International Journal of Advanced Education
www.allpaperjournal.com
Online ISSN: 3107-9601
Received: 17-01-2026, Accepted: 16-02-2026, Published: 03-03-2026
Volume 2, Issue 1, 2026, Page No. 99-100

Cotton composition determined by IR spectroscopy

Ioana Stanciu*
Faculty of Chemistry, Department of Physical Chemistry, University of Bucharest, Elisabeta Blvd, Bucharest, Romania

Abstract
In this article, we determined the composition of cotton by IR spectroscopy using a Nicolet spectroscope. Infrared (IR) spectroscopy was employed to analyze and confirm the chemical composition of cotton fibers. The spectrum of the cotton sample displayed characteristic absorption bands corresponding to cellulose, the primary structural component of cotton. Major peaks were observed at approximately 3330 cm^{-1} (O–H stretching), 2900 cm^{-1} (C–H stretching), 1640 cm^{-1} (adsorbed water), and 1030 cm^{-1} (C–O–C stretching), consistent with polysaccharide structures. The absence of significant peaks attributed to synthetic polymers or protein-based materials confirmed the sample's natural cellulose composition. This study demonstrates that IR spectroscopy provides a rapid, non-destructive method for identifying and verifying the purity and molecular structure of cotton fibers.

Keywords: Chemical composition, cotton, IR spectroscopy

Introduction

Cotton is a natural fiber obtained from the plant of the same name. Cultivated since ancient times, this is one of the most widely used natural fibers at the moment. An integral part of the mallow family, with delicate flowers, cotton is an easy-to-process plant. The fibers produced around its seeds are soft and fluffy, making it ideal for textile use.

Cotton requires warmth, germinating at temperatures of 12 – 14 degrees Celsius. This plant grows at temperatures exceeding 20 degrees Celsius. In the event of frost or frost, the sensitivity of this plant is increased. On the other hand, although it loves water, cotton also resists well in drought conditions. During the cultivation and harvesting stages, cotton gradually changes its color from yellow to red [1, 5].

After harvesting the cotton, its seeds must be removed in order to process the fiber. In the past, this was done by combing. Now, the process is carried out using the cotton gin. When several wavy fibers are gathered, stretched and twisted, they form a strong thread, easy to weave, knit or dye.

Since cotton is a highly flammable plant, with numerous air bubbles in its composition, it is necessary to chemically treat it in order to reduce this risk. This is achieved by mixing natural fibers with certain amounts of cotton wool, in order to increase the strength of the fiber obtained. In addition, this process adds texture to the finished product obtained.

Short-length cotton is white, with a yellowish tinge. Medium-length cotton has the same shade, being processed through the carding process. The threads obtained in this way are resistant, leading to the creation of medium-quality fabrics.

Long-length cotton is white. Its appearance is shiny, silky and includes a reduced amount of impurities. The threads obtained from it, by spinning, are very fine and resistant. Thus, this cotton is considered the ideal option for making the highest quality textiles.

Organic cotton is obtained without the infestation of plants with pesticides during cultivation or the processing process. It is the most suitable option for making textiles, as it does not pose health risks.

Here are the main stages of the cotton processing process:

- **Cotton cleaning:** Impurities are removed from the cotton that reaches the textile factory.
- **Cotton ginning:** The fiber is broken into smaller pieces.
- **Cotton carding:** The fibers are separated, and the waste or those that are too short are eliminated.
- **Cotton spinning:** the fibers are reduced to smaller structures, which are straightened and then twisted.
- **Weaving, knitting or other processing processes:** Depending on the results that are desired to be obtained, the cotton fibers obtained are woven, knitted or processed in other ways (scorching, desizing, bleaching, mercerization or dyeing).

Here are the most important properties of cotton, which make it an advantageous choice for use in the textile sector:

- Cotton is a 100% natural textile material, being the ideal choice for making outfits that are beneficial for the skin.
- This material is non-allergenic, representing the perfect option for people who experience allergic reactions.
- Cotton absorbs and eliminates moisture easily, thus keeping the body ventilated, while wearing cotton clothes.

People who suffer from asthma can benefit from the advantages of this organic material, since cotton does not release small particles, which could trigger attacks specific to this condition.

Cotton can be processed at high temperatures, without affecting the durability and quality of textile products obtained from this material [6, 9].

This organic material can be easily sterilized, a property that makes it the ideal choice for making textiles for babies.

Materials and methods

The fibers were also investigated using Fourier transform infrared spectroscopy (FTIR – Nicolet IS10 – Thermo Scientific) with attenuated total reflectance (ATR).

Fig 1: FTIR spectrometer Nicolet

Results and discussions

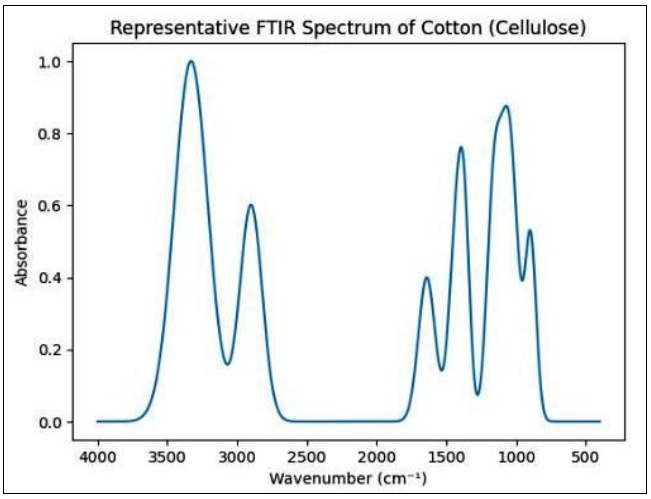

Fig 2: FTIR spectrum of cotton

Figure 2 shows the ATR-FTIR spectrum of the cotton fiber and typical bands of cellulose, lignin and hemicellulose are observed. The strong peak observed at 3330 cm^{-1} is characteristic of the hydroxyl (OH) groups of cellulose, lignin and water [12]. The peak at 2896 cm^{-1} is characteristic of the stretching vibration of C-H present in cellulose and hemicellulose [9], and the band at 1622 cm^{-1} may be related to the presence of water in the fibers [10].

The absorption band at 1428 cm^{-1} is associated with the CH2 symmetric bending of the cellulose. The absorption bands at 1360 and 1315 cm^{-1} are relative to bending vibrations of the C-H and C-O groups, respectively, of the aromatic rings in cellulose polysaccharides. Intense peak vibrations observed at 1032 cm^{-1} are related to the (CO) and (OH) stretching vibrations of the polysaccharide in cellulose. The peak at 894 cm^{-1} indicates the presence of β-glycosidic linkages between monosaccharides [11, 13].

Conclusions

Cotton contains the following functional groups: C-O-C, C-H and OH for wavelengths between 3330cm^{-1} and 894cm^{-1}. Short-length cotton is white, with a yellowish tinge. Medium-length cotton has the same shade, being processed through the carding process. The yarns obtained in this way are resistant, leading to the creation of medium-quality fabrics. The infrared spectroscopic analysis confirmed that cotton is primarily composed of cellulose. The characteristic absorption bands corresponding to O–H, C–H, and C–O–C functional groups were clearly identified, matching the known spectral features of polysaccharides. The absence of peaks related to synthetic polymers or other impurities indicates that the sample was composed of pure natural cellulose. Therefore, IR spectroscopy proves to be an effective, reliable, and non-destructive method for determining the chemical composition and verifying the purity of cotton fibers.

References

1. Subagio A, Morita N. Food Chemistry,2003:81:97–102.
2. Dupont J, White PJ, Carpenter MP, Schaefer EJ, Meydani SN, Elson CE, *et al*. Journal of the American College of Nutrition,1990:9(5):438-470.
3. Veljković VB, Biberdžić MO, Banković-Ilić IB, Djalović IG, Tasi MB, Nježić ZB, *et al*. Renewable and Sustainable Energy Reviews,2018:91:531-548.
4. Beadle JB, Just DE, Morgan RE, Reiners RA. Journal of the American Oil Chemists' Society,1965:42(2):90-95.
5. Strocchi A. Journal of Food Science,1982:47(1):36-39.
6. Stanciu I. Rheological behaviour of biodegradable lubricant, Journal of Science and Arts,2019:3(48):703-708.
7. Stanciu I. Rheological investigation of soybean oil from soya beans, Journal of Science and Arts,2019:4(49):938-988
8. Stanciu I. Modeling the temperature dependence of dynamic viscosity for rapeseed oil, Journal of Science and Arts,2011:1:55-58.
9. Satyanarayana KG, Guimarães JL, Wypych F. Studies on lignocellulosic fibers of Brazil. Part I: Source, production, morphology, properties and applications. Composites Part A-Applied Science and Manufacturing,2007:38(7):1694-1709. doi:10.1016/j.compositesa.2007.02.006
10. De Rosa IM, Kenny JM, Puglia D, Santulli C, Sarasini F. Morphological, thermal and mechanical characterization of okra (abelmoschus esculentus) fibers as potencial reinforcement in polymer composites. Composite Science and Technology,2010:70(1):116-122. doi:10.1016/j.compscitech.2009.09.013
11. Romanzini D, Ornaghi Jr. HL, Amico SC, Zattera AJ. Preparation and characterization of ramie-glass fiber reinforced polymer matrix hybrid composites. Materials Research,2012:15(3):415- 420. http://dx.doi.org/10.1590/S1516-14392012005000050
12. Tomczak F, Satyanarayana KG, Sydenstricker TH. Studies on lignocellulosic fibers of Brazil: Part III – Morphology and properties of Brazilian curauá fibers. Composites Part A: Applied Science and Manufacturing,2007:38(10):2227-2236. doi:10.1016/j.compositesa.2007.06.005
13. Sgriccia N, Hawley MC, Misra M. Characterization of natural fiber surfaces and natural fiber composites. Composites Part A-Applied Science and Manufacturing,2008:39(10):1632-1637. doi:10.1016/j.compositesa.2008.07.007