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The Effect of Isolated Natural Colorants on Cell Proliferation: A Review

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Abstract: The natural colorants are widely used in food, cosmetics, and other products. They are also being investigated for their potential health benefits, including their ability to inhibit cell proliferation occurs due to synthetic colouring agent There is some evidence that certain food coloring agents may be linked to cancer. For example, a study published in the journal Cancer Epidemiology, Biomarkers & Prevention found that people who ate the most artificial food coloring were more likely to develop bladder cancer. Additionally, a study published in the journal Environmental Health Perspectives found that children who were exposed to high levels of artificial food coloring were more likely to develop ADHD. This review discusses the effects of isolated natural colorants on cell proliferation in vitro. The results of these studies suggest that some natural colorants, such as anthocyanins, catechins, and curcumin, can inhibit cell proliferation in a variety of cell types. These findings suggest that natural colorants may have potential as cancer chemopreventive agents. However, more research is needed to confirm these findings and to determine the optimal doses and delivery methods for natural colorants.

Key Words: Natural colorants, cell proliferation, Cancer, Synthetic colorants

I. INTRODUCTION

Color is a perception that is manifested in response to a narrow span of electromagnetic spectrum emitted by light sources . Colorants are defined as substance that modify the perceived color of objects, or impart color to otherwise colorless objects. Natural colorants are colorants that are derived from natural sources, such as plants, animals, and minerals. They have been used for centuries to color food, textiles, and other products. On the other hand, artificial or man-made colourant called as synthetic colourant.

Natural colorants are generally considered to be safe for human consumption. However, some natural colorants have been shown to have effects on cell proliferation.

While synthetic colorants are used in a variety of products, including food, beverages, cosmetics, and textiles. They are also used in some medical applications. Synthetic colorants are generally considered to be safe for human consumption, but there is some concern that they may have adverse effects on cell proliferation. Some studies have shown that synthetic colorants can have a stimulating effect on cell proliferation. For example, one study found that the synthetic colorant FD&C Red No. 3 can increase the proliferation of human breast cancer cells.

Other studies have shown that synthetic colorants can have an inhibitory effect on cell proliferation. For example, one study found that the synthetic colorant FD&C Blue No. 1 can decrease the proliferation of human colon cancer cells.

The effects of synthetic colorants on cell proliferation appear to be dependent on the type of cell, the concentration of the synthetic colorant, and the length of exposure to the synthetic colorant.

Cell proliferation is a fundamental process in the life of a cell. It is the process by which cells divide to form new cells. Cell proliferation is essential for the growth, repair, and regeneration of tissues. It is also involved in the development of cancer.

The review article "The Effect of Isolated Natural Colorants on Cell Proliferation: A Review" discusses the effects of isolated natural colorants on cell proliferation. The article reviews the results of studies that have investigated the effects of a variety of natural colorants on cell proliferation in different cell types. The results of the studies reviewed in the article suggest that some natural colorants can have a stimulating effect on cell proliferation, while others can have an inhibitory effect. The effects of natural colorants on cell proliferation appear to be dependent on the type of cell, the concentration of the natural colorant, and the length of exposure to the natural colorant.

The article concludes that more research is needed to fully understand the effects of synthetic and natural colorants on cell proliferation. However, the results of the studies reviewed in the article suggest that natural colorants may have potential as therapeutic agents for the treatment of diseases that are associated with abnormal cell proliferation, such as cancer as compared to synthetic colouring agent.

In addition to the information presented in the review article, it is important to note that the safety of natural colorants has not been fully established. Some natural colorants have been shown to have adverse effects in animal studies. Therefore, it is important to use natural colorants with caution and to consult with a healthcare professional before using them.

1.1 A NATURAL COLOURANTS:

The use of natural colorants dates back to prehistoric times. Some of the earliest evidence of their use has been found in cave paintings, which often depict people and animals in brightly colored clothing. Natural colorants were also used by ancient civilizations for a variety of purposes, including dying fabric, painting pottery, and creating cosmetics.

In the Middle Ages, natural colorants were still the primary source of color for textiles and other goods. However, the development of synthetic dyes in the 19th century led to a decline in the use of natural colorants. Synthetic dyes were cheaper and easier to produce, and they offered a wider range of colors. As a result, natural colorants were largely replaced by synthetic dyes in the 20th century. In recent years, however, there has been a renewed interest in natural colorants. This is due in part to concerns about the environmental impact of synthetic dyes. Natural colorants are often seen as a more sustainable alternative, as they are derived from renewable resources and do not produce harmful pollutants. Additionally, some people believe that natural colorants have a more subtle and appealing appearance than synthetic dyes. Today, there is a growing market for natural colorants. They are used in a variety of products, including textiles, cosmetics, and food. As awareness of the environmental and health benefits of natural colorants continues to grow, it is likely that their use will continue to increase in the years to come.

Some of natural colorants are listed in table number 1;

Table 1: All biological information of natural colourant

Scientific classification	Chemistry of pigments	Medicinal importance
Turmeric:  Turmeric is commonly known as Indian saffron. It consists of dried, as well as fresh rhizomes of the plant Curcuma longa Linn. Kingdom : Plantae Family : Zingiberaceae Genus : Curcuma Species : C. longa	Turmeric contains about 5% of volatile oil, resin and yellow colouring substances known as curcuminoids. The chief component of curcuminoids is known as “curcumin”. Chemically curcuma species contain volatile oils, starch and curcumin (50 – 60 %). Curcumin and other related curcuminoids are reported to be responsible for yellow colour of the dye	Curcumin : antioxidant, anti-inflammatory, anti cancer and hepatoprotective. The phenolic yellow curry pigment curcumin used in the Alzheimer's disease . It has anti-inflammatory effects in arthritis. It has anti-platelet, anti viral, anti fungal, anti bacterial effects (inhibits Helicobacter Pylori) and powerful antiseptic agent (1)
Saffron:  Saffron is commonly known as saffron crocus or autumn crocus, is a species of flowering plant in the iris family Iridaceae.	Certainly, saffron contains different compounds including polyphenols (phenolic acids, tannins, stilbenes, lignin, phytosterols, amino acids, and flavonoids) , quinones , vitamins , and terpenoids(2)	Carotenoids crocin and crocetin, and the monoterpene aldehydes picrocrocin and safranal . The chemopreventive effects of crocins against hepatocarcinogenic compounds. Crocetin, a deglycosylated crocin derivative, has shown inhibitory effects on intracellular nucleic acid synthesis but no effect on colony formation in diverse solid tumor cell types . Nevertheless, in vitro proliferation of promyelocytic leukemia cells is inhibited by crocins and crocin derivatives .

Kingdom: Plantae Family: Iridaceae Genus: Crocus Species: Sativus L		To date, the contribution of other saffron non-carotenoid compounds to the cytotoxicity of stigma extracts on tumoral cells has not been elucidated.(3) Saffron has been intensively used as a spice for flavoring and coloring foods since ancient times; it has also been used in traditional medicine as a eupeptic, diaphoretic, expectorant, tranquilizer, aphrodisiac, emmenagogue, abortifacient, and in the treatment of hepatic disorders, flatulence, vomiting, spasm, dental and gingival pain, insomnia, depression, cognitive disorders, seizures, lumbago, cough, asthma, bronchitis, fever, colds, cardiovascular disorders, and cancer.(4)
Annatto  Annatto is an orange-red condiment and food coloring derived from the seeds of the achiote tree (Bixa orellana), native to tropical America. Kingdom: Plantae	The yellow to orange color is produced by the chemical compounds bixin and norbixin, which are classified as carotenoids. The fat-soluble color in the crude extract is called bixin, which can then be saponified into water-soluble norbixin. This dual solubility property of annatto is rare for carotenoids.[31] The seeds contain 4.5–5.5% pigment, which consists of 70–80% bixin	Ground annatto seeds, often mixed with other seeds or spices, are used in the form of paste or powder for culinary use. In Guam, it is used to make a staple rice dish flavored with annatto, onion, garlic, butter, and other spices. Annatto is commonly used to impart a yellow or orange color to many industrialized and semi-industrialized foods, including cheese, ice cream, bakery products, desserts, fruit fillings, yogurt, butter, oils, margarines, processed cheese, and fat-based products

Family: Bixaceae Genus: B. orellana Species: Malvales		
Beet  Chukandar, Sugar beets, Mangel, Spinach beet Biological source: It consists of fresh root of Beta vulgaris. Betanin is usually obtained from the extract of beet juice Kingdom: Plantae Family: Chenopodiaceae /Amaranthaceae. Genus: Beta vulgaris	The color of betanin depends on pH; between four and five it is bright bluish-red, becoming blue-violet as the pH increases. Once the pH reaches alkaline levels betanin degrades by hydrolysis, resulting in a yellow-brown color. Betanin is a betalain pigment, together with isobetanin, probetanin, and neobetanin. Other pigments contained in beet are indicaxanthin and vulgaxanthins	The most common uses of betanins are in coloring ice cream and powdered soft drink beverages; other uses are in some sugar confectionery, e.g. fondants, sugar strands, sugar coatings, and fruit or cream fillings. Betanin can be also used for coloring meat and sausages. Betanin has also shown to have antimicrobial activity and can be used as a natural antimicrobial agent in food preservation.
Cochineal  The cochineal is a scale insect in the suborder Sternorrhyncha, from which the natural dye carmine is derived. A primarily sessile parasite native to tropical and subtropical South America through North America.	The insect produces carminic acid that deters predation by other insects. Carminic acid, typically 17–24% then mixed with aluminium or calcium salts to make carmine dye, also known as cochineal. Today, carmine is primarily used as a colorant in food and in lipstick (E120 or Natural Red 4).	Cochineal continues to be used as a fabric dye, a cosmetics dye and as a food coloring It is also used in histology as a preparatory stain for the examination of tissues and carbohydrates. But Natural carmine dye used in food and cosmetics can render the product unacceptable to vegetarian or vegan consumers.

2.2 Classification of Natural Colourants (6)

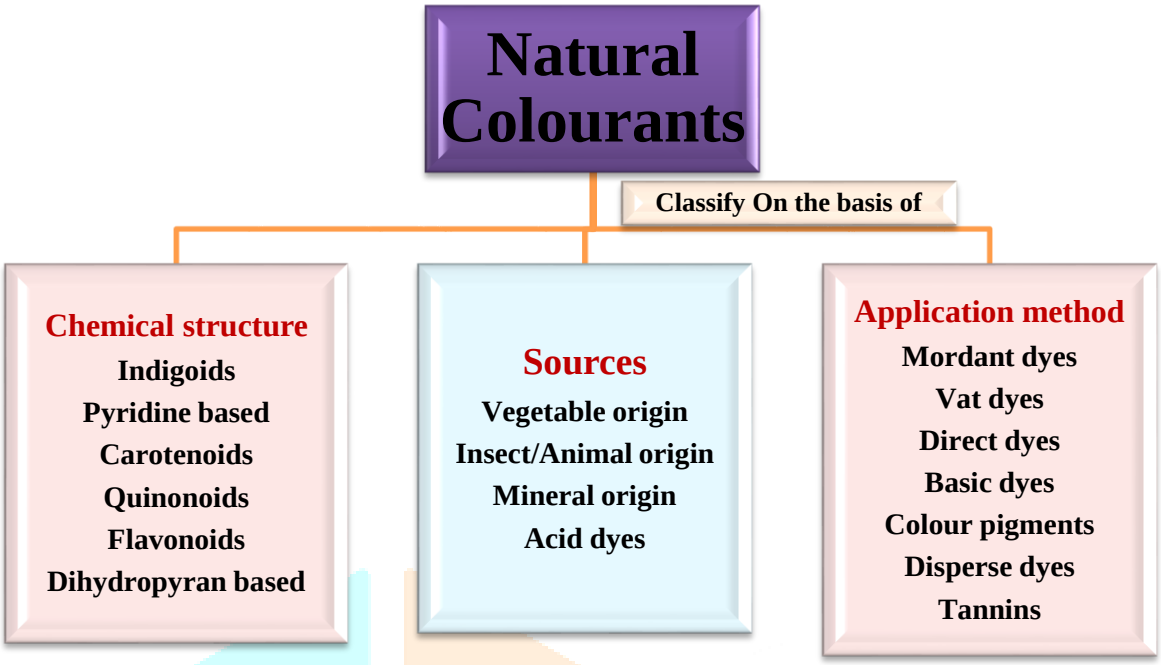

Figure 1 : Diagram of Classification of Natural Colourants

2.3 Extraction of natural dyes:

1)Aqueous extraction method: Aqueous extraction is a traditional method for extracting plants and other materials which uses water for extraction with or without the addition of salt/acid/alkali/alcohol to the extraction bath. Typically, aqueous extraction was used to extract colours from plants and other materials.

2)Solvent extraction method: Natural colouring materials can also be extracted using organic solvents such as acetone, petroleum ether, chloroform, ethanol, methanol, or a mixture of solvents such as a mixture of ethanol and methanol, a mixture of water and alcohol, and so on, depending on their nature. Solvent Extraction requires appropriate extraction equipment, such as the Soxhlet extractor, and solvents such as alcohol, hexane, or benzene.

3)Acid and alkali extraction: The majority of natural colours are glycosides, which may be extracted in either acidic or alkaline conditions. The extraction of tesu natural dye from tesu flowers uses an acidic hydrolysis process. Alkaline solutions are appropriate for dyes with phenolic groups in their structure.

4)Supercritical Fluid Extraction: Due to increasingly restrictive environmental laws, supercritical fluid extraction (SFE) using carbon dioxide (CO2) as a solvent has acquired widespread popularity in recent years as an alternative to traditional chemical solvent extraction for organic compound separation in a variety of analytical and industrial processes. As it is harmless, clean, safe, cheap, widely available, and leaves no traces

5)Ultrasound-assisted Extraction : Ultrasound-assisted extraction (UAE) is a potentially useful technology since it does not need the use of complicated instruments and is reasonably inexpensive. [29, 44] Ultrasonic energy provided a simple productive method for colourant extraction, mordanting, and colouration treatments

6)Enzyme assisted extraction method: In recent years, there has been a lot of interest in employing enzymes to extract natural useful chemicals from plants. A variety of approaches have been taken to the preparation and colouring operations of cotton, wool, and other material filaments using natural dyes using various types of enzymes. They discovered that enzymatic treatment resulted in the extraction of natural colourants.(7)

2.4 CARCINOGENESIS:

Carcinogenesis is a multistage and multistep process involving modification and mutation to genes that regulate normal cellular function including cell growth control processes.

Cancer is a leading cause of death worldwide with over 8 million annual deaths. Over 14 million new cancer cases are reported each year. Understanding the cause of cancer is paramount to reduce the incidence and prevent this disease. Epidemiological evidence suggests that the majority of cancers, 90%–95%, are related to environmental factors, while the remaining 5%–10% due to genetic inheritance. The environmental factors are predominantly related to lifestyle including tobacco use, diet and obesity, alcohol, and sunlight overexposure.(22)

Plants have a wide array of colors in different parts of their body and have been used for multiple purposes. Several colored components (secondary metabolites) such as anthocyanins, carotenoids, apocarotenoids, anthraquinones, flavonoids, etc., were investigated for their potential therapeutic efficacy as antitumorigenic agents.(23)

2.5 ROLE OF SYNTHETIC COLORANTS IN CANCER

Dyes are included in the class of important pollutants due to their main components called chromophores and auxochromes.

Azo dyes containing at least one –N = N– group have a wide range of colors and are the most important synthetic materials of the dye classes (Kiayi et al. 2019). Carmoisine (disodium-4-hydroxy-3-[(4-sulfo-1-naphthalenyl)azo]-1-naphthalenesulfonate) in this group is an anionic food dye with a color scale from red to burgundy (Ai-Mashhedy and Fijer 2016). Carmoisine is also known by different names such as Azorubine, Food Red 3, Azorubin S, Brillantcarmoisin O, Acid Red 14, and CI 14720.

Highly water-soluble carmoisine is an organic azo dye that is widely used in food products such as jams, marzipan, jellies, yogurts, breadcrumbs, and cheesecake mixes, as well as in the pharmaceutical, textile and cosmetic industries (Amin et al. 2010). Due to this highly water-soluble feature, it does not degrade by exposure to light and oxygen, and as a result, it can be a permanent pollutant, especially in the aquatic environment (Micheletti et al. 2020). Due to this potential pollutant feature, many studies have been reported in which various methods have been tried to remove carmoisine from aquatic environments (Kiayi et al. 2019).(24)

2.6 CELL PROLIFERATION-

Cell proliferation is defined as an increase in cell number secondary to cell growth and division (reviewed in Schafer, 1998). Assessing cell proliferation is a cornerstone of basic, translational, and clinical research and of clinical medicine. Given this pervasiveness, it is important for the clinical dermatologist and dermatology researcher alike to have a basic comprehension of cell proliferation and the assays most commonly used to measure it.(17)

is placed Cell proliferation – the increase in cell numbers resulting from cell division – is a complex, tightly controlled, well-defined process. The mechanisms of normal cell proliferation, as well as the pathologic consequences occurring when the system malfunctions, are critical to many areas of medicine, from embryogenesis, to tissue repair, to oncogenesis. This article describes the normal process of cell division, including the cells involved, the normal series of steps that take places, and the growth factors and cytokines that mediate the process. Particular emphasis on the crucial role cell proliferation plays in tissue repair following toxic injury.(18)

2.7 THE CELL CYCLE

Cellular proliferation results from progression through the cell cycle . The cell cycle has two major phases: interphase and mitosis .

A cell spends most of its life in interphase, which is divided into three stages: Gap 1 (G1), Synthesis (S), and Gap 2 (G2). During interphase, the cell is growing and preparing for division. Cellular division occurs during mitosis, or (M) phase, which actually consists of both mitosis and cytokinesis. Mitosis refers to division of the nucleus resulting in equal separation of chromosomes and is subdivided into phases: prophase, prometaphase, metaphase, anaphase, and telophase. Cytokinesis is the equal division of the cell membrane, cytoplasm, and organelles. M phase results in two daughter cells identical to their parent cell. A fourth stage, Gap zero (G0), describes resting cells and cells that rarely or never divide.

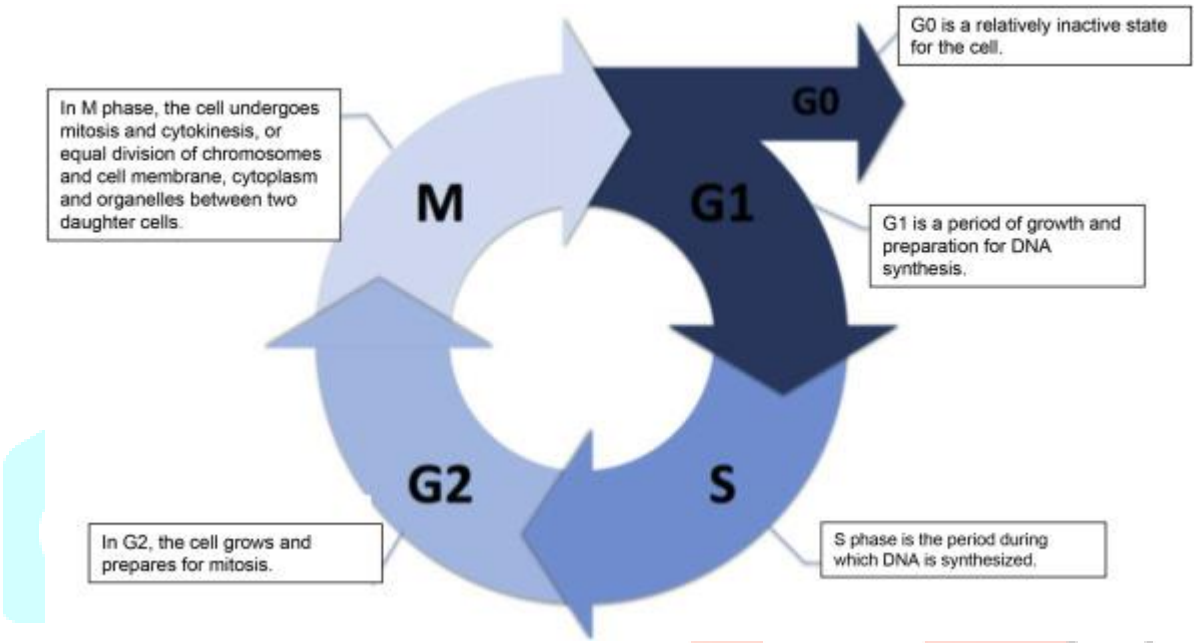

Figure 2: Phases of cell cycle

The stages of the cell cycle can be identified based on specific characteristics. For example, nucleosides are incorporated into replicating DNA exclusively during S phase, and histone protein H3 is only phosphorylated during M phase. Many proliferation assays take advantage of these unique characteristics of each cell cycle phase.(17)

2.8 TOXICITY EVALUATION OF SYNTHETIC FOOD DYES

Increasing attention has been recently paid to the toxicity of additives used in food, namely to azo-dyes. This group of colorants typically consists of bright colours. However, the main concern often limiting their use is potential carcinogenicity occurring after their azoreduction to carcinogenic metabolites by intestinal microbiota (Feng et al., 2012). These metabolites are known to be produced in the human body; however, the clinical importance of this phenomena depends on the ingested food colour.(19)

2.9 ADVANTAGES OF NATURAL COLOURANTS

Overall, natural colorants offer a number of advantages over synthetic colorants. They are environmentally friendly, safe for human health, versatile, and aesthetically pleasing. As a result, they are a growing trend in the food, textile, and cosmetics industries.

It is important to note that the color intensity of natural colorants can vary depending on the source, the method of extraction, and the mordant used. Mordants are substances that help to bind the dye to the fabric. Some common mordants include alum, vinegar, and tannic acid.

Natural colorants can be used to dye fabrics, yarns, and other materials. They can also be used to color food, cosmetics, and other products. When using natural colorants, it is important to follow the instructions carefully to ensure that the desired color is achieved.

Environmentally friendly: Natural colorants are derived from plants, minerals, or animals, and are therefore biodegradable and non-toxic. This makes them a much more sustainable option than synthetic colorants, which can pollute the environment during production and disposal.

Safe for human health: Natural colorants are generally considered to be safe for human health, even when ingested. This is in contrast to some synthetic colorants, which have been linked to health problems such as allergies and cancer.

Versatile: Natural colorants can be used to create a wide range of colors, from vibrant shades to subtle tones. This makes them a versatile option for a variety of applications, including food coloring, textile dyeing, and cosmetics.

Aesthetically pleasing: Many people find that natural colorants have a more pleasing appearance than synthetic colorants. This is due in part to the fact that natural colorants often have a more complex and nuanced color palette.

2.10 DISADVANTAGES OF NATURAL COLOURANTS:

Generally, natural dyes have the following limitations.

- ✓ Limited number of suitable dyes, leading to a similarly limited range of shades.
- ✓ Colour yield and efficiency both of dyeing and of cultivation.
- ✓ Reproducibility of shades.
- ✓ Process complexity.
- ✓ Availability: natural resources are not available in all countries.

Apart from these limitations, there are various other technical drawbacks also associated with the use of natural dyes (Schweppe, 1992). These are as follows:

- ✓ Limitations on fabric that can be dyed (mostly only wool, natural silk, linen and cotton).
- ✓ Low suitability for synthetic fibres.
- ✓ Difficulties in blending dyes to produce compound shades (Samanta et al., 2008).
- ✓ Lack of standardisation.
- ✓ Difficulty in collecting the dyes.
- ✓ Inadequate degree of fixation and fastness properties.
- ✓ Water pollution caused by heavy metals used for mordanting specific dyes, which remain unfixed in the dyebath effluent(9)

2.11 EXAMPLES OF MARKETED SYNTHETIC COLOURANTS:

Carmiosine: Carmoisine is a red to maroon food colorant of azo dye group with an aromatic structure. It is approved by US Food and Drug Administration (FDA). It usually exists as a disodium salt and is widely used in food, agrochemical, cosmetics, textile, paper, and pharmaceutical industries. It is used in various food items such as chocolate, jams, jellies, Swiss roll, marzipan, preserves, yogurts, blancmange, breadcrumbs, and cheesecake mixes. Carmoisine is also used in oraldene mouthwash as a colorant. Owing to the appearance of an azo group, carmoisine can be reduced by intestinal microorganisms in vivo to an aromatic amine, which is highly sensitized. Sulfanilic acid is the chief metabolite of carmoisine. Nitrite compounds present in various foods after combining with certain amino acids transform into N-nitroso compounds or nitrosamines, and these are carcinogenic. International Agency for Research on Cancer classifies azo dyes like carmoisine as category 3 carcinogens.

It has been reported that synthetic food colors induced behavioral changes in children, for example, hyperactivity. The individual response depends not only on dose, age, gender, nutritional status, and genetic factors but also on long-term exposure to low doses. Carmoisine alters biochemical markers in vital organs even at low doses and reduces the helical composition by changing the secondary structure of haemoglobin.

Tartrazine: Tartrazine (E-102) is a synthetic lemon-yellow azo dye primarily used as a food coloring. Its presence is allowed in various foodstuffs and beverages . Both the JECFA and the EU Scientific Committee for Food (SCF) established an ADI of 7.5 mg/kg·bw/day in 1996 . Controversial studies about the effects of

Tartrazine on health have been reported. The most adverse effects have been related to DNA damage , hyperactivity , changes in the central nervous system , and allergic reactions .(21)

Erythrosine: Erythrosine (E-127) is a cherry-pink synthetic food colorant with a polyiodinated xanthene structure . It is widely used to color children's sweets , as well as to determine the presence of dental plate in Odontology . The ADI of Erythrosine was established by the JECFA and SCF in 0.1 mg/kg·bw/day . Regarding the FDA, it allows the use of Erythrosine both for food and drugs . Some studies suggested a relationship between Erythrosine consumption and altered cognition and behavior in children, which could be due to the inhibition of dopamine receptors . Moreover, different studies suggested the induction of chromosome aberrations and an increase in the incidence of thyroid tumors by Erythrosine consumption .(21)

2.12 NATURAL FOOD COLORANTS

Riboflavin: Riboflavin (E-101) is part of the vitamin B group. It is a yellow-orange solid substance with poor solubility in water. This food coloring is present in a wide range of foods, with liver, milk, meat, and fish being the most important sources . Riboflavin can be obtained by controlled fermentation using a genetically modified strain of Bacillus subtilis or the fungus Ashbya gossypii . Riboflavin was evaluated by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) in 1969, which established an acceptable daily intake (ADI) of 0.5 mg/kg·body weight (bw)/day on the basis of limited data . No adverse toxic, genotoxic, cytotoxic, or allergic effects have been related to Riboflavin in different organisms .(21)

Carmicic acid: Carminic Acid (E-120) is a natural red colorant which comes from Datylopius coccus, an insect which lives on Opuntia coccinellifer. In order to obtain this dye, it is necessary to dry and spray the body of pregnant females of these insects . The JECFA and SCF committees established an ADI of 5 mg/kg·bw/day for Carminic Acid . This dye is called by the FDA "cochineal extract" or "carmine" and is classified as exempt from certification. According to the FDA, it is used in food, drugs, and cosmetics . Despite the absence of genotoxic or cytotoxic effects described for Carminic Acid, it has been related to anaphylactic reactions, asthma, urticaria, and angioedema . Furthermore, impairment in renal function has been demonstrated in male albino rats .

2.13 USES OF NATURAL COLORANTS:

The use of natural colorants can have a positive impact on the economy by creating jobs in the agriculture and food processing industries. It can also help to support local farmers and promote sustainable farming practices.(10)

The necessity of the use colorants in food substances has been highlighted by Food and Nutrition Board to

(1) maintain original food appearance,

(2) assure colour uniformity,

(3) intensify food's normal colour,

(4) protect characteristics of food such as flavour and Vitamins, and

(5) increase food acceptability. Generally in pharmaceutical industry, the formulation of tablets, tablets coatings, capsules, liquid orals, toothpaste and ointment are coloured to increase the aesthetic appearance, prolong the stability, produce standard preparations or for identification purposes(11)

Natural colorants are preferred mainly for their health benefits, providing additional properties such as antioxidant, antimicrobial, and surface-active activity to colored cheese products.(12)

Antimicrobial : Antimicrobial agents from both synthetic and naturalorigin were applied to get rid of these microorganisms. Dueto eco-friendly nature of natural origin agents, are to bemore favoured in the textile finishing. In past, natural dyeswere applied to textiles for simultaneous coloration andantimicrobial finishing successfully. An attempt to examinethe effect of Rheum emodi L. as dye and its dyed woolyarns activity against two bacterial (Escherichia coli andStaphylococcus aureus) and two fungal (Candida albicansand Candida tropicalis) species was studied and resultedinto successful antimicrobial finishing of wool fibres.(13)

UV protective : Three natural yellow dyes, namely Rheum emodi,Gar-denia yellow and curcumin, were successfully applied forsimultaneous dyeing and functionalization of silk to get UV protection abilities for textiles.(14) Dye extracted from the leaves of eucalyptus and applied to wool fabric by using two padding techniques, namely the pad-batch and pad-dry techniques under different conditions and it was observed that with an increase in the dye concentration, the ultraviolet protection factor (UPF) values ranged between very good and excellent for wool fabric.(15)

Moth resistant : Moth is an insect and itslarvae eat the protein present in wool. Cloths moth (Tineolabisselliella) and carpet beetle (Anthrenus verbasci) arecommon moths attacking the wool materials. DDT(Dichlorodiphenyltrichloroethane), permethrin, perme-thrin/hexahydro pyrimidine derivative, cyhalothrin, etc.are some of the chemicals used as antimoth finishingagents. Nano TiO2particles were also utilized as anantifeeding compound on wool fabric against larvae of thecarpet beetle, Anthrenus verbasci, feeds on protein fibers.(16)

3 CONCLUSIONS:

The review of "Isolated Natural Colorants on Cell Proliferation: A Review" discusses the potential effects of isolated natural colorants on cell proliferation. The review found that some natural colorants, such as anthocyanins and carotenoids, can have a positive effect on cell proliferation, while others, such as curcumin and beta-carotene, can have a negative effect. The review also found that the effects of natural colorants on cell proliferation can vary depending on the type of cell, the concentration of the colorant, and the length of exposure. Overall, the review suggests that further research is needed to fully understand the effects of isolated natural colorants on cell proliferation. However, the review does provide some evidence that natural colorants may have a positive effect on cell proliferation, and this could lead to the development of new natural therapies for diseases that are associated with cell proliferation, such as cancer.

In addition to the review, here are some additional thoughts on the potential effects of isolated natural colorants on cell proliferation: It is important to note that the effects of natural colorants on cell proliferation can vary depending on the type of cell, the concentration of the colorant, and the length of exposure. Some natural colorants, such as anthocyanins and carotenoids, have been shown to have a positive effect on cell proliferation. Other natural colorants, such as curcumin and beta-carotene, have been shown to have a negative effect on cell proliferation. Further research is needed to fully understand the effects of isolated natural colorants on cell proliferation.

However, the available evidence suggests that natural colorants may have a potential role in the development of new natural therapies for diseases that are associated with cell proliferation, such as cancer.

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