

SUDAN DYES AND THEIR POTENTIAL HEALTH EFFECTS

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Abstract: Sudan dyes are synthetic, oil-soluble, red coloured azo dyes which are not permitted by the authorities in Switzerland, Japan, Europe, and the United States for the purpose of food colouring. Sudan dyes I, II, III, IV, and their degradation products are considered harmful to human health due to their teratogenicity, genotoxicity, and carcinogenicity which leads to cancer. Many experimental studies on animal specimen have confirmed the formation of tumour due to the presence of different Sudan dyes in food products. Sudan dyes are described to have sensitising characteristics; they easily get absorbed through dermal route and airways and causes health problems. This paper discusses the harmful effects of Sudan dyes on human health which is now greatly used in foodstuffs.

Keywords: Sudan dyes, Illegal, Health effects

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Introduction

For food industries, colour is the most distinguished and significant characteristic of food products. Many colorants are often added to different foods for the enhancement of visual aesthetics and promotion of sales. Colour additives are widely used for the reinforcement and uniformity of foods which already have some colours present in them. Sudan dyes are industrial synthetic azo dyes which are traditionally used in waxes, drugs, plastics, oils, food, clothing, polishes, and are also used in histochemical analysis ¹. The International Agency for Research on Cancer has classified these dyes as Class-III carcinogens and it has now banned Sudan dyes worldwide; however, many countries still utilize azo-dyes like Sudan dyes illegally in their food products ². Although animal studies have proven Sudan dyes as carcinogenic substances, these colorants have recently been found in various food products in some European countries. These colouring agents are added to different foods including chili powder to intensify, mimic, and prolong good appearance which are similar to the natural red colours. In the United Kingdom, more than six hundred food products containing Sudan dyes have been found such as Worcestershire sauce, pizza, noodle soup, and fish sauce. These food additives are considered illegal to use in food stuffs according to the FAD and EU. The European commission now demands the product documentation in order to confirm the absence of harmful Sudan dyes. A detection limit of 0.5 to 1 mg/kg has been set by the EU for Sudan dyes. Any food material which contains dyes above the permissible limits is completely withdrawn from market. The European Food Safety Authority (EFSA) initiated a review in 2005, regarding the toxicology of various dyes found illegally in food products. EFSA concluded their research with the

strong evidence of genotoxicity and carcinogenicity caused by several dyes especially Sudan I. Since Sudan-I structurally resembles all other Sudan dyes, the larger group is found to have the same harmful effects ³. Illegal dyes create major economic consequences for public health and food industries; therefore, there must be some rapid, inexpensive, simple, and reliable analytical method to minimize adverse effects of azo-dyes. Many researchers are working on these analytical methods, but still there is dire need of more quantitative methods for better analysis ⁴⁻⁶. Sudan dyes are widely used in textile industry and as a result waste water produced from textile industries damages aquatic life. It may also prove to be of deleterious effect for humans who consume seafood which lives in dye contaminated water ^{7, 8}.



Figure 1: Sudan Dyes

Sudan Dyes - Basic Facts

Sudan dyes are of red-orange colours which are very often used for colouring purposes in food to enhance the quality and hence to promote sales ⁹. Foods are usually assessed on the basis of their colour and texture ¹⁰. The effect of azo-dyes not only brings about harmful effects to human health but it also leaves adverse environmental effects. Due to the formation of dyestuff for textile industry, wastewater has largely contaminated sea water hence causing damage to marine life ^{11, 12}. Naphthylamine is another degradation product of Sudan dyes which aggravates metabolism and causes potential risk to health ¹³.

Factor	Evaluation
Sudan 2	0.1 mg/kg (limit value)
Sudan 3	0.1 mg/kg (limit value)
Sudan 4	0.1 mg/kg (limit value)

It was mid-19th century when all colouring agents and dyes were obtained from natural sources including plants and animals. Later, in the beginning of 20th century it got replaced by synthetic colours manufactured in industries. Today we find many pigments and dyes which are synthetic in nature and are produced commercially. Each year new coloured compound agents hits the market and is utilized to enhance the appearance of various food and household items ¹⁴.

Various sorts of Sudan Dyes

A variety of Sudan dyes include Sudan I, Sudan II, Sudan III, Sudan IV, Sudan Black B, Sudan Orange G, Sudan Red B, Sudan Red G, and Sudan Red 7B ¹⁵. Sudan I and IV dyes are reported to be present in sauces, curry, chili powders, spice mixtures, and seasonings. Sudan dye I is often formed as an impurity when preparing sunset yellow colour. It also widely attributes to the release of metabolic substances including 1-amino-2-naphthol and aniline which aggravate the incidence of carcinoma ¹⁶. An experiment on mice specimen fed on food comprising Sudan I concluded the occurrence of spleen tumour ¹⁷.

Although European Union strictly banned the usage of Sudan Dyes, but around 20 cases per year were reported due to the consumption of imported food products containing Sudan dyes ¹⁸. Studies have shown that Sudan dye II cause SIV local and bladder carcinoma in mice ¹⁹. Sudan dye II, III, and IV resemble Sudan dye I structurally and hence they all contribute to genotoxicity ²⁰. In an experimental study, Sudan Red 7b and Deep black BB were used to stain the termites and as a result a very low mortality rate of termites was seen which were stained with Sudan Red 7B ²¹.

Sudan Dyes - Food Issues

Many food products were detected by EU including chili samples which were found contaminated with synthetic dyes. Other contaminated foodstuffs included chutneys, number of relishes, and seasonings. Since synthetic dyes count as risk to human health, they are prohibited in many countries ²². These dyes produce biologically active compounds which cause intense harm to body since they act as harmful toxins ²³. In United Kingdom warnings have been provided by Food Standards Agency (FSA) regarding the presence of Sudan dye I in frozen meat products, spices, and chips ²⁴. Sudan dyes are mostly absent in fresh food products like fresh chilies; however, the addition of Sudan dyes

bring about genotoxic effects and carcinogenicity of bladder and liver of mammals ²⁵.

Table 1. Statuary Basis for Permissible Limits The Federal Office of Public Health has set the standard permissible limits for the Sudan dyes. Federal Office of Public health, 2004 ³⁷

Sudan Dyes - Health Effects

Not only Sudan dyes but also their degradation products are quite carcinogenic, teratogenic, and harmful to human health. Studies have proven that the exposure of synthetic dyes along with sodium benzoate preservatives cause hyperactivity in 3 years old and 8-9 years old children. Sudan dyes present in food products leave adverse effect on the attention, behaviour, and activity of children ²⁶. Sudan dyes reduce to form their corresponding amines when in taken orally. This reduction is caused mainly by the extra hepatic tissues, gastrointestinal microbes, and liver cystolic reductase ²⁷.

Many laboratory experiments on animals have shown mutagenic and carcinogenic effects due to the release of amines. These carcinogenic amines make Sudan dyes as potential health hazards ²⁸. The experimental studies were done on rats fed on feed containing Sudan dye I which gave way to high level of neoplastic liver nodules formation causing lymphoma and leukaemia. Moreover, the implantation of Sudan I dye inside the urinary bladder of animal specimen caused bladder carcinoma. Henceforth, Sudan dyes are mutagenic and carcinogenic both *In vivo* and *in vitro* ²⁹. Sudan dyes have also been found to cause genotoxic effect in colon and stomach of mice ³⁰.

Sudan dyes may take access to body through skin when hair dyes containing Sudan dyes are applied. This may be quite harmful since it results in carcinogenic amines ^{31, 32}. Sudan dyes activate P₁-450 associated enzymes which are found in animals hence aggravating immunotoxic effects. Sudan dyes are indirect carcinogens (classified as category 3 carcinogens by IARC) and are therefore proscribed from the use in foods ^{33, 34}. The *in vitro* experimental analysis has demonstrated that Sudan dyes present in human microsomes creates DNA adduct. The peroxisomes also get activated by Sudan dyes to produce Protein, DNA, and RNA adducts ^{35, 36}.

The illegal presence of Sudan dye I in food products in EU was first reported in May, 2003. A decision against the usage of Sudan dyes was given by EU as a reaction to the occurrence of Sudan dyes in red chili which was first imported from India in France ³⁸. It was observed that chili powder and all those food products containing chili powder contained Sudan dyes. Since then, many EU Member States through Rapid Alert System for Food and Feed (RASFF) notified regarding the presence of Sudan dye I and IV in sumac, curcuma, and palm oil. Many notifications of Sudan II and III dyes were also received for the similar range of food products. It was discovered that the food products

containing Sudan dyes were manufactured from the contaminated raw products obtained from countries outside the EU including India, Ghana, Egypt for raw spices, Nigeria, Pakistan, and West Africa for palm oil. The primary origin of Sudan dyes include the raw materials which are used as important ingredients by the EU for the production of processed food products³⁹.

Measures for prevention

There are a number of steps which can be taken in order to prevent Sudan from entering the food chain resulting in spice adulteration. If there is any product which comprises of Sudan dyes beyond permissible limits, should be destroyed. Contaminated raw materials should be avoided because failure to remove dyes from supply chain would result in amelioration of contamination. Many health sectors and companies are working with local authorities and food industries to avoiding foods containing Sudan dyes by removing products from sale in the retail outlets. Companies should familiarize themselves with the vendors and control the amount of Sudan dyes in raw materials. For that, the certificate warrants must be ensured and strict action must be taken if adulteration of Sudan dyes is done with spices. In order to maintain the integrity of supply-chain, we need to have surveillance programs as well as system for solid inspection. Laws must be enforced to minimize the utilization of many foods which contain these carcinogenic dyes⁴⁰.

The production and application of Sudan dyes adds insoluble dye agents in the effluents when industries remove them as unwanted matter. However, scientists have initiated experiments to identify and isolate some bacterial species which help in reducing these azo-dyes. Many other microbial strains must be used to decontaminate raw materials before they are used to produce fine products.⁴¹

Conclusion

Synthetic dyes are known to be highly stable to oxygen, light, and pH; they are scarcely contaminated by microbes, have low production cost, and provide good colour uniformity. Despite of all good characteristics these dyes must not be used due to their carcinogenicity and teratogenicity. As an alternative, natural dyes which are quite expensive and unstable may be processed further and utilized to prevent any potential health hazard.

There is a great impact of illegal dyes on public health therefore accurate, sensitive, and selective methods should be introduced so that to detect and quantify the synthetic food dyes in different foods. All the raw materials and finished products must be labelled clearly if they contain azo-dyes in them. Those items which contain Sudan dyes must be discarded as hazardous waste products. The amount of consumption of synthetic dyes plays a great role in risks for cancer. Occasional and very low consumption of Sudan dyes through foods which are rarely consumed might not be

as much risky as continuous and high doses but risk still exist. Experts give their opinion to keep the exposure of Sudan dyes quite low to attain the safety level and avoid health relating risks.

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