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Effect of PPD on Human Health

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ABSTRACT

Hair dye poisoning is one of the most emerging and active issue in India as well as in other countries of the world. The primary cause of hair dye poisoning occurs due to chemical PPD (para-phenylenediamine) which is used along with Heena in the commercially marketed hair dye. The end product BB (Bandrowski's base) formed on oxidation of PPD which is mutagenic and allergic in nature. In ancient times, PPD has been used for decorating palm and soles. The effets are devastating as it affects all body systems. PPD is said to be hazardous and toxic to human health.

Keywords: PPD, poisoning, toxic, Bandrowski's base, symptoms

INTRODUCTION

PPD (para-Phenylenediamine or 1,4-Diaminobenzene), first described by Hoffmann in 1863 (Mukunna *et al.* 2017, Imran *et al.* 2016). It is a chemical compound having formula $C_6H_8(N_2)_2$ appear in white to light brown color in solid form. This chemical is considered to be active ingredient present in various synthetic or permanent hair dyes (Suvarna P *et al.* 2013, Shalaby *et al.* 2010). PPD has a molecular weight of 108 Dalton, along with boiling point of 267°C and melting point of 140°C (Senthilkumaran and Thirumalaikolundusubramanian, 2018). Chemically, PPD is a derivative of aniline (also known as coal-tar derivative) which becomes darker in color when it undergoes oxidation (Ahmed and Alturki, 2018, Sampathkumar and Yesudas, 2009). In ancient times, it was used along with Heena (*Lawsonia alba*) for decoration of palms and soles during wedding ceremonies, synthesizing various dyes, manufacturing azo dyes, dying furs, photographic development and lithography plates, photochemical measurements, accelerating vulcanization process and many more (Singla *et al.* 2005, Abdelraheem *et al.* 2010). PPD is used as color enhancer agent in hair dyes which shows rapid coloring of hair as compared to naturally occurring hair dyes along with reduction in the application time.

PPD is commonly used as raw material for the purpose of cosmetics mostly in India and African countries (Abdelraheem *et al*., 2010). PPD has auto-oxidative property, as it acts as pre or pro haptens which convert into various haptens. The amines and their derivatives might undergo photolytic or photo-oxidative degradation when exposed to direct sunlight. In the last decades, PTD (para-toulenediamine) has similar profile as PPD and also it was replaced now by PPD (Meyer and Fischer, 2015).

The absorption of PPD occurs in blood through mucuous membrane of the digestive tract after oral ingestion. Following the oral ingestion, respiratory syndrome produces severe breathing problem as a result of direct trauma which causes dysnopia and asphyxia. PPD toxicity is due to altered vascular permeability and involvement of PNS(para-sympathethic nerve system). It was either believed that PPD toxicity is due to conversion of PPD on its oxidative products (Senthilkumaran and Thirumalai-kolundusubramanian, 2018) There are many cases of PPD toxicity reported in various countries such as Egypt, East Africa (Sudan), Israel, India, Saudi Arabia, Morocco and Tunisia.(Ahmed *et al*.,2013). 3 gram of PPD can cause systemic poisoning. The lethal dose is about 7-10 grams (Abdelraheem *et al*., 2010). PPD can cause many allergic and hypersensitivity reactions to human health such as acute renal failure, rabhdomyolysis, contact dermatitis, loss of vision, swelling on neck and face region myocarditis, myocardial rabhdomyolysis, acute renal failure, acute liver injury, necrosis, cervicofacial edema, hemoglobinuria (Ahmed and Alkturi, 2018). Rabhdomyolysis occurs due to the calcium ions leakage in prolonged muscular contraction. Focal glomerulosclerosis with skin exposure to PPD have been investigated as chronic effect to human health (Chrispal *et al*., 2010).

DISCUSSION

PPD is non toxic in nature but when it undergoes air oxidation, it forms the end product in the reaction which is considered to be highly toxic and mutagenic metabolite called BB (Bandrowski's Base)(Ahmed and Alkturi, 2018, Altman and Reiger, 1968). BB, a trimer which acts as main allergen in patients reacting to PPD (White *et al.* 2006, Kruger *et al*, 2011). Under chemical reaction, PPD reacts with hydrogen peroxide undergoes oxidation which forms the intermediate called benzoquinone (BQ) diamine. This BQ diamine undergoes further oxidation and forms the end product called Bandrowski's base (BB) which causes mutation and allergen (Prabhakaran, 2012).

PPD has been banned in almost all countries but its presence in various marketed commercial products creates a threatening condition to the most vulnerable population of the country. PPD, a potent allergen, is approximately present in 70% of all hair dyes worldwide (White *et al*, 2006). The first reported case of PPD poisoning occurs in 1924 described by Nott (Singla *et al.* 2005, Senthilkumaran and Thirumalaikolundu-subramanian, 2018). Specifically, India has documented with almost 23.92% of mortality rate due to PPD poisoning cases (Umair *et al.* 2018) In India, Telangana is the most affected states due to PPD poisoning and related health issues (Alugonda *et al.* 2013). Also, poisoning cases has been occurred mostly in female population as compared to male population. There have been many poisoning cases of PPD emerging from India as well as other developing countries of the world that took the lives of many peoples. This current and active issue all over the world creates an alarming sign.

PPD can be detected in various biological specimens such as blood, urine, saliva, gastric contents etc and it has been helpful for forensic purposes. The forensic field demands qualitative and quantitative analysis of the chemicals in the poisoning death cases which is essential for revealing the nature of the suspected metabolite. There must be proper toxicity warnings, awareness and its effect regarding PPD. The early symptoms and manifestations of PPD might reduce the chances of mortality rate. There is no specific antidote for reducing the effect of PPD on human body systems (Chrispal *et al.* 2010).

PPD ingestion can cause systemic toxicity include hepatitis, dysphagia with mucosal irritation followed by myocarditis, angio-neurotic edema, tachycardia (Umair *et al.* 2018). The severity of occurring symptoms may vary from mild pruritus to prominent eyelid and facial edema, and formation of blisters. The earliest symptoms of contact dermatitis can develop within 1-3 days in most vulnerable and sensitized people while it takes 4-14 days in non-vulnerable people. The beginning symptoms show rapid development of oedema on face, neck, tongue, larynx

with respiratory distress. In the later stage, acute tubular necrosis, vomiting, convulsions, gastritis can develop (Singla et al, 2005). Hypersensitivity delayed type-IV reactions seen in most of the cases by exposure to hair dye. In some reported cases, the manifestation occurs such as erythma multiforme, severe inflammatory, keloidal allergic reaction, content urticaria and anaphylaxis. PPD has multiple organ effect in human body as it affects heart, liver and muscles. Majorly, PPD affects kidney, as it received large amount of blood and due to aromatic structure makes it easy for reabsorption and concentration in tubule leads to Acute renal failure. (Abdelraheem *et al.* 2011, Senthilkumaran and Thirumalaikolundusubramian, 2018)

CONCLUSION:

PPD on oxidation converts into primary intermediate (BQ) which further on oxidation leads to BB results in change in darker color. PPD exposure leads to various harmful human health effects and even death also. The use of PPD must be restricted as the poisoning cases increases day by day and issue related to them. There must be rules and legislation for the prevention of use of PPD in different hair dye production and looking for the alternative agent, restriction for the sale of PPD. Also, it is important to create awareness regarding its use, advantage and negative effect to the human health, because it is freely available in market, reach easily to common person and used extensively in commercial marketed hair dye products.

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