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Different Food Color Used in Food Samples: A Chemical Analysis Study in Kishoreganj District, Bangladesh

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Abstract:

Background: One of the most important organoleptic characteristics that influences consumers' acceptance and choice of food is color. However, food coloring pigments are typically unstable and change during processing, so food products all over the world contain colorants to preserve or restore product's color uniformity. This research study was conducted to find out the percentage of consumption of adulterated or substandard food color by general public particularly young school children. ***Methods:*** Qualitatively using a UV-visible Spectrophotometer (PharmaSpec UV-1700 Series, Shimadzu Corporation) utilizing Pearson's Composition & Analysis of Foods (1989) and the AOAC (2000) method. By making a neutral dye solution at a concentration appropriate for spectrophotometric analysis (0.001-0.01%), the colors' purity was tested. In total 68 food samples and 11 beverage samples of various foods and drinks were gathered from several educational institutions, the neighborhood market, and stores situated in various parts of Kishoreganj district, Bangladesh. This study was carried out from 12 August to 21 October 2023. ***Results:*** The majority of branded food items contained permitted colors however most of the foods manufactured locally, contained non-permitted colors. The use of prohibited food coloring was more common among local food producers. ***Conclusion:*** To make sure that the local manufacturers are adhering to the laws governing food colors, both with regard to the prohibited and restricted food colors, constant monitoring is required. Furthermore, educating the public about the harmful effects of food coloring can help reduce the consumption of colored food items.

Key Words: Food color; Market; Consumer use; Confection; Beverage.

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INTRODUCTION

Edibles are aesthetically enhanced and tempted by the addition of food coloring [1]. Food coloring can be obtained from pigments, dyes, or any other substance that adds color to food. Adulteration is the process of increasing the amount and quality of a substance by adding a non-food or non-permitted substance [2]. It causes the product's actual quality to decline. Permitted and non-permitted food colors are the two categories into which food colors belong [3]. Foods can be colored or dyed for a variety of reasons, including product identification, maintaining a visually appealing and colorful appearance, and creating a more enticing appearance. These colors fall into three categories: mixes, straight colors, and lakes [4, 5]. Like other food additives, food coloring is subject to certain laws in the European Union. These laws cover the reported food product categories, maximum allowable quantities, chemical characterization, and purity [6-10].

Food coloring can come from natural sources, synthetic sources, or both. While plants are the primary source of most naturally occurring food colors, some can also be found in animals or even minerals [11]. The majority of natural colorants have some drawbacks, like reactivity with other food ingredients or in the presence of scents or odors; they can also become unstable in water or when exposed to heat or light. Natural food coloring is in demand because to its dependability, functionality, biological potential, and health advantages; in contrast to synthetic colors, it can also have a number of positive effects. Synthetic dyes are created chemically, while natural colors are derived from nature and can be separated through somewhat complex extraction procedures. Due to its chemical composition, artificial food coloring is not found in nature. However, it has the benefit of being soluble in water and available in the form of powders, pastes, or granulates. However, some artificial color additives may pose health risks, such as allergic reactions, which in young children can result in hyperactivity and even mutagenic or carcinogenic diseases. Natural food colorants are often an alternative to synthetic colors due to their lack of harmful effects on health. For example, the use of cochineal (E120), a red food coloring made from an insect, was increased, as was the use of beetroot red (E162), a red food coloring, and chlorophylls (E140), a green food coloring.

Among the majority of developing nations, Bangladesh too has both the industrial and non-industrial sectors involved in food processing. Because the non-industrial sector is by its very nature exempt from quality controls, there is an increased production of inferior food products that endanger human health and cause serious illnesses, which in turn places a financial strain on the country's economy. The amount of food products, such as bakery goods like cakes, snacks, candies, and other food items, produced in the non-industrial sector is two to three times that of the industrial sector.

Food coloring is the big cause of food intoxication, and studies have been done to find out whether certain food products contain prohibited food coloring [12]. The natural tendency of people, especially young children, to be drawn to food and beverages with appealing hues means that adding vibrant colors to food and drink would undoubtedly increase its palatability and enticing value for consumers. The majority of producers use a range of colors in their baked goods. Similar to this, both large producers and street vendors frequently use colors in the production of soft drinks, different types of toffees, ice cream, jams, and jellies, among other products. Even housewives tint rice and other food items using dyes, mostly to make them look more enticing. It has been proposed that eating foods with color additives may occasionally have negative consequences [13]. 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 are sold 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 [14-16], and in humans [17, 18].

The highest amount of colors that can be added to food—0.1 g/kg of food consumed—is allowed. The quantity of a substance that can be ingested every day for the duration of a person's lifetime without having a noticeable negative impact on their health is known as the Acceptable Daily Intake (ADI) [19]. If taken carelessly, even acceptable artificial colors are not safe. Because erythrosine affected thyroid function in short-term rat tests, its ADI was lowered from 2.5 to 0.1 mg/kg body weight [20]. Food color can influence the micronutrients content present in different types of food and fruits [21]. Given the risks associated with coloring compounds, a study was carried out to determine the proportion of the general public, especially young schoolchildren, that consume contaminated or subpar food products. The health of people is compromised by non-food grade colors found in snack foods, colored candies, bakery goods, chewing gum, toffees, colored ice balls, cold drinks, and ice creams that are sold outside of educational institutions.

METHOD AND MATERIALS

Samples of various foods and drinks were gathered from several educational institutions, the neighborhood market, and stores situated in various parts of Kishoreganj district, Bangladesh from 12 August to 21 October 2023. These encompassed a wide range of neighborhoods, from slums, or low-income individuals, to middle-class and upper-class neighborhoods, to upscale neighborhoods, or homes occupied by affluent individuals. Samples were categorized as unbranded, meaning they had no labels and had either been packed or unpacked by the vendors, or as branded, meaning they had labels and trade names. Ethical approval was taken from Institutional Review Board, Jahangirnagar University with Ref. No: {JU/ A/ 2024 (2)}. Additional pertinent data about the samples, such as market location, collection site, etc., were also noted.

Figure 1: Study location in Bangladesh Map (Kishoreganj district)

Samples:

A total of 68 samples of various foods, including ice balls, chewing gum, confections, and bakery goods, were examined for color; of these, 32 were branded and the remaining 36 were unbranded. Similarly, 8 branded and 3 unbranded items made up the 11 beverages items that were examined for their color. Samples of food were gathered in polythene bags, and samples of drinks were gathered in glass bottles with screw tops that had been sanitized. A date and lab code were written on the collected samples' labels. Additional pertinent data about the samples, such as market location, collection site, etc., were also noted.

Extraction of color:

Every sample that was collected was examined for color using established guidelines for food and fabric colors. Before isolating colors from various food samples, solid and semi-solid food products were dissolved in water; liquid food samples were used immediately [22, 23].

Identification:

Food colors were examined at various levels of complexity, from a quick look to verify identity to a thorough analysis to determine purity. Food materials such as candy, chewing gum, candies, ice creams, ice lollies, soft drinks, snack items, and colored beverages such as gola-gandas, sherbets, carbonated drinks, and other drinks sold on vending carts (thelas) were evaluated qualitatively using a UV-visible Spectrophotometer (PharmaSpec UV-1700 Series, Shimadzu Corporation) utilizing Pearson's Composition & Analysis of Foods (1989) and the AOAC (2000) method. By making a neutral dye solution at a concentration appropriate for spectrophotometric analysis (0.001-0.01%), the colors' purity was tested. The solution is split into three parts. A little amount of ammonium acetate crystals was added to one part, and 0.1 N of diluted hydrochloric acid and diluted sodium hydroxide were added to the second and third portions, respectively. Under the same circumstances, the spectrophotometric curves of these solutions were ascertained and contrasted with the matching standard curves. Carefully adjusting the pH of the colored solution to make it more acidic or alkaline can have a substantial impact on the distinctive characteristics of these spectra, adding a crucial layer of distinction. The available standard food and textile colors are displayed in Tables 1 and those were used as standards for testing the samples.

Table 1: Standard food and textile color additives

Serial no.	Food color additives	Serial no.	Textile color
1	Erythrosine	1	TC Blue
2	Brilliant Blue FCF	2	TC Red
3	Tartrazine	3	TC Yellow
4	Amaranth	4	TC Black
5	Acid violet 49		
6	FD&C Red No. 4		
7	FD&C Blue 2 powder		
8	Ponceau 4R		
9	Indigo carmine		
10	Sunset Yellow FCF		
11	Acid blue 9		
12	FD&C Green No. 3		

RESULT AND DISCUSSION

Colorants have historically been employed to enhance the look of various food products, stimulate appetite, and increase sales. Age, ethnicity, and class can all be strongly indicated by the foods that a person chooses to eat. For example, young children tend to like vivid, dramatic colors when it comes to sweets and desserts. Adolescence has brought about a shift in color taste toward pastel color. The adult perspective on food leans heavily toward health and other adult-oriented thinking, whereas the child's view is one of sensory reinforcement and enjoyment. Food is one of the most basic human needs for survival, so research on food additives, especially those related to colorants, is crucial. Food should be fresh and free of harmful substances, especially substandard food colors and/or additives, which are commonly used in food items like many unpackaged foods that include snacks, colored candies, bakery products, chewing gum, colored ice balls, and cold drinks that contain harmful chemicals or additives and are typically sold outside of schools or in low-income neighborhoods.

Table 2: Food items fit to eat according to analysis

Variable	Branded items	Unbranded items
Items	32	36
Fit to eat according to color analysis	28 (87.5%)	17 (47.22%)

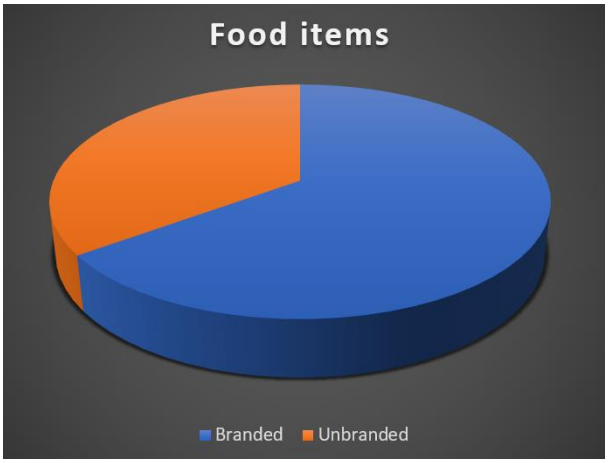

Figure 2: Percentage of food items fit to eat according to analysis

Results of the study revealed that 87.5% of branded and 47.22% of unbranded food items were fit for human consumption respectively, whereas 23% of branded and 11% of unbranded items having either natural colors or the colors for which standards were not available. Tartrazine and sunset yellow were found to be the most often used approved colors in a range of food goods. The general trend of the frequency of the allowed food colors revealed that the most frequently used color in a range of colored food items is tartrazine combined with brilliant blue FCF. This is followed by sunset yellow (in combination with ponceau 4R, erythrosine, and carmosine), carmosine, and ponceau 4R (Table – 2).

Table 3: Beverage items fit to eat according to analysis

Variable	Branded	Unbranded
Items	8	3
Fit to eat according to color analysis	6 (75%)	0 (0%)

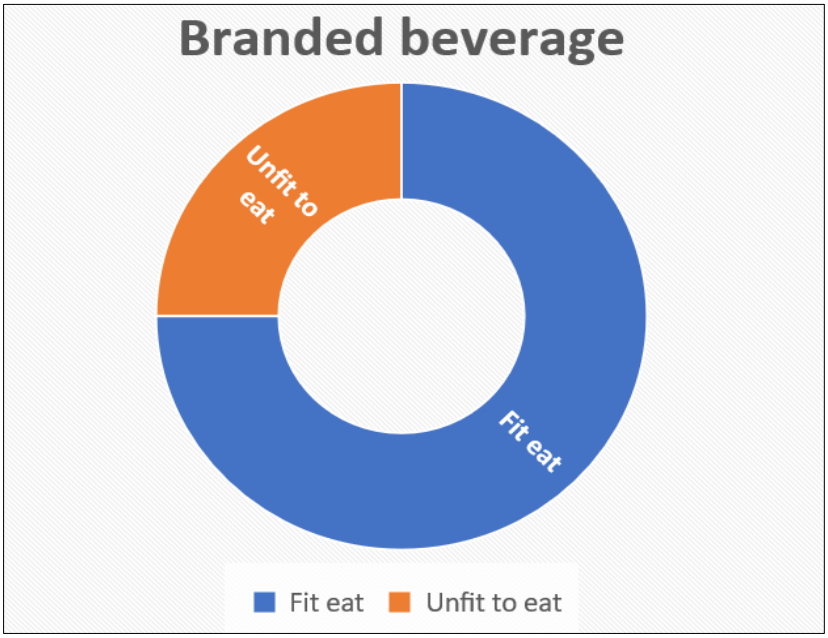

Figure 3: Branded beverage items fit to eat and not eat

It was found that 75% of branded beverages and no item (0%) of unbranded beverages were safe to consume, whereas about 30% of samples had either natural colors or colors for which there were no criteria (Table – 3). The majority of the colors that are commonly utilized in our food items and beverages are synthetic, according to the results. Food colors that are allowed are present in branded products, however samples made locally in the unorganized sector were found to have unwanted amounts of food colors. Ponceau 4R, Sunset yellow, Amaranth, Blue FCF, and tartrazine were discovered to be permissible food colors in the samples that were evaluated; however, non-permitted food colors, such as Congo Red, Metanil yellow, and Orange 11, were found to be present in several low-quality and inexpensive food products. Natural

colors are less common in samples, which is important from a safety perspective because natural colors are safer to use in food than artificial ones. Because of their volatility, poor tinctorial potency, or disadvantageous cost, natural colorants are currently only used in restricted quantities. Although it entirely depends on consumer demand, there is a need to buck the trend toward the use of natural colorants, as many regulatory authorities have outlawed the use of some synthetic dyes in food.

Table 4 displays the list of food colors that are allowed under the EU (European Union) system. Many of the colors overlap since they are allowed under one or more regulatory systems. The international system of regulations must be adhered to when using the permitted colors in meals in order to guarantee the necessary implementation of safety measures.

Table 4: List Of Certified Food Colors According to Ins-Number (International Numbering System For Ingredients) EU System

Serial no.	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**

Key, * 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

Raising awareness of the harmful effects of food coloring—both the overuse of colors that are not allowed and the usage of colors that are—at all levels is essential. There were numerous reports of tartrazine sensitivity in the 1970s. Many food products include tartrazine (FD &C Yellow No. 5), an authorized azo dye whose sensitivity is most commonly shown as urticaria and asthma; the sensitivity's cause is unclear and is referred to as faux allergy [24]. Studies have shown that commonly used azo dyes (Amaranth, Ponceau SX, Allura Red, Sunset yellow, and tartrazine) can be broken down by the gut microbiota into aromatic amines, which can lead to intestinal cancer [25]. Regulation of food-allowed dye consumption is crucial since, in order to comply with safety protocols, food products must not only be colored within permissible limits but also not exceed permissible amounts of these dyes. There is proof that consuming these dyes in excess can have negative health effects [26]. According to a paper on carcinogenesis, intestinal bacteria can convert benzidine-derived azo dyes into aromatic amines, which may have carcinogenic properties. The textile, printing, pharmaceutical, food, and cosmetic sectors all make extensive use of azo dyes (methyl orange, methyl red, methyl yellow, Ponceau 4R, Ponceau SX, red 2G, sunset yellow, tartrazine, acid yellow, and amaranth). Given that intestine cancer is more prevalent in highly industrialized nations, there may be a link between the usage of azo dyes and the rise in cancer cases [27-30]. Dyes have reportedly been shown to be the most genotoxic of all the additives. In the glandular stomach, colon, and/or bladder, Amaranth, Allura Red, New Coccine, Tartrazine, Erythrosine Phloxine, and Rose Bengal caused dose-related DNA damage [31]. People in Bangladesh are less aware of the potential health risks associated with food coloring and drug residue [32-34]. If appropriate precautions are taken to ensure that the use and consumption of these dyes in food products are properly regulated, using synthetic colors might not be an issue. Additionally, using non-edible (artificial/textile) colors in food is discouraged because they pose a serious risk of poisoning if consumed. Given the significance of safety limits for colorants used in food processing, the purpose of this study is to offer information regarding the general characteristics, uses, creating awareness about colorants and human health.

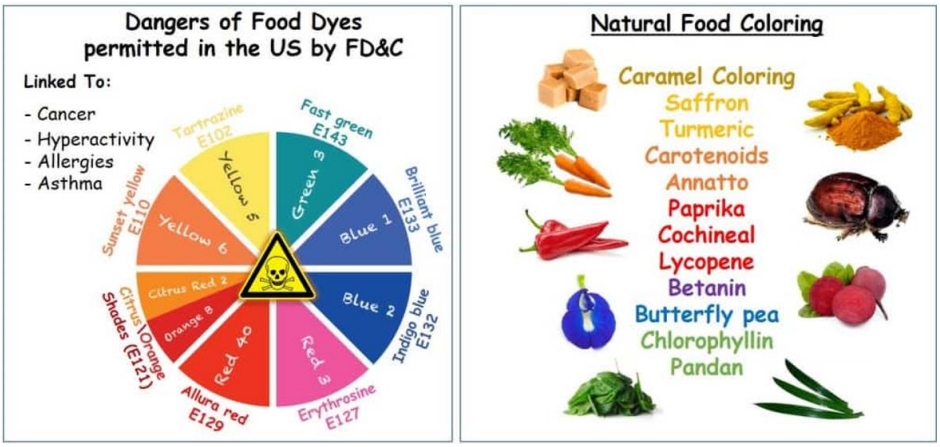

Figure 4. Health hazards of food color additives

Bad health impact of food color:

Food color additives are used to make food more appetizing. The United States Food and Drug Administration (FDA) permitted nine artificial colorings in foods, drugs, and cosmetics, whereas the European Union (EU) approved five artificial colors (E-104, 122, 124, 131, and 142) for food. However, these synthetic coloring materials raise various health hazards. Blue 1 causes kidney tumor in mice, and there is evidence of death due to ingestion through a feeding tube. Blue 2 and Citrus Red 2 cause brain and urinary bladder tumors, respectively, whereas other coloring additives may cause different types of cancers and numerous adverse health effects [35].

CONCLUSION

These days, there is concern over food adulteration. Consumer safety and health rights are at the center of the forensic investigation into food coloring use. According to the study's findings, the quality of goods intended for local markets is extremely poor and legislation must be made in this area at the provincial and national levels, with strict enforcement of the regulations against the producers of these goods to guarantee the country's low-income population has access to high-quality food products. Given the challenge that the food industries face, therefore, alternatives must be developed in order to overcome the technological limitations imposed by richly colored pigments due to their properties/abilities (i.e., the chemical stability of naturally derived food pigments that is affected by pH, temperature, light, oxygen, solvents, enzymes, proteins, and metallic ions). Additionally, in order to prevent the harmful effects of food grade colors, their use should be strictly prohibited as well as their consumption should be limited.

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REFERENCES

1. Kapoor VP (2006) Colors may enhance appearance, but cause ill-effects. Enviro News 12.
2. Color Additives: FDA's Regulatory Process and Historical Perspectives (2003) Food Safety Magazine
3. Food Ingredients & Colors (2010) International Food Information Council
4. Barrows, Julie N Lipman, Arthur L Bailey, Catherine J (2009) "Color Additives: FDA's Regulatory Process and Historical Perspectives", Food Safety Magazine
5. Meggos H (1995) Food colors: an international perspective". The Manufacturing Confectioner
6. Commission Regulation (EU) No. 1129/2011. Amending Annex II to Regulation (EC) No. 1333/2008 of the European Parliament and of the Council by Establishing a Union List of Food Additives. J. Eur. Union 2011, L295, 1–177.
7. Regulation (EC) No. 1333/2008 of 16 December 2008. On Food Additives. Off. J. Eur. Union 2008, L 354, 16–33.
8. Commission Regulation (EU) No. 1274/2013 of the European Parliament and of the Council of 6 December 2013 Amending and Correcting Annexes II and III to Regulation (EC) No. 1333/2008 of the European Parliament and of the Council and the Annex to Commission Regulation (EU) No. 231/2012 as Regards Certain Food Additives. J. Eur. Union 2013, L328, 79–85.
9. Commission Regulation (EU) No. 2015/1378 of the European Parliament and of the Council of 11 August 2015 amending Annex II to Regulation (EC) No. 1333/2008 of the European Parliament and of the Council as Regards the Use of Riboflavins (E 101) and Carotenes (E 160a) in Dried Potato Granules and Flakes. J. Eur. Union 2015, L213, 1–3.

10. Commission Regulation (EU) No. 2020/771 of the European Parliament and of the Council of 11 June 2020 amending Annexes II and III to Regulation (EC) No. 1333/2008 of the European Parliament and of the Council and the Annex to Commission Regulation (EU) No. 231/2012 as Regards the Use of Annatto, Bixin, Norbixin (E 160b). J. Eur. Union 2020, L184, 25–42.
11. Lidon, F.C.; Silvestre, M.M.A.S. Princípios de Alimentação e Nutrição Humana; Escolar Editora: Lisboa, Portugal, 2010. ISBN 9789725922705
12. Koutsogeorgopoulou L, Maravelias C, Methenitou G, Koutselinis A. (1998) Immunological aspects of the common food colorants, Amaranth and Tartrazine. Department of Forensic Medicine and Toxicology. School of Medicine. Athens. Greece
13. NIN (1994) Studies on newer adulterants and contaminants. Annual Report 1993–94 of the National Institute of Nutrition. Hyderabad: Indian Council of Medical Research
14. Prasad M, Rastogi PB (1982) Effect of feeding a commonly used non-permitted colour orange II on the hematological values of Mus musculus. Journal of Food Science and Technology. 19: 150–153
15. Singh RL, Khanna SK, Singh GB (1987) Acute and short-term toxicity studies in orange II. Veterinary Human Toxicology. 29:300–304
16. Wess JA, Archer DC (1982) Disparate in vivo and in vitro immuno-modulatory activities of Rhodamine B. Food and Chemical Toxicology. 20: 9–14
17. Power JP, Barnes RM, Nash WC, Robinson JD (1969) Lead poisoning in Gurkha soldiers in Hong Kong. British Medical Journal. 3: 336–337
18. Sachadeva SM, Mani KS, Adaval SK, Jalpota YP, Rasela KC, Chadha DS (1992) Acquired toxic methaemoglobinaemia. Journal of Association of Physicians India. 40: 239–240
19. JECFA (1996) Summary of Evaluations Performed by the Joint FAO/WHO Expert Committee on Food Additives. 1956–1996. FAO/IPCS/WHO. Geneva: WHO
20. Larsen JC (1991) Erythrosine toxicological evaluation of certain food additives and contaminants. 37th meeting of JECFA-WHO. Food Additives Series. 28: 171– 180
21. Majedul Hoque. A Review on Different Dietary Sources of Important Vitamins and Electrolytes. International Journal of Research Publication and Reviews, Vol 4, no 8, pp 731-736, August 2023. https://doi.org/10.55248/gengpi.4.823.50408
22. Ronald SK, Ronald S (1989) Food Additives. In; Pearson's Composition and Analysis of Foods, 9th (Ed.). UK. 65–139
23. AOAC (2000) Food Color Additives. In; Official Methods of Analysis. Association of Official Analytical Chemists Inc. Gaithers Burg. USA
24. Dipalma JR (1990) Tartrazine sensitivity. Hahnemann University School of Medicine, Philadelphia, Pennsylvania. PMID: 2239641
25. Chung KT, Stevens SE Jr (1978) Reduction of azo dyes by intestinal anaerobes. Appl. Environ. Microbiol. PMID: 25047
26. Combes RD, Haveland-Smith RB (1982) A review of the genotoxicity of food, drug and cosmetic colors and other azo, triphenylmethane and xanthene dyes. Mutat Res. 98: 101–248
27. Chung, KT, Stevens SE Jr, Cerniglia CE (1983) The significance of azo reduction in the mutagenesis and carcinogenesis of azo dyes. Mutat Res. PMID: 6339890
28. Chung KT, Cerniglia CE (1992) Mutagenicity of azo dyes: Structure-activity relationships. Mutat Res. 277: 201–220.
29. Hoque, M., Emon, K., Malo, P. C., Hossain, M. H., Tannu, S. I., Roshed, M. M. (2023). Comprehensive guide to vitamin and mineral sources with their requirements. Indiana Journal of Agriculture and Life Sciences, 3(6), 23-31. DOI- https://doi.org/10.5281/zenodo.10284736
30. Iftear Kazim Rafi et al (2023). The Impact of Banana Consumption on Bangladeshi Rickshaw Pullers' Assessing Cholesterol, Liver and Blood Pressure Functions. Middle East Res J Biological Sci, 3(2): 24-28. Doi: 10.36348/merjbs.2023.v03i02.001
31. Sasaki YF, Kawaguchi S, Kamaya A, Ohshita M, Kabasawa K, Iwama K, Taniguchi K, Tsuda S (2002) The comet assay: results with currently used food additives. Laboratory of Genotoxicity. Faculty of Chemical and Biological Engineering. Hachinohe National College of Technology. Japan.
32. Hoque, M et al., Advancing healthcare: Exploring recent innovations in drug delivery systems, International Journal of Multidisciplinary Research and Growth Evaluation, 2023, 4(5), 50-55, https://doi.org/10.54660/.IJMRGE.2023.4.5.50-55.
33. Hoque, M. and Rafi, I.K. (2023). Practice and awareness about unused and expired drug disposal among village people and city people in Bangladesh. GSC Biological and Pharmaceutical Sciences, 24(03), 132–139. Doi: https://doi.org/10.30574/gscbps.2023.24.3.0377

34. Hoque M et al., Prevalence of malnutrition in children in Narsingdi district, Bangladesh: An observational study. GSC Biological and Pharmaceutical Sciences, 2024, 26(01), 162–166. https://doi.org/10.30574/gscbps.2024.26.1.0013
35. Sultana S, Rahman MM, Aovi FI, Jahan FI, Hossain MS, Brishti SA, Yamin M, Ahmed M, Rauf A, Sharma R. Food Color Additives in Hazardous Consequences of Human Health: An Overview. Curr Top Med Chem. 2023;23(14):1380-1393. doi: 10.2174/1568026623666230117122433.