ANTIBIOTIC SYNTHESIS FROM MICROORGANISMS

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Аннотация:

В данной статье рассматривается процесс синтеза антибиотиков из микроорганизмов, их биологическое значение и возможности промышленного применения. В статье анализируются бактерии родов Acremonium chrysogenum, Streptomyces и их роль в синтезе бета-лактамных антибиотиков (цефалоспорина С, цефтриаксона натрия, Азобакта). В статье последовательно описаны процесс ферментации, образование 7-аминоцефалоспорановой кислоты (7-АЦК) из цефалоспорина С, а также этапы получения цефтриаксона натрия методом химической модификации. Результаты исследования показывают, что производство антибиотиков на основе микроорганизмов является не только экономически доступным, но и экологически безопасным и высокоэффективным биотехнологическим путем. Этот подход может также служить основным источником для создания новых видов антибиотиков в будущем.

Abstract:

This article discusses the process of synthesizing antibiotics from microorganisms, their biological significance, and the possibilities of their industrial application. The study specifically analyzes bacteria belonging to the Acremonium chrysogenum, Streptomyces genera, and their role in the synthesis of beta-lactam antibiotics (Cephalosporin C, Ceftriaxone sodium, Azobact). The article consistently describes the fermentation process, the formation of 7-aminocephalosporanic acid (7-ACA) from Cephalosporin C, as well as the stages of the production of Ceftriaxone sodium through chemical modification. The results of the study show that the production of antibiotics based on microorganisms is not only an economically affordable, but also an environmentally safe and highly efficient biotechnological route. This approach can also serve as the main source for the creation of new types of antibiotics in the future.

Ключевые слова:
Антибиотики, микроорганизмы, ферментация, цефалоспорин С, 7-АСА, цефтриаксон натрия, Азобакт, биотехнология.
Keywords:
Antibiotics, microorganisms, fermentation, Cephalosporin C, 7-ACA, Ceftriaxone sodium, Azobact, biotechnology.

Currently, the issue of synthesizing antibiotics using microorganisms is one of the most important and promising areas in the field of medicine and pharmacy. Antibiotics are substances produced by microorganisms or created on their basis. They stop the growth of pathogenic bacteria or completely destroy them. The discovery of antibiotics is one of the most important scientific achievements in human history, sharply reducing the mortality rate from various infectious diseases. Among microorganisms, genera such as Streptomyces, Acremonium chrysogenum, Penicillium are known as the most abundant sources of antibiotics. In particular, powerful antibiotics such as Ceftriaxone sodium are obtained semi-artificially from Cephalosporin C, which is synthesized by Acremonium chrysogenum. This process includes the stages of growing microorganisms (fermentation), isolating the antibiotic, enzymatic hydrolysis and chemical modification. In recent years, due to the increase in the number of antibiotic-resistant bacteria, improving existing antibiotics and increasing their effectiveness has become a pressing issue. Therefore, the efficiency is increased by adding beta-lactamase inhibitors such as Sulbactam (for example, the drug Azobact - a combination of Ceftriaxone and Sulbactam). The technology of synthesizing antibiotics from microorganisms is not only medical, but also economic and environmental. This method effectively uses natural resources, reduces waste, and produces a high-quality medicinal substance.

Acremonium chrysogenum is a filamentous fungus that synthesizes the antibiotic Cephalosporin C. The fermentation process is the process of microorganisms multiplying in a nutrient medium and producing a secondary metabolite (antibiotic). Fermentation biologically consists of two main stages:

1. Growth phase (trophic phase)

Fungal cells actively divide, their biomass increases.

At this stage, the main metabolites (proteins, lipids, amino acids) are synthesized.

2. Antibiotic formation phase (productive phase)

Cell growth slows down. The flow of energy is directed to secondary metabolism - that is, the formation of Cephalosporin C begins. In this process, the 7-aminocephalosporanic acid (7-ACA) molecule is enzymatically separated from

Cephalosporin C. This subsequently serves as the basis for the production of semi-synthetic antibiotics such as Ceftriaxone sodium.

Ceftriaxone sodium is a third-generation cephalosporin antibiotic, i.e. an antibiotic with a beta-lactam ring. It is obtained semi-synthetically from the natural derivative Cephalosporin C.

The process of obtaining Ceftriaxone sodium from Cephalosporin C is as follows.

1. When the Cephalosporin C molecule is broken down using special enzymes or chemicals, 7-ACA (7-aminocephalosporanic acid) is released.
2. When the 7-ACA molecule is attached to special chemical groups (for example: thiotriazine ring, oxime groups), its stability increases and Ceftriaxone sodium is formed.
3. The resulting substance is separated from the solution, purified by filtration and crystallization.

As a result, Ceftriaxone sodium is obtained in the form of white crystals. This substance is used in the production of medicines. Its main structure contains a β-lactam ring, which blocks the enzymes (transpeptidases) that synthesize the bacterial cell wall. As a result, the bacterial wall is destroyed and it dies.

According to the mechanism of action: Ceftriaxone stops the synthesis of the bacterial cell wall, that is:

1. Stops the growth of the bacteria.
2. The wall is destroyed.
3. The cell breaks down and dies.

The microbes affected include the following: Streptococcus pneumoniae, Staphylococcus aureus, Escherichia coli, Klebsiella spp, Neisseria gonorrhoeae, Salmonella, Shigella, Proteus, Haemophilus influenzae, etc.

Ceftriaxone sodium is currently used for a number of diseases, including respiratory tract infections (pneumonia, bronchitis), urinary tract infections, skin and soft tissue infections, abdominal infections, blood infections (sepsis), inflammation of the meninges (meningitis), sexually transmitted infections (e.g. gonorrhea).

When Ceftriaxone sodium and Sulbactam are used together, the spectrum of action expands and the effectiveness increases by 2 times. That is, it affects gram-positive, gram-negative, even β-lactamase-producing bacteria. Infection resistance decreases Sulbactam inhibits enzymes that break down antibiotics and is effective in treating severe infections, especially pneumonia, sepsis, skin and soft tissue infections, and urinary tract infections.

The combination of Ceftriaxone and Sulbactam is a protected antibiotic. It not only kills bacteria, but also eliminates the mechanism by which they develop antibiotic

resistance. It not only kills bacteria, but also destroys the mechanism by which they develop antibiotic resistance. That is why this drug is very effective in medicine, especially popular antibiotics such as **Azobact, Ceftriax-S, Monocef-SB**.

Azobact is a drug belonging to the group of antibiotics. It is used to treat bacterial infections. It contains Ceftriaxone and Sulbactam in a 2:1 ratio. Azobact is a "protected" form, which increases its effectiveness against bacteria that produce beta-lactamase. Sulbactam destroys this enzyme and reduces the risk of re-infection. Resistant bacteria are also defeated. Ceftriaxone sometimes has less effect on bacteria such as E. coli, Klebsiella, Proteus, Pseudomonas, because they produce beta-lactamase. Therefore, combining it with Sulbactam (Azobact) increases the effectiveness of the drug by 2 times

Azobact is used to treat the following infections: respiratory tract infections (bronchitis, pneumonia), blood infections (sepsis), urinary tract infections, abdominal infections, skin and soft tissue infections, female genital tract infections.

According to the method of administration, it is usually administered in the form of an injection (syringe) - intramuscularly or intravenously. The dosage is determined depending on the type of disease and the age of the patient.

It should be used only on the recommendation of a doctor!

Synthesis of antibiotics from microorganisms is one of the most effective areas of modern biotechnology. Studies show that microorganisms of the genera Acremonium chrysogenum and Streptomyces are the main natural sources of antibiotics, in particular, substances such as Cephalosporin C, which belongs to the beta-lactam class, and Ceftriaxone sodium derived from it. Fermentation processes are biologically important, as they increase the rate, quality and yield of antibiotic biosynthesis. The possibility of obtaining Ceftriaxone sodium through the formation of 7-aminocephalosporanic acid (7-ACA) from Cephalosporin C and subsequent chemical modifications provides the development of antibiotic production technology.

Analyses show that the production of antibiotics based on microorganisms is:

—economically inexpensive,

—environmentally safe,

—highly efficient biotechnological method.

Also, the combination of Ceftriaxone and Sulbactam (for example, Azobact) is of significant clinical importance in combating bacterial resistance.

In general, the field of synthesis of antibiotics from microorganisms serves as a solid scientific basis not only for improving existing drugs, but also for creating new generation antibiotics in the future.

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