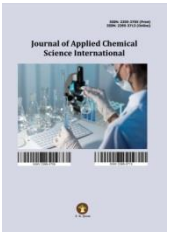

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FTIR Spectroscopy Analysis of Butanoic Acid

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

In this article, we determined the chemical composition of butanoic acid using FTIR spectroscopy. It is a short chain saturated fatty acid found in the form of esters in animal fats and plant oils. Acid butanoic is used in the manufacture of esters for artificial flavourings, as a food additive, in the manufacture of varnishes, and in decalcifying hides used in the manufacture of perfume, flavourings, pharmaceuticals, and disinfectants, used as an important flavouring agent in a number of food, including beer and may be present in cosmetic and detergent preparation. From the spectroscopy data, it appears that it is composed of groups: hydroxyl O-H, C-H stretching vibrations and -C=O stretching vibration.

Keywords: Composition; spectroscopy; butanoic acid.

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1. INTRODUCTION

Analyzing the composition of a product with FTIR is mainly used for the following purposes: identification and characterization of unknown materials such as films, solids, powders or liquids identification of contamination on or in a material such as particles, fibers, powders or liquids , identification of additives after extraction from a polymer matrix, to identify oxidation, segregation or impure monomers in failure analysis investigations.

Butyric acid, also known as butanoic acid, is a carboxylic acid with four carbon atoms. It is produced naturally in the body by intestinal bacteria, as a result of the fermentation of dietary fibers and is also found in certain products, such as butter and cheese. Butyric acid has a chemical structure that makes it soluble in water and is classified as a short-chain fatty acid. There are several types of butyric acid, including free butyric acid and bound butyric acid. Free butyric acid is the active form and functions as an energy source for intestinal cells, contributing to maintaining the health of the digestive tract. Bound butyric acid, on the other hand, is bound to other molecules, such as fiber and protein, and plays an important role in digestion and absorption of nutrients [1]. Butyric acid production in the body occurs mainly in the large intestine, where intestinal bacteria ferment indigestible dietary fibers such as cellulose and pectin. This fermentation produces butyric acid, along with other short-chain fatty acids. The resulting butyric acid plays a crucial role in maintaining intestinal health and the function of the immune system [2]. Among the most important properties of butyric acid, we mention:

1. Structure and chemical formula: Butyric acid, also known as butanoic acid, is a carboxylic acid with the chemical formula C4H8O2. It is a colorless substance with a strong smell, which is found naturally in butter and other food products.
2. Solubility and boiling point: Butyric acid is soluble in water, ethanol and ether. It has a melting point of -5 degrees Celsius and a boiling point of 163-164 degrees Celsius [2].
3. Production in the body: Butyric acid is produced by bacteria in the large intestine by fermenting fibers, including cellulose and starch. It plays an important role in maintaining the health of the intestines and the immune system [3,4].
4. Anti-inflammatory properties: Research has shown that butyric acid has anti-inflammatory properties, being able to reduce inflammation in the case of conditions such as Crohn's disease or ulcerative colitis. It can also have beneficial effects in the case of neurological diseases, such as Alzheimer's or Parkinson's [5]. Recent studies have shown that butyric acid can inhibit the production of pro-inflammatory cytokines and inflammatory enzymes, thus reducing inflammation in the body. It has also been found that it can have neuroprotective effects by protecting nerve cells against oxidative stress and inflammation.

The health benefits of butyric acid are multiple and have been supported by research and studies. Here are some of them:

1. Promoting intestinal health: Butyric acid is essential for intestinal health, because it nourishes the cells of the large intestine and helps repair the damaged intestinal wall. It can play an important role in the prevention and improvement of inflammatory bowel diseases, such as Crohn's disease and ulcerative colitis [6-9].
2. Contribution to weight control: Butyric acid can have a beneficial effect on body weight management. Studies suggest that it can help prevent weight gain and reduce the risk of obesity by promoting satiety and improving insulin sensitivity. Also, butyric acid can reduce fat storage [2].
3. Improving brain function: Butyric acid can have a positive impact on brain health. There is preliminary evidence suggesting that it may have neuroprotective benefits, by reducing inflammation and supporting the formation of myelin, an insulating layer that surrounds nerve fibers. These effects can contribute to the prevention of neurodegenerative diseases such as Alzheimer's and Parkinson's [7-14].
4. Fight inflammation: Butyric acid has strong anti-inflammatory properties and can help reduce systemic inflammation, which is a risk factor for many chronic diseases, including heart disease and diabetes. By reducing inflammation, butyric acid can contribute to maintaining general health and preventing conditions associated with chronic inflammation [15-22]

2. MATERIALS AND METHODS

The traditional method to obtain butyric acid is from petroleum feedstocks, which is unsustainable and causes environmental concerns. One alternative is through fermentation, using obligate anaerobic bacteria, like Butyribacterium, Butyrivibrio, Eubacterium, and Fusobacterium.

FT-IR spectrum were accomplished and recorded with Fourier-Transform infrared spectrophotometer (Bruker , Alpha ATR) between 4000 and 375 cm^{-1}, with resolution of 4 cm^{-1}.

Fig. 1. Infrared spectrophotometer Bruker

3. RESULTS AND DISCUSSION

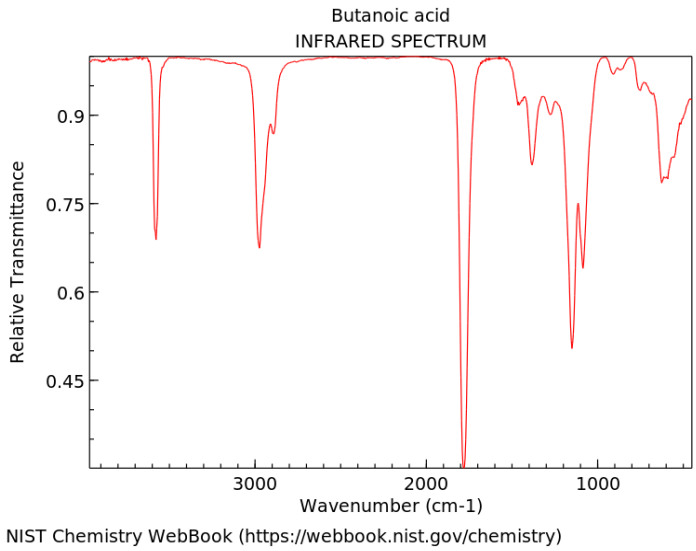

Fig. 2. Infrared spectrum analysis result

The -CO_2H group characteristic of carboxylic acids shows two absorptions in IR spectroscopy. The O-H bond belonging to the carboxyl group shows absorption bands between 2500 and 3300cm^{-1}. The characteristic absorption band of the C=O bond appears between 1710 and 1760 cm^{-1}. In the case of other groups containing the carbonyl group, the frequency of the C=O band decreases by 20 to 30 cm^{-1}.

4. CONCLUSION

The following conclusions can be drawn from the IR spectrum of butanoic acid:

- the O-H group has absorption bands between 2500 and 3300cm^{-1}.
- the C=O group presents bands between 1710 and 1760cm^{-1}.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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