

# Microencapsulated Natural Food Colourants in Malaysia



by Engr. Assoc. Prof. Yus Aniza Yusof  
and Mr. Chong Rik Han

**CONSUMERS** have become increasingly aware of the ingredients used in food products and thus, they always look for natural foods as much as possible. Such consumer preference coupled with technological development have accelerated the usage of natural colourants instead of synthetic ones. Natural colourants are considered very unstable and sensitive to pH, sunlight and heat. Amongst the methods used to overcome these drawbacks, microencapsulation has been proven to be a potential technique in terms of protection and stabilisation of natural colourants. A short outline of plant-derived natural food colourants, their potential sources in Malaysia, stabilisation of the colourant by microencapsulation of betalains and their phytochemical properties are described in the review.

## AN OVERVIEW OF FOOD COLOURANTS

In response to the current trend of avoiding foods containing synthetic colourants, more manufacturers and retailers are coming into the market with products containing natural colourants. The use of synthetic azo-dyes for colouring is still a common practice. It is considered low in cost and high in stability. However, researches have revealed that food coloured with synthetic dyes are associated with numerous health-related impacts, especially hyperactivity in children (McCann *et al.*, 2007). For this reason, the food and pharmaceutical industries have paid more attention to the use of natural pigments in food as colouring agents instead of synthetic ones.

Much work have focused on the health benefits of natural pigments, especially those of anthocyanins and carotenoids, which possess anti-oxidant properties that have been extensively studied. The current market for all food colourants is estimated at US \$1 billion, with natural pigments representing for only one fourth of the total (Azeredo, 2009). Fletcher (2006) reported that the market for synthetic colourants would decline in favour of natural ones.

The fast growing economy of Malaysia has had a great influence on consumers' attitude towards healthy foods. People have become increasingly aware of the ingredients in their foods. Thus, they would prefer foods labelled as 'natural'. This has contributed towards the increase of the use of natural colourants in processed foods in Malaysia.

With regard to natural sources of the raw materials for natural colourants, Malaysia is also at an advantage. Malaysia is a tropical country and is rich with coloured plants, which are available year-round. In a large plantation,

coloured plants can also be cultivated as secondary crops for use as raw materials for natural colourants.

## FOOD COLOURANTS AND MARKET SHARE

Food colourants are the colourants that are used in food preparation to replace colour lost during processing, to enhance colour that is already present, to minimise batch to batch variation, or to add colour to otherwise uncoloured foods. They are classified based on two approaches:

- Origin of colourant
- Chemical structure.

In relation to origin, food colourants could be natural, nature-identical or synthetic (Delzell, 1997). Natural colourants are defined as colourants which are synthesised, accumulated and excreted from living cells. Nature-identical colourants are man-made ones but identical to the chemical structure of colourants present in nature, whereas synthetic colourants are also man-made but do not occur in nature. In relation to the chemical structure, food colourants may be isoprenoid derivatives, tetrapyrrole derivatives, benzopyran derivatives or artefacts (Moss, 2002). There are no statistics on the size of the colourant market of Malaysia. However, according to Downham and Collins (2000), the global market value for food colours can amount to \$940 million. In terms of individual types, the breakdown is shown in Figure 1

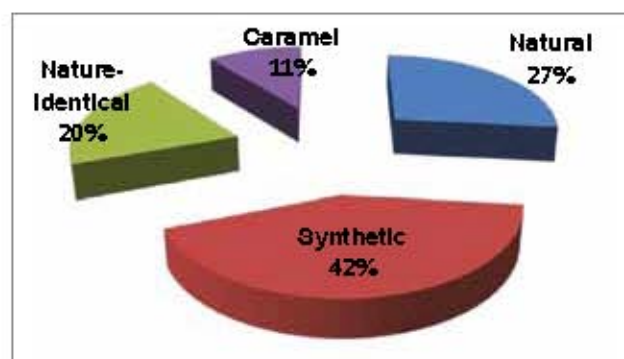


Figure 1: Percentage in market share of food colours (Moss, 2002)

The current trend of advances in the food processing industry has led to advances of the colour market. The current improved technology and consumers' attitude have led to a significant growth in naturally derived colour. The prediction of the future growth of the colour market is estimated to be at a rate of 5% to 10% for naturally-derived

colours. Synthetic colours are still forecasted to grow but at a lower rate of between 3% and 5% (Moss, 2002).

**NATURAL COLOURANTS**

Nature produces a variety of compounds adequate for food colouring, such as water-soluble anthocyanins, betalains, and carminic acid, as well as oil-soluble carotenoids and chlorophylls. Mostly they are found in fruits, vegetables, roots and seeds. Amongst them, water-soluble colourants are preferred for their properties and are used in a wide variety of products. Tetrapyrrols, tetraterpenoids and flavonoids are the three principal classes of natural food colours.

The chlorophylls are green, a major member of tetrapyrrols, whereas carotenoids are the important member of tetraterpenoids and contribute shades of yellow, orange or red. The blue or red of anthocyanins and the red or yellow of betalains are in the group of flavonoids. The anthraquinones is other important class of natural colourants and carmine, lac, kermes and madder are the major members of this group. Chlorophylls, carotenoids, anthocyanins and betalains are the principal groups of pigments that are present in fruits and vegetables. Carotenoids and anthocyanins are the most widely studied natural pigments, while betalains has also gained attention as a promising water-soluble natural pigment amongst food scientists. Betalains, comprising water-soluble nitrogen containing pigments, was previously thought as nitrogenous anthocyanins as they contained nitrogen in their ring structures and also contained glycoside residues. The betalain group contains approximately 50 red pigments termed betacyanins and 20 yellow pigments termed betaxanthins (Figure 2).

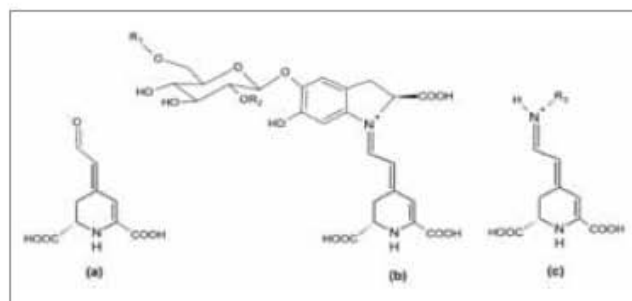


Figure 2: General structure of (a) betalamic acid (b) betacyanins (c) betaxanthins

Betalains are characteristic pigments in the plant members of the Caryophyllales. A few of the vital sources of betalain have been shown in Figure 3. To date, despite its high nitrate level (Santamaria, 2006) and its earthy smell caused by geosmin and pyragine derivatives (Acree *et al.*, 1976) the most common betalain source is red beet. Literatures report few other potential sources of betacyanins like cactus pear (Casteller *et al.*, 2006; Saenz *et al.*, 2009), pitaya (Kharidah *et al.*, 2009; Yusof *et al.*, 2011, Ng *et al.*, 2012) and Amaranth (Cai *et al.*, 2005). Betacyanin content of Amaranthus species, and extraction and production of powder by spray drying were reported by Cai & Corke

(2000) and Cai *et al.* in 2005, respectively.



Figure 3: Potential betalain source in Malaysia

Stability, price and yield are the major factors that affect the marketing potential of colourants in the food industry. Natural colourants are considered very unstable and sensitive to pH, sunlight and heat (Hallagen *et al.*, 1995). Due to its gaining of relative importance of natural colourants to a wider range of consumers because of health and hygiene, nutrition, pharmaceutical activities, fashion and environmental consciousness, efforts to improve the technological processes to minimise their disadvantages are ongoing.

Suppliers have mainly focused on the development of currently permitted pigments in three main areas, namely the formulation technology, processing technology, and alternative sources of pigments (Downham & Collins, 2000). These approaches have proved very successful since finding of a new pigment source requires lengthy and costly safety assessment. The formulation has mainly been focused on increasing the stability of natural or nature-identical colour; for instance, by using various emulsifying techniques.

Process technology mainly focuses on microencapsulation of milled pigments into insoluble carriers, such as microencapsulation by spray drying. The use of untapped raw materials instead of extracting pure colour compounds also provides an alternative source of pigments, as the use of coloured raw materials as food colourants requires no lengthy and costly safety testing and regulatory approval.

Microencapsulation of pigments encompasses both formulation and process technology. Complete microencapsulation stabilises the pigment from the common factors that cause loss of colour, such as heat, sunlight and pH. The microencapsulation process can be simply explained as a solid matrix (such as maltodextrin or acacia gum) dissolved in water and the core materials (food ingredients) are dispersed into it. The encapsulation of food ingredients is achieved by rapid solidification caused by water evaporation during spray drying (Desai and Park, 2005). Spray drying, spray coating and spinning disc technology are the common encapsulating methods. The procedure of microencapsulation by spray drying is shown in Figure 4.

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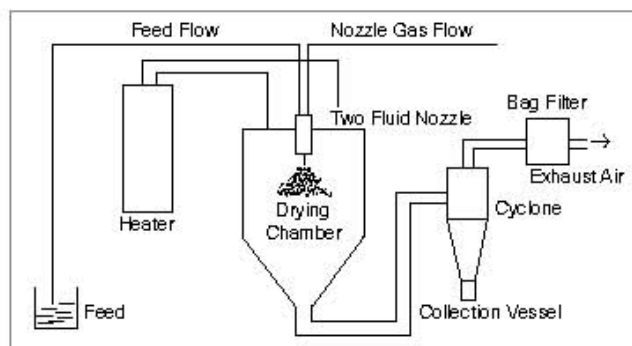


Figure 4: Schematic diagram of spray drying (Patel et al. 2009)

Microencapsulation is an area of great potential in the protection of natural colourants. The main challenge of this method is the encapsulation efficiency, which varies depending on purity of pigments and pigment source (Sa'enz et al., 2009). The highest microencapsulation efficiency of amaranth betacyanins was found to be 82% and the change of betacyanin retention as influenced by inlet temperature and coating agent concentration is shown in Figure 5. Before calculation of microencapsulation efficiency, proper sample preparation is very important for the determination of colour compound. Figure 6 shows the sample preparation for betacyanin determination of pitaya fruit by using a spectrophotometer method.

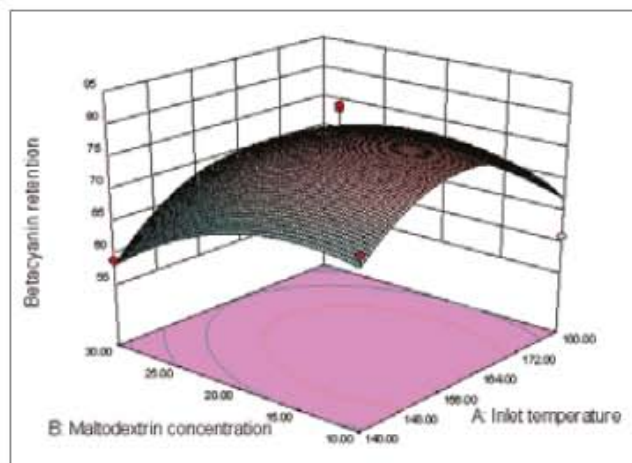


Figure 5: Response surface plot showing the relation between betacyanin retention as affected by inlet temperature and maltodextrin concentration of red amaranth



Figure 6: Sample preparation for betacyanin determination by using spectrophotometer of pitaya fruit

### PHYTOCHEMICAL PROPERTIES OF NATURAL COLOURANT

The major advantage of using natural colourants is the functionality, besides their colouring potential. Functionally, they improve the nutritional quality due to their potential role in human health as an anti-oxidant. Many natural colourants used for food colouring are exhibited as phytochemicals. The untapped pitaya fruit pulp spray dried to powder, used as a natural colourant, is found to be nutritionally rich as shown in Table 1.

Table 1: Nutrition content of pitaya fruit powder at 155°C with 20% maltodextrin composition (Ng et al., 2012)

Nutrition contents	Pitaya fruit powder at 155°C, 20% Maltodextrin
Moisture (%)	4.07±0.12
Water activity (%)	0.34±0.006
Protein (%)	0.182±0.02
Fat (%)	1.203±0.09
Crude fiber (%)	38.051±7.58
Ash (%)	0.794±0.28
Betacyanin content (mg/100 g of powder)	44.72±0.15
Antioxidant, DPPH (IC <sub>50</sub> /mg/L)	2.25±0.09

Functional properties of anthocyanin as an anti-oxidant present in red wine have been extensively studied. Carotenoid shows anti-oxidant properties as well as being a provitamin. Chlorophyll has been shown to have wound healing, anti-ogenotoxic and anti-mutagenic properties. Lycopene helps in reducing the risk of several cancers such as prostate and cervical cancer. Lutein and betacyanin have been recognised as anti-oxidants.

### CONCLUSION

Due to the negative publicity of synthetic colours, the market for natural colours is growing at a faster rate and it has been forecasted that this will continue owing to the consumer pressure and attitude towards natural food. Significant development of natural colours has occurred over the last 10 years. However, there is still room for future research, particularly in the area of stabilising the current permitted pigments through further development of the formulation and process technology, as well as continued searches for 'untapped' sources of permitted pigments. ■

Engr. Assoc. Prof. Yus Aniza Yusof completed her PhD in the Department of Chemical Engineering and Chemical Technology, Imperial College, London, in 2006. She is currently an Associate Professor and Department Head of Process and Food Engineering, Universiti Putra Malaysia.

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