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A Case Study

Edible colours and their scope

■ RAKESH KUMAR, SHIVANI SHARMA AND A.P.S. BRAR

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■ **ABSTRACT :** In the present era of life, most of the peoples are busy in jobs and have very little time for preparation food for their family and hence, dependent upon the processed food products *i.e.* ready to serve meal. In such type of food products, the natural ingredients undergo processing which impact upon the appearance of the food. Moreover, the consumer goes for shopping on less frequent basis therefore the shelf-life of food products becomes a key consideration. To restore the originality of the food products, the manufacturers are using food colours. These colours can be artificial or natural. Many types of natural and artificial colours are being used by the manufactures to maintain the particular shade of a product for the duration of shelf-life. Despite, widespread use of colourants (synthetic) in food products, repots of allergic reaction, indigestion have been reported from additives. Very few report for turmeric, carmine, annatto and saffron were reported, though nobody gave conformity. Thus, it may be concluded that natural colours are safe and could be used into processed foods in place of synthetic ones to enhance the appeal of the processed food.

■ **KEY WORDS:** Food colour, Synthetic colour, Natural colour

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See end of the paper for authors' affiliations

RAKESH KUMAR
Krishi Vigyan Kendra, FARIDKOT (PUNJAB) INDIA

Why do we need food colours? In the present modern living system, one has very little time for food preparation and the food habits of the peoples are changing at very fast pace *i.e.* people are opting for pre-prepared convenience foods ranging from breakfast replacements, drinks, cereal/ fruits bars for snacking or the classic 'ready meal'. In all the processed food products, which we are consuming now-a-days, the ingredient undergoes processing which affects the appearance of the food. Today's consumer is conscious about his/ her health and is quite aware about the quality of food items he / she is going to consume. Moreover, the processed food products are kept in shops / retail outlets for days till they are purchased by the consumer, and hence, to meet the requirement of the consumer the shelf-life of these food products become a key consideration. Food colours are therefore used by the manufacturers to restore the appearance of the food after processing and also maintain the natural colour of the product for the duration of shelf-life. The colour is the major criteri on for selecting the particular food product by the consumer and it is mainly the colour that affects the commercial value of the product. The colour of the product is also important to support flavour association. For manufacturer, it is a fine balance to provide vibrant appealing colours that do not look either artificial or too dull as consumers and retailers are prepared to compromise the visual appearance of their food.

Food colours can be broadly categorized as artificial (colour that have been chemically synthesized) or natural. Colours are being used in food products since long back and those are mostly artificial colours. However, recent research has provided natural colours, which are equally stable as synthetic (artificial) colours and can be used in wide range of applications. Natural colours are being used in our diet. They have been isolated and added back to foods for the same reasons as the synthetic colours. Chlorophylls, carotenoids and anthocyanins are consumed in the foods through our diet. Other common natural colourings include annatto, saffron, paprika, grapes skin, caramel, beet root, cochineal and turmeric. According to PFA (2007), the following natural colour principles whether isolated from natural or produced

synthetically may be used in or upon any food article :

Beta-carotene	Riboflavin (lactoflavin)
Beta-apo-8carotenal	Caramel
Methyl ester of eta –apo-8' carotenoic acid	Annatto
Ethyl ester of beta-apo-8' carotenoic acid	Saffron
Canthaxanthin	Curcumin (turmeric)
Chlorophyll	

Natural colours having low tinctorial strength need to be used at higher levels than their synthetic counterparts. Natural colours are often duller, more pastel and more easily affected by the food matrix, pH, salt, vitamins, flavour and other factors. They are also more likely to be contaminated with the undesirable traces metals, insecticides, herbicides and bacteria. "Natural colour additives are considered to be derived from the plant or animal sources by extraction or other physical processing. The natural and synthetic colour additives are subject to the same safety standards under the regulatory scheme in the US Food and Drug Administration (FDA) (Hallagan *et al.,* 1995). In general, the synthetic colour additives are subjected to a certification requirements to assure that each batch of material manufactured meets the standard specifications while the natural colour are 'exempt' from certification and may be manufactured and marketed without certification of FDA.

If the food contains the synthetic colour additive, declaration of the presence of the colour additive is necessary but if the food contains natural additive, then they can be declared in generic manner in the ingredient statement using a statement such as "artificially coloured" or "colour added" no specific declaration is required. Some consumer groups have questioned the exemption status of "natural" colour additives from specific label declaration, citing the possibility of adverse reactions and the same is being reviewed here.

The colouring compounds in natural colour additives are small molecular weight, non-protein chemical that would not be expected to elicit true food allergies, either IgE medicated or cell mediated. However, natural colour additives are often extracts of biological material that many contain many other compounds, including proteins in addition to colouring compounds. Reactions to natural colour additives are reported occasionally and are attributed to the presence of proteins residues in colours such as carmine and annatto (Taylor and Dormedy, 1998). No evidence exists to suggest the involvement of natural colour additives in cell-mediated allergic reactions or in any of the various types of food intolerance. The discussion here is limited to case reports of reactions, following ingestion of natural colour additives.

Carmine :

Carmine is dark red colour additive obtained by aqueous extraction of cochineal, which derived from the dried bodies of gravid female insect, *Coccus cacti*. It is an anthraquinone which forms part of a group of pigments known as the quininoid. Different species of coccid insects are associated with different cochineal colours. Carmine is a complex of carminic acid with various metals. Aluminium is the metal usually used in the commercial preparation of the carmine. The intense red colour of carmine makes it a popular colouring agent for jams, syrups, preserve confectionary and baked goods. Variations in the ratio of carminic acid to aluminum also produces range of colours from pale "straw berry" to near "black current".

Carmine is widely consumed in the foods and beverages and has been rarely implicated in adverse reactions. Acero *et al.* (1998) reported that IgE-mediated allergy may occur by the consumption of carmine, due to the presence of protein residues. Once IgE sensitization to these carmine proteins occurs, the level of exposure to these residual proteins through carmine-containing foods and beverages may be sufficient to elicit allergic reactions. Kagi *et al.* (1994) reported an anaphylactic reaction in a 34 year old female atopic patient after ingestion of an orange beverage, which contains carmine. They observed symptoms like urticaria, rhinitis, nausea, vomiting, asthama, chillis and diorrhea. Skin prick tests to the orange beverage, carmine and cosmetics containing the dye were positive and were considered an indication of carmine specific IgE-medicated allergy. Beaudouin *et al.* (1995) described a reaction to carmine in a 35 year old woman after she ingested yoghurt that contained mixed fruits. Approximately after 2 h of the consumption of yoghurt, she experienced symptoms of anaphylaxis including generalized urticaria, angioedema (localized swelling) and asthma. Six weeks after the skin prick test was performed using yoghurt, which she had consumed that day of her reaction and carmine, both skin prick tests were positive. A leukocyte histamine release teat was also performed using the patients' blood basophils to determine if exposure of these cells to carmine would elicit the release of histamine. The test was found positive. Withrich *et al.* (1997) reported four adverse reactions following consumption of alcoholic beverage containing carmine in women ranging from 25-43 years old, with the symptoms of urtcaria and angioedema. Skin prick test was performed and found positive for caramine supplied by orange beverage. Baldwin *et al.* (1997) also reported an anaphylactic reaction in a 27 year old woman after consumption of a popsicle coloured with carmine. Within 3 h of consumption patient experienced urticaria, hypotension and tachycardia (rapid heartbeat). Kume *et al.* (1997) described four instances of acute allergic reactions in a 28 year old female after ingestion of caramine –containing orange beverage, straw berry milk and red coloured cocktail. Her symptoms included urticaria, abdominal pain, fever, throat discomfort and diorrhea.

Annatto :

Annatto is an orange yellow coloured carotenoid derived from the pericarp of the seeds belonging to the small shrub, *Bixa orellena*. The shrub is mainly found in the tropical countries like Brazil, Mexico, Peru, Jamaica and India. Annatto is basically a mixture of two compounds, bixin and norbixin. Bixin is the monomethylester of a dicarboxylic carotenoid and major component of annatto. Alkaline hydrolysis of the bixin yields the free acid norbixin and is the minor component of annatto (Marmion, 1991). Annatto is prepared by leaching the annatto seeds with an extractant prepared from one or more food grade materials such as various solvents, edible vegetable oil and fats, alkaline aqueous and alcoholic solutions (Marmion, 1991).

Nish *et al.* (1991) reported an anaphylactic reaction in a 62 year old male after ingestion of fibre one cereal which contained, wheat bran, corn bran aspartame, corn syrup, vitamin A, C, D, B_6, B_{12}, B_1 and annatto extract colour. The patient within minute showed symptoms of anaphylactic shock, including generalized pruritius, urticaria, angioedema of the eyes and lips and loss of consciousness. Skin prick test to milk, corn wheat were negative. For annatto, the skin prick test at the 1:10,000 dilution was negative while the 1:1000 dilution and full strength tests were positive. The patient's serum was also found positive for the presence of an annatto specific IgE. This was the first report of anaphylactic shock due to ingestion of annatto. However, Fuglsang *et al.* (1994) conducted a large clinical study of the prevalence of adverse

Table 1 : Colours exempted from certification

Colour name	Applications	21 CFR regulation
Annatto extract	Foods generally	73.30
Astaxanthin	Salmonid fish feed	73.35
Beet powder	Foods generally	73.40
Ultramarine blue	Salt for animal feed	73.50
Canthaxanthin	Foods generally, broiler chicken feed, salmonid fish feed	73.75
Caramel	Foods generally	73.85
Beta-apo-8-carotenal	-do-	73.90
Beta carotene	-do-	73.95
Cochineal extract-carmine	-do-	73.100
Sodium copper chlorphyllin	Citrus-based dry beverages mixes not to exceed 0.2% dry mix	73.125
Toasted partially defatted cooked cottonseed flour	Foods generally	73.140
Ferrous gluconate	Ripe olives	73.160
Ferrous lactate	-do-	73.165
Grape colour extract	Non-beverage foods	73.169
Grape skin extract	Still and carbonated drinks, alcoholic drinks	73.170
Haematococus algae meal	Salmonid fish feed	73.185
Synthetic iron oxide	Sausage casings (not to exceed 0.1% by weight), dog and cat foods (not to exceed 0.25% be weight)	73.200
Fruit juice	Foods generally	73.250
Vegetable juice	-do-	73.260
Dried algae meal	Chicken feed	73.275
Tagetes (marigold) meal and extract	-do-	73.295
Corn endosperm oil	Chicken feed	73.295
Carrot oil	Foods generally	73.300
Paprika	Foods generally	73.340
Paprika oleoresin	-do-	73.345
Phaffia yeast	Salmonid fish feed	73.355
Riboflavin	Foods generally	73.450
Saffron	-do-	73.500
Titanium oxide	Foods generally (not to exceed 1% by weight)	73.575
Turmeric	Foods generally	73.600
Turmeric lotion	-do-	73.615

Source: CFR (2004c)

reactions of food additives including preservatives, natural colourings, synthetic colourings, flavourings and acids and reported that out of 16 children, two reacted positively to the natural colouring capsules, which contained a mixture of 2.5 mg/100ml turmeric, 1.6mg/100ml annatto, 6.0mg/100ml beta-carotene, 1.0mg/100ml canthaxanthin and 5.5mg/100ml beat colouring. The first patient experienced atopic dermatitis, while the second reported symptoms of uritcaria. Because a mixture colourants was employed in the capsule challenge, the role of annatto in the two positive reactions remained unclear.

Turmeric / Curcumin :

Turmeric is a fluorescent obtained from the rhizome of the *Curcuma longa*. The turmeric extract actually comprises three pigments, curcumin, demethoxycurcumin and bisdemethoxy curcumin, out of which, the major pigment is water insoluble curcumin. However, it has been reported that a water soluble complex may be obtained by reaction of the pigment with metal such as zinc chloride (Humphrey, 1980). The major disadvantages of using turmeric or curcumin is that they impart a characteristics odour and sharp taste to the food stuff to which they are applied. However, after deodorization process, the odorless commercial extract generally find application in food products such as soups, mustard, pickles confectionery and canned products.

Fuglsang *et al.* (1993, 1994) included turmeric pigments in a mixture of natural colouring (2.5 mg/100ml) and administered during double-blind, placebo-controlled food challenge. In one study (Fuglsang *et al.*, 1993) the challenges were negative to the mixtures of natural food colourings while in the second study (Fuglsang *et al.*, 1994), two positive with symptoms of atopic dermatitis and urticaria were reported, but it was not clear to determine which of the natural food colourants may have triggered the adverse reactions. Veien *et al.* (1987) also conducted orally challenged clinical trial with a capsule containing a mixture of food colouring including 11 per cent curcumin and observed that the number of reactions to the capsule containing the food colouring mixture was not statically significant. Thus, no convincing evidence exists for allergic reactions to turmeric / curcumin.

Saffron :

Saffron is one of the earliest food additive used by human. It is a water soluble extract obtained from the stigma of the flowers of *Corcus sativa*. The saffron extract is made up of water soluble crocin and fat soluble crocetin. The major component of the saffron is crocin, which is the digentiobioside ester of crocetin (Farell, 1985). High cost of the production for the saffron colourants makes it most expensive. That is why it is usually added to the food stuff as spices such as curry products, soups, meat and certain confectionary goods where a spicy flavour is desirable while at the same tine to enhance the yellow colour of the product.

Anaphylactic reactions after ingestion of a meal of saffron rice and mushroom were reported in a 21 year old atopic farmer with mild atopic dermatitis and allergy syndrome (angioedema and itching confined to the face, mouth and throat) (Withrich *et al.*, 1997). Skin prick test was performed using rice and saffron and observed that rice has negative, whereas saffron gave a strongly positive result.

Grape anthocyanins / Grape skin extract :

Anthocyanins are widely distributed in the plant kingdom and they are basically glycosides (associated with a sugar moiety) in combination that produces red, blue or purple colouration in a variety of fruits and vegetables. The major source of anthocyanins is still grape skin and nearly all the commercially available anthocyanins, known under the generic name of enocyanina are obtained from the grape skin and other by products of the vine industry. Water soluble pigments such as 3-mono and 3, 5 di-glucosides of malvidin, delphinidin and cyanidin and their acylated derivatives are responsible for the purple colour extract (Marmion, 1991).

Several adverse reactions, sensitivities and confirmed allergic reactions following ingestion of grapes or grape products have been reported by the researchers (Eriksson *et al.*, 1982; David , 1984; Eriksson, 1984; Frankland and Aalberse, 1987; Ortolani *et al.*, 1988; Dohi *et al.*, 1991; Steinman and Potter, 1994; Vaswani *et al.*, 1998). However, no allergic reaction has been reported by either grape skin extract or grape colour extract. The allergic reaction reported to grapes are likely from exposure to protein in the grapes that would not be present in either grape skin extract or grape colour extract.

The colours exempted from certification are listed in Table 1.

Conclusion :

Despite, widespread use of natural colourants in food products, few reports of allergic reactions following ingestion have been reported for the some natural colour additives. Numerous reports of reactions to grapes or grape products have been reported in the literature, but no reports of sensitivities to grape skin extract have been found. Very few reports for turmeric, annatto, carmine and saffron were reported, however none gave conformity. Keeping in view very little adverse effect of natural colours on human being, it may be concluded that natural colours are safe and could be used into processed foods in place of synthetic ones to enhance the appeal of the processes foods.

Authors' affiliations:
SHIVANI SHARMA AND A.P.S. BRAR, Krishi Vigyan Kendra, FARIDKOT (PUNJAB) INDIA

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