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Full Length Research Paper

Identification and spectrophometric determination of hydroquinone levels in some cosmetic creams

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Hydroquinone, a dihydroxylated benzene derivative is used therapeutically as a topical agent for the treatment of certain skin conditions. Ten (10) cosmetic creams containing hydroquinone were randomly sampled based on consumer demand from the open market in Jos, Plateau State. The labels on the packages noticeably did not indicate the levels of hydroquinone present. The creams were subjected to colour and chromatographic test for identification, as well as assay by UV spectrophotometry. All ten (10) creams sampled, gave positive results to the test for hydroquinone. The level of hydroquinone was below 2% for seven of the creams, between 2 - 5% for two and above 5% for one. (The upper limit for cosmetic creams is 2 and 5% for therapeutic use). This study shows that despite the potential health hazards of hydroquinone, cosmetic products containing this agent are available for sale in the open market with inadequate warning on the labels.

Key words: Spectrophotometric analysis, hydroquinone, cosmetics.

INTRODUCTION

A cosmetic agent is a preparation used for the purpose of increasing beauty and hiding the defects of something-especially the face (Encyclopaedia Brit, 1979). Cosmetic preparations include skin care preparations; (creams, lotions, emollients and de-pigmentation agents such as hydroquinone, hair preparations, perfumes and fragrances) . Cosmetics used on the skin and cutaneous therapeutic agents include sunscreen moisturizers and topical anti-aging products. Dermatological therapeutic agents include ancient topical medications (with no theoretical basis for action) such as coal tar for psoriasis and agents developed through study of their structure-activity relationships and *in-vitro* pharmacokinetic parameters such as absorption, distribution, metabolism, excretion and toxicity. Products intended for treatment of abnormal conditions are not generally classified as cosmetics but as drugs (Encylop. Brit, 1979).

Hydroquinone is indicated clinically as a 2 - 5% ointment for the gradual bleaching of hyper-pigmented skin in conditions such as melasma, freckles and senile lentigines as well as chloasma. On the eye, conjuctival changes and depigmentation, as well as opacification and staining of the cornea are known to occur (Physicians Desk Reference, 1998). Hydroquinone, when applied to the skin, can cause dermatitis and allergy. Other local skin toxicities include corrosion, bleaching, pigmented colloid milium and ochronosis (Martindale, 1967). Occupational Safety and Health Administration (OSHA) U.S.A categorizes it as a mutagen.

When administered to mice, benzene and its metabolite, hydroquinone causes granulocytic differentiation of myeloblasts. Some studies indicate that hydroquinone darkens certain areas of the skin permanently, and has cancer-causing potential making it potentially hazardous (U.S EPA, 1993).

The U.S Environmental Protection Agency has not established a reference dose (RfD) for hydroquinone. However, EPA has calculated a provisional RfD of 0.04 mg/kg/d. EPA estimates that consumption of this dose or less over a lifetime would not likely result in the occurrence of chronic non-cancer effects. The RfD is not a direct estimator of risks but rather, a reference point to gauge the potential effects. As the amount and frequency

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Table 1. Thin layer chromatographic values.

Samples	Rf values: (solvent front; 10 cm)
A,B,C,D,E,F,G,H,I,J	0.92 - 0.97cm

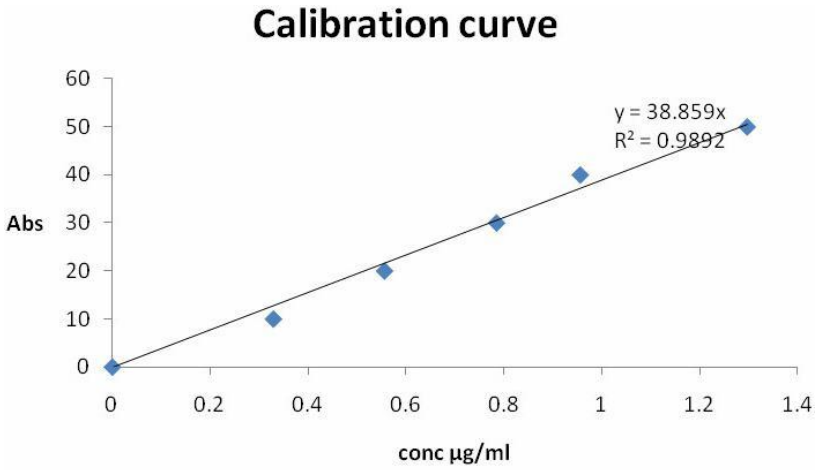

Figure 1. Spectroscopic assay: calibration curve (λ_{max} = 293 nm).

of exposures exceeding the RfD increase, the probability of adverse health effects also increases (U.S EPA, 1994). Nausea, vomiting, abdominal cramps and diarrhoea occurred in humans who chronically consumed water contaminated with hydroquinone.

However in one study, no effect on blood or urine parameters was observed in people who were exposed to low doses of hydroquinone for less than 6 months (U.S, EPA, 1987). Rats chronically exposed via gavages suffered from tremors, convulsions and death at the highest levels as well as toxic neuropathy (NTP, 1989). There are reported effects on the stomach and fore stomach lesions in mice (NTP, 1989).

In addition, rats studied developed weight loss, ate less and had aplastic anaemia when exposed to hydroquinone in their diet (NTP, 1989).

EXPERIMENTALS

Identification tests

The identification tests was carried out on ten (10) creams using the procedure described in the U.S.P (1985) and Clark's (1974) isolation and identification of drugs. For the thin-layer chromatographic determination, 2.5 g of each cream equivalent to about 50 mg of hydroquinone was dissolved in a mixture of equal volumes of methanol and chloroform (analytical grade) to make 50 ml (Table 1).

A 5 µl portion of each of the solutions so produced with an equal volume of a 1 mg/ml solution of USP hydroquinone RS was spotted on activated silica gel chromatographic plates (20 x 20 cm). The air-dried plates were developed using a methanol; chloroform (1:1) solvent system and the results compared to the reference standard.

Drug assay

A 1% solution (standard hydroquinone in methanol) was prepared as stock and serially diluted to give 10, 20, 30, 40 and 50 µg/ml solutions. For each cream sample, 0.5 g equivalent to about 10 mg hydroquinone was triturated with 25 ml of methanol, transferred into a 250 ml volumetric flask and made up to volume. A final concentration of 10 µg/ml was obtained by further dilution.

The absorbance's of the dilutions of the standard was read at the λ_{max} of 293 nm using methanol as blank on a Shimadzu UV-160A spectrophotometer. The measurements were carried out in triplicate to obtain a Beer's plot. The absorbance readings of the solutions of the (10) ten creams were also taken at the same wavelength and the concentrations determined from the calibration curve (Figure 1).

RESULTS and DISCUSSION

The choice of creams selected from the open market in Jos, Plateau State was informed based on market survey within the Jos main-market. They were said to be fast selling and commonly purchased brands.

The identification and chromatographic test confirmed the presence of hydroquinone in all ten creams at varying levels. Seven out of the ten, contained less than 2%, the permitted official range for cosmetic use and three above the range (Tables 1 and 2).

With Ferric chloride solution, all samples tested positive (Transient green colour produced) and with Chloroform and KOH granules, all samples tested positive (Yellow-red to red-brown colour produced).

Though hydroquinone is allowed for certain dermato-logical conditions, it's presence in creams meant to serve as emollients, gives cause for concern as to the potential

Table 2. Percent content of hydroquinone in creams.

Sample code name	Absorbance values	Concentration (µg/ml)	% Hydroquinone
A	0.465	17.5	3.5
B	0.574	12.5	4.3
C	0.074	2.0	0.4
D	0.819	31.0	6.2
E	0.256	9.0	1.8
F	0.109	3.5	0.7
G	0.147	5.0	1.0
H	0.180	6.0	1.2
I	0.173	5.5	1.1
J	0.258	9.0	1.8

health implications more so, as it is being used on intact skin for skin lightening and not for therapeutic purposes. The labels do not give adequate warning to the users about the levels of hydroquinone present and even with the NAFDAC regulatory law concerning sale of cosmetics 1993 No. 15 ("Prohibition of bleaching agents e.g. hydroquinone, corticosteroids, mercury and mercury compounds") it appears that these products are still being imported, sold and distributed in the open market.

The topical administration of hydroquinone is known to produce a reversible depigmentation of the skin by inhibition of the enzymatic oxidation of tyrosine to 3,4-dihydroxyl phenylalanine (DOPA) and suppression of other melanocyte metabolic processes. Re-exposure to sunlight or UV light will cause re-pigmentation (Guzzo et al., 1996).

Creams such as Diprosone®, Betnovate® and Hydro-cortisone® are prescription drugs, meant for clinical use and not as ordinary skin bleaching products. Mid-term effects such as leukoderma-en-confetti/occupational vitili-go have resulted in its ban in some countries (Westerhof and Kooyers, 2005). The National Toxicology Program under the Department of Health and Human Services in their study reports, observed that under the conditions of a 2-year gavage studies, no information is available on the carcinogenic effects of hydroquinone in humans but increased skin tumor incidence has been reported in mice treated dermatologically (Coffee Research Institute, 2001). Further studies on humans would give a better prognosis of adverse health implications.

RECOMMENDATION

Histological work could be carried out to determine the short-term and long-term effect on intact skin.

Conclusion

The idea for this study evolved from an earlier survey carried out (unpublished) on the attitudes of women to the use of creams containing bleaching agents. This study establishes the presence of hydroquinone in ten (10) creams randomly sampled and aims at raising the awareness of the need for more stringent control of the use and distribution of such products to prevent possible long-term adverse effects.

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