



## Review article

Secondary metabolite compounds from *Sida* genus and their bioactivityN.S. Aminah<sup>a,\*</sup>, E.R. Laili<sup>a</sup>, M. Rafi<sup>b</sup>, A. Rochman<sup>c</sup>, M. Insanu<sup>d</sup>, K.N.W. Tun<sup>e,f</sup><sup>a</sup> Department of Chemistry, Faculty of Science and Technology, Universitas Airlangga, Komplek Kampus C, Jl. Mulyorejo, Surabaya, 60115, Indonesia<sup>b</sup> Department of Chemistry, Faculty of Mathematics and Natural Sciences, Institut Pertanian Bogor, Jalan Tanjung Kampus IPB Dramaga, Bogor 16680, Indonesia<sup>c</sup> Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Universitas Gadjah Mada, Yogyakarta, 55281, Indonesia<sup>d</sup> Department of Pharmaceutical Biology, School of Pharmacy, Institut Teknologi Bandung, Bandung, West Java, Indonesia<sup>e</sup> Postdoc Fellow Department of Chemistry, Faculty of Science and Technology, Universitas Airlangga, Komplek Kampus C, Jl. Mulyorejo, Surabaya, 60115, Indonesia<sup>f</sup> Department of Chemistry, Patheon University, Patheon, Myanmar

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## ABSTRACT

Plants are the key source for the production of novel therapeutic products for new medicines. The biological properties of the plant species used world wide are mainly accountable for their secondary metabolites obtained from plants. The goal of this analysis is to summarize the chemical composition and biological effects of the genus *Sida* (Malvaceae) to identify potential research opportunities. This analysis draws on the literature review of scientific journals, and books from libraries, and electronic sources like ScienceDirect, Springer, PubMed, ResearchGate, Google Scholar, and the Website. Some groups of secondary metabolite compounds isolated from the genus *Sida* include alkaloids, flavonoids, coumarin, and others. Pharmacological experiments found that there are a wide variety of biological activities in extracts and compounds isolated from the genus *Sida* comprising antimalarial, antiplasmodial, antimicrobial, analgesic, antibacterial, antioxidant, vasorelaxant, wound healing, antifungal activities, the inhibition of quinone reductase, and mouse mammary organ culture.

## 1. Introduction

Metabolites are the transitional products of metabolism and restricted to small molecules. Plant produces a lot of chemicals that can be categorized into primary metabolites and secondary metabolites. Primary metabolites are necessary for cell function and they are omnipresent. Secondary metabolites are useful for human because of their diverse applications (Dufour and Rao, 2011; Olivoto et al., 2017; Yang et al., 2018).

The genus *sida* has relatively 200 species scattered in every part of tropical and subtropical regions in the world (Mabberley, 1997). The genus *sida* is originated in Brazil (Bovini, 2015). This plant can be used as traditional medicine, but no reviews have been made on the phytochemical, toxicological and pharmacological properties of the genus *Sida*. The main focus of this review is phytochemistry, pharmacological properties, botanical aspects of the herbs, their experimental application and translational investigation of genus *sida* (see Table 1).

## 2. Botanical description

2.1. *Sida cordifolia*

*Sida cordifolia* is an erect perennial growing up to 50–200 cm high. Leaves are oblong, hair-coated and 3.5 cm long. The trunks

are green-yellow, thick, long and short. The cycle of flora and fruit is from October to December (Shetu et al., 2019). *Sida cordifolia* plants according to Khurana et al. (2016) have the following categorization:

Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Dilleniidae
Superorder	Malvanae
Order	Malvales
Family	Malvaceae
Subfamily	Malvoideae
Tribe	Malveae
Genus	<i>Sida</i>
Species	<i>S. cordifolia</i>
Scientific name	<i>S. cordifolia</i> L.

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**Table 1.** Isolated compounds from Genus *Sida* and their biological activities.

Compound name	Species	Biological activities	References
Ψ-(pseudo)-ephedrine (1)	<i>S. cordifolia</i>		Ghosh and Dutta (1930)
β-phenethylamine (2)	<i>S. cordifolia</i>		Ghosal et al. (1975)
ephedrine (3)	<i>S. cordifolia</i>		Ghosal et al. (1975)
Ψ-ephedrine (4),	<i>S. cordifolia</i>		Ghosal et al. (1975)
S-(+) N <sub>6</sub> -methyltrypto-phanmethyl ester (5)	<i>S. cordifolia</i>		Ghosal et al. (1975)
hypaphorine (6)	<i>S. cordifolia</i>		Ghosal et al. (1975)
vasicinone (7)	<i>S. cordifolia</i>		Ghosal et al. (1975)
vasicine(8)	<i>S. cordifolia</i>		Ghosal et al. (1975)
vasicinol (9)	<i>S. cordifolia</i>		Ghosal et al. (1975)
quindolinone (10)	<i>S. acuta</i>	Quinone reductase	Jang et al. (2003)
cryptolepinone (11)	<i>S. acuta, S. rhombifolia</i>	Vasorelaxant, Mouse mammary organ culture, Quinone reductase	Jang et al. (2003), Chaves et al. (2013)
11-methoxyquindoline (12)	<i>S. acuta</i>	Quinone reductase	Jang et al. (2003)
N-trans-feruloyltyramine (13)	<i>S. acuta</i>	Mouse mammary organ culture	Jang et al. (2003)
5'-hydroxymethyl-1'-(1,2,3,9-tetrahydro-pyrrolo[2,1-b]quinazolin-1-yl)-heptan-1-one (14)	<i>S. cordifolia</i>		Sutradhar et al. (2006)
1,2,3,9-tetrahydro-pyrrolo [2,1-b] quinazolin-3-ylamine (15)	<i>S. cordifolia</i>		Sutradhar et al. (2007)
2-(1'-amino-butyl) indol-3-one (16)	<i>S. cordifolia</i>		Sutradhar et al. (2007)
2'-(3H-indol-3-ylmethyl)-butan-1'-ol (17)	<i>S. cordifolia</i>		Sutradhar et al. (2007)
a salt of cryptolepine (18)	<i>S. cordifolia</i>		Chaves et al. (2013)
11-methoxy-quindoline (19)	<i>S. cordifolia</i>		Chaves et al. (2013)
quindoline (20)	<i>S. cordifolia</i>		Chaves et al. (2013)
1,2,3,9-tetrahydro-pyrrolo[2,1-b]quinazolin-3-amine (21)	<i>Sida glutinosa</i>		Das et al. (2011)
3,4,5,6-tetrahydro-3-methyl-β-carboline-5-carboxylic acid (22)	<i>Sida szechuensis</i>		Yao and Xu (2000)
cryptolepine (23)	<i>S. acuta</i>	Antiplasmodial	Banzouzi et al. (2004)
3'-(3'',7''-dimethyl-2'',6''-octadiene)-8-C-β-D-glucosyl-kaempferol 3-O-β-D-glucoside (24)	<i>S. cordifolia</i>		Sutradhar et al. (2007)
3'-(3'',7''-dimethyl-2'',6''-octadiene)-8-C-β-D-glucosyl-kaempferol 3-O-β-D-glucosyl [1→4]-β-D-glucoside (25)	<i>S. cordifolia</i>		Sutradhar et al. (2007)
6-(3''-methyl-2''-butene)-3'-methoxyl-8-C-β-D-glucosyl-kaempferol 3-O-β-D-glucosyl [1→4]-β-D-glucoside 3, 3'-(3'', 7''-Dimethyl 2'',6'' otadiene)-8-C β-D-glucosylkaempferol 3-O-β-D-glucoside (26)	<i>S. cordifolia</i>		Sutradhar et al. (2007)
5,7-dihydroxy-3-isoprenylflavone (27)	<i>S. cordifolia</i>		Sutradhar et al., (2008)
5-hydroxy-3-isoprenyl Flavone (28)	<i>S. cordifolia</i>		Sutradhar et al., (2008)
5,7-dihydroxy-4'-methoxyflavone (29)	<i>S. rhombifolia</i>		Chaves et al. (2013)
kaempferol (30)	<i>S. rhombifolia</i>		Chaves et al. (2017)
kaempferol-3-O-β-D-glycosyl-6''-α-D-rhamnose (31)	<i>S. rhombifolia</i>		Chaves et al. (2017)
Glutinoside (32)	<i>S. glutinosa</i>		Das et al. (2012)
Chrysin (33)	<i>S. glutinosa</i>		Das et al. (2012)
scopoletin (34)	<i>S. acuta, S. rhombifolia</i>		Jang et al. (2003)
scoporone (35)	<i>S. rhombifolia</i>		Jang et al. (2003)
20-hydroxy,24-hydroxymethyl ecdysone (36)	<i>S. spinosa</i>		Darwish and Reinecke (2003); Jadhav et al. (2007)
20-hydroxyecdysone (37)	<i>S. spinosa</i>		Darwish and Reinecke (2003); Jadhav et al. (2007)
turkesterone (38)	<i>S. spinosa</i>		Darwish and Reinecke (2003)
makisterone C (39)	<i>S. spinosa</i>		Darwish and Reinecke (2003)
20-Hydroxyecdysone-20,22-monoacetone (40)	<i>S. spinosa</i>		Darwish and Reinecke (2003)
24(28)-Dehydromakisterone A (41)	<i>S. glutinosa</i>		Das et al. (2012)
2β,3β,14α,20,21,22R,24-heptahydroxycholest-7-en-6-one (42)	<i>S. szechuensis</i>		Yao and Xu (2000)
polypodine B (43)	<i>S. szechuensis</i>		Yao and Xu (2000)
α-ecdysone (44)	<i>S. szechuensis</i>		Yao and Xu (2000)
25-acetoxy-20-hydroxyecdysone-3-O-β-D-glucopyranoside (45)	<i>S. rhombifolia</i>		Jadhav et al. (2007)
Pterosterone-3-O-β-D-glucopyranoside ecdysteroid (46)	<i>S. rhombifolia</i>		Jadhav et al. (2007)
ecdysone-3-O-β-D-glucopyranoside (47)	<i>S. rhombifolia</i>		Jadhav et al. (2007)
2-deoxy-20-hydroxyecdysone-3-O-β-D-glucopyranoside (48)	<i>S. rhombifolia</i>		Jadhav et al. (2007)
20-hydroxyecdysone-3-O-β-D-glucopyranoside (49)	<i>S. rhombifolia</i>		Jadhav et al. (2007)
taraxast-1,20(30)-dien-3-one (50)	<i>S. acuta</i>	Antioxidant	Chen et al. (2007)
taraxasterone (51)	<i>S. acuta</i>	Antioxidant	Chen et al. (2007)
7a-methoxy-α-tocopherol (52)	<i>S. acuta</i>	Antioxidant	Chen et al. (2007)

(continued on next page)

Table 1 (continued)

Compound name	Species	Biological activities	References
$\beta$ -tocopherol (53)	<i>S. acuta</i>		Chen et al. (2007)
$\alpha$ -tocopherol (54)	<i>S. acuta</i>		Chen et al. (2007)
$\alpha$ -tocospiro B (55)	<i>S. acuta</i>		Chen et al. (2007)
vomifoliol (56)	<i>S. acuta</i>		Jang et al. (2003)
Ioliolide (57)	<i>S. acuta</i>		Jang et al. (2003)
4-ketopinonesinol (58)	<i>S. acuta</i>		Jang et al. (2003)
evofolin-A (59)	<i>S. acuta</i>		Jang et al. (2003)
evofolin-B (60)	<i>S. acuta</i>		Jang et al. (2003)
glyceryl-1-eicosanoate (61)	<i>S. spinosa</i>		Darwish and Reinecke (2003)
p-hydroxyphenethyl trans-ferulate (62)	<i>S. spinosa</i>		Darwish and Reinecke (2003)
triacontane (63)	<i>S. spinosa</i>		Darwish and Reinecke (2003)
1-eicosene (64)	<i>S. spinosa</i>		Darwish and Reinecke (2003)
9-hydroxy-cis-11-octadecenoic acid (65)	<i>S. spinosa</i>		Darwish and Reinecke (2003)
1-O- $\beta$ -D-Glucopyranosyl-(2S,3S,4R,8Z)-2-[(2'R)-2'-hydroxypalmito-ylamino]-8-octadecene-1,3,4'-triol (66)	<i>S. spinosa</i>		Darwish and Reinecke (2003)
phaeophytin A (67)	<i>S. rhombifolia</i>		Chaves et al. (2013)
17 <sup>3</sup> -ethoxyphosphorbide A (68)	<i>S. rhombifolia</i>		Chaves et al. (2013)
13 <sup>2</sup> -hydroxy phaeophytin B (69)	<i>S. rhombifolia</i>		Chaves et al. (2013)
17 <sup>3</sup> -ethoxyphosphorbide B (70)	<i>S. rhombifolia</i>		Chaves et al. (2013)

## 2.2. *Sida acuta*

There was no literature for plant description of *Sida acuta*. *Sida acuta* plants according to Mohideen et al. (2002) have the following categorization:

Kingdom	Plantae
Class	Dicotyledoneae
Order	Malvales
Family	Malvaceae
Genus	<i>Sida</i>
Specie	<i>S. acuta</i>
Scientific name	<i>Sida acuta</i> Burman f.

## 2.3. *Sida rhombifolia*

*Sida rhombifolia* is a member of the genus *Sida* which belongs to the Malvaceae family. Local names are called guri, sidaguri, saliguri (Sumatra), sadagori, sidaguri, otok-otok, taghuri, sidagori (Java), kahindu, mistaken (Nusa Tenggara) and hutugamo, bitumu, digo, sosapu (Maluku) (Dalimarta, 2003). Sidaguri plants (*Sida rhombifolia* L) according to Sivarajan and Pradeep (1994), have the following classification:

Divisio	Spermatophyta
Sub Divisio	Angiospermae
Classis	Dicotyledoneae
Sub classis	Dialypetalae
Ordo	Malvales/Columniferae
Familia	Malvaceae
Genus	<i>Sida</i>
Species	<i>S. rhombifolia</i>
Scientific name	<i>Sida rhombifolia</i> L.

## 2.4. *Sida spinosa*

*Sida spinosais* recognized as Kantakinibala (prickly fanpetals) is an erect perennial shrub. This plant is primarily found in the warmer parts of India at the height of 4400 ft. The plant is stellate, with filiform leaves 30

cm–1 m high, stipules 2–5 mm long, petiole length 2–20 mm, 1–3 spiny tubercles present on the stem at the base of petiole, lanceolate to ovate, oblong or rather orbicular, round at the base, acute or obtuse at the apex, and serrate at the apex. Moreover, flowers in terminal branches, axillary, solitary or 2–5 in fascicles, 2–5 mm pedicel, 0.2 cm long fruits, attached close to the center or tip. Calyx is 4–5 mm long and the fruits are compressed spherical with pubescent above. Furthermore, the length of the reddish brown glabrous seeds are 1.5 mm (Lin et al., 2010). *Sida spinosa* plants according to Singh and Navneet (2018) have the following classification:

Kingdom	Plantae
Division	Tracheophyta
Class	Mangnoliopsida
Order	Malvales
Genus	<i>Sida</i>
Species	<i>S. spinosa</i>
Scientific name	<i>Sida spinosa</i>

## 2.5. *Sida tuberculata*

In an area of South America, *Sida tuberculata* is mostly grown and is a well-known drink such as infusion or tea. *Sida tuberculata* is an herbaceous or subshrub plant that grows between 40 and 80 cm in length and expands by kernels. leaf blades elliptic or subrhombic to narrowly linear, upper surface with stellate trichomes; flowers and fruits crowded in subsessile axillary glomerules or, if solitary, the pedicels up to 15 mm long; calyx lobes with stellate trichomes and often with sparse simple trichomes in addition; and mericarps 6–8, muticous to submuticous, indehiscent (Rosa et al., 2015). *Sida tuberculata* plants according to <https://www.earth.com/earthpedia/plant/no/sida-tuberculata/> have the following classification:

Kingdom	Plantae
Class	Mangnoliopsida
Order	Malvales
Family	Malvaceae
Genus	<i>Sida</i>
Species	<i>S. tuberculata</i>
Scientific name	<i>Sida tuberculata</i>

## 2.6. *Sida cordata*

*Sida cordata* (Burm.f.), a medicinal plant, has been used for several illnesses. This plant belongs to the family Malvaceae which commonly grow in India. The plant is 30–80 cm tall. Soft hairy grows in its stems, petioles and pedicels pubescent. The heart-shaped leaves are 1–5.5 cm long and one at every node. The yellow flowers are produced on the axils of the leaf. Furthermore, flowers are axillary, solitary, 8–10 mm in diameter, Calyx 5 × 6 mm across, campanulate, 5-fid, simple and some stellate-hairy outside, glabrous within and around the margin, while the length of petioles is 1.5–30 mm. Moreover, the width of Corolla orange-yellow is 10 mm, the size of petals is 6 × 5 mm, obovate, base ciliate. There are 4 × 3 mm schizocarps, globose, enclosed in persistent calyx; mericarps 5, awnless. The colour of the seeds is brownish black. The plant is blooming and fruiting throughout the year, but it is mainly produced from September through November. The plant is also best to live in unused lands, damp and cool which needs up to one thousand and five hundred meter of area (Ugborogho, 1980). *Sida cordata* plants according to <https://www.gbif.org/species/5406739> have the following classification:

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Malvales
Family	Malvaceae
Genus	<i>Sida</i>
Species	<i>S. cordata</i>
Scientific name	<i>Sida cordata</i> (Burm. f.)

## 2.7. *Sida glutinosa*

*Sida glutinosa* is different from other species. It has a viscid dense stem with glandular and cutaneous hair, sometimes with star hair; leaves 2–4 × 1–3 cm, symmetrical, concolor, heart-shaped oval; solitary interest in axils or in diffuse terminal panicles; calyx 4.5–5.0 mm, unaccented, densely covered by viscid glandular hair and mixed with simple hair and stellate, obtrullate sepals; 1–2 cm in diameter; symmetrical petals, retuse, yellow with or without a red center, stamens 12–20, free filaments leading to the apex; and merger 5, apical 2-spined, dense thorn covered with antorse hair (Baracho and Agra, 2016; Abat et al., 2017). This species can be found in tropical America, from northwestern Mexico and the Caribbean to Argentina and Brazil (Krapovickas, 2006). *Sida glutinosa* plants according to <http://plantamor.com/species/info/sida/glutinosa> have the following classification:

Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Dilleniidae
Order	Malvales
Family	Malvaceae
Genus	<i>Sida</i>
Species	<i>S. glutinosa</i>
Scientific name	<i>Sida glutinosa</i> Comm. ex Cav.

## 2.8. *Sida szechuensis*

*Sida szechuensis* is a Vietnamese plant. Its main uses are as an herb, the petiole and pedicle have slightly thick hair, penninerved leaves, axillary, solitary or in panicles; calyx campanulate, with 5 triangular lobes; pale yellow or orange crown, with pointed petals, mostly more or less

obliquely; staminal column ca. 5 mm long with long hair; ovaries with hair like a star; style more than 7; the outside of the protruding proticulate veined, short-tent; reniform seeds, dark brown or black, with white hair (Xuyen, 2006). *Sida szechuensis* plants according to <https://www.gbif.org/species/119199119> have the following classification:

Kingdom	Plantae
Family	Malvaceae
Genus	<i>Sida</i>
Species	<i>S. szechuensis</i>
Scientific name	<i>S. szechuensis</i> Matsuda

## 2.9. Methods

The documentation for this review was compiled from various data sources likes ScienceDirect, Springer, PubMed, ResearchGate, Google Scholar, and the Website.

## 3. Chemical constituents

### 3.1. Alkaloid

Ghosh and Dutt (1930) isolated Ψ-(pseudo)-ephedrine (1) from the *S. cordifolia*. From the roots of *S. cordifolia*, Ghosal et al. (1975), reported β-phenethylamine (2), ephedrine (3), Ψ-ephedrine (4), S-(+) N<sub>b</sub>-methyltryptophanmethyl ester (5), hypaphorine (6), vasicinone (7), vasicine (8), and vasicinol (9) Jang et al. (2003), isolated quindolinone (10), cryptolepinone (11), 11-methoxyquindoline (12), N-trans-feruloyltyramine (13) from the whole plants of *S. acuta*. From the aerial parts of *S. cordifolia*, Sutradhar et al. (2006), isolated a new alkaloid, 5'-hydroxymethyl-1'-(1,2,3,9-tetrahydro-pyrrolo [2,1-b] quinazolin-1-yl)-heptan-1-one (14). Sutradhar et al. (2007), studied the aerial parts of *S. cordifolia* revealed the presence of four new alkaloids., 1,2,3,9-tetrahydro-pyrrolo [2,1-b] quinazolin-3-ylamine (15), 5'-hydroxymethyl-1'-(1,2,3,9-tetrahydro-pyrrolo [2,1-b] quinazolin-1-yl)-heptan-1-one (14), 2-(1'-amino-butyl) indol-3-one (16), and 2'-(3H-indol-3-ylmethyl)-butan-1'-ol (17). Chaves et al. (2013), isolated cryptolepinone (11) and a salt of cryptolepine (18). From the aerial parts of *S. rhombifolia*. Chaves et al. (2017), reported quindolinone (10), the cryptolepine salt (18), 11-methoxy-quindoline (19), and quindoline (20) from the aerial parts of *S. rhombifolia*. Das et al. (2011) isolated 1,2,3,9-tetrahydro-pyrrolo[2,1-b] quinazolin-3-amine (21) from the aerial parts of *Sida glutinosa*. Yao and Xu (2000) reported 3,4,5,6-tetrahydro-3-methyl-β-carboline-5-carboxylic acid was isolated from *Sida szechuensis*. Banzouzi et al. (2004), isolated cryptolepine (23) from the ethanolic extract of *S. acuta*. Alkaloid group compounds in the genus *Sida* are presented in Figure 1.

### 3.2. Flavonoid

Sutradhar et al., (2007), isolated three new flavonol C-glycosides: 3'-(3'',7''-dimethyl-2'',6''-octadiene)-8-C-β-D-glucosyl-kaempferol 3-O-β-D-glucoside (24), 3'-(3'',7''-dimethyl-2'',6''-octadiene)-8-C-β-D-glucosyl-kaempferol 3-O-β-D-glucosyl [1→4]-β-D-glucoside (25), and 6-(3''-methyl-2''-butene)-3'-methoxyl-8-C-β-D-glucosyl-kaempferol 3-O-β-D-glucosyl [1→4]-β-D-glucoside 3, 3'-(3'', 7''-Dimethyl 2'',6'' otadiene)-8-C β-D-glucosylkaempferol 3-O-β-D-glucoside (26) from the aerial parts of *S. cordifolia*. Sutradhar et al., (2008), isolated two new flavones, 5,7-dihydroxy-3-isoprenylflavone (27) and 5-hydroxy-3-isoprenyl Flavone (28) from the chloroform extract of *S. cordifolia*. In 2013, Chaves et al. isolated 5,7-dihydroxy-4'-methoxyflavone (29) from the aerial parts of *S. rhombifolia*. Chaves et al. (2017), also isolated kaempferol (30) and kaempferol-3-O-β-D-glycosyl-6''-α-D-rhamnose (31) from the aerial parts of *S. rhombifolia*. Das et al. (2012) isolated

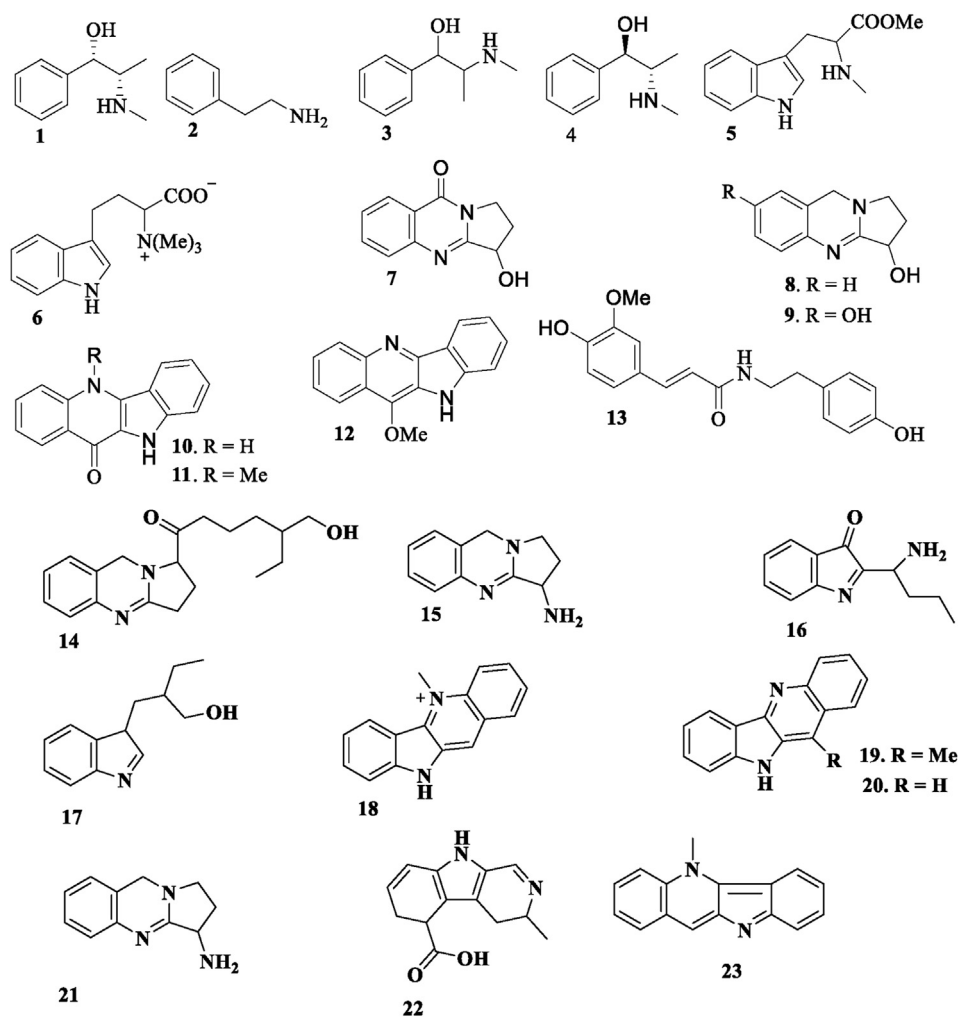


Figure 1. Alkaloids 1–23 isolated from genus *Sida*.

Glutinoside (32) and Chrysin (33) from the aerial parts of *Sida glutinosa*. Figure 2 presents the reported flavonoid compounds isolated from the genus *Sida*.

### 3.3. Coumarins

Jang et al. (2003), isolated scopoletin (34) from the whole plants of *S. acuta*. Chaves et al. (2017), reported scopoletin (34) and scoporone (35) from the aerial parts of *S. rhombifolia*. The two structures of coumarin compound are shown in Figure 3.

### 3.4. Ecdysteroids

From the aerial parts of *S. spinosa*, Darwish and Reinecke (2003), reported five ecdysteroids, 20-hydroxy,24-hydroxymethyl ecdysone (36), 20-hydroxyecdysone (37), turkesterone (38), makisterone C (39), and 20-Hydroxyecdysone-20,22-monoacetone (40). Das et al. (2012) reported 24(28)-Dehydromakisterone A (41) found in dried aerial parts of *Sida glutinosa*. Yao and Xu (2000) isolated 2 $\beta$ ,3 $\beta$ ,14 $\alpha$ ,20,21,22R, 24-heptahydroxycholest-7-en-6-one (42), polypodine B (43), and  $\alpha$ -ecdysone (44) from *Sida szechuensis*. Jadhav et al. (2007) isolated ecdysone (36), 20-hydroxyecdysone (37), 25-acetoxy-20-hydroxyecdysone-3-O- $\beta$ -D-glucopyranoside (45), Pterosterone-3-O- $\beta$ -D-glucopyranoside ecdysteroid (46), ecdysone-3-O- $\beta$ -D-glucopyranoside (47), 2-deoxy-20-hydroxyecdysone-3-O- $\beta$ -D-glucopyranoside (48), and 20-hydroxyecdysone-3-O- $\beta$ -D-glucopyranoside from the whole plant of

*S. rhombifolia*. Figure 4 shows the molecular structure of the ecdysteroid group of compound of the genus *Sida*.

### 3.5. Triterpenes

Chen et al. (2007), reported two triterpenes, including a new taraxast-1,20(30)-dien-3-one (50) and taraxasterone (51) from the whole plant of *S. acuta*. The two triterpenes structure can be seen in Figure 5.

### 3.6. Tocopherols

Chen et al. (2007), reported a new tocopherol derivative, 7 $\alpha$ -methoxy- $\alpha$ -tocopherol (52), along with  $\beta$ -tocopherol (53),  $\alpha$ -tocopherol (54), and  $\alpha$ -tocospiro B (55) from the whole plant of *S. acuta*. The structure of the tocopherol's derivatives is shown in Figure 6.

### 3.7. Other compounds

Jang et al. (2003), isolated vomifoliol (56), Ioliolide (57), 4-ketopinoresinol (58), evofolin-A (59), and evofolin-B (60) from the whole plants of *S. acuta*. Darwish and Reinecke (2003) reported two new compounds, namely glyceryl-1-eicosanoate (61) and p-hydroxyphenethyl trans-ferulate (62), together with four known compounds, triacontane (63), 1-eicosene (64), 9-hydroxy-cis-11-octadecenoic acid (65), and 1-O- $\beta$ -D-Glucopyranosyl-(2S,3S,4R,8Z)-2-[(2'R)-2'-hydroxypalmito-ylamino]-8-octadecene-1,3,4'-triol (66), from the aerial parts of *S. spinosa*. Chaves et al. (2013), isolated phaeophytin A (67),

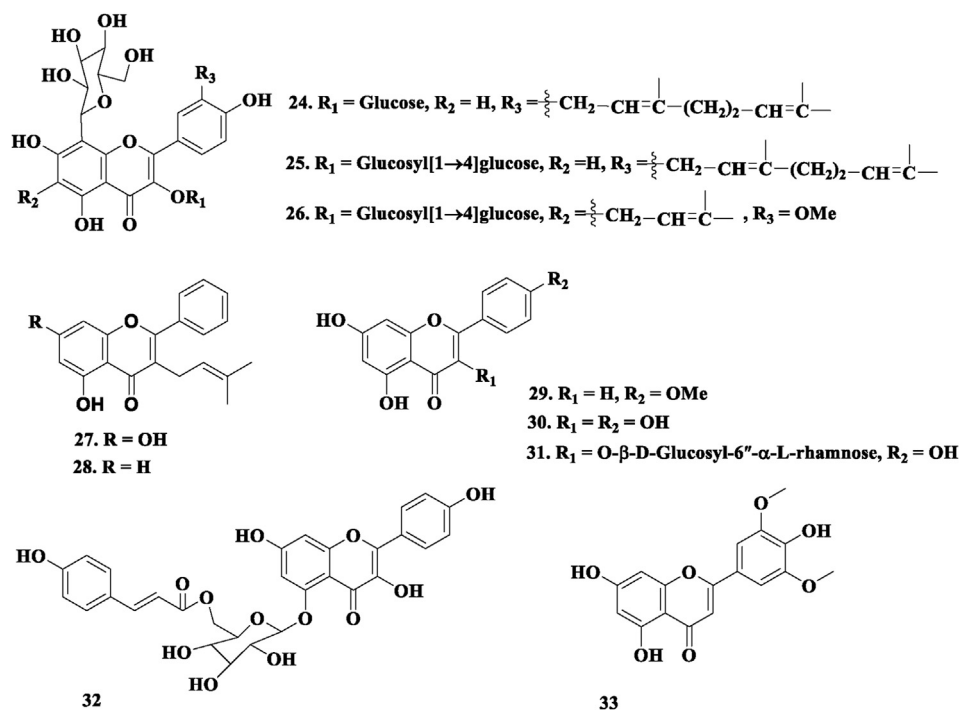


Figure 2. Flavonoids 24–33 isolated from genus *Sida*.

17<sup>3</sup>-ethoxyphosphoride A (68), 13<sup>2</sup>-hydroxy phaeophytin B (69), 17<sup>3</sup>-ethoxyphosphoride B (70), from the aerial parts of *S. rhombifolia*. The structure of compounds's 56–70 is presented in Figure 7.

#### 4. Biological activities

##### 4.1. Antimalarial activity

Karou et al. (2003), reported that various fractions of *S. acuta* showed the antimalarial activity with the IC<sub>50</sub> values in the range of 0.05–57.04  $\mu\text{g/mL}$ .

##### 4.2. Antiplasmodial activity

The EtOH roots extract of *S. acuta* displayed the antiplasmodial activity with the IC<sub>50</sub> values in the range of 3.9–5.4  $\mu\text{g/mL}$ . In addition, compound 23 from *S. acuta* also showed potent antiplasmodial activity (Banzouzi et al., 2004).

##### 4.3. Antimicrobial activity

Momin et al. (2014), evaluated the antimicrobial activity of *S. cordifolia* EtOH extract using five pathogenic bacteria with standard antibiotic kanamycin. The extract of *S. cordifolia* has no antimicrobial activity against five selected bacteria.

##### 4.4. Analgesic activity

Momin et al. (2014), evaluated the analgesic activity *S. cordifolia* EtOH extract using acetic acid-induced writhing reflex model in mice with standard drug diclofenac. The extract displayed a significant ( $P > 0.001$ ) decrease in the writhing reflex of mice induce acetic acid at a dose

of 500 mg/kg. Moreover, the aqueous acetone extract of *S. acuta* and *S. cordifolia* was reported to inhibit dose-dependent analgesic activity (Konaté et al., 2012).

##### 4.5. Anti-inflammatory activity

Moreover, aqueous leaves extract of *S. cordifolia* was found to inhibit the carrageenin-induced rat paw edema at a dose of 400 mg/kg administered orally (Franzotti et al., 2000).

##### 4.6. Antibacterial activity

Islam et al. (2003) studied the antibacterial activity of various extracts of *S. rhombifolia* with Gram-positive and Gram-negative test organisms. The results revealed that all extracts exhibited weak activity. Karou et al. (2005), conducted the antibacterial activity of *S. acuta* alkaloids fraction using agar-well diffusion assay and broth microdilution assay. The highest zone inhibition diameters were identified by Gram-positive bacteria in accordance with agar-well diffusion assay. From the broth microdilution assay, the MIC and MBC values observed in the range of 16–400  $\mu\text{g/mL}$  and 80–400  $\mu\text{g/mL}$ . In 2007, Oboh et al. evaluated the antibacterial activity of the 90% EtOH extract of *S. acuta* aerial parts with agar-dilution method. The results of the MIC were found values in the range of 5–10 mg/mL. In other studies, Assam et al. (2010) evaluated antibacterial activity of the aqueous-methanol extract of *S. rhombifolia* (1:4, v/v) using agar disc diffusion and agar dilution methods. The results found that aqueous-methanol extract of *S. rhombifolia* displayed moderate activity. Moreover, Halilu et al. (2016) evaluated antibacterial activity of *S. cordifolia* ethanolic leaves extract using cup plate method against Gram-positive and Gram-negative microorganisms. The results showed that the extract has potent activity on all tested organisms.

##### 4.7. Antioxidant activity

In 2003, Auddy et al. (2003) assessed the antioxidant activity of EtOH extract and water infusions of *S. cordifolia* with ABTS radical cation decolorization assay and lipid peroxidation. According to the ABTS assay,

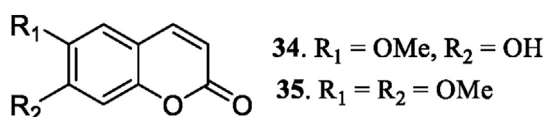
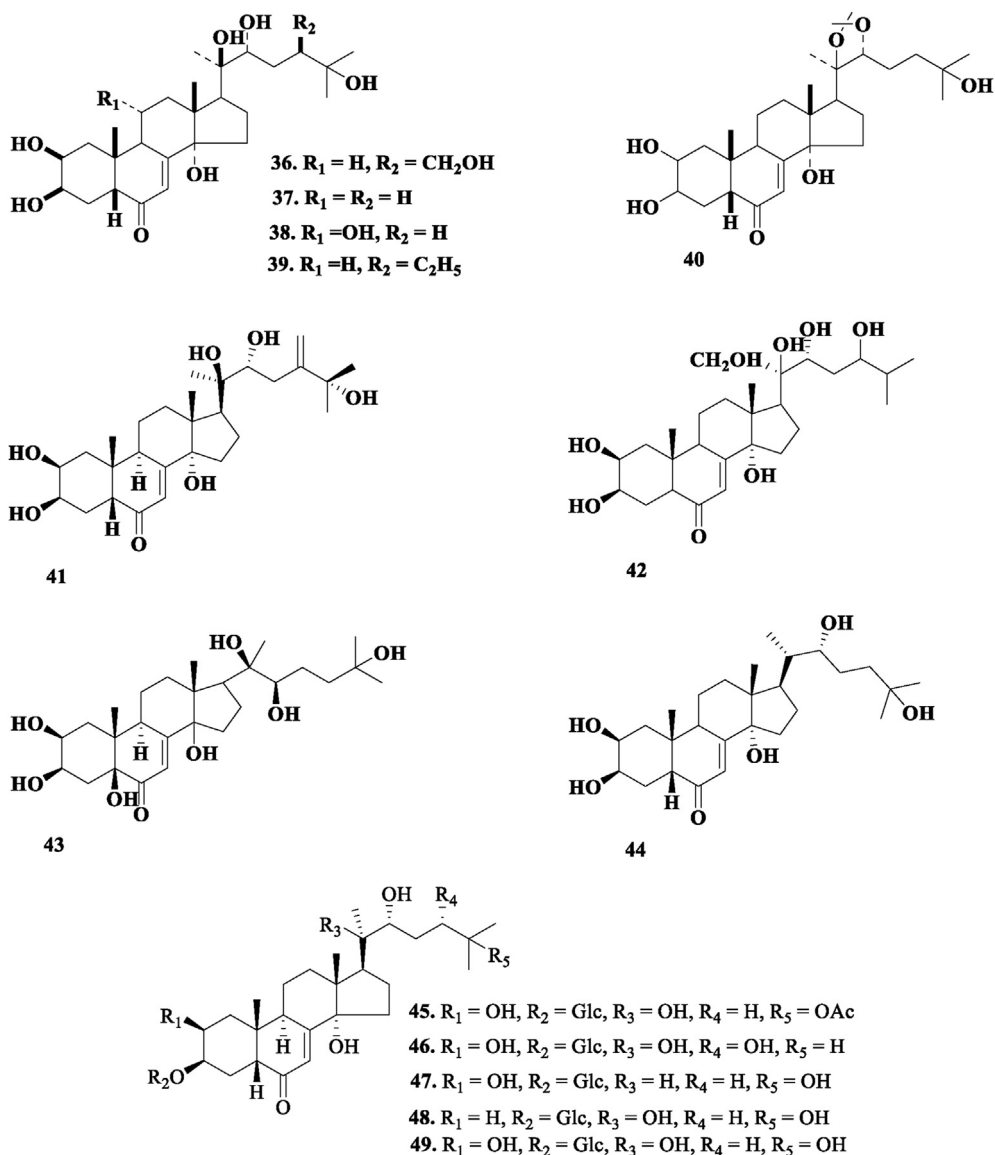
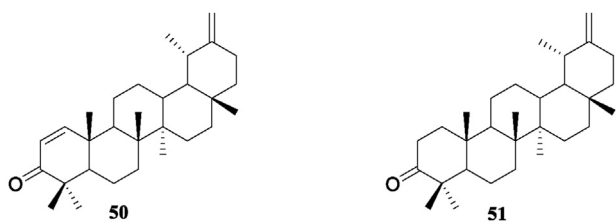
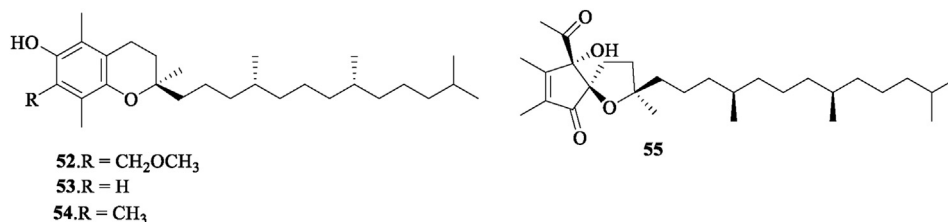


Figure 3. Coumarins 34–35 isolated from genus *Sida*.

Figure 4. Ecdysteroids 36–49 isolated from genus *Sida*.Figure 5. Triterpenes 50–51 isolated from genus *Sida*.Figure 6. Tocopherols 52–55 isolated from genus *Sida*.

the EtOH extract displayed potent activity ( $IC_{50}$  16.07  $\mu g/mL$ ). [Chen et al. \(2007\)](#), studied the antioxidant activity of compounds 52–55 with DPPH assay, and the result showed that compound 52, 53, and 54 displayed significant activities with the  $EC_{50}$  values of 86.9, 68.2, and 70.9  $\mu M$ . [Momin et al. \(2014\)](#), evaluated the antioxidant activity of EtOH extract of *S. cordifolia* using DPPH assay with standard ascorbic acid. According to the results, the  $IC_{50}$  values of the extract and standard ascorbic acid was 50 and 1.16  $\mu g/mL$ . In addition, [Kumar et al. \(2019\)](#), assessed the antioxidant activity of various extracts of *S. cordifolia* using DPPH assay with standard ascorbic acid. The results found that various

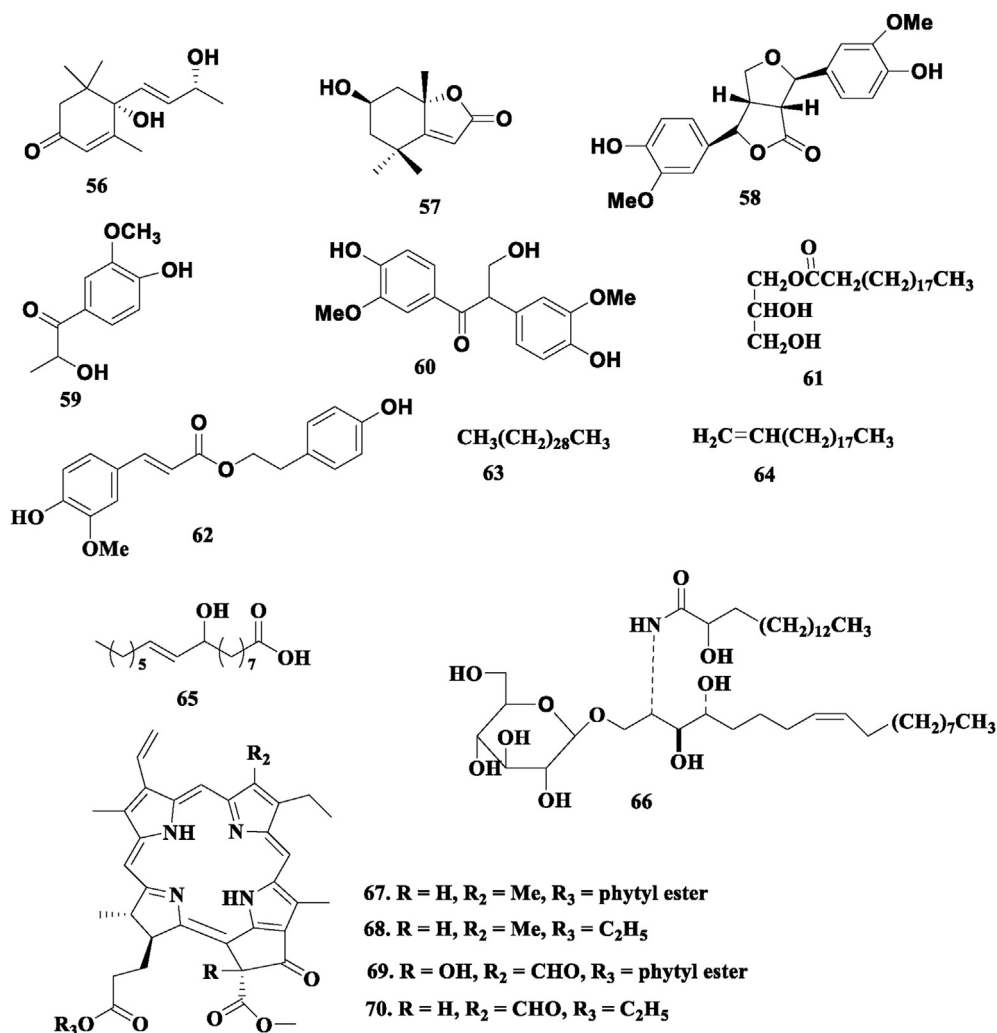


Figure 7. Other compounds 56–70 isolated from genus *Sida*

extracts and standard ascorbic acid displayed concentration-dependent percent inhibition of DPPH radical.

#### 4.8. Vasorelaxant activity

In another study, the vasorelaxant activity was detected in the rodent isolated mesenteric arteries by the compound **11** (Chaves et al., 2013).

#### 4.9. Wound healing activity

Pawar et al. (2013), informed that the EtOH extract of *S. cordifolia* displayed wound healing activity in rats. Moreover, Francis et al. (2018), also informed that EtOH leaves extract of *S. rhombifolia* has a prospective advantage in enhancing wound healing. In another study, Kumar et al. (2019), studied wound healing activity of various extract of *S. cordifolia* against dexamethasone-induced retardation in rats. According to the results, aqueous extract of *S. cordifolia* displayed significant activity.

#### 4.10. Antifungal activity

Rosa et al. (2015), evaluated the antifungal activity of aqueous infusion from *S. tuberculata* leaves and roots, using the broth micro-dilution method against 37 clinical isolates of opportunistic yeasts.

The MIC (minimal inhibitory concentration) and MFC (minimal fungicidal concentration) were identified toward *Candida krusei* isolates.

#### 4.11. Antidiabetic activity

Ahmad et al. (2014) documented that the alcoholic extract of *S. cordifolia* displayed antihyperglycemic action when administered to streptozotocin-induced diabetic rats.

#### 4.12. Toxicity

Islam et al. (2003) evaluated the toxicity of various extracts of *S. rhombifolia* using brine shrimp bioassay with standard reference gallic acid. According to the results, EtOAc extract of *S. rhombifolia* exhibited significant cytotoxic activity with LC<sub>50</sub> value of 5.41 ppm. In addition, the aqueous extract of *S. cordifolia* has low acute toxicity in mice (Franzotti et al., 2000).

#### 4.13. Antiarthritic activity

Gupta et al. (2009) assessed the antiarthritic activity of various extracts of *S. rhombifolia*. According to the results, EtOH and aqueous extracts displayed significant activity.



#### 4.14. Quinone reductase induction assay

Jang et al. (2003), evaluated quinone reductase induction activity of compounds (10–14, 34, and 56–60) with culture mouse Hepa 1c1c7 cell. The results showed that compounds 10–11 have the most potent activity.

#### 4.15. Mouse mammary organ culture assay

Jang et al. (2003), studied the prospective of compounds (10–14, 34, and 56–60) to inhibit the 7,12-dimethylbenzene (DMBA)- induced pre-neoplastic lesion in a mouse mammary organ culture. According to the results, compounds 11 (83.3%) and 13 (75.0%) displayed the activity to inhibit 7,12-dimethylbenzene (DMBA)- induced preneoplastic lesion at a dose of 10 µg/mL.

### 5. Conclusion

Eight species of the genus *Sida* have been explained and discussed in this review article. The eight species produce a variety of secondary metabolite compounds, namely alkaloids, flavonoids, coumarins, ecdysteroids, triterpenes, tocopherols, and other compounds. The compounds depicted a variety of interesting biological activities. So they can be used as a reference for the researchers to develop further research or exploration.

### Declarations

#### Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

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#### Data availability statement

Data included in article/supplementary material/referenced in article.

#### Declaration of interests statement

The authors declare no conflict of interest.

#### Additional information

No additional information is available for this paper.

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Wubet Alebachew Bayih, Demeke Mesfin Belay, Metadel Yibeltal Ayalew, Misganaw Abie Tassew, Ermias Sisay Chanie, Dejen Getaneh Feleke, Sintayehu Asnakew, Getasew Legas, Amsalu Belete, Maru Mekie, Getachew Yideg Yitbarek, Tigabu Munye Aytenew, Tigabu Dessie, Nigus Selomon, Solomon Demis Kebede, Tewachew Muche Liyeh, Binyam Minuye Birhanie  
e06740

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- The role of nanotechnology in current COVID-19 outbreak**

Shima Tavakol, Masoumeh Zahmatkeshan, Reza Mohammadinejad, Saeed Mehrzadi, Mohammad T. Joghataei, Mo S. Alavijeh, Alexander Seifalian  
e06841

[Full-Text HTML](#) | [PDF](#)

- Epidemiology and sex differences of podoconiosis in Ethiopia: A systemic review and meta-analysis**

Yohane Berhe, Haftom Legese, Fitsum Mardu, Kebede Tesfay, Gebre Adhanom, Tsega  
e05446



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**Involvement of myocyte enhancer factor 2c in the pathogenesis of autism spectrum disorder**

Rishabh Chaudhary, Vipul Agarwal, Arjun Singh Kaushik, Mujeeba Rehman  
e06854

[Full-Text HTML](#) | [PDF](#)

**Review of life cycle models for enhancing machine tools sustainability: lessons, trends and future directions**

Ilesanmi Daniyan, Khumbulani Mpofo, Boitumelo Ramatsetse, Munish Gupta  
e06790

[Full-Text HTML](#) | [PDF](#)

**Expansion of hay production and marketing in Brazil**

M.A. Neres, C.D. Nath, S.M. Hoppen  
e06787

[Full-Text HTML](#) | [PDF](#)

**Considering the use of the terms strain and adaptation in prion research**

Robert M. Zink  
e06801

[Full-Text HTML](#) | [PDF](#)

**Review on the occurrence of the mcr-1 gene causing colistin resistance in cow's milk and dairy products**

Ágnes Nagy, Rita Székelyhidi, Erika Hanczné Lakatos, Viktória Kapcsándi  
e06800

[Full-Text HTML](#) | [PDF](#)

**Applications of artificial intelligence to improve patient flow on mental health inpatient units - Narrative literature review**

Paulina Cecula, Jiakun Yu, Fatema Mustansir Dawoodbhoy, Jack Delaney, Joseph Tan, Iain Peacock, Benita Cox  
e06626

[Full-Text HTML](#) | [PDF](#)

**Gendered stereotypes and norms: A systematic review of interventions designed to shift attitudes and behaviour**

Rebecca Stewart, Breanna Wright, Liam Smith, Steven Roberts, Natalie Russell  
e06660



[Full-Text HTML](#) | [PDF](#)



- Conceptualization of population-specific human functional immunogenomics projects to identify factors that contribute to variability in immune and infectious diseases**  
Collins K. Boahen, Leo A.B. Joosten, Mihai G. Netea, Vinod Kumar  
e06755  
[Full-Text HTML](#) | [PDF](#)
  
- A short review, effect of dimethyl- $\beta$ -cyclodextrin on the interaction between *Helicobacter pylori* and steroidal compounds**  
Kiyofumi Wanibuchi, Kouichi Hosoda, Avarzed Amgаланbaatar, Yoshikazu Hirai, Mitsuru Shoji, Hirofumi Shimomura  
e06767  
[Full-Text HTML](#) | [PDF](#)
  
- Secondary metabolite compounds from *Sida* genus and their bioactivity**  
N.S. Aminah, E.R. Laili, M. Rafi, A. Rochman, M. Insanu, K.N.W. Tun  
e06682  
[Full-Text HTML](#) | [PDF](#)
  
- The potential of metformin as an antineoplastic in brain tumors: A systematic review**  
Famila Takhwifa, Tiara Aninditha, Heri Setiawan, Rani Sauriasari  
e06558  
[Full-Text HTML](#) | [PDF](#)
  
- Prevalence of anxiety and depression in South Asia during COVID-19: A systematic review and meta-analysis**  
Md Mahbub Hossain, Mariya Rahman, Nusrat Fahmida Trisha, Samia Tasnim, Tasmiah Nuzhath, Nishat Tasnim Hasan, Heather Clark, Arindam Das, E. Lisako J. McKyer, Helal Uddin Ahmed, Ping Ma  
e06677  
[Full-Text HTML](#) | [PDF](#)
  
- Asymptotic behaviour of solutions to certain nonlinear third order neutral functional differential equation**  
Adeleke Timothy Ademola  
e06615  
[Full-Text HTML](#) | [PDF](#)
  
- Endovascular therapies for pulmonary embolism**  
ǎrvé Rousseau, Costantino Del Giudice, Olivier Sanchez, Emile Ferrari, Marc Sapoval, Pierre arek, Clément Delmas, Charline Zadro, Paul Revel-Mouroz  
e06574





## Erratum

- Erratum to “Making better decisions by applying mathematical optimization to cost accounting: An advanced approach to multi-level contribution margin accounting” [Heliyon 7 (2) (February 2021) e06096]**

Michael Gutiérrez

e06586

[Full-Text HTML](#) | [PDF](#)

## Case report

- Cerebellar tonsillar descent: A diagnostic dilemma between Chiari malformation type 1 and spinal cerebrospinal fluid leak**

Tommy Lik Hang Chan, Kiven Vuong, Tara Chugh, Ian Carroll

e06795

[Full-Text HTML](#) | [PDF](#)

- Tuberculous septic arthritis of the hip with large abscess formation mimicking soft tissue tumors: A case report**

Marcel Prasetyo, Indah Maria Adistana, Stefanus Imanuel Setiawan

e06815

[Full-Text HTML](#) | [PDF](#)

- Groundwater pollution assessment in a coastal aquifer in Cape Coast, Ghana**

George Lutterodt, Michael K. Miyittah, Bright Addy, Ebenezer D.O. Ansa, Mohammed Takase

e06751

[Full-Text HTML](#) | [PDF](#)

- Reduction of Salmonella prevalence at slaughter in Lawsonia intracellularis co-infected swine herds by Enterisol® Ileitis vaccination**

J. Meschede, S. Holtrup, R. Deitmer, A.P. Mesu, C. Kraft

e06714

[Full-Text HTML](#) | [PDF](#)

- Endoscopic treatment of spinal arachnoid cysts**



Papadimitriou, G. Cossu, R. Maduri, M. Valerio, S. Vamadevan, R.T. Daniel, M. Messe

e06736



[Full-Text HTML](#) | [PDF](#)

**Radiographic case report of a heart transplanted patient suffering from COVID-19**

Leona S. Alizadeh, Moritz H. Albrecht, Christian Booz  
e06688

[Full-Text HTML](#) | [PDF](#)

**Erratum to “Improved fermentation strategies in a bioreactor for enhancing poly(3-hydroxybutyrate) (PHB) production by wild type *Cupriavidus necator* from fructose” [Heliyon 7 (1) (January 2021) Article e05979]**

Daiana Nygaard, Oxana Yashchuk, Diego G. Nosedá, Beatriz Araoz, Élica B. Hermida  
e06716

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### In Memoriam

**Remembering Hamish Small**

Theodore E. Miller  
e06594

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### Agriculture

Meet the full editorial team for [Heliyon Agriculture](#).



**Dr. Athanasios Damialis**

Dr. Athanasios Damialis is a multi-disciplinary scientist working for more than 20 years on the fields of plant and fungal ecology, environmental sciences, biometeorology, climate change and environmental health. His particular focus lies on the reproductive biology of plants (flowering phenology, atmospheric circulation of airborne pollen) and on endophytic fungi. He uses an inter-disciplinary research approach with environment-environment interactions and human-environment interactions. This includes mainly those interactions including, but not limited to, the detection of bio-climatic indicators and spatiotemporal patterns of plant, forest and agricultural habitats and ecosystems, in relation to ongoing and simulated climate change. His research goal is to comprehend the responsive ability of organisms under stress conditions, ultimately, attempting to promote sustainable growth and environmental quality.

### Arts and humanities

Meet the editorial team for [Heliyon Arts and humanities](#).

### Biochemistry, molecular biology and cell biology

Meet the full editorial team for [Heliyon Biochemistry, molecular biology and cell biology](#).



**Prof. Nicola Zambrano**

Nicola Zambrano is professor of Molecular Biology at the University of Naples Federico II, and group leader at CEINGE Advanced Biotechnologies, Naples, Italy. He holds a M.Sc. degree in biological sciences and a Ph.D. in biotechnologies, acquired within a joint doctoral program from the Universities of L'Aquila and Naples, Italy. He was a visiting fellow at National Cancer Institute, NIH in Bethesda from 1991 to 1994, and visiting scientist at EMBL in Heidelberg, Germany in 1997. His academic career at the Federico II University in Naples started with an assistant professor position in biochemistry (1996), before being enrolled as an associate professor (2002) and then, as a full professor in molecular biology (2010).

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[Agriculture](#)

[Arts and humanities](#)

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[Biology](#)

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[Clinical research](#)

[Computer science](#)

[Earth science](#)

[Education](#)

[Energy](#)

[Engineering](#)

[Environment](#)

[Food science and nutrition](#)

[Global Health & Infectious Disease](#)

[Materials science](#)

[Mathematics](#)

[Microbiology](#)

[Neuroscience](#)

[Pharmaceutical science, pharmacology and toxicology](#)

[Physics](#)

[Psychology](#)

[Quantitative biology, biotechnology and bioengineering](#)

[Social science](#)



**Prof. Jinrong Min**

Professor Jinrong Min received his Ph.D. degree in physics from the Institute of Physics, Chinese Academy of Sciences in China, and carried out his post-doctoral training in chromatin structural biology at the Cold Spring Harbor Laboratory, USA. He is currently the principal investigator of the Chromatin Structural Biology Group at the Structural Genomics Consortium (SGC), University of Toronto, and an associate professor in the Department of Physiology at the University of Toronto.

## Biology

Meet the editorial team for [Heliyon Biology](#).

## Business and economics

Meet the full editorial team for [Heliyon Business and economics](#).



**Dr. Larisa Yarovaya**

Professor Larisa Yarovaya received her doctorate in finance from Northumbria University in England. Currently, she is a lecturer in finance, Programme Director BSc Finance, and deputy head of Centre for Digital Finance at the Southampton Business School, University of Southampton.

Prof. Yarovaya is a researcher the fields of international finance, digital finance, financial integration, Islamic finance, energy economics, information transmission, and international business. She has published her research in peer-reviewed academic journals and is an associate editor of the *International Review of Financial Analysis*, *Journal of International Financial Markets Institutions and Money*, *Heliyon*, and *Data-in-Brief*.



**Dr. Pavlos Delias**

Pavlos Delias is a tenured faculty member at the [International Hellenic University](#), Department of Accounting and Finance. He holds a jointly supervised PhD from both [Technical University of Crete](#) and [University Paris Dauphine](#), under a cotutelle agreement.

Pavlos Delias has been invited as a visiting professor in several universities (national as well as international). He has contributed to numerous research projects, focusing on applying the principles of business analytics and operational research to decision support systems design and use. He is also a member of the coordination board for the EURO working group on decision support systems. His research interests are in the areas of business process analytics, business analytics and operational research, and multiple criteria analysis.

## Chemistry

Meet the full editorial team for [Heliyon Chemistry](#).



**Dr. Francesco Epifano**

Prof. Epifano obtained his degree in medicinal chemistry and pharmaceutical technology in 1993 from the University of Perugia, Italy. In 1998, he obtained his Ph.D. in agricultural entomology at the Faculty of Agricultural Sciences of the University of Perugia. Currently, he is an associate professor of medicinal chemistry at the Department of Pharmacy of the University Gabriele D'Annunzio of Chieti-Pescara. His recent work is concerned with synthesis and pharmacological properties of secondary metabolites from plants, fungi, and bacteria. Dr. Epifano was the recipient of the 2010 IADR / Glaxo Smith Kline Innovation in Oral Care Award as the co-investigator of the project entitled "Therapeutic potential of Citrus auraptene for periodontal disease", the 2012 Apivita Award for Phytochemistry, and the 2017 Pierre Fabre – Phytochemical Society of Europe Innovation Award.

## Clinical research

Meet the full editorial team for [Heliyon Clinical research](#).



**Dr. Carolyn Mackintosh-Franklin**

Dr. Carolyn Mackintosh-Franklin has had an extensive career in both clinical practice and higher education working at the University of Bradford, University of Liverpool, University of Hull and currently working at the University of Manchester. She received her first degree from the University of Newcastle Upon Tyne, her MSc from the University of Manchester and doctorate from the University of Bradford. She is also a registered nurse specializing in the assessment and management of acute and chronic pain. Her research interests are broad ranging; encompassing work on health care professionals' attitudes towards those in pain, aspects of pain assessment and management, and pedagogic research into learning needs of mature students, with a range of highly cited publications and conference presentations in these areas.



**Prof. Giuseppe Musumeci**

Giuseppe Musumeci received a BS, MS and PhD in Human Movement and Sport Sciences from the University of Catania, Italy. Currently, he works as a Professor of Sports Sciences at the Department of Biomedical and Biotechnological Sciences, School of Medicine, University of Catania, Italy. He is also an Adjunct Professor at the Temple University's College of Science and Technology, Philadelphia, USA and at the Faculty of Sport Sciences, Fujian Normal University, Fuzhou, China. Prof. Musumeci is the Director of the Research Center on Motor Activities (CRAM), the Director of School of Posturology and Physical Exercise Sciences, the Dean of the Human Movement Sciences Faculty and the Head of the Movement Innovation PosturaLab at the University of Catania. He is currently Editor-in-Chief of "Journal of Functional Morphology and Kinesiology". Musumeci's research interests are centered on morphological, molecular, biochemical and clinical aspects of osteoarthritis and musculoskeletal disorders and the relative effects of diet, ageing and physical activity. Other research topics of interest are tissue engineering and mechanobiology related to the musculoskeletal system in the clinical context.



**Prof. Graham Pawelec**

Graham Pawelec received an MA in natural sciences and a PhD in transplantation immunology from the University of Cambridge, UK. He is currently professor of experimental immunology in the Department of Immunology, University of Tübingen, Tübingen, Germany. He is a visiting professor at Nottingham Trent University, UK and at King's College London, UK, holds an honorary chair at Manchester University, UK. He is a member of the Cancer Solutions Program at the Health Sciences North Research Institute of Canada, Sudbury, Ontario, Canada. He is currently co-editor-in-chief of "Immunity and Aging". Graham's research interests are centred on alterations to immunity, especially T cell-mediated immunity, in ageing and cancer in man, and the influence these have on the outcome of vaccination and immunomodulatory antibody therapies. The impact of polypathogenicity (including multiple infections, cancer, Alzheimer's, diabetes, autoimmunity) as well as stress (psychological, nutritional) on immune signatures reflecting individual immune status is of particular interest in the clinical context.

## Computer science

Meet the full editorial team for [Heliyon Computer science](#).



**Dr. Jonathan Chan**

Dr. Jonathan H. Chan is an associate professor of computer science and a co-founder of D-Lab at the School of Information Technology, King Mongkut's University of Technology Thonburi, Thailand. Jonathan holds a Ph.D. from the University of Toronto, where he has also served as a visiting professor. In addition to his role as the section editor of *Heliyon Computer science*, Dr. Chan is an action editor of *Neural Networks*, and a member of the editorial boards of *International Journal of Machine Intelligence and Sensory Signal Processing*, *International Journal of Swarm Intelligence*, and *Proceedings in Adaptation, Learning and Optimization*.

Dr. Chan is a founding member and a current VP of the IEEE-CIS Thailand Chapter, and a senior member of IEEE, ACM, and INNS, a member of the Professional Engineers of Ontario (PEO), and a governing board member of APNNS. He also holds an NVIDIA Deep Learning Institute (DLI) University Ambassadorship and is a certified DLI instructor. His research interests include intelligent systems, biomedical informatics, and data science and machine learning in general.

## Earth science

Meet the full editorial team for [Heliyon Earth science](#).



**Prof. Andrew S. Hursthouse**

Professor Hursthouse is a professor of environmental geochemistry at the University of the West of Scotland (UWS) and holds a Ph.D. in environmental radioactivity from University of Glasgow and a B.Sc. degree in geochemistry from University of Reading. He holds a 100 talent high-end expert fellowship at Hunan University of Science & Technology, Xiangtan, PRC. He has editorial roles in several earth and environmental science journals and has worked in academic and industrial research environments.

Professor Hursthouse's areas of interest and expertise are in earth process interactions and the environmental geochemistry of metallic elements, resource exploitation and implications for human health, and this approach also applied to environmental pollution, industrial processes, economic development and society; remediation and treatment of chemical pollution; chemical and environmental hazards, waste and environmental management and regulation.

## Education

Meet the full editorial team for [Heliyon Education](#).



**Prof. David González-Gómez**

*Heliyon Education* is led by Section Editor David González-Gómez, Ph.D. Dr. González-Gómez is a Professor in the Department of Science and Mathematics Education and the Dean of the Teaching Trainer School at the University of Extremadura (Spain). Dr. González-Gómez is known internationally for work in science education; science, technology, engineering, and mathematics (STEM); active learning methodologies for teaching science; affective domain in the science learning process; education for the sustainability; SDGs. Currently, he is an advisory council of the Science, Technology, and Innovation of Extremadura government in Spain.

## Energy

Meet the full editorial team for [Heliyon Energy](#).



**Dr. Socrates Kaplanis**

Prof. Socrates Kaplanis obtained his degree in physics from University Thessaloniki, a MSc in nuclear reactors from Aston University, and a PhD in radiation detection and modelling from the University Patra. He has held academic positions including professor of renewable energy systems at the Technological Educational Institute of Patra, head of the renewable energy systems laboratory, honorary professor and doctor honoris causa at the Transylvania University in Brasov, and as a visiting professor at the University of Applied Sciences in Aachen, Germany.

Prof. Kaplanis has a research background in solar radiation, prediction modelling, zero and intelligent energy buildings, PV systems engineering, solar thermal engineering, and PV based hybrid systems. He has held various posts, including president of the Technological Educational Institute of Patra, president of the Technological Educational Institute of Western Greece, and vice-president and President of the European Institutions in Higher Education (EURASHE).

## Engineering

Meet the full editorial team for [Heliyon Engineering](#).



**Dr. Andrea Francesco Morabito**

Professor Andrea Francesco Morabito received his Ph.D. in computer, biomedical, and telecommunications engineering from the University of Reggio Calabria, Italy, where he has also served as an assistant professor in electromagnetic fields since 2010. His research work is mainly focused on models and effective strategies for the solution of inverse problems, in particular, antenna synthesis, phase retrieval, and electromagnetic inverse scattering.



**Prof. Mohammad Mehdi Rashidi**

Professor Mohammad Mehdi Rashidi received his Ph.D. in mechanical engineering from Tarbiat Modares University, Iran. He is currently a professor of mechanical engineering at Tongji University in Shanghai, China, and previously taught at Bu-Ali University in Iran. Prof. Rashidi was named a 2018 highly cited researcher by Clarivate Analytics.

## Environment

Meet the full editorial team for [Heliyon Environment](#).



**Prof. Frederic Coulon**

Professor Frederic Coulon holds a chair in Environmental Chemistry & Microbiology at Cranfield University, UK. In addition to his position as section editor for *Heliyon Environment*, Prof. Coulon is an associate editor for *Environment International* and *Science of the Total Environment*. His professional interests include: soil and water chemistry; fate and transport of chemicals in surface and subsurface waters; water and wastewater treatment; soil and sediment treatment; hazardous waste site remediation; energy and environment; population and environment; and public communication of environmental science and engineering. His research achievements address international priorities under the umbrella of the Water-Soil-Waste nexus across sectors and scales. His work is premised on the understanding that environmental resources are inextricably intertwined and therefore there is a need of advancing a nexus approach to enable integrated and sustainable management of water, soil and waste systems.



**Prof. Christian Sonne**

Professor Christian Sonne, DVM, PhD, DScVetMed, Dipl. ECZM-EBVS, holds a professorship in veterinary ecotoxicology and wildlife medicine at Aarhus University, Denmark. In addition to his position as section editor for *Heliyon Environment*, Prof. Sonne serves as special issues editor for *Environmental Pollution*. Since 1997, Prof. Sonne has specialized in the cross-field of biological effects from exposure to environmental chemicals, diseases and climate change, giving him a unique insight and profile working with a broad range of animals including predatory mammals, raptorial birds, sea birds, fish and humans. He has a broad insight and interest in internal and reproductive organs (histopathology, size, and morphology), skeletal system (bone density and morphology using e.g. DXA scanning), immune system (intra dermal testing of lymphocyte functioning, immune globulin production and cytokine and APP expressions), endocrine system (steroid and peptide hormones), PBPK modelling, blood biochemistry and infectious diseases (zoonosis). Prof. Sonne uses his global network to obtain interdisciplinary research results. Since 2015, he has applied his in-depth knowledge and understanding of biological processes to also include specific un-solved wildlife issues in Denmark (eider duck population declines) and health of raptors. Recently his innovative approaches have led to the first interactions with private industry focusing on natural resources developments and translational medicine within insulation, osteoporosis and metabolic syndrome. Prof. Sonne also specializes in surgical field implantations of intra-coelomic (abdominally) and subcutaneously satellite transmitters (PTTs) in various sea bird species and immobilization of deer spp.

## Food science and nutrition

Meet the full editorial team for [Heliyon Food science and nutrition](#).



**Prof. Lilian Mariutti**

Prof. Lilian R. B. Mariutti received her master and doctorate degrees in food science from the School of Food Engineering - University of Campinas, Brazil, where she currently has a position as assistant professor. She was a researcher fellow in the Laboratory of Veterinary Drug Residues of the Brazilian Ministry of Agriculture, Livestock and Food Supply. Her research focuses on the identification and bioaccessibility of bioactive compounds and lipids and design of food ingredients from non-conventional sources.

## Global Health & Infectious Disease

Meet the full editorial team for [Heliyon Global Health & Infectious Disease](#).



**Dr. Chaisiri Angkurawaranon**

Public Health

[Chiang Mai University](#), Chiang Mai, Thailand

Chaisiri Angkurawaranon received his MD from Chiang Mai University and specialises in Family Medicine. He received a Masters in Medical Statistics and a PhD in Non-communicable Disease Epidemiology from the London School of Hygiene and Tropical Medicine. His research focuses on global health issues related to ageing and chronic conditions (both communicable and non-communicable) in primary care.



**Dr. Nitika Pant Pai**

Infectious Disease

[McGill University](#), Montreal, Canada

Dr. Nitika Pant Pai is a tenured Associate Professor in the Department of Medicine at McGill University. Her global implementation research program for the past twenty years is focused on point-of-care diagnostics for HIV and other sexually transmitted blood borne infections; specifically the innovation, implementation and impact of digital strategies with rapid diagnostics and wearable solution. She develops integrated connected strategies with digital innovations, Bayesian diagnostics, artificial intelligence to plug health service delivery gaps in diagnostics in rapid diagnostics. She serves to inform domestic and global policy on point-of-care diagnostics.

Her research program is based in Canada, India and South Africa. She has led many diagnostic trials, cohort/cross sectional studies, meta-analyses, systematic reviews, modelling studies, to inform the gaps in policies to end the HIV epidemic. Her research has been supported by grants from the Canadian Institutes of Health Research, the FRQS, Grand Challenges Canada, Bill and Melinda Gates Foundation, National Institutes of Health, MRC SHIP, South African DST, IC-IMPACTS, Clinton Health Access Initiative, among others.

She has served on many technical working groups for national and international agencies: WHO, Foundation for Innovative Diagnostics, PSI, The Bill and Melinda Gates Foundation, ASLM, CDC, PHAC, REACH, among others. She has advised the office of the US Congress on multiplex testing. She has also contributed to HIV self-testing guidelines and policy guidance for HIV self-testing for the WHO. She serves the Strategic Advisory Board of the Foundation for Innovative Diagnostics and is on WHO's Roster of Digital Health Experts. She serves on the Editorial Moard for biomedical journals and regularly reviews for key international health agencies.

She is an elected member of the College of New Scholars, Artists & Scientists of the Royal Society of Canada.

## Materials science

Meet the full editorial team for [Heliyon Materials science](#).



**Prof. Luis M. Gandía**

Luis M. Gandía is a full professor of chemical engineering at the Public University of Navarre (UPNA) since 2010. Prof. Gandía obtained his Ph.D. in chemistry at the Faculty of Chemistry of the University of the Basque Country in Donostia/San Sebastián in 1993. He is a founding member of the Institute for Advanced Materials (InaMat) at UPNA. He is the head of a multi-disciplinary research team mainly working on renewable resources valorization and the development of catalytic materials for environmental and energy applications. His research interests include: preparation and physico-chemical characterization of heterogeneous catalysts; structured and micro-structured catalysts and chemical reactors; photocatalysis; biofuels and synthetic fuels; hydrogen energy; Li-ion batteries; methane conversion; CO<sub>2</sub> valorization and Computational Fluid Dynamics (CFD).

## Mathematics

Meet the full editorial team for [Heliyon Mathematics](#).



**Prof. Hermann J. Eberl**

Dr. Hermann Eberl is a professor in the Department of Mathematics and Statistics at the University of Guelph (Canada), where he is also the director of the Biophysics Interdepartmental Graduate Program. Prior to joining the University of Guelph he obtained his graduate degrees (Dipl.Math., Dr.rer.nat) at the Technical University of Munich (Germany) and was a postdoctoral fellow first at the Delft University of Technology (the Netherlands), and then at the GSF National Research Center for Environment and Health in Oberschleissheim (Germany).



His research is in mathematical modelling, analysis, and simulation of biological systems and their interaction with their physical environment. This encompasses dynamical systems, partial differential equations, numerical analysis and scientific computing. The two primary strands of his research in recent years were the development and application of mathematical methods in biofilm research and mathematical modelling of honeybee colonies and their diseases.

## Microbiology

Meet the full editorial team for [Heliyon Microbiology](#).



**Dr. Dana Stanley**

Associate Professor Dana Stanley was awarded a PhD in molecular microbiology from Victoria University, Melbourne, in 2009. Her PhD project, "Generation and Characterisation of Ethanol-Tolerant *Saccharomyces cerevisiae* Mutants," investigated the molecular and metabolic determinants of ethanol tolerance in yeast and was awarded "the most outstanding PhD in 2009" by the University. Prof. Stanley held a postdoctoral position in CSIRO's Animal Health Laboratories (AAHL), one of the world's most sophisticated animal research laboratories, where she researched poultry intestinal health, specifically gut microbiota and genetics. Currently, Prof. Stanley is a leader of the molecular microbiology research cluster at Central Queensland University, focusing in human and livestock intestinal health, probiotic and next generation antibiotic development and pathogen control. She is working in collaboration with world's leading probiotic companies on research projects aiming to improve intestinal health of agricultural animals and humans. Prof. Stanley's work has been published in *Nature Medicine* (as the first author), *Nature Communications* and *Nature Immunology*.

## Neuroscience

Meet the full editorial team for [Heliyon Neuroscience](#).



**Dr. Mario Tiberi**

Dr. Mario Tiberi is a senior scientist at the Ottawa Hospital Research Institute's Neuroscience Program, and associate professor at the University of Ottawa Faculty of Medicine in the departments of medicine, cellular and molecular medicine, and psychiatry. He is also a member of the University of Ottawa Brain and Mind Research Institute. Dr. Tiberi completed his PhD in Pharmacology (1990) on opioid receptors at the Université de Montréal under the supervision of Dr. Jacques Magnan, before moving on to a very successful post-doctoral training at the Howard Hughes Medical Institutes at Duke University in Dr. Marc Caron's laboratory. It was during his postdoctoral training that Dr. Tiberi refined his area of research expertise in molecular biology and biochemistry of dopamine receptors. His research interests focus on dopamine receptors, G proteins, signal transduction, desensitization and phosphorylation. Dr. Tiberi's work aims to understand complex structure and molecular relationships of dopamine receptor signaling complexes using in vitro cellular systems and pre-clinical in vivo models, with the aim of aiding in the development of novel therapeutic strategies for brain disorders such as Parkinson's disease, stroke, schizophrenia and drug addiction. Dr. Tiberi has published over 50 scientific papers and edited two books. He has wide experience with undergrad and graduate student supervision as well as teaching. Many of his former graduate students have gone on to successful independent research careers.

## Pharmaceutical science, pharmacology and toxicology

Meet the full editorial team for [Heliyon Pharmaceutical science, pharmacology and toxicology](#).



**Prof. Emilio Clementi**

Emilio Clementi graduated in medicine and surgery at the University of Milano, received his doctorate in pharmacotherapy at the University of Brescia to move as research fellow to the University College London. He is currently full professor of pharmacology and director of the clinical pharmacology unit of the National Health System at the University of Milano, co-opted member in the executive committee of the International Union of basic and clinical Pharmacology (IUPHAR).

He has published on the pathophysiology of nitric oxide and its relevance in therapeutic perspective, especially in skeletal muscle, and on pharmacokinetics, pharmacogenetics and pharmacoepidemiology in paediatrics. He is presently the editor in chief of pharmacological research.



**Dr. Dimitrio Lamprou**

Dimitrios Lamprou (Ph.D. MBA) is a reader in pharmaceutical engineering and the MSc programme director in industrial pharmaceuticals at the School of Pharmacy in Queen's University Belfast (UK). He is also the chair at United Kingdom and Ireland Controlled Release Society (UKICRS). Dr. Lamprou specialises in the areas of pharmaceutical manufacturing & emerging technologies and his research and academic leadership have been recognised in a range of awards, including the Royal Pharmaceutical Society Science Award and the Scottish Universities Life Sciences Alliance Leaders Scheme Award. His group is applying nano and microfabrication techniques in pharmaceutical and medical device manufacturing, such as 3D printing & bioprinting, electrospinning and microfluidics.



**Dr. Martin Leonard**

Dr. Leonard obtained his PhD in pharmacology in 2000 from University College Dublin, Ireland. He has over 15 years' experience as a toxicologist focussed to developing and improving on models and methods for assessment of toxicological hazard, including the use of high content omics technology and iPSC in vitro models of the airway. Dr. Leonard is a European registered toxicologist and currently holds a position as principal toxicologist at Public Health England directing research into the mechanisms of allergen and particulate hazard associated with asthma and allergic airway disease. Dr. Leonard has published extensively in the fields of toxicology, cell biology and immunology. In addition to section editor at Heliyon, he is also associate editor for the journal Toxicology in Vitro.

## Physics

Meet the full editorial team for [Heliyon Physics](#).



**Prof. Gerald Cleaver**

Gerald B. Cleaver earned his Ph.D. in early universe cosmology and string theory at Caltech. He is a professor and graduate program director of the department of physics at Baylor University in Waco, Texas. He also heads the Early Universe Cosmology and String Theory (EUCOS) division of Baylor's Center for Astrophysics, Space Physics and Engineering Research (CASPER).

With CASPER colleagues, Prof. Cleaver (i) explores quantum gravity effects in the early universe and the signatures of specific quantum gravity proposals, especially with regard to the cosmic microwave background (CMB), (ii) studies relativistic thermodynamics and physics & cosmology applications to cryptography, (iii) analyzes spacetime curvatures (and their possible divergences) for theorized spacetime wormholes, and (iv) investigates advanced spacecraft propulsion systems. Prof. Cleaver was a member of a NASA blue-ribbon review committee for advanced propulsion system proposals. He has written over 100 journal articles and conference proceedings, is co-author of an elementary particle physics textbook, author of six book chapters, on the editorial board of four science journals, and referee for nine physics journals.

## Psychology

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**Dr. Pavica Sheldon**

Dr. Pavica Sheldon received her PhD in communication studies from Louisiana State University, and currently serves as chair and associate professor in the Department of Communication Arts at University of Alabama in Huntsville. Dr. Sheldon is an author of three books and over 40 journal articles, studying uses and gratifications of social media, and also how people communicate forgiveness in interpersonal relationships.

## Quantitative biology, biotechnology and bioengineering

Meet the full editorial team for [Heliyon quantitative biology, biotechnology and bioengineering](#).



**Dr. Andrea de Martino**

Andrea De Martino received his PhD in theoretical physics from SISSA (Trieste, Italy). He worked at the Hahn-Meitner-Institut (Berlin, Germany), the Italian Institute for the Physics of Matter (Rome, Italy) and Sapienza University (Rome) before joining the National Research Council and, more recently, the Italian Institute for Genomic Medicine in Turin, where he is part of the Statistical Inference & Computational Biology Unit.

Dr. De Martino is generally interested in the physics of living systems across multiple scales, from single cells to ecosystems. He works in broadly defined systems biology (computational & mathematical biology, genome-scale models, bioinformatics, etc.). Dr. De Martino's favorite questions revolve around the functional roles of cell-to-cell heterogeneities, the interplay between physiology and gene expression in proliferating vs quiescent cells, the processing of information by biological networks, and the emergence of multi-cellular and population-level behavior.

## Social science

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**Prof. P. Vigneswara Ilavarasan**

P. Vigneswara Ilavarasan (PhD - IIT Kanpur) is a professor of information systems at the Dept. of Management Studies, Indian Institute of Technology Delhi. He researches and teaches about the interaction of information and communication technologies (ICTs), society, and business.

Dr. Ilavarasan has been a visiting research fellow at United Nations University - School of Computing and Society (Macau) and School of Management, Curtin University (Perth). He is a recipient of the Outstanding Young Faculty Fellowship Award at IIT Delhi and Prof. M.N. Srinivas Memorial Prize of the Indian Sociological Society. He is also a senior research fellow at LIRNEasia, a leading regional ICT policy and regulation think tank. He has received large research grants from Dept of Science & Technology (Govt of India), ICSSR (India), IDRC (Canada), Oxford Analytica (UK), IPTS (European Commission), CIPPEC (Argentina) and IdeaCorp (Philippines). His research has appeared in various leading international journals and at numerous global conferences.

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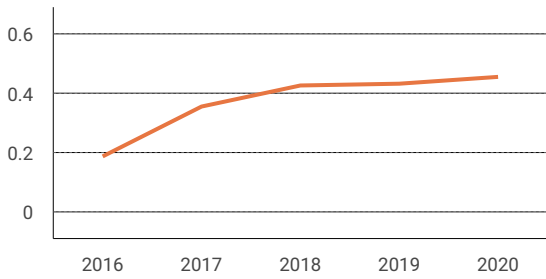


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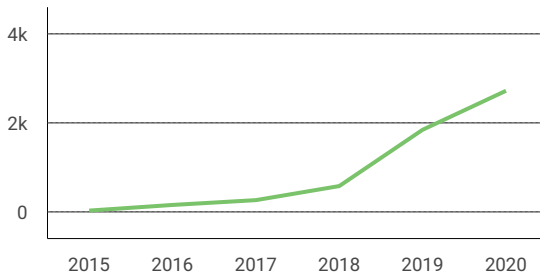
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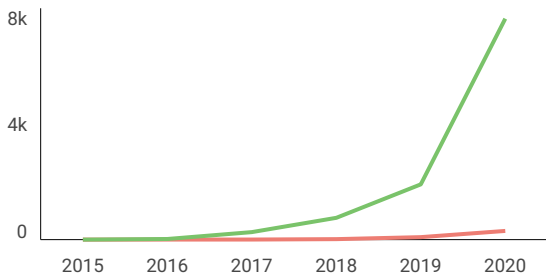
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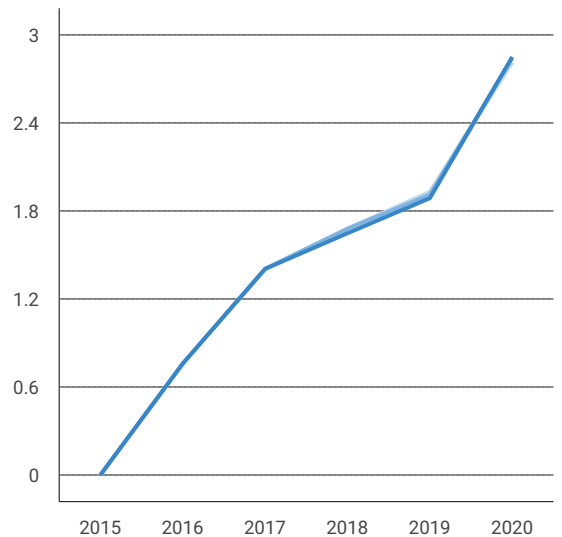
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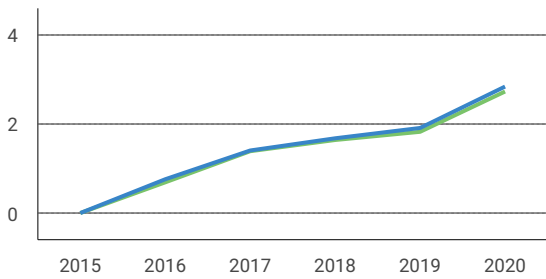


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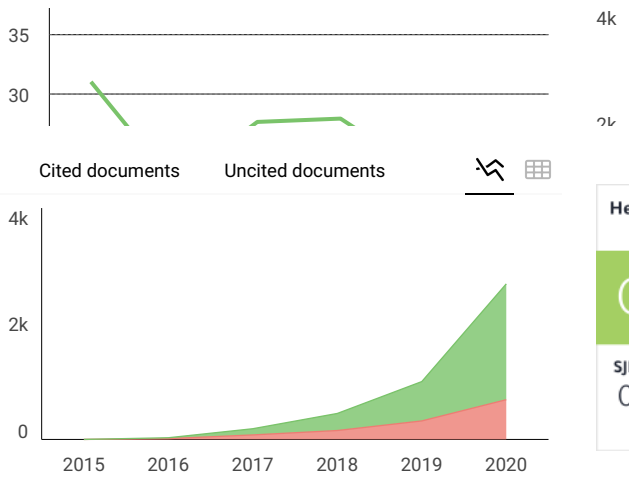
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**Melanie Ortiz** 4 days ago

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D **Dr. Md. Ismail Hossain** 6 days ago

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## Confirming submission to Heliyon

1 message

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**Heliyon** <em@editorialmanager.com>  
Reply-To: Heliyon <info@heliyon.com>  
To: Nanik Siti Aminah <nanik-s-a@fst.unair.ac.id>

Fri, Jul 17, 2020 at 7:51 PM

CC: "Erlinda Rhoematul Laili" [erlinda.rhoematul.laili-2015@fst.unair.ac.id](mailto:erlinda.rhoematul.laili-2015@fst.unair.ac.id), "Mohamad Rafi" [mra@ipb.ac.id](mailto:mra@ipb.ac.id), "Abdul Rochman" [abdulkimfar@gmail.com](mailto:abdulkimfar@gmail.com), "Muhamad Insanu" [insanu@fa.itb.ac.id](mailto:insanu@fa.itb.ac.id), "Khun Nay Win Tun" [khun.nay.win-2017@fst.unair.ac.id](mailto:khun.nay.win-2017@fst.unair.ac.id)

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Secondary Metabolite Compounds from Sida Genus and Their Bioactivity-A review

Dear Dr Aminah,

We have received the above referenced manuscript you submitted to Heliyon. It has been assigned the manuscript number HELIYON-D-20-05079. To track the status of your manuscript, please log in as an author at <https://www.editorialmanager.com/heliyon/>, and navigate to the "Submissions Being Processed" folder.

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Kind regards,  
Heliyon

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## Decision on submission HELIYON-D-20-05079 to Heliyon

3 messages

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Heliyon <em@editorialmanager.com>  
Reply-To: Heliyon <info@heliyon.com>  
To: Nanik Siti Aminah <nanik-s-a@fst.unair.ac.id>

Thu, Oct 8, 2020 at 4:41 PM

Manuscript. Number.: HELIYON-D-20-05079  
Title: Secondary Metabolite Compounds from Sida Genus and Their Bioactivity-A review  
Journal: Heliyon

Dear Dr. Aminah,

Thank you for submitting your manuscript to Heliyon.

We have completed the review of your manuscript and a summary is appended below. The reviewers recommend major revisions are required before publication can be considered.

If you are able to address all reviewer comments in full, I invite you to resubmit your manuscript. We ask that you respond to each reviewer comment by either outlining how the criticism was addressed in the revised manuscript or by providing a rebuttal to the criticism. This should be carried out in a point-by-point fashion as illustrated here: <https://www.cell.com/heliyon/guide-for-authors#Revisions>

To allow the editors and reviewers to easily assess your revised manuscript, we also ask that you upload a version of your manuscript highlighting any revisions made. You may wish to use Microsoft Word's Track Changes tool or, for LaTeX files, the latexdiff Perl script (<https://ctan.org/pkg/latexdiff>).

To submit your revised manuscript, please log in as an author at <https://www.editorialmanager.com/heliyon/>, and navigate to the "Submissions Needing Revision" folder. Your revision due date is Nov 17, 2020.

We understand that the global COVID-19 situation may well be causing disruption for you and your colleagues. If that is the case for you and it has an impact on your ability to make revisions to address the concerns that came up in the review process, please let us know so we can discuss with you potential revision deadline extensions. Please also note that Heliyon focuses on technically correct science and so you are only expected to include revisions that are necessary to ensure that the content and the conclusions of the research are technically correct.

I look forward to receiving your revised manuscript.

Kind regards,  
Salvatore Genovese  
Associate Editor - Chemistry  
Heliyon

Editor and Reviewer comments:

**Reviewer #1: Methods:**In the abstract the authors didnot talked about the meaning of secundary metabolite of sida and also the family name of sida, why did the authors choose to research on the secondary metabolites of sida?. The authors spoke about some pharmacological activities but did not made it clear whether the crude of sida or pure compounds (secondary metabolites) that exhibited those activities. The authors have to do a lot of proofreading and correct all the spelling mistakes.

**Results:**I would expect the authors to differentiate clearly between the specie name and scientific name in their botanical description for all the speices of the genus Sida. There should be a sub heading Pharmacological activites or propertied for the authors to tell the reader what are the types of extracts, how the secondary metabolite compounds are extracted and how the bioactivities are done. Authors also need to proofread for correction.

**Interpretation:**The conclusions are good and relevant, assuming the above modifications are made in order to properly justify them. In summary, it's the basis for a really interesting and relevant review article, on a timely and important subject, but unfortunately I'm afraid it needs a bit of work before publication if it is to be properly useful to the reader.

**Other comments:**The authors have no recommendations and this is important in every review paper.

The conclusions are good and relevant, assuming the above modifications are made in order to properly justify them. In summary, it's the basis for a really interesting and relevant review article, on a timely and important subject, but unfortunately I'm afraid it needs a bit of work before publication if it is to be properly useful to the reader.

#### Reviewer #2: Methods:

The methods used to search for evaluation resources are not mentioned, it is important to mention the search engines/databases used, in addition to the criteria used to determine the inclusion of the article in this review.

For example:

- A literature search on PubMed was conducted to gather articles in this study using the MeSH terms.....
- The following criteria were used to determine article inclusion in this review: (1) original research articles written in English; (2) randomized trial; .....

#### Results:

- 1-You did not devote a specific section to the results: It is very important to highlight the results that you obtained through your research on this topic in the previous literature, and your presentation of these results must be clear and appropriate.
- 2- is necessary for such type of research that you represent the results you obtained from previous studies or your conclusions with tables and figures that make it easy for the reader to reach the largest amount of information easily and quickly.

#### Interpretation:

1-The discussion of the findings was not critical, but rather a descriptive summary of the topic. There is a lot of contradictory research in this area, you should include an element of debate and present both sides of the argument. You must use this review paper to resolve the conflict between contradictory studies.

2-You did not adopt any hypothesis, the review article should be based on the adoption of a theory by the author and it should take into account different approaches, then the author's hypothesis against the prevailing opinion against the undisputed facts is precisely determined.

#### Other comments:

Dear authors, I thank you for all your efforts

Dear Sirs, it is no secret to you that the literature review is a comprehensive and broad set of facts related to the subject of study, and it serves as the backbone of successful biomedical research. Ideal selection of related topics is the first step towards an educational review. The benefit of this type of writing is that it contains detailed information on progress made in past years with an emphasis on future prospects. The progress of science depends on the development of an agreed version of the current scientific facts. This compliance is created and modified by various activities, including the creation, peer review, and publishing of review papers. A good review paper can clarify the state of knowledge, explain obvious contradictions, define the research needed, and even create a consensus where there was no consensus before.

From here it becomes clear that the review is not a collection of some information and merely listing it. Rather, the scientific review must be based on main pillars, unfortunately, the review that you submitted did not meet these conditions and we will summarize that with the following axes:

#### 1- Abstract

- The main purpose of this review is not sufficiently clarified.
- The lack of clarity of the findings of this reference study, in addition to neglecting to mention the methods used to collect the results, viewpoints of previous research, and the conclusions obtained.

#### 2-Introduction

- Your presentation of the topic should be beginning with a general view, give some contexts, and the necessary reasons must be explained that led you to review this topic. Define the research question clearly and provide sufficient justification for it.
- There is no indications that your article will contribute something new to the field.
- It is very important to define the scope of your review so that it is manageable, not too lengthy, or too small; It is necessary to focus on recent developments if the field is well established.

#### 3-Methodology:

The methods used to search for evaluation resources are not mentioned, it is important to mention the search engines/databases used, in addition to the criteria used to determine the inclusion of the article in this review.

For example:

- A literature search on PubMed was conducted to gather articles in this study using the MeSH terms.....
- The following criteria were used to determine article inclusion in this review: (1) original research articles written in English; (2) randomized trial; .....

4-Results:

-You did not devote a specific section to the results: It is very important to highlight the results that you obtained through your research on this topic in the previous literature, and your presentation of these results must be clear and appropriate.

- is necessary for such type of research that you represent the results you obtained from previous studies or your conclusions with tables and figures that make it easy for the reader to reach the largest amount of information easily and quickly.

5-Discussion and Conclusions

The discussion of the findings was not critical, but rather a descriptive summary of the topic. There is a lot of contradictory research in this area, you should include an element of debate and present both sides of the argument. You must use this review paper to resolve the conflict between contradictory studies.

You did not adopt any hypothesis, the review article should be based on the adoption of a theory by the author and it should take into account different approaches, then the author's hypothesis against the prevailing opinion against the undisputed facts is precisely determined.

The main message for this review is unclear?

1- It is not easy even for an expert to know what the authors are trying to say or what they are trying to reach.

2- In fact, the authors do not say anything at all. Rather, this review is an account of the results of previous research only without discussion or analysis.

Others

There are many errors, which include not mentioning the references in the list of references, especially since these references are mentioned in the text, and we remind you to pay attention to formulating the phrases in a proper language and bypassing some spelling mistakes.

I will give you some examples

Sutradhar et al., (2007)

Chaves et al., (2013), mentioned in the text and not mentioned in the list of references

Krapovickas., 2006

Branda J. L et al., 2017

(Xuyen Do Thi., 2006)

Ghosh and Dutta, (1930)

Dalimarta S., 2003: The author's name is incorrect

Ethnomedisinal: Wrongly written

Reviewer #3: Methods:

Results:

Interpretation:

Other comments:

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## Decision on submission HELIYON-D-20-05079R2 to Heliyon

1 message

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Heliyon <em@editorialmanager.com>  
Reply-To: Heliyon <info@heliyon.com>  
To: Nanik Siti Aminah <nanik-s-a@fst.unair.ac.id>

Thu, Mar 4, 2021 at 12:46 PM

Ms. No.: HELIYON-D-20-05079R2  
Title: Secondary Metabolite Compounds from Sida Genus and Their Bioactivity  
Journal: Heliyon

Dear Dr. Aminah,

Thank you for submitting your manuscript to Heliyon.

We have now received all of the editor and reviewer comments on your recent submission to Heliyon. Your paper will become acceptable for publication after implementation of minor formatting and/or administrative changes outlined below.

To submit your revised manuscript, please log in as an author at <https://www.editorialmanager.com/heliyon/>, and navigate to the "Submissions Needing Revision" folder under the Author Main Menu. When submitting your revised manuscript, please ensure that you upload your most recent document with the "Revised manuscript file - highlighting revisions made" item type.

Kind regards,

Like Wang  
Editorial Assistant  
Heliyon

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"Dr. Nanik Siti Aminah was supported by Hibah Riset Kolaborasi Indonesia 2020 (10/RKI/Thp-I/2020)."

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Wed, Mar 31, 2021 at 9:42 PM

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