TLC-based fingerprinting for *Phyllanthus niruri* from diverse geographical origins in East and Central Java Indonesia

TLC-based fingerprinting for *Phyllanthus niruri* from diverse geographical origins in East and Central Java Indonesia

K Kartini*, W A Wulandari, N I E Jayani and F Setiawan

Department of Pharmaceutical Biology, Faculty of Pharmacy, University of Surabaya, Jl. Raya Kalirungkut 60293 Surabaya, Indonesia

*Corresponding author: kartini@staff.ubaya.ac.id

Abstract. *Phyllanthus niruri* L. (meniran), the member of *Euphorbiaceae*, is a medicinal plant that is commonly found in tropical and sub-tropical areas such as Asia, America, and China. Various factors such as environment, geographical location, harvest time, and post-harvest process can affect the quality of crude drugs produced from *P. niruri*. The objective of this study was to evaluate the quality of meniran herbs obtained from 15 geographical origins in East and Central Java, Indonesia using Thin Layer Chromatography (TLC) profiles analyzed by chemometrics. TLC was carried out using TLC plate Si Gel 60 GF_{254} as stationary phase; toluene, ethyl acetate, methanol, 85% formic acid (75:25:25:6) as mobile phase; and visualized using NP/PEG Reagent. The results showed TLC-fingerprinting combined with chemometric (PCA and CA) analyses were able to discriminate the origin of *P. niruri* from different geographical origins. *P. niruri* from 15 locations of East and Central Java Indonesia were classified into 5 groups based on their chemical similarity. The samples that are grouped in one cluster have the similar quality of chemical compounds, while the samples in different clusters also have different qualities.

Keywords: chemometric, geographical origin, herbal medicine, principal component analysis, TLC

1. Introduction

Phyllanthus niruri L. (meniran) belongs to *Euphorbiaceae* family and grows in tropical and sub-tropical environment such as Asia including Indonesia [1]. This plant has various pharmacological activities such as anti-inflammatory, antioxidant, antihyperuricemic, antimalarial, anticancer, antihyperlipidemic, hepatoprotector, and immunomodulatory [2, 3]. The chemical compounds contained in meniran herbs include flavonoids (rutin, quercetin, quercitrin, astragalin, catechin), alkaloids (norsecurinine, nirurine, phyllochrysine), terpenoids (limonene, p-cymene, lupeol), lignans (phyllanthin, hypophyllanthin, niranthin, nirtetralin, phyltetralin, lintetralin), tannins (repandusinic acid, geraniin, corilagin), coumarins (ellagic acid, methyl brevifolincarboxylate), and saponins (diosgenin) [4].

In general, quality of herbal medicine raw materials is determined by a number of variables, i.e., environment, geographical location, harvest time, and post-harvest process [5-7]. Considering that *P. niruri* can be grown in various habitat, it is possible that the quality of the crude drugs and its products will also vary. Therefore, a specific method is needed to evaluate the quality of meniran herbs obtained from various growing environment.

Quality evaluation of the crude drugs can be done by using specific parameters and non-specific parameters. Specific parameters can be determined utilizing a chemical marker and fingerprint profile approaches. The marker approach involves one or several specific compounds in plants, while fingerprinting profile involves the use of information from all or almost all chemical compounds in plants obtained through spectroscopic or chromatographic methods [8-10]. Thin Layer Chromatography (TLC) is a simple, fast, and inexpensive chromatographic method. The results are visually more attractive and informative than other chromatographic methods [11]. Multivariate data produced from TLC profiles need a special technique analysis called as chemometrics. It uses statistics and mathematics for chemical data processing [12]. Various statistical methods can be used in chemometrics, including Principal Component Analysis (PCA) and Cluster Analysis (CA). The objective of the study was to evaluate the quality of meniran herbs obtained from 15 geographical origins in East and Central Java, Indonesia based on TLC profiles analysed by chemometrics.

2. Material and methods

2.1. Plant materials

Phyllanthus niruri samples were collected from 15 locations in East and Central Java, Indonesia (table 1) and were authenticated by the Center for Information and Traditional Medicine Development (PIPOT), Faculty of Pharmacy, University of Surabaya with a letter of determination no. 1432/D.T/I/2021.

Table 1. Geographical location of *Phyllanthus niruri* from East and Central Java, Indonesia.

No.	District	Height (m a.s.l.)	*Latitude, Longitude*	Time of collection	Moisture content (%)[a]
1	Surabaya	2	7°15’ S; 112°45’ E	June 2019	6.64 ± 0.11
2	Gresik	3	7°09’ S; 112°39’ E	July 2020	5.52 ± 0.19
3	Sidoarjo	3	7°28’ S; 112°40’ E	September 2020	5.23 ± 0.44
4	Pasuruan	5	7°38’ S; 112°53’ E	August 2020	6.73 ± 0.08
5	Banyuwangi	25	8°13’ S; 114°22’ E	July 2020	5.25 ± 0.18
6	Mojokerto	30	7°28’ S; 112°26’ E	June 2019	6.69 ± 0.33
7	Bangkalan	47	7°01’ S; 112°45’ E	June 2019	6.39 ± 0.32
8	Lumajang	51	8°50’ S; 113°14’ E	August 2020	5.84 ± 0.55
9	Nganjuk	56	7°36’ S; 111°53’ E	June 2019	6.90 ± 0.13
10	Kediri	60	7°50’ S; 112°01’ E	June 2019	6.93 ± 0.53
11	Jember	83	8°11’ S; 113°40’ E	September 2020	5.71 ± 0.18
12	Tulungagung	85	8°03’ S; 111°54’ E	August 2020	5.02 ± 0.43
13	Blitar	167	8°05’ S; 112°09’ E	June 2019	6.74 ± 0.60
14	Batu	831	7°52’ S; 112°31’ E	August 2020	5.72 ± 0.35
15	Tawangmangu	1200	7°42’ S; 111°08’ E	August 2020	6.72 ± 0.38

[a]mean ± SD (n = 3)

2.2. Preparation of extracts

The *P. niruri* parts used in this study were all plant parts above the ground (shoot). The shoot was washed with tap water, air dried, ground and sieved. The water content was then determined using moisture content balance (Moisture Analyzer HB43 Mettler-Toledo GmbH, Laboratory & Weighing Technologies, Switzerland). One gram of powdered material was then extracted with 10 ml methanol (Merck KGaA, Germany) using an ultrasonic bath (As One, Japan) at 42 kHz for 15 min. The extract was filtered into a 10 ml volumetric flask and then stored in a closed vial. Extraction was conducted in triplicate for each plant sample.

2.3. TLC condition and selection of mobile phase

Phyllanthus niruri extract and phyllanthin (Sigma Aldrich Co., USA) were applied on a silica gel 60 GF_{254} TLC plate (Merck KGaA, Germany). The plate was inserted into a chamber that has been pre-saturated with a mobile phase. The plate was eluted and then derivatized using NP/PEG reagent (Merck KGaA, Germany). It was then observed and documented using TLC-Visualizer (Camag, Switzerland) under white light, 254 nm UV light, and 366 nm UV light. Each single solvent, i.e., chloroform, tetrahydrofuran, ethanol, dioxane, n-hexane, toluene, ethyl acetate, acetic acid, 2-propanol, diethyl ether, and dichloromethane (Merck KGaA, Germany) were used for optimization of the initial mobile phase. The selected mobile phase for the next stage was the mobile phase which shows the highest number of spots with the best separation. The three mobile phases that show these characteristics were then combined with the mixture design method for optimization of the mixed mobile phase.

2.4. TLC-fingerprint analysis

Phyllanthus niruri extracts from 15 different locations were spotted on a TLC plate and eluted using optimized mobile phase. The chromatogram was then transferred into videoscan to obtain a videodensitogram, Rf value, area, and peak height. The data matrix was then analyzed chemometrically using Minitab v.16 software (Minitab Inc., State College, PA). Chemometrics were performed using Principal Component Analysis (PCA) and Clustering Analysis (CA) methods.

3. Results

3.1. Selected mobile phase

Phyllanthus niruri powder from 15 locations are shown in figure 1. One of the *P. niruri* extract was then used for mobile phase optimization. In the initial stage, chloroform, dichloromethane, and ethanol were the three single solvents that revealed the best separation. In the next stage, using the mix design method, the results showed that chloroform, dichloromethane, ethanol (8:1:1) was the ratio resulting a good separation. However, the separation was not optimal yet. Therefore, other mobile phase mixtures were tried which produced better separation, i.e., toluene, ethyl acetate, methanol, 85% formic acid (75:25:25:6) (figure 2).

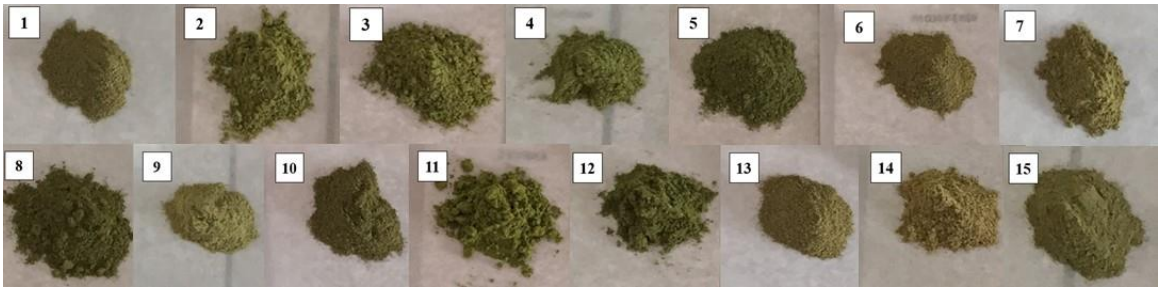


Figure 1. *Phyllanthus niruri* powder collected from Surabaya (1), Gresik (2), Sidoarjo (3), Pasuruan (4), Banyuwangi (5), Mojokerto (6), Bangkalan (7), Lumajang (8), Nganjuk (9), Kediri (10), Jember (11), Tulungagung (12), Blitar (13), Materia Medica Batu (14), and B2P2TOOT Tawangmangu (15).

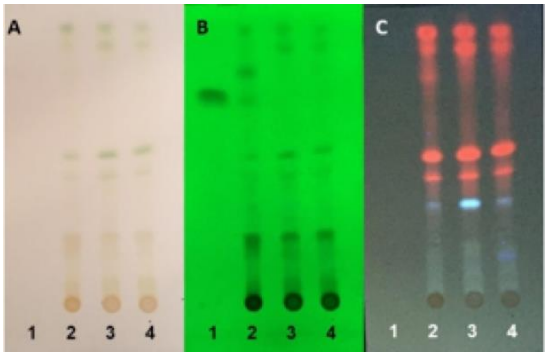


Figure 2. TLC profile of phyllanthin (1) and *P. niruri* extract (2, 3, 4) using optimized mobile phase. MP (mobile phase): toluene, ethyl acetate, methanol, 85% formic acid (75:25:25:6). D (detection): NP-PEG reagent, white light (A), 254 nm UV light (B), 366 nm UV light (C).

3.2. TLC-fingerprints of P. niruri collected from different origins

The TLC profile of *P. niruri* from 15 locations after derivatization can be seen in figure 3. The chromatogram was then transferred into videodensitogram to determine the Rf value, height, and area of each detected peak. As an example, a videodensitogram is shown in figure 3D.

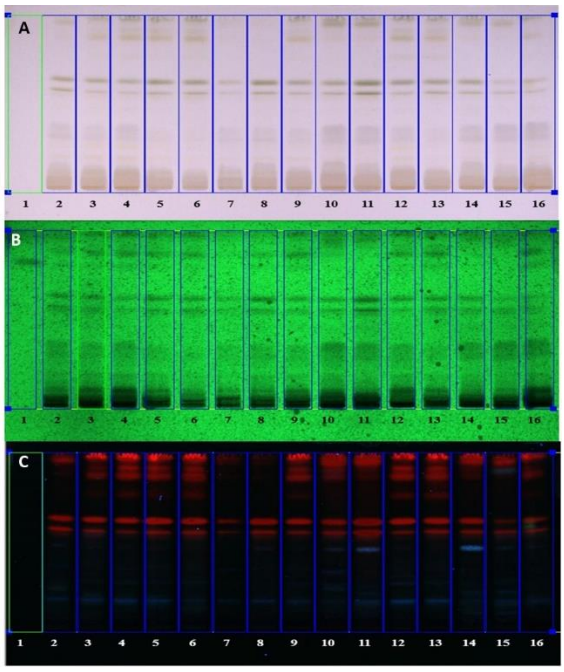


Figure 3. TLC profile of phyllanthin (1) and *P. niruri* collected from Surabaya (2), Gresik (3), Sidoarjo (4), Pasuruan (5), Banyuwangi (6), Mojokerto (7), Bangkalan (8), Lumajang (9), Nganjuk (10), Kediri (11), Jember (12), Tulungagung (13), Blitar (14), Batu (15), and Tawangmangu (16). MP: toluene, ethyl acetate, methanol, 85% formic acid (75:25:25:6). D: NP-PEG reagent, white light (A), 254 nm UV light (B), 366 nm UV light (C). The videodensitogram of *P. niruri* transferred from the track 2 of Figure 3B (D).

3.3. Principal Component Analysis (PCA) results

Videodensitogram data (i.e., peak height at a certain Rf) of all *P. niruri* samples from the chromatogram observed under 254 nm UV light were then tabulated into data matrix 15 x 10 (table 2). These data were then analysed with chemometric using PCA and CA. The scree plot of the PCA (figure 4) exhibits that total variance was shared among the ten Principle Components (PCs). figure 5 plots the scores of the 2 Principle Components (PC1 and PC2) for the fifteen *P. niruri* herbs in table 1, whereas figure 6 shows the loading plot on the first 2 PCs.

3.4. Clustering analysis

The next analysis was Cluster Analysis (CA) which divide 15 *P. niruri* herbs based on their similarity. The dendogram resulted from CA can be seen in figure 7.

4. Discussion

In general, the powder showed a dark green color, except those from Surabaya (1), Bangkalan (7), Nganjuk (9), Blitar (13), Batu (14), and Tawangmangu (15) which are brownish green. This is an early indicator that meniran originating from these locations may have similar characteristics. The moisture content of all *P. niruri* powder was less than 10% (table 1) and this was in accordance with the Indonesian Herbal Pharmacopoeia [13]. It indicates that the drying process of plant materials was appropriate.

Thin Layer Chromatography (TLC) is an analytical technique that has been commonly used for both qualitative and quantitative analysis, even for testing biological activity when combined with bioautography. TLC is the choice of screening technique because it is fast, simple, and inexpensive. TLC is also a method with high flexibility because 20 samples can be analyzed simultaneously under the same conditions. With the advancement of technology, modern high performance thin layer chromatography (HPTLC) has been successfully developed, which is a reliable and powerful analytical technique, which can meet the requirements of today's GMP (cGMP) [14-16].

Table 2. Matrix data of *P. niruri* origin *vs* height of peaks detected from TLC chromatogram.

Origin	Height of peak at a certain Rf value									
	0.0-0.1	**0.1-0.2**	**0.2-0.3**	**0.3-0.4**	**0.4-0.5**	**0.5-0.6**	**0.6-0.7**	**0.7-0.8**	**0.8-0.9**	**0.9-1.0**
Surabaya	2138.1	3271.3	3267.6	3329.9	3377.9	3064.3	3085.0	2790.2	2164.7	1068.7
Gresik	1894.9	3626.0	3638.1	3741.5	3738.5	3306.7	3281.1	2971.2	2277.0	1424.8
Sidoarjo	1959.8	3808.6	3726.4	3973.3	4100.7	3823.7	3736.1	3376.1	2369.0	1722.1
Pasuruan	2860.3	3808.6	3568.6	3797.4	3736.3	3370.4	3287.7	3223.9	2330.4	1441.5
Banyuwangi	2253.6	3627.4	3654.8	3675.9	3486.6	3378.9	3488.6	3015.7	2407.6	1563.2
Mojokerto	2779.5	3575.8	3253.9	3677.7	3638.9	3313.2	3339.3	3121.6	2484.4	1246.7
Bangkalan	2387.3	3493.8	3190.5	2733.2	2995.3	3204.2	3238.0	2803.8	1973.5	1003.3
Lumajang	1892.5	3899.3	3959.4	3318.1	3745.6	3900.3	3902.9	3389.7	2322.8	1569.0
Nganjuk	2623.8	3727.7	3593.7	4110.3	4250.4	3997.5	3895.5	3506.2	2817.5	942.9
Kediri	2536.0	3985.2	3359.3	3773.5	3750.2	3600.9	3640.0	3297.5	2722.4	1352.2
Jember	2450.5	3925.6	3726.9	4037.8	4179.4	3954.1	3861.2	3386.3	2608.6	1548.7
Tulungagung	2357.8	3483.0	3666.8	3598.6	3664.8	3394.3	3454.2	3049.6	2257.4	1303.0
Blitar	2060.3	3585.8	3413.0	3736.6	3888.9	3930.8	3829.1	3536.6	2836.3	1766.1
Batu	2331.5	3555.2	3100.4	3498.2	3677.2	3554.7	3427.8	3499.7	2879.7	1868.4
Tawangmangu	1709.2	3463.3	3362.8	3707.8	4051.0	3911.6	4070.3	3649.0	2740.0	2125.1

Figure 3 shows the different TLC profiles of each sample visually. For example, tracks 2 (Surabaya), 7 (Mojokerto), 8 (Bangkalan), 14 (Blitar), and 15 (Batu) in figure 3C produce less red bands than the other samples. This red band under 366 nm UV light is predicted as chlorophyll. Therefore, samples from Surabaya, Mojokerto, Bangkalan, Blitar, and Batu are predicted to contain different types and

levels of chlorophyll from other samples. This finding is consistent with the color of meniran powder, where samples from Surabaya, Bangkalan, Blitar, and Batu show a paler color than other samples (figure 1). To identify whether there were other differences, chemometrics analysis using PCA and CA were then applied.

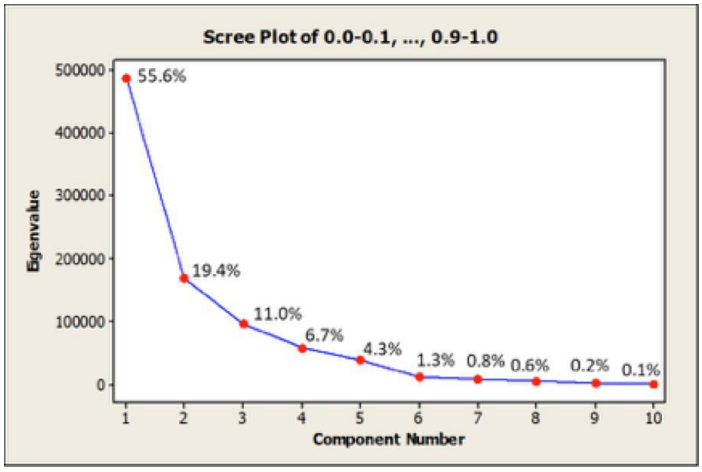


Figure 4. Result of eigen analysis and scree plot of PCs.

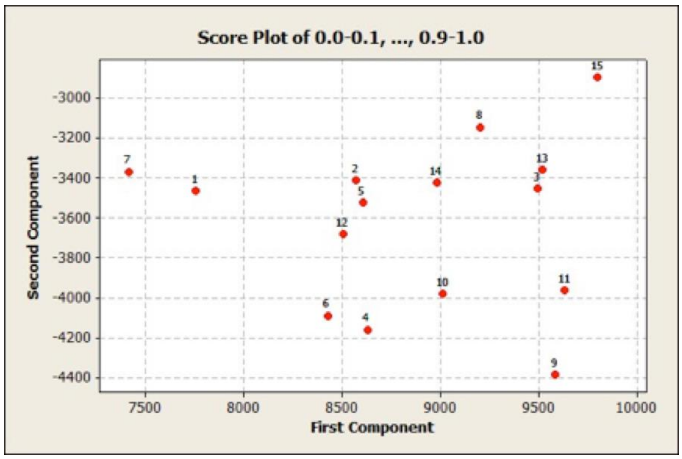


Figure 5. The PCA score plots of *P. niruri* from different locations on the first two PCs. 1-15 were *P. niruri* collected from Surabaya (1), Gresik (2), Sidoarjo (3), Pasuruan (4), Banyuwangi (5), Mojokerto (6), Bangkalan (7), Lumajang (8), Nganjuk (9), Kediri (10), Jember (11), Tulungagung (12), Blitar (13), Materia Medica Batu (14), and B2P2TOOT Tawangmangu (15).

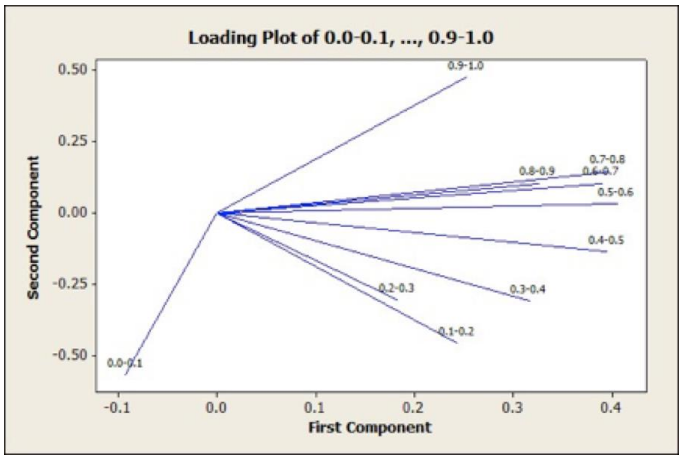


Figure 6. The PCA loading plots of *P. niruri* from different locations on the first two principal components.

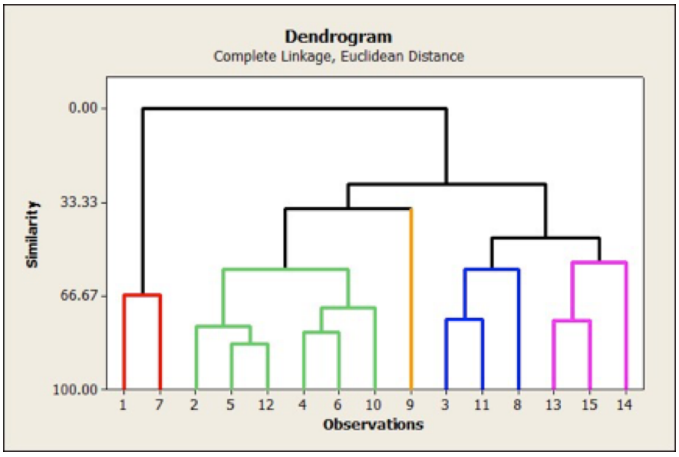


Figure 7. The dendrogram resulted from a complete linkage in the CA. 1-15 were *P. niruri* powder collected from Surabaya (1), Gresik (2), Sidoarjo (3), Pasuruan (4), Banyuwangi (5), Mojokerto (6), Bangkalan (7), Lumajang (8), Nganjuk (9), Kediri (10), Jember (11), Tulungagung (12), Blitar (13), Materia Medica Batu (14), and B2P2TOOT Tawangmangu (15).

From the PCA (figure 4), it is known that the total variance is shared among the 10 Principle Components (PCs). PC1 has a variance of 55.6% of the total variance. This value gives the largest proportion compared to the original variable. PC2 gives 19.4% of the total variance. Therefore, it can be concluded that PC1 and PC2 provide a variation of 75.0%. Thus, PCA was able to reduce the data that originally had 10 variables (peak height at 10 Rf values) can be explained by 2 new variables (up to PC2), because until PC2 was able to extract 75.0% information. figure 5 plots the scores of the 2 Principle Components (PC1 and PC2) for the fifteen *P. niruri* herbs in table 1. The loading plot (figure 6) illustrates how strong each character affects the PC. Two adjacent PCs with a narrow angle indicate a positive correlation, while two PCs that form an angle close to 90° show no correlation. On the other hand, two PCs that are scattered at an angle close to 180° indicate a tendency for negative correlation.

The dendogram resulted from CA (figure 7) showed that the *P. niruri* from 15 locations could be divided into 5 groups. The first group consisted of samples from Batu, Tawangmangu, and Blitar. The second group is from Lumajang, Jember, and Sidoarjo. The third group is Nganjuk, the fourth group consists of Kediri, Mojokerto, Pasuruan, Tulungagung, Banyuwangi, and Gresik, while Surabaya and Bangkalan are included in group 5.

The samples that are in one cluster indicate that the samples have similar chemical content, indicating the quality of *P. niruri* is also similar. Conversely, samples grouped in different clusters indicated different quality. The formation of 5 clusters of *P. niruri* in this study was estimated to be caused by differences in the geographical conditions of the sample origin. All samples used in this study were from the lowlands (<100 m asl), except for three samples from Blitar, Batu, and Tawangmangu. These three samples were from areas with an altitude of >100 m asl and based on CA, they formed one cluster. It is predicted that the altitude of the geographical origin has an effect on the grouping of the *P. niruri*. The grouping of samples due to the influence of the altitude has also been investigated on celery leaves [7]. However, whether this grouping is also influenced by other factors needs further research.

5. Conclusion

TLC-fingerprinting combined with chemometric (PCA and CA) were able to discriminate *P. niruri* originated from various origins. *P. niruri* from 15 locations in East and Central Java, Indonesia used in this study can be classified into 5 clusters. The samples that are joined in one group showed the similarity of chemical content both qualitatively and quantitatively. On the other hand, samples in different groups indicated differences in the quality of the chemical content.

Acknowledgments

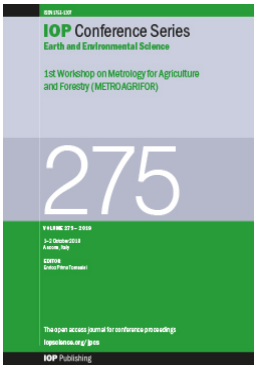
The authors acknowledge the Ministry of Research and Technology/National Research and Innovation Agency of the Republic of Indonesia (Kemenristek/BRIN) for financially supporting this research under

PDUPT Research Scheme with the grant number 008/SP-Lit/LPPM-01/Dikbudristek/Multi/FF/VII/ 2021.

References

[1] Paithankar V, Raut K, Charde R and Vyas J 2015 *Res. Pharm.* **1** 1
[2] Narendra K, Swathi J, Sowjanya K and Satya A K 2012 *J. Pharm. Res.* **5** 4681
[3] Sukweenadhi J, Yunita O, Setiawan F, Siagian M T and Avanti C 2020 *Biodiversitas* **21** 2062
[4] Bagalkotkar G, Sagineedu S, Saad M and Stanslas J 2006 *J. Pharm. Pharmacol.* **58** 1559
[5] Mukherjee P K 2019 *Quality control and evaluation of herbal drugs: Evaluating natural products and traditional medicine* (Amsterdam: Elsevier) p 53
[6] Kartini K, Andriani Y A, Priambodo W, Jayani N I and Hadiyat M A 2021 *J. Pharm. Pharmacogn. Res.* **9** 704
[7] Kartini K, Putri L A D and Hadiyat M A 2020 *J. Appl. Pharm. Sci.* **10** 062
[8] Xie P, Chen S, Liang Y-z, Wang X, Tian R and Upton R 2006 *J. Chromatogr. A* **1112** 171
[9] Ristivojević P, Andrić F L, Trifković J Đ, Vovk I, Stanisavljević L Ž, Tešić Ž L, et al. 2014 *J. Chemom.* **28** 301
[10] Rohman A, Wijayanti T, Windarsih A and Riyanto S 2020 *Mol.* **25** 3928
[11] Vermaak I, Hamman J H and Viljoen A M 2010 *S. Afr. J. Bot.* **76** 119
[12] Bansal A, Chhabra V, Rawal R K and Sharma S 2014 *J. Pharm. Anal.* **4** 223
[13] RI D 2017 *Farmakope Herbal Indonesia Edisi II* (Jakarta: Departemen Kesehatan Republik Indonesia) p 317
[14] Cheng Z and Wu T 2013 *Comb Chem High Throughput Screen* **16** 531
[15] Legerská B, Chmelová D, Ondrejovič M and Miertuš S 2020 *Crit. Rev. Anal. Chem.* **1** 1
[16] Milojković Opsenica D, Ristivojević P, Trifković J, Vovk I, Lušić D and Tešić Ž 2016 *J. Chromatogr. Sci.* **54** 1077

NOTICE: There is planned maintenance due to take place between 10:00 and 11:00 GMT today. This may cause brief disruption to service.



The open access *IOP Conference Series: Earth and Environmental Science (EES)* provides a fast, versatile and cost-effective proceedings publication service.

Latest published conferences

Vol 1904 Go

Conference archive

2022 Go

View forthcoming volumes accepted for publication.

If you would like more information regarding *IOP Conference Series: Earth and Environmental Science* please visit conferenceseries.iop.org, and if you are interested in publishing a proceedings with IOP Conference Series please visit our page for conference organizers.

Conference organizers can use our online form and we will get in touch with a quote and further details.

Most read

Most cited

Latest articles

JOURNAL LINKS

Journal home

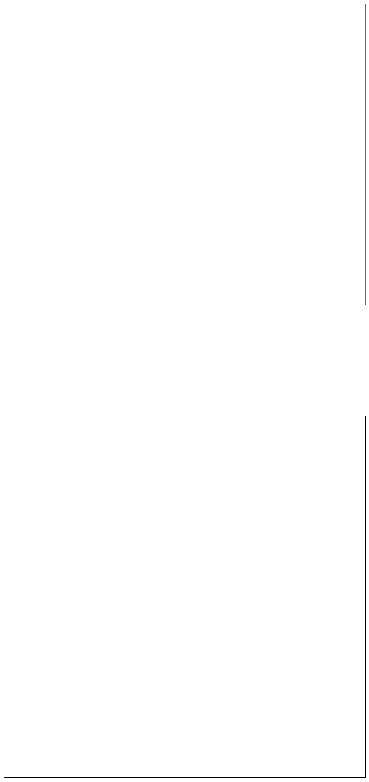
Journal scope

Information for organizers

Information for authors

Contact us

Reprint services from Curran Associates



JOURNAL HISTORY

2008-present IOP Conference Series: Earth and Environmental Science
doi:10.1088/issn.1755-1315
Online ISSN: 1755-1315
Print ISSN: 1755-1307

Table of contents

Volume 948

2021

Previous issue Next issue

4th International Conference on Biosciences (ICoBio 2021) 11th -12th August 2021, Bogor, Indonesia

Accepted papers received: 25 November 2021
Published online: 16 December 2021

Open all abstracts

Preface

Biodiversity, Conservation Biology, Climate Change

TLC-based fingerprinting for *Phyllanthus niruri* from diverse geographical origins in East and Central Java Indonesia

K Kartini, W A Wulandari, N I E Jayani and F Setiawan

+ Open abstract View article PDF

OPEN ACCESS 012004

Agro-morphological characterization based genetic diversity of Indonesian local rice germplasm

I W Mulsanti, A Risliawati and N Yunani

+ Open abstract View article PDF

OPEN ACCESS 012005

Mosses diversity from Simeulue Island, Sumatera, Indonesia

F I Windadri, D Rosalina and A P Keim

+ Open abstract View article PDF

OPEN ACCESS 012006

Javan langur responses to the repeated exposure of ground survey and novel stimulus, unmanned aerial vehicles

D A Rahman, Y Setiawan, A A A F Rahman and T R Martiyani

+ Open abstract View article PDF

OPEN ACCESS 012007

Species and prevalence of parasitic mites on tree geckos in Purwokerto, Central Java

B H Budianto and E Basuki

+ Open abstract View article PDF

OPEN ACCESS 012008

Germination biology of the exotic ice cream bean (*Inga edulis* Mart.) seed from Bedugul, Bali

F Kuswantoro and A S Li'aini

+ Open abstract View article PDF

OPEN ACCESS 012009

Flowering phenology and fruit formation of *Capparis micracantha* in the Bogor Botanic Gardens

I P Astuti, Z Mutaqien, F Damayanti, S Normasiwi and A H Rozak

+ Open abstract View article PDF

OPEN ACCESS 012010

Time budget of daily activity of silvery lutung (*Trachypithecus cristatus*) in coastal forest habitat at Gunung Padang, West Sumatra

+ Open abstract View article PDF

OPEN ACCESS 012018

The unusual sclerotium of *Rhizopogon roseolus* reported from pure cultures

P Putra, R Hermawan, T Aimi and N Shimomura

+ Open abstract View article PDF

OPEN ACCESS 012019

A new report of three parasitoids of the cogongrass gall-midge *Orseolia javanica* Kieffer & Van Leeuwen-Reijnvaan (Diptera: Cecidomyiidae) in Bogor West Java

M N Maqalina, I S Harahap and P Hidayat

+ Open abstract View article PDF

OPEN ACCESS 012020

Predicting habitat suitability of critically endangered *Nepenthes sumatrana*

A Yudaputra

+ Open abstract View article PDF

OPEN ACCESS 012021

Reproductive biology of the Rote Snake-necked Turtle *Chelodina mccordi* (Rhodin, 1994) in Oelsonbai Captivity, Kupang

Kayat and G S Saragih

+ Open abstract View article PDF

OPEN ACCESS 012022

Response of banana germplasms to banana bunchy top virus

D Arubi, Giyanto, D Dinarty, A Sutanto and S H Hidayat

+ Open abstract View article PDF

OPEN ACCESS 012023

Cucurbit aphid-borne yellows virus (CABYV) infecting melon and bitter gourd in Java, Indonesia

T A Damayanti, M Rahmatilah, Listihani, S H Hidayat and S Wiyono

+ Open abstract View article PDF

OPEN ACCESS 012024

Study of a green algae *Lobochlamys segnis* Strain-019 from peatland

H Susanti and T Nakayama

+ Open abstract View article PDF

OPEN ACCESS 012

Diversity of waterbirds in mudflat and fishpond habitats in coastal Wetlands of East Lampung, Indonesia

A R A Khalil, Y A Mulyani, A Mardiastuti and D Iswandaru

+ Open abstract View article PDF

OPEN ACCESS 012026

Electrochemical profiles of bacteria isolated from crude oil on simple benzene compounds detection

A A Ghozali, D Iswantini, C Kusmana and N Nurhidayat

+ Open abstract View article PDF

OPEN ACCESS 012027

Microdebris in Echinodea *Tripneustes gratilla* at Spermonde Archipelago, South Sulawesi, Indonesia

J D D Tanjung, I Ilham, C Liza and W Priawandiputra

+ Open abstract View article PDF

OPEN ACCESS 012028

Patch size does not always indicate bird species diversity: case in peri-urban tropical habitat in Riau, Indonesia

M K Alghifari, A Mardiastuti and Y A Mulyani

+ Open abstract View article PDF

OPEN ACCESS 012029

Occurrence of microdebris in commercial cephalopod

I Ilham, J D D Tanjung, C Liza and W Priawandiputra

+ Open abstract View article PDF

OPEN ACCESS 012030

Reassessment on the monophyly of the fruit-piercing moth, *Eudocima* bilberg, 1820 (Lepidoptera: Erebidae) using molecular data

A B Dharmayanthi, E Arida, Darmawan, S Y Wiyati, T Haryoko, M S A Zein and H Sutrisno

+ Open abstract View article PDF

OPEN ACCESS 012031

Isolation and characterization of fungi from deteriorated old manuscripts from Banyumas, collection of Library of Universitas Indonesia

W Lintang, T Susetyo-Salim, A Oetari and W Sjamsuridzal

+ Open abstract View article PDF

OPEN ACCESS 012032

An optimized method for high-quality DNA extraction medicinal fungi *Mycoleptodonoides aitchisonii* for whole genome sequencing

R Riffiani, T Wada, N Shimomura, T Yamaguchi and T Aimi

+ Open abstract View article PDF

OPEN ACCESS 012033

Habitat use and diet of the bear cuscus *Ailurops ursinus* (Temminck, 1824) in various forest ecosystem types in South Sulawesi

R Nugraha, A A Andriyani and S N Marliana

+ Open abstract View article PDF

OPEN ACCESS 012034

Distribution and characteristics of the Makassar tarsius *Tarsius fuscus* fischer, 1804 sleeping nest in the tropical primary and secondary forests of South Sulawesi

A A Andriyani, R Nugraha and S N Marliana

+ Open abstract View article PDF

OPEN ACCESS 012035

Study on the daily activity of scaly-breasted Munia (*Lonchura punctulata*) in the Indonesian rice field

E Dwijayanti, Mahyana, U Nurlaily and T H Widarto

+ Open abstract View article PDF

OPEN ACCESS 012036

Bio-ecological study of *Culex quinquefasciatus* as a potential vector of *Japanese encephalitis* in some provinces in Indonesia

R Setiyaningsih, Y M Anggraeni, Mujiyono, A O Yanti, Mujiyanto, T A Garjito, M T Prihatin and F D Ayuningrum

+ Open abstract View article PDF

OPEN ACCESS 012037

Flower endophytic fungi of *Geodorum densiflorum* endangered orchid

N D Rahayu, N Sukarno, S Listiyowati, M Rafi, S Mursidawati and E Sandra

+ Open abstract View article PDF

OPEN ACCESS 012038

Mungbean germplasms tolerance to salinity stress correlated with age character and potential yield

H Pratiwi, R T Hapsari, N Nugrahaeni and R Iswanto

+ Open abstract View article PDF

OPEN ACCESS 012039

Species diversity and breeding site of mosquito larvae (Diptera: Culicidae) in *Macaca fascicularis* breeding area

D Novianto, U K Hadi, S Soviana, Supriyono and H S Darusman

+ Open abstract View article PDF

OPEN ACCESS 012040

Nutritional indices and feeding preference of the *Plutella xylostella* L. (Lepidoptera: Yponomeutidae) in several Brassicaceae plants

P P Asmoro, Dadang, Pudjianto and I W Winasa

+ Open abstract View article PDF

OPEN ACCESS 012041

Biology and life tables of *Telenomus remus* (Hymenoptera: Scelionidae) as parasitoid of *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae)

Oktaviani, N Maryana and Pudjianto

+ Open abstract View article PDF

OPEN ACCESS 012042

The diversity of chili pepper volatile compounds and its relationship to insect pests

R Kirana, M J Anwariudin and W Setiawati

+ Open abstract View article PDF

OPEN ACCESS 012043

Callus regeneration and polyploidy induction of *Allium cepa* L var. Bima Brebes using oryzalin

R Q A' yun, D Dinarti, A Husni and M Kosmiatin

+ Open abstract View article PDF

OPEN ACCESS 012044

Biology and life table of *Trichogramma chilotraeae*, Egg parasitoids of *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae)

L Sari, N Maryana and P Hidayat

+ Open abstract View article PDF

OPEN ACCESS 012045

Macrofungal identification and species richness in Cigelung Landscape and its influence on the presence of oil palm pathogens in PTPN VIII

P F Arko, L I Sudirman and I Qayim

+ Open abstract View article PDF

OPEN ACCESS 012046

Flower-visiting insects to *Coffea arabica* flower at different temperatures and the production of the fruit of arabica coffee

H Hafsah, I Iriawati and T S Syamsudin

+ Open abstract View article PDF

OPEN ACCESS 012047

Phenology and morphological flower of *Prunus cerasoides* Buch.-Ham. ex D. Don

V Kurniawan, D M Putri, S Normasiwi and M I Surya

+ Open abstract View article PDF

OPEN ACCESS 012048

Exploration of plant diversity at the forest patches in North Sulawesi and Their Conservation Strategy

H Helmanto, M Siregar, S U Rahmawati, Usman and U Sahrudin

+ Open abstract View article PDF

OPEN ACCESS 012049

Salinity stress affects growth and physiology of mulberry (*Morus* sp.)

Y R E Wulandari, T Triadiati, Y C Sulistyaningsih, A Suprayogi and M Rahminiwati

+ Open abstract View article PDF

OPEN ACCESS 012050

Characteristics of apiculture and meliponiculture in Banten Province, Indonesia: profile of beekeepers, bee and pollen diversity

H S Hanifa, D Sartiami, W Priawandiputra and D Buchori

+ Open abstract View article PDF

Bioprospecting, Health Issues, and Industrial Biology

OPEN ACCESS 012051

Callus of *Curculigo latifolia* Dryand. ex W.T. Aiton: initiation, regeneration, secretory structure and histochemistry

A H Umar, D Ratnadewi, M Rafi, Y C Sulistyaningsih and H Hamim

+ Open abstract View article PDF

OPEN ACCESS 012052

The selection of laccase producing polypores fungi and inducer addition on the degradation of batik waste

A F Mantovany, I M Artika and YB Subowo

+ Open abstract View article PDF

OPEN ACCESS

Beneficial effect of *Achromobacter insolitus* MB20 and manures in reducing *Pythium aphanidermatum* disease in cucumber 012053

Yuliar, N Nuramida and A Salmah

+ Open abstract View article PDF

OPEN ACCESS 012054

Inorganic and organic phosphate solubilization potential of *Stenotrophomonas maltophilia*

Suliasih and S Widawati

+ Open abstract View article PDF

OPEN ACCESS 012055

The effect of water content and carbon source addition on lipase production from *Aspergillus aculeatus* Ms.11 using spent coffee ground

A Yuliyanti, M C D Manullang and M Ilmi

+ Open abstract View article PDF

OPEN ACCESS 012056

Uncovering the potential of actinobacterium BLH 1-22 isolated from marine sediment as a producer of antibiotics

A Atikana, S Ratnakomala, I Nurzijah, M N Sari, A Agnestania, II Aisy, F Untari, F Fahrurozi, M Bintang, L Sukmarini *et al*

+ Open abstract View article PDF

OPEN ACCESS 012057

The effect of *Etlingera elatior* J. flower on the pulmo histology of white rat (*Rattus novergicus* L.) after cigarette smoke exposure

F Hasri, K Manalu, E P S Tambunan and Syukriah

+ Open abstract View article PDF

OPEN ACCESS 012058

Field evaluation of the combination of larvicide and rice stem immersion to improve lethal ovitrap effectiveness in dengue vector control

A Pujiyanti, M Mujiyanto, R Setiyaningsih, R R Kinansi, L Susanti, A Mulyono, T A Garjito and W Trapsilowati

+ Open abstract View article PDF

OPEN ACCESS 012059

Characterization of secondary metabolites in kasturi mango (*Mangifera casturi*) using gas chromatography-mass spectrometry

S Zulfina, M A N Fathoni, R Poerwanto and D D Matra

+ Open abstract View article PDF

OPEN ACCESS 012060

Bioactivities of Lamiaceae, Myristicaceae, and Myrtaceae plant oils against *Nilaparvata lugens* Stâl. (Hemiptera: Delphacidae)

T L Mardiningsih and Rohimatun

+ Open abstract View article PDF

OPEN ACCESS 012061

Bird visit to *Ficus benjamina* in two urbanization gradients in the tropics

A Mardiastuti, Y A Mulyani and M D Kusrini

+ Open abstract View article PDF

OPEN ACCESS 012062

Bioactive compounds derived from *Streptomyces* sp. SA32: antibacterial activity, chemical profile, and their related genes

D Ryandini, O K Radjasa and Oedjijono

+ Open abstract View article PDF

OPEN ACCESS 012063

Mechanical properties of edible film based bacterial cellulose from sago liquid waste using starch as stabilizer

N A Yanti, S W Ahmad, L O A N Ramadhan and T Walhidayah

+ Open abstract View article PDF

OPEN ACCESS 012064

Chitosan-Ag nanoparticle antifungal activity against *Fusarium* sp., causal agent of wilt disease on chili

S Wahyuni, K R P Wibowo, H T Prakoso, M Bintang and Siswanto

+ Open abstract View article PDF

OPEN ACCESS 012065

The qualitative screening of cellulolytic, chitinolytic, IAA-producing, and phosphate solubilizing bacteria from black soldier fly larvae (*Hermetia illucens* L.)

H Tamrela, A Sugiyanto, I Santoso and Q G Fadhilah

+ Open abstract View article PDF

OPEN ACCESS 012066

Isolation, characterization, and screening of antioxidant activity of endophytic bacteria from *Leea Indica* (Burm. F) Merr. Leaf

D Arivo, N R Mubarik, I Rusmana and I Batubara

+ Open abstract View article PDF

OPEN ACCESS 012067

Analysis of Multidimensional Stunting Intervention Factor Using Mixed Model

D N Agustina, B Sartono and K A Notodiputro

+ Open abstract View article PDF

OPEN ACCESS 012068

In vitro antimicrobial activities of several extracts endophytic *Pseudomonas azotoformans* UICC B-91

E Oktarina, R H Pratiwi, W Mangunwardoyo, I Hidayat and E Saepudin

+ Open abstract View article PDF

OPEN ACCESS 012069

Antibacterial activity of endosymbiotic fungi isolated from marine sponges collected from Kotok Kecil Island, Seribu Islands, Jakarta

R Trifani, Noverita, T A Hadi and E Sinaga

+ Open abstract View article PDF

OPEN ACCESS 012070

Motivation, purpose, and purchasing frequency of honey consumption in West Java

D Purnomo, A Bunyamin, W Gunawan, N A Faizah, T G Danuwidjaja, L N Rohman and R Annisa

+ Open abstract View article PDF

OPEN ACCESS 012071

Genetic construction of HBsAg gene subgenotype B3 in *Lactococcus lactis* as hepatitis B vaccine candidate

A Z Mustopa, H H Putri, Kusdianawati, B R Budiarto, A Kusumawati, M Nurfatwa, N Ekawati, A Prastyowati, L Triratna, A Hertati *et al*

+ Open abstract View article PDF

OPEN ACCESS 012072

New record of *Gymnoascus udagawae* associated with *Clathria* sp. sponge from Indonesia and the potency as *anti-Candida*

W N Fadillah, N Sukarno, D Iswantini, M Rahminiwati and S Listiyowati

+ Open abstract View article PDF

OPEN ACCESS 012073

Decolourization of congo red synthetic dyes by dark septate endophytes

I Melati, G Rahayu, Surono, H Effendi and C Henny

+ Open abstract View article PDF

OPEN ACCESS 012074

Antagonistic capacity of dark septate endophytes (DSE) against *Ganoderma boninense* from oil palm (*Elaeis guineensis* Jacq.)

G Rahayu, Surono and D A Octaviani

+ Open abstract View article PDF

OPEN ACCESS 012075

In vitro plant growth promoter assay of actinobacteria potential for tidal land farming

D Alfiyah, M Ghulamahdi and Y Lestari

+ Open abstract View article PDF

OPEN ACCESS 012076

Analysis of climatic variability and dengue hemorrhagic fever incidence at the Tsunami Area Banda Aceh City

E Agustina, A S Leksono, Z P Gama and B Yanuwiadi

+ Open abstract View article PDF

OPEN ACCESS 012077

Genetic diversity of multiple human immunodeficiency virus-1 (HIV-1) clades in West Papua

M Widiyanti, S Adiningsih and T N Kridaningsih

+ Open abstract View article PDF

OPEN ACCESS 012078

Nephroprotective and antioxidant effects of ethanol extract of *Coprinus comatus* mushroom fruit-bodies on streptozotocin-induced diabetic rat models

N I Ratnaningtyas, Hernayanti, N Ekowati and F Husen

+ Open abstract View article PDF

Omics, Bioinformatics, and Computational Biology

OPEN ACCESS 012079

Melting curve analysis to differentiate *Rickettsia* spp. and *Rickettsia felis*

D Widiastuti, Agustiningsih, S P M Wijayati and E Lestari

+ Open abstract View article PDF

OPEN ACCESS 012080

Computational antigenic epitope prediction of clinical Indonesian Dengue virus NS1 protein

S Pambudi, D Irawan, A Danny, T Widayanti and Tarwadi

+ Open abstract View article PDF

OPEN ACCESS 012081

Expression comparison between two genes encoding CSF3 recombinant proteins having different codon composition at N-terminal in *Escherichia coli*

K S Dewi, F D Wahyuni, S Salsabila, Aminah, N D Yanthi and A M Fuad

+ Open abstract View article PDF

OPEN ACCESS 012082

Development and characterization of Simple Sequence Repeats (SSRs) markers in durian kura-kura (*Durio testudinarius* Becc.) using NGS data

Mahat Magandhi, Sobir, Yudiwanti W.E. Kusumo, Sudarmono and Deden Derajat Matra

+ Open abstract View article PDF

OPEN ACCESS 012083

sgRNA design for *DLT* gene editing using CRISPR-Cas9 and *in-silico* mutation prediction in Rice cv. Hawara Bunar

I Halim, M H Fendiyanto and Miftahudin

+ Open abstract View article PDF

Techno-biology and Bioengineering

OPEN ACCESS 012084

Transformation and characterization of human insulin precursor gene in *Pichiapastoris* X-33

F C Sekaringtyas, D Hardianto, N Karimah, V Nida and A Zahra

+ Open abstract View article PDF

OPEN ACCESS 012085

Optimization of silver nanoparticles synthesis by the green method using *Streptomyces* sp. SSUT88A and their antimicrobial activity against *Pseudomonas aeruginosa*

A Rosyidah, N Nantapong, N Chudapongse, O Weeranantanapan and W Limphirat

+ Open abstract View article PDF

Smart and Sustainable Agro-maritime

OPEN ACCESS 012086

GO potato aeroponic seed production in Indonesia, producers' perception toward the benefits and challenges

A Sembiring, R Murtiningsih, J P Sahat and S Hartanto

+ Open abstract View article PDF

OPEN ACCESS 012087

Kaolin application to increase lettuce (*Lactuca sativa*) growth under suboptimal watering condition

H F Fawwaz, S Lathifatunnisa, N M Hemelda and R Yuniati

+ Open abstract View article PDF

OPEN ACCESS 012088

Prospects of neem and citronella oil against *Pseudococcus longispinus* (hemiptera: Pseudococcidae) on Phalaenopsis

D Hutapea, I B Rahardjoa and M Thamrin

+ Open abstract View article PDF

OPEN ACCESS 012089

Nitrogen (N_2) fixation activity under different oxygen concentration of methanotrophic bacteria isolated from rice fields and their molecular identification

I Rusmana, A Akhdiya and B T Sagala

+ Open abstract View article PDF

OPEN ACCESS 012090

Automatic monitoring system of *Apis cerana* based on image processing

A Nurhiman, A Almira, R Raffiudin, M N Indro, A Maddu and T Sumaryada

+ Open abstract View article PDF

JOURNAL LINKS

IOP Conference Series: Earth and Environmental Science

COUNTRY

United Kingdom

Universities and research institutions in United Kingdom

SUBJECT AREA AND CATEGORY

Earth and Planetary Sciences
Earth and Planetary Sciences (miscellaneous)

Environmental Science
Environmental Science (miscellaneous)

Physics and Astronomy
Physics and Astronomy (miscellaneous)

PUBLISHER

IOP Publishing Ltd.

H-INDEX

34

PUBLICATION TYPE

Conferences and Proceedings

ISSN

17551307, 17551315

COVERAGE

2010-2021

INFORMATION

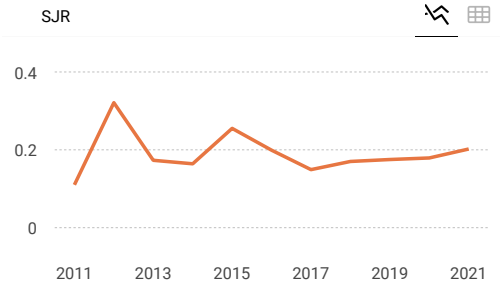
Homepage

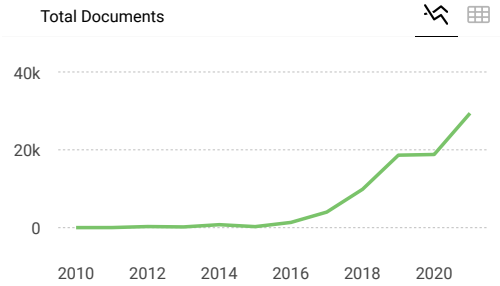
How to publish in this journal

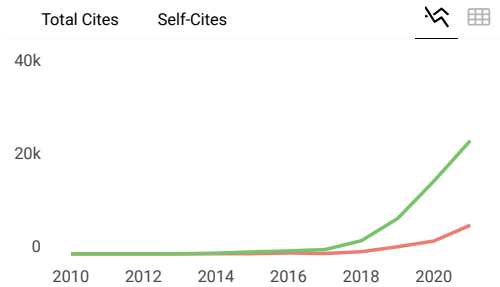
ees@ioppublishing.org

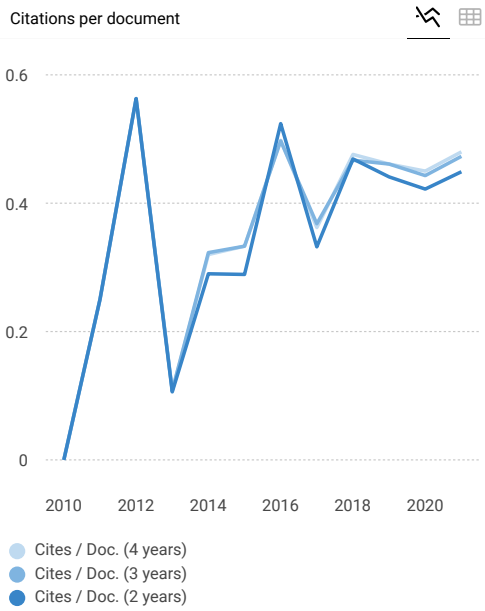
SCOPE

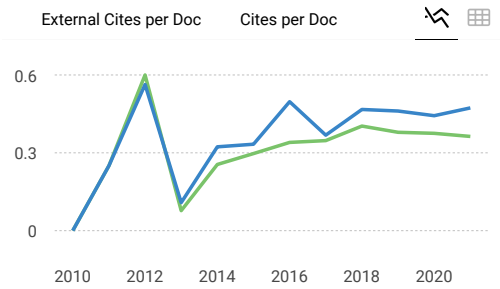
The open access IOP Conference Series: Earth and Environmental Science (EES) provides a fast, versatile and cost-effective proceedings publication service.

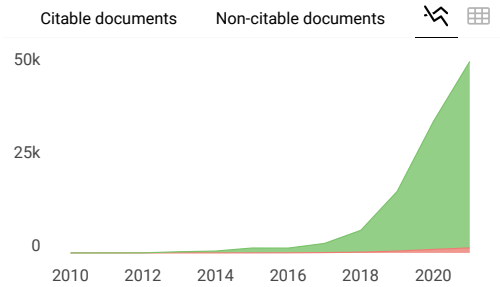


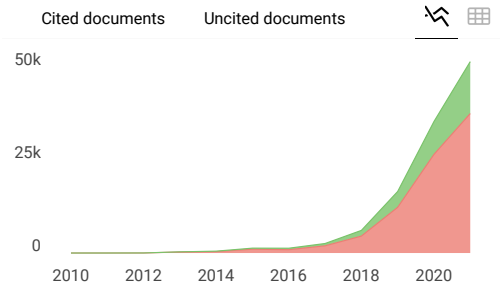












← Show this widget in your own website

Just copy the code below and paste within your html code:

<a href="https://www.scim

SCImago Graphica

Explore, visually
mmunicate and make

Source details

IOP Conference Series: Earth and Environmental Science

Scopus coverage years: from 2010 to Present

ISSN: 1755-1307 E-ISSN: 1755-1315

Subject area: Environmental Science: General Environmental Science

Earth and Planetary Sciences: General Earth and Planetary Sciences

Physics and Astronomy: General Physics and Astronomy

Source type: Conference Proceeding

CiteScore 2020
0.5

SJR 2020
0.179

SNIP 2020
0.436

View all documents > | Set document alert | Save to source list | Source Homepage

CiteScore | CiteScore rank & trend | Scopus content coverage

CiteScore 2020

$$0.5 = \frac{25{,}463 \text{ Citations } 2017 - 2020}{49{,}883 \text{ Documents } 2017 - 2020}$$

Calculated on 05 May, 2021

CiteScoreTracker 2021

$$0.6 = \frac{44{,}677 \text{ Citations to date}}{74{,}322 \text{ Documents to date}}$$

Last updated on 06 April, 2022 • Updated monthly

CiteScore rank 2020

Category	Rank	Percentile
Environmental Science General Environmental Science	#183/220	17th
Earth and Planetary Sciences General Earth and Planetary Sciences	#157/186	15th

View CiteScore methodology > | CiteScore FAQ > | Add CiteScore to your site

About Scopus

What is Scopus

Content coverage

Scopus blog

Scopus API

Privacy matters

Language

日本語に切り替える

切换到简体中文

切換到繁體中文

Русский язык

Customer Service

Help

Tutorials

Contact us

ELSEVIER

CERTIFICATE

This certificate is presented to:

Kartini, S.Si., M.Si., Apt., Ph.D.

as

Presenter

in **The 4th International Conference on Biosciences (ICoBio) and The 17th National Congress of Indonesian Biological Society (PBI) 2021, With theme "Bioscience Innovations for Sustainable Development Goals (SDGs)"**
organized by the Department of Biology, IPB University, in collaboration with Indonesian Biological Society (PBI), and Universiti Putra Malaysia (UPM), held on 11-12 August 2021
Virtually via Zoom Meeting

Bogor, 12 August 2021

Dr. Berry Juliandi
Dean, Faculty of Mathematics and Natural Sciences, IPB University

Prof. Dr. Yulin Lestari
Organizing Committee Chairman
The 4th ICoBio and 17th PBI Congress 2021

Dr. Ence Darmo Jaya Supena
Head of PBI