FTIR Profiling of Herbal Teas prepared from Medicinal Plants

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ABSTRACT: Polyphenols are the important contributors of health protection and preventing various diseases including type 2 diabetes (T2D). Hence an investigation was made to determine the polyphenols of selected Indian medicinal herbs of *Ocimum* (T2) *Gymnema* (T3) ; *Senna auriculata* and cinnamon bark extracts (T4) and *Senna auriculata* and ginger extracts (T5) by Fourier Transform Infrared (FTIR) spectroscopy. The results were compared with the leaves of *Cameilla sinensis* (T1-Green tea). Infra red *absorption spectra* of T4 revealed new peaks in the regions 4623 cm^{-1} and 4337.91 cm^{-1} were related directly to the presence of more functional groups such as polyphenols. This showed active constituents in herbal polyphenols of the T4 with mixed formulation of *Senna auriculata* and *Cinnamum zeylanicum*. In all infusions the IR spectral peak values are absent between region 2220-2250 cm^{-1}. This indicates the absence of cyanide groups. From this it was confirmed that due to the absence of toxic substances in the selected medicinal plants are suitable for consumption. Hence the leaves of *Ocimum sanctum* and *Gymnema sylvestre*, flowers of *Senna auriculata*, bark of *Cinnamum zeylanicum* (cinnamon) and rhizome of *Zingiber officinale* (ginger) are recommended for herbal tea formulations.

Keywords: Herbal tea, FTIR study, Functional groups, Polyphenols.
Abbreviation : FTIR- Fourier Transform Infra Red, IR- Infra Red, T2D- type2 diabetes, KBr-Potassium bromide.

INTRODUCTION

Polyphenols are the important contributors of health protection and preventing various diseases. Unhealthy eating habits and sedentary lifestyles associated with urbanisation are common risk factors in developing type2 diabetes (T2D). Consuming functional food and beverages can help to overcome T2D. Polyphenols are the heterogeneous phytochemical group containing phenol rings. Plant-based and fruit-based foods are the main sources of polyphenols (Alma *et al.,* 2003; Rusak *et al.*, 2008; Anesini *et al.*, 2008 ; Alothman and Bhat 2009).

Dietary polyphenols could reduce starch digestion by the inhibition of α-amylase and α-glucosidase (Khokhar and Magnusdottir 2002; Kwon *et al.,* 2008; Liang *et al.,* 2007; Jianbo *et al.,* 2011). Herbal tea consumed everyday as functional beverage influence the activities of α-amylase (Bailey, 2001; Cheng *et al.,* 2012; Manousi *et al.*, 2019; Raman *et al.*, 2019). With the goodness of antidiabetic potentiality various herbal formulations were experimented for their phytochemical constituents by conventional methods which are time consuming and non-reliable in the research field.

FTIR is one of the most widely used methods to identify the chemical constituents and determine the functional group and the chemical structure of the constituents. Earlier studies from the literature with reference to determination of functional groups and the chemical constituents profiling by FTIR had a remarkable role in medicinal plant study (Muruganantham *et al.*, 2009; Qin *et al.*, 2010 ; Baseri and Baker (2011) ; Ragavendran *et al.,* 2011).

Screening of phytochemical constituents of the medicinal herbs by the conventional methods may not be reliable and a challegeable task in the field of research. Hence in the present study pure and mixed form of five medicinal herbs *viz., Ocimum sanctum, Gymnema sylvestre*, flowers of *Senna auriculata*, bark of *Cinnamum zeylanicum* (cinnamon) and rhizome of *Zingiber officinale* (ginger) were selected to determine the phytoconstituents and functional groups by FTIR. IR spectra of the selected medicinal plants were analysed according to the peak/wave numbers.

MATERIALS AND METHODS

Preparation of plant materials. Five medicinal plants leaves of *Ocimum sanctum, Gymnema sylvestre*, flowers of *Senna auriculata* , bark of *Cinnamum zeylanicum* (cinnamon) and rhizome of *Zingiber officinale* (ginger) were collected from the herbal garden of Madha Engineering College (MEC) of Chennai, India. Healthy plants were selected from

MEC herbal garden and the leaves, bark and flowers of the selected Indian medicinal plants for the study were dried at 50ºC in an oven. The powdered samples were stored in air tight bottles at room temperature for further analysis.

FTIR Study. The FTIR analysis was conducted on leaf powder samples of *Ocimum* (T2), *Gymnema* (T3), *Senna auriculata* and cinnamon bark extracts (T4) and *Senna auriculata* and ginger extracts (T5). Fine powder of oven-dried (50ºC) leaves of selected medicinal herbs were taken. 1 mg of the sample was mixed with 50 mg KBr (FTIR-grade) and experiments were performed with an IR Prestige-21 (Shimadzu). One drop of the diluted extract was then mixed with 50

mg KBr. The scanning absorption range was 500 to 5000 cm^{-1}. The peak values of FTIR were recorded for T1, T2, T3, T4 and T5. Each and every analysis was repeated twice to confirm the spectrum.

RESULTS AND DISCUSSION

FTIR spectrum was used to identify the functional group of the active components based on the peak value in the region of infra red radiation (Sohrabi *et al.*, 2005; Schulz and Baranska 2007). The results with reference to pure and mixed medicinal herbal formulations in terms of peaks and wave numbers were explored. The IR spectra of illustrated in the Fig. 1-5.
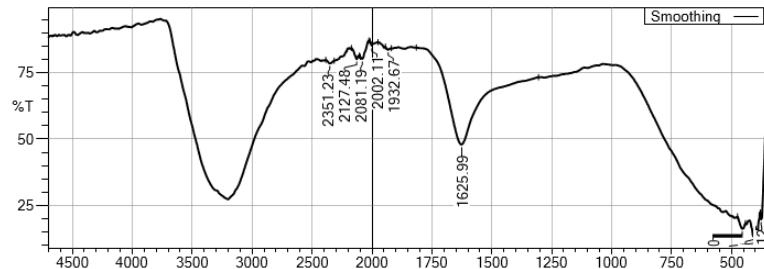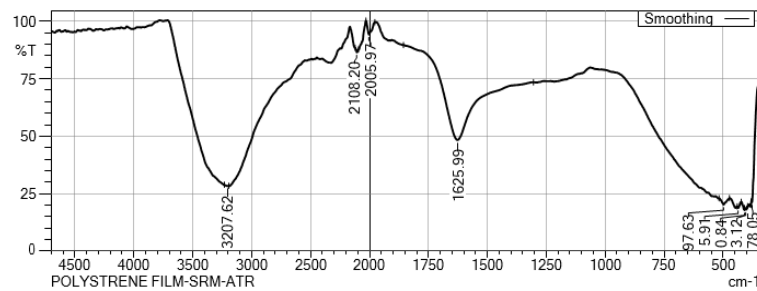

Fig. 1. FTIR profile of green tea extract (T1).
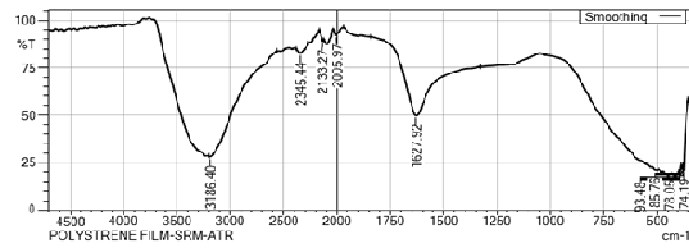

Fig. 2. FTIR profile of *Ocimum sanctum* (T2).

Fig. 3. FTIR profile of *Gymnema sylvestre* (T3).
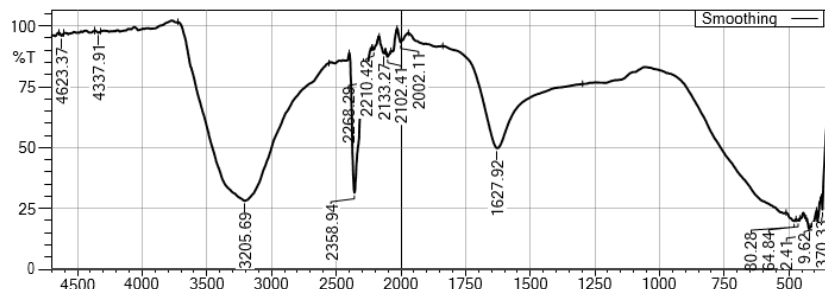

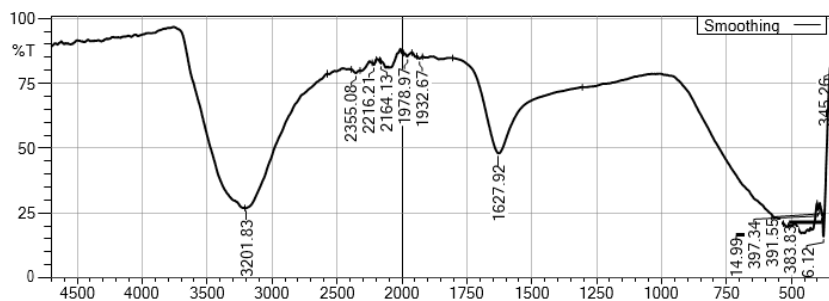**Fig. 4.** FTIR profile of *Senna auriculata & Cinnamum zeylanicum* (T4).

Fig. 5. FTIR profile of *Senna auriculata* and *Zingiber officinale* (T5).

The FTIR spectra of pure and mixed tea formulations of *Ocimum* (T2) *Gymnema* (T3) ; *Senna auriculata* + cinnamon bark extracts (T4) and *Senna auriculata* + ginger extracts (T5) were illustrated in Fig. 2-5. The FTIR spectra of Green tea (*Camellia sinensis*) in T1 (Fig. 1) was used for comparison.

It is possible to directly relate the intensities of absorption bands to the concentration of the corresponding functional groups present in the *Ocimum sanctum, Gymnema sylvestre, Senna auriculata, Cinnamum zeylanicum* and *Zingiber officinale*.

Similar kind of study made by many researchers (Demiray *et al*., 2009; Konwar *et al*., 2011; Helal *et al*., 2014) for the rapid analysis and confirmation of phytoconstituent structures. At present Infra red absorption spectroscopy revealed new peaks in the regions 4623 cm^{-1} and 4337.91 cm^{-1} were related directly to the presence of more functional groups such as polyphenols. This showed the presence of active constituents in herbal polyphenols of the T4 with the combination of *Senna auriculata* and *Cinnamum zeylanicum.*

The results of Fourier Transform Infra red absorption spectroscopy revealed the peak values are illustrated in the Fig. 1-5. FTIR spectrum confirmed the presence of alcohol, phenol, alkanes, alkyl halide, amino acids , carboxylic acid, aromatic, amines in the rhizome, bark, flowers and leaves of the selected medicinal plants.

FTIR spectroscopy measurements are faster and accurate. The absorption radiations in FTIR for the green tea (T1) in the region 1626 cm^{-1} exhibits C=C stretching vibration which can be conjugated with C=O. The intensities of absrorption bands between 2002.11 cm^{-1} and 2352 cm^{-1} illustrates the free amino acids and amino related functional groups. Variable stretching vibrations of T4 spectra are found in the region 4623 cm^{-1} to 4337 cm^{-1}. Most organic and inorganic compounds were identified within this region (Fig. 6).
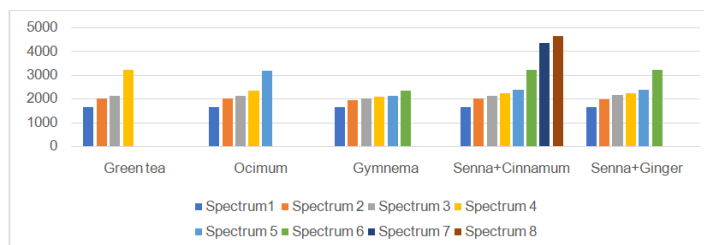

Fig. 6. Analysis of FTIR Spectral functional groups of herbal teas.

The more intense band occurring at 4623.37 cm^{-1} to 4337.91 cm^{-1}; 3205.69 to 3186.40; 2358.94 to 2355.08; 2268.29 to 2002.11 and 1978.97 to 1625.99 cm^{-1} corresponding to O-H/N-H/ C-H/C=O stretching, bending, vibrations respectively indicate the presence of alcohol, amines, amides, amino acids and amino related compounds in *Senna auriculata, Ocimum sanctum, Gymnema sylvestre, Cinnamum zeylanicum* and *Zingiber officinale*. Peak values are absent between region 2220-2250 cm^{-1} which indicates the absence of cyanide groups. From this it was confirmed that the absence of toxic substances in the selected medicinal plants. Hence all the selected medicinal plants are suitable for consumption and recommended for herbal tea formulations. Many researchers determined and confirmed the phytochemical constituents of various medicinal plants because of faster and accurate results obtained in FTIR (Saxena and Saxena 2012; Helal *et al.,* 2014; Gorgulu *et al.,* 2007; Kumar and Prasad 2011).

It is evident from the results of FTIR indicated that herbal tea formulation of T4 and T5 had contained higher amount of total phenols than green tea (T1) where as T2 and T3 showed similar peaks corresponding to T1 (Fig. 6).

CONCLUSIONS

FTIR measurements were made for accuracy and direct identification of functional groups in the selected medicinal herbs. It is evident from the results of FTIR indicated that herbal tea in T4 (*Senna auriculata* and *Cinnamum zeylanicum*) T5 (*Senna auriculata* and *Zingiber officinale*) formulation also contained higher amount of total phenols than green tea and more peaks in the spectrum next to T4. Whereas T2 (*Ocimum sanctum)* and T3 (*Gymnema sylvestre*) were recorded similar peaks in the FTIR spectrum corresponding to T1 (green tea). In summary all the selected medicinal plants are suitable for consumption and recommended for herbal tea formulations.

FUTURE SCOPE

FTIR profiling of selected medicinal plants can be further studied with reference to the quality checking and characterization of new compounds/functional groups in the formulations for the pharmaceutical research and food science/technology.

Conflict of Interest. None.

REFERENCES

Alma, M. H., Mavi, A., Yildirim, A., Digrak, M. and Hirata, T. (2003). Screening chemical composition and in vitro antioxidant and antimicrobial activities of the essential oils from *Origanum syriacum* L. growing in turkey. *Biological and Pharmaceutical Bulletin, 26,* 1725-1729.

Anesini, C., Ferraro, G. E., and Filip, R. (2008). Total polyphenol content and antioxidant capacity of commercially available tea (*Camellia sinensis*) in Argentina. *Journal of agricultural and food chemistry*, *56*(19), 9225-9229.

Alothman, M. and Bhat, R. (2009). Antioxidant capacity and phenolic content of selected tropical fruits from Malaysia, extracted with different solvent. *Food Chemistry, 115,* 785-788.

Bailey, C. J. (2001). New approaches to the pharmacotherapy of diabetes. 3rd ed. In Text Book of Diabetes, edited by Pickup, J.C. & William, G. UK: Blackwell Science Ltd.2: 73., 1-73.2.

Baseri, M. K. and Baker, S. (2011). Identification of cellular components of Medicinal plants using FTIR, Romanian I. *Biophys., 21*(4), 277-284.

Cheng, D. M., Kuhn, P., Poulev, A., Rojo, L. E., Lila, M. A. and Raskin, I. (2012). In Vivo and in Vitro Antidiabetic Effects of Aqueous Cinnamon Extract and Cinnamon Polyphenol-Enhanced Food Matrix. *Food Chemistry 135* (4), 2994–3002.

Demiray, S., Pintado, M. E. & Castro, P. M. L. (2009). Evaluation of phenolic profiles and antioxidant activities of Turkish medical plants: *Tilia argentea, Crataegi folium leaves* and *Polygonum bistorta* roots. *World Academy of Science, Engineering and Technology, 3*, 06-24.

Gorgulu, S. T., Dogan, M. and Severcan, F. (2007). The characterization and differentiation of higher plants by Fourier transform infrared spectroscopy. *Appl Spectrosc, 61*, 300-308.

Helal, A., Tagliazucchi, D., Verzelloni, E., and Conte, A. (2014). Bioaccessibility of Polyphenols and Cinnamaldehyde in Cinnamon Beverages Subjected to in Vitro Gastro-Pancreatic Digestion. *Journal of Functional Foods*, *7*, 506–516.

Jianbo, X., Guoyin, K., Xiaoling, N., Fan, Y. and Xiaoqing, C. (2011). Interaction of natural polyphenols with α-amylase in vitro: Molecular property–affinity relationship aspect. *Mol. Bio Syst., 7,* 1883-1890.

Khokhar, S. and Magnusdottir, S. G. M. (2002). Total phenol, catechin, and caffeine contents of teas commonly consumed in the United Kingdom. *J. Agric. Food Chem., 50,* 565-570.

Kumar, J. K., and Prasad, A. D. (2011). Identification and comparison of biomolecules in medicinal plants of Tephrosia tinctoria and *Atylosia albicans* by using FTIR. *Romanian Journal of Biophysics*, *21*(1), 63-71.

Konwar Mitali and Baruah, G. D. (2011). On the nature of vibrational bands in the FTIR spectra of Medicinal plant leaves. *Archives of Applied Science Research, 3*(1), 214-221.

Kwon, Y.I., Apostolidis, E. and Shetty, K. (2008). Inhibitory potential of wine and tea against alpha-amylase and alpha-glucosidase for management of hyperglycemia linked to type 2 diabetes. *J. Food Biochem., 32,* 15-31.

Liang, H., Liang, Y., Dong, J., Lu, J., Xu, H. and Wang, H. (2007). Decaffeination of fresh green tea leaf (*Camellia sinensis*) by hot water treatment. *Food Chemistry, 101,* 1451-1456.

Muruganantham, S., Ambalagan, G. and Ramamurthy, N. (2009). FTIR and Sem-eds comparative analysis of medicinal plants, Eclipta Alba Hassk and *Eclipta prostrata* Linn, *Romanian J. Biophys, 19*(4), 285-294.

Manousi, N., Sarakatsianos, I. and Samanidou, V. (2019). Extraction Techniques of Phenolic Compounds and Other Bioactive Compounds from Medicinal and Aromatic Plants. In Engineering Tools in the Beverage Industry; Elsevier: Amsterdam, the Netherlands, pp. 283–314.

Qin, B., Panickar, K. S., and Anderson, R. A. (2010). Cinnamon: potential role in the prevention of insulin resistance, metabolic syndrome, and type 2 diabetes. *Journal of Diabetes Science and Technology*.

Raman, M., Ambalam, P. and Doble, M. (2019). Probiotics, Prebiotics, and Fibers in Nutritive and Functional Beverages. In Nutrients in Beverages; Elsevier: Amsterdam, The Netherlands, pp. 315–367

Rusak, G., D. Komes, S. Liki´c, D. Horˇzi´c, and M. Kovaˇc (2008). Phenolic content and antioxidative capacity of green and white tea extracts depending on extraction conditions and the solvent used. *Food Chemistry*, *110*(4) 852–858.

Ragavendran, P., Sophia, D., Arul Raj, C. and Gopalakrishnan V. K. (2011). Functional group analysis of various extracts of *Aerva lanata* by FTIR spectrum, *Pharmacology* online 1, 358-364.

Sohrabi, M. R., Davallo, M., Tadayyon, F., Nabipoor, F., & Khamneifar, A. (2005). Simultaneous determination of acetyl salicylic acid and acetaminophen in acetaminophen-caffeine-aspirin (ACA) tablets by FT-IR/ATR spectrometry with multivariate calibration data treatment. *Asian Journal of Chemistry*, *17*(1), 541.

Schulz, H., and Baranska, M. (2007). Identification and quantification of valuable plant substances by IR and Raman spectroscopy. *Vibrational Spectroscopy, 43*(1), 13-25.

Saxena, M., & Saxena, J. (2012). Evalution of phytoconstituents of *Acorus calamus* by FTIR and UV-VIS spectroscopic analysis. *International Journal of Biological & Pharmaceutical Research*, *3*(3), 498-501.