

Investigation of the Effect of Moisture, Heat and Sunlight on Some Antibiotics Using Infra-Red Spectroscopy

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Abstract: The infra-red spectroscopic studies have been done on antibiotic exposed to moisture, sunlight and heat. The degradation studies of antibiotics in solid states during exposure for 60 days to various environmental conditions have been studied. Ampicillin pure drugs exposed to temperature 70°C exhibited loss in potency and degradation as evidenced by disappearance of absorption band at 1785 cm⁻¹ of the C = O (stretching) in the Beta-lactam ring. Appearance of new absorption band at 2926.2 cm⁻¹ C-H stretching and 3700 cm⁻¹ OH stretching showed evidence of hydrolysis when tetracycline was exposed to moisture. Chloramphenicol when exposed to sunlight, showed disappearance of absorption band at 3788.1 cm⁻¹ O-H stretching, 2920 cm⁻¹ C-H stretching and 2160 cm⁻¹ C-X stretching.

Key words: Infra-red spectroscopy, degradation, antibiotics, potencies and hydrolysis

INTRODUCTION

Several methods for the degradation studies of antibiotics with exposure to various conditions have been published. Only a few instrumental techniques viz: spectrophotometric, thin layer chromatography, high performance liquid chromatography, determinations of residual percent drug by different analytical techniques have been reported for the degradation studies of antibiotics. Degradation studies of Tetracycline Hydrochloride using TLC was reported by Omer *et al.* (1981). Da-Penwang (1983) studied degradation of procaine in aqueous system using high performance liquid chromatography. Fadiran and Grudzinski (1987) also studied degradation of chloramphenicol in sunlight and U.V radiations using thin layer chromatography.

Kabela (1982) studied the influenced of temperature on the stability of solid tetracycline Hydrochloride measured by high performance liquid chromatography.

The present study was therefore undertaken to investigate the effect of moisture, heat and sunlight on some antibiotics using infra-red spectroscopy.

MATERIALS AND METHODS

Tetracycline, Ampicillin, Chloramphenicol, pure drug and capsules were obtained from RAJRAB Nig Ltd, Ilorin, Nigeria and Medac Pharmaceutical Productions Limited, Oyo State, Nigeria.

Other chemicals and reagents were of analytical reagent grade and were used as received.

Exposure of samples to various conditions

Exposure to moisture: Total 80 capsules of tetracycline were put into Petri-dish. The Petri-dish was inside a damp room for a period of 60 days. Samples were removed after 60 days for analysis.

Exposure to sunlight: Five gram of the chloramphenicol pure drug was weighed into 100 mL amber coloured bottles with metallic caps. They were exposed to sunlight for a period of 60 days after which they were removed for analysis.

Exposure to temperature: Five gram of the Ampicillin pure drug was weighed into 100 mL amber coloured bottles with metallic caps. They were put in the oven at temperature of 70°C for a period of 60 days after which they were removed for analysis.

Infra-red spectra of selected samples of antibiotics pure drug and capsules after exposure for 60 days: Infra-red spectra of both the exposed samples and unexposed samples were run in the region of 4000-667 cm⁻¹ using KBr disc method.

RESULTS AND DISCUSSION

The IR Spectra of both the exposed and unexposed drugs are shown in Fig. 1-3. By comparing the spectrum

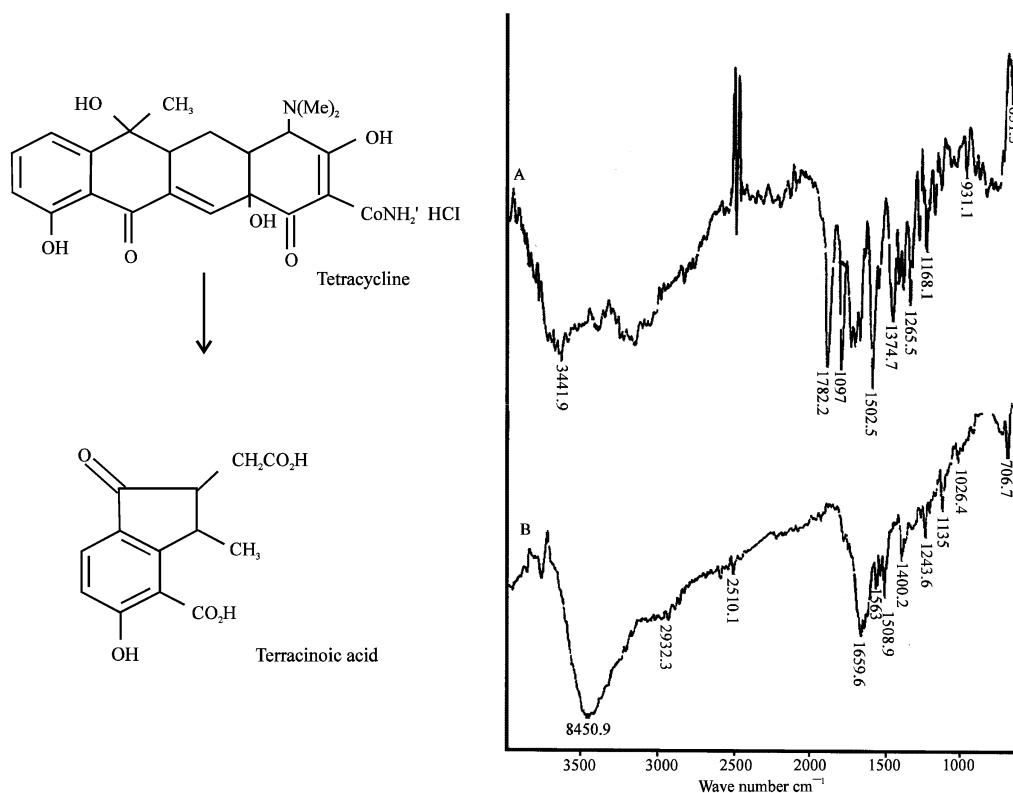


Fig. 1: (a) The infrared spectra ampicillin trihydrate pure drug (Unexposed) (b) ampicillin trihydrate pure drug exposed to 70°C for 60 days

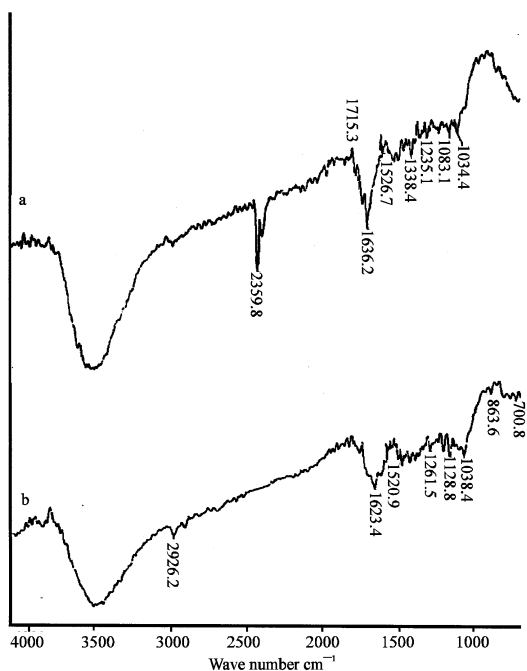


Fig. 2: (a) The infrared spectra trihydrate capsule (Unexposed) (b) Tetracycline capsule exposed to moisture for 60 days

of unexposed and exposed capsule from Fig. 1 it can be observed that the peaks at 2359.8 cm^{-1} due to H-X (stretching) and 1715.3 cm^{-1} due to C=O (stretching) in unexposed capsule disappeared in the spectrum of the exposed capsule. Also, the C=O stretching at 1715.3 cm^{-1} was found to have shifted to a lower peak at 1623.4 cm^{-1} in the exposed capsule. New peak at 2926.2 cm^{-1} due to C-H (stretching) appeared in the exposed capsule. The band at 3700 cm^{-1} in the exposed capsule is distinct as compared to unexposed. This is probably due to free OH, an indication that hydrolysis of tetracycline may have taken place. The infra-red spectra of the unexposed capsule and the exposed capsule when compared showed evidence of degradation. The proposed degradation product of the drug (Terracinoic acid) is shown in Fig. 2.

From Fig. 2, it can be observed that the peaks at 3788.7 cm^{-1} due to OH, 2920 cm^{-1} for C-H (stretching) and 2160 cm^{-1} for C-X (stretching) in unexposed pure drug disappeared in the pure drug exposed to sunlight. The infra-red spectra of the exposed drug and unexposed drug are not essentially the same which is an indication that degradation has occurred. The observation is in agreement with the work of Fadiran and Grudzinski (1987), who reported that chloramphenicol when exposed to

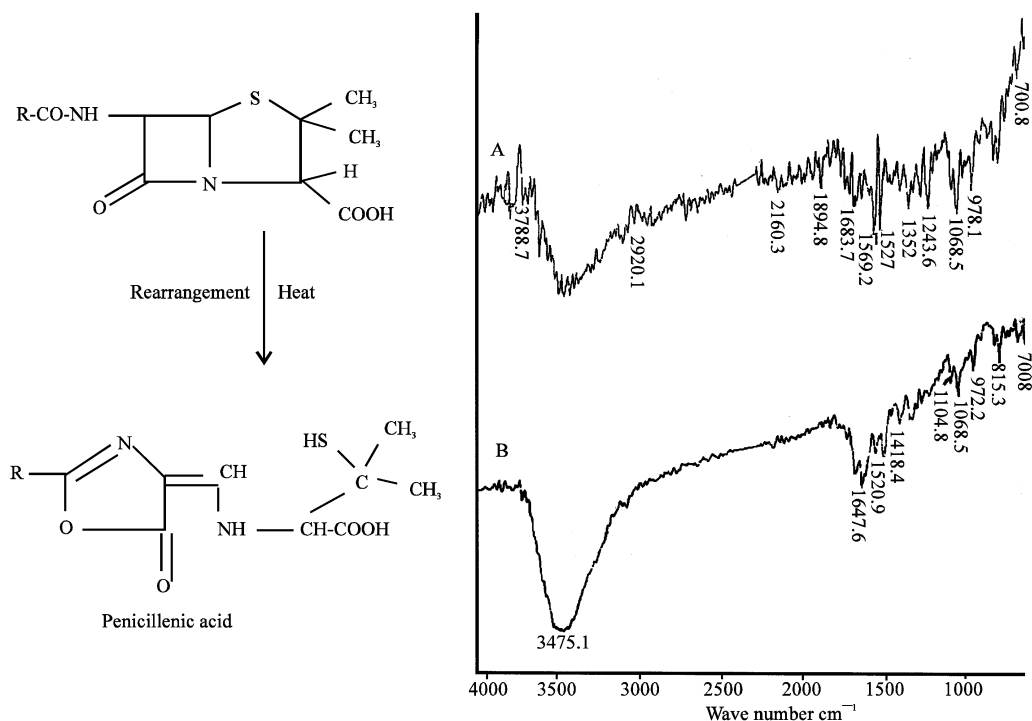


Fig. 3: (a) The infrared spectra chloramphenicol pure drug (Unexposed) (b) chloramphenicol pure drug exposed to sunlight for 60 days

sunlight the β bond to the aromatic ring undergoes cleavage to form one aromatic and alkyl radical.

It can be observed from Fig. 3 that the major peak at 178.2 cm^{-1} of the β lactam ring in ampicillin pure drug disappeared in ampicillin exposed to 70°C . Facile opening of the β lactam ring was brought about by heating. Heating of Ampicillin caused variety of re-arrangement and fragmentation products that no longer containing β lactam ring. This leads to the appearance of new band at 2932.3 cm^{-1} probably due to C-H stretching and 2510 cm^{-1} due to S-H stretching and C = N stretching at 1563 cm^{-1} in the Ampicillin exposed to 70°C to form penicillenic acid. The probable equation of the reaction as proposed by Bell (1970).

The 3 drugs showed evidence of degradation when exposed to moisture, heat and sunlight as revealed by infra-red spectroscopic analysis. The drugs should be protected from exposure to sunlight, excessive local heating and kept in dry conditions as much as possible.

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