

SURVEY ON THE USE OF SYNTHETIC FOOD COLORS IN FOOD SAMPLES PROCURED FROM DIFFERENT EDUCATIONAL INSTITUTES OF KARACHI CITY

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ABSTRACT

The present study was carried out to find the type of food colors added to various food products especially those vended at or near different educational institutes of Karachi city. Different types of food items were analyzed for isolation and identification of the added synthetic food colors. The majority of branded food items contained permitted colors however some foods manufactured locally, contained non-permitted colors. About 11% branded and 44% unbranded food items, respectively, were found with not permitted colors for human consumption. Similarly, 4% branded and 30% unbranded beverages were found unfit due to the presence of prohibited colors. Incidences of the use of non-permitted food colors were higher in case of unorganized food makers. Constant vigilance is needed to ensure that the local manufacturers comply with the regulations of food colors not only in terms of non-permitted food colors but also about the control and limits of permitted food colors. Moreover, consumption of colored food items should also be controlled by making the society aware of the hazardous effects of food colors.

Keywords: *synthetic food colors, consumption, branded food items, hazardous effects*

BACKGROUND

In Pakistan, like most developing countries, both the industrial and non-industrial sectors are engaged in food processing activities. The industrial sector is subjected to quality checks whereas the non-industrial sector, by its nature, is outside of this realm, resulting in increased production of sub-standard food products compromising human health to serious diseases, leading to an indirect financial burden on the national economy. Food products including bakery products like cakes, snacks, confectionaries and other food items, produced in non-industrial sector are two to three times of that produced in industrial sector [1-5].

Food colors are the major source of food intoxication and surveys have been conducted to determine the presence of non-permitted food colors in different food products [6]. It is an instinct phenomenon that humans, specifically

young children are always attracted to food and drinks bearing pleasant colors, so addition of attractive colors can definitely enhance the appetizing value and the palatability of food and drink for the consumers. Most manufacturers use variety of colors in their bakery products. Similarly, colors are often used in the manufacturing of soft drinks, various kinds of toffees, ice-creams, jams and jellies etc, by the big manufacturers as well as both street vendors. Even house wives use dyes to color rice and other dishes, mainly to give them a more appetizing look. It has been suggested that consumption of foods containing color additives could sometimes lead to harmful effects [7].

Synthetic colors are reliable and economical for restoring the original shade of the foods (that would otherwise be virtually dull) compared to the natural colorants which are expensive, less stable, and possess lower tinctorial power [8, 9]. The use of synthetic colors by the food processing industry is increasing because they are considered as important adjuncts.

Many unpacked foods consisting of snacks, colored candies, bakery products, chewing gums, colored ice balls and cold drinks containing prohibited colors and toxic chemicals or additives in quantities higher than the toxic levels

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are vended outside educational institutes and other areas inhabited by low income populations and there is no quality control on such products. The use of non-permitted colors is known to cause adverse effects in experimental animals [10-12] and in humans [13-15]. Repeated exposure to even the permitted synthetic colors may be hazardous^{1, 21}. Many of these dyes are originally derived from coal tar, commonly called coal-tar dyes, contain the azo group. By definition, colored chemicals are active chemicals hence requiring greater care than bland additives such as emulsifiers.

Table 1: List Of Permissible Food Colors According To Pakistan Pure Food Rules (1965)

S.#	Permitted Food Colorants	S. #	Permitted Food Colorants
1	Food Blue 1 (Indigo Carmine)	10	Food Yellow 3 (Sunset yellow)
2	Food Blue 2 (Brilliant Blue)	11	Food Yellow 4 (Tartrazine)
3	Food Blue 4 (Indanthrone)	12	Food Brown 1 (Brown F.K)
4	Food Blue 5 (Patent Blue V)	13	Food Brown 2 (Choc. Brown)
5	Food violet 2 (Violet 6B)	14	Food Brown 3 (Choc. Brown H.T)
6	Food violet 3 (Violet BNB)	15	Food Red 1 (Ponceau SX)
7	Food Green 1 (Sulpho green 2BA)	16	Food Red 9 (Amaranth)
8	Food Green 2 (Acid Brilliant 3)	17	Food Red 14 (Erythrosine B.S)
9	Food Green 3 (A.F Green No.3)	18	Food Black 1 (Black B.N)

In recent years, these colors have been subjected to rigid toxicological examination with the result that most of the countries now have a very short list of permitted colors and/or additives. Different countries permit different synthetic food colors. The USA permits seven food colors, including Fast Red (which is prohibited in India), Iran and Australia permit thirteen each and in the European Union (EU) sixteen synthetic food colors are permitted. European countries have been harmonizing the regulations, and most of the controls on colorings in food items from EU directives. Each country is attempting to review these controls by surveillance work [17]. According to Pakistan pure food rules (1965), eighteen synthetic and five natural food colors are permitted in Pakistan (Table 1) in specified food items. The use of black and brown dyes is completely banned in developed countries as they contain harmful ingredients. The maximum limit of permissible colors to be added in any food shall be 0.1 g/Kg of food as consumed. The Acceptable Daily

Intake (ADI) has been defined as the amount of a substance that can be consumed everyday throughout the lifetime of an individual without any appreciable health effects [18]. Even permissible artificial colors, if consumed indiscriminately are not safe. The ADI of erythrosine was reduced from 2.5 to 0.1 mg kg⁻¹ body-weight, as it produced effects on thyroid function in short-term studies in rats [19].

Keeping in view the hazards of coloring compounds, a research study was conducted to find out the percentage of consumption of adulterated or substandard food products by general public particularly young school children. Snack foods, colored candies, bakery products, chewing gums, toffees, colored ice balls, cold-drinks and ice-creams vended outside the educational institutes, usually contain non-food grade colors, thus compromising the health of people to serious diseases.

MATERIALS AND METHODS

Samples of different food items and beverages were collected from different educational institutes, both from the canteens and vending carts outside the schools, located in different areas of Karachi. These included all types of areas ranging from slums i.e. those inhabited by low income populations, middle class, upper middle class, to posh areas, resided by rich and wealthy people. The government and private both kinds of institutions were included in the study in order to get a true picture of the metropolis so far as the quality of the food products available to people especially young children is concerned. Samples were categorized as branded i.e. having some labels and trade names and unbranded having no labels either unpacked or packed by the vendors.

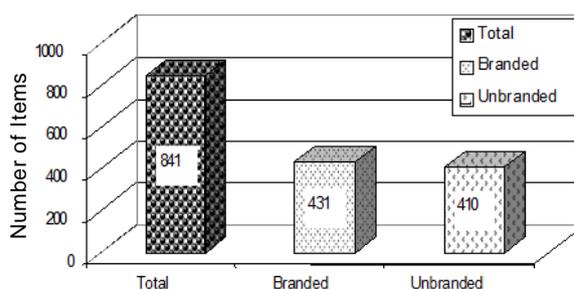


Figure 1. Survey of Colored food Items

A total of 841 samples of different food items such as confectioneries, ice balls, chewing gums and bakery products were analyzed for their

colors out of which 431 were branded and 410 were unbranded items. Similarly 1060 beverages analyzed for their colors consisted of 349 branded and 711 unbranded items. Food samples were collected in polythene bags while those of beverages were collected in sterilized screw-capped glass bottles. Insulated ice chest with ice packs was used for collection of samples (Fig. 1 and 2).

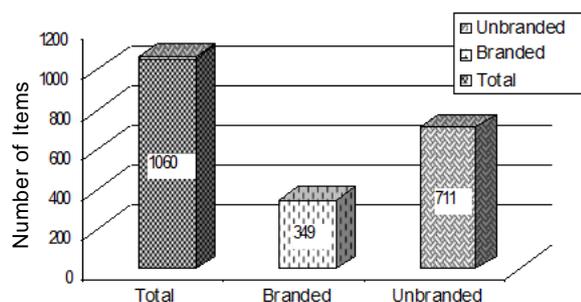


Figure 2. Survey of Colored Beverages

The collected samples were labeled with date and lab code. The other necessary information of the samples, like area or location of school, collection point, etc was also recorded. Colors were extracted [20, 21] from all the samples and then analytical techniques were used to analyze the colors qualitatively and quantitatively.

Color Extraction

All the collected samples were tested for their colors against the available standards for food and textile colors (Table 2 and 3). Colors were extracted from different food samples by dissolving solid and semi solid food items in water before isolation of colors whereas liquid food samples were used directly [21, 22].

Table 2. List Of Standard Food Colors

S. #	Food Color Additives
1	Erythrosine
2	Brilliant Blue FCF
3	FD&C Blue 2 powder
4	Patent Blue V powder
5	Tartrazine
6	Sunset Yellow FCF
7	Ponceau 4R
8	FD&C Green No. 3
9	Indigo carmine
10	Acid Blue 9
11	Amaranth
12	Black PN powder
13	Bluish Red
14	Brown HT powder
15	FD&C Red No. 4
16	Acid Violet 49

Identification of Extracted Colors

Food colors were analyzed at all levels of complexity, ranging from the cursory examination for confirmation of identity, to the exhaustive purity determinations. Food colors were extracted from food materials including candies, chewing gum, sweets, ice-lollies, ice creams, soft drinks, snack products and colored beverages consisted of gola-gandas, sherbets, carbonated and other drinks sold on vending carts (thelas) that have been identified qualitatively by UV-visible Spectrophotometer (PharmaSpec UV-1700 Series, Shimadzu Corporation) using AOAC (2000) method and Pearson's Composition & Analysis of Foods (1989). The purity test of the colors was carried out by preparing a neutral solution of the dye at a concentration suitable for spectrophotometric analysis (0.001-0.01%). The solution is divided into three portions; to one portion a few crystals of ammonium acetate were added; to the second and third portions dilute hydrochloric acid and dilute sodium hydroxide was added, respectively, to make them 0.1 N. The spectrophotometric curves of these solutions were determined and compared with the corresponding standard curves under the same conditions. The distinguishing features of these spectra may be significantly affected by careful adjustment of the pH of the colored solution towards acidic or alkaline, thus providing a valuable additional degree of discrimination. Tables 2 & 3 show the available standard food and textile colors, respectively, used as standard against which the samples were tested.

Table 3. List Of Textile Colors

S. #	Textile Colors
1.	TC Yellow
2.	TC Red
3.	TC Blue
4.	TC Black

RESULT AND DISCUSSION

Traditionally, colorants are used to improve the appearance of different food products and to promote appetite and selling. Food selections are strong markers of age, ethnic group and class; for instance, young children prefer strong bright colors, and this extends to their choices of sweets and desserts. By adolescence, color preference has changed to pastel shades. The child view of foods is of sensory reinforcement and fun, while the adult view tends strongly

towards health and other adult-oriented messages. The research on food additives particularly relating to colorants is very important because food is one of the most fundamental needs of man to sustain life that's why it should be fresh and free from hazardous matter particularly the sub-standard food colors and/or additives which have been frequently used in food items such as many unpacked food consisting of snacks, colored candies, bakery products, chewing gums, colored ice balls and cold drinks containing prohibited colors and toxic chemicals or additives and are usually vended outside educational institutes or in other areas inhabited by low income populations. There is no quality control in such products and the quantity of the colors and additives is generally higher to the toxic levels, even if the colors used are permissible colors or additives, compromising human health to serious diseases, resulting to an indirect financial burden over national economy. Results of the study revealed that 11% of branded and 44% of unbranded food items were unfit for human consumption respectively, whereas 16% of branded and 10% of unbranded items having either natural colors or the colors for which standards were not available (Fig. 3). Similarly 4% of branded and 30% of unbranded beverages were unfit, whereas 3% samples having either natural or those colors whose standards were not available (Fig. 4).

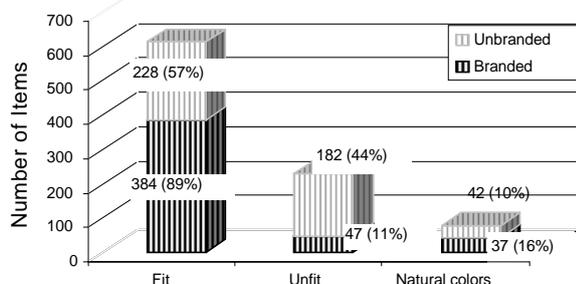


Figure 3. Analysis of Colors in Food Items

Table 1 shows the list of permissible food colorings that are approved by Pakistan Pure Food Rules 1965 (P.F.R) for the use in different food products in Pakistan; but if they are not used according to safety regulations as permitted by FDA (Table 4) then they may cause certain health threatening effects on an individual as they are reported to cause some serious diseases. It was observed that tartrazine and sunset yellow were the most common permitted colors used in various food products. The overall pattern of the frequency of the permitted food colors showed that tartrazine in blend with brilliant blue FCF is the most widely used color indicated in a variety

of colored food items, followed by sunset yellow (in blend with ponceau 4R, erythrosine and carmosine), carmosine, ponceau 4R, brilliant blue FCF (in blend with erythrosine and tartrazine).

Table 5 shows the list of food colors permitted by EU (European Union) system in which many of the food colors show overlapping as they are present in one or more than one system of regulations. While using the permissible colors in foods, the international system of regulations must be followed to assure the implementation of safety strategies, as required.

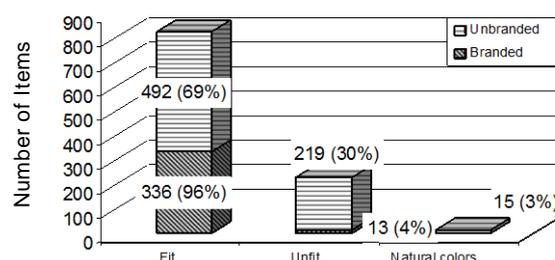


Figure 4. Analysis of Colors in Beverages

Results show that the colors that are widely used in our food items and beverages are mostly synthetic. Branded items contain permissible food colors while the samples manufactured locally in unorganized sector were found to contain undesirable quantities of food colors. In the examined samples, the colors which were found as permitted food colors were Ponceau 4R, Sunset yellow, Amaranth, Blue FCF, Tartrazine (Table 4 and 5) whereas Congo Red, Metanil yellow, Orange 11 were identified as non-permitted food colors found in different low-grade and cheap food products.

There is a dire need to create awareness at different levels about the toxicity of food colors both the use of non-permitted colors or excessive use of permitted food colors. During the 1970s, many cases of Tartrazine sensitivity were reported. Tartrazine (FD &C Yellow No.5) is an approved azo dye present in many food products; its sensitivity is most frequently manifested by urticaria and asthma, the mechanism of sensitivity is obscure and is called pseudo allergy [23]; the management of pseudo allergy consists mainly of avoidance of food products that contain tartrazine. It has been reviewed that azo dyes (Amaranth, Ponceau SX, Allura Red, Sunset yellow, and Tartrazine) that are widely used can be reduced to aromatic amines by the intestinal micro flora and hence causes intestinal cancer [24]. In the present study, the branded food items showed satisfactory results in which only 11% of the

food samples and 4% of beverages were unfit whereas unbranded foods and beverages showed alarming results, that is 44% of food items and 30% of beverages were unfit for human consumption (Fig. 3 and 4). The regulation of the consumption of food permissible dyes is very important because only the application of permissible amount of these dyes in food products is not sufficient to meet the safety strategies, but consumption of colored food products should also be within limits. There are evidences which show that the over consumption of these dyes leads to health hazards [25]. A report on carcinogenesis [26] stated that the metabolism of azo dyes derived from benzidine converted to aromatic amines by intestinal bacteria is potentially carcinogenic. Azo dyes (methyl orange, methyl red, methyl yellow, Ponceau 4R, Ponceau SX, red 2G, sunset yellow, tartrazine, acid yellow, and amaranth) are widely used in textile industry, printing, cosmetics, drugs and food industries. Since intestinal cancer is more common in highly industrialized countries a possible connection may exist between the increase in the number of cancer and the use of azo dyes [27, 28].

Table 4: (FDA) Color Additives Certifiable For Food Use

S.#	Color Additive	Common Name
1	FD&C Blue No.1	Brilliant Blue FCF
2	FD&C Blue No.2	Indigotine
3	FD&C Green No.3	Fast Green FCF
4	FD&C Red No.40	Allura Red AC
5	FD&C Red No.3	Erythrosine
6	FD&C Yellow No.5	Tartrazine
7	FD&C Yellow No.6	Sunset Yellow

According to a report recently published in Current Sciences [29] some synthetic dyes like auramine, metanil yellow, lead chromate, rohdamine, sudan-3 and 4, orange-2 and malachite green pose serious health hazards being mutagenic and potentially carcinogenic. Metanil yellow, the most frequently used non-permitted food color widely used in food items, like "ladoos", causes insufficient oxygen supply to skin and mucous membranes along with degenerative changes in the stomach, liver, kidney, abdomen and testes and also found to cause cyanosis [13]. Another report proves that the consumption of food color Red No. 3, that has estrogen like growth stimulatory properties, may be genotoxic and could be a significant risk factor in human breast cancer [29].

It has been reported that of all the additives, dyes were the most genotoxic. Amaranth, Allura Red, New Coccine, Tartrazine, Erythrosine,

Phloxine and Rose Bengal induced dose-related DNA damage in the glandular stomach, colon, and/or urinary bladder [30]. The acceptable daily intake (ADI) levels recommended by the joint FAO/WHO Expert Committee on Food Additives [18] for amaranth and allura red are 0.5 and 7 respectively, because these dyes were tested and found responsible for the induction of DNA damage, mainly in colon [31]. Some food color additives pose a potential risk to the public health and are prohibited in food items and such color additives include FD&C Red No. 4 [32]. The use of amaranth as a food additive has not been permitted in the United States since 1976 [33]. Human carcinomas of the gastrointestinal tract have high incidence and mortality rates, and colorectal cancer incidence become much higher in recent years, suggesting environmental causes [34].

Table 5: List Of Certified Food Colors According To Ins-Number (International Numbering System For Ingredients) Eu System

S.#	E. Number	Common Name
1	E102	Tartrazine *
2	E104	Quinoline Yellow ***
3	E110	Sunset Yellow *
4	E122	Carmosine ***
5	E123	Amaranth **
6	E124	Ponceau 4R ***
7	E127	Erythrosine *
8	E131	Patent Blue V **
9	E132	Indigo Carmine*
10	E142	Green S *
11	E151	Black PN **
12	E107	Yellow 2G ***
13	E128	Red 2G ***
14	E133	Brilliant Blue FCF*
15	E154	Brown FK ****
16	E155	Brown HT **
17	E180	Rubine BK ***

* Permissible Food color found in FDA & EU system and P.F.R

** Permissible Food color found in both P.F.R & EU system

*** Permissible Food color found in EU system only

**** Permissible Food color found in P.F.R only

Few samples show the presence of natural colors, which is significant from safety point of view because natural colors are safer to use in foods as compared to synthetic colors. Currently the use of natural colorants is limited due to their instability, low tinctorial power or price disadvantage. There is a need to change the trend towards the use of natural colorants, though it totally depends upon the consumer demand, as many regulatory bodies have banned the use of some of the synthetic dyes in foods. Evidence reported for Amaranth and Tartrazine induce immunosuppressive effects in an individual that cytotoxic effects of these substances were studied in human PBL by colorimetric method in

vitro cytotoxicity assays; the results showed clear immunosuppressive effects from the two substances tested [6]. In Pakistan, there is no awareness among the people about health hazards of food colors. Using synthetic colors may not be a problem if certain control measures are taken to keep and maintain proper regulation over the use and consumption of these dyes in foods and to discourage the use of non edible (artificial/textile colors) in food as they are life threatening when consumed.

CONCLUSION

The results of this study revealed that the quality of the products meant for local markets is highly unsatisfactory and there is a dire need to make legislation, in this regard, at provincial and national levels, and to enforce and implement those regulations on the manufacturers of such products to ensure the provision of good quality of food products meant for the low income population of the country. The assessment of information related to food color additives and public awareness is lacking in our country because of limited number of investigations as well as the poor information management and exchange activities but this lack of management can be improved by compiling a database to identify the problems of food related to color additives, quality and safety strategies. Moreover, bright and rich colored as well as unbranded food items should be avoided. Furthermore, use of food grade colors not only should be enforced strictly but their consumption should be controlled in order to get prevention from their hazardous effects. Prevention is better than cure; but, this could only be possible when each and every individual have some awareness about what he or she is going to take as a "FOOD" and it is a desired duty of both the parents and teachers to keep the children aware for what they are eating and what they have to eat especially during lunch hours in school and they should take their lunch from home rather than to buy from school canteen or from a vender outside their schools.

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