

POTENTIAL PRODUCTION OF FOOD COLORANT FROM COFFEE PULP

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Abstract

Coffee pulp is the waste produced during the pulping operation of the coffee berries. Coffee pulp is reported as a good candidate of material for food colorant production. The food pigment found in coffee pulp is anthocyanin. The anthocyanin content in coffee pulp is reported up to 25 mg of monomeric anthocyanins/100 g of fresh pulp on a dry weight basis. As the fourth largest coffee producer in the world, Indonesia has the potency to produce food colorant from coffee pulp. There are several methods that can be applied in the separation of anthocyanins from coffee pulp. The methods are include solvent extraction, microwave assisted extraction, ultrasound assisted extraction, supercritical fluid extraction and enzymatics extraction. Further researchs are needed in order to find the suitable method for anthocyanins production from coffee pulp.

Keywords: coffee pulp, food colorant, anthocyanin

INTRODUCTION

Color appearance of food products is one of the major concerns of the food industry. The use of colorants as additives for food and drinks is a significant factor to food manufacturer and consumer in determining the acceptability of processed food.

Nowadays, it is reported that some food producers are using textile colorants to color their food product. According to BPOM (2008), in 2006 approximately 12,9% of the food sample tested used textile coloring for food (Martianto, 2010). The usage of textile colorants on food product will effect on human health since it contain materials that can not be destroy and accumulate on human body.

Color is added to food for one or more of the following reasons: (i) offsetting color loss due to light, air, extremes of temperature, moisture, and storage conditions, (ii) masking natural variations in color, (iii) enhancing naturally occurring colors, (iv) providing identity to foods; protecting flavors and vitamins from damage by light, (v) decorative or artistic purposes, (vi) crease appetite appeal, (vii) to make less desirable food more desirable, (viii) to mask defects, and (ix) may keep certain foods tasting fresher for long time (Sabitha, 2012).

The food industry tends to classify colors into two classes: (i) chemically synthesised color and (ii) color derived from natural sources. Chemically synthesised color is comprised of artificial colors e.g. tartrazine and synthesised colors identical to those pigments in nature e.g. synthetic beta-carotene or riboflavin. While color derived from natural sources is comprised of color selectively extracted by solvents e.g. anthocyanins and color selectively extracted by solvents then chemically modified e.g. copper chlorophyll (FSA, 2011).

Because of health issues, nowadays, the use of unnatural additives is becoming less popular among the consumers. It is especially due to psychological reasons as the consumer easily associates natural colorants to health benefits and synthetic colorants to toxic issues (Ketmaro, 2010). Therefore, replacing synthetic colorants and textile colorants by natural colorants has become a major issue over the last years.

Natural Colorant

Natural colorants for food are made from renewable sources. Most often, the colorants are extracted from plant material, but other sources such as insects, algae, cyanobacteria and fungi are used as well.

The natural food color industry market is growing at 10% -15% annually. The rationale for growth is increasing awareness among the developed countries about the harmful effects and consequences of using synthetic color. The reason for accelerating demand of the natural food






colors in international market is the growing awareness of environmental hazards of synthetic colors and harmful impact of chemicals used for manufacturing them. The demand for natural colors is increasing because of the following reasons: (i) health-promoting properties of biocolorant food; ii) natural colors has been the consumer priority; (iii) low-fat content' is the objective for many new or improved food formulations, replacing fats with thickeners or other food additives; (iv) increased consumer preferences for organic food; (v) variety and internationalisation of food color and flavours (Rymbai, 2011).

The global food colors market was worth an estimated \$1.45 billion in 2009. World usage of food colors is currently about 40,000-50,000 tons. From 2005-2009, the global market for natural colors increased almost 35% in value, with much future growth expected to come from natural colors and coloring foodstuffs. Foods account for some 67% of the food coloring global market, followed by soft drinks (28%) and alcoholic beverages (5%). Europe accounts for 36% of the global coloring market, followed by the U.S. (28%), Japan (10%) and China (8%), with the remaining 18% from developed economies, such as Canada and Australia, and emerging food markets, such as India and Brazil (Leatherhead Food Research, 2010).

Commonly, natural colorants can be grouped into a few of classes. The most important classes are comprised of tetrapyrroles, tetraterpenoids and flavanoids (Aberounmand, 2011; Rymbai, 2011). Tetrapyrroles are the most abundant pigment molecules on the planet. Tetrapyrroles are compounds containing four pyrrole rings. With the exception of corrin, the four pyrrole rings are interconnected through one-carbon bridges, in either a linear or a cyclic fashion. The most important member of cyclic tetrapyrroles is chlorophyll, which is found in higher plants. Tetraterpenoids are terpenoids of 8 isoprene units. Caretonoid is one of the most important tetraterpenoids. While anthocyanin, chalcone, and flavones are belong to flavonoid.

Natural colorant gives a certain shades. Shades of several natural food colorant are given in Table 1.

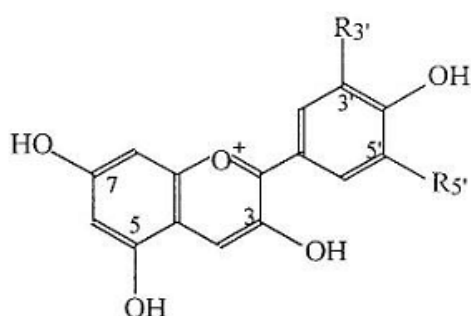
Table 1. Shades of natural food colorant

Color	Wavelenght	Biocolorant	Shades
Red	~630-700 nm	Red bit juice Paprica	
Orange	~590-630 nm	Mango Annato (bixin)	
Yellow	~560-590 nm	Turmeric	
Green	~490-560 nm	Chlorophyll	
Blue-violet	~400-490 nm	Anthocyanin	

Source:Chattopadhyay, 2008

Food Colorant from Fresh Cofee Pulp

One of biomass that can be used as source of food colorant production is cofee pulp. The food pigment found in coffee pulp is anthocyanin. The acid extraction of coffee pulp is reported yielded 25 mg of monomeric anthocyanins/100 g of fresh pulp on a dry weight basis (Murthy, 2012).



Pelargonidin	: R ₃ '=R ₅ '=H
Cyanidin	: R ₃ '=OH, R ₅ '=H
Peonidin	: R ₃ '=OMe, R ₅ '=H
Delphinidin	: R ₃ '=R ₅ '=OH
Petunidin	: R ₃ '=OMe, R ₅ '=OH
Malvidin	: R ₃ '=R ₅ '=OMe

Figure 1. Structure of some major anthocyanin

Anthocyanins are basically glycosides of anthocyanidins. The six major anthocyanidins are illustrated in Figure 1. The sugar moieties are usually attached to the anthocyanidins via the 3 or 5-hydroxyl positions and to a lesser extent the 7-hydroxyl position. The anthocyanin sugars may be simple sugars such as glucose, galactose, rhamnose, and arabinose, or complex sugars such as rutinose and sambubiose.

Anthocyanins are being responsible for their red to purple colors. The most common anthocyanidins are cyanidin (red purple), delphinidin (blue-purple), malvidin (deep purple), peonidin (red), petunidin (purple) and pelargonidin (orange-red) (Rymbai, 2011).

The role of anthocyanins as food colorant is becoming increasingly important. Not only do they contribute to the most important attributes of food but also they tend to yield potential positive health effects, as they have been observed to possess potent antioxidant properties. Anthocyanins are also approved as food colorants. The use of anthocyanins may show benefits over that of synthetic colours (Duangmal, 2004).

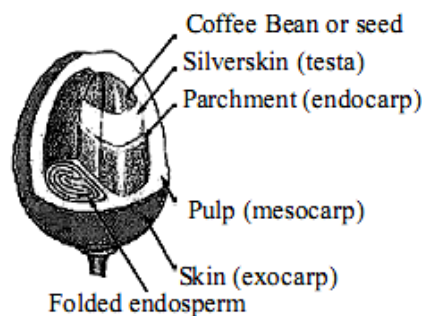


Figure 2. Morfology of Coffee Berries

After the coffee berries (Figure 2) are harvested, they are processed in order to separate the outer part of the coffee berry e.g coffee berry skin (exocarp), pulp (mesocarp), mucilage and the endocarpal parchment part (Edeeen, 2002).

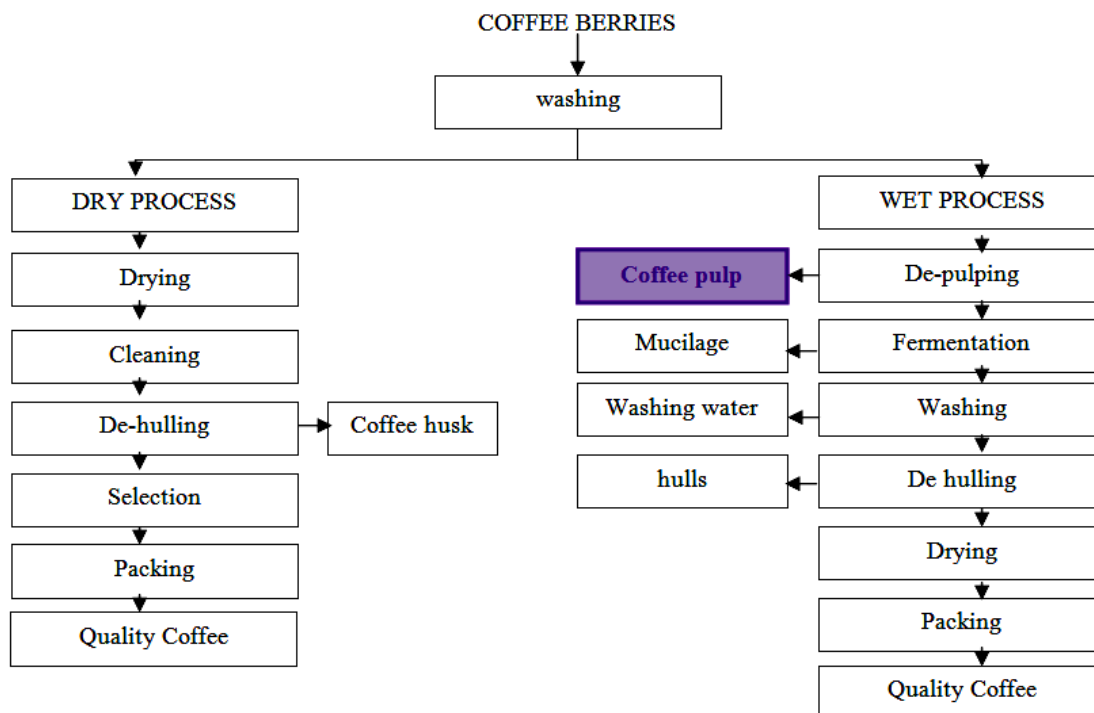


Figure 3. Coffee Processing Method

There are two ways in processing of the coffee berries: dry and wet processing method (Figure 3). On the dry processing method, the separation of the outer part of the berries is done after the berries are dried. While on the wet processing method, the separation of the outer part is done before the drying step (Ridwansyah, 2003). In the wet processing method, coffee cherries are depulped to remove the skin (exocarp) and the pulp (outer mesocarp). The skins separated by pulping are led away from the vats into the collection pits. These coffee pulps (Figure 4) represent the most abundant waste produced during the pulping operation of the coffee. It represent 55,4% of the fruit on dry wet basis (Murthy, 2012).



Figure 4. Coffee husk

Indonesia is currently the fourth largest coffee producers after Brazil, Vietnam and Colombia (Figure 5) (Mawardi, 2007). The coffee production of Indonesia is up to 683 thousand tons on 2008. (Deptan, 2009). Hence the potency of the coffee pulp is up to 378,3 thousand tons.

Unfortunately, though the volume of the coffee pulp is enormous, the utilization of coffee pulp is not optimal yet. Commonly, the coffee husk is just collected around the coffee processing location and become a pollutant. Recently, it is used as compost raw material, animal feed, raw material for biogas production and activated carbon (Rathinavelu & Grazioni, 2005; Yesuf, 2010). Therefore, it is urge to find a way to utilize coffee pulp. As describe above it is possible to utilize coffee pulp as raw material for anthocyanins production and use them as food colorant.

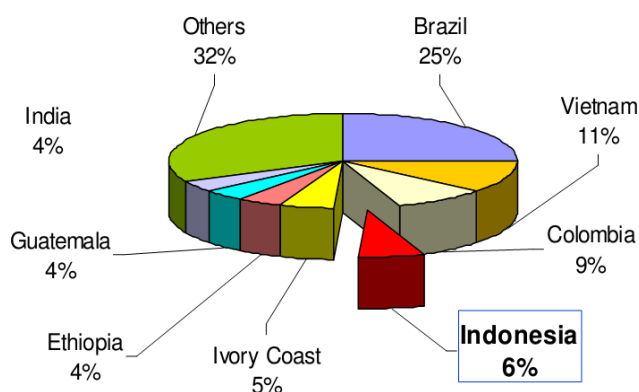


Figure 5. Composition of world coffee production (Mawardi, 2007)

Anthocyanin Extraction Methods

Extraction is a very important stage in the isolation, identification, and use of anthocyanins. Isolation of anthocyanin pigments from plants is typically done using solvent extraction processes. Anthocyanins are polar molecules and consequently more soluble in polar solvents. Methanol is the most commonly used solvent, but it is also considered more toxic and hazardous to handle than other alcohols. Ethanol for example is more environmentally friendly and can also recover anthocyanins with good quality characteristics (Bridgers, 2010). Beside the solvent type, solvent concentration, liquid-to-solid ratio, temperature, and time are another important parameters that are needed to be optimized (Zou, 2011). Solvent extraction of anthocyanin was applied in the extraction of anthocyanin from purple sweet potato (Bridgers, 2010) and grape (Vanini, 2009).

In order to seek more efficient methods for anthocyanin separation, solvent consumption should be decreased, extraction time should be shortened, and extraction yield should be increased. Various novel extraction techniques have been developed for the extraction of anthocyanin from plants, such as microwave assisted extraction, ultrasound-assisted extraction, supercritical fluid extraction, and enzymatic extraction.

Microwave assisted extraction of anthocyanin was investigated in anthocyanin separation from mulberry (Zou, 2011), red raspberry (Zhangzou, 2007), purple corn (Yang, 2010), and from grape skin (Liazida, 2011). Ultrasound assisted extraction was already investigated in anthocyanin extraction from mulberry (Zou, 2011), grape peel and seed (Ghafoor, 2011) and red raspberry (Chen, 2007). The enhancement in extraction obtained by using ultrasound is mainly attributed to the effect of acoustic cavitations produced in the solvent by the passage of an ultrasound wave. Ultrasound also exerts a mechanical effect, allowing greater penetration of solvent into the tissue, increasing the contact surface area between the solid and liquid phase. As a result, the solute quickly diffuses from the solid phase to the solvent. Supercritical fluid extraction with CO₂ has been used for the extraction of phytochemical compound from natural products. Supercritical fluid extraction of anthocyanin from elderberry pomace is already conducted by Seagra et.al (2008). While supercritical fluid extraction of anthocyanin from grape peel and seed is already conducted by Ghafoor et.al (2011). CO₂ is an inert, non-toxic, environmentally friendly solvent and allows extraction at lower temperatures and relatively low pressures. The extracts obtained by SFE are of better quality than those obtained by organic solvent extraction methods. Supercritical fluid extraction can be particularly attractive for the extraction of antioxidants and anthocyanins because it may also avoid their thermal degradation, and due to the absence of light and oxygen, it can prevent oxidation reactions (Seagra, 2008). Ping et.al (2008) extracted anthocyanin from blackcurrant by using cellulase and pectinase. The research result showed that pectinase gave better effect to extraction rate.

One of the separation methods described above can be applied in the separation of anthocyanin from coffee pulp. Further researchs are needed in order to find the suitable methods.

CONCLUSION

Coffee pulp with its anthocyanin content can be utilize as the raw material for anthocyanin production. Indonesia is currently the fourth largest coffee producer in the world. Hence Indonesia has the potency to produce anthocyanin from coffee pulp and use it as food colorant. Several methods that can be applied in the separation of anthocyanin from coffee pulp are include solvent extraction, microwave assisted extraction, ultrasound assisted extraction, supercritical fluid extraction and enzymatics extraction. Further researchs are needed in order to find the suitable method for anthocyanin production from coffee pulp.

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