Asian Journal of Research in Botany

4(2): 26-32, 2020; Article no.AJRIB.58461

Ecological and Phytochemical Significance of *Croton bonplandianum* (Bail)

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Authors' contributions

This work was carried out in collaboration between both authors. Author MSAA designed the project and all the experiments. Characterization work performed by author MAT. Both authors read and approved the final manuscript.

Article Information

Editor(s):
(1) Dr. Magdalena Valsikova, Slovak University of Agriculrure, Slovakia.
Reviewers:
(1) Dr. Krishna Chaithanya Karri, Aksum University, Ethiopia.
(2) Mary Ann Faller Daclan, Mindanao State University, Philippines.
Complete Peer review History: http://www.sdiarticle4.com/review-history/58461

Original Research Article

Received 17 April 2020
Accepted 22 June 2020
Published 06 July 2020

ABSTRACT

The aim of current research work is to explore the ecological role of *Croton bonplandianum* specie dominant to north eastern Punjab region of Pakistan. Under extreme drought condition the plant species survives modestly. The plant on blooming attract economic pollinator insects like honey bees even in dry climate periods. *Croton bonplandianum* (bail) was collected from wild and re-cultivated under normal atmospheric conditions. Its flowering body parts and stems were plucked and kept under shade for about two weeks for drying. The flowering inflorescence and herbaceous green portions were subjected to maceration, then grinded to fine powder. The powdered samples were analyzed using FTIR spectroscopic technique. FTIR spectral lines have shown different characteristic peaks pattern in case of flowers and non-flowering portion of plant inflorescence segment. Appropriate correlations of peaks to functional groups present were debated.

Keywords: Ecological study; phytochemicals; Croton bonplandianum (bail), FTIR analysis.

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1. INTRODUCTION

Croton is a diverse and complex taxonomic group of plants ranging from herbs and shrubs to trees, though native to south America, but now have global distribution [1]. Croton species are known as traditional medicinal plants in Africa, Asia and South America net [2-8]. The *Croton* species are rich in alkaloids, flavonoids and terpenoids [9-14]. So due to presence of bioactive compounds, the croton species are commonly used to treat cancer, hypertension, inflammation, rheumatism, bleeding gums, malaria, asthma, syphilitic ulcers, diabetes, pain and ulcers [15-22]. *Croton gratissimus Burchell, C. sylvaticus Hoechst and C. pseudopulchellus Pax* are well known croton species [23].

Croton bonplandianum (bail) an exotic weed is one of the important member of genus *Croton*. The plant is usually 1-2 ft in height, it grows in sandy clay but unpolluted soil along road side. As mentioned earlier that the specie has been is native to Southern Bolivia, Paraguay, South Western Brazil, North Argentina, Bangladesh, South America, India and Pakistan. In Indo-Pak it is widely distributed in the Sub-Himalayan region [24]. In sub-Himalayan region it is often called Ban Tulsi (wild tulsi). *Croton bonplandianum* (bail) is shown in Fig. 1.

Fig. 1. *Croton bonplandianum (bail)*

1.1 Ecological Importance

Under hot climatic environment the specie *Croton bonplandianum* serve as the source of nectar and food. Economically useful insects like honey bees frequently sit the flowers (Fig. 2) of *Croton* species, the stalked inflorescence attract the pollinator insects.

Fig. 2. Honey Bees looming *C. bonplandianum* flowers

The plant species grow-well on arid land because of woody scaly nature of stem and deep penetrating roots, even a very small plant would have a long root penetrated deeper into the soil. *Croton bonplandianum* growing on arid land as shown in Fig. 3.

Fig. 3. *Croton bonplandianum* in hot dry environment

1.2 Phytochemical Importance

Croton bonplandianum (ban tulsi), commonly called wild tulsi, belong to genus *Croton* which is famous among plant science community as rich source of medicinal compounds [25]. So Croton b. will also be a good source of bioactive compounds. It was verified by successful correlation of FTIR spectral lines with expected bioactive compounds.

1.3 Biological Activities

Croton bonplandianum possess immense medicinal value and its stem latex is used by

different region as a medicinal plant for the treatment of fresh skin cuts and minor bleeding wounds [26,27]. The plant acquires important biological activities like antioxidant, anti-inflammatory and anticancer [28,29]. These activities are attributed to the presence of total ester terpenoids-flavonoids contents [30]. Moreover the extracts of plant have known bio-medical applications in diseases like respiratory, gastro intestinal and skin etc. [31].

1.4 Instrumental Investigation

For investigating bioactive compounds in *Croton bonplandianum (bail)*, simple, cost effective and user friendly tool (FTIR) was used. It is becoming popular technique, especially in testing of biological specimens due to its nondestructive analyzing ability. FTIR provides information as spectral lines only which are related to functional groups of chemical compounds. So for confirmation, other analyzing techniques are needed.

Finger print region (600-1450 cm^{-1}) is most important for interviewing biological specimens. Both frequency regions (lower and higher) are important to determine functional groups and molecular structure of specimens.

Since long ago researchers have started investigating phytochemicals in medicinal plants by using FTIR [32-36].

Current work is a simple effort to assess presence of phytochemicals in *Croton bonplandianum (bail)* by taking Infrared spectra on Varian 640-IR using KBR palettes techniques.

2. MATERIAL AND METHODS

Based on leaf morphology and flowering body structure (inflorescence) the plant is recognized as *Croton bonplandianum* (ban tulsi). The plants were collected from sub-urban region of city Rawalpindi where it grown wild. The plants were re-grown in our herbs garden, buds and flowers were appeared on them in short time (two months).

Flowering bodies were harvested in the month of August; the elongated flowering body or heads (inflorescence) were separated from main plant as shown in Fig. 4-a. Flowers and buds were separated (Fig. 4-b) and set for drying under shade to avoid photochemical changes. After 20 days, dried samples (buds and flowers) were grinded to powder. The powders were saved in plastic vials and were subjected to FTIR spectroscopic analysis.

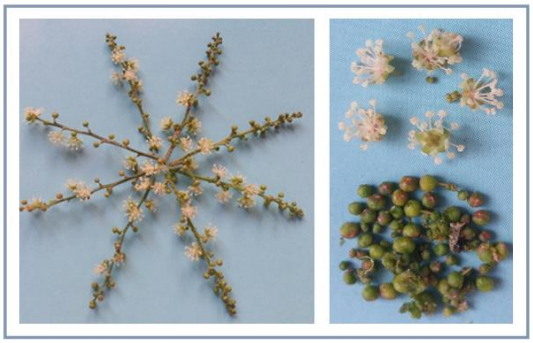

Fig. 4. Fresh twigs (a), Fresh flowers and buds (b) of *Croton bonplandianum*

3. RESULTS AND DISCUSSION

The FTIR spectroscopic result of flowers of *Croton bonplandianum* is shown in Fig. 5.

On the basis of FTIR spectra of flowers, expected phytochemical class of compounds are tabulated as under.

The FTIR umax values between 3433-3256 cm^{-1} exhibited the presence of alcohols, phenols and amino acids [37]. Absorption values between 1620-1680 cm^{-1} are of -C=C- stretching related to unsaturated aromatic, carbonyls, terpenoids and α, β unsaturated compounds [38]. Absorption between 1400-1600 cm^{-1} are -C=C- stretching of multiple bond containing compounds like terpenoids [39]. Values near about 1100 cm^{-1} are C-O stretching of alcohols. Absorption bands at around 800 cm^{-1} that were attributed to the presence of compounds with exocyclic double bonds [40-42].

The FTIR absorption peaks between 600-700 cm^{-1} indicate aromatic compounds, thiols etc.

The FTIR result of inflorescence part (buds) of *Croton bonplandianum* are presented in Fig. 6.

On the basis of FTIR spectra of buds (nonflowering) expected phytochemical class of compounds are tabulated as under.

The FTIR λmax values between 3480-3298 cm^{-1} exhibited the presence of compounds as discussed before in case of FTIR spectra's of flowers. In FTIR spectrum, absorption bands at 2904 and 2823 cm^{-1} attributable to CH stretching of hydrocarbons and fatty acids and Absorption

band at 1733 cm^{-1} that was ascribed to a carbonyl group stretch of an α, β unsaturated γ - lactone ring [40]. Absorption peak at 1630 cm^{-1} attributed to compounds containing double bonds and conjugated groups and carbonyl group (ester) stretch was observed at 1733 cm^{-1} confirming the presence of a lactone groups [38].

Stretching vibrations between 1200-1300 cm^{-1} depicts presence of hydrocarbons, phenols, alcohols and ethers. Values at 1025 cm^{-1} related to ether linkage due to –CO stretching. Currently, finger print region (condensed region) in between 600 to 650 cm^{-1} is not simple to evaluate due to peaks condensation.

Moisture peaks were not observed indicating complete drying of samples. Also absence of strong absorption band in the region of spectrum between 3400 cm^{-1} 3100 cm^{-1} indicates the absence of hydrogen bonded OH. Most of the peaks in both spectra are common and hence both part of herb is equally important from application point of view. Hydrocarbon peaks are missing in spectrum of flowers. It may be important indication for further research on *Croton bonplandianum*. Esters are also indicated in spectrum of buds. To study further for Phorbols esters, important exploration in *Croton bonplandianum* may also be possible.

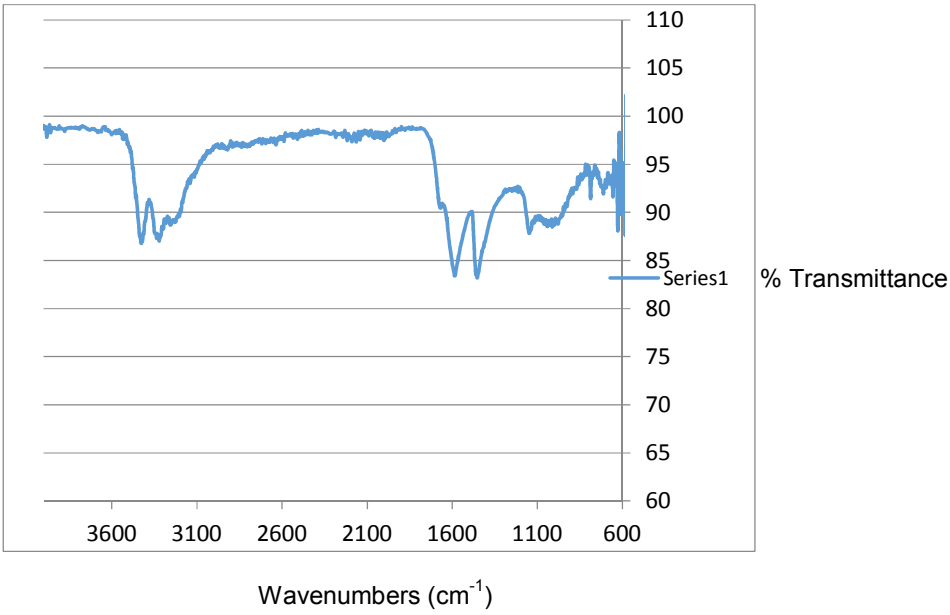

Fig. 5. FTIR spectrum of flowers of *Croton bonplandianum*

Table 1. Shows absorption groups and expected class of compounds in flowering part

Sr. #	Absorption wave #	Group Assigned	Expected phytochemical class
1	3433 (s)	R-OH, R_2-NH	Amino acids, Alkaloids, Alcohols etc.
2	3322 (s)	R-OH, R_2-NH	Amino acids, Alkaloids, Alcohols etc.
3	3256 (w)	R_2-NH	Cyclic amines
4	1667 (w)	-C=C-, CO-R	Aromatic, unsaturated and conjugated compounds , Alkenyl -C=O stretch
5	1581 (s)	-C=C-	Aromatic compounds, nitro oxy comp
6	1469 (s)	-C-H_3	CH sym and asym bending
7	1156 (w)	R-$COOCH_3$	Esters
8	800 (s)	-CH-	Saturated Hydrocarbon, exocyclic double bond stretches
9	715 (w)	-CH-	Five or Six membered Rings, Methylene -(CH2)n- rocking, thiol comp.
10	630 and 660 (s)	organohalogen compound gp	Poly sulfer, thiol compounds

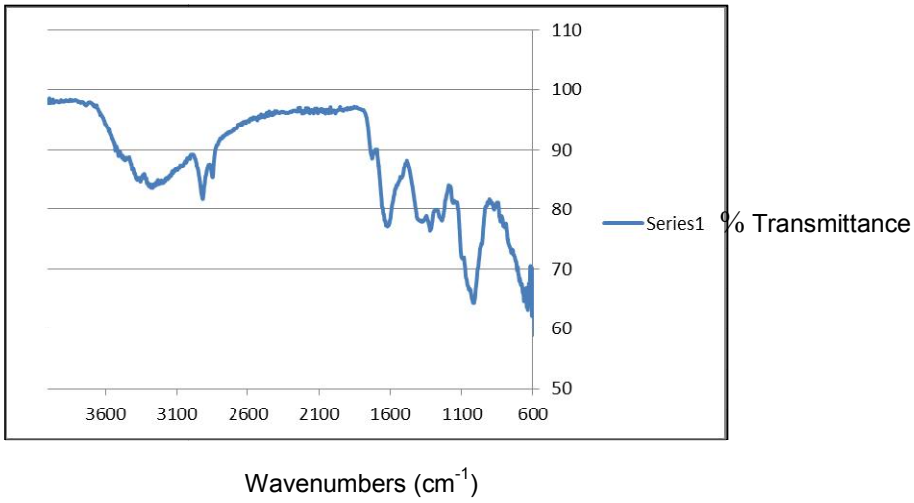

Fig. 6. FTIR spectrum of non-flowering part of flowering twig of *Croton bonplandianum*

Table 2. Shows absorption groups and expected class of compounds in buds (non-flowering) part

Sr. #	Absorption wave #	Group Assigned	Expected phytochemical class
1	3480 (w)	R2-NH, R-OH	Amino acids, Alcohols
2	3392 (w)	R2-NH, R-OH	Amino acids, Alcohols
3	3298 (w)	R2-NH, R-OH	Amino acids, Alcohols
4	2904 (s)	-CH-	SP^3 Hydrocarbons, fatty acids
5	2823 (s)	-CH-	SP^3 Hydrocarbons, fatty acids
6	1733 (w)	-CO-, esters stretch	Carbonyl and ester containing compounds, lipids
7	1630 (s)	C=C	Conjugated systems
8	1325 (w)	-CH- bending	Hydrocarbons
9	1235 (w)	OH Aromatic ethers stretch	
10	1025 (s)	-CO-	Ether linkages
11	600-650 (condensed)	Alkyne CH bend	Compounds of CH out-of-plane bending (aromatic compounds)

4. CONCLUSION

The plant *Croton bonplandianum (bail)* is known to contain important phytochemicals which belong predominantly to family of cyclic terpenoids, chiefly diterpenoid types like Clerodanes and Phorbols. Current work, therefore may be useful for future researchers to use this plant in drug development for the treatment of various diseases. Successful acquisition of noise free FTIR spectra of delicate parts of plant has made the study possible. Moreover, *Croton bonplandianum* specie endemic to North-East Punjab has potential ecological role as source of food for variety of ecologically economical insects such as honey bees, larvae of Lepidoptera, especially under hot and droughty climatic situations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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