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FTIR Spectroscopic Study of *Aloe vera barbadensis Mill* Buds

Muhammad S. A. Abbasi[1], Muhammad Aslam Tahir[2*] and Sidra Meer[3]

[1]G.I.X Labs, PINSTECH, P.O. Box. 1356, Nilore, Islamabad, Pakistan.
[2]Allama Iqbal Open University, Islamabad, Pakistan.
[3]Faculty of Pharmacy and Alternative Medicine, IU Bahawalpur, Pakistan.

Authors' contributions

This work was carried out in collaboration among all authors. Authors MAT and MSAA managed the literature searches. The research project was designed by mutual discussion among all the authors. Author SM contributed in technical discussion. Author MAT performed the experiment and characterization work. Author MSAA wrote the first draft of manuscript. All the three authors read and approved this final manuscript.

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ABSTRACT

The objective of this research is to investigate number and types of bioactive compounds present in Aloe Vera buds grown in North East Punjab region of Pakistan by FTIR which is simple, nondestructive, cost effective and user friendly. Aloe vera was cultivated under normal atmospheric conditions. After two years, buds (early stage of flowers) were grown on twigs. The buds were plucked and blended with distilled water in National Juicer machine to have a concentrated blend. The blend was filtered to get clear solution, mixed with ethyl acetate and then solvent extracted. The organic part was isolated and dried at water bath at 60°C. Dried sample was analyzed using FTIR spectroscopic analysis. All activities were performed consecutively to avoid photochemical changes. The characteristic FTIR spectral lines have shown different characteristic peaks that correspond to different functional groups indicating presence of bioactive compounds like substituted cyclic alkanes, alkenes, alcohols, phenols, and aromatics etc. have been investigated.

**Corresponding author: E-mail: aslamtahir30@gmail.com;*

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1. INTRODUCTION

Since antiquity herbs, plants and their parts have been used as natural curative agents. Aloe vera synonymous *A. barbadensis Mill* or *Aloe vera var. chinensis* is an evergreen perennial, succulent herbal plant of Arabian origin, cultivated all over the world for agricultural, medicinal, cosmetic and decorative purposes. Different parts of plants or herbs i.e. roots, stems, walls, leaves, flowers, fruits, and seeds are used as medicines. These medicinal plants are also good source of our foods [1]. It is our experience that natural and herbal medicines are much better than synthetic drugs because of minimum their side and toxic effects [2]. Herbal therapeutic restoratives work slowly but always more effective than synthetic drugs.

Aloe vera gel is used domestically and industrially as herbal food supplementary additive. Its properties as soothing, moisturizing and emollient are quite well documented [3,4]. The domestic skin care use of Aloe vera gel free from bitter constituents is quite common practice all over the globe [5].

Aloe vera, in Fig. 1, commonly called burn herb belongs to herb *Asphodelaceae* family famous for its medicinal/herbal use. It shares important biological activities like antioxidant [6], anti-inflammatory [7] and anticancer [8]. These activities are attributed to the presence of phenolic compounds [9], terpenoids [10], flavonoids [11] and natural quinone contents [12].

Fig. 1. Aloe Vera

Recently we have studied the presence of bioactive compounds in *Menthe spicata L*(garden mint) by FTIR spectroscopic analysis [13]. Aloe vera is known as magic plant because it is a rich source of vitamins, enzymes, minerals, sugars, lignin, phenolic compounds, sterols saponins, salicylic acid and amino acids [14]. Aloe vera has also been well established for its use as a traditional medicine [15]. Aloe vera gel has good wound healing effect but effective component for this purpose has to be established [16]. FTIR analysis indicated presence of bioactive functional groups present in leaf powder of *Calotropis gigantea* [17]. Aloe vera has also an important role in the treatment of metabolic syndrome [18] and is good alternative therapy in the treatment of oral sub mucous fibrosis [19]. In literature, except Aloe vera buds, comprehensive FTIR analysis of herbal and medicinal plants is available (Literature survey of ref # 13).

Our work is aa effort to investigate functional groups present in *Aloe vera* buds by using FTIR spectroscopic technique which is simple, cost effective and user friendly technique to investigate functional groups of compounds in sample. FTIR analysis of biological specimens is becoming more popular tool for its nondestructive nature, label-free testing and studying molecular dynamics and composition [20-22].

2. MATERIALS AND METHODS

Reddish orange buds as an early stage of flowers of Aloe vera were plucked from elongated flowering stalks and were blended in distilled water to have a concentrated solution. The solution was filtered out using Whatman (Grade 595, 4-7 μm) filter paper to which an equivalent portion of ethyl acetate solvent was added. The organic part was separated and slowly evaporated at water bath at 60°C. The residue obtained was dried and transformed into powder form, then analyzed using Varian 640IR FTIR spectroscopic analysis using KBR pellet techniques.

Some buds were also put under shade for drying purpose but in short time (seven days) fungus appeared on the buds. In an alternative approach the buds were semi-dried while being adhered to the parent plant then plucked off and grinded to powder as shown in Fig. 3.

3. RESULTS AND DISCUSSION

FTIR spectrum of dried ethyl acetate extract powder was found to be stimulating due to the fact that it contains the clear pattern of IR signal peaks with well-defined resolution. Graphic layout of IR spectrum is displayed in Fig. 4.

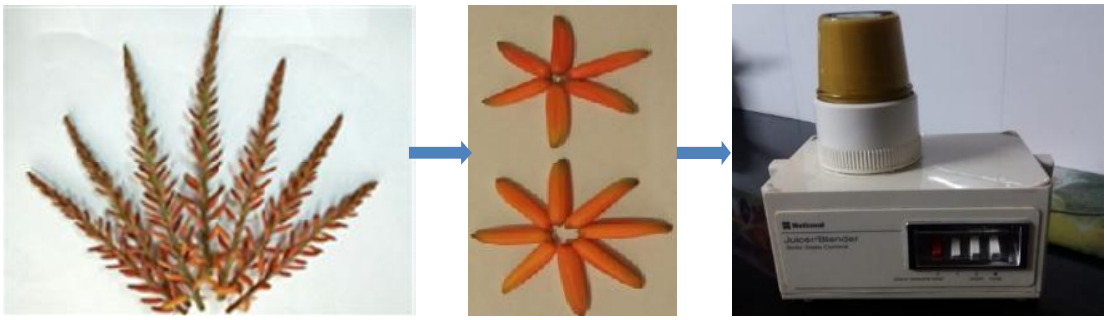

Fig. 2. Bouquet of Aloe vera flowering stalks, reddish orange buds and their blend

(A) **(B)**

Fig. 3. (A) Dried Aloe vera buds, (B) Powder of Aloe vera buds

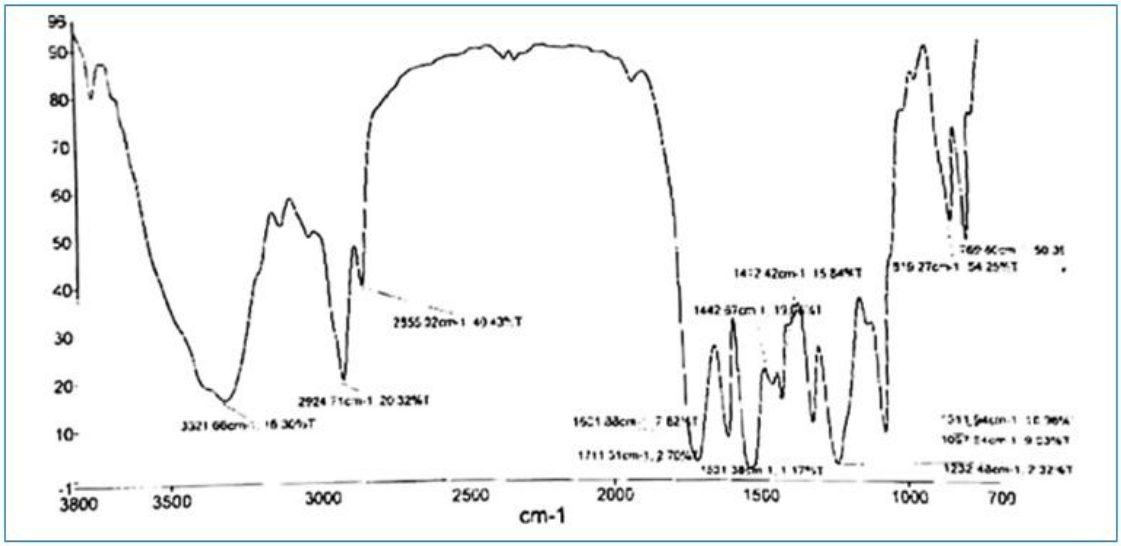

Fig. 4. FTIR spectrum of dried ethyl acetate extract powder

The absorbing frequencies and intensities are tabulated in Table 1.

Hydroxyl peak at 3321 cm^{-1} indicates the presence of medicinal compounds like alcohols, phenols, acids and their derivatives.

Signal at 3672 cm^{-1} is out of bound. Both sharp peaks at 2855 and 2924 cm^{-1} correspond to alkyl functional group of compounds like alkanes, acetates, esters, acids and ethers etc.

Absorption at 1711 cm^{-1} lower sharp corresponds to a carbonyl peak C=O belonging to acids, aldehydes, ketones etc. Sharp signals at 1531 cm^{-1} and 1601 cm^{-1} corresponds to C=C belonging to aromatic medicinal compounds. Absorption at 1311 cm^{-1} related to functional group "R-$COCH_3$" containing compounds and their derivatives. Strong peak at 1232 cm^{-1} corresponds to R=C-O-C belongs to ethers. Signals at 1058 cm^{-1} corresponds to C=C related to unsaturated five or six membered ring compounds.

Alkenes are represented by signals at around 819 cm^{-1}. Signal at 769 cm^{-1} belong to C-H peak of five membered aromatics as shown in Fig. 5.

The wavenumbers of IR signal peaks and their respective band forms are given as tabulated format, as shown in Table 2.

Table 1. FTIR frequencies and band pattern of dried ethyl acetate extract powder

Sr. No	Wave number (cm^{-1})	Signal Forms
1	3672	Higher sharp
2	3321	Lower broad
3	2924, 2855	Medium sharp
4	1711	Lower broad
5	1601,1531,1311	Lower sharp
6	1232, 1058	Lower sharp
7	819, 769	Higher sharp

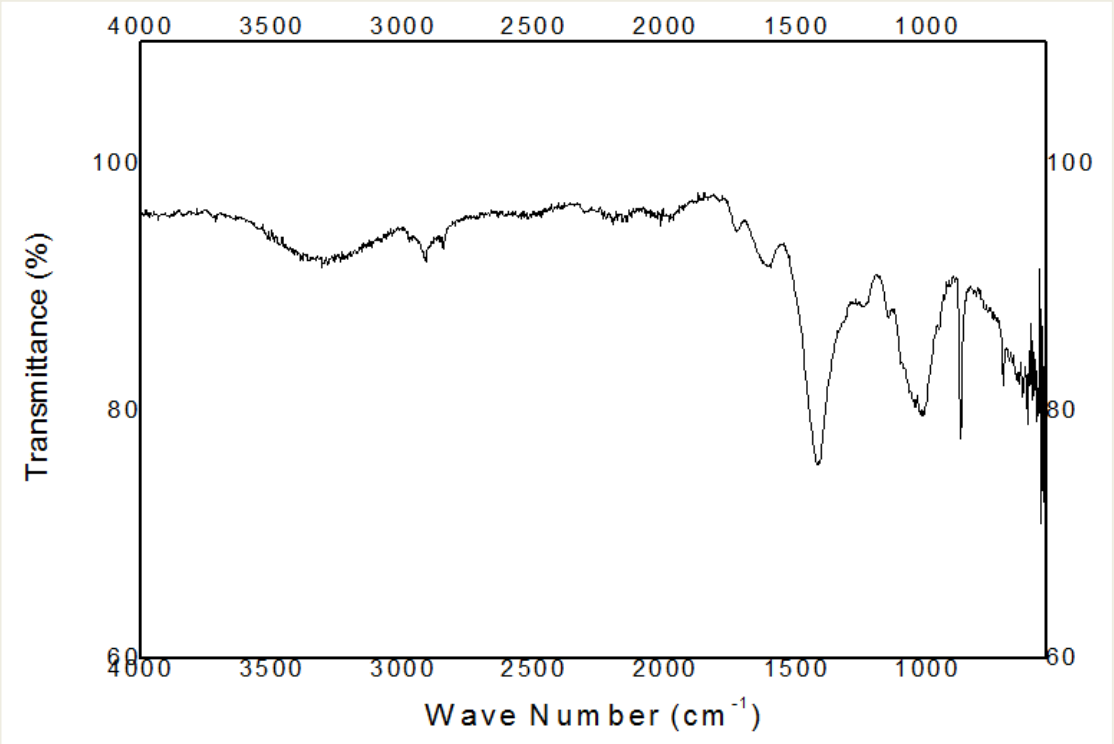

Fig. 5. FTIR spectrum of shade dried powder of Aloe buds

Table 2. FTIR frequencies and band pattern of dried powder of Aloe buds

Sr. No	Wave number (cm^{-1})	Signal Forms
1	3300	Higher broad
2	2924, 2840	Higher sharp
3	1600, 1420	Lower sharp
4	1020, 750	Lower sharp

IR absorption peaks of plant dried buds were found to be partially similar to that of ethyl acetate extracted dried powdered sample in a way that both spectra reveal the presence of hydroxylated functional groups pre-dominantly the non-hydrogen bonded ones and sp^3 hybridized hydrocarbon functionalities significantly and respectively. However, the IR spectrum of dried ethyl acetate extract powder has shown extensive signals to lower frequency region of spectrum that exhibits the presence of unsaturated hydrocarbons, aromatics and oxygenated heterocyclic moieties.

4. CONCLUSION

Semi-shade/air dried powder and ethyl acetate extract dried powder samples of *Aloe vera barbadensis Mill* buds were analyzed using FTIR (ATR) spectroscopic technique. Some degree of similarity was found in FTIR spectrum of both samples especially in the higher frequency region and assigned to corresponding functional groups to signify the presence of biologically active compounds like alkenes, alcohols, polyphenols, and aromatics and heterocyclic quinonoids etc. in plant matrix.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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