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椿亚科和麻棟亚科植物化学成分和生物活性的研究进展

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摘要:本文简要综述了棟科椿亚科香椿属(*Toona*)和洋椿属(*Cedrela*)以及麻棟亚科麻棟属(*Chukrasia*)、桃花心木属(*Swietenia*)和非洲棟属(*Khaya*)植物的化学成分和生物活性的研究情况。

关键词:棟科; 四降三萜; 抗病毒; 抗疟; 免疫调节

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The Chemical Constituents and Bioactivities of Cedreloideae and Swietenioidea

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Abstract: The chemical constituents and bioactivities of the genus *Toona* and *Cedrela* of the sub-family Cedreloideae, and the genus *Chukrasia*, *Swietenia* and *Khaya* of the sub-family Swietenioidea were summarized.

Key words: Meliaceae; tetraneortriterpenoid; antivirus; antimalaria; immunomodulation

棟科全世界约有 50 属 1400 种, 广布于全热带, 少数分布于亚热带, 极少分布于温带。我国有 15 属约 60 种, 其中药用植物 10 属 19 种, 大部分分布在华南和西南, 极少数属分布至长江以北, 秦岭以北只有香椿 1 种。棟科下分 3 个亚科^[1]: 1. 椿亚科 *Cedreloideae*, 3 族 4 属, 我国产 1 族 1 属(香椿属 *Toona*), 引入栽培 1 属(洋椿属 *Cedrela*)。2. 麻棟亚科 *Swietenioidea*, 全世界产 8 属, 我国产 1 属(麻棟属 *Chukrasia*), 引入栽培 2 属(桃花心木属 *Swietenia* 和非洲棟属 *Khaya*)。3. 棟亚科 *Melioidae*, 全世界产 5 族, 38 属, 我国产 4 族 13 属。本科药用植物的化学成分还研究得不多。下面就《中国植物志》中介绍的椿亚科和麻棟亚科五属植物的化学成分和生物活性的研究情况做简要概括。

1 香椿属 (*Toona Roem.*)

该属约 15 种, 分布于印度、马来半岛地区一带, 我国有 3 种。香椿(*T. sinensis*)的根皮有开窍、止痢

去湿的功能。用于痢疾、肠炎、尿道感染、便血、血、白带、风湿腰腿痛。果有收敛止血、去湿止痛的功能。用于肠炎、痢疾、胃炎、胃溃疡、十二指肠溃疡。嫩枝幼叶可治疮、痢疾, 也可供蔬食。树皮含川楝素、洋椿苦素(cedrelone)、甾体、鞣质。*T. ciliata* 的茎皮提取物和其中的一个香豆素 siderin 具有显著的抗菌活性, 同时也具有中等抗真菌活性^[2]。从 *T. ciliata* 中分离到的四降三萜(如 cedrelone)对 *Puccinia arachidis* 病原体显示一定的抗真菌活性, 其中 cedrelone 能最有效地减少锈孢子的出现^[3]。从该属植物 *T. ciliata* 和 *T. sureni* 中主要分离得到四降三萜类化合物(1~10)(表 1)^[4-6]。

2 洋椿属 (*Cedrela P. Br.*)

该属约有 7~8 种, 分布于美洲和大、小安的列斯群岛, 我国广东栽培 1 种。将 *C. tubiflora* 叶的水溶性多糖提取物分成中性和酸性两部分, 其中中性部分显示很好的抗补体活性^[7]; 酸性部分对囊泡口炎病毒(VSV)和疱疹病毒(HSV-2)分别显示 IC₅₀ 为 0.13、0.17 mg/mL 的抗病毒活性^[8]。*C. lilloi* 叶的水

提取物对老鼠免疫系统显示强抗补体活性，并抑制被调理的绵羊红斑的吞噬作用，是显著的免疫调节剂^[9]。*C. tubiflora* 叶的水提取物能减小人体末梢的血单核和同质多核白细胞的吞噬和呼吸裂解活性；此外，也能抑制刀豆球蛋白 A 激活的淋巴细胞的增殖，降低人体中补体的溶血能力^[10]。已从该属植物 *C. odorata*、*C. angustifolia*、*C. toona*、*C. glaziovii*、*C. salvadorensis*、*C. mexicana*、*C. fissilis* 中主要分离得到四降三萜类化合物(12~20)(表 2)^[11-15]。

3 麻棟屬 (*Chukrasia* A. Juss.)

该属约 1~2 种，广布于亚洲各热带地区。我国 1 种产广东、广西和云南。麻棟 (*C. tabularis*) 的树皮主治感冒发热。*C. tabularis* 的叶的甲醇、乙酸乙酯、石油醚的提取物对 10 种微生物的生长分别有不同程度的抑制作用，且从中检测到生物碱、香豆素、黄酮、甾体、单宁、皂甙、蛋白质、糖等化学成分的存在^[16]。从该植物中主要分离到四降三萜和黄酮类化合物(21~26)(表 3)^[17,18]。

4 桃花心木屬 (*Swietenia* Jacq.)

该属约 7~8 种，均产亚热带和热带美洲、安的

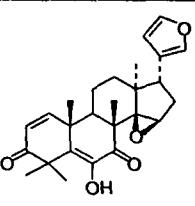
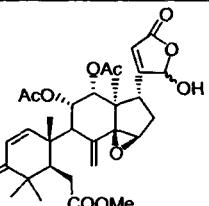
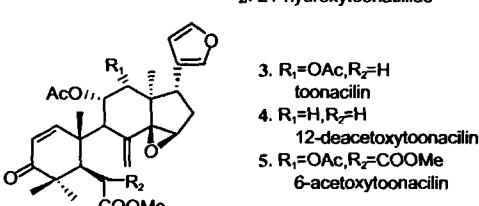
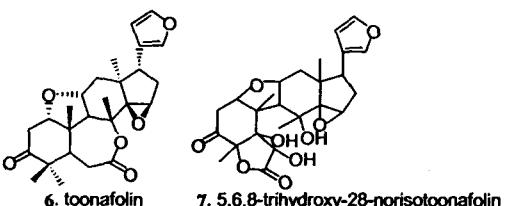
列斯群岛和西非等地。我国广东和云南栽培 1 种。从该属植物 *S. mahagoni*、*S. humilis*、*S. macrophylla* 中主要分离到四降三萜类化合物(27~34)(表 4)^[19-22]。

5 非洲棟屬 (*Khaya* A. Juss.)

该属约有 8 种，分布于非洲热带地区和马达加斯加。我国广东引种栽培 1 种。*K. grandifoliola* 的树皮和种子的提取物对恶性疟原虫显示 IC_{50} 为 $13.23 \mu\text{g}/\text{mL}$ 的抗疟活性；从该提取物中分离得到七个柠檬苦素类化合物：methylangolensate (I)、6-methylhydroxyangolensate (II)、gedunin (III)、7-deacetylkhivorin (IV)、1-deacetylkhivorin (V)、swietenolide (VI)、6-acetylswietenolide (VII)，和一个黄酮 catechin，I、III、V、VI、VII 都显示活性 IC_{50} 在 $1.25 \sim 9.63 \mu\text{g}/\text{mL}$ 之间，而后 catechin 缺乏活性，活性最好的 gedunin 和氯喹(抗疟药)联合服用时能增加抗疟效果^[23]。*K. senegalensis* 对恶性疟原虫氯喹敏感菌株 3D7 和氯喹耐药菌株 Dd2 显示 IC_{50} 小于 $5 \mu\text{g}/\text{mL}$ ^[24]。从该属植物 *K. senegalensis*、*K. grandifoliola*、*K. anthotheca*、*K. ivorensis* 中主要分离到四降三萜类化合物(35~43)(表 5)^[23,25-27]。

表 1 香椿屬植物中分离到的化合物

Table 1 Compounds isolated from the genus *Toona* Roem.

| 化合物 Compounds | 植物来源 Source | 文献 Reference |
|--|-------------------------------------|--------------|
|  1. cedrelone | <i>Toona ciliata</i> | 3 |
|  2. 21-hydroxytoonacilide | <i>Toona ciliata</i> | 4 |
|  3. $R_1=OAc, R_2=H$ toonacillin 4. $R_1=H, R_2=H$ 12-deacetoxytoonacilin 5. $R_1=OAc, R_2=COOMe$ 6-acetoxytoonacilin | <i>Toona ciliata</i> | 4 |
|  6. toonafolin 7. 5,6,8-trihydroxy-28-norisotoonafolin | <i>Toona ciliata var. australis</i> | 5 |

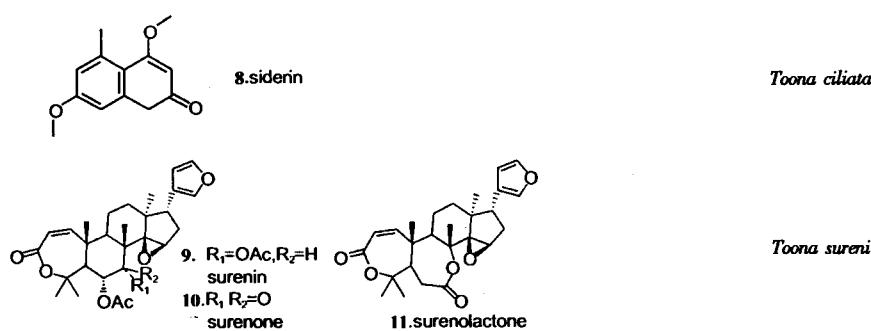


表 2 洋椿属植物中分离到的化合物

Table 2 Compounds isolated from the genus *Cedrela* P. Br.

| 化合物 Compounds | 植物来源 Source | 文献 Reference |
|--|--|--------------|
| 12. R ₁ =COOH, R ₂ =H angolensic acid 13. R ₁ =COOH, R ₂ =OH 6-hydroxy angolensic acid 14. R ₁ =R ₂ =COOMe, R ₃ =OH 6-hydroxy,Methyl angolensate | 15. odoratin <i>Cedrela odorata</i> | 11 |
| 16. 8,12-epoxy-4-cadinone <i>Cedrela odorata</i> | | 12 |
| 17. angustidienolide <i>Cedrela angustifolia</i> | | 13 |
| 18. cedrelone 19. calamenen <i>Cedrela toona</i> | | 14 |
| 20. cedrelanolide I <i>Cedrela salvadorensis</i> | | 15 |

表 3 麻棟植物中分离到的化合物

Table 3 Compounds isolated from *Chukrasia tabularis*.

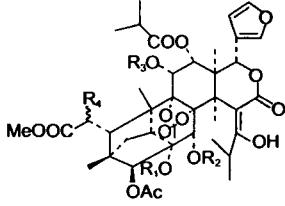
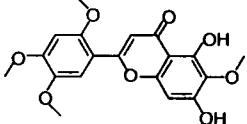
| 化合物 Compounds | 植物来源 Source | 文献 Reference |
|--|----------------------------|-----------------|
|  <p>21. R₁=H, R₂, R₃=Ac, (CH₃)₂CHCO, R₄=OH chukrasin A 22. R₁=R₄=H, R₂=R₃=(CH₃)₂CHCO chukrasin B; 23. R₁=R₄=H, R₂, R₃=Ac, (CH₃)₂CHCO chukrasin C; 24. R₁=Ac, R₂, R₃=Ac, (CH₃)₂CHCO, R₄=H chukrasin D; 25. R₁=Ac, R₂=R₃=(CH₃)₂CHCO, R₄=H; chukrasin E;</p> | <i>Chukrasia tabularis</i> | 17 |
|  <p>26. tabularin</p> | <i>Chukrasia tabularis</i> | 18 |

表 4 桃花心木属植物中分离到的化合物

Table 4 Compounds isolated from the genus *Swietenia* Jacq.

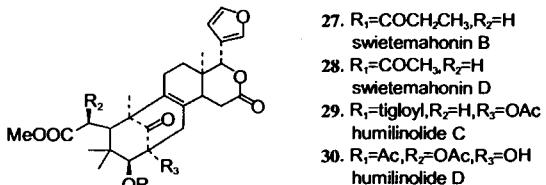
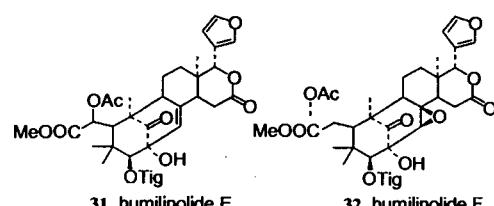
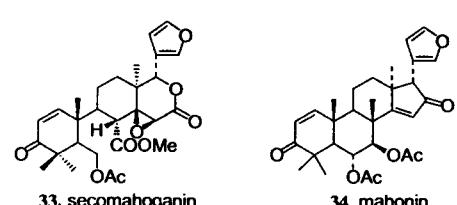
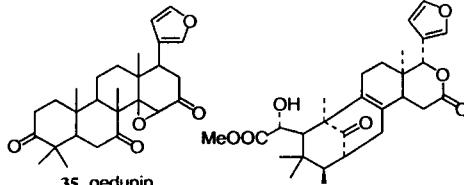
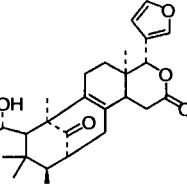
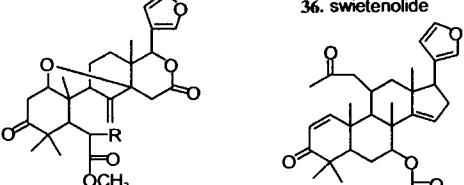
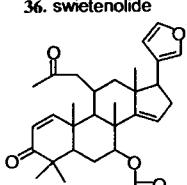
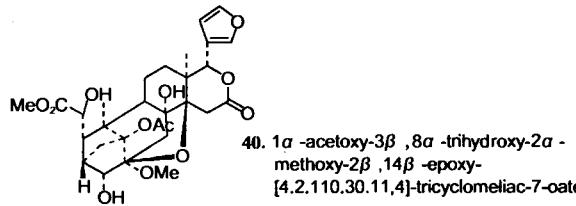
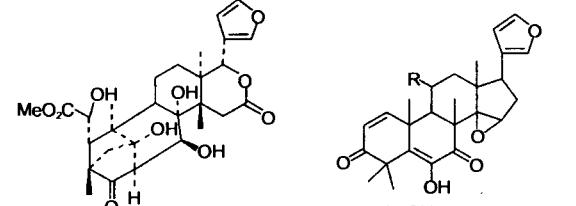
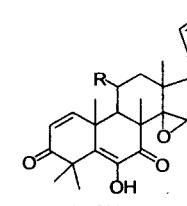
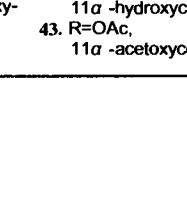
| 化合物 Compounds | 植物来源 Source | 文献 Reference |
|--|---|-----------------|
|  <p>27. R₁=COCH₂CH₃, R₂=H swietemahonin B 28. R₁=COCH₃, R₂=H swietemahonin D 29. R₁=tigloyl, R₂=H, R₃=OAc humilinolide C 30. R₁=Ac, R₂=OAc, R₃=OH humilinolide D</p> | <i>Swietenia mahagoni</i> <i>Swietenia humilis</i> | 19, 21 |
|  <p>31. humilinolide E 32. humilinolide F</p> | <i>Swietenia humilis</i> | 22 |
|  <p>33. secocomahoganin 34. mahonin</p> | <i>Swietenia mahagoni</i> | 20 |

表 5 非洲棟屬植物中分离到的化合物

Table 5 Compounds isolated from the genus *Khaya* A.Juss.

| 化合物 Compounds | 植物来源 Source | 文献 Reference |
|--|----------------------------------|--------------|
|  35. gedunin | 35 ~ 38 <i>Khaya grandifolia</i> | 23 |
|  36. swietenolide | 39 <i>Khaya senegalensis</i> | 25 |
|  38. R=OH 6-hydroxy-Methyl angolensate | 35 ~ 38 <i>Khaya grandifolia</i> | 23 |
|  39. R=OAc 6-acetoxy-Methyl angolensate | 39 <i>Khaya senegalensis</i> | 25 |
|  37. 11α-acetoxyazadirone | | |
|  40. 1α-acetoxy-3β,8α-trihydroxy-2α-methoxy-2β,14β-epoxy-[4.2.11.0.30.11.4]-tricyclomeliac-7-oate | <i>Khaya senegalensis</i> | 26 |
|  41. 1α,6,8α,14β,30β-pentahydroxy-3-oxo-[3.3.11.0.2.11.4]-tricyclomeliac-7-oate | <i>Khaya anthotheca</i> | 27 |
|  42. R=OH, 11α-hydroxycedrelone | | |
|  43. R=OAc, 11α-acetoxycedrelone | | |

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