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### 3. Harmful Preservative in Personal Care Products - A Review

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#### Abstract

Most of us are unaware of the different harmful ingredients present in our personal care products which are silently pushing us towards a more complicated life. Although these products are of immense importance for the modern era, awareness of the harmful ingredients present in these will at least reduce the exposure levels amongst us. One of the very harmful yet most widely used chemicals present in our cosmetics, perfumes and luxury items are the parahydroxybenzoates (parabens). They occur naturally at low levels in some foods like strawberries, carrots and onions. Parabens in food are metabolized when eaten, making them less strongly estrogenic. But the presence of intact par benzoates in human body tissues coming from the cosmetics has now been confirmed. They have also been detected in human breast cancer tissues. It is studied that females had several folds higher concentration of methylparaben, butylparaben and propylparaben than males, reflecting the greater use of products containing parabens by females. Routes of the exposure and the mechanism of action of these noxious chemicals are an important fact which we must become concern of to save our present and future generation from their life threatening effects. It is high time now for becoming aware of the different deadly health disorders imposed by these chemicals on a healthy life style.

**Keywords:** Cancer, Estrogenic, Perfumes, Personal care products

#### Introduction

Parabens represent a homologous series of chemicals where p-hydroxybenzoic acid is esterified at the C-4 position with either alkyl groups of varying length or an aryl group (Fig 1). The chemical structure of parabens is similar to the female sex hormone estrogen (Ye *et al.*, 2006). They occur naturally at low levels in barley, strawberries, vanilla, carrots, and onions.

Parabens in foods are readily metabolized when eaten, making them less strongly estrogenic (Smith *et al.*, 2012). Parahydroxybenzoates or parabens are a class of preservative which typically includes methylparaben, ethylparaben, propylparaben, butylparaben, isobutylparaben, isopropylparaben and benzylparaben (Fig 2). The chain length of the alkyl group on the paraben is directly proportional to their antimicrobial activity and inversely to their water solubility (Soni *et al.*, 2005; Taxvig *et al.*, 2008). These are widely used in cosmetics, toiletries and pharmaceuticals to inhibit the microbial growth and extend the product shelf life (Golden *et al.*, 2008). The consumers of these products are frequently affected via the skin, lips, eyes, oral mucosa and hair.

Parabens are the endocrine disruptors (Prusakiewics *et al.*, 2008). The ability of different chemicals to interfere with the performance of the endocrine system, affecting the normal development, reproduction and general hormonal functions of the body (such as metabolism, growth, fluid balance and cardiovascular functions) is known as the endocrine disruption. A xenobiotic may produce such disruptions by a variety of mechanisms, such as interacting with a target (via a hormone receptor or non-receptor pathway), affecting hormone secretion or biological half-life or by modulating the feedback relationships that exist in the hypothalamo-pituitary target organ (gonadal, thyroid) systems (Karpuzoglu *et al.*, 2013).

In the recent years, studies have been conducted to determine whether components of personal care products (cosmetics, soaps, hair sprays and shampoos) possess endocrine disrupting activities due to the presence of parabens (Witorsch and Thomas, 2010).

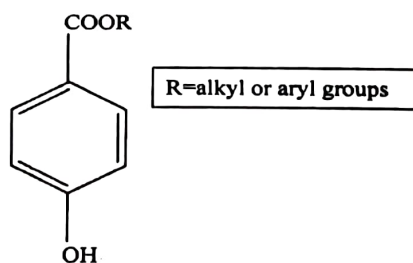


Fig 1. Structure of para hydroxybenzoate

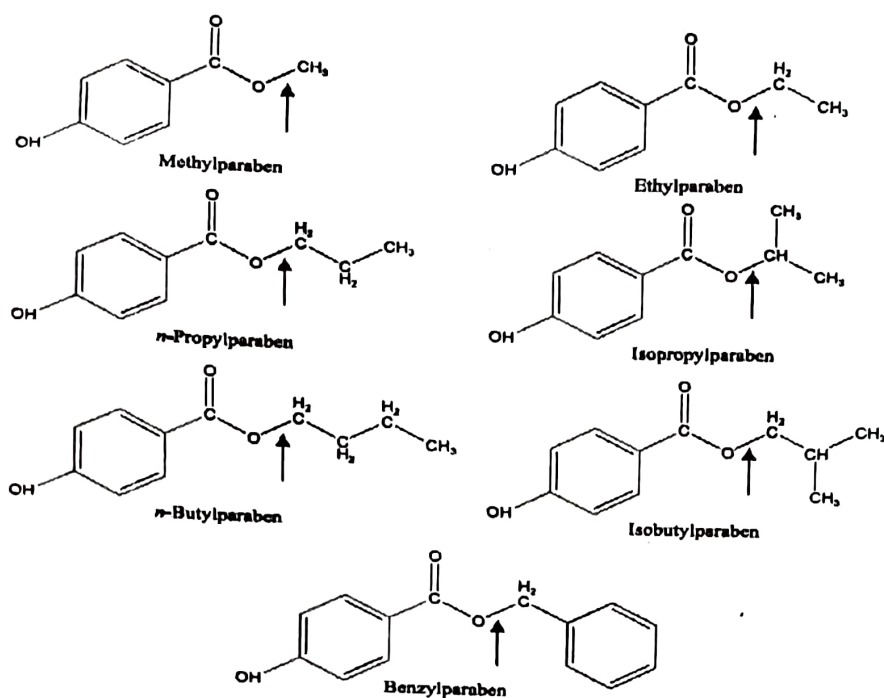


Fig 2. Structures of different parabens

## Parabens and their harmful effects

The chemical structure of parabens is similar to that of estrogen, so they can mimic estrogenic effects in the body (Boberg *et al.*, 2010). A variety of *in vitro* methods have been employed to assess the estrogenic activities of parabens, such as, competitive binding with tritiated estradiol-17 $\beta$  to the estrogen receptor (ER) (using rat urine cytosol preparations), the E-screen assay (yeast cell transected with ER and reporter construct), and proliferative or other biological responses of estrogen sensitive cells (such as MCF-7 human breast cancer cells) (Byford *et al.*, 2002). The European Cosmetic Directive has restricted the maximum level of parabens in cosmetics to 0.4% for one ester and 0.8% for a mixture of ester (EC, 2009). They can easily penetrate through the skin. Parabens in cosmetics bypass the metabolic processes and enter the blood stream and body organs intact. Estrogen receptor alpha (ER $\alpha$ ), also known as NR3A1 (nuclear receptor subfamily 3, group A, member 1), is one of two main types of estrogen receptor, a nuclear receptor that is activated by the sex hormone estrogen (Anderson and Anderson, 1998) (Fig 3). Various studies have shown that butylparaben stimulate oncogene (a gene that has the potential to cause cancer) expression and breast cancer cell proliferation *in vitro* via ER $\alpha$  by mimicking estrogenic activity (Anderson and Anderson, 1998). These suggest that parabens can cause cancer (Darbre *et al.*, 2004). Parabens interfere with male reproductive functions. The interaction between parabens and mitochondrial function in the testis is the reason



explaining the contribution of parabens for decrease in reproductive potential (Darbre and Harvey, 2008). They were shown to damage the late stages of spermatogenesis (Handa *et al.*, 2006). Butylparaben, propylparaben decrease the serum testosterone concentration (Oishi, 2002). Studies have shown that butylparabens are known to cause impaired sexual behavior in pregnant Wister rats (Boberg *et al.*, 2010). It was demonstrated that the exposure of post-weaning mammals to butylparaben adversely affects the secretion of testosterone (Hui-Ting *et al.*, 2017). Recent work has also revealed that the hydrolysis of parabens by esterases is slower in human skin than in rat skin, suggesting that predictions based on the rat skin metabolism data may significantly underestimate the level of paraben esters that can be absorbed from topical application into underlying tissues of human skin (Darbre and Harvey, 2008). Confirmation of the ability of parabens to be absorbed systematically from topical application to human subjects has now been published in a study where levels of parabens could be shown to increase in both blood and urine of 26 healthy young men following topical application of parabens in a cream cosmetic formulation (Rossi and Desiderio, 2002). The potential effects of parabens on estrogenicity were depicted in the histopathological abnormalities in the reproductive organs. The histological analysis of the ovaries of peripubertal rats also revealed a decrease of corpora lutea, increase in the number of cystic follicles and thinning of the follicular epithelium (Vo *et al.*, 2010). Furthermore, morphological analysis of the uterus revealed the myometrial hypertrophy under a high dose of propyl as well as isopropylparaben (1000mg/kg-day) and in all dose groups of butyl as well as isobutylparabens (Vo *et al.*, 2010).

Due to the widespread use of Parabens, it has also been detected in soil, sewage water, swimming pools, house dust, but at least not in drinking water in developed countries. Few studies show the presence of methylparabens in fishes from Michigan, New York, and Florida (Oishi, 2002).

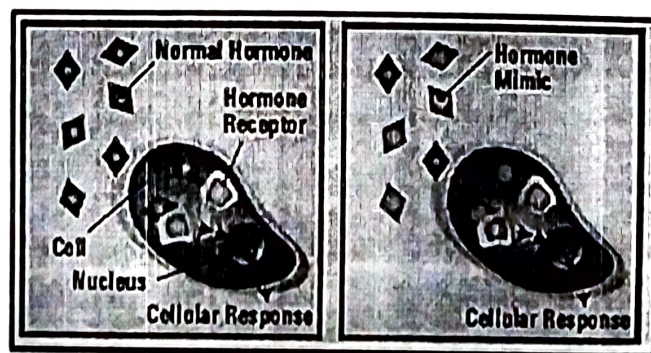


Fig 3. Action of normal hormone and hormone mimic

## Conclusion

The review accounts a glimpse of the exposure of parabens in our daily life. Different routes of exposure and the mechanism of action of these noxious chemicals are an important fact which we must become concern of to save our present and future generation from their life threatening effects. A safety concern is to be developed for the benefits of the mankind, so that we and our environment are protected from the health hazardous effects of these chemicals. Now, research is going on to focus on the use of herbal formulations which have lesser side effects than chemicals. Furthermore, we should be cautious while selecting the products to be used.

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