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REVIEW

Occupational Diseases In Textile Dyers – A Brief Review

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ABSTRACT:

The textile industry not only accounts for a large percentage of India's industrial production and export earnings, but also generates employment in both organized and unorganized sectors. The industrial operations, specifically dyeing, encompasses many occupational diseases, which have either long term or short term health effects, depending on the type of exposure and its duration. The exposures to such chemicals may occur, through any route of entry, like inhalation or absorption. This study attempts a brief review of the occupational diseases caused by textile dyes and suggests mitigation measures.

Occupational skin diseases like Allergic Contact Dermatitis (ACD) and Irritant Contact Dermatitis (ICD), involving exposed sites, cause significant morbidity in textile industry workers. Occupational eczema and urticaria from reactive dyes, has also been reported. Dyes used by textile industries are known to be carcinogenic, teratogenic and mutagenic, with genotoxic risk to textile dyers. The International Agency for Research on Cancer (IARC) has classified various dyes as being associated with cancer in humans. The spraying of Acramin F system, led to Organizing Pneumonia (OP). Reactive dyes (Lanasol Yellow 4G) and carmine dye have been implicated as etiologic agents of occupational asthma and allergic rhinitis. Occupational exposure to vat dyes may result in sub-clinical adverse effects on the liver.

Strategies like, implementation of safety measures according to the type of work, periodic screening coupled with worker-oriented educational approaches, further epidemiological study, and modern Occupational Health Safety (OHS) legislation will help deal with this problem.

Keywords:

Occupational disease, textile dyes, carcinogen, mutagen.

Abbreviations:

ACD–Allergic Contact Dermatitis, ICD–Irritant Contact Dermatitis, IARC – International Agency for Research on Cancer, OP – Organizing Pneumonia, SCEs – Sister Chromatid Exchanges, CA – Chromosomal Aberration, PRR – Pooled Relative Risk, ALP – Alkaline Phosphatase, ALT – Alanine Transaminase, AST – Aspartate Transaminase, SHE – Sentinel Health Event, OHS – Occupational Health Safety

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INTRODUCTION

Textiles account for a large percentage of India's industrial production and export earnings. The textile industry covers a wide range of economic activities, including employment generation in both organized and unorganized sectors. The industry comprises diverse operations such as fiber synthesis, weaving, manufacturing, dyeing and finishing.

There are numerous health and safety issues associated with the textile industry. They include: chemical exposure from the processing and dyeing of materials, exposures to various solvents, exposure to cotton and other organic dusts, musculoskeletal stresses, and noise exposure. The exposures to chemicals may occur through inhalation or absorption. Thus, textile industries encompass many occupational hazards, which have either long term or short term health effects (occupational diseases), depending on the type of exposure and its duration.

An "occupational disease" is any chronic ailment that occurs as a result of work or occupational activity. They are the illness caused by the substances or conditions that the worker was brought into contact with at the workplace or while he was working at his respective work environment.

Occupational skin diseases of textile dyers

Occupational skin disease can cause significant morbidity in textile industry workers. Both Allergic Contact Dermatitis (ACD) and Irritant Contact Dermatitis (ICD) have been reported among textile workers. Soni and Sherertz (1996) characterized and determined the relative frequency of work-related ACD and ICD in textile workers. 29% were diagnosed as having a predominantly work-related ACD. Allergens included textile dyes. 38% were diagnosed as having work-related ICD. The hands were the most common site of involvement.

Singhi *et al.,* (2005) studied the prevalence of contact dermatitis among workers engaged in the 'tie and dye' industries in and around Jodhpur (Western Rajasthan, India). 7.69% had dermatitis involving the exposed sites, the hands and forearms. The nature of the job had a significant bearing on the prevalence of skin lesions. The dermatitis showed clearing on temporary discontinuation of work and relapse on resuming the work. Singh (1970) found benzanthrone to be the main allergen causing dermatitis. Mathur (1981) described 49 cases of contact dermatitis among 250 workers in a cottage dyeing industry in Jaipur (Rajasthan).

A study of the clinical and aetiological features of contact dermatitis in Israel, to assess the sensitization to textile dyes, revealed that 12.9% had allergic reactions to a dye and/or resin allergen (Lazarov, 2003). Although chronic dermatitis was the typical clinical presentation, purpuric, hyperpigmented and papulopustular lesions, erythema multiforme-like, nummular-like lesions, lichenification and erythrodermia were observed. The trunk and extremities, less frequently, the hands, face, genital area and the soles were affected.

Estlander (1988) reported five cases of occupational eczema, urticaria and respiratory disease from reactive dyes, among workers in dye houses or textile plants, who were exposed to reactive dyes for eight months to four years before symptoms developed.

The efficacy of using barrier creams in lowering the incidence of skin lesions was assessed among workers of dyeing and printing factories in Como, N. Italy (Duca *et al.*, 1994). The use of a hydrocarbon cream was found to be more effective than a silicone cream.

Genotoxic and Mutagenic Effects of Textile Dyes

Mathur *et al.,* (2012) have reviewed literature on the mutagenicity of azo and non-azo textile dyes, and discussed the genetic hazards associated with the production and use of these dyes throughout the world.

Donbak *et al.,* (2006) evaluated the genotoxic risk of workers from textile dyeing plants in Kahramanmaras, Turkey. Sister Chromatid

Exchanges (SCEs) and Chromosomal Aberrations (CAs) were investigated in peripheral blood lymphocyte cultures. The frequency of CA was significantly higher. There was a significant correlation between years of exposure and CA frequency.

Mathur *et al.,* (2005) tested seven dyes used in textile printing and dyeing in Pali district, Rajasthan, for their mutagenicity, by Ames assay, using strain TA 100 of *Salmonella typhimurium*. Three of these were processing dyes or cremazoles (Orange 3R, Brown GR and Blue S1) while remaining four were direct dyes (Violet, Congo red, Royal blue and Bordeaux). Only one dye, Violet showed absence of mutagenic activity. The remaining six dyes were positively mutagenic, and caused genetic damage through base pair substitution mutations.

Carcinogenic effects of textile dyes

Many of the dyes used by textile industries are known carcinogens (IARC, 1982; Jenkins, 1978) and teratogens (Beck, 1983). The International Agency for Research on Cancer (IARC) has classified various dyes like benzidine as being associated with cancer in humans (IARC, 1982). Two benzidine dyes, Direct Blue 6 and Direct Black 38, have been reported to be such potent carcinogens that, hepatocellular carcinomas and neoplastic liver nodules occurred in rats after only 13 weeks of exposure (Robens *et al.*, 1980). A number of dyes have been tested for mutagenicity using *Salmonella* assay. Several of them have been found to be carcinogenic (Garner and Nutman,1977; Venturini and Tamaro, 1979). Triple primary cancers involving kidney, urinary bladder and liver in a dye worker have been reported (Morikawa *et al.*, 1997).

Workplace exposures account for 5 to 25% of all bladder cancer cases. Olfert *et al.,* (2006) reviewed the literature between 1938 and 2004, and found that occupational exposures to bladder carcinogens, particularly beta-naphthylamine occur in a number of industries, including dyestuff manufacture and use.

Mastrangelo *et al.,* (2002) analyzed epidemiologic studies for textile industry workers, to evaluate whether the cancer risk varied within the textile industry in relation to the job held. The increased bladder cancer Pooled Relative Risk (PRR) in dyers was attributed to textile dye exposure.

The association of aniline dyes with bladder cancer was first described in 1895. Dye intermediates, such as beta-naphthylamine (BNA) and benzidine have been implicated in the development of bladder cancer; ortho-toluidine and ortho-dianisidine are also suspected agents.

Morrison *et al.,* (1985) evaluated the relationship between occupational history and the development of cancer of the lower urinary tract ("bladder cancer"). In Boston, Massachusetts, USA, elevated risk of bladder cancer associated with employment related to dyes was observed.

Gonzales *et al.,* (1988) investigated the possible causes of an unusually high mortality rate from bladder cancer in Mataro, Spain, with focus on occupational exposures. An increased risk for past employment in the textile industry was found. Further analyses indicated that the risk was elevated for subjects who worked in dyeing or printing, and who were most probably exposed to azo-dyes.

Urothelial tumors were detected in 10.3% male dye workers in Wakayama City (1951-1990), formerly engaged in manufacturing of benzidine and/or beta-naphthylamine. The mean period from exposure to such carcinogenic chemicals to the onset of the disease was estimated to be 25 years (Shinka *et al.*, 1991). Further, the biological behavior of occupational urothelial tumors may be different from that of urothelial tumors in the general population.

Frumin *et al.,* (1990) reported six cases of bladder cancer from different fabric dyeing plants in New Jersey and North Carolina. The average latency from onset of exposure to diagnosis was 23.3 years.

The results of You *et al.,* (1990) suggested that, in Shanghai, the main cause of bladder cancer was occupational exposure, especially to benzidine. The risk of bladder cancer, however, existed only in the presynthesis stage of dye manufacture. Bladder cancer was also reported in dye-manufacturing workers in South Korea (Kim *et al.*, 2007).

However, in a recent study, Serra *et al.,* (2008) investigated the risk of bladder cancer in Spanish textile workers (1998-2001), but found no overall increased risk for textile workers.

Occupational respiratory ailments in dyers

A study by Alanko *et al.,* (1977) reports four cases of immediate-type occupational allergy to reactive dyes. All the patients had symptoms of asthma and allergic rhinitis. The identification of specific IgE showed that the mechanism of the hypersensitivity was immunological, reactive dyes probably acting as haptens.

Romano *et al.,* (1991) reported a case of occupational asthma, in a wool and cotton dyer handling reactive dyes. A bromoacrilamidic dye (Lanasol Yellow 4G) was identified as being responsible for the sensitization. A very short (4-minute) exposure produced a severe immediate obstructive ventilatory defect followed by arterial hypotension and urticaria.

Carmine dye has been implicated as an etiologic agent of occupational asthma. Lizaso *et al.,* (2000) identified three allergens of around 17, 28, and 50 kD implicated in occupational asthma of three carmine workers.

The outbreak of severe respiratory illness during 1992 among aerographic textile printing workers in Valencia, Spain, was linked to the inhalation of a reformulated aerosolized product, Acramin-FWN. Clinical, laboratory, and pathological data confirmed Organizing Pneumonia (OP). The common clinical findings were cough, epistaxis, dyspnoea, oppressive chest pain, and crackles. The organizing pneumonia tended to evolve into progressive interstitial fibrosis. Once respiratory failure developed, the prognosis was poor (Romero *et al.*, 1998). Another report by Moya *et al.,* (1994) states that 27% of Spanish textile dye sprayers developed bronchiolitis obliterans organizing pneumonia.

Hoet *et al.,* (1999) studied the pulmonary disease in textile printing sprayers in Spain and Algeria (Ardystil syndrome), caused by spraying of Acramin F system. The study showed that, the three polycationic paint components, Acramin FWR (a polyurea), Acramin FWN (a polyamide-amine), and Acrafix FHN (a polyamine) exhibited considerable cytotoxicity.

Effect of textile dyes on liver function and general health

Soyinka *et al.,* (2007) investigated the possible effects of occupational exposure (textile dyeing and finishing), to vat dyes on liver function in Abeokuta, South Western Nigeria. The activity of Alkaline Phosphatase (ALP) and the concentrations of total protein and albumin were lower, while Alanine Transaminase (ALT) and Aspartate Transaminase (AST) were significantly higher, in the exposed group. The results indicated that occupational exposure to vat dyes resulted in sub-clinical adverse effects on the liver, involving inhibition of its synthetic function.

Mortality from diabetes and ischaemic heart disease was found to be increased across a wide range of textile occupations among people born in the Indian subcontinent, with increased risk specific to men (Zanardi *et al.*, 2011).

The occupational health problems of desert textile workers and their association with nutritional and environmental factors were explored in Jodhpur and Pali, Rajasthan by Singh *et al.,* (2005). 25.5% of dyers suffered the most from aches, probably due to a higher percentage of severe anaemia, besides physical labour.

Mitigation measures and Conclusion

Occupational environment is the sum of external

condition and influences which prevail at the place of work and which have a bearing on the health of the working population (Jaiswal, 2007). An occupational Sentinel Health Event (SHE) is a disease, disability, or untimely death which is occupationally related and whose occurrence may: 1) provide the impetus for epidemiologic or industrial hygiene studies; or 2) serve as a warning signal that materials substitution, engineering control, personal protection, or medical care may be required (Rutstein *et al.,* 1983).

Ramaswamy (1987) draws attention to the issues which need to be considered when dealing with health hazards due to toxic exposure in the work environment: (i) Growth pattern of industries inherent with such hazards. (ii) Statutory and other safeguards available for controlling such hazards. (iii) Documented statistics on the magnitude of such health hazards in the typical industries/processes. (iv) Reasons for the shortfall in efforts to control such health hazards in the past. (v) Future strategy to control the hazards, and monitor the levels from time to time.

The need of the hour is compulsory implementation of worker safety measures according to the type of work in the textile industry, Occupational exposure to hazardous chemicals can be prevented or minimized by using protective equipment such as gloves, goggles, masks, etc.

Researchers should focus on collecting epidemiological data and evidences as to the nature of conditions caused, chemical/allergen responsible, the type of workforce at risk, period of exposure, latency period, if any, rate of incidence, etc. The mutagenicity testing of textile dyestuffs is crucial for accurately predicting health risks for consumers and workers exposed to dyes (Mathur *et al.*, 2012).

Based on the epidemiological data collected, periodic screening programs should be conducted for both the organized and unorganized workforce, in addition to extension of health and nutrition education and welfare programs. Soni and Sherertz (1996) emphasize the importance of patch testing with standard screening allergens and textile dye and finish allergens, in the diagnostic evaluation of patients with dermatitis who work in the textile industry. As bacterial mutagenicity assays can be carried out in 48 hrs, they have been suggested as rapid pre-screens for distinguishing between carcinogenic and non-carcinogenic chemicals (Mathur *et al.,* 2005). Ames test (Ames *et al.*, 1975) can easily and quickly assess mutagenic potential of these dyes. Screening of high risk populations with urinary cytology tests was found to be effective for early diagnosis and treatment of urothelial tumors, and it improved patient prognosis (Shinka *et al.*, 1991). Screening programs will be more successful if coupled with worker-oriented educational approaches, as compliance with health screening programs will be greater in the case of better-informed employees (Frumin *et al.,* 1990).

Agnihotram (2005) suggests strategies such as modern Occupational Health Safety (OHS) legislation, enforcement machinery at sub-district level, training to health professionals, and international collaboration, to deal with the situation.

The interaction between man and his working environment may lead to betterment of health, when work is fully adapted to human needs and factors, or to ill health, if work stresses are beyond human tolerance. The administrative machinery, industrial community and society at large are thus faced with the daunting task of ensuring the safety of the workforce which toils for its economic prosperity.

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