

The occurrence of "red" substances in "green" household products: A preliminary investigation

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Abstract During the last decades, a vast number of synthetic organic substances, proved to be toxic for the environment and human health, have been included in almost every single product used in our everyday life, from cosmetics and detergents to baby care products. The green chemistry sector, trying to cope with this problem, introduced less toxic products, more friendly to the environment, with minimized toxic substances use. Many of these products today are being used by consumers and are labeled as natural products. However is this true in all cases? The present paper aims to highlight the "red" substances problem in "green" household products. Initially a literature review was performed to determine the most common categories of substances in household products. A preliminary investigation followed, by selecting representative products from different categories of household products, labeled as natural, and analyzing their ingredients according to their toxicity via relevant databases available online. The results revealed that most "green" products we use daily, actually include more "red" substances than we think they do...

Keywords: "red" substances, green chemistry, household products, toxicity, environment

1. Introduction

In our everyday life we are exposed to a large number of toxic substances. Many of them can enter our organism via the application of personal care products (PCPs), the use of cleaning products (house, laundry, softeners etc) and household products. According to a recent survey about PCPs, 2300 people, on average, use 9 products daily, with 126 unique ingredients. 1% of men and 25% of women surveyed apply 15 or more products each day (www.ewg.org).

Commonly used PCPs include:

- Shampoo
- Toothpaste
- Soap
- Deodorant
- Hair conditioner

- Lip balm
- Sunscreen
- Body lotion
- Shaving products
- Makeup

Children/babies are mainly exposed to the following PCPs:

- Sunscreen
- Diaper cream
- Shampoo
- Lotion

Prenatal exposure to phthalates —found in PCPs and other household products — could cause the reproductive organs of male infants to develop abnormally. Hormone systems of wildlife are disrupted by chemicals from PCPs that enter the water cycle.

PCPs are manufactured with 10,500 unique chemical ingredients, some of which are known or suspected carcinogens, toxic to the reproductive system or known to disrupt the endocrine system. Some companies make products that are safe to eat, but others choose to use dangerous ingredients like coal tar and formaldehyde, both human carcinogens, and lead acetate, a developmental toxin. No premarket safety testing is required for the industrial chemicals that go into PCPs: "...a cosmetic manufacturer may use almost any raw material as a cosmetic ingredient and market the product without an approval from Food and Drug Administration" (FDA 2012).

The FDA does no systematic reviews of safety, instead authorizing the cosmetics industry to self-police ingredient safety through its Cosmetics Ingredient Review panel. Over its 36 years, this industry panel has rejected only 11 ingredients as unsafe in cosmetics. By contrast, the European Union has banned hundreds of chemicals in cosmetics (European Commission 2012).

"When risky chemicals are used in cosmetics, the stakes are high. These are not trace contaminants that may be measured in parts-per-million or even parts-per-billion in food or water. They are substantial components of the product, just as flour is a primary ingredient in bread." (www.ewg.org).

Cosmetic ingredients do not remain on the surface of the skin. They are designed to penetrate. Scientists have found many common cosmetic ingredients in human tissues, including phthalates in urine, preservatives called parabens in breast tumor tissue and persistent fragrance components in human fat. Do the concentrations at which they are typically found pose risks? For the most part, those studies have not been done. But a small but growing number of studies suggest they can (Swan 2005, Sathyanarayana 2008, Swan 2010).

To learn about the safety of ingredients in personal care products, the Environmental Working Group (EWG) has compiled an electronic database of ingredient labels for body care products and cross-linked these ingredients with large databases describing chemical toxicity and government determinations. The database also contains information about cosmetics ingredient restrictions in Canada, Japan and the European Union. According to the database, the most toxic substances according to existing data are classified as "red" substances. In the same concept, substances of lower toxicity are categorized as "orange" and less harmful substances as "yellow", while the safe ones are "green".

2. Commonly used categories of household products containing toxic substances

Personal Care Products (PCPs) -Some alarming facts...

-By use of conventional makeup on a daily basis, a person can absorb almost five pounds of chemicals into the body each year — and that's without adding in body lotion, deodorant, shampoo, conditioner, and other personal care products

-The average woman applies over 500 chemicals a day to her body via her beauty routine.

-Lipstick only can contain up to nine different metals! "toxic metals in cosmetics should be regulated to protect women's health in the United States, as has already been undertaken by the European Union through their Cosmetics Directive." (EWG) The key here is "SHOULD be regulated", but is currently not.

-Commercial skin care products often contain:

- Triclosan – a pesticide that can affect hormone levels, commonly found in antibacterial soaps and hand sanitizers.
- Parabens – a germicide and preservative found in most body care products like shampoos, deodorants, lotions that is banned in Japan and Sweden. Paraben esters were detected in 99% of breast cancer tissues sampled.
- Sodium Lauryl Sulfate (SLS) – an engine degreaser that is found in most personal care products. SLS is linked to hair loss, skin irritation and organ damage. It's currently banned in Europe and Canada.
- Fragrance – often means "hidden chemicals" due to a loophole in the chemical labeling system that

means it could basically include any number of over 3,000 chemicals.

- DEA (Diethanolamine) used as an emulsifier in many personal care and cleaning products. DEA has been linked to certain cancers, reproductive damage, accumulation in the liver and kidneys, irritation to the skin, as well as the nose/throat if inhaled.
- Propylene Glycol – can damage cell membranes and is linked to liver disease, kidney damage and cause inflammation of the skin.
- Phthalates – a known carcinogen linked to birth defects, reduced sperm count and certain cancers (banned in Europe).
- Metals – like lead, aluminum, arsenic, mercury, nickel, iron. These have estrogenic effects, and increase the risk of cancer. Metals are especially common in PCPs like antiperspirants.

Cleaning products/detergents –Pleasant-smelling house and laundry vs health risks?

Thousands of synthetic chemicals are used to create modern day fragrances for cleaning products; some have been linked to health impacts ranging from eye and skin irritation to hormone imbalance and risk of breast cancer. Furthermore, these ingredients are kept secret—the vast majority of manufacturers currently are not disclosing fragrance ingredients on websites or on the product label, and these ingredients are frequently claimed as confidential business information.

The term "fragrance" covers any substance, either natural or man-made, which conveys an odor or scent. Any one fragrance can be made up of potentially hundreds of different ingredients. The International Fragrance Association (IFRA, 2009) defines a fragrance ingredient as: "Any basic substance used in the manufacture of fragrance materials for its odorous, odor-enhancing or blending properties. Fragrance ingredients may be obtained by chemical synthesis from synthetic, fossil or natural raw materials or by physical operations from natural sources." Today, fragrances created for cosmetics, PCPs and cleaning products are dominated by synthetic, instead of natural, ingredients. Estimates indicate 80-90% of the raw materials used in fragrances today are synthetic. However, there has been very little research on the potential impacts of all these new synthetic ingredients on human health.

Women use cleaning products on average more than men do, and have higher exposure to potentially hazardous chemicals in fragranced cleaning products. Women also generally carry a higher percentage of body fat, where many chemicals tend to accumulate. Finally women can pass chemicals on to their developing children during pregnancy and later through breastfeeding.

Toxic substances in fragrance (Reiner, 2006, Roosens, 2007, :

- Synthetic musk galaxolide in 72% of products sampled, and tonalide in 32%, the highest levels

were found in laundry detergent, furniture polish and fabric softener.

- Musk xylene was found in 10% of products tested and musk ketone in 9% of cleaning products in another study.
- Perfumes contain the most allergens, some with as many as 21 different chemicals.
- Household cleaners contain an average of three different allergens
- Most commonly labeled allergens: linalool, limonene, geraniol and citronellol.
- 58 other volatile organic compounds (VOCs) emitted from products, several of which are considered hazardous or toxic.
- Phthalates, including dibutyl phthalate (DBP), diethylhexyl phthalate (DEHP), dimethyl phthalate (DMP), di-isononyl phthalate (DINP), di-isobutyl phthalate (DIBP) and diethyl phthalate (DEP) -are known to cause reproductive and developmental harm in laboratory animals and are linked to similar impacts in humans.

“Green” alternatives - how green really?

To avoid “SLS”, sodium coco sulfate (SCS) is used in “green” PCPs. The process for making SCS is the same as for SLS except rather than isolate a single fatty acid from the coconut oil (lauric acid for sodium lauryl sulphate) a broad cut of saturated fatty acids is used (C12 – C18 saturated fatty acids) and these are all turned into sulfates. From the typical fatty acid composition of coconut oil we can see that sodium coco sulfate would be about 66% sodium lauryl sulfate. Though as the proportion of lauryl sulfate in sodium coco sulfate is not strictly defined this percentage could be higher, and manufacturers are free to make it as high as they like. SCS, therefore, contains SLS as a predominant component, with all the concerns that are linked to that chemical. Basically it is just another way to hide SLS in formulations with yet another name. Both SCS and SLS are synthetic detergents and should never be part of any natural cleanser. Same applies for lauryl sulfate, laureth sulfate, coco sulfate or other synthetic detergents (www.ewg.org).

“Red” substances are being increasingly identified in most household products, even in “green” or “natural” called. A recent study investigated volatile organic compounds (VOCs) emitted from 25 common fragranced consumer products—laundry products, personal care products, cleaning supplies, and air fresheners—using headspace analysis with gas chromatography/mass spectrometry (GC/MS). The authors found 133 different VOCs emitted from the 25 products, with an average of 17 VOCs per product. Of these 133 VOCs, 24 are classified as toxic or hazardous under U.S. federal laws, and each product emitted at least one of these compounds. For “green” products, almost half of the products studied, emissions of these compounds were not significantly different from the other products (Steinemann, 2009).

Commonly encountered “red” substances included in household products “green” alternatives are the following (toxicity data according to EWG database is mentioned):

Retinyl Palmitate -Biochemical or cellular level changes, Cancer, Developmental/reproductive toxicity, Organ system toxicity

Oxybenzone – Enhanced skin absorption, Biochemical or cellular level changes, Developmental/reproductive toxicity, Endocrine disruption, Allergies/immunotoxicity, Organ system toxicity (non-reproductive), Persistence and bioaccumulation

Octinoxate – Enhanced skin absorption, Biochemical or cellular level changes, Developmental/reproductive toxicity, Endocrine disruption, Allergies/immunotoxicity, Organ system toxicity (non-reproductive), Persistence and bioaccumulation

Phenoxyethanol –Allergies/immunotoxicity, Irritation (skin, eyes, or lungs), Organ system toxicity (non-reproductive), Occupational hazards, Use restrictions

Fragrance – (which can be a chemical cocktail of anything) Ecotoxicology, Allergies/immunotoxicity, Irritation (skin, eyes, or lungs), Miscellaneous, Organ system toxicity (non-reproductive)

Retinyl acetate – Biochemical or cellular level changes, Cancer, Developmental/reproductive toxicity, Organ system toxicity (non-reproductive), Use restrictions

Heavy metals like tin and aluminum

Artificial colors made with aluminum

Retinyl palmitate – Biochemical or cellular level changes, cancer

Eugenol – Allergies/immunotoxicity, Organ system toxicity (non-reproductive), Use restrictions

Benzyl benzoate – Ecotoxicology, Endocrine disruption, Allergies/immunotoxicity, Occupational hazards, Use restrictions

Artificial colors – cancer, organ system toxicity, persistence and bioaccumulation

Aluminum powder – neurotoxin, Enhanced skin absorption, Organ system toxicity (non-reproductive),

Retinyl palmitate – Biochemical or cellular level changes, Cancer, Developmental/reproductive toxicity, Organ system toxicity (non-reproductive), Use restrictions

Octinoxate – Enhanced skin absorption, Biochemical or cellular level changes, Developmental/reproductive toxicity, Endocrine disruption, Allergies/immunotoxicity, Organ system toxicity (non-reproductive), Persistence and bioaccumulation

Polysorbate-60 – Biochemical or cellular level changes, Cancer, Developmental/reproductive toxicity, Organ system toxicity (non-reproductive), Use restrictions

Phenoxyethanol -Allergies/immunotoxicity, Irritation (skin, eyes, or lungs), Organ system toxicity (non-reproductive), Occupational hazards, Use restrictions

Ethanol – Enhanced skin absorption, Multiple, additive exposure sources, Organ system toxicity (non-reproductive)

Sodium laureth sulfate – Contamination concerns (ETHYLENE OXIDE, 1,4-DIOXANE, ETHYLENE OXIDE, 1,4-DIOXANE), Organ system toxicity (non-reproductive), Use restrictions

Diazolidinyl Urea – formaldehyde releaser that can cause cancer

3. “Red” substances in representative products from the Greek market

A preliminary investigation was performed in “green” products from the Greek market to check for the presence of “red” substances.

In particular, selected products that claimed to be “natural”, “non-toxic”, “organic” etc, were investigated through the EWG database according to their ingredients. Each ingredient was entered into the database to check for its classification/toxic effects known up-to-date.

The results of this preliminary investigation, which is still a work in progress, can be summarized as follows:

- Out of the 20 personal care products 18 contained one or more “red” or “yellow” substances.
- Out of 15 detergents/cleaning products, 12 contained one or more “red” or “yellow” substances.
- Among the above products, baby products were included, in the majority of them “red” or “yellow” substances were contained.

The “red” substances identified more frequently in the selected products, including baby care products, are:

- Titanium dioxide in its nano-form, which can penetrate the skin with adverse effects, mostly in deodorants, but also in body lotions and creams, including baby sunscreen products.
- Aluminum chlorohydrate, mostly in deodorants.
- Benzyl alcohol, in body lotions, creams and baby wipes.
- Cetearyl alcohol/ceteareth-20, in shampoo and shower gel, including baby shampoo and shower gel.
- Ceteareth-12, in shampoo and shower gel, including baby shampoo and shower gel.
- Geraniol, in shampoo and shower gel, including baby shampoo and shower gel.
- Parabens, in body lotions, creams, sunscreen and baby care products.
- Sodium benzoate, in body lotions, creams, sunscreen and baby care products.
- DMDM Hydantoin in baby care products.
- Coumarin in cleaning products and in baby care products.
- Cinnamic alcohol in cleaning products and baby care products.
- Acrylates in cleaning products and baby care products.
- Potassium alum in cleaning products and baby care products.

- Parfum, in the majority of products (with unknown composition).
- Ethylene oxide, 1,4 dioxane and hydroquinone were among the most expected impurities in the products.

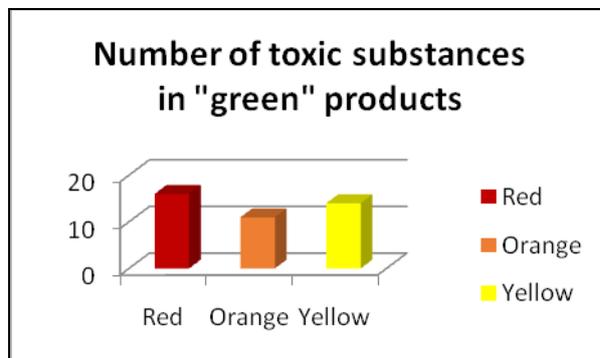


Figure 1. Number of “red”, “orange” and “yellow” substances contained in the “green” products studied.

“Orange” and “yellow” substances

In the majority of the products studied in the Greek market, the presence of “orange” and “yellow” substances was ubiquitous:

- PEG-200
- Hydrogenated Glyceryl Palmate
- Cocamidopropyl Betaine
- PEG-7
- Glyceryl Cocoate
- Diazolidinyl Urea
- Polysorbate 20
- Paraffinum Liquidum
- Phenoxyethanol
- Camomile
- Glycol
- Alcohol Denat
- Propylene Glycol
- PEG-12
- Dimethicone
- Limonene
- Dehydroacetic Acid
- Citronellol
- Linalool
- Benzyl cinnamate
- Alpha-isomethylionone
- Alcohol denat
- Octocrylene
- CI16035
- Cocamidopropyl betaine
- Sodium fluoride

- Phenoxyethanol
- Potassium sorbate
- Lecithin
- Tocopheryl acetate

4. Conclusions

“Red” substances are frequently detected in “green” household products routinely used in everyday life. To minimize exposure, and to encourage the production of really green products, the consumers need to read carefully the labels with the ingredients. The database created by EWG is very helpful. However, “hidden” red substances under the term “fragrance” or other names, or present as impurities, cannot be avoided. The regulation needs to be updated for public health protection. The problem is international. “Red” substances were identified also in green products from the Greek market during the present preliminary study. “Orange” and “yellow” substances are present as well.

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