

Fourier Transform Infrared and Ultraviolet-Visible Spectroscopic Characterization of Ammonium Acetate and Ammonium Chloride: An Impact of Biofield Treatment

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Abstract

Ammonium acetate and ammonium chloride are the white crystalline solid inorganic compounds having wide application in synthesis and analytical chemistry. The aim of present study was to evaluate the impact of biofield treatment on spectral properties of inorganic salt like ammonium acetate and ammonium chloride. The study was performed in two groups of each compound i.e., control and treatment. Treatment groups were received Mr. Trivedi's biofield treatment. Subsequently, control and treated groups were evaluated using Fourier Transform Infrared (FT-IR) and Ultraviolet-Visible (UV-Vis) spectroscopy. FT-IR spectrum of treated ammonium acetate showed the shifting in wavenumber of vibrational peaks with respect to control. Like, the N-H stretching was shifted from 3024-3586 cm^{-1} to 3033-3606 cm^{-1} , C-H stretching from 2826-2893 cm^{-1} to 2817-2881 cm^{-1} , C=O asymmetrical stretching from 1660-1702 cm^{-1} to 1680-1714 cm^{-1} , N-H bending from 1533-1563 cm^{-1} to 1506-1556 cm^{-1} etc. Treated ammonium chloride showed the shifting in IR frequency of three distinct oscillation modes in NH_4^+ ion i.e., at ν_1 , 3010 cm^{-1} to 3029 cm^{-1} ; ν_2 , 1724 cm^{-1} to 1741 cm^{-1} ; and ν_3 , 3156 cm^{-1} to 3124 cm^{-1} . The N-Cl stretching was also shifted to downstream region i.e., from 710 cm^{-1} to 665 cm^{-1} in treated ammonium chloride. UV spectrum of treated ammonium acetate showed the absorbance maxima (λ_{max}) at 258.0 nm that was shifted to 221.4 nm in treated sample. UV spectrum of control ammonium chloride exhibited two absorbance maxima (λ_{max}) i.e., at 234.6 and 292.6 nm, which were shifted to 224.1 and 302.8 nm, respectively in treated sample.

Overall, FT-IR and UV data of both compounds suggest an impact of biofield treatment on atomic level i.e., at force constant, bond strength, dipole moments and electron transition energy between two orbitals of treated compounds as compared to respective control.

Keywords: Ammonium acetate; Ammonium chloride; Biofield treatment; Fourier transform infrared spectroscopy; Ultraviolet spectroscopy

Introduction

Ammonium acetate ($\text{CH}_3\text{COONH}_4$) is a white crystalline solid, water soluble compound derived from the chemical reaction ammonia and acetic acid. Being a salt of weak base and weak acid, it possesses several distinct applications like, it is used as an aqueous buffer for High-Performance Liquid Chromatography (HPLC) with Evaporative Light Scattering Detector (ELSD) and Electrospray Ionization Mass Spectrometry (ESI-MS) of proteins [1,2]. It is also used as a food additive to regulate the acidity. Therapeutically, it is reported as an antidiuretic and antipyretic and also as a nutrient [1,3]. Ammonium acetate is also used as an intermediate and catalyst in numerous chemical reactions [1,4]. On the contrary, ammonium acetate also associated with its toxicities like flaccidity of facial muscles, generalized discomfort, tremor, anxiety, and impairment of motor performance [3].

Ammonium chloride (NH_4Cl) is also a white crystalline inorganic salt, having high solubility in water. The natural and mineralogical form of ammonium chloride is known as sal ammoniac. The ammonium chloride has wide application in the field of medicine, agriculture and in food. In medicine, it is used as an expectorant in cough syrup due to irritative effect on the bronchial mucosa. Ammonium chloride causes the nausea and vomiting effects owing to irritative effect on gastric mucosa [5]. It is also used as a systemic acidifying agent for the treatment of severe metabolic alkalosis, and to maintain the urine at acidic pH in the treatment of urinary-tract disorders [6]. In food products, ammonium chloride is used as an additive or feed supplement for cattle and as a nutrient for yeast and other microbes [7,8]. It is also used to improve the crispness of cookies and snacks items. In agriculture, the ammonium chloride is used as an important

source of nitrogen in fertilizers [9]. The chemical and physical stability of any chemical compound are most desired qualities that determine its shelf life and effectiveness [10]. Hence, it is advantageous to find out an alternate approach, which could enhance the stability of compounds by altering the structural properties of these compounds. Recently, biofield treatment is reported to alter the physical, and structural properties of various living and non-living substances [11,12]. The relation between mass-energy was described by Einstein through a well-known equation $E=mc^2$ [13]. Planck M gave a hypothesis that energy is a property of matter or substances that neither can be created nor destroyed but can be transmitted to other substances by changing into different forms [14]. According to Maxwell JC, every dynamic process in the human body had an electrical significance [15]. Researchers have experimentally demonstrated the presence of electromagnetic field around the human body using medical technologies such as electromyography, electrocardiography and electroencephalogram [16]. This electromagnetic field of the human body is known as biofield and energy associated with this field is known as biofield energy [17]. Mr. Trivedi has the ability to harness the energy from environment or

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universe and can transmit into any object (living or nonliving) around this Globe. The object(s) always receive the energy and responding into useful way, this process is known as biofield treatment [11,12]. Mr. Trivedi's unique biofield treatment is also called as The Trivedi Effect, and known to alter the characteristics of many things in the verities of research fields including microbiology [11,18], agriculture [19,20], and biotechnology [21,22]. Recently, impact of biofield treatment on atomic, crystalline and powder characteristics as well as spectroscopic characters of different materials were studied and alteration in physical, thermal and chemical properties were reported [12,23,24].

Considering the effects of biofield treatment on various living and nonliving things, the study was aimed to evaluate the impact of biofield treatment on spectral properties of ammonium acetate and ammonium chloride. The effects were analyzed using Fourier Transform Infrared (FT-IR) and Ultraviolet-Visible (UV-Vis) spectroscopic techniques.

Materials and Methods

Study design

The ammonium acetate and ammonium chloride were procured from Sigma-Aldrich, India. Each compound was divided into two parts and coded as control and treatment. The control samples were remained as untreated, and treatment samples were handed over in sealed pack to Mr. Trivedi for biofield treatment under laboratory conditions. Mr. Trivedi provided this treatment through his energy transmission process to the treatment groups without touching the samples. The control and treated samples of ammonium acetate and ammonium chloride were evaluated using FT-IR and UV-Vis spectroscopic techniques.

FT-IR spectroscopic characterization

For FT-IR analysis of control and treated samples of ammonium acetate and ammonium chloride, the samples were crushed into fine powder. Consequently, the crushed powder was mixed in spectroscopic grade KBr in an agate mortar and pressed into pellets with a hydraulic press. FT-IR spectra of were acquired on Shimadzu's Fourier transform infrared spectrometer (Japan) with frequency range of 500-4000 cm^{-1} and a maximum resolution of 0.5 cm^{-1} . The analysis was carried out to evaluate the impact of biofield treatment at atomic level such as force constant, dipole moment, and bond strength in chemical structure [25].

UV-Vis spectroscopic analysis

UV spectra of control and treated ammonium acetate and ammonium chloride were acquired on Shimadzu UV-2400 PC series spectrophotometer with 1 cm quartz cell and a slit width of 2.0 nm. The study was carried out using wavelength in the range of 200-400 nm. The UV spectral analysis was performed to determine the effect of biofield treatment on the energy gap between bonding ($\pi-\pi^*$) and nonbonding ($n-\pi^*$) electrons transition [25].

Results and Discussion

FT-IR spectroscopic analysis

The FT-IR spectra of control and treated ammonium acetate are shown in Figure 1 and the IR spectral interpretation results are reported in Table 1. The FT-IR spectrum of control ammonium acetate (Figure 1a) showed the IR peaks at 3024-3586 cm^{-1} for N-H stretching of NH_4 group. These peaks were shifted to higher frequency region i.e., at 3033-3606 cm^{-1} in treated sample (Figure 1b), which indicated an enhanced force constant of N-H bond as compared to control. IR frequency (ν) of

stretching vibrational peak depends on two factors i.e., force constant (k) and reduced mass (μ) which can be explained by following equation [26].

$$\nu = 1/2\pi c \sqrt{(k/\mu)}, \text{ Here, } c \text{ is speed of light.}$$

If μ is constant, then the frequency is directly proportional to the force constant; hence, alteration (increase or decrease) in frequency of any bond indicates a respective change in force constant [25].

The C-H stretching's were appeared at 2826-2893 cm^{-1} in control sample that were shifted to lower wavenumber in treated sample i.e., at 2817-2881 cm^{-1} . The C=O asymmetrical stretchings were appeared at 1660-1702 cm^{-1} in control sample, which were shifted to higher wavenumber in treated sample i.e., at 1680-1714 cm^{-1} . This could be due to increased bond strength of C=O bond in treated sample as compared to control. N-H bending was assigned to peaks at 1533-1563 cm^{-1} in control sample of ammonium acetate that were observed at 1506-1556 cm^{-1} in treated sample. It depicted a reduced torsion force of N-H bending after biofield treatment as compared to control. The C=O symmetrical stretching was assigned to peak at 1404 cm^{-1} in control sample, which was observed at higher wavenumber i.e., at 1422 cm^{-1} in treated sample as compared to control. This shifting of C=O bond to higher frequency region was occurred possibly due to increased force constant of C=O bond. The C-H deformation bends were assigned to the peaks at 1281-1342 cm^{-1} in control and 1292-1340 cm^{-1} in treated sample of ammonium acetate. Likewise, the C-O stretching peaks were observed at 1016-1050 cm^{-1} in control sample, which were slightly shifted to lower frequency i.e., at 1006-1043 cm^{-1} in treated sample. This could be due to reduced force constant of C-O bond after biofield treatment as compared to control. Overall, the FT-IR results of ammonium acetate suggest a significant impact of biofield treatment at the atomic level i.e., at dipole moment and force constant of respective bonds. The FT-IR data of control ammonium acetate was well supported by the literature [27].

The FT-IR spectra of control and treated ammonium chloride are shown in Figure 2 and the IR spectral interpretation results are reported in Table 2. Krishnan RS reported that NH_4 ion has tetrahedral symmetry therefore it showed four distinct mode of oscillations i.e., ν_1 and ν_2 due to single and double degenerate, and ν_3 and ν_4 are triply degenerate N-H vibrations, respectively [28,29]. The ν_1 and ν_3 peaks were observed at 3010 cm^{-1} and 3156 cm^{-1} , respectively in control (Figure 2a). Whereas, these were observed at 3029 cm^{-1} (ν_1) and 3124 cm^{-1} (ν_3) in treated sample (Figure 2b). The result showed an upstream shifting of peak ν_1 and downstream shifting of peak ν_3 in treated sample with respect of control. This could be due to biofield induced alteration in force constant of N-H stretching in treated sample as compared to control. Likewise, the vibrational peaks ν_2 and ν_4 were appeared at 1724 cm^{-1} and 1402 cm^{-1} , respectively in control sample and 1441 cm^{-1} (ν_2) and 1401 cm^{-1} (ν_4) in treated sample of ammonium chloride. The result showed an upstream shifting of peak ν_2 i.e., from 1724 cm^{-1} to 1741 cm^{-1} in treated sample, which depicted a corresponding increase in torsional force of ν_2 oscillation. Additionally, the N-Cl stretching was assigned to peak at 710 cm^{-1} in control sample that was shifted to lower frequency at 665 cm^{-1} in treated sample. This similarly suggests a possible decrease in force constant of N-Cl stretching after biofield treatment as compared to control. Overall, the FT-IR spectral data of control and treated ammonium chloride showed an impact of biofield treatment on the internal oscillation of NH_4 group and N-Cl stretching. This could be due to alteration in force constant and dipole moment of ammonium chloride molecules after biofield treatment as compared to control. Because of alteration in force constant and bond strength, the

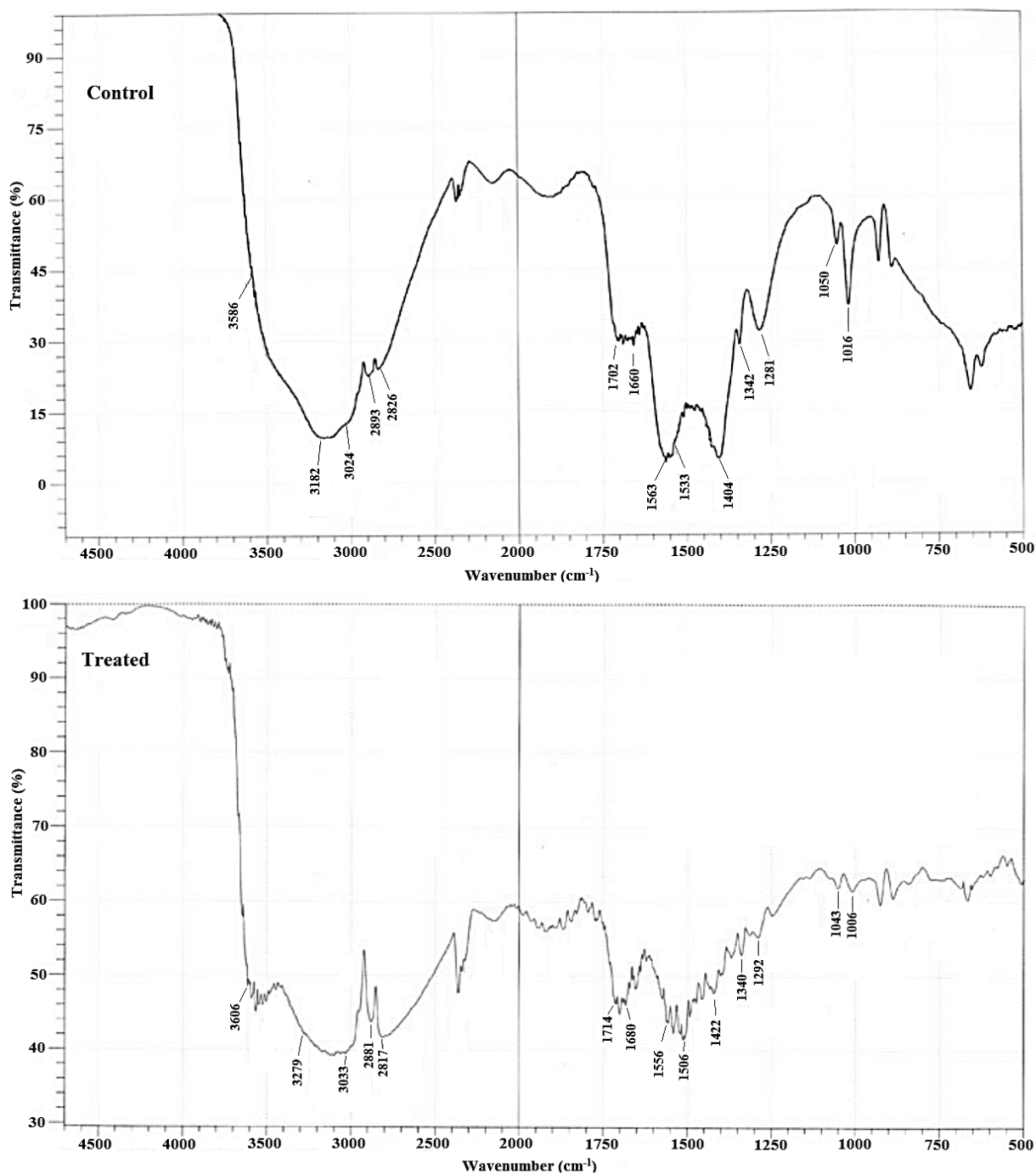


Figure 1: FT-IR spectra of control and treated ammonium acetate.

chemical stability of treated compounds might also be alter. Based on this, it is speculated that biofield treatment could be used to increase the chemical stability of any compound, which might be more useful than the untreated compound.

UV-Vis spectroscopy

UV spectra of control and biofield treated ammonium acetate are shown in Figure 3. The UV spectrum of control ammonium acetate (Figure 3a) showed the absorption maxima (λ_{\max}) at 258.0 nm. Whereas,

in biofield treated sample of ammonium acetate, this absorption maxima (λ_{\max}) was appeared at 221.4 nm and 204.6 nm (Figure 3b). As per existing literature on principle of UV spectrophotometer, the compound can absorbs UV light due to the presence of conjugated pi (π) bonding systems ($\pi-\pi'$ transition) and nonbonding electron system ($n-\pi'$ transition). There are certain energy gap between $\pi-\pi'$ and $n-\pi'$ orbitals. When this energy gap altered, the wavelength (λ_{\max}) was also altered respectively [25]. Based on this, it is speculated that, due to influence of biofield treatment, the energy gap between $\sigma-\sigma'$, $\pi-\pi'$ or $n-\pi'$ transition in ammonium acetate molecules might be altered,

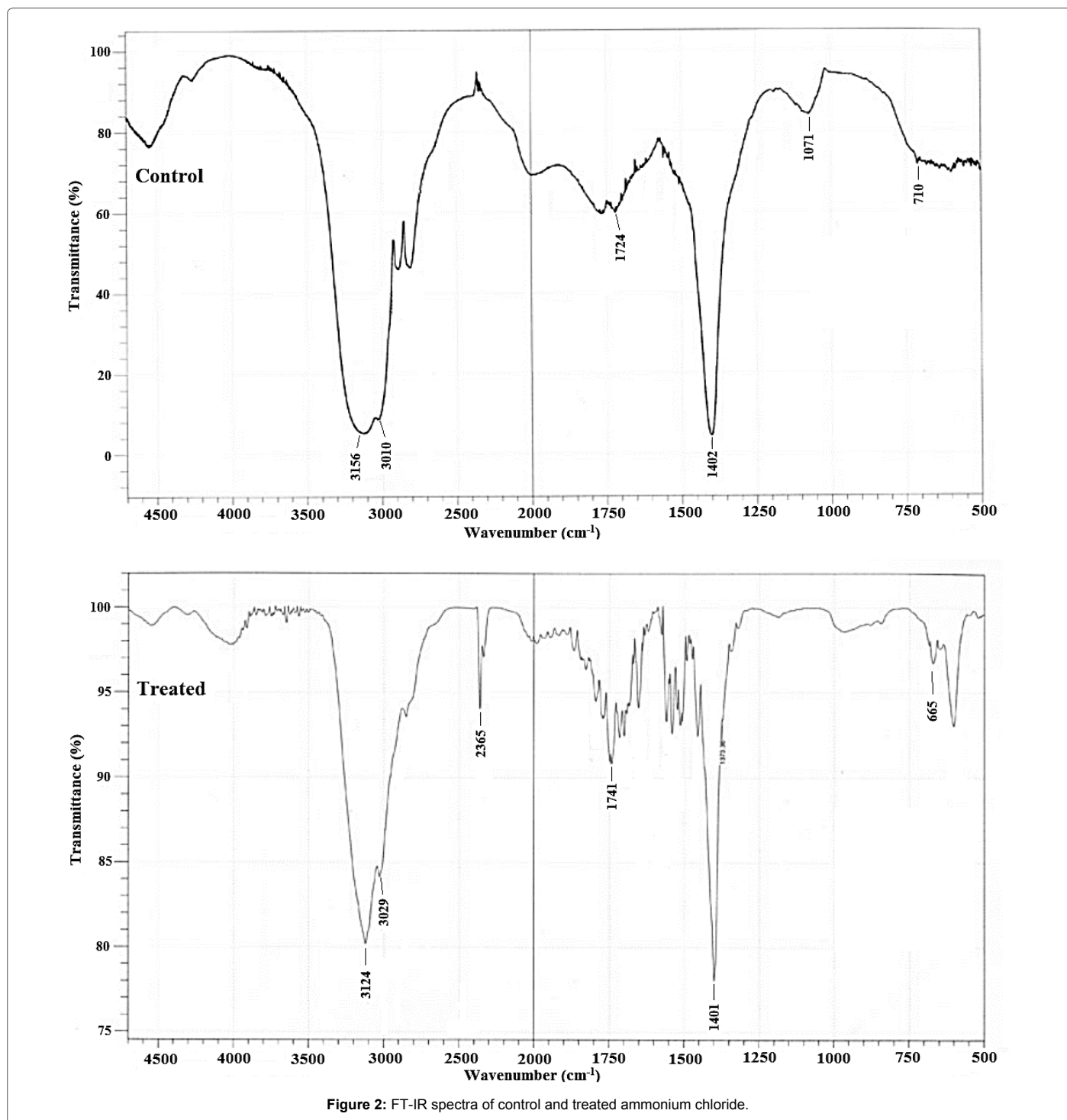


Figure 2: FT-IR spectra of control and treated ammonium chloride.

which causes the shifting of wavelength (λ_{\max}) in treated sample with respect to control.

The UV spectra of control and treated ammonium chloride are shown in Figure 4. The control sample (Figure 4a) exhibited the absorbance maxima (λ_{\max}) at 234.6 nm and 292.6 nm. Whereas, the biofield treated ammonium chloride exhibited the absorbance maxima (λ_{\max}) at 224.1 nm and 302.8 nm (Figure 4b). This slight shifting of λ_{\max} after biofield treatment also suggest a possible alteration in energy gap between $\sigma-\sigma^*$, $\pi-\pi^*$ or $n-\pi^*$ transition in ammonium chloride molecule

with respect to control. Altogether, the UV spectral data of both the ammonium acetate and ammonium chloride (control and treated) revealed a considerable impact of biofield treatment on the atomic level of respective compound.

Conclusion

FT-IR spectrum of biofield treated ammonium acetate showed the alteration in wavenumber of IR peaks assigned to N-H, C-H, C=O and C-O stretching as compared to control. Likewise, the biofield treated

| Wave number (cm ⁻¹) | | Frequency Assigned to group |
|---------------------------------|-----------|-----------------------------|
| Control | Treated | |
| 3586-3024 | 3606-3033 | N-H stretching |
| 2893-2826 | 2881-2817 | C-H stretching |
| 1702-1660 | 1714-1680 | C=O asymmetrical stretching |
| 1563-1533 | 1556-1506 | N-H bending |
| 1404 | 1422 | C=O symmetrical stretching |
| 1342-1281 | 1340-1292 | C-H deformation |
| 1050-1016 | 1043-1006 | C-O stretching (ester) |

Table 1: FT-IR vibrational peaks observed in ammonium acetate.

| Wave number (cm ⁻¹) | | Frequency Assigned to group |
|---------------------------------|---------|---|
| Control | Treated | |
| 3156 | 3124 | ν_3 single degenerate N-H oscillation |
| 3010 | 3029 | ν_1 doubly degenerate N-H oscillation |
| 1724 | 1741 | ν_2 Triply degenerate N-H oscillation |
| 1402 | 1401 | ν_4 Triply degenerate N-H oscillation |
| 710 | 665 | N-Cl stretching |

Table 2: FT-IR vibrational peaks observed in ammonium chloride.

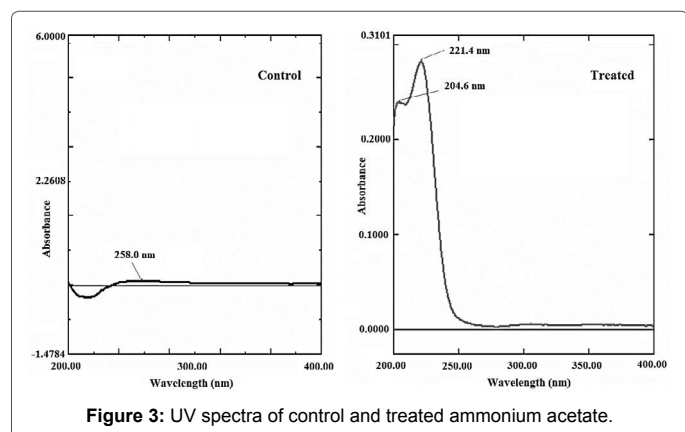


Figure 3: UV spectra of control and treated ammonium acetate.

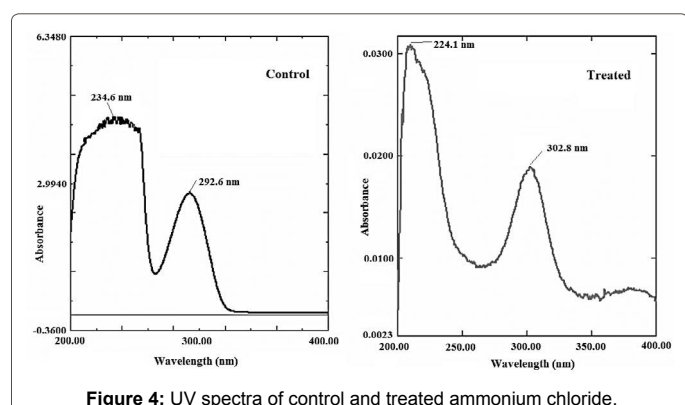


Figure 4: UV spectra of control and treated ammonium chloride.

ammonium chloride showed the alteration in wavenumber of IR peaks assigned to three (ν_1 , ν_2 , and ν_3) out of four distinct internal oscillations of NH_4 group as well as N-Cl stretching with respect of control. UV spectra of ammonium acetate and ammonium chloride showed the alteration in absorption maxima (λ_{max}) after biofield treatment as compared to respective control.

Altogether, the FT-IR results suggest an impact of biofield treatment on atomic level like dipole moment, force constant, bond strength, and flexibility of treated compounds with respect to control. Likely, the UV result suggests the impact of biofield treatment on

bonding and nonbonding electron transition of treated compounds with respect to control.

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