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Composition of ampicillin determined by IR spectroscopy

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Abstract
In this article, we determined the composition of ampicillin by IR spectroscopy using a Bruker spectroscope. The IR spectrum of ampicillin contains bands between wavelengths of 4000cm^{-1} and 450cm^{-1}. The functional groups in the composition of ampicillin are: N-H, COO, OH, N-C, C=C. Ampicillin is a semisynthetic antibiotic of the penicillin class, belonging to the aminopenicillin subgroup. Its chemical composition is based on the beta-lactam nucleus characteristic of penicillins, formed by a beta-lactam ring fused to a thiazolidine ring. An aminobenzyl side chain is attached to this skeleton, which confers extensive antibacterial activity against Gram-negative bacteria, while maintaining efficacy against many Gram-positive bacteria. Ampicillin is usually formulated in salt form (e.g., ampicillin trihydrate or ampicillin sodium) to improve its stability and solubility. From a pharmaceutical point of view, preparations may include excipients such as stabilizing agents, diluents and substances for pH adjustment, depending on the pharmaceutical form (capsules, tablets, injectable powder). Its structural and pharmacological properties allow ampicillin to inhibit bacterial cell wall synthesis, which leads to its bactericidal effect.

Keywords: Composition, ampicillin, IR spectrum

Introduction

Ampicillin, commonly known as a broad-spectrum penicillin, is a type of aminopenicillin, a semisynthetic group of β-lactams that were developed for effectiveness against both gram-negative and gram-positive organisms. Aminopenicillins were created by joining penicillin to an amino group or side chain. Addition of the side chain significantly changed the activity of the drug against some bacteria. Initially these antimicrobials were effective against *Proteus mirabilis*, *E. coli*, *Shigella*, *Salmonella*, *Hemophilus* and *Neisseria* species. However due to changes in susceptibility, ampicillin is no longer the drug of choice in treating infections with several of these organisms, such as *E. coli* urinary tract infections, unless culture and sensitivity results indicate susceptibility [1-5].

The mechanisms of action of ampicillin are interference with cell wall synthesis by attachment to penicillin-binding proteins (PBPs), inhibition of cell wall peptidoglycan synthesis and inactivation of inhibitors to autolytic enzymes. Ampicillin is also generally inactivated by β-lactamases (See penicillin section for information on acquisition of resistance to β-lactams.). In recent years *Enterococcus faecium and Streptococcus pneumoniae* have begun to exhibit, through mutations, lowaffinity PBPs as a mechanism of resistance to aminopenicillins.

Ampicillin and amoxicillin share the same spectra of activity, although amoxicillin is characterized by superior bio-availability. Genera regarded to be generally susceptible to ampicillin and amoxicillin are *Staphylococcus*, *Streptococcus*, *Corynebacterium*, *Clostridium*, *Escherichia*, *Klebsiella*, *Shigella*, *Salmonella*, *Proteus* and *Pasteurella*, although many of these bacteria have acquired resistance. Ampicillin is often used to treat urinary infections with Gram-negative enteric bacterial etiologies. The drug is also used to treat respiratory tract infections. Additionally ampicillin is uniformly effective against group B *Streptococcus*, but is ineffective against *Enterobacter*, *Hemophilus influenzae*, *Pseudomonas* and indole positive *Proteus* infections. See the penicillin section for an explanation of uptake in body fluids and CSF. [6-17]

Materials and methods

Chemical structure

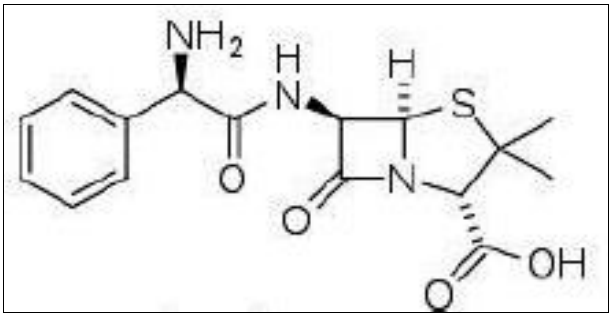

Fig 1: Chemical structure of ampicilina

ICL polystyrene standard #0009-7394-0025A, thin film reflectance: ±2% using SRS reflectance standards 50-010-DH27B-4878

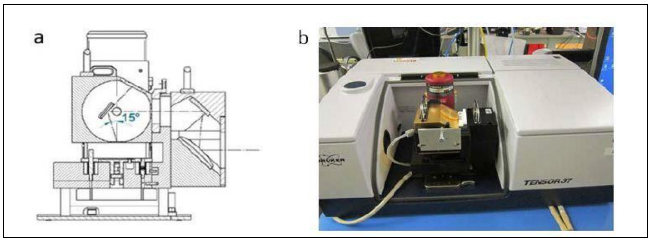

Fig 2: The Bruker 562-G integrating sphere (a) and Tensor 37 (b)

Results and discussions

Spectre IR ampicilina expected wave number: 1375 cm^{-1} for the N—C aromatic bond, 1610 cm^{-1} for aromatic C=C vibration, 1775 cm^{-1} and 3208 cm^{-1} for C=O and O—H vibration of carboxylic acid, 2090 cm^{-1} bending of S-C and 3450-3500 cm^{-1} for amine groups (fig. 3).

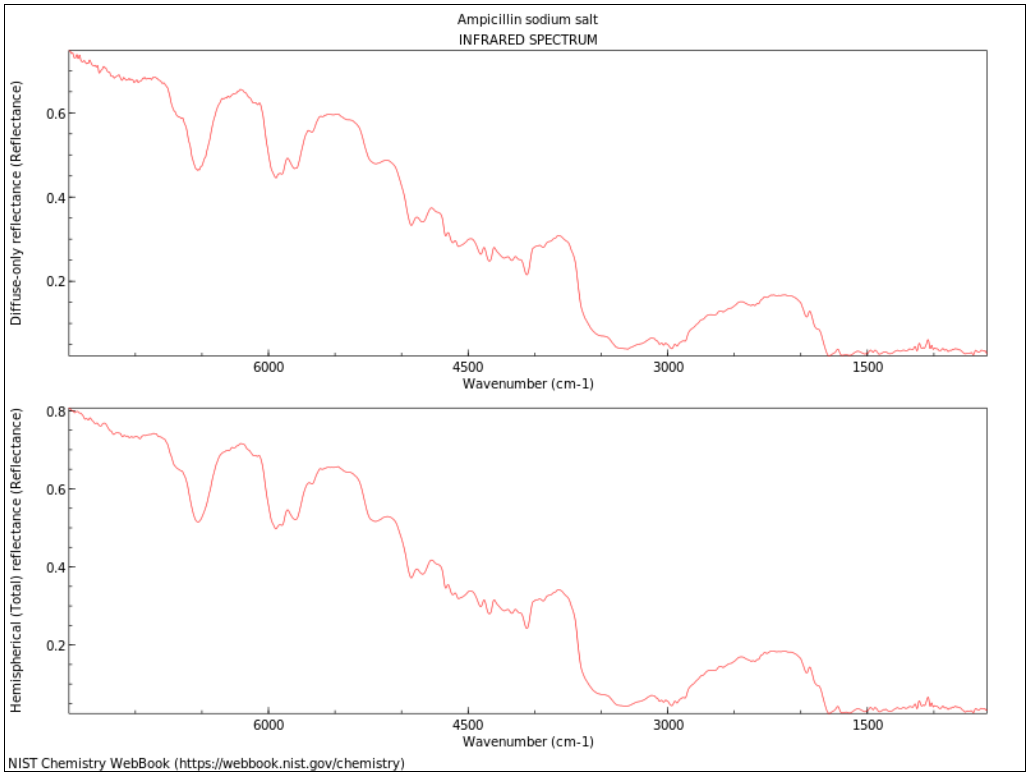

Fig 3: Spectrul IR al ampicillin

Conclusions

The functional groups in the composition of ampicillin are: N-H, COO, OH, N-C, C=C and were determined by IR spectroscopy using a Bruker spectrometer. Ampicillin and amoxicillin share the same spectra of activity, although amoxicillin is characterized by superior bio-availability. The composition of ampicillin, based on the beta-lactam nucleus typical of penicillins and its aminobenzyl side chain, explains both its extensive antibacterial spectrum and the mechanism of action on bacterial cell wall synthesis. In the form of stable salts and accompanied by excipients suitable for different pharmaceutical presentations, ampicillin maintains its efficacy and bioavailability. Overall, its structural features justify the use of ampicillin as a basic antibiotic in the treatment of various bacterial infections.

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