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**Review Article**

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# Chemistry and pharmacology of *Salvia plebeia* R. Brown (Lamiaceae)

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**ABSTRACT**

*Salvia plebeia is a biannual grass, distributed widely in many countries. The whole plant has been used in fork medicine as hemogenetic, hemostatic, anti-oncotic and anti-inflammatory. The aim of the present review is to summarize the research related to the chemistry and pharmacology of this plant.*

**Key words:** *Salvia plebeia*; Lamiaceae; Biological activities; Chemical constituents

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## INTRODUCTION

*Salvia plebeia* R. Brown (Lamiaceae) is well-known as a common sage herb, which has been widely distributed in many countries. In the folk, it has been used a medicine for the treatment many diseases including hepatitis, cough, diarrhea, gonorrhea, menorrhagia, tumors, and hemorrhoids [1].

With the development of herbal medicines, the intensive research about *S. plebeia* is now being pursued all over the world. Hard efforts are being made by the phytochemists and botanists in exploring the plant in the world to discover more new drugs. In this work, a comprehensive review on chemistry and pharmacology has been made of this plant. Moreover, an intense search of the references has been revealed that the stems, leaves, roots and seeds are potential sources of chemical constituents [2].

## CHEMISTRY

### 1. Flavonoid type

1.1. *S. plebeia* contains several flavonoids possessing the flavone moiety (Figure 1). Their structures have been seen in Table 1.

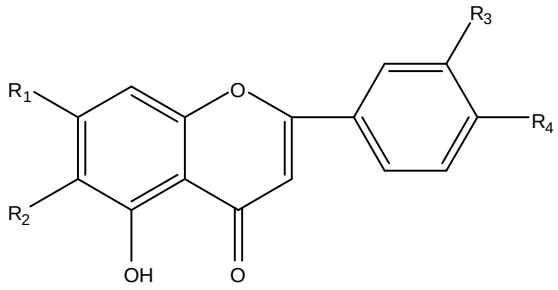


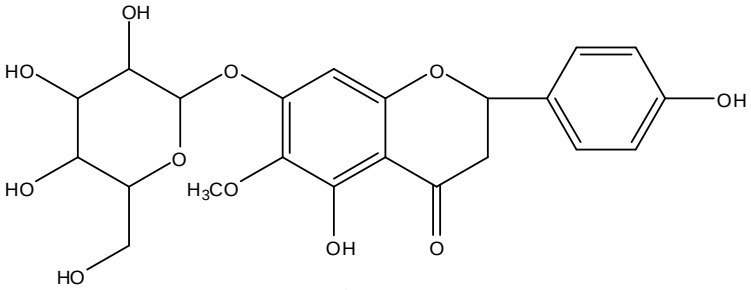

**Figure 1**

**Table 1: The flavonoids (Figure 1) obtained from the *S. plebeian***

| No. | Compound | Formula | Substituents | | | | Ref. |
|---|---|---|---|---|---|---|---|
| | | | $R_1$ | $R_2$ | $R_3$ | $R_4$ | |
| 1 | Hispidulin | $C_{16}H_{12}O_6$ | OH | $OCH_3$ | H | OH | [3, 4] |
| 2 | Homoplantaginin | $C_{22}H_{22}O_{11}$ | O-glucoside | $OCH_3$ | H | OH | [3, 4] |
| 3 | Nepetin | $C_{16}H_{12}O_7$ | OH | $OCH_3$ | OH | OH | [3, 4] |
| 4 | Nepetin-7-glucoside | $C_{22}H_{22}O_{12}$ | O-glucoside | $OCH_3$ | OH | OH | [3] |
| 5 | Luteolin | $C_{15}H_{10}O_6$ | OH | H | OH | OH | [3] |
| 6 | Luteolin-7- glucoside | $C_{21}H_{20}O_{11}$ | O-glucoside | H | OH | OH | [3] |
| 7 | Nepitrin | $C_{22}H_{22}O_{12}$ | O-glucoside | $OCH_3$ | OH | OH | [4] |
| 8 | Eupatorin | $C_{18}H_{16}O_7$ | $OCH_3$ | $OCH_3$ | OH | $OCH_3$ | [5] |
| 9 | Cynaroside | $C_{21}H_{20}O_{11}$ | O-glucoside | H | OH | OH | [6] |
| 10 | Quercetin | $C_{15}H_{10}O_7$ | OH | H | OH | OH | [6] |
| 11 | Eupatilin | $C_{18}H_{16}O_7$ | OH | $OCH_3$ | $OCH_3$ | $OCH_3$ | [6] |
| 12 | Pectolinarigenin | $C_{17}H_{14}O_6$ | OH | $OCH_3$ | H | $OCH_3$ | [7] |
| 13 | Apigenin | $C_{15}H_{10}O_5$ | OH | H | H | OH | [8] |

1.2. Flavanone

A flavanone (Figure 2) was isolated and identified from *S. plebeia*.



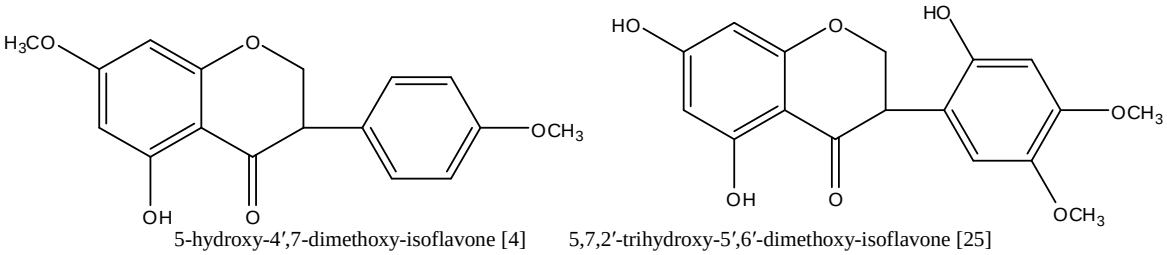
5,7,4′ -trihydroxy-6-methoxy-flavanone-7-O-D-glucopyranoside [4]

$C_{22}H_{24}O_{11}$

**Figure 2**

1.3. Isoflavone

Two isoflavones (Figure 3) were obtained from the different parts of *S. plebeia*.



5-hydroxy-4′,7-dimethoxy-isoflavone [4] $C_{17}H_{16}O_5$

5,7,2′-trihydroxy-5′,6′-dimethoxy-isoflavone [25] $C_{17}H_{16}O_7$

**Figure 3**

**2. Sesquiterpene**

2.1. Eudesmanolide type

*S. plebeia* contains several sesquiterpene possessing the eudesmanolide moiety (Figure 4). The compounds isolated have been given in Table 2.

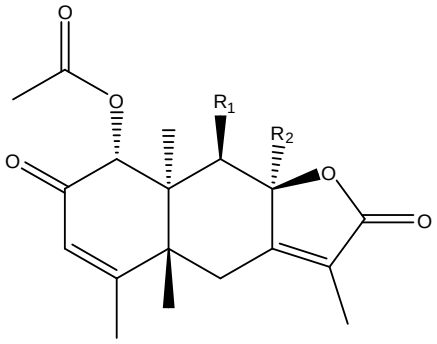


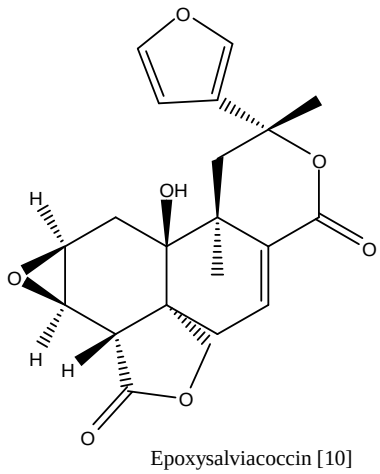
**Figure 4**

**Table 2: The eudesmanolide type sesquiterpene (Figure 4) isolated from the *S. plebeian***

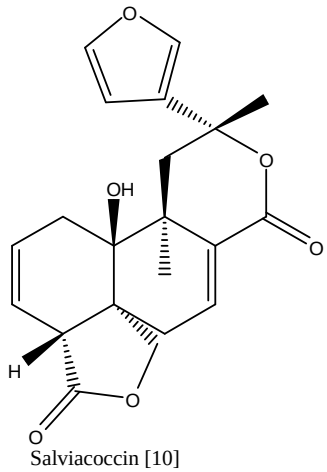
| No. | Compound | Formula | Substituents | | Ref. |
|---|---|---|---|---|---|
| | | | $R_1$ | $R_2$ | |
| 1 | 1a-acetoxy-8a-hydroxy-2-oxoeudesman-3,7(11)-dien-8,12-olide | $C_{18}H_{22}O_6$ | H | OH | [9] |
| 2 | 1a-acetoxy-8a,9b-dihydroxy-2-oxo-eudesman-3,7(11)-dien-8,12-olide | $C_{17}H_{20}O_7$ | OH | OH | [9] |
| 3 | 1a,8a-diacetoxy-2-oxo-eudesman-3,7(11)-dien-8,12-olide | $C_{20}H_{24}O_7$ | H | OAc | [9] |

2.2. Clerodane type

Two clerodane dieterpenoids (Figure 5) with five cyclic ring structures, epoxysalviacoccin and salviacoccin, have been isolated from *S. plebeia*.



Epoxysalviacoccin [10]
$C_{21}H_{22}O_7$

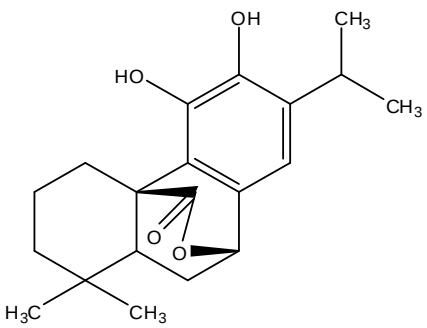


Salviacoccin [10]
$C_{21}H_{22}O_6$

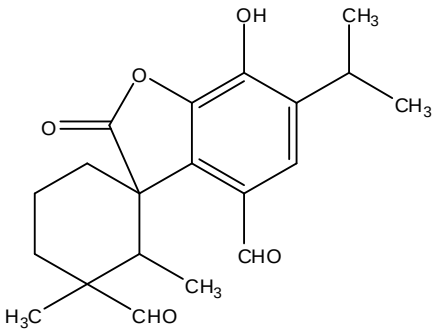
**Figure 5**

2.3. Abietane type

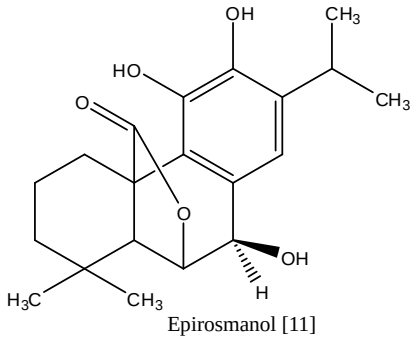
Till today, four abeo-abietanoids (Figure 6) have been obtained from this plant.



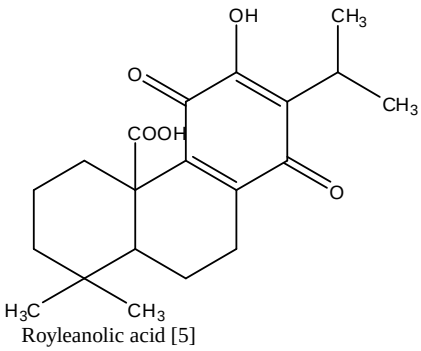
Carnosol [11]
$C_{20}H_{26}O_4$



Rosmadial [11]
$C_{20}H_{24}O_5$



Epirosmanol [11]
$C_{20}H_{26}O_5$

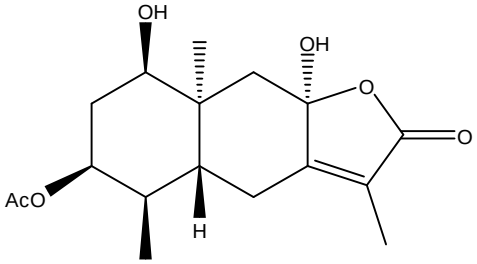


Royleanolic acid [5]
$C_{20}H_{26}O_5$

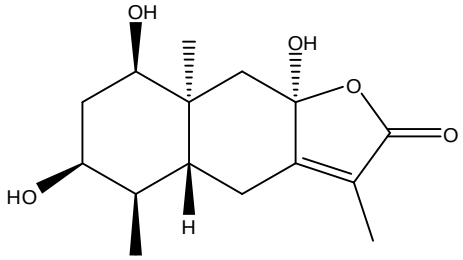
**Figure 6**

2.4. Eudesmane-type sesquiterpene lactone type

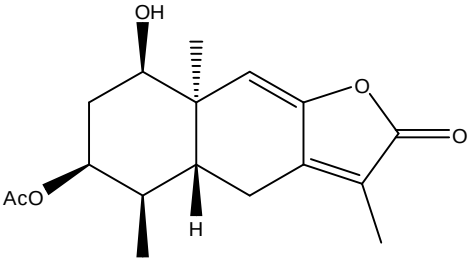
In 2014, Yiqun Dai et al had isolated five eudesmane-type sesquiterpene lactones (Figure 7) from *S. plebeia*.



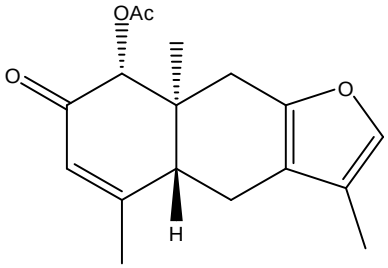

Plebeiolide A [12]
$C_{17}H_{24}O_6$



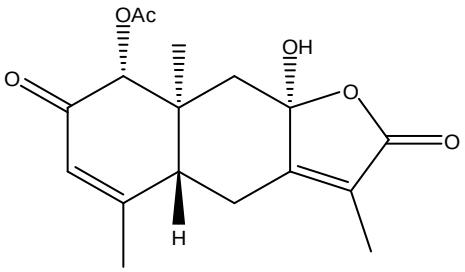

Plebeiolide B [12]
$C_{15}H_{22}O_5$




Plebeiolide C [12]
$C_{17}H_{22}O_5$




Plebeiafuran [12]
$C_{17}H_{20}O_4$

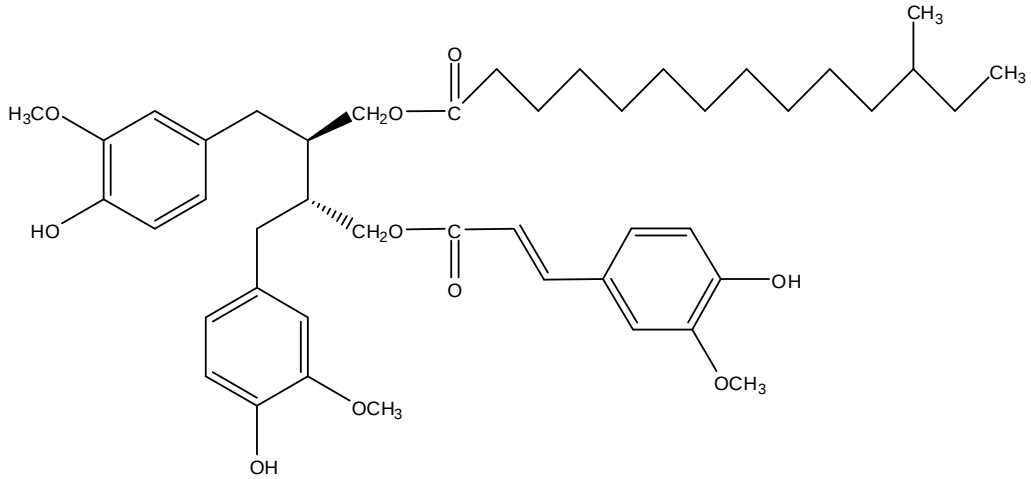



Eudesmanolide [12,13]
$C_{17}H_{20}O_6$

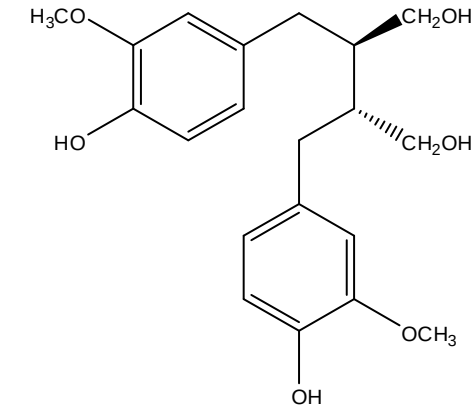
**Figure 7**

**3. lignan**

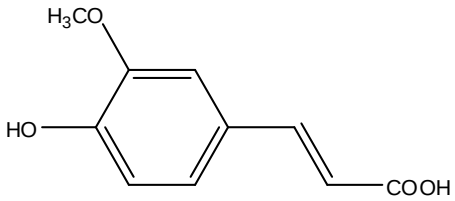
The lignan derivatives (Figure 8) have been isolated from the seeds of this plant.



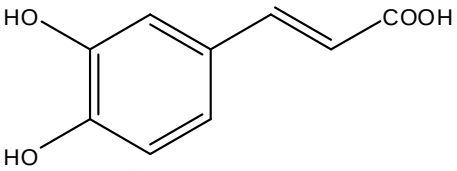

Lignan diester [14]
$C_{45}H_{62}O_{10}$



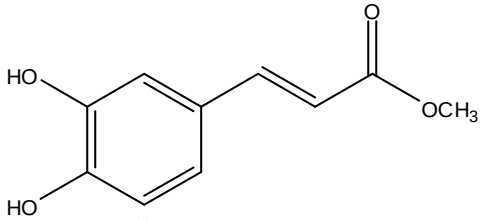

Secoisolariciresinol [14]
$C_{20}H_{26}O_6$




Ferulic acid [14]
$C_{10}H_{10}O_4$




Caffeic acid [3]
$C_9H_8O_4$




Caffeic acid methyl ester [11]
$C_{10}H_{10}O_4$

**Figure 8**

## 4. Essential oil

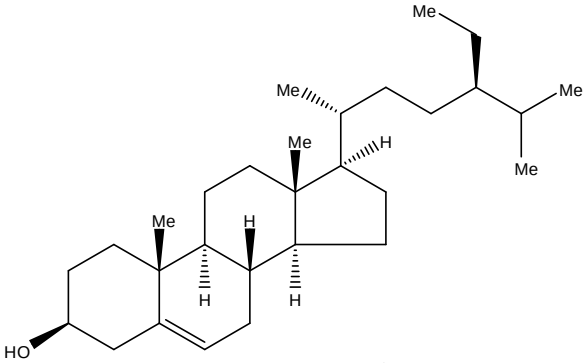
The essential oils (Table 3) were analysed by GC and GC/MS and revealed the presence of several different types of compounds in trace amounts from *S. plebeia*.

**Table 3: The The essential oils obtained from the *S. plebeian***

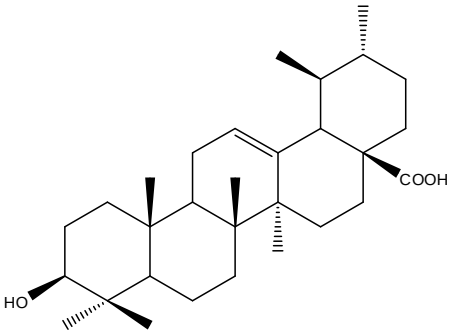
| No. | Compounds | References | No. | Compounds | References |
|---|---|---|---|---|---|
| 1 | Elemol | [15] | 16 | *α*-curjunene | [15] |
| 2 | *α*-pinene | [16] | 17 | (-)-Isoledene | [16] |
| 3 | *β*-pinene | [16] | 18 | 2,6,10-trimethyl-tetradecane | [17] |
| 4 | Borneol | [15] | 19 | 4,6(E),8(Z)-megastigmatrien | [16] |
| 5 | *β*-eudesmol | [15] | 20 | Oleic acid | [15] |
| 6 | Ylangene | [15] | 21 | (Z,Z)-9,12-octadecadienoic acid | [15] |
| 7 | Phytol | [17] | 22 | Agarospirol | [15] |
| 8 | Cinnamic acid | [17] | 23 | Guaiol | [15] |
| 9 | Caryophyllene | [16] | 24 | 1,3,5 -trimethyl -6-methenyl -cyclohexene | [16] |
| 10 | *β*-humulene | [16] | 25 | 6,10,14-trimethyl -2-pentadecacnone | [17] |
| 11 | Cinene | [16] | 26 | n-hendecanol | [15] |
| 12 | *α*-cadinene | [16] | 27 | Copaene | [15] |
| 13 | Pentadecanoic acid | [17] | 28 | (-)-Alloaromadendrene | [15] |
| 14 | *α*-farnesene | [16] | 29 | (+)-Aromadendrene | [15] |
| 15 | Benzyl benzoate | [15] | 30 | 9,10-dehydroisolongifolene | [15] |

## 5. Others

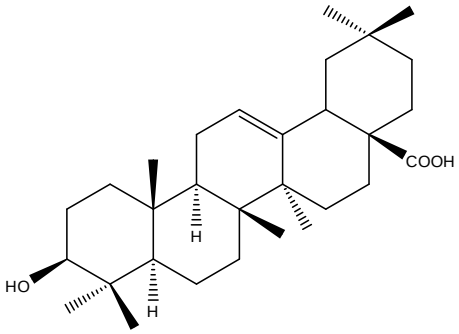
Some other compounds (Figure 9) were isolated from *S. plebeia*.



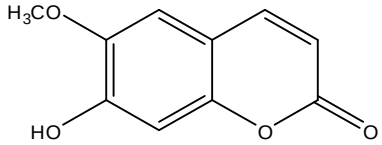

*β*-Sitosterol [8]
$C_{29}H_{50}O$



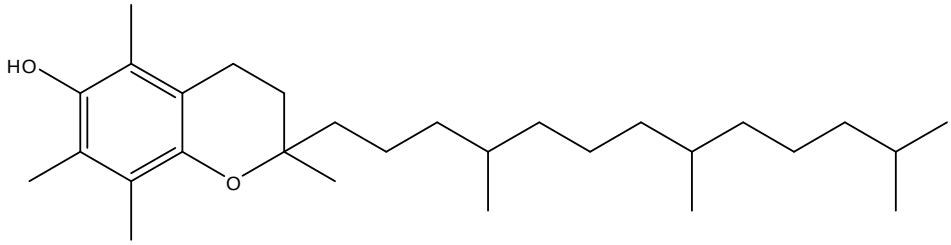

Ursolic acid [8]
$C_{30}H_{48}O_3$




Oleanolic acid [18]
$C_{30}H_{48}O_3$




Scopoletin [11]
$C_{10}H_8O_4$




*α*-tocopherol [25]

**Figure 9**

**PHARMACOLOGY**

The ethanol extract of *S. plebeia* possesses anti-inflammatory, anti-angiogenic, anti-nociceptive, and anti-oxidant activities, which offers partial support to its folkloric use. [19]

Three compounds were isolated and identified as royleanonic acid, hispidulin, and eupatorin from *S. plebeia*, which displayed anti-oxidant activity. [5]

In 2012, Agung Nugroho et al found that the composition of polyphenols played a major role in the sedative and gastroprotective effects of *S. plebeia* by animal experiments. [6]

The effect of aqueous extract of *S. plebeia* showed strong anti-allergic activity and the differences in bioavailability may cause differential activity following different administration routes. [20]

Homoplantaginin isolated from *S. plebeia* (Lamiaceae**)** has protective effects on hepatocyte injury, which might be associated with its anti-oxidant properties. [21]

The study investigated sage weed (*S. plebeia*) extract (SWE) influences cholesterol handling of J774A1 murine macrophages, which showed SWE may serve as a protective therapeutic agent against the development of atherosclerosis. [22]

The compound *S. plebeia* granules (CSPG) isolated from *S. plebeia* showed significantly diuretic, anti-blastic, anti-pyretic, anti-inflammatory, and anti-dynous activities which support its folk medicine use on urinary tract infection (UTI). [23]

Three compounds, 6-methoxy-luteolin-7-glucoside, *β*-sitosterol, and 2′- hydroxy-5′-methoxy -biochanin A were isolated from *S. plebeia* which showed strong anti-oxidant activities, their anti-oxidant activities were investigated individually and compared with butylatedhydroxytoluene (BHT) and *α*-tocopherol by the oxidative stability instrument (OSI) at 100 °C. [24]

The inhibitory activity of plebeiolide C and plebeiafuran isolated from *S. plebeia* which were evaluated by NO production in lipopolysaccharide-induced RAW264.7 cells. The two compounds displayed moderate inhibition with $ED_{50}$ values of 105 and 127 μM. [12]

The ethanol extract of *S. plebeia* could prolong the latent period of cough and decrease the frequency of cough induced by citric acid in guinea pigs and by sulfur dioxide in mice. It could increase phenolred output of trachea in mice. It could also prolong the latent period of histamine which induce asthma in guinea pig and inhibit the isolated tracheal smooth muscle induced by histamine of guinea pigs. So, *S. plebeia* has a titussive, expectorant, and

anti-asthmatic action. [25]

## CONCLUSION

In a word, *S. plebeia* plays an important role in medical science, which attracts the attention of chemists and pharmacologists to research and develop.

**Acknowledgements**
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