American Journal of Analytical Chemistry, **2014, 5, 91-121**
Published Online January 2014 (http://www.scirp.org/journal/ajac)
http://dx.doi.org/10.4236/ajac.2014.52014

Scientific Research

Secondary Metabolites of the Genus *Trichilia*: Contribution to the Chemistry of Meliaceae Family

Ivo J. Curcino Vieira*, Wagner da Silva Terra, Milena dos Santos Gonçalves, Raimundo Braz-Filho
Laboratório de Química de Produtos Naturais (LCQUI)-CCT—Universidade Estadual do Norte Fluminense
Darcy Ribeiro, Campos dos Goytacazes City, Rio de Janeiro, Brazil
Email: *curcino@uenf.br

Received December 6, 2013; revised January 6, 2014; accepted January 21, 2014

ABSTRACT

According to the literature data on the chemical composition of the *Trichilia* genus performed in this work, it can be concluded that 334 different compounds were isolated and identified, distributed in monoterpenes, sesquiterpenes, diterpenes, triterpenes, steroids, limonoids, coumarins, flavonoids, lignans, phenolic acids, amino acids and lactones. Together with the structures of this compound, data from botanical classification and pharmacological results from extracts and pure compounds on the *Trichilia* genus were also described. The compounds derived from terpenes pathway were more significant, corresponding to about 87.7% of isolated and identified compounds from various *Trichilia* species. Among the different terpenoid skeletons of this kind, limonoids were meanly reported, appearing a total of 33.9% of compounds isolated from several *Trichilia* species.

KEYWORDS

Meliaceae; *Trichilia* Species; Botanic Aspects; Taxonomical Classification; Pharmacology Data; Chemical Structures of Constituents

1. Introduction

The Meliaceae family, included in the order Rutales and subdivided in the four subfamilies Swietenioideae, Melioideae, Quivisianthoideae and Capuronianthoideae [1], represents plants classified in 51 genera containing about 1400 species of the tropics and subtropics of both hemispheres [2]. In Brazil, the Meliaceae family appears actually with seven representatives genus: *Cedrela*, *Cabralea*, *Swietenia*, *Carapa*, *Guarea*, *Trichilia* and *Khaya*. Plants of this genus present great economic interest by the wood industries (e.g. mahogany, "cedro-rosa", "canjerana") and the provision of essential oils [3,4].

The *Trichilia* genus consists of about 70 species, mainly distributed in tropical America and Africa, of which 43 species occur in Brazil [5-8].

Trichilia is a genus which has the largest number of species in the family as well as presents the greatest anatomical features of Meliaceae [9,10].

*Corresponding author.

2. Botanical Aspects

The *Trichilia* species are presented as trees (measuring 20 to 30 m in height) or groves (measuring from 3 to 10 m height) with pinnate leaves and young shoots, or trifoliate. Flowers are normally unisexual (dioic plant) with four to five petals, seeds are fleshy, partially or completely surrounded by a thin rim or Chubby. The *Trichilia* name is derived from the Greek "*Tricho*", which refers to the three locules of the ovarian and three valves in the fruit [9,11].

3. Taxonomical Background

The taxonomic classification of the *Trichilia* species is as follows:

Kingdom: Plantae
Subkingdom: Tracheobionta
Division: Angiosperma
Class: Magnoliopsida
Subclass: Magnoliidae
Order: Rutales

Family: Meliaceae
Subfamily: Melioideae
Genus: *Trichilia*

Only 27 species of the genus *Trichilia* were studied chemically; species are cited here:

T. americana	*T. elegans*	*T. prieuriana*
T. catigua	*T. estipulata*	*T. quadrijuga*
T. casaretti	*T. havanensis*	*T. ramalhoi*
T. cipo	*T. heudellotti*	*T. reticulata*
T. claussenii	*T. hirta*	*T. rubescens*
T. connaroides	*T. hispida*	*T. rubra*
T. cuneata	*T. lepidota*	*T. schomburgkii*
T. dregeana	*T. martiana*	*T. silvatica*
T. emetica	*T. pallida*	*T. trifolia*

4. Biological/Pharmacological Activities of Crude Plant Materials as Well as of Chemical Constituents

A significant number of papers reported biological and pharmacological activities of crude extracts and pure chemical constituents isolated from different parts of species of *Trichilia* genus, most of which are summarized in **Tables 1** and **2**.

5. Chemical Constituents of *Trichilia*

Species of the *Trichilia* genus revealed with relative frequency the presence of secondary metabolites from the metabolic pathway of terpenoids.

Between the metabolites present in *Trichilia* the limonoids, triterpenes modified with high oxygenation, were observed with expressive frequency. These request special attention because they are considered the major chemosystematics markers of the Meliaceae family [34,35]. These compounds are also known as meliacins because of its bitter taste.

The phytochemical investigation of the *Trichilia* genus, until August 2013, had isolated and identified 334 compounds with varying structural skeleton. These compounds are classified as monoterpenes (**01-07**, **Figure 1**, **Table 3**), sesquiterpenes (**08-64**, **Figure 2**, **Table 4**), diterpenes (**65-71**, **Figure 3**, **Table 5**), tetracycles triterpenes (**72-103**, **Figure 4**, **Table 6**), cycloartane-type triterpenes (**104-117**, **Figure 5**, **Table 7**), pentacyclic triterpenes with *seco*-A-ring (**118-121**, **Figure 6**, **Table 8**), pentacyclic triterpenes (**122-128**, **Figure 7**, **Table 9**), steroids (**129-158**, **Figure 8**, **Table 10**), meliacin-type limonoids (**159-182**, **Figure 9**, **Table 11**), limonoids with furan-ring (**183-285**, **Figure 10**, **Table 12**), degraded limonoids (**286-287**, **Figure 11**, **Table 13**), coumarins (**288-291**, **Figure 12**, **Table 14**), flavonoids (**292-302**, **Figure 13**, **Table 15**), glycosylated lignans (**303-306**, **Figure 14**, **Table 16**) and other constituents from *Trichilia* genus (**307-334**, **Figure 15**, **Table 17**).

Table 1. Principal biological activities of some compounds isolated of the *Trichilia* species.

Compounds	Biological activity	Ref.
sendanin **(226)**	Inhibits the growth of: *Pectinophora gossypiella* (pink bollworm), *Heliothis virescens* (tobacco attacks), *H. zea* (cotton attacks) and *Spodoptera frugiperda.*	[12]
Tr-A **(248)**, Tr-B **(249)** and Tr-C (**261**)	Antifeedant activity front larvae *Ajrostis sejetum* Denis (insect from Japan).	[13]
7-acetyltrichilin-A **(230)**	Activity against *Spodoptera littoralis* (attacking Japanese plants), *S. eridania* and *Eplilachna varivestis* (Mexican bean beetle).	[14]
trichilins A **(229)**, B **(228)**, C **(233)**, D **(231)**, E **(227)**, F **(234)** and G **(232)**	Activity against *Spodoptera eridania* and *Epilachna varivestis.*	[13]
hispidins A **(251)**, B **(265)** and C **(264)**	Cytotoxic activity in KB^{23} cells (nasopharyngeal cancer).	[15]
catiguanin A **(294)** and B **(295)**, cinchonain Ia **(296)**, Ib **(297)**, Ic **(298)** and Id **(299)**	Potent antioxidant activity in DPPH.	[16]
cinchonain Ia **(296)** and Ib **(297)**	Bactericide activity against *Bacillus cereus*, *Eschericha coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus.*	[17]
24-methylenocycloarta-3*β*-ol **(106)**, 24-methylene-3*β*,22-dihydroxycolesterol **(152)** *α*-gedunine **(183)**	Activity against larvae of *Tuta absoluta*.	[18]
cycloarta-23-ene-3,25-diol **(109)**	Anti-inflammatory activity.	[19]
dolabellanes **(65)**, **(66)** and **(67)**	Activity against *Sitophilus oryzae.*	[8]
methyl-6,11*β*-dihydroxy-12*α*-(2-methylpropanoyloxy)-3,7-dioxo-14*β*, 15*β*-epoxy-1,5-meliacadien-29-oate **(189)**	Activity against *Heliothis virescens* and *H. armigera.*	[20]
hirtine **(191)**	Inhibits the growth of *Peridroma saucia*.	[21]
prieurianin **(246)** and prieurianin acetate **(245)**	Active against *Heliothis virescens* (tobacco attacks) and *Epilachna varivestis* (Mexican bean beetle).	[22]
rubrins A **(252)**, B **(253)**, C **(251)**, D **(254)**, E **(255)**, F **(256)** e G **(257)**	Potent inhibitor of cell adhesion, and potential anti-inflammatory or immunosuppressive agents.	[23]

Table 2. Biological activity of some extracts of *Trichilia* species.

Species	Extracts/Plant part	Biological activity	References
T. americana	methanol/wood	Inhibiting the growth of *Spodoptera litura*.	[24]
T. casaretti	ethyl acetate/leaves	Microbial growth inhibition of *Staphylococcus aureus*.	[25]
T. catigua	hexane and methanol/seeds	Approximately 50% mortality of the larvae of *S. frugiperda*.	[26]
T. connaroides	dichloromethane and chloroform/seeds	Activity against *Plasmodium falciparum*.	[27]
T. elegans	hexane and methanol/fruits	100% mortality of larvae of *S. frugiperda*.	[26]
	dichloromethane/leaves	Bactericidal activity in *Enterococcus faecalis* and *Escherichia coli*.	[11]
	methanol/fruits	Inhibition of growth of *Candida albicans*, *Cryptococcus neoformans*, *Aspergillus flavus*, *Trichophyton mentagrophytes* and *T. violaceum*.	[11]
T. emetica	aqueous/roots	Bactericidal activity in *Staphylococcus aureus*, *Streptococcus pyogenes*, *S. pnuemoniae*, *Moraxella catarrhalis* and *Haemophilus influenzae*.	[28]
	ethyl ether/roots	Bactericidal activity in *Staphylococcus aureus* and *Streptococcus pyogenes*.	[28]
T. gabla	methanol/wood	Inhibition of growth of *Spodoptera litura*.	[24]
	aqueous/leaves	Anti-inflammatory effect.	[29]
T. hirta	ethanol/roots	Stimulating the production of white blood cells.	[30]
T. lepidota	ethanol/leaves	Activity against DNA damage in *Saccharomyces cerevisiae* mutant strains, presenting data to damage selective topoisomerase I and II.	[31]
T. quadrijuga	ethyl acetate/twigs	Growth inhibition of different strains of *Staphylococcus aureus* and *S. epidermidis*.	[32]
T. ramalhoi	hexane and methanol/stem	trypanocidal activity.	[33]
T. silvatica	*n*-butanol/leaves	Growth inhibition of *Streptococcus salivarius* and *S. mutans*.	[25]

5.1. Monoterpenes

To date 07 monoterpenes only were identified only in the *Trichilia* genus.

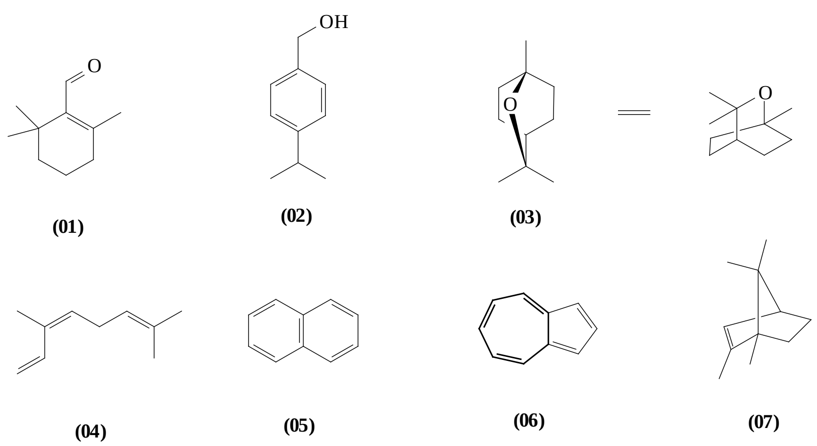


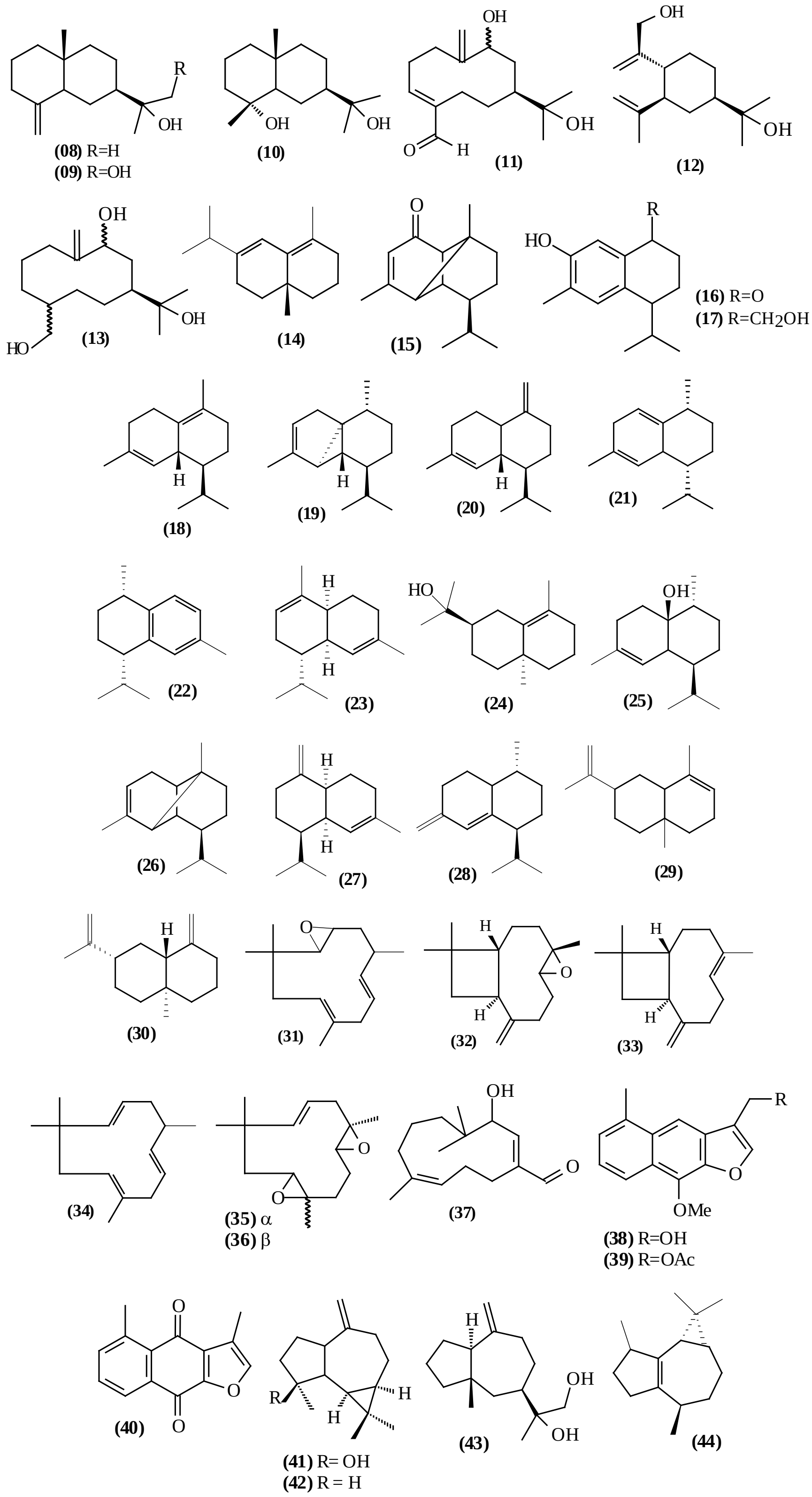
Figure 1. Structures of monoterpenes from *Trichilia*.

Table 3. Monoterpenes from *Trichilia*.

Species	Plant part	Compounds	References
T. connaroides	leaves	*β*-cyclocitral **(01)**	[27]
	wood	eucalyptol **(03)**	
		cuminol **(02)**	
		cis-ocimene **(04)**	
	leaves, roots, stem and wood	azulene **(06)**	
		2-methyl-2-bornene **(07)**	
T. pallida	leaves	naphthalene **(05)**	[36]

5.2. Sesquiterpenes

57 sesquiterpenes (**08**-**64**) were identified in the *Trichilia* genus, revealing various skeletons, being mostly cyclic sesquiterpenes.



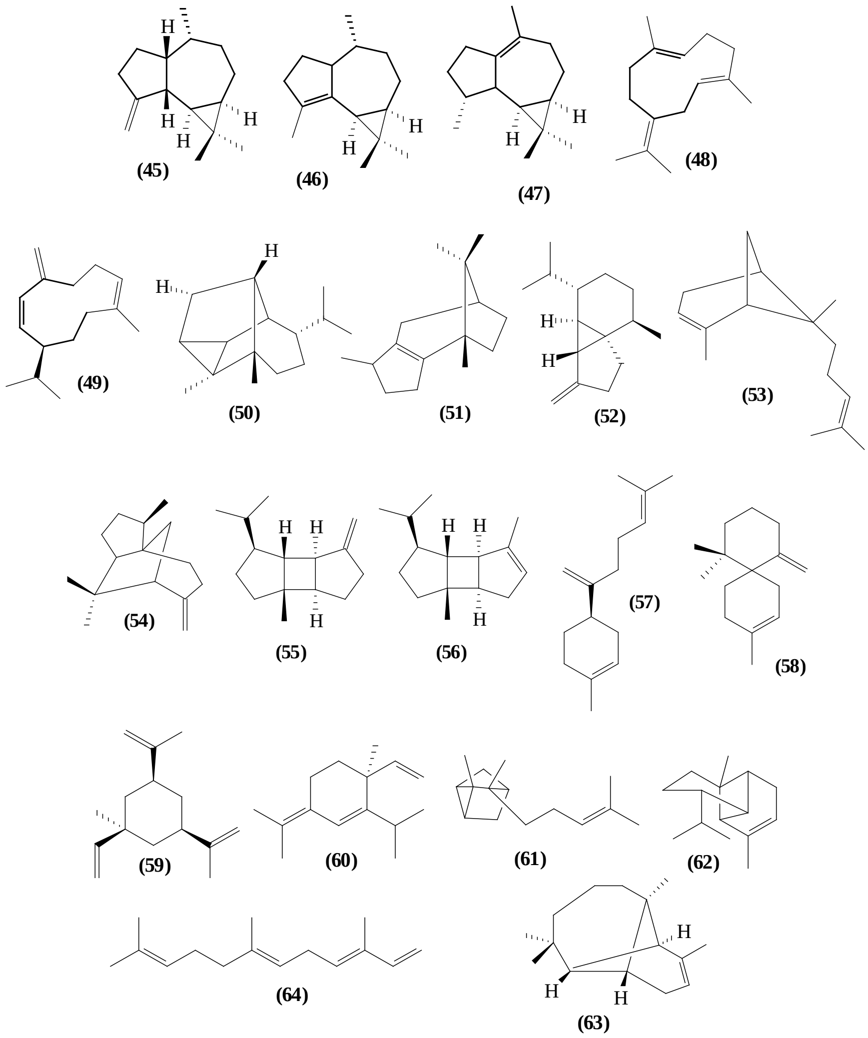


Figure 2. Structures of sesquiterpenes from *Trichilia*.

Table 4. Sesquiterpenes from *Trichilia*.

Species	Plant part	Sesquiterpenes	References
T. catigua	stem	7-hydroxy-1-oxo-14-norcalamenene **(16)**	[37]
		7,14-dihydroxycalamenene **(17)**	
T. cipo	leaves	β-elemene **(59)**	
		β-selinene **(30)**	[38]
		epoxide cariofilene **(32)**	
		epoxide humulene **(31)**	
	wood	epoxide cariofilene **(32)**	
		β-elemene **(59)**	
		β-eudesmol **(08)**	
T. connaroides		α-cubebene **(19)**	
	leaves, roots, stem and wood	ylangene **(62)**	[27]
		α-copaene **(26)**	
	leaves and wood	α-bourbonene **(56)**	
		β-patcholene **(51)**	
		γ-cadinene **(20)**	
	leaves, stem and wood	β-caryophyllene **(33)**	
		δ-cadinene **(18)**	
	leaves	β-bourbonene **(55)**	

Continued

		α-farnesene **(64)**	
	leaves, roots and wood	*γ*-murolene **(27)**	
	stem and wood	*β*-cubebene **(52)**	
		germacrane D **(49)**	
	stem and roots	isoledene **(44)**	
		α-bergamotene **(53)**	
	stem, roots and wood	cyclosativene **(50)**	
	stem and wood	cadien-1,4-diene **(21)**	
	stem	*α*-selinene **(29)**	
		β-bisabolene **(57)**	
		α-gurjunene **(46)**	
	roots and wood	*δ*-selinene **(14)**	
		calamenene **(22)**	
	roots	*β*-cedrene **(54)**	
		α-santalene **(61)**	
		i-longipinene **(63)**	
		β-chamigrene **(58)**	
	wood	(+)-*epi*-bicyclosesquiphellandrene **(28)**	
		(−)-isoledene **(44)**	
		aromadendrene **(42)**	
		β-elemene **(59)**	
		α-elemene **(60)**	
		α-murolene **(50)**	
		β-gurjunene **(45)**	
	wood	*β*-eudesmol **(08)**	
		cryptomeridiol **(10)**	
T. claussenii		germacra-3,10(14)-dien-9,11-diol-4-carbaldehyde **(11)**	[39]
		14-hydroxyelemol **(12)**	[7]
		germacra-10(14)-en-9,11,15-triol **(13)**	
	leaves	epoxide cariofilene **(32)**	
		13-hydroxy-14-nordehydrocacalohastine **(38)**	
T. cuneata	stem and leaves	13-acetoxy-14-nordehydrocacalohastine **(39)**	[40]
		maturinone **(40)**	
T. emetica	leaves	kurubasch aldehyde **(37)**	[41]
T. hirta	fruits	spathulenol **(41)**	[42]
T. lepidota	leaves	epoxide caryophyllene **(32)**	
		epoxide humulene **(31)**	[7]
		spathulenol **(41)**	
T. pallida	leaves	*α*-copaene **(26)**	[36]
		β-elemene **(59)**	
		β-caryophyllene **(33)**	[36]
		viridiflorene **(47)**	
		α-selinene **(29)**	
		δ-cadinene **(18)**	
		germacrene B **(48)**	
		α-cubebene **(19)**	
		α-humulene **(34)**	
		γ-muurolene **(27)**	
		10-*epi*-*γ*-eudesmol **(24)**	
		1-*epi*-cubenol **(25)**	
	wood	quadrijugol **(43)**	[43]
T. quadrijuga		kudtdiol **(09)**	[32]
	leaves	spathulenol **(41)**	
	leaves	(2*S*,3*S*,6*R*,7*R*)-humulene-2,3,6,7-diepoxide **(35)**	[44]
T. silvatica		(2*R*,3*R*,6*R*,7*R*)-humulene-2,3,6,7-diepoxide **(36)**	
		mustacone **(15)**	

5.3. Diterpenes

Only 07 diterpenes were identified only in the *Trichilia* genus.

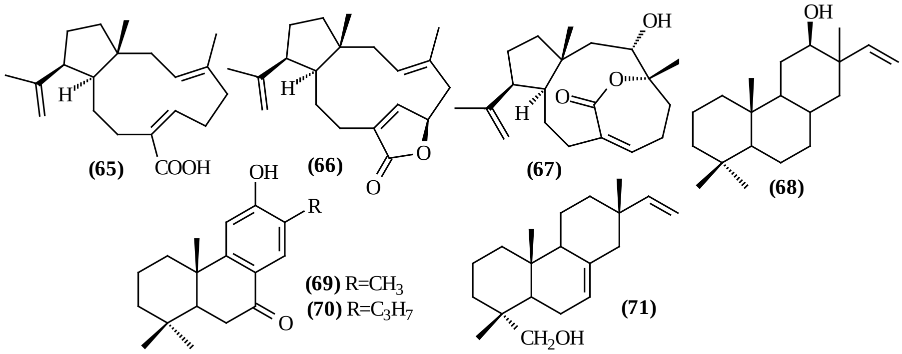


Figure 3. Structures of diterpenes from *Trichilia*.

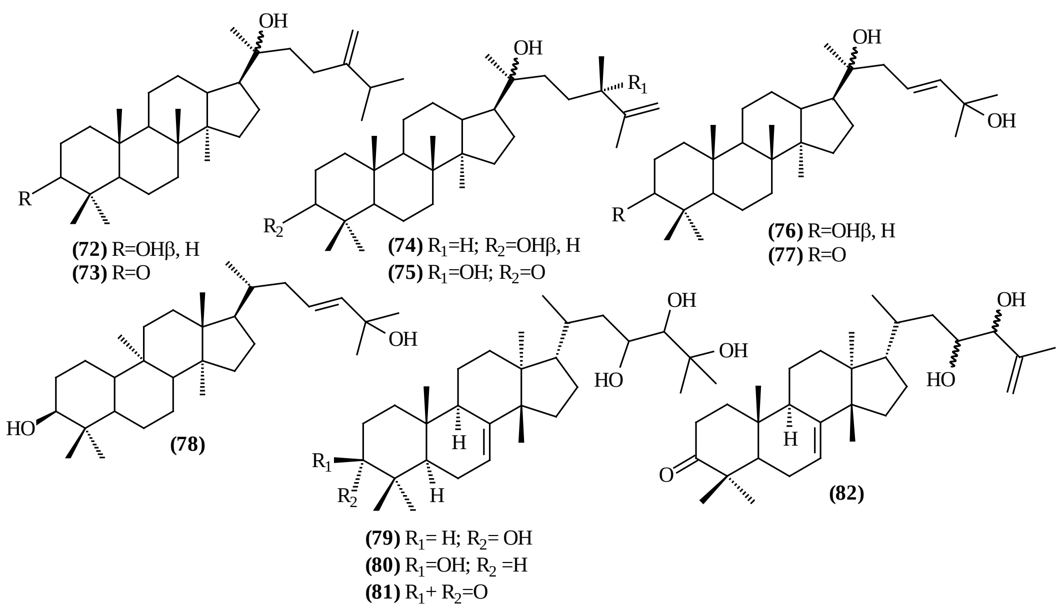
Table 5. Diterpenes from *Trichilia*.

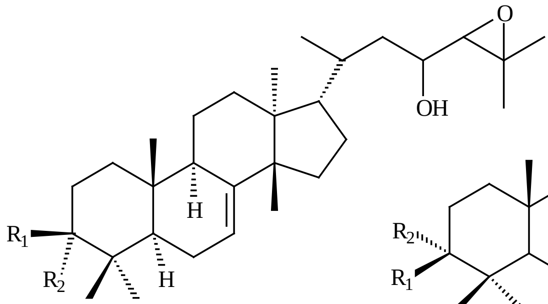
Species	Plant part	Diterpenes	References
T. heudellotti	leaves	12*β*-hydroxysandaracopimar-15-ene **(68)**	[45]
		nimbiol **(69)**	
		7-ketoferruginol **(70)**	
		isopimarinol **(71)**	
T. trifolia	stem	(1*R*,3*E*,7*Z*,11*S*,12*S*)-dolabella-3,7,18-trien-17-oic acid **(65)**	[8]
		(1*R*,3*E*,6*R*,7*Z*,11*S*,12*S*)-dolabella-3,7,18-trien-6,17-olide **(66)**	
		(1*R*,3*S*,4*R*,7*Z*,11*S*,12*S*)-3-hydroxydolabella-7,18-dien-4,17-olide **(67)**	

5.4. Triterpenes

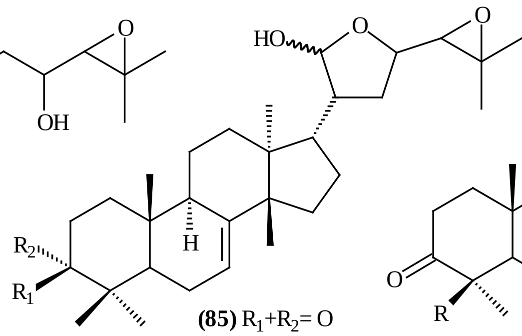
5.4.1. Tetracyclic Triterpenes

Were isolated and identified 32 tetracyclic triterpenes (**72** to **103**) in *Trichilia*, mostly in the leaves.

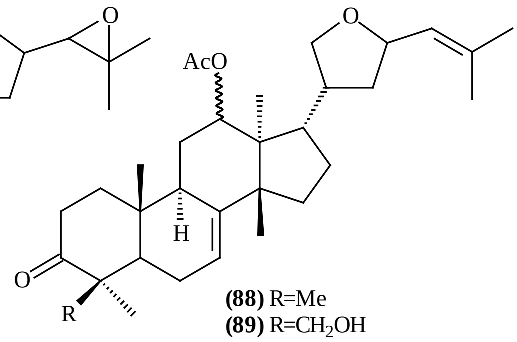




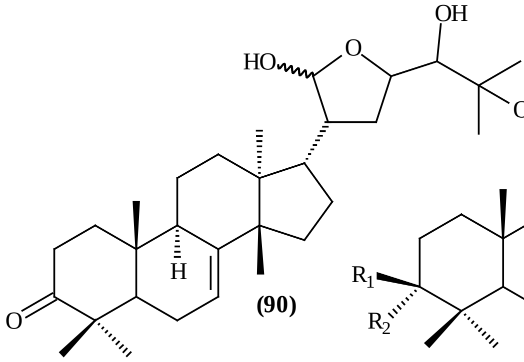
(83) R_1=OH; R_2=H
(84) R_1+R_2 =O



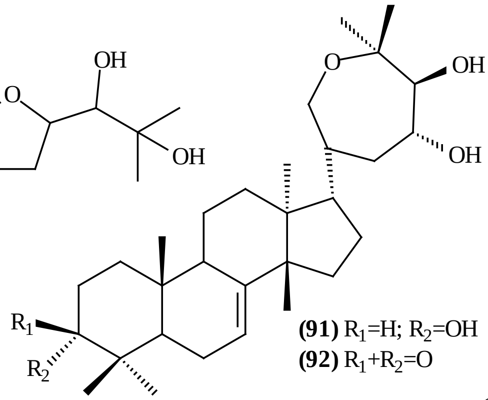
(85) R_1+R_2= O
(86) R_1=OH; R_2=H
(87) R_1=OCO$(CH_2)_nCH_3$; R_2=H
n=(10,12,14,16)



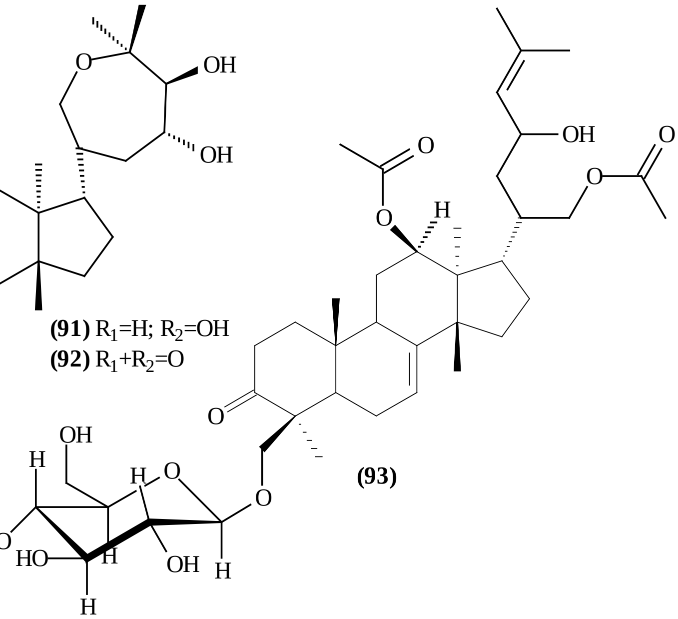
(88) R=Me
(89) R=CH_2OH



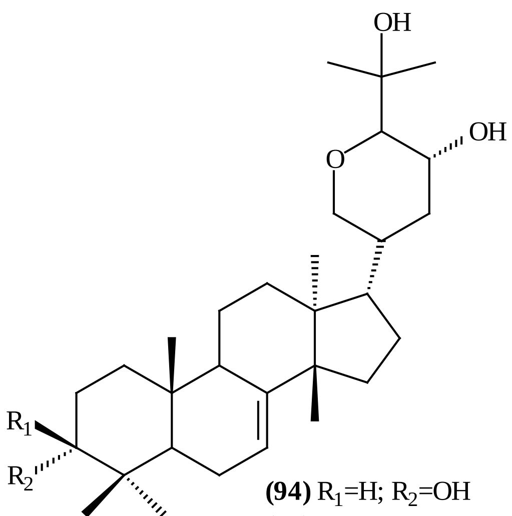
(90)



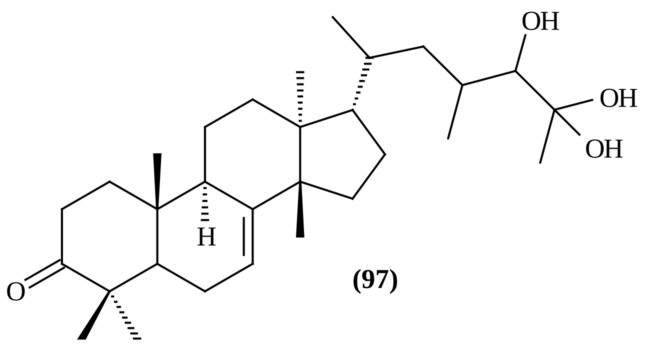
(91) R_1=H; R_2=OH
(92) R_1+R_2=O



(93)



(94) R_1=H; R_2=OH
(95) R_1+R_2=O
(96) R_1=OCO$(CH_2)_nCH_3$; R_2=H
n=(10,12,14,16)



(97)

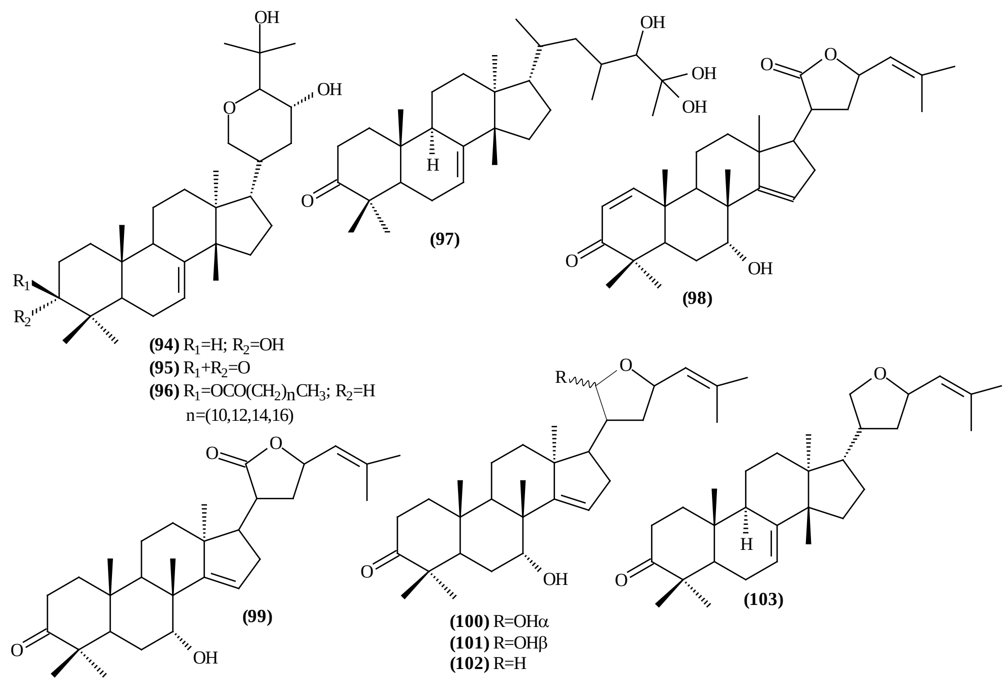


Figure 4. **Structures of tetracyclic triterpenes from *Trichilia.***

Table 6. **Tetracyclic triterpenes from*Trichilia.***

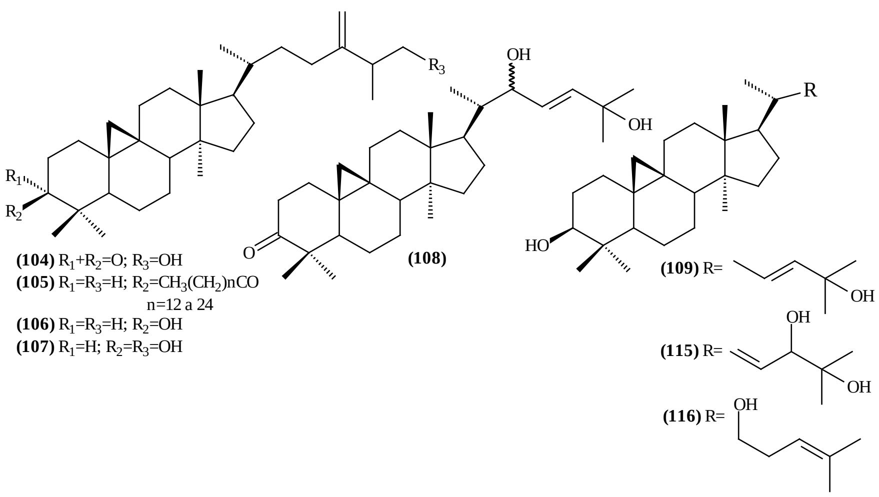
Species	Plant part	Tetracyclic Triterpenes	References
T. connaroides	wood	melianone **(85)**	[46]
		melianol **(86)**	
		lipomelianol **(87)**	
		melianodiol **(90)**	
		dihydroniloticin **(83)**	
		lipo-3-episapelin A **(96)**	
T. estipulata	leaves	vellozonol **(72)**	[47]
		vellozone**(73)**	
		carnaubadiol **(74)**	
		carnauba-21-ol-3-one **(75)**	
		fouqueriol **(76)**	
		isofouquerione **(77)**	
T. hirta	fruits	melianone **(85)**	[48]
		melianol **(86)**	
		bourjotinolone A **(95)**	
		nilocitin **(84)**	[42]
		dihydronilocitin B **(83)**	
		melianone **(85)**	
		piscidinol **(97)**	
		melianone lactone **(81)**	

Continued

	leaves	hispidol A **(79)**	
T. hispida		hispidol B **(80)**	[49]
		sapelin A **(94)**	
		sapelin B **(91)**	
		sispidone **(92)**	[50]
		bourjotinolone A **(95)**	
T. lepidota	leaves	lepidotrichilin A **(98)**	[51]
		lepidotrichilin B **(99)**	
		21,23-epoxy-7α,21α-dihydroxyapotirucalla-14,24-dien-3-one **(100)**	
		21,23-epoxy-7α,21β-dihydroxyapotirucalla-14,24-dien-3-one **(101)**	
		dysorone D **(102)**	
		desoxyflindissone **(103)**	
	leaves	prieurone **(88)**	[52]
T. prieuriana		29-hydroxypreurione **(89)**	
		prieurianoside **(93)**	[53]
	leaves	dihydroniloticin **(83)**	
T. quadrijuga		niloticin **(84)**	[43]
		bourjotinolone B **(82)**	
		piscidinol A **(97)**	
	leaves	dihydroxyniloticin **(83)**	
T. reticulata		melianone **(85)**	[54]
		melianodiol **(90)**	
		9,19-ciclolanost-23-ene-3,25(3β,23*E*) **(78)**	
	leaves	piscidinol A **(97)**	[55]
T. schomburgkii		niloticin **(84)**	
		dihydroxyniloticin **(83)**	

5.4.2. Cycloartane-Type Triterpenes

Were identified 14 cycloartane-type triterpenes (**104-117**) *Trichilia*, most of which were isolated from the leaves.



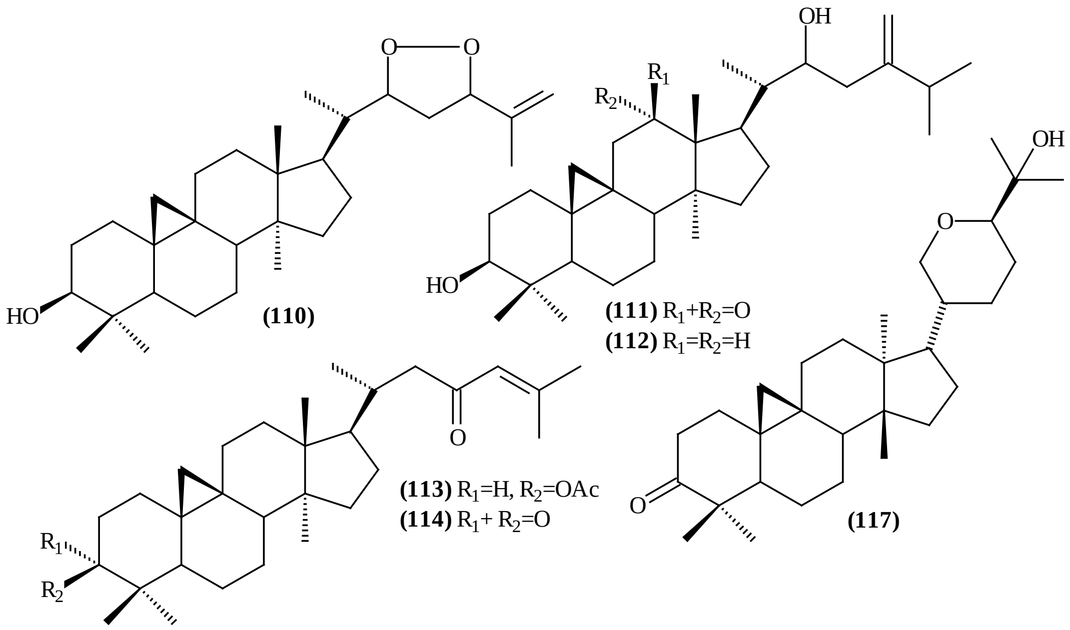


Figure 5. Structures of cycloartane-type triterpenes from *Trichilia*.

Table 7. Cycloartane-type triterpenes from *Trichilia*.

Species	Plant part	Cycloartane-type triterpenes	References
T. casaretti	leaves	24-methylen-cicloartan-12-oxo-3β,22α-diol **(111)**	
		24-methylen-cicloartan-3β,22-diol **(112)**	
		trichiliol **(110)**	[25]
		24,25-dihydroxycicloartan-22-enol **(115)**	
		22(*R*)-hydroxycicloartan-24-en-3-ol **(116)**	
	leaves	24-methylen-26-hydroxycicloartan-3-one **(104)**	[39]
T. claussenii		24-methylen-cicloartanol etherified **(105)**	
	wood	22,25-dihydroxy-9β,19-ciclolanostan-23-en-3-one **(108)**	[7]
T. dregeana	leaves	cycloartan-23-en-3β,25-diol **(109)**	[19]
T. hirta	fruits	hirtinone **(117)**	[42]
	leaves	24-methylen-cycloartan-3β-ol **(106)**	
T. pallida		24-methylen-cycloartan-3β-26-diol **(107)**	[18,10]
		cycloartan-23-en-3β,25-diol **(109)**	
T. reticulata	leaves	9,19-cycloartan-24-en-3,23-dione **(114)**	
		3-(acetyloxy)-9,19-cycloartan-24-en-23-one **(113)**	[54]
		cycloartan-23-en-3β,25-diol **(109)**	
T. rubra	leaves	24-methylen-cycloartan-3β,22-diol **(112)**	[10]

5.4.3. Triterpenes with A-*seco*-Ring

Only four triterpenes with A-*seco*-ring (**118**-**121**) were identified, all isolated from the *T. elegans* and *T. emetica* species.

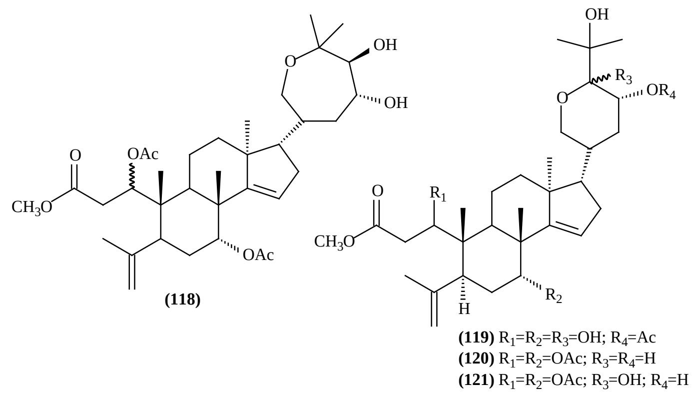


Figure 6. **Structures of triterpenes with A-*seco*-ring from *Trichilia*.**

Table 8. **Triterpenes with A-*seco*-ring from *Trichilia*.**

Species	Pant part	Triterpenes with ring A-*seco*	References
T. elegans	seeds	methyl-1ξ,7(*R*)-diacetoxy-23(*R*),25(*S*)-dihydroxy-20(*S*)-21,25-epoxy-3,4-*seco*-apotirucall-4(28), 4(15)-dien-3-oate **(118)**	[56]
		methyl-1ξ,7(*R*)-diacetoxy-3*R*,25-dihydroxy-20*S*,24(*R*)-21,24-epoxy-3,4-*seco*-apotirucall-4(28), 14(15)-dien-3-oate **(120)**	
		methyl-1ξ,7(*R*)-diacetoxy-23*(R)*,24,25-trihydroxy-20(*S*)-21,24-epoxy-3,4-*seco*-apotirucall-4(28), 14(15)-dien-3-oate **(121)**	
T. emetica (*T. roka*)	stem	methyl-1(*S*),23(*R*)-diacetoxy-7(*R*),24,25-trihydroxy-20(*S*)-21,24-epoxy-3,4-*seco*-apotirucall-4(28), 14(15)-dien-3-oate **(119)**	[57]

5.4.4. Pentacyclic Triterpenes

Only seven pentacyclic triterpenes were isolated from the leaves and wood of species of *Trichilia* genus.

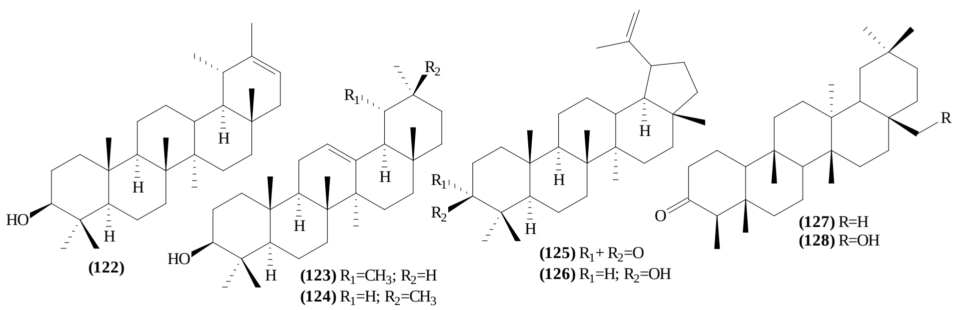


Figure 7. **Structures of pentacyclic triterpenes from *Trichilia*.**

Table 9. **Pentacyclic triterpenes from *Trichilia*.**

Species	Plant part	Pentacyclic triterpenes	References
T. casaretti	leaves	lupeol **(126)**	[25]
T. pallida	leaves	friedelan-28-ol **(128)**	[10]
		lupeol **(126)**	
	wood	α-amirine **(123)**	
		β-amirine **(124)**	
T. ramalhoi	leaves	lupenone **(125)**	[33]
		lupeol **(126)**	
T. rubra	leaves	friedelan-28-ol **(128)**	[10]
	wood	friedelin **(127)**	
T. silvatica	leaves	pseudotaraxasterol **(122)**	[44]
		α-amirine **(123)**	
		β-amirine **(124)**	
		lupeol **(126)**	

5.5. Steroids

A total of 30 steroids (**129-158**) were isolated of *Trichilia*, distributed in the leaves and stem of the species *T. claussenii* and *T. connaroides*.

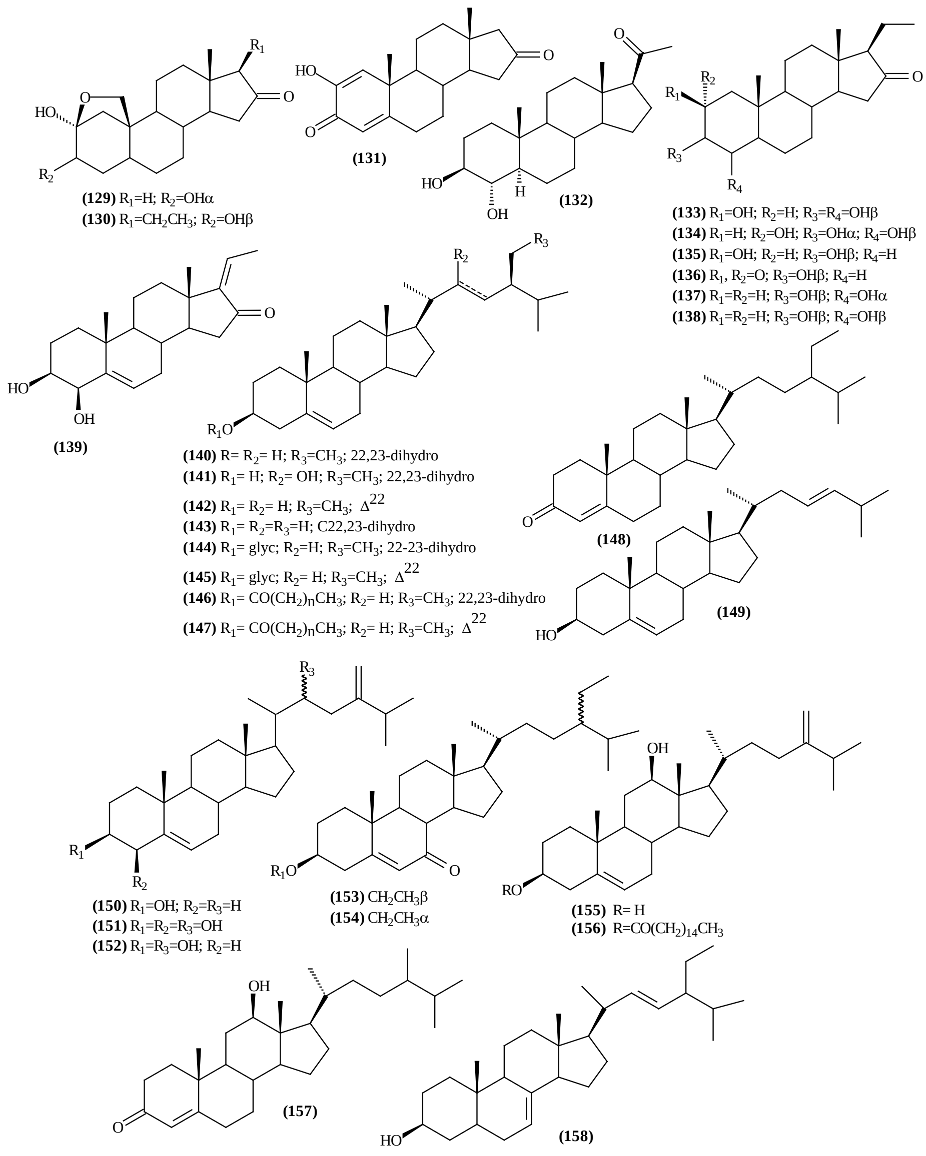


Figure 8. **Structures of steroids from *Trichilia*.**

Table 10. **Steroids from *Trichilia*.**

Species	Plant part	Steroids	References
T. americana	stem	2-hydroxyandrost-1,4-dien-3,16-dione **(131)** (trichiliasterone B)	[58]
T. casaretti	leaves	*β*-sitosterol **(140)**	[25]
		stigmasterol **(142)**	
T. catigua	stem and leaves	*β*-sitosterol **(140)**	[35]
		stigmasterol **(142)**	
T. claussenii	leaves	*β*-sitosterol **(140)**	
		stigmasterol **(142)**	[39]
		3-*O*-*β*-glycopyranoside sitosterol **(144)**	[59]
		3-*O*-*β*-glycopyranoside stigmasterol **(145)**	
		β-sitosterol etherified **(146)**	[7]

Continued

		stigmasterol etherified **(147)**	
	wood	2*α*,3*α*-dihydroxyandrostan-16-one-2*β*,19-hemiketal **(129)**	[59]
		2*α*,3*β*-dihydroxypregnan-16-one-2*β*,19-hemiketal **(130)**	[39]
		2*β*,3*β*,4*β*-trihydroxypregnan-16-one **(133)**	
		2*α*,3*α*,4*β*-trihydroxypregnan-16-one **(134)**	
		2*β*,3*β*-dihydroxypregnan-16-one **(135)**	
T. connaroides	stem	3*β*-hydroxy-colestan-23-ene **(149)**	[60]
		3-*O*-*β*-glycopyranoside stigmasterol **(145)**	
		7-oxo-24*β*-sitosterol **(153)**	
		3-*O*-*β*-glycopyranoside sitosterol **(144)**	
		stigmasterol **(142)**	
		β-sitosterol **(140)**	
	wood and leaves	3*β*,4*α*-dihydroxypregnan-21-one **(132)**	[61]
		3*β*,4*α*-dihydroxypregnan-16-one **(137)**	[62]
		α-spinasterol **(158)**	
	fruits	stigmasterol **(142)**	
		β-sitosterol **(140)**	[63]
T. elegans		sitostenone **(148)**	[26]
		campesterol **(143)**	
		3-*O*-*β*-glycopyranoside sitosterol **(144)**	[37]
	stem	3-*O*-*β*-glycopyranosidesitosterol **(144)**	
		7-oxo-24*β*-sitosterol **(153)**	
T. estipulata		7-oxo-24*α*-sitosterol **(154)**	[47]
	leaves	*β*-sitosterol **(140)**	
		sitosterone **(148)**	
T. hirta	fruits and leaves	*β*-sitosterol **(140)**	[48]
	stem and wood	trichiliasterone A **(136)**	[64]
		trichiliasterone B **(131)**	[58]
	leaves	sitostenone **(148)**	[48]
T. lepidota	leaves	ergost-5,24(28)-dien-3,12-diol-(3*β*,12*β*) **(155)**	[7]
		ergost-5,24(28)-diene-3,12-diol-3-hexadecanoate (3*β*,12*β*) **(156)**	
		24-methyl-12-*β*-hydroxycolest-4-en-3-one **(157)**	
		β-sitosterol **(140)**	[7,51]
		stigmasterol **(142)**	
		campesterol **(143)**	
		24-methylen-colesterol **(150)**	[7]
T. pallida	leaves	24-methylen-3*β*,4*β*,22-trihydroxycolesterol **(151)**	
		24-methylen-3*β*,22-dihydroxycolesterol **(152)**	[18]
		24-methylen-colesterol **(150)**	
	wood	*β*-sitosterol **(140)**	[10]
T. quadrijuga	leaves	*β*-sitosterol **(140)**	
		itesmol **(141)**	[32]
		stigmasterol **(142)**	[43]
	wood	3-*O*-*β*-glycopyranoside sitosterol **(144)**	
	wood	2*β*,3*β*,4*β*-trihydroxypregnan-16-one **(133)**	
		3*β*,4*β*-dihydroxypregnan-16-one **(138)**	
T. ramalhoi	leaves	stigmasterol **(142)**	[33]
		β-sitosterol **(140)**	
T. reticulata	leaves	24-methylen-3*β*,4*β*,22-trihydroxycolesterol **(151)**	[54]
		volkendousin **(139)**	
T. rubra	leaves	3*β*-hydroxy-colestan-23-ene **(149)**	[10]
	leaves and wood	24-methylen-3*β*,4*β*,22-trihydroxycolesterol **(151)**	
		24-methylen-3,22-dihydroxycolesterol **(152)**	
T. shomburgkii	roots	2*β*,3*β*,4*β*-trihydroxypregnan-16-one **(133)**	[65]
		2*α*,3*α*,4*β*-trihydroxypregnan-16-one **(134)**	
T. silvatica	leaves	*β*-sitosterol **(140)**	[44]

5.6. Limonoids

5.6.1. Meliacin-Type Limonoids

The 24 meliacin-type limonoids more than 50% were isolated from the seeds of *T. elegans*.

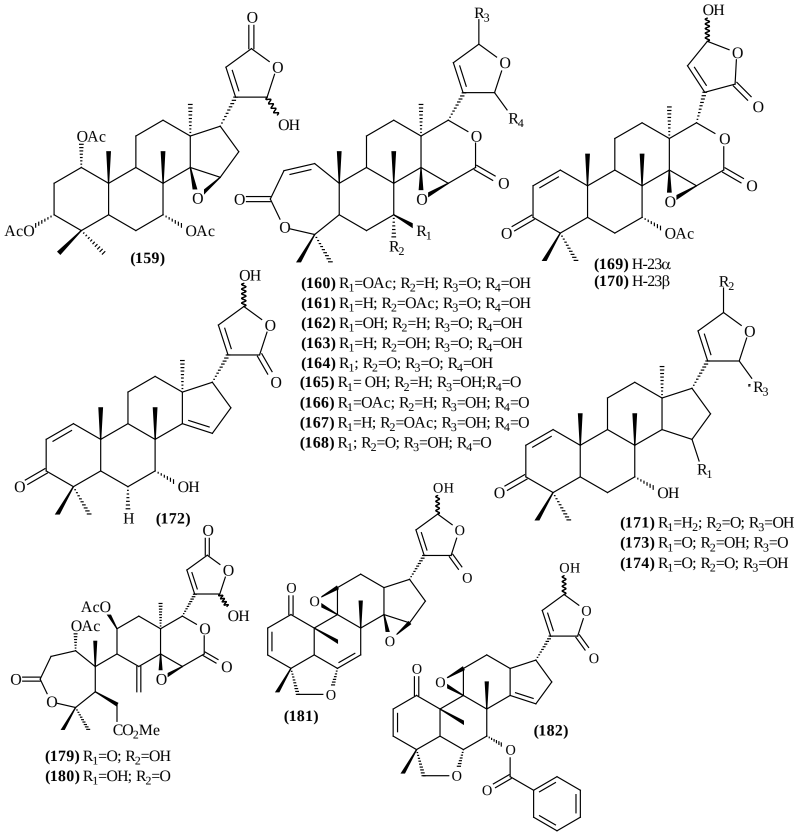


Figure 9. **Structures of meliacin-type limonoids from *Trichilia.***

Table 11. **Meliacin-type limonoids from *Trichilia*.**

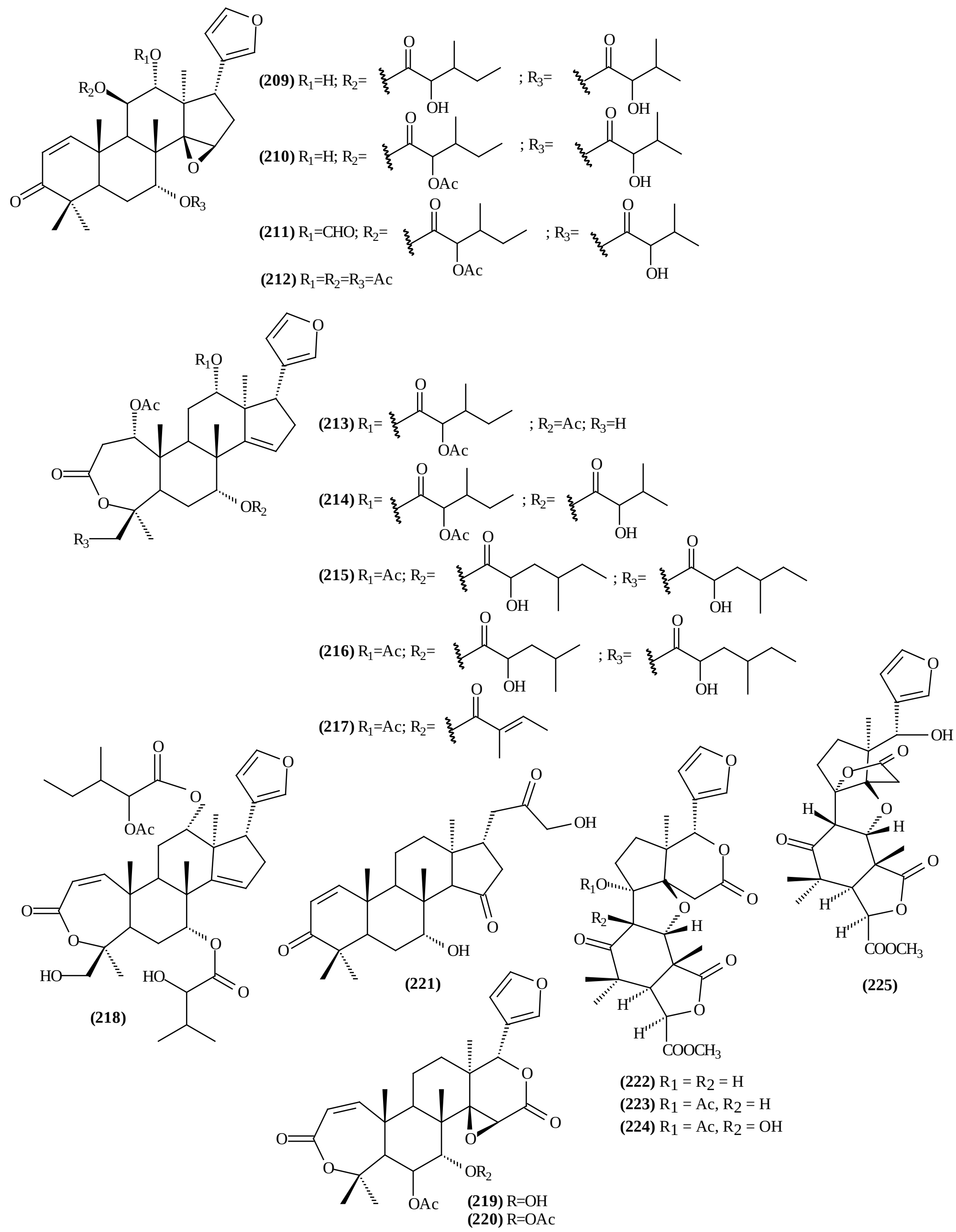
Species	Plant part	Meliacins	References
T. catigua	fruits	fotogedunin A **(169)**	[66]
		fotogedunin B **(170)**	
	seeds	7-deoxo-7*β*-acetoxykihadanin A **(160)**	[67]
		7-deoxo-7*β*-acetoxykihadanin B **(166)**	
		7-deoxo-7*β*-hidroxykihadanin A **(162)**	
		7-deoxo-7*β*-hidroxykihadanin B **(165)**	
		7-deoxo-7*α*-hidroxykihadanin A **(163)**	
T. elegans		7-deoxo-7*α*-acetoxykihadanin A **(161)**	[68]
		7-deoxo-7*α*-acetoxykihadanin B **(167)**	
		kihadanin A **(164)**	
		kihadanin B **(168)**	
		elegantin A **(179)**	[63]
		elegantin B **(178)**	
		1,2-dihydro-1*α*-acetoxyelegantin A **(177)**	
		1,2-dihydro 1*α*-acetoxyelegantin B **(180)**	
T. estipulata	stem	7-deacetyl-21-hydroxyneotrichilenonelide **(171)**	[47]
		7*α*-23-dihydroxy-3-oxo-24,25,26,27-tetranorapotirucall-1,14,20(22)-trien-21,23-olide **(172)**	
		7-deacetyl-23-hydroxyneotrichilenonelide **(173)**	
		21-hydroxyneotrichilenonelide **(174)**	
T. havanensis	seeds	hydroxybutenolide **(159)**	[69]

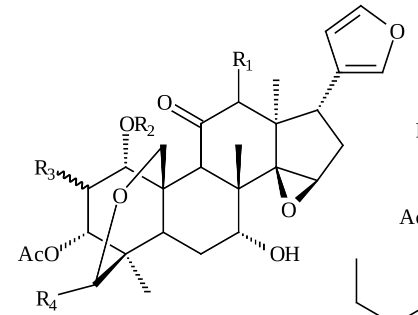
Continued

	fruits	carda-14,20(22)-dienolide-1,3,7-*tris*(acetyloxy)-21-hydroxy-4,4,8-trimethyl-α, 3α,5α,7α,13α,17α,21*R*) **(175)**	
T. hirta	fruits	methyl-11β-acetoxy-6,23-dihydroxy-12α(2-methylpropionyloxy)-3, 7,21-trioxo-1,5,14,20-meliacatetraen-29-oate **(176)**	[48]
T. rubescens	leaves	trichirubun A **(181)**	[70]
		trichirubun B **(182)**	[71]

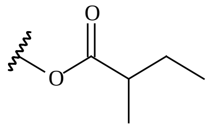
5.6.2. Limonoids with Furan-Ring

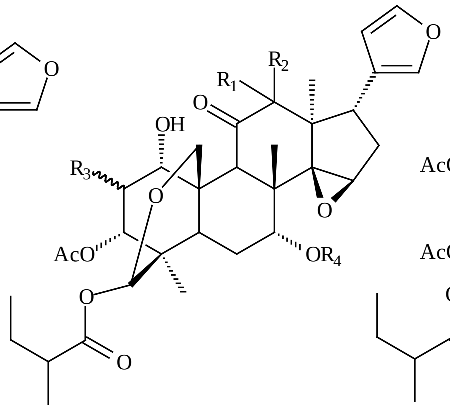
Among all the compounds isolated and identified by investigation of species of the *Trichilia* genus, the limonoids sustaining furan ring represent the largest number, totaling 103 limonoids (**183**-**285**). *T. connaroides*, *T. emetica*, *T. havanensis* and species of the *Noteworthy* genus revealed the higher amounts of these compounds compared with other species.



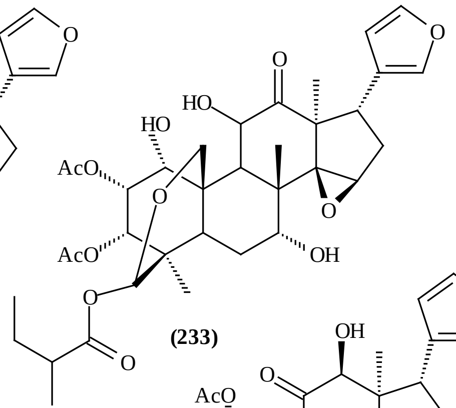


(226) R_1= αOAc; R_2=R_3=H; R_4=OAc
(227) R_1=βOH; R_2=Ac; R_3=αOH;

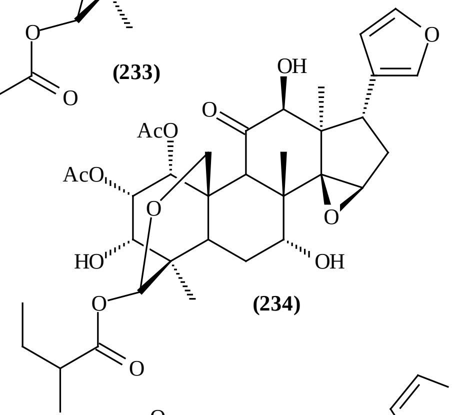
R_4= 



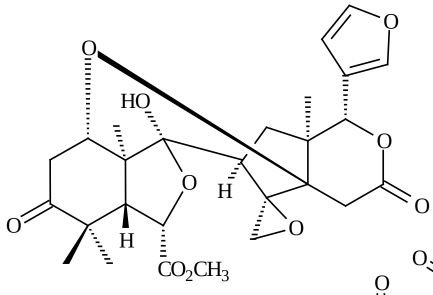
(228) R_1=αOH; R_2=R_4=H; R_3=αOAc
(229) R_1=βOH; R_2=R_4=H; R_3=αOAc
(230) R_1=βOH; R_2=H; R_3=αOAc; R_4=Ac
(231) R_1=R_2=R_4=H; R_3=αOAc
(232) R_1=βOH; R_2=H; R_3=αOH; R_4=H



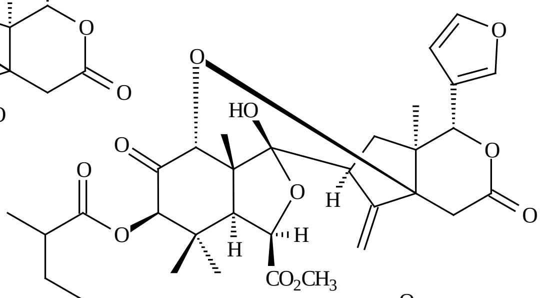
(233)



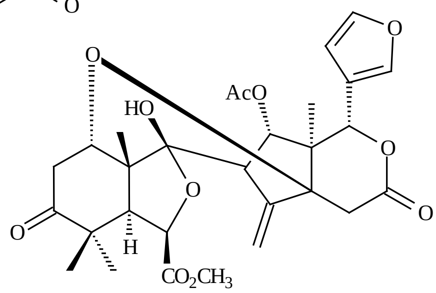
(234)



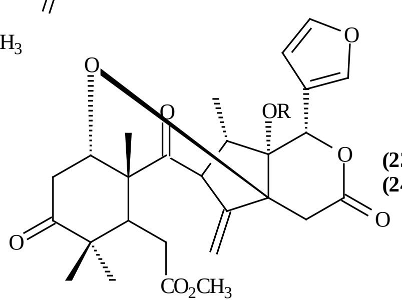
(235)



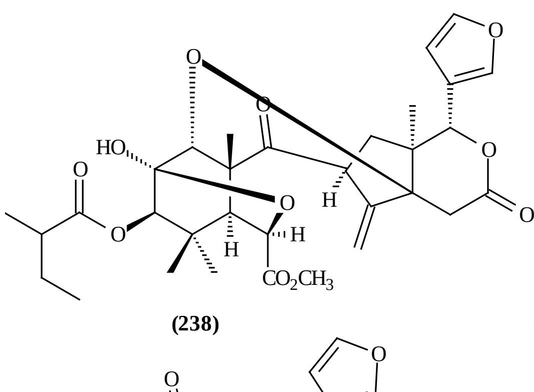
(236)



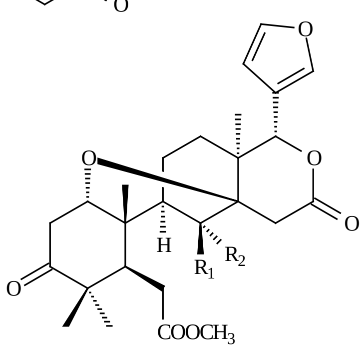
(237)



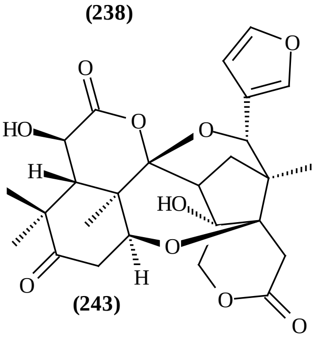
(239) R=H
(240) R=Ac



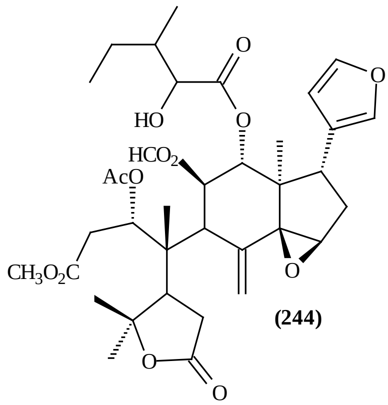
(238)



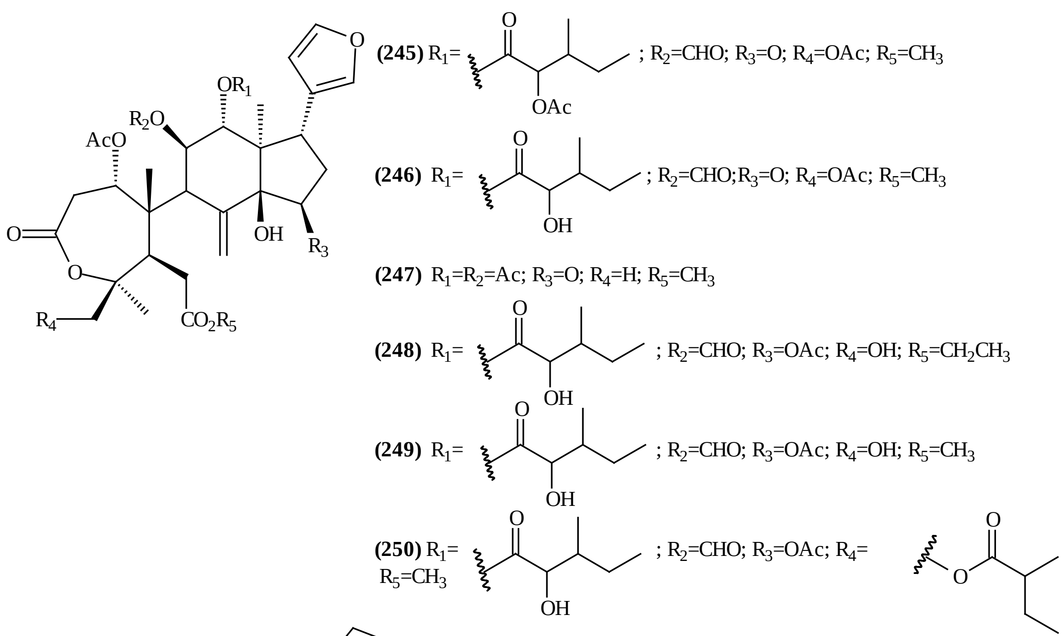
(241) R_1, R_2=CH_2
(242) R_1=CH_3; R_2=OH

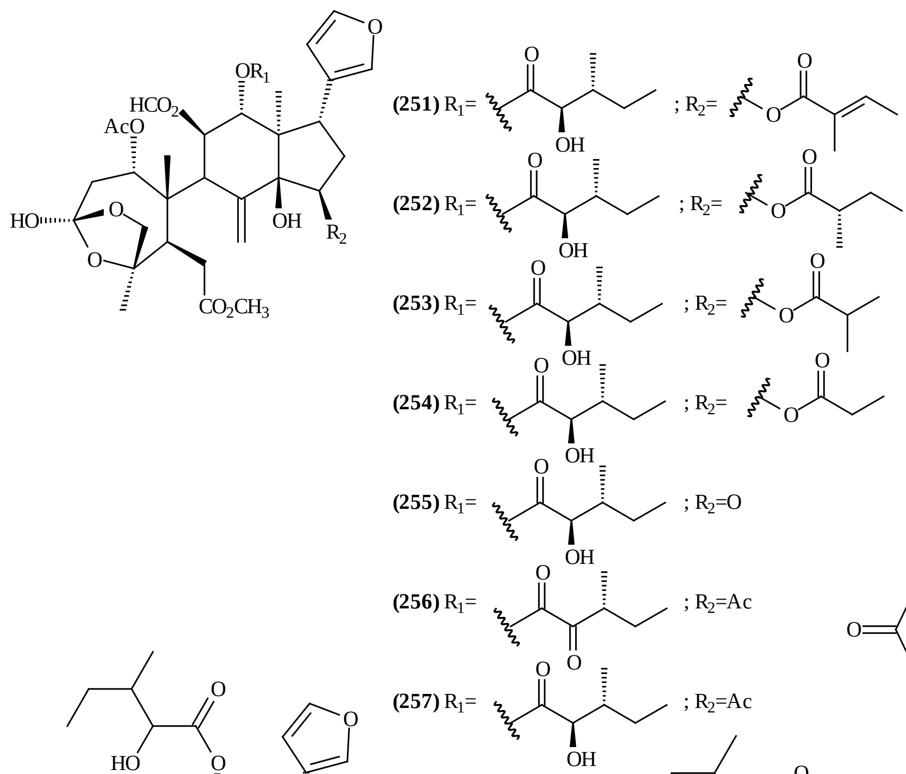


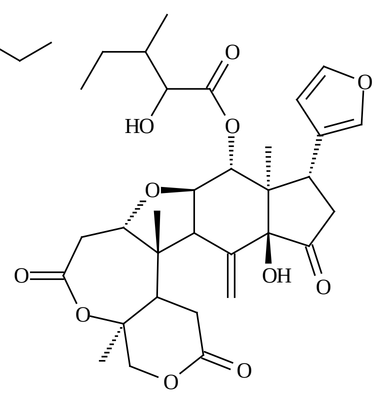
(243)



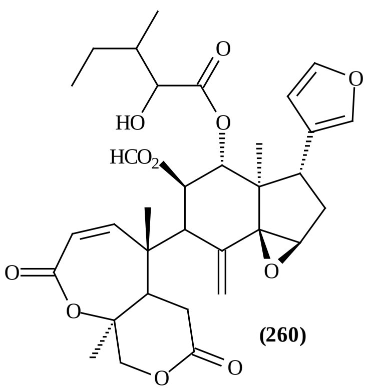
(244)



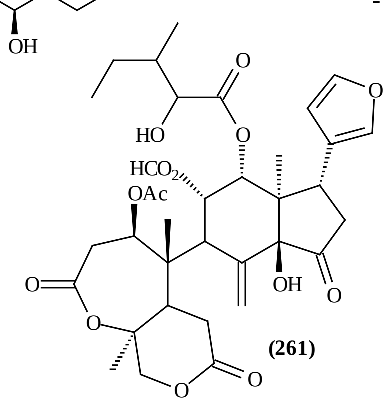




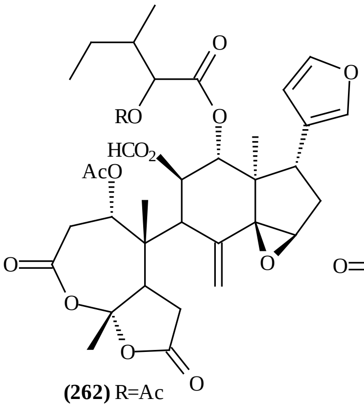
(258) R1 + R2 = O
(259) R1 = OAc; R2=H



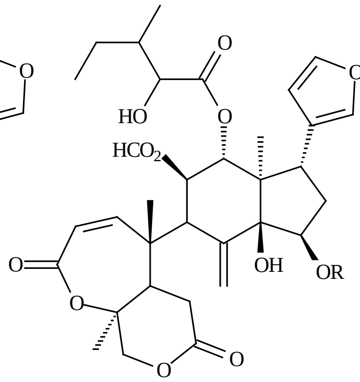
(260)



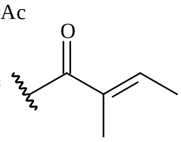
(261)

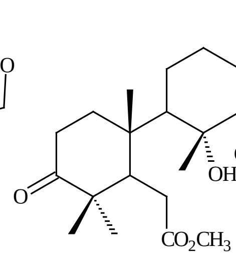


(262) R=Ac
(263) R=H

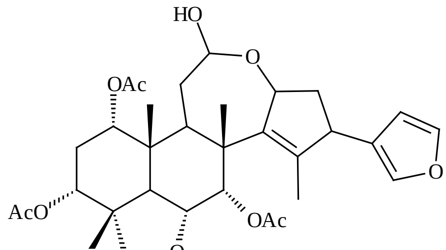


(264) R=Ac

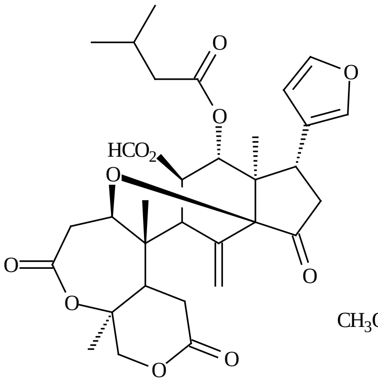
(265) R= 



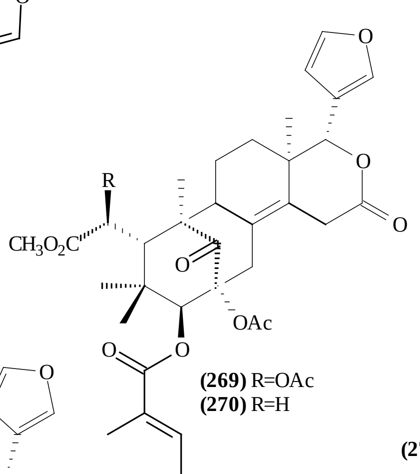
(266)



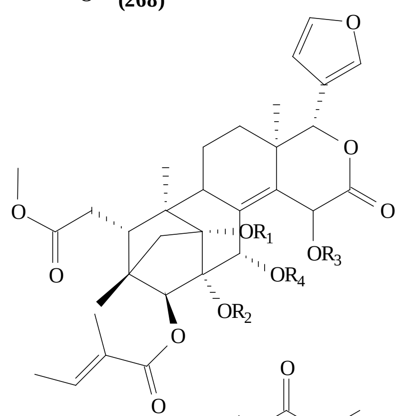
(268)

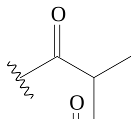


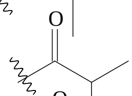
(267)

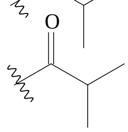


(269) R=OAc
(270) R=H



(271) $R_1 = R_2 = R_3 = H$; R_4 = 

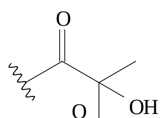
(272) $R_1 = R_2 = H$; $R_3 = Ac$; R_4 = 

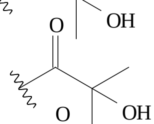
(273) $R_1 = R_2 = Ac$; $R_3 = H$; R_4 = 

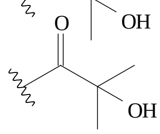
(274) $R_1 = R_2 = H$; $R_3 = R_4 = Ac$

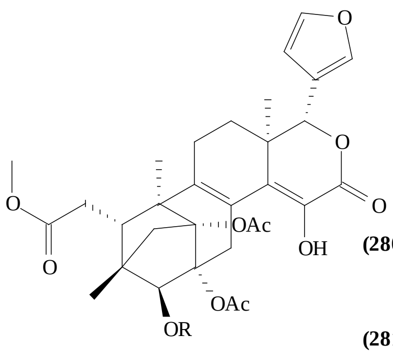
(275) $R_1 = R_2 = R_4 = H$; $R_3 = Ac$

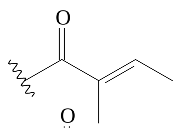
(276) $R_1 = R_2 = R_3 = R_4 = Ac$

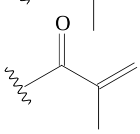
(277) $R_1 = R_2 = R_4 = H$; R_3 = 

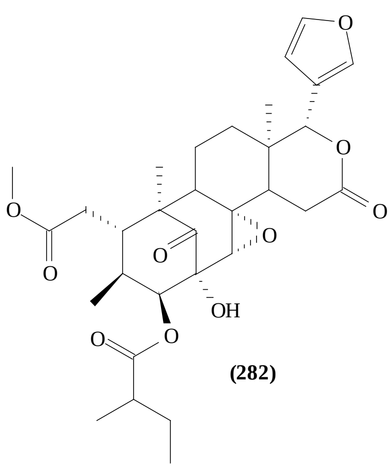
(278) $R_1 = R_2 = H$; $R_4 = Ac$; R_3 = 

(279) $R_1 = R_4 = Ac$; $R_2 = H$; R_3 = 



(280) R = 

(281) R = 



(282)

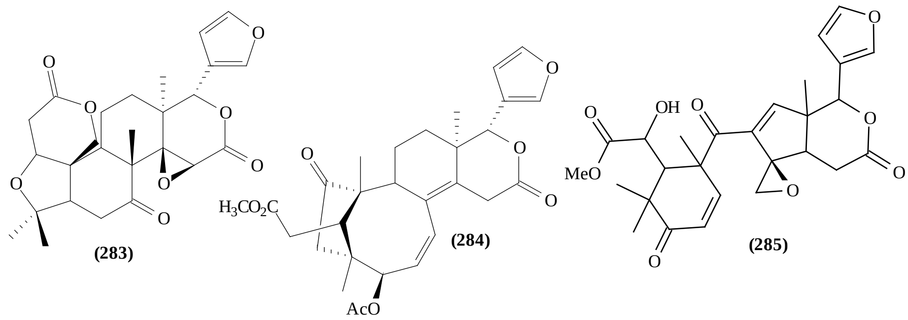


Figure 10. Structures of limonoids with furan-ring from *Trichilia*.

Table 12. Limonoids with furan-ring from *Trichilia*.

Species	Plant part	Limonoids	References
		cedrelone **(186)**	
T. catigua	seeds	methyl angolensate **(241)**	[66]
		11*β*-methoxycedrelone**(187)**	
	leaves	trichilin A **(235)**	
		trijugin A **(237)**	[72]
		trichilin B **(243)**	
		trijugin B **(239)**	[73]
		trijugin B acetate **(240)**	
		trijugin C **(222)**	
		trijugin D **(223)**	
T. connaroides		trijugin E **(224)**	
		trijugin F **(225)**	[74] [61]
		trijugin G **(236)**	
		trijugin H **(238)**	
		methyl-8α-hydroxy-8,30-dihydroangolesate **(242)**	
		$\Delta^{8,14}$-2-hydroxy-6-deoxyswietenine **(270)**	[74]
		trichiliton **(284)**	
		trichagmalin A **(280)**	[75]
		trichagmalin B **(281)**	
		trichagmalin C **(271)**	
		15-acetyltrichagmalin C **(272)**	
		1,2-dimethyltrichagmalin A **(273)**	
		trichagmalin D **(274)**	
		trichagmalin E **(275)**	
		15-acetyltrichagmalin E **(276)**	
		trichagmalin F **(277)**	
		30-acetyltrichagmalin F **(278)**	
		1,30-diacetyltrichagmalin F **(279)**	
		trichanolide **(282)**	
	fruits	2-hydroxy-3-*O*-tigloyl-6-*O*-acetyl-swietenolide **(269)**	[46]
	wood and leaves	trichiliton B **(285)**	[73]
	seeds	dregeana-1 **(267)**	
		dregeana-2 **(247)**	
		dregeana-3 **(213)**	[76]
T. dregeana (*T. splendida*)		dregeana-4 **(214)**	
		hispidin C; rohituka-7 **(264)**	
		dregeana-5 **(218)**	
	stem	dregeanin **(262)**	[77]
		12-(2'-deacetyl)-dregeanin **(263)**	

Continued

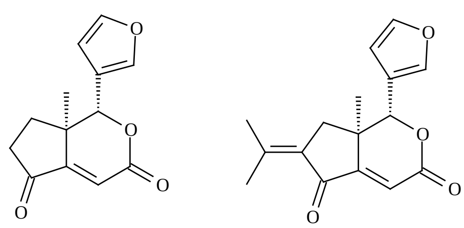
T. elegans	fruits	11β-acetoxyobacunone **(198)**	[26]
	fruits	sendanin **(226)**	[12]
T. emetica (*T. Roka*)	roots	trichilin E; aphonastatine **(227)**	[78]
		trichilin B **(228)**	
		trichilin A **(229)**	
		7-acetyltrichilin A **(230)**	[79]
		trichilin D **(231)**	
		trichilin C **(233)**	
		trichilin G **(232)**	[14]
		trichilin F **(234)**	
	stem	trichilin **(207)**	[80]
		1-acetyltrichilin **(208)**	
		Tr-A **(248)**	
		Tr-C **(249)**	
		Tr-B **(261)**	
		dregeana-4 **(214)**	[57]
		rohituca-3 **(258)**	
		rohituca-5 **(259)**	[11]
		rohituca-7 **(264)**	
		Nimani-1**(255)**	
T. estipulata	stem	21,24,25,26,27-pentanor-15,22-oxo-7α, 23-dihydroxy-apotirucalla(eupha)-1-en-3-one **(221)**	[81]
T. havanensis	fruits	1β,2β,21,23-diepoxy-7α-hydroxy-24,25,26,27-tetranor-14,20, 22-trien-3-one **(199)**	[32]
		1,7-diacetyl apotirucalla-havanensin **(196)**	[82]
		3,7-diacetyl-havanensin **(195)**	
		1,7-diacetyl-14,15-deoxy-havanensin **(203)**	[69]
		Triacetyl-14,15-deoxy-havanensin **(204)**	
		azadirone **(201)**	
		3,7-diacetyl-14,15-deoxyhavanensin **(205)**	[83]
		1,7-diacetyl apotirucalla-havanensin **(196)**	[82]
		3,7-diacetyl-havanensin **(195)**	
		havanensin **(193)**	
		trichavensin **(250)**	[84]
	stem	*neo*-havanensin **(206)**	[82]
	stem and fruits	triacetyl-havanensin **(194)**	[82]
		trichilenone acetate **(202)**	
T. heudelotti	stem	heudelottin E **(209)**	[85] [86]
		heudelottin C **(210)**	
		heudelottin F **(211)**	
		heudelottin **(212)**	[87]
		dregeanin**(262)**	[88]
		12-(2'-desacetyl)-dregeanin**(263)**	
	roots	heudebolin **(268)**	
T. hirta	seeds and leaves	hirtine **(191)**	[89]
	seeds and fruits	deacetylhirtine **(192)**	
		azadirone **(201)**	[48]
		methyl-11β-acetoxy-6-hydroxy-12α(2-methyl-propionyloxy)-3, 7-dioxo-1,5,14,20,22-meliacapentaen-29-oate **(200)**	
	fruits	hirtine **(191)**	[42]

Continued

		hispidin C; rohituka-7 **(264)**	
T. hispida	leaves	hispidin B **(265)**	[49]
		hispidin A **(251)**	
T. martiana	seeds	methyl angolensate **(241)**	[90]
		8-hydroxyandirobin **(266)**	
	roots	methyl 6-hydroxy-11*β*-acetoxy-12*α*-(2-methylpropanoyloxy)-3, 7-dioxo-14*β*,15*β*-epoxy-1,5-meliacadien-29-oate **(188)**	
		methyl 6,11*β*-dihydroxy-12*α*-(2-methylpropanoyloxy)-3, 7-dioxo-14*β*,15β-epoxy-1,5-meliacadien-29-oate**(189)**	[20]
T. pallida		methyl-6-hydroxy-11*β*-acetoxy-12*α*-(2-methylbutanoyloxy) 3,7-dioxo-14*β*,15*β*-epoxy-1,5-meliacadien-29-oate **(190)**	
		hirtine **(191)**	
		deacetylhirtine**(192)**	
	fruits	*α*-gedunine **(183)**	[18]
	Seeds	*α*-gedunine **(183)**	[10]
		7-deacetylgedunine **(184)**	
		limonine **(283)**	
		trichilia lactone D-5 **(244)**	
	stem	trichilia lactone D-4 **(260)**	[91]
T. prieuriana		12-(2'-deacetyl)-dregeanin **(263)**	
	stem	prieurianin acetate **(245)**	[92]
		prieurianin **(246)**	
T. rubra	roots	rubralin A **(215)**	
		rubralin B **(216)**	[93]
		rubralin C **(217)**	
		hispidin A; rubrin C **(251)**	
		rubrin A **(252)**	
		rubrin B **(253)**	
		rubrin D **(254)**	[23]
		nymania-1; Rubrin E **(255)**	
		rubrin F **(256)**	
		rubrin G **(257)**	
T. shomburgkii	leaves, roots and wood	7-deacetoxy-7-oxogedunin **(185)**	[55]
		α-gedunin **(183)**	
		7-deacetylgedunin **(184)**	
T. trifolia	fruits	trifolin **(197)**	[94]
		6*β*-acetoxyobacunol **(219)**	
		6*β*-acetoxy-7*α*-acetylobacunol **(220)**	

5.6.3. Degraded Limonoids

Only two (**286** and **287**) were found in *T. connaroides*.



(286) **(287)**

Figure 11. **Structures of degraded limonoids from *Trichilia*.**

Table 13. **Degraded limonoids from *Trichilia*.**

Species	Plant part	Degraded limonoids	References
T. connaroides	leaves	trichiconnarin A **(286)** trichiconnarin B **(287)**	[61]

5.7. Coumarins

Only 4 coumarins (**288** to **291**) were isolated in the *Trichilia* genus.

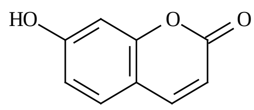


Figure 12. **Structures of coumarins from *Trichilia*.**

Table 14. **Coumarins from *Trichilia*.**

Species	Plant part	Coumarins	References
T. casaretti	wood	scopoletin **(288)**	[25]
T. elegans	seeds	scopoletin **(288)**	[26]
		scoparone **(289)**	
		umbelliferone **(290)**	
T. estipulata	stem	scopoletin **(288)**	[47]
		isofraxidin **(291)**	
T. lepidota	stem	scopoletin **(288)**	[51]

5.8. Flavonoids

In *Trichilia* species were identified 11 flavonoids (**292-302**). Almost entirely found in the seeds of *T. catigua*.

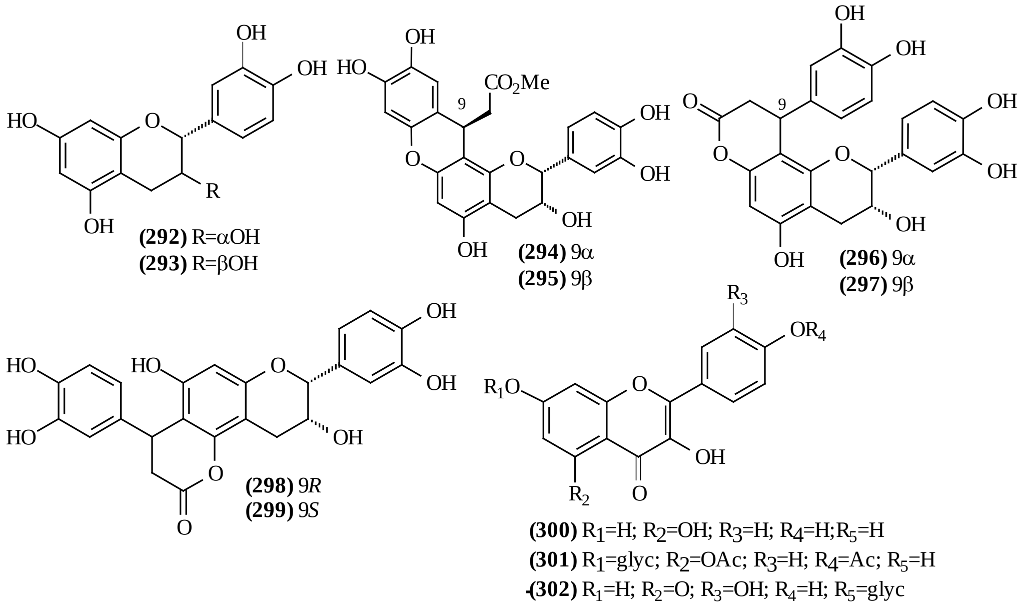


Figure 13. **Structures of flavonoids from *Trichilia*.**

Table 15. **Flavonoids from *Trichilia*.**

Species	Plant part	Flavonoids	References
T. catigua	stem	catiguanin A **(294)**	[95] [16]
		catiguanin B **(295)**	
		cinchonain Ia **(296)**	
		cinchonain Ib **(297)**	
		cinchonain Ic **(298)**	
		cinchonain Id **(299)**	
	stem and leaves	Catechin **(292)**	[35]
		epi-catechin **(293)**	
T. connaroides	leaves	kaempferol-7-*O*-glycosyde **(301)**	[96]
T. pallida	leaves and seeds	quercetin **(300)**	[10]
	leaves and wood	quercitrin **(302)**	

5.9. Glycosylated Lignans

All four glycosylated lignans isolated from *Trichilia* were found in the seeds of *T. estipulata*.

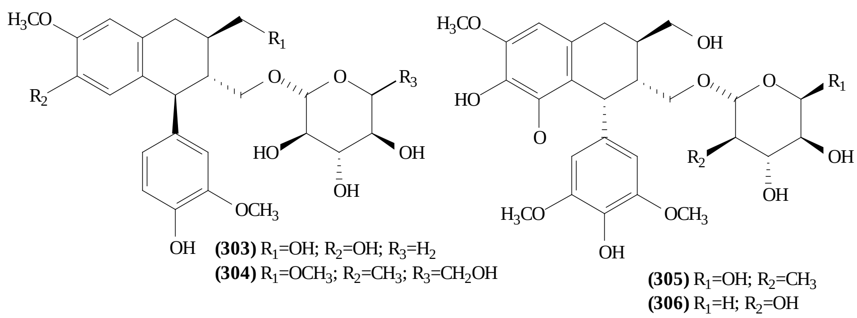
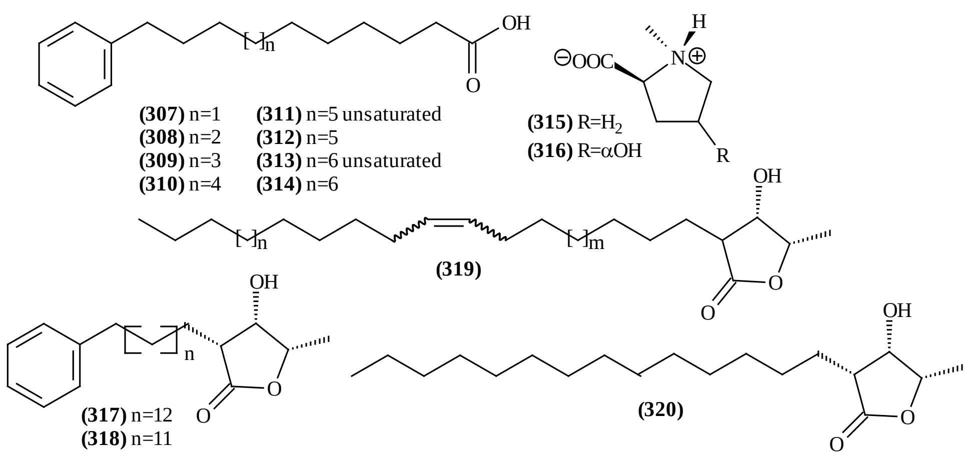


Figure 14. **Structures of glycosylated lignans from *Trichilia*.**

Table 16. **Glycosylated lignans from *Trichilia*.**

Species	Plant part	Glycosylated lignans	References
T. estipulata	Stem	(−)-isolariciresinol-3*α*-*O*-*β*-D-xylopyranoside **(303)**	[97]
		(+)-4'-*O*-methyl-9'-deoxyisolariciresinol-3*α*-*O*-*β*-D-glucopyranoside **(304)**	
		(−)-lyoniresinol-3*α*-L-rhamnopyranoside **(305)**	
		(−)-lyoniresinol-3*α*-*O*-*β*-D-xylopyranoside **(306)**	

5.10. Other Compounds from *Trichilia*



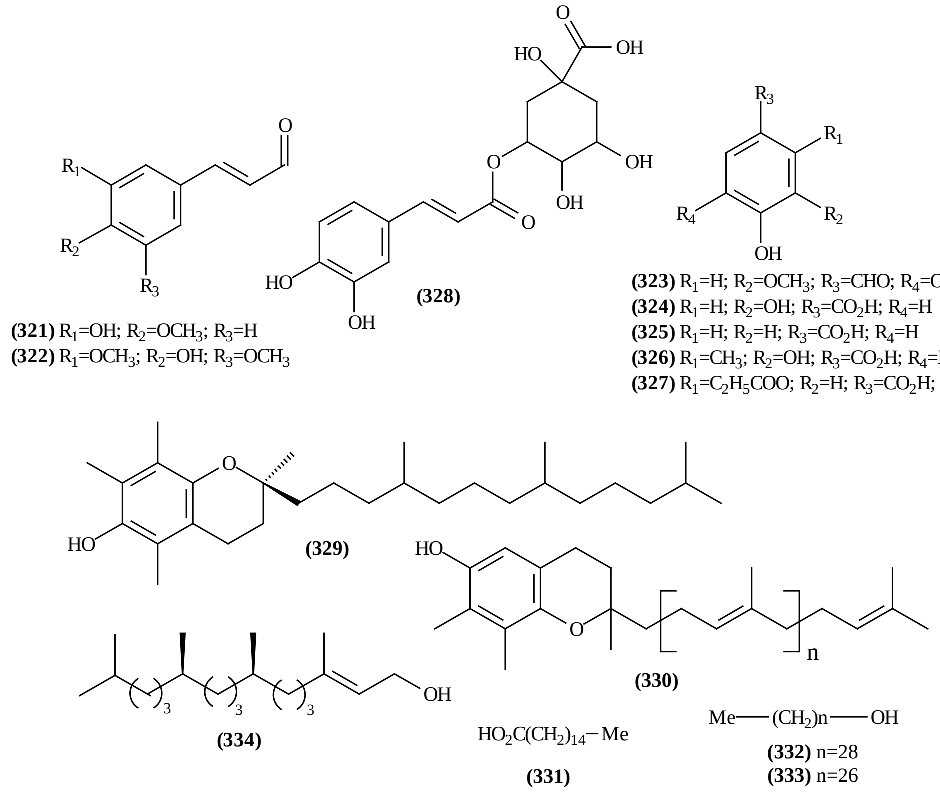


Figure 15. Structures of other compounds from *Trichilia*.

Table 17. Other compounds from *Trichilia*.

Species	Plant part	Other compounds	References
T. casaretti	leaves	phytol **(334)**	[25]
T. claussenii	fruits	(2*R*,3*S*,4*S*)-3-hydroxy-4-methyl-2-(13'-phenyl-1'-*n*-tridecyl)-butanolide **(317)**	[98]
		(2*R*,3*S*,4*S*)-3-hydroxy-4-methyl-2-(11'-phenyl-1'-*n*-undecyl)-butanolide **(318)**	
		(2*R*,3*S*,4*S*)-3-hydroxy-4-methyl-2-(1'-*n*-hexadec-7'(*Z*)-enyl)-butanolide **(319)**	[39]
		(2*R*,3*S*,4*S*)-3-hydroxy-4-methyl-2-(1'-*n*-tetradecyl)-butanolide **(320)**	
	leaves	*ω*-phenyl alkanoic and alkenoic acids **(307-314)**	[39]
		N-methylproline **(315)**	
		4-hydroxy-*N*-methylproline **(316)**	
		α-tocopherol **(329)**	
		plastocromenol **(333)**	
T. connaroides	stem	palmitic acid **(331)**	[60]
		nonacosanol **(332)**	
		n-heptacosyl alcohol **(333)**	
T. heudelotti	leaves	protocatechuic acid **(324)**	[45]
		4-hydroxybenzoic acid **(325)**	
		2-methylprotocatechuic acid **(326)**	
		2-propylonoxy-*β*-resorcylic acid **(327)**	
T. lepidota	leaves	phytol **(334)**	
		α-tocopherol **(329)**	
		N-methylproline **(315)**	
T. schomburgkii	stem	4-hydroxy-*N*-methylproline **(316)**	[55]
T. sp	stem	3-hydroxy-4-methoxycinamaldeide **(321)**	[99]
		3,5-dimethoxy-4-hydroxycinamaldeide **(322)**	
		4-hydroxy-3,5-dimethoxybenzaldeide **(323)**	
	stem and leaves	chlorogenic acid **(328)**	[35]

6. Results and Discussion

Following the literature of the chemical constituents of *Trichilia* species, these were grouped according to the part of the plant of origin (leaves, wood, fruits, seeds and roots). This survey was performed in order to check which part of the plant has increased production of limonoids, data that may help future research for new limonoids (**Figures 16-21**).

According to the literature of the chemical constituents of *Trichilia* species performed in this work, it can be concluded that were isolated and identified 334 different compounds, which are distributed in monoterpenes, sesquiterpenes, diterpenes, triterpenes, steroids, limonoids, coumarins, flavonoids, lignans, phenolic acids, aminoacids and lactones, forming the chemical constitution of this *Trichilia* genus.

This study, the chemical constituents were also grouped according to the part of the plant of the species of origin (leaves, wood, fruits, seeds and roots), as can be seen in **Figures 17-21**.

Compounds derived from the metabolic pathway of terpenes were more significant, representing 88.1% of the compounds isolated and identified from various and some species of plant species. Among the different carbon skeletons of this *Trichilia* genus, highlight the limonoids representing a total of 31.5% of the compounds isolated from various *Trichilia* species (**Figure 16**).

It can be seen that the limonoids, present in lower amounts in the leaves of species of this *Trichilia* genus with 17.6% of all isolated compounds, are more abundant in stems and branches (19.1%—**Figure 18**), roots (58%—**Figure 20**), fruits (60%—**Figure 19**) and seeds (82.1%—**Figure 21**). In leaves, the main constituents are the triterpenoids with 27.9% of compounds published to date.

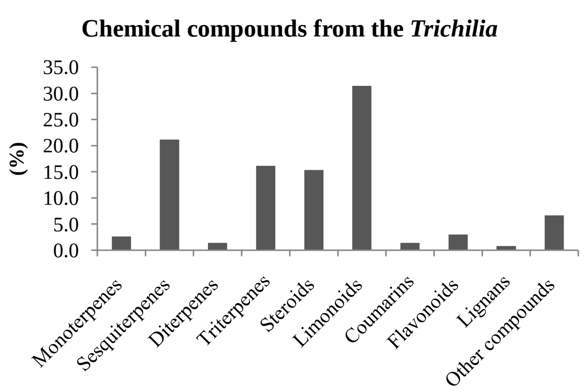


Figure 16. **Chemical compounds of *Trichilia.***

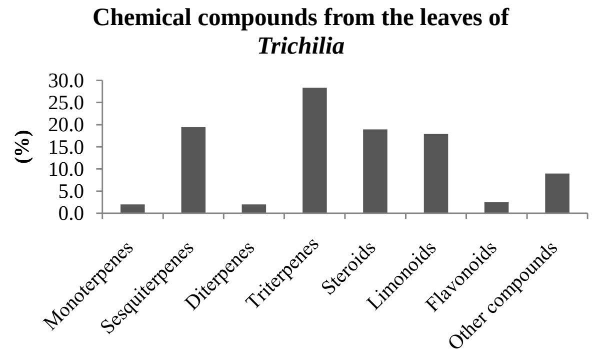


Figure 17. **Chemical compounds from the leaves of *Trichilia.***

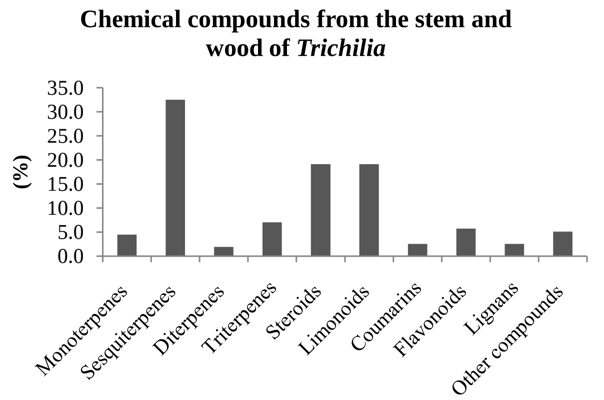


Figure 18. **Chemical compounds from the stem and wood of *Trichilia.***

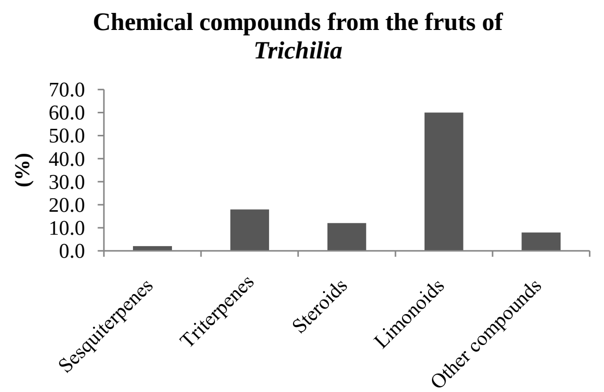


Figure 19. **Chemical compounds from the fruits of *Trichilia.***

7. Concluding Remarks

According to the literature, it is observed that secondary metabolites derived from the metabolic pathway of terpenes which are prevalent in the *Trichilia* genus, which stand up the limonoids, which are mostly in the *Trichilia* genus.

Comparing *Trichilia* species studied in Brazil and other countries, it is observed that most of limonoids isolated stem from *Trichilia* species not studied in Brazil, totaling 77% (**Figure 22**) and the predominance of the limonoids with the furan ring-type was 96%, while the species in Brazil make up a total of 23% (**Figure 22**) and the predominance of limonoids meliacin-type was 66%, the opposite of the species outside of Brazil.

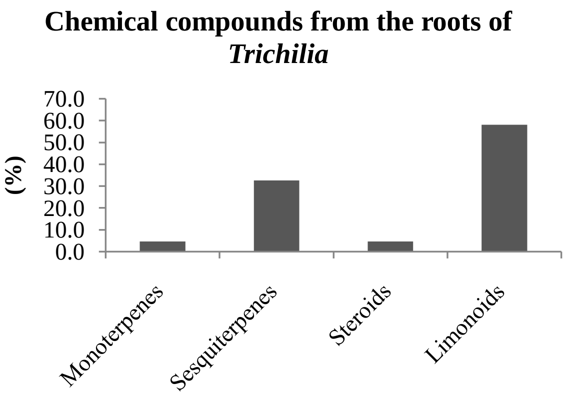


Figure 20. Chemical compounds from the roots of *Trichilia*.

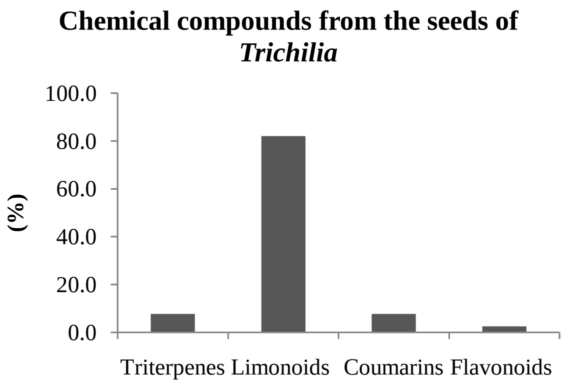


Figure 21. Chemical compounds from the seeds of *Trichilia*.

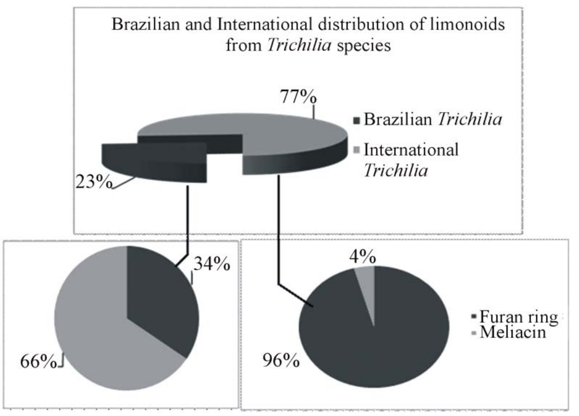


Figure 22. Brazilian and International distribution of limonoids from *T.* species.

Acknowledgements

The authors are thankful to FAPERJ, Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (N˚ do Processo E-26/111.898/2012) for financial support.

REFERENCES

[1] L. R. Salles, "Evolução de Limonoides em Meliaceae e Estudo Fitoquímico de *Khaya senegalensis* (Meliaceae)," Thesis, Federal University of São Carlos, São Carlos, 1995.

[2] B. Banerji and S. K. Nigam, "Constituents of Meliaceae: A Review," *Fitoterapia*, Vol. 55, 1984, pp. 3-36.

[3] I. S. Mosqueta, "Morfologia e Desenvolvimento dos Frutos, Sementes e Plântulas de *Cabralea canjerana* Vell. Mart., *Guarea Kunthiana* A. Juss e *Trichilia catigua* A. Juss (Meliaceae-Melioideae)," Thesis, Paulista State University, Paulista, 1995.

[4] T. D. Penington, "Flora da Reserva Ducke, Amazonas, Brasil: Meliaceae," *Floresta Neotropical*, Vol. 28, 1981, pp. 1-470.

[5] A. P. Matos, "Busca de Compostos Inseticidas: Estudo de Espécies do Gênero *Trichilia* (Meliaceae)," Thesis, Federal University of São Carlos, São Carlos, 2006.

[6] M. T. Pupo, P. C. Vieira, J. B. Fernandes and M. F. G. F. Silva, "A Cycloartane Triterpenoid and ω-Phenyl Alkanoic and Alkenoic Acids from *Trichilia claussenii*," *Phytochemistry*, Vol. 42, No. 3, 1995, pp. 795-798. http://dx.doi.org/10.1016/0031-9422(95)00969-8

[7] M. T. Pupo, M. A. T. Adorno, P. C. Vieira, J. B. Fernandes, M. F. G. Silva and J. R. Pirani, "Terpenoids and Steroids from *Trichilia* Species," *Journal of The Brazilian Chemical Society*, Vol. 13, No. 3, 2002, pp. 382-388. http://dx.doi.org/10.1590/S0103-50532002000300014

[8] M. C. Ramírez, R. A. Toscano, J. Arnason, S. Omar, C. M. C. G. Rojas and R. Mata, "Structure, Conformation and Absolute Configuration of New Antifeedant Dolabellanes from *Trichilia trifolia*," *Tetrahedron*, Vol. 56, No. 29, 2000, pp. 5085-5091. http://dx.doi.org/10.1016/S0040-4020(00)00423-3

[9] P. C. Patricio and A. C. Cervi, "O gênero *Trichilia* (Meliaceae) no Estado do Paraná, Brasil," *Acta Biológica Paranaense*, Vol. 34, 2005, pp. 27-71.

[10] W. C. Rocha, "Busca de Substâncias Bioativas em Plantas Amazônicas: *Adiscanthus fusciflorus* (Rutaceae), *Trichilia pallida e T. rubra* (Meliaceae)," Thesis, Federal University of São Carlos, São Carlos, 2004.

[11] B. M. Komane, E. I. Olivier and A. M. Viljoen, "*Trichilia emetica* (Meliaceae)—A Review of Traditional Uses, Biological Activities and Phytochemistry," *Phytochemistry Letters*, Vol. 4, No. 1, 2011, pp. 1-9. http://dx.doi.org/10.1016/j.phytol.2010.11.002

[12] I. Kubo and J. A. Klocke, "An Insect Growth Inhibitor from *Trichilia roka* (Meliaceae)," *Experientia*, Vol. 38, No. 6, 1982, pp. 639-640. http://dx.doi.org/10.1007/BF01964065

[13] M. Nakatani, M. Okamoto, T. Iwashita, K. Mizukawa, H. Naoki and T. Hase, "Isolation and Structures of Three Seco-Limonoids, Insect Antifeedants from *Trichilia roka* (Meliaceae)," *Heterocycles*, Vol. 22, No. 10, 1984, pp. 2335-2340. http://dx.doi.org/10.3987/R-1984-10-2335

[14] M. Nakatani and K. Nakanishi, "Structures of Antifeedant Limonoids Trichilins F and G, from *Trichilia roka*," *Heterocycles*, Vol. 36, No. 4, 1993, pp. 725-731. http://dx.doi.org/10.3987/COM-92-6194

[15] S. D. Jolad, J. J. Hoffmann, K. H. Schram, J. R. Cole, M.

S. Tempesta and R. B. Bates, "Constituents of the Cytotoxic Limonoids: Hispidins A, B and C," *Journal Organic Chemistry*, Vol. 46, No. 3, 1981, pp. 641-644. http://dx.doi.org/10.1021/jo00316a035

[16] W. Tang, H. Hioki, K. Harada, M. Kubo and Y. Fukuyama, "Antioxidant Phenylpropanoid-Substituted Picatechins from *Trichilia catigua*," *Journal of Natural Products*, Vol. 70, No. 12, 2007, pp. 2010-2013. http://dx.doi.org/10.1021/np0703895

[17] M. G. Pizzolatti, A. F. Venson, A. Smania Jr., E. F. Samania and R. Braz-Filho, "Two Epimeric Flavalignans from *Trichilia catigua* (Meliaceae) with Antimicrobial Activity," *Zeitschrift für Naturforschung*, Vol. 57, No. 5-6, 2002, pp. 483-488.

[18] U. S. Cunha, J. D. Vendramim, W. C. Rocha and P. C. Vieira, "Bioatividade de Moléculas Isoladas de *Trichilia pallida* Swatz (Meliaceae) Sobre *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae)," *Neotropical Entomology*, Vol. 37, No. 6, 2008, pp. 709-715. http://dx.doi.org/10.1590/S1519-566X2008000600013

[19] I. M. S. Eldeen, F. R. V. Heerden and J. V. Staden, "Biological Activities of Cycloart-23-ene-3,25-Diol Isolated from the Leaves of *Trichilia dregeana*," *South African Journal of Botany*, Vol. 73, No. 3, 2007, pp. 366-371. http://dx.doi.org/10.1016/j.sajb.2007.02.192

[20] M. S. Simmonds, P. C. Stevenson, E. A. Porter and N. C. Veich, "Insect Antifeedant Activity of Three New Tetranortriterpenoids from *Trichilia pallid*," *Journal of Natural Products*, Vol. 64, No. 8, 2001, pp. 1117-1120. http://dx.doi.org/10.1021/np010197o

[21] Y. S. Xie, M. B. Isman, P. Gunning, S. Mackinnon, J. T. Arnason, D. R. Taylor, P. Sanchez, C. Hasbun and G. H. N. Towers, "Biological Activity of Extracts of *trichilia* Species and the Limonoid Hirtin against *lepidopteran larvae*," *Biochemistry Systematic and Ecology*, Vol. 22, No. 2, 1994, pp. 129-136. http://dx.doi.org/10.1016/0305-1978(94)90003-5

[22] D. A. H. Taylor, Z. Lidert and M. Thirugnanam, "Insect Antifeedant Activity of Four Prieurianin-Type Limonoids," *Journal of Chemistry Ecology*, Vol. 48, No. 5, 1985, pp. 843-845.

[23] L. L. Musza, L. M. Killar, P. Speight, S. Mcelhiney, C. J. Barrow, A. M. Gillum and R. Cooper, "Potent New Cell Adhesion Inhibitory Compounds from the Root of *Trichilia rubra*," *Tetrahedron*, Vol. 50, No. 39, 1994, pp. 11369-11378. http://dx.doi.org/10.1016/S0040-4020(01)89279-6

[24] D. A. Wheeler, M. B. Isman, P. E. Sanchez-Vindas and J. T. Arnason, "Screening of Costa Rican *Trichilia* Species for Biological Activity against the Larvae of *Spodoptera litura* (Lepidotera: Noctuidade)," *Biochemistry Systematic and Ecology*, Vol. 29, No. 4, 2001, pp. 347-358. http://dx.doi.org/10.1016/S0305-1978(00)00070-3

[25] E. R. Figueiredo, "Estudo Fitoquímico de *Trichilia casarettii* e *Trichilia silvatica*," Thesis, State University of North Fluminense, Campos dos Goytacazes, 2010.

[26] A. P. Matos, L. Nebo, P. C. Vieira, J. B. Fernandes and M. F. G. F. Silva, "Constituintes Químicos e Atividade Inseticida dos Extratos de Frutos de *Trichilia elegans e T. catigua* (Meliaceae)," *Química Nova*, Vol. 32, No. 6, 2009, pp. 1553-1556. http://dx.doi.org/10.1590/S0100-40422009000600037

[27] R. Kumar, G. Verma, O. Prakash and A. K. Pant, "Head Space GC/MS Analysis of Volatile Constituents of *Trichilia connaroides* Wight and Arn. Extracts and Their *in Vitro* Anti-Plasmodium Activity against *Plasmodium falciparum* Isolates," *Research Journal of Phytochemistry*, Vol. 5, No. 1, 2011, pp. 41-47. http://dx.doi.org/10.3923/rjphyto.2011.41.47

[28] M. P. Germano, V. D. Angelo, R. Sanodo, S. Catania, R. Alma, R. De Pasquale and G. Bisigmano, "Hepatoprotective and Antibacterial Effects Extracts from *Trichilia emetica* Vahl. (Meliaceae)," *Journal of Ethnopharmacology*, Vol. 96, No. 1-2, 2005, pp. 227-232. http://dx.doi.org/10.1016/j.jep.2004.09.011

[29] F. Benencia, C. Courréges and F. C. Coulombié, "Anti-Inflammatory Activities of *Trichilia glabra* Aqueous Leaf Extract," *Journal of Ethopharmacology*, Vol. 71, No. 1-2, 2000, pp. 293-300. http://dx.doi.org/10.1016/S0378-8741(00)00192-6

[30] E. H. Sosa, Y. M. Castejón, A. B. Duharte, D. Portuondo, V. Tamayo, H. J. M. Quevero and C. E. M. Manrique, "Leukocyte-Stimulating Effect and Phytochemistry Screening of *Trichilia hirta* Extracts," *Journal of Medicinal Food*, Vol. 14, No. 9, 2011, pp. 1057-1059. http://dx.doi.org/10.1089/jmf.2010.0166

[31] D. G. Agripino, M. E. L. Lima, M. R. Silva, C. I. Meda, V. S. Bolzani, I. Cordeiro, M. C. M. Young and P. R. H. Moreno, "Screening of Brazilian Plants for Antimicrobial and DNA-Damaging Activities. I. Atlantic Rain Forest—Ecological Station Juréia-Itatins," São Paulo, *Biota Neotropica*, Vol. 4, No. 2, 2004, pp. 1-15.

[32] V. F. Rodrigues, H. M. Carmo, R. R. Oliveira, R. Braz-Filho, L. Mathias and I. J. C. Vieira, "Isolation of Terpenoids from *Trichilia quadrijuga* (Meliaceae) by Droplet Counter-Current Chromatography," *Chromatographia*, Vol. 70, No. 7-8, 2009, pp. 1191-1195. http://dx.doi.org/10.1365/s10337-009-1293-7

[33] A. R. P. Ambrozin, "Estudo Fitoquímico de Plantas das famílias Rutaceae e Meliaceae Visando o Isolamento de Substâncias Protótipos Para o Desenvolvimento de Novos Fármacos Antichagásicos e Antileishmanioses," Thesis, Federal University of São Carlos, São Carlos, 2004.

[34] B. Rodriguez, C. Caballero, F. Ortego and P. Castañera, "A New Tetranortriterpenoid from *Trichilia havanensis*," *Journal of Natural Products*, Vol. 66, No. 3, 2003, pp. 452-454. http://dx.doi.org/10.1021/np0204646

[35] J. B. Lagos, "Estudo Comparativo da Composição Química das Folhas e Cascas da *Trichilia catigua* A. Juss., Meliaceae," Thesis, Federal University of Paraná, Curitiba, 2006.

[36] A. C. Tissot, S. L. Oliveira, J. E. L. Duque, M. A. N. Silva, G. Frensh, E. V. Costa, B. H. L. N. S. Maia and F. A. Marques, "Avaliação do Efeito de Repelência do Óleo Essencial das Folhas de *Trichilia pallida* Swartz (Meliaceae) Frente a Mosquitos *Aedes aegypti*," 34*th Annual Convention of Brazilian Society of Chemistry*, Florianópolis City, Santa Catarina State, 23-26 May 2011, CD

Data.

[37] W. S. Garcez, F. R. Garcez, L. Ramos, M. J. Camargo and G. A. Damasceno Jr., "Sesquiterpenes from *Trichilia catigua*," *Fitoterapia*, Vol. 68, No. 1, 1997, pp. 87-88.

[38] M. P. Lima, L. A. M. Magalhães, M. O. M. Marques and R. Facanali, "Análise dos Óleos Essenciais de *Trichilia cipo* (A. Juss.) C.DC. (Meliaceae) ocorrente na Reserva Ducke-AM," 34*th Annual Convention of Brazilian Society of Chemistry*, Florianópolis City, Santa Catarina State, 23-26 May 2011, CD Data.

[39] M. T. Pupo, "Constituintes Químicos de *Trichilia claussenii* (Meliaceae)," Thesis, Federal University of São Carlos, São Carlos, 1997.

[40] M. Doe, T. Shibue, H. Haraguchi and Y. Morimoto, "Structures, Biological Activities, and Total Syntheses of 13-Hydroxy- and 13-Acetoxy-14-Nordehydrocacalohastine, Novel Modified Furanoeremophilane-Type Sesquiterpenes from *Trichilia cuneata*," *Organic Letters*, Vol. 7, No. 9, 2005, pp. 1765-1768. http://dx.doi.org/10.1021/ol050346k

[41] T. Maminata, Z. Lin, C. Ming, C. E. Olsen, O. Nacoulma, P. I. Guissou, Q. J. Quedrago, R. T. Guigemde and S. C. Brogger, "Cytotoxic Kurubasch Aldehyde from *Trichilia emetic*," *Natural Product Research*, *Part A*: *Structure and Synthesis*, Vol. 21, No. 1, 2007, pp. 13-17. http://dx.doi.org/10.1080/14786410600921698

[42] I. J. C. Vieira, O. A. Azevedo, J. J. Souza, R. Braz-Filho, M. S. Gonçalves and M. F. Araújo, "Hirtinone, a Novel Cycloartane-Type Triterpene and Other Compounds from *Trichilia hirta* L. (Meliaceae)," *Molecules*, Vol. 18, No. 3, 2013, pp. 2589-2597. http://dx.doi.org/10.3390/molecules18032589

[43] V. F. Rodrigues, "Estudo Fitoquímico da Espécie *Trichilia quadrijuga* (Meliaceae) e Seu Potencial Antimicrobiano," Thesis, State University of North Fluminense, Campos dos Goytacazes, 2009.

[44] P. R. Souza, V. F. Paula, S. J.Correia and J. C. Nascimento, "Terpenos das Folhas de *Trichilia silvatica* (Meliaceae)," 32*nd Annual Convention of Brazilian Society of Chemistry*, Fortaleza City, Ceará State, 30 May-2 June 2009, CD Data.

[45] A. J. Aladesanmi and S. A. Odediran, "Antimicrobial Activity of *Trichilia heudelotti* Leaves," *Fitoterapia*, Vol. 71, No. 2, 2000, pp. 179-182. http://dx.doi.org/10.1016/S0367-326X(99)00143-4

[46] A. Inada, M. Konishi, H. Murata and T. Nakanishi, "Structure of a New Limonoid and a New Triterpenoid Derivative from Pericarps of *Trichilia connaroides*," *Journal of Natural Products*, Vol. 57, No. 10, 1994, pp. 1446-1449.

[47] D. A. G. Cortez, J. B. Fernandes, P. C. Vieira, M. F. G. F. Silva, A. G. Ferreira, Q. B. Cass and J. R. Pirani, "Meliacin Butenoides from *Trichilia estipulate*," *Phytochemistry*, Vol. 49, 1998, pp. 2493-2496.

[48] D. A. G. Cortez, P. C. Vieira, J. B. Fernandes, M. F. G. F. Silva and A. G. Ferreira, "Limonoids from *Trichilia hirta*," *Phytochemistry*, Vol. 31, No. 2, 1992, pp. 625-628.

[49] S. D. Jolad, J. J. Hoffmann, K. H. Schram, J. R. Cole, M. S. Tempesta and R. B. Bates, "Constituents of *Trichilia hispida* (Meliaceae). Hispidols A and B, Two New Tirucallane Triterpenoids," *Journal of Organic Chemistry*, Vol. 46, No. 20, 1981, pp. 4085-4088.

[50] S. D. Jolad, J. J. Hoffmann, J. R. Cole, M. S. Tempesta and R. B. Bates, "Constituents *Trichilia hispida* (Meliaceae). 2. A, New Triterpenoid, Hispidone and Bourjotinolone A," *Journal of Organic Chemistry*, Vol. 45, No. 15, 1980, pp. 3132-3135.

[51] W. S. Terra, "Constituintes Quimicos de *Trichilia lepidota* (Meliaceae) e Avaliação Biológica Frente a Micro0 rganismos e Linhagens de Células Cancerígenas," Thesis, State University of North Fluminense, Campos dos Goytacazes, 2012.

[52] T. A. Olugbade, "Tetracyclic Triterpenoids from *Trichilia prieuriana* Leaves," *Phytochemistry*, Vol. 30, No. 2, 1991, pp. 698-700.

[53] T. A. Olugbade and S. A. Adesanya, "Prieurianoside, a Protolimonoid Glucoside from the Leaves of *Trichilia prieuriana*," *Phytochemistry*, Vol. 54, No. 8, 1999, pp. 867-870.

[54] W. W. Harding, S. Krief, M. T. Martin, P. Grellier, J. Kasenene and T. Sévenet, "Cycloartanes, Protolimonoids, a Pregnane and New Ergostane from *Trichilia reticulate*," *Natural Product Letters*, Vol. 15, No. 4, 2004, pp. 253-260.

[55] W. F. Tinto, P. K. Jagessar, P. Jetwaru, W. F. Reynolds and S. Mclean, "Constituents of *Trichilia schomburgkii*," *Journal of Natural Products*, Vol. 54, No. 4, 1991, pp. 972-977.

[56] F. R. Garcez, W. S. Garcez, E. D. Rodrigues, V. L. Pott and N. F. Roque, "Seco-Protolimonoids from *Trichilia elegans ssp. elegans*," *Phytochemistry*, Vol. 42, No. 5, 1996, pp. 1399-1403.

[57] A. A. L. Guanatilaka, V. S. Bolzani, E. Dagne, G. A. Hofmann, R. K. Johnson, F. L. Mccabe, M. R. Mattern and D. G. I. Kingston, "Limonoids Showing Selective Toxicity to DNA Repair-Deficient Yeast and Other Constituents of *Trichilia emetic*," *Journal of Natural Products*, Vol. 61, 1998, pp. 179-184.

[58] S. M. Hantos, S. Tripathy, N. Alibhai and T. Durst, "Synthesis of Trichiliasterones A and B-16-Ketosteroids Isolated from *Trichilia hirta* and *Trichilia Americana*," *Canadian Journal of Chemistry*, Vol. 79, No. 11, 2001, pp. 1747-1753.

[59] M. T. Pupo, P. C. Vieira, J. B. Fernandes and M. F. G. F. Silva, "Androstane and Pregnane 2β, 19-Hemiketal Steroids from *Trichilia claussenii*," *Phytochemistry*, Vol. 45, No. 7, 1997, pp. 1495-1500.

[60] H. Lu, J. Li, X. Lu, Y. Chen and X. Chen, "Chemical Constituents of *Trichilia connaroides*," *Zhongchengyao*, Vol. 33, 2011, pp. 1194-1196.

[61] X. N. Wang, C. Q. Fan, S. Yin, L. S. Gan and J. M. Yue, "Structural Elucidation of Limonoids and Steroids from *Trichilia connaroides*," *Phytochemistry*, Vol. 69, No. 6, 2008, pp. 1319-1327.

[62] H. P. Zhang, S. H. Wu, Y. M. Shem, Y. B. Ma, D. G. Wu, S. H. Qi and X. D. Luo, "A Pentanortriterpenoid with a

Novel Carbon Skeleton and a New Pregnane from *Trichilia connaroides*," *Canadian Journal of Chemistry*, Vol. 81, No. 3, 2003, pp. 253-257.

[63] F. R. Garcez, "Limonóides e Protolimonóides de *Trichilia elegans* ssp. *elegans* A.juss. (Meliaceae)," Thesis, University of São Paulo, São Paulo, 1995.

[64] D. C. Chauret, T. Durst, J. T. Arnason, P. Sanches-Vindas, L. S. Roman, L. Poveda and P. A. Keifer, "Novel Steroids from *Trichilia hirta* as Identified by Nanoprobe INADEQUATE 2D-NMR Spectroscopy," *Tetrahedron Letters*, Vol. 37, No. 44, 1996, pp. 7875-7878.

[65] P. Ketwaru, J. Klass, W. F. Tinto, S. Mclean and W. F. Reynolds, "Pregnane Steroids from *Trichilia schomburgkii*," *Journal of Natural Products*, Vol. 56, No. 3, 1993, pp. 430-431.

[66] A. P. Matos, L. Nebo, P. C. Vieira, P. R. Souza, J. B. Fernandes, M. F. G. F. Silva and R. R. Rodrigues, "Atividade Biológica dos Extratos de Fungos e Sementes de *Trichilia* spp. Sobre *Spodoptera frugiperda:* Limonóides de *T. catigua*," 30*th Annual Convention of Brazilian Society of Chemistry*, Águas de Lindóia City, São Paulo State, 31 June-3 July 2007, CD Data.

[67] F. R. Garcez, W. S. Garcez, N. F. Roque, E. E. Castellano and J. Zukerman-Schpector, "7β-Oxygenated Limonoids from *Trichilia elegans ssp. elegans*," *Phytochemistry*, Vol. 55, No. 7, 2000, pp. 733-740.

[68] F. R. Garcez, W. S. Garcez, M. T. Tsutsumi and N. F. Roque, "Limonoids from *Trichilia elegans* ssp. *elegans*," *Phytochemistry*, Vol. 45, No. 1, 1997, pp. 141-148. http://dx.doi.org/10.1016/S0031-9422(96)00737-6

[69] C. Arenas and L. Rodrigues-Hahn, "Limonoids from *Trichilia havanensis*," *Phytochemistry*, Vol. 29, No. 9, 1990, pp. 2953-2956.

[70] S. Krief, M. A. Huffman, T. Sévenet, C. M. Hladik, P. Grellier, P. M. Loiseau and R. W. Wrangram, "Bioactive Properties Plants Species Ingested by Chimpanzees (*Pan troglodytes schweinfurthii*) in the Kibale National Park, Uganda," *American Journal of Primatology*, Vol. 68, No. 1, 2006, pp. 51-71.

[71] S. Krief, M. T. Martin, P. Grellier, J. Kasenene and T. Sévenet, "Novel Antimalarial Compounds Isolated in a Survey of Self-Medicative Behavior of Wild Chimpanzees in Uganda," *Antimicrobial Agents and Chemotherapy*, Vol. 48, No. 8, 2004, pp. 3196-3199.

[72] R. A. Hill and A. Sutherland, "Hot off the Press," *Natural Product Reports*, Vol. 29, 2009, pp. 725-728.

[73] Z. L. Geng, X. Fang, Y. T. Di, Q. Zhang, Y. Zeng, Y. M. Shen and X. J. Hao, "Trichilin B, a Novel Limonoid with Highly Rearranged Ring System from *Trichilia connaroides*," *Tetrahedron Letters*, Vol. 50, No. 18, 2009, pp. 2132-2134.

[74] X. Fang, Y. Di, Z. Geng, C. Tan, J. Guo, J. Ning and X. Hao, "Trichiliton A, a Novel Limonoid from *Trichilia connaroides*," *European Journal of Organic Chemistry*, Vol. 2010, No. 7, 2010, pp. 1381-1387.

[75] Q. Zhang, Y. Zhang, H. P. He, Y. T. Di and X. J. Hao, "Trichilone, a New C21 Steroid from *Trichilia connaroides*," *Natural Product Communications*, Vol. 7, No. 10, 2012, pp. 1267-1268.

[76] D. A. Mulholland and D. A. H. Taylor, "Limonoids from the Seed of the Natal Mahogany, *Trichilia dregeana*," *Phytochemistry*, Vol. 19, No. 11, 1980, pp. 2421-2425.

[77] J. D. Connolly, D. A. Okorie, L. D. De Wit and D. A. H. Taylor, "Structure of Dregeanin and Rohitukin, Limonoids from the Subfamily Melioideae of the family Meliaceae. An Unusual High Absorption Frequency for a Six-Membered Lactone Ring," *Journal of the Chemical Society*, *Chemical Communications*, No. 22, 1976, pp. 909-910.

[78] M. Nakatani, J. C. James and K. Nakanishi, "Isolation and Structures of Trichilins, Antifeedants against the Southern Army Worm," *Journal of the American Chemistry Society*, Vol. 103, No. 5, 1981, pp. 1228-1230.

[79] M. Nakatani, T. Iwashita, H. Naoki and T. Hase, "Structure of Limonoid Antifeedant from *Trichilia Roka*," *Phytochemistry*, Vol. 24, No. 1, 1985, pp. 195-196.

[80] M. Nakatani, T. Iwashita, K. Mizukawa and T. Hase, "Trichilin, a New Hexacyclic Limonoid from *Trichilia roka*," *Heterocycles*, Vol. 26, No. 1, 1987, pp. 43-46.

[81] D. A. G. Cortez, J. B. Fernandes, P. C. Vieira, M. F. G. F. Silva and A. G. Ferreira, "A Limonoid from *Trichilia estipulata*," *Phytochemistry*, Vol. 55, No. 7, 2000, pp. 711-713.

[82] W. R. Chan, J. A. Gibbs and D. R. Taylor, "The Limonoids of *Trichilia havanensis* jacq.: An Epoxide Rearrangement," *Chemical Communications*, No. 14, 1967, pp. 720-721.

[83] F. Ortego, J. Lópes-Olguin, M. Ruiz and P. Castarera, "Effects of Toxic and Deterrent Terpenoids on Digestive Protease and Detoxication Enzyme Activities of Colorado Potato Beetle Larvae," *Pesticide Biochemistry and Physiology*, Vol. 63, No. 2, 1999, pp. 76-84.

[84] L. Rodriguez-Harn, J. Cárdenas and C. Arenas, "Trichavensin, a Prieurianin Derivative from *Trichilia havanensis*," *Phytochemistry*, Vol. 43, No. 2, 1996, pp. 457-459.

[85] D. A. Okorie and D. A. H. Taylor, "Limonoids from *Trichilia heudellotti*, Parte II," *Journal of the Chemistry Society Perkin Transactions* I, No. 24, 1972, pp. 1488-1490.

[86] D. A. Okorie and D. A. H. Taylor, "Limonoids from the Timber of *Trichilia heudelottii*," *Journal of the Chemical* Society, Vol. 14, 1968, pp. 1828-1831.

[87] G. A. Adesina and D. A. Okorie, "Heudebolin, a New Limonoid from *Trichilia heudelottii*," *Phytochemistry*, Vol. 12, No. 12, 1973, pp. 3007-3008. http://dx.doi.org/10.1016/0031-9422(73)80532-1

[88] D. A. Okorie and D. A. H. Taylor, "The Structure of Heudelottin, an Extractive from *Trichilia heudelotti*," *Journal of the Chemical Society*, *Chemical Communications*, Vol. 2, 1967, pp. 83-87.

[89] W. R. Chan and D. R. Taylor, "Hirtin and Deacetylhirtin: New 'Limonoids' from *Trichilia hirta*," *Chemical Communications*, No. 7, 1966, pp. 206-207.

[90] R. T. Cardé and J. G. Millar, "Advances in Insect Chemical Ecology," Cambridge University Press, Cambridge, 2004. http://dx.doi.org/10.1017/CBO9780511542664

[91] L. K. Maclachlan and D. A. H. Taylor, "A Revision of the Structures of Three Limonoids," *Phytochemistry*, Vol. 21, No. 9, 1982, pp. 2426-2427.

[92] V. P. Gullo, I. Miura, K. Nakanishi, A. F. Cameron, J. D. Connolly, F. D. Duncanson, A. E. Harding, R. Mccrindle and D. A. H. Taylor, "Structure of Prieurianin, a Complex Tetranortriterpenoid; Nuclear Magnetic Resonance Analysis at no Ambient Temperatures and X-Ray Structure Determination," *Journal of the Chemical Society*, *Chemical Communications*, No. 9, 1975, pp. 345-346.

[93] L. L. Musza, L. M. Killar, P. Speight, C. J. Barrow, A. M. Gillum and R. Cooper, "Minor Limonoids from *Trichilia rubra*," *Phytochemistry*, Vol. 39, No. 3, 1995, pp. 621-624.

[94] D. R. Taylor, "New Limonoids from *Trichilia trifolia* (Meliaceae)," *Revista Latino America na de Química*, Vol. 2, 1971, pp. 87-92.

[95] F. L. Beltrame, E. D. Rodrigues, F. A. P. Barros, D. A. G. Cortez and Q. B. Cass, "A Validated Higher-Performance Liquid Chromatography Method for Quantification of Cinchonain Ib in Bark and Phytopharmaceuticals of *Trichilia catigua* Used as Catuaba," *Journal of Chromatography* A., Vol. 1119, No. 1-2, 2006, pp. 257-263.

[96] M. Dudecula, V. Somasekhar, A. Purnima and S. Patil, "Isolation, Characterization and Pharmacological Studies of a Flavonol Glucoside from *Trichilia connaroides* (W & A) Bentilizen," *International Journal of Research in Science*, Vol. 1, No. 2, 2011, pp. 91-101.

[97] D. A. G. Cortez, P. C. Vieira, E. Ranieri, L. Cortez, J. B. Fernandes, J. R. Pirani, A. G. Ferreira, M. F. G. Silva and Q. B. Cass, "Lignan Glucosides from *Trichilia estipulata* Bark," *Natural Product Letters*, Vol. 11, No. 4, 1998, pp. 255-262.

[98] M. T. Pupo, P. C. Vieira, J. B. Fernandes and M. F. G. F. Silva, "γ-Lactones from *Trichilia claussenii*," *Phytochemistry*, Vol. 48, No. 2, 1997, pp. 307-310.

[99] C. M. Cazal, A. R. Alves, A. P. Matos, J. B. Fernandes, F. G. F. Silva and P. C. Vieira, "Constituintes Químicos de *Trichilia sp* (Meliaceae) e Atividade Biológica de Seus Extratos Orgânicos Sobre *Spodoptera frugiperda*," 31*st Annual Convention of Brazilian Society of Chemistry*, Águas de Lindóia City, São Paulo State, 26-29 May 2008, CD Data.