Sono-Soxhlet Extraction: The sono-soxhlet extraction is also termed as ultrasound assisted soxhlet. It ensures fast and accurate sample extraction. Soxhlet is used for extraction by using fresh solvent repeatedly whereas, ultrasound lower extraction time also maximizes the mass transfer³⁴.

Conclusion

Numerous optimized extraction techniques were developed in past years to extract natural pigments from animal and plant source because consumers among worldwide demanded for natural food dyes not just because of their functional and safe to use properties but as well as their positive impact on the human health and environment in a long term manner if compared to the synthetic food dyes had made them popular in this era. To meet the growing demand and attention of the population technologies such as conventional, advanced and combination of two or more technologies are made to gain more yield and higher quality dyes. Conclusively it can be stated as the use of more than one technique together might results in higher yield with low time consumption as they are eco-friendly.

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