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Identification And Quantification of Dm Dm Hydantoin In Selected Shampoos

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ABSTRACT

DM DM hydantoin is a formaldehyde releaser, used in cosmetic products at concentrations up to 1.0%. It is found in products like shampoos, hair conditioners, hair gels, Rite Aid Liquid Lubricant, and skin care products. The present study is an attempt to develop a rapid but simple spectrophotometric method in the UV/ visible mode for the identification and quantification of DM DM hydantoin in cosmetic products like shampoos to aid regulatory agencies confirm manufacture's substantiation claims. Here, we use different brands of shampoos are selected and comparative study is made using the developed spectrophotometric method using ethanol solvent. By comparing the 4 samples (A, B, C, D) of shampoos with a selected standard shampoo, the concentration and percentage content of the different samples were calculated. The quantified amount (mg/ml) of DM DM Hydantoin were 1.7 ± 0.0124 , 0.541 ± 0.0011 , 1.956 ± 0.0132 , 0.245 ± 0.00045 , 0.3810 ± 0.00071 in standard and samples A, B, C, D respectively. The percentage content is low in sample C and high in sample B while comparing with the standard sample. This method can be utilize in industry to determine preservative content.

Keywords: DMDM Hydantoin, Preservative, Formaldehyde releaser, UV/Visible spectrophotometer

INTRODUCTION

Preservatives are substances added to various pharmaceutical dosage forms and cosmetic preparations to prevent or inhibit microbial growth. An ideal preservative would be effective at low concentrations against all possible micro-organism, be non-toxic and compatible with other constituent of the preparation and be stable for the shelf-life of the preparation [1-3].

DM DM Hydantoin is an antimicrobial formaldehyde releaser preservative with the trade name Glydant appeared as white crystals having very slight odor. It is used in cosmetic products at concentrations up to 1%. This ingredient is a formaldehyde donor containing up to 2% of the free aldehyde in equilibrium with the hydantoin [1-15]. The IUPAC name is 1,3-Bis(hydroxymethyl)-5,5dimethylimidazolidine-2,4-dione and the other names are 1,3-Dimethylol-5,5dimethylhydantoin and Glydant [6] [Figure 1].

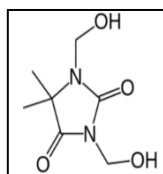


Figure 1: Chemical structure of DM DM Hydantoin [6].

The DM DM Hydantoin was found to be active and stable over a wide range of pH and temperature conditions. Its water solubility allows it to be incorporated in cosmetic formulations at room temperatures (high processing temperatures are not required), but it can be heated up to 80°C if necessary [6]. DMDM Hydantoin and Imidazolindinyl Urea and other formaldehyde-releasing preservatives are found in many common beauty products, including: body washes, lotions, creams, shampoo, hair products, baby soap, baby shampoo, nail polish, nail glue, eyelash glue and tinted cosmetics [8,11].

It performs their role in products by releasing formaldehyde in small amounts over time. Even low levels of formaldehyde are the cause for health concerns, including cancer, skin irritation, respiratory problems and ear, nose and throat concerns. According to the United States National Toxicology Program and the International Agency for Research on Cancer DM DM hydantoin is considered as a human carcinogen. It can also irritate skin with eczema, blisters, reddening, cracking and dryness. When inhaled, formaldehyde releasers may irritate eyes, nose and throat,

creating a cold or flu-like decongestion. Eventually this leads to respiratory problems including asthma, potential inner ear problems and ear infections, headaches and leaves the body more susceptible to cancer. Additionally, DMDM Hydantoin and Imidazolindinyl Urea have been linked to chest pain, chronic fatigue, depression, joint pain and insomnia [4,5,12].

As with many products, much of the health concerns come from cumulative exposure. The Cosmetic Ingredient Review committee permits formaldehyde releasers in skin care products, personal care items and cosmetics at 0.2% or lower. With low doses in thousands of products, it's impossible to determine the level of exposure for any given individual. Because even small amounts of formaldehyde can cause adverse health risks, the overall risk is great. Although, several methods have been developed for the identification and quantification of DM DM hydantoin in different personal care products like shampoos. However, we developed a rapid, easy and convenient method for the determination of DMDMH in shampoos.

MATERIALS AND METHODS

Materials

Five shampoos of different brands (standard, A, B, C, D) were purchased from local market, Malappuram, Kerala. Concentrated hydrochloric acid, Ethanol, Phenolphthalein indicator were purchased from Sigma Aldrich, Other materials including, a UV/VIS spectrophotometer with a variable wavelength, hot plate with a magnetic stirrer, Whattmann No. 4 filter paper and distil water were available in the research laboratory.

Composition of samples used

Standard: Water (Aqua), Sodium Laureth Sulphate, Glycol Distearate, Cocamidopropyl Betaine, Sodium Chloride, Fragrance (Parfum), Glycerin, Dimethicone, Dimethiconol, Acrylates/Beheneth-25 Methacrylate Copolymer, Styrene/Acrylates Copolymer, Guar Hydroxypropyltrimonium Chloride, Citric Acid, Tetrasodium EDTA, Amodimethicone, DMDM Hydantoin (Company claimed that Content of DM DM Hydantoin in 340 ml of standard is 0.5% of total chemical), PEG-45M, Tea-Dodecylbenzenesulfonate, Cocamide Mea, Lysine HCl, Arginine, PEG-9M, Cetrimonium Chloride, PPG-9, Propylene Glycol, Methylchloroisothiazolinone, Methylisothiazolinone, Mica (CI 77019), Titanium Dioxide (CI 77891), Yellow 5 (CI 19140), Red 33 (CI 17200) [Figure 2].

The concentration of DMDMH in control is 0.5% of the total chemical. In other samples the quantity of DMDMH is not mentioned. According to USP/NF grade, DMDMH is an approved preservative with permissible concentration of 0.2-0.6%. So, it was taken as standard [Table 1].

Table 1: Calibration of standard.

Quantity in ml	Absorbance
2	0.0152
4	0.0521
6	0.105
8	0.1532
10	0.192
Mean	0.1035
Standard deviation	0.06441031

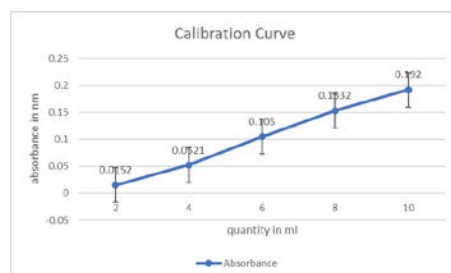


Figure 2: Calibration curve of standard.

Sample A: Water, Sodium Laurethsulphate, Dimethiconol and Trideceth-10 and Tea-dodecylbenzenesulfonate, Cocamidopropyl betaine, Perfume, Sodium chloride, Carbomer, Amodimethicone and Cetrimonium chloride and Trideceth-12, Glycol distearate, Guar hydroxypropyltrimonium chloride, Mica and Titanium dioxide, Disodium EDTA, DMDM hydantoin (quantity not mentioned), Hydrolyzed keratin, Ethylchloroisothiazolinone and Methylisothiazolinone, Sodium hydroxide.

Sample B: Water, Sodium Laureth Sulfate, Dimethiconol and Tea-Dodecylbenzene Sulfonate, Cocamide Mea, Perfume, Carbomer, Mica And Titanium dioxide, Guar Hydroxypropyltrimonium Chloride, Disodium EDTA, DMDM Hydantoin (quantity not mentioned), Disodium Distyrylbiphenyl Disulfonate, Lysine Hydrochloride, Methylchloroisothiazolinone and Methylisothiazolinone, Sodium Chloride, Sodium hydroxide, CI 42090.

Sample C: Water, Sodium laurethsulfate, Cocamidopropyl betaine, Dimethiconol and Tea-dodecylbenzene sulfonate, Glycol distearate, Disodium EDTA, Cocamide mea, Climbazole, Perfume, Carbomer, Mica and Titanium dioxide, Glycerin, PEG-45m, Sodium chloride, Sodium hydroxide, Guar hydroxypropyltrimonium chloride, Panthenol, *Argania spinosa* (argan) kernel oil, *Olea europaea* (olive) fruit oil, *Camellia oleifera* (camellia) seed oil, *Prunus dulcis* (sweet almond) oil, *Simmondsiachinensis* (jojoba) seed oil, Lysine hydrochloride, DMDM hydantoin (not mentioned), Methylchlorosothiazolinone and Methylisothiazolinone, CI 77266.

Sample D: Water, Sodium laurethsulfate, Glycerin, Cocomonethanolamide, Ethylene glycol, Glycolmonostearate, Cocodiethanolamide, *Thujaoccidentalis* bark extract, Polyquaternium-7, Lanolin ethoxylated, Acrylates/c10-30 alkyl acrylates cross polymer, Methylpropanediol, Polysorbate-80, salicylic acid, Isoleptosperme, Leptosperme, Flavesone, *Salix alba* (willow) bark extract, Sodium chloride, Cyclopentasiloxane, Dimethiconol, Dimethicone cross polymer and Phenyltrimethicone blend, Niacinamide, Methylchloroisothiazolinone & Methylisothiazolinone, *Melaleuca alternifolia* (tea tree) oil, Disodium EDTA, Sodium hydroxide, citric acid, DMDM hydantoin (quantity not mentioned), Perfume [Table 2 & 3, Figure 3].

Table 2: Quantification of Samples ($\lambda_{max}=242nm$).

Sample	Absorbance (nm)	Concentration (mg/ml)	Standard deviation	Standard error
A	0.301	0.542	0.0011	0.00049
	0.302	0.540		
	0.301	0.542		
	0.302	0.542		
	0.301	0.540		
	0.301	0.540		
		Mean = 0.541		
B	0.083	1.966	0.0132	0.00588
	0.084	1.942		
	0.083	1.966		
	0.084	1.942		
	0.083	1.966		
	0.083	1.966		
		Mean = 1.956		
C	0.664	0.245	0.00045	0.0002
	0.664	0.245		
	0.663	0.246		
	0.665	0.245		
	0.664	0.245		
	0.664	0.245		
		Mean = 0.245		
D	0.428	0.381	0.00071	0.00032
	0.428	0.381		
	0.429	0.380		
	0.427	0.382		
	0.428	0.381		
	0.428	0.381		
		Mean = 0.381		

Table 3: Concentration of DMDM Hydantoin In Different Samples.

Sl. No.	Sample	Absorbance (nm)	Mean Concentration(mg/ml)	Standard deviation	Standard Error
1	A	0.301	0.541	0.0011	0.00049
2	B	0.083	1.956	0.0132	0.00588
3	C	0.664	0.245	0.00045	0.0002
4	D	0.428	0.381	0.00071	0.00032
5	Standard	0.096	1.7	0.0124	0.0055

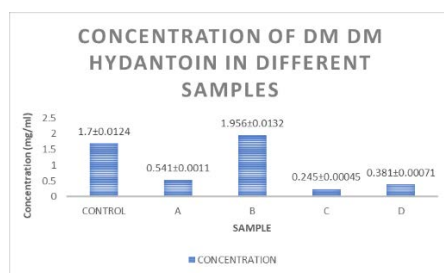


Figure 3: Concentration of DM DM hydantoin in different samples.

Each sample has analyzed for 6 times and the mean and standard deviation was analyzed by one-way ANOVA followed by Dunnet [Table 4].

Table 4: Statistical Analysis.

Samples	Standard deviation	Standard error
Standard	1.7±0.0124	0.0055
A	0.541±0.0011	0.00049
B	1.956±0.0132	0.00588
C	0.245±0.00045	0.0002
D	0.381±0.00071	0.00032

The P value was found to be <0.0001

METHOD

5ml sample of shampoo were weighed into a 250 ml flat bottomed flask. 50 ml of concentrated HCl was added and mixed. This mixture heated up to 55°C for 5 minutes with continuous stirring using a magnetic stirrer. The thoroughly mixed sample was filtered quickly into a 100 ml beaker using whattmann no.4 filter paper. 50 ml of ethanol was added to the mixture, corked and shaken sufficiently and allowed to stand and cooled to 25°C under refrigeration. The mixture was again filtered between whattmann no.4 filter papers. Using ethanol as standard, the wavelength of samples was read at 242 nm, to obtain characteristic peaks for DM DM hydantoin [2,13].

RESULTS AND DISCUSSION

DMDM hydantoin is an antimicrobial formaldehyde releaser preservative belonging to the class of hydantoin. A rapid but simple spectrophotometric method in the UV/ visible mode for the identification and quantification of DM DM hydantoin in cosmetic products like shampoos was developed and studied. By comparing the 4 samples (A, B, C, D) of shampoos with a standard shampoo, concentration and percentage content were calculated. The quantified amount (mg/ml) of DM DM Hydantoin were 1.7 ± 0.0124 , 0.541 ± 0.0011 , 1.956 ± 0.0132 , 0.245 ± 0.00045 , 0.381 ± 0.00071 in standard and samples A, B, C, D respectively (given in Table 2). The percentage content is low in sample C and high in sample B while comparing with the standard sample (given in Figure 3). This indicates sample C contain less amount of formaldehyde releasing preservative and it is better for use. This type of products reduces future health issues.

Quantification of control

Content of DM DM Hydantoin in 340 ml of standard is 0.5% of total chemical.

$$\text{Concentration of DM DM Hydantoin} = \frac{0.5 \times 340}{100} = 1.7 \text{ mg/ml at } 242\text{nm}$$

CONCLUSION

Selected five different shampoos and comparative study was done by using the developed spectrophotometric method using ethanol as solvent. By comparing the 4 samples (A, B, C, D) of shampoos with a selected standard shampoo, the concentration and percentage content of the different samples were calculated. The quantified amount (mg/ml) of DM DM Hydantoin were 1.7 ± 0.0124 , 0.541 ± 0.0011 , 1.956 ± 0.0132 , 0.245 ± 0.00045 , 0.381 ± 0.00071 in standard and samples A, B, C, D respectively. Sample C contain less amount of formaldehyde releasing preservative and it is better for use. This type of products reduces future health issues. A simple and easiest UV spectrophotometric method for the identification and quantification of DM DM hydantoin, preservative in shampoos have been developed and validated.

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