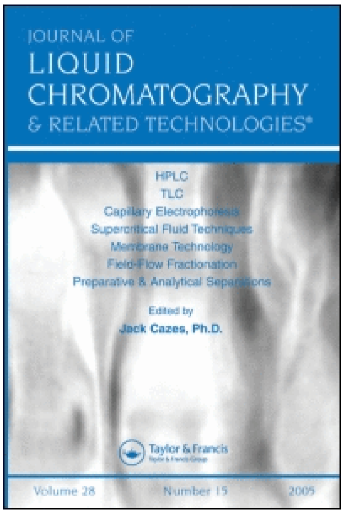

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DETERMINATION OF ZINC PYRITHIONE IN HAIR CARE PRODUCTS BY NORMAL PHASE LIQUID CHROMATOGRAPHY

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ABSTRACT

A liquid chromatographic method is described for the determination of zinc pyrithione (ZPT) in shampoos, hair conditioners and hair dressings. The method involves simultaneous transchelation to the cupric complex and extraction into methylene chloride. The cupric complex is then separated by normal phase liquid chromatography and detected by UV absorbance at 254 nm. A slight modification of the chromatographic conditions allows the separation of several common impurities. When compared to alternative techniques, this procedure offers improved specificity, precision and accuracy for ZPT, as well as decreased analysis time for multiple samples.

INTRODUCTION

Zinc pyrithione (ZPT), the Zn^{+2} chelate of 2-pyridinethiol-1-oxide, possesses a wide range of antibacterial and antifungal properties. It is one of the most effective antidandruff agents, and finds extensive use in antidandruff shampoos, conditioners, rinses, and hair dressings. Antidandruff shampoos are normally formulated with one or two percent ZPT, while hair rinses, conditioners, and dressings typically contain lower concentrations.

The analytical methods most commonly used at present for the determination of ZPT in hair care products include iodimetric titration(1) and polarography(2). Chelate-exchange(3), thin layer(4), and liquid chromatographic(5,6) methods have also been reported. All of these methods have some associated disadvantages. Titrimetric methods suffer from a lack of selectivity for zinc pyrithione and from the frequent presence of titratable interferents in hair care products. Although polarography offers somewhat greater specificity, problems can result from wave distortions associated with certain samples, making quantitation difficult. For this reason a "blank" formulation is often required for accurate analysis. Chelate-exchange techniques are time-consuming and do not offer very good accuracy due to their lack of specificity. Quantitative TLC techniques require the use of a spectrodensitometer and are also not very accurate or precise.

Zinc pyrithione is substantially insoluble in water, and is present in aqueous based products as a dispersion of fine solid particles. This fact has until recently handicapped the development of reverse phase liquid chromatographic methods. Although a reverse phase method not requiring derivatization has been reported(5), preparation of standards and samples appears tedious, and several mixed solvents are necessary to effect compatibility with the reverse phase system. More recently, HPLC after fluorescent pre-labeling has been applied to the determination of low concentrations of ZPT in cosmetic products and on hair (6).

While ZPT is soluble to some extent in common normal phase liquid chromatographic solvents, attempts at a direct normal phase analysis have failed, possibly due to transchelation with a variety of dissolved trace metals of construction from the chromatographic components. (Iron, for example, forms a much stronger complex with pyrithione than does zinc.) Pyrithione forms an extremely strong complex with cupric ion(7), however, and quantitative transchelation from the zinc to the copper complex is easily achieved. The copper complex is readily extracted into methylene chloride and can be separated on a normal phase column. This forms the basis of the present method.

EXPERIMENTAL

Equipment

Normal phase liquid chromatography was performed using a Varian 5060 liquid chromatograph with a Varian 8000 autosampler, Rheodyne 7126 loop injector, and Varian UV50 detector monitoring UV absorbance at 254 nm. A 30 cm x 3.9 mm uPorasil column (Waters Associates) was used for all analyses. Integration of peak areas was accomplished with a Varian Vista 402 data station. A home-constructed vigorous mechanical shaker was used to homogenize samples and extract sample solutions, and a Sorvall GLC-2B centrifuge was used to facilitate phase separation of the extracts.

Reagents

Copper pyrithione standard was prepared from the sodium salt and recrystallized to >99% purity. High purity standards of 2-pyridinethiol (2MP), 2,2'-dithiobis-pyridine-1,1'-dioxide (OMDS) and 2,2'-dithiobis-pyridine (PDS) were prepared and purified by the Biocides Group, Chemicals Division, Olin Corporation. ACS reagent grade cupric sulfate pentahydrate, SDA3A alcohol and AR grade isopropanol all were obtained from Fisher Scientific, and HPLC grade methylene chloride was obtained from Burdick & Jackson.

HPLC Mobile Phase

Mobile phase was prepared by pipetting 5 mL of isopropanol into 2 liters of methylene chloride. Standard cupric pyrithione solutions ranging from 15 to 120 ppm were prepared in mobile phase.

Preparation of Standards

Five standards of copper pyrithione in mobile phase, ranging from 15 to 120 ppm, were analyzed in duplicate and the resultant average peak areas plotted versus concentration. This standard curve had a correlation coefficient of 0.9996 by least squares linear regression.

Sample Preparation

Since ZPT is present in shampoos as a dispersion of solid particles in a viscous liquid matrix, and will gradually settle over a period of time, all liquid samples were shaken on a mechanical shaker for one hour prior to analysis to insure homogeneity. One gram of sample was then accurately weighed into a tared 100 mL screw top centrifuge tube, to which was added 50 mL of 10mM copper sulfate solution and 50 mL of methylene chloride. The tubes were sealed using TEFLON film and shaken for ten minutes on the mechanical shaker. Samples were subsequently centrifuged at 3000 rpm for 5 minutes to expedite phase separation.

Two mL of the methylene chloride layer was then drawn off with a glass pipet into a 10 mL volumetric flask and diluted to volume with methylene chloride. This solution was then transferred to an autosampler vial. Twenty microliters of each diluted sample solution and all standard solutions was then injected into the chromatograph. Quantitation was accomplished by comparison of sample peak area to a standard calibration plot.

Separation of Related Compounds

Several commonly found ZPT impurities: 2-pyridinethiol, 2,2'-dithiobis- pyridine-1,1'-dioxide, 2,2'-dithiobis-pyridine, and 2,2'-dithiobispyridine-1-oxide (MxDS) were seperated from the methylene chloride layer through the use of the gradient shown in Table 1.

TABLE 1

Gradient HPLC Conditions for Separation of Impurities

Time (min.)	CH_2Cl_2 w/0.25% Isopropanol	SDA3A ALCOHOL
0	99	1
4	99	1
7.5	93	7
15	40	60
20	99	1

RESULTS AND DISCUSSION

Zinc Pyrithione

A typical chromatogram of a methylene chloride extract of a shampoo sample is shown in Figure 1. The elution time for the copper pyrithione may be adjusted up or down by slightly decreasing or increasing the concentration of isopropanol in the mobile phase.

For recovery determinations, six samples of a control shampoo (without zinc pyrithione) were spiked to contain 0.5% by wt. of zinc pyrithione; an additional six samples were spiked to contain 2.0%. These samples

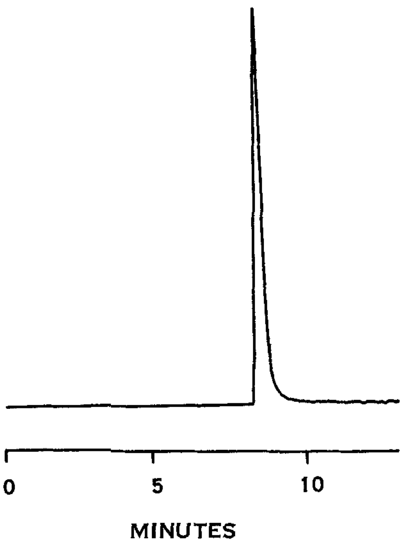

FIGURE 1. Chromatogram of Copper Pyrithione in Shampoo Extract

were taken through the entire sample preparation procedure described above. Recoveries for all samples shown in Table 2, were excellent, and relative standard deviations were within 1.5% at both concentrations. Analysis of the control sample with no zinc pyrithione added indicated the absence of interferents.

TABLE 2

ZPT Recoveries From Shampoo Matrix

Added (%)	Measured (%)	Recovery (%)
0.574	0.588	103
0.545	0.553	102
0.579	0.588	102
0.552	0.550	99.6
0.499	0.502	101
0.507	0.503	99.3
		Average = 101% ± 1.5%
2.13	2.14	100
2.04	2.06	101
1.93	1.97	102
2.05	2.05	100
2.02	1.99	98.5
2.09	2.07	99.0
		Average = 100% ± 1.3%

This method was further evaluated by analyzing five hair care products and comparing results to those obtained by polarography and iodine titration. This work is summarized in Table 3. In all cases, excellent agreement is shown between the present method and the titration procedure, while polarographic results for three of the samples, despite the use of a control shampoo for background correction, were significantly higher than those obtained by either HPLC or titration.

Related Impurities

Figure 2 shows a gradient separation of several of the commonly seen impurities originating from ZPT. The two most commonly found disulfides (OMDS and MxDS) are well separated from other components, while two other

TABLE 3

Comparison of HPLC to Other Techniques

Sample	HPLC	Polarography	I_2 Titration
Shampoo A	2.09%	2.45%	1.99%
Shampoo B	0.87%	1.10%	0.88%
Shampoo C	0.02%	0.13%	0.01%
Conditioner	0.99%	0.95%	1.01%
Hair dressing	0.05%	0.05%	0.05%

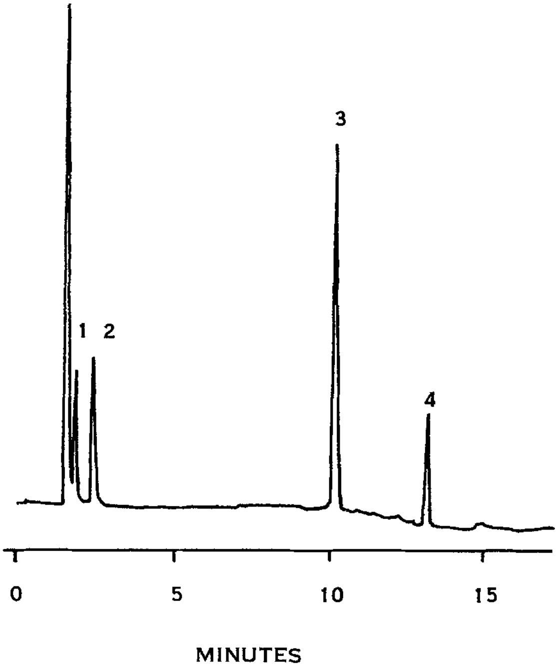

FIGURE 2. Separation of Several Impurities by Normal Phase Gradient HPLC.

Peak Identification:
1. Copper Pyrithione
2. 2MP and PDS
3. MxDS
4. OMDS

impurities (2MP and PDS) coelute under these conditions. While recoveries of these compounds were not determined, they all show a preferential solubility in methylene chloride, and could be quantitated by this technique after evaluation of recoveries from specific sample matrices.

In summary, the normal phase liquid chromatographic method described above for the determination of zinc pyrithione in hair care products is shown to be specific, giving good precision and accuracy. In addition, the analysis time is much shorter for this method, particularly when several samples must be analyzed.

REFERENCES

1. Olin Corp. internal method

2. Olin Corp. internal method

3. Kabacoff, B. L. and Fairchild, C. M., J. Soc. Cosmet. Chem. 26, 453 (1975)

4. Seymour, M. D. and Bailey, D. L., J. Chromatogr. 206 , 301 (1981)

5. Cheng, H. and Gadde, R. Rao, J. Chromatogr. 291, 434 (1984)

6. Kondoh, Y. and Takano, S., J. Chromatogr. 408, 255 (1987)

7. Sun, P.-J., Fernando, Q., and Freiser, H., Anal. Chem. 36, 2485 (1964)