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TARTRAZINE SYNTHESIS, APPLICATIONS AND ISSUES: A CASE STUDY

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Abstract
Dyes are mostly used for coloring various day to day items. It includes foo as well as other items used by human being. Mostly dyes are Azo dyes and out of these one of the most widely used is Tartrazine. It has most of its uses in food industry which directly effects the human being. Still lot of research is going on the minimize its effects or to find suitable natural replacement so that it can be avoided. As it has lots of side effect on human beings as well as on our environment.

Key Words: Azo dyes, food dyes, synthesis, alternative method

1. Introduction

In chemistry, an organic compound made entirely from hydrogen and carbon atoms is known as hydrocarbon and in nature there exists many different kinds of hydrocarbons. Now, From these hydrocarbon lots of products are obtained from various chemical process. One of the main product is an azo dye. In such dyes two hydrocarbon groups are joined by two nitrogen atoms. These azo dyes account for roughly 60 to 70% of all dyes used in the food and textile industries. As thesedyes are cheap to produce and are more stable than most natural food dyes these are mostly used in different industries, On analysing the chemical formula for tartrazine, $C_{16}H_9N_4Na_3O_9S_2$ it is observed that there are other elements besides nitrogen, carbon and hydrogen present. Categorically, tartrazine also contains sodium (Na), oxygen (O), and sulfur (S).

One of the most artificially produced azo dyes (1) is Tartrazine, also known as FD&C Yellow 5, which is derived from petroleum..Artificial colorants are used to enhance the aesthetic appeal of food. Natural ingredients are unable to produce certain colors, but these dyes can. Foods that may have lost some of their original appearance after manufacture can also be utilised to restore it. Natural food coloring is frequently more expensive and more expensive than artificial food coloring (2-4). The bright yellow pigment tartrazine is present in a variety of foods, pharma and cosmetic industry and beverages. Mixing several pigments together will yield a variety of colors, including green, pink, orange, and many others.

2. Synthesis

In 1884 Johann Heinrich Ziegler a German Chemist originally discovered it. during investigating the various new molecules that could be distilled from coal tar for their useful properties. But nowadays, a diazo-coupling methos is used in which a reaction between sulfonic acid diamine and pyrazolone T takes palce.. This forms an azo linkage, which is the basis for the high coloration found in all azo dyes. Tartrazine is prepared from 4-amino-benzenesulphonic acid, which is diazotized using hydrochloric acid and sodium nitrite. The diazo compound is then coupled with 4,5-dihydro-5-oxo-1-(4sulphophenyl)-1H-pyrazole-3-carboxylic acid or with the methyl ester, the ethyl ester, or a salt of this carboxylic acid. The resulting dye obtained is then purified and isolated as the sodium salt. Tartrazine consists essentially of trisodium 5-hydroxy-1-(4-sulfonatophenyl)-4-(4-sulfonatophenylazo)-H-pyrazole-3-carboxylate and subsidiary coloring matters together with sodium chloride and/or sodium sulphate as the principal uncolored components.; Tartrazine is described as the sodium salt. The calcium and the potassium salt are also permitted.

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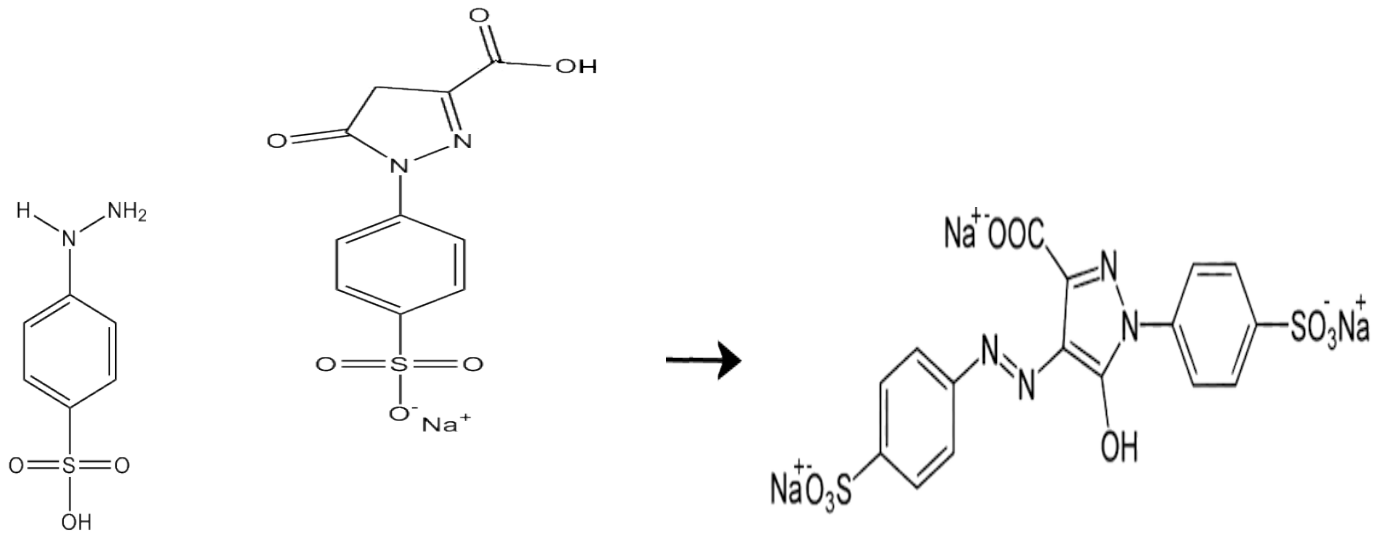

Sulfonic acid diamine | Pyrazolone T | Tartrazine

3. Applications

A coloring agent Brilliant Blue FCF, E133 on mixing with tartrazine makes peas look green. This azo dyes is one of the mostly used coloring agent by cosmetics industry (5) in lipsticks, face products, toothpaste, mouthwash, shampoos and detergents, and many other common products. Also used as dye for wool, silk as it doesn't bleach with strong sunlight and is washable This is because the acid groups enable the dye molecule to bind strongly to the amine groups of proteins in the fabric structure. Used as indicator in biochemistry and chemistry labs and in sanitizing solutions for food-processing equipment, utensils, and other items that contact food. Widely used by food industry in Soft drink breakfast cereals processed cheese, pasta, sweets and candies, jams, jellies, mustard, and even bread. Pharmaceutical Industries use it in some medications, such as vitamin pills, throat lozenges, and indigestion tablets which may contain tartrazine to give their coatings distinctive, easily identifiable colors. Different forms of tartrazine can also be used to dye leather, in agriculture industry as well as a pigment for artists..

Older yellow pigment called 'Indian yellow', a mixture of hydrated magnesium and/or calcium salts of euxanthic acid, Mg,Ca$[C_{19}H_{15}O_{10}]_2.nH_2O$ was replaced by tartrazine. The reason for this was the very high cost of the Indian Yellow as it was harvested form urine of camels and cow. For obtaining this Indian Yellow color, these animal were fed only on diet of mango leaves, Since, mango tree are found in some parts of India, this dye was available only some specific parts of India, hence was highly prized.

Due to its chemical preparation synthetic tartrazine was an immediate replacement as it was easily available and cheap. This has also art dealers a method of detecting forgeries in ancient paintings which supposedly dates from before this period cannot contain tartrazine in comparison after that date as they almost have tartrazine dyes in painting (because Indian yellow is virtually unobtainable nowadays except in special museum collections). To detect such types of frauds a simple non-destructive Raman spectroscopy analysis is carried out. This simple techniques can easily tell whether a painting dates from before after the discovery of tartrazine . This has led to the unveiling of many fakes.

4. Issues with tartrazine

It has been noted that a very small minority of people (less than 0.1 percent, according to estimates) appear to be intolerant to tartrazine, and this can cause them to experience symptoms including itching, rashes, coughing, vomiting, and even asthma attacks (6).There have also been connections with child hyperactivity. There have not been enough rigorous scientific investigations to determine whether tartrazine is indeed the cause of any of these

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symptoms, thus the data is currently inconclusive. However, the matter is still debatable among the 99.9% of people who are not tartrazine sensitive. Tartrazine has taken on some significance and controversial also. Despite the fact that there is essentially no proof that it is hazardous to the vast majority of people wants to that it should not be present in their food.

Tartrazine has been found to be intolerant reactions in a few individuals as it has been used for many years to produce large amount of food cosmetics, drugs and other daily used items, however, it has been found to produce. Some of the cases of adverse reactions have been related to its use in pharmaceutical preparations (7) Tartrazine intolerance has been estimated to affect between one and ten people in every ten thousand (between 0.01% and 0.1% of the population). The adverse reactions which have been reported such as urticaria (allergic skin rash), rhinitis (runny nose), asthma, purpura (purplish skin bruising) and systemic anaphylaxis (shock). The adverse reaction is more common in asthmatics and people who are sensitive to aspirin.

Sensitive individuals react to this dye in different ways. Major symptoms of tartrazine intolerance include skin rashes, hives, and nasal congestion. Rarely, tartrazine is said to cause asthma (6) in sensitive individuals. Tartrazine allergy symptoms usually manifest as an increase in reaction to other allergens rather than as a direct reaction to tartrazine. When combined with the preservative sodium benzoate, certain food colorings including tartrazine, may be linked to hyperactivity in children it causes hyperactivity.

According to studies, adverse reactions to tartrazine may also affect the gastrointestinal tract, central nervous system, and respiratory tract, though many of these effects are rare and unconfirmed. Some studies even claim that tartrazine causes thyroid tumors and lymphomas, but the evidence is not convincing enough. As it is also used in cosmetic industry some absorption through the skin also occurs.

On measuring toxicity on flies it was observed that around 20 percent of flies in the group didn't survive on giving high concentration of tatrzine, but there may have been other factors at play in addition to this being an animal study yellow 5 and other AFCs can increase tumor cell growth in human leukemia cells were exposed to different food food."

5. Pesticides and Disinfectants

Pesticides include insecticides, fungicides, herbicides, rodenticides, and fumigants. Chemicals called disinfectants are used to prevent or eliminate germs. Antiseptics and biocides are other names for disinfectants. Antiseptics are applied to the skin or other living tissue while disinfectants are typically utilised in physical media (solutions or on surfaces). Some of these substances are also used to preserve food, medicines, drugs (8) and other commercial and home goods. Substances. like formaldehyde, sodium bisulfite, chloramine T, glutaraldehyde, hexachlorophene, chlorohexidine, benzalkonium chloride, isononanoyl oxybenzene sulfonate, lauryl dimethyl benzyl ammonium chloride, and isothiazolinones are among most of the substances that can lead to occupational asthma as the skin and respiratory systems are sensitive to several of these chemicals used industry. On being exposed to disinfectants containing chloramines, aldehydes, and quaternary ammonium in the food industry, acute irritation symptoms were more prominent but not persistent respiratory symptoms. [work-related asthma] prevalence"

6. Genotixity

Many of the studies to date have been done on rats to have the knowledge of cytotoxicity (the ability of a substance to be toxic to cells), mutagenicity (9) (the ability of a substance to cause gene mutations) and to study closely at genotoxicity (the ability to be toxic to genes)

7. Neurotoxin

At least in rats, tartrazine appears to be a neurotoxic (harmful to brain cells). It is believed that tartrazine has negative effects on rats' neurological systems, including issues with spatial memory. This is important enough that tartrazine has been examined alongside other substances to see whether those other substances might serve as protection against tartrazine-induced nervous system harm. In a study giving rats vitamin E, a neuroprotective drug, may be able to stop tartrazine's effects on both structural and behavioural changes. Numerous observations in the central nervous system (10) of tartrazine-treated rats include a deficiency in brain neurotransmitters increasing brain cell death

8. Behavioural Problem in Childrens

Whether tartrazine can induce behavioral changes in human offspring as well as rat offspring has not been evaluated directly to the same extent, but some studies have been conducted. A study specifically examining the use of artificial coloring (AFC) in childrens (10) found that high doses (defined as AFC greater than 50 milligrams) had a greater adverse effect on children than children with low intakes. rice field. 6 Use of Synthetic Colorants Food colorants have increased by 500% over the last 50 years, with an increase in behavioral disorders

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(11-12) such as ADHD. However, many changes have occurred in the meantime beyond the introduction of artificial food dyes, and this correlation, and all other possible links, is largely speculative.

9. Carcinogenic

n DNA (13)repair studies, tartrazine had no cytotoxic effect, but had a significant genotoxic effect at all concentrations tested3. It is important to note that even if DNA is damaged, there are many repair systems (such as tumor suppressor genes) that can repair this damage. Studies examining tartrazine found that most injuries could be repaired, but even 24 hours after exposure, the injuries persisted in some tartrazine-exposed samples, as opposed to unexposed samples. Did it. The conclusion was that long-term exposure to tartrazine could induce carcinogenesis.

10. Tartrazine During Pregnancy

It has been found that there is decrease in motivation and anxiety in offspring of rats exposed during pregnancy, such studies have indicated the possible effects of prenatal exposure to artificial food colorings. There have been some substances which causes problems in rats but not in humans and vice versa. What these animal studies suggest, however, is that it is important to further study this issue until more is known.

11. Effect on Environment

The production and use of tartrazine as an aquatic algaecide/herbicide, food (14), drug, and cosmetic coloring agent, as well as a dye for wool and silks, may result in its release to the environment through a number of waste streams. If tartrazine is discharged into the air, it will only exist in the particulate phase of the atmosphere because it is a salt and is not volatile. Wet or dry deposition will remove tartrazine from the environment when it is in the particle-phase. The first order rate constant of tartrazine in distilled water after exposure to sunshine was $2.31x10^{-3}$ per day, equivalent to a half-life period of 300 days. It's possible that sunshine might directly photolyze tartrazine. Tartrazine's production and use as a dye for wool and silks, and as a colorant in food, drugs and cosmetics may result in its release to the environment through various waste streams; its use as an aquatic algaecide/herbicide will result in its direct release to the environment. If released to soil, tartrazine is anticipated to be mobile considering this compound is anticipated to exist almost totally in anion form inside the environment and anions generally do now not adsorb greater strongly to soils containing organic carbon and clay than their impartial counterparts. Volatilization from wet soil surfaces isn't always expected to be an important destiny process because the compound exists as an anion and anions do not volatilize. If released into water, tartrazine is not anticipated to adsorb to suspended solids and sediment primarily based upon this compound's ionic nature inside the surroundings. Tartrazine exceeded thru pilot scale remedy activated sludge techniques noticeably unchanged, indicating that biodegradation is not anticipated to be an crucial environmental destiny process.

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