·综述·

中药天葵子的化学成分研究进展

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摘要：中药天葵子是毛茛科植物天葵 *Semiaquilegia adoxoides*(DC.)Makino 的干燥块根，为我国常用中药品种。具有清热解毒，消肿散结之功效，其主要成分有生物碱、氰基和硝基类、酚酸类等。该文对天葵子化学成分的研究进行整理和总结，为进一步研究提供参考。

关键词：天葵子；植物化学；化学成分
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Research Progress on Chemical Constituents from *Radix Semiaquilegiae*

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ABSTRACT: *Radix Semiaquilegiae* (Tiankuizi in Chinese), the root of *Semiaquilegia adoxoides*, has been widely used in China, according to the traditional Chinese medicine (TCM) principle, it has effect of heat clearing and detoxicating, detumescence, lump dissipation. The main components of *Radix Semiaquilegiae* are alkaloids, cyano compounds and nitro compounds, phenolic acids. This review summarizes the achievements of the investigations in phytochemistry on *Radix Semiaquilegiae* in order to provide reference for further study.
KEY WORDS: *Radix Semiaquilegiae*; phytochemistry; Chemical constituents

1 Introduction

Radix Semiaquilegiae (Tiankuizi in Chinese), the root of *Semiaquilegia adoxoides* belongs to the genus Ranunculaceae plant. [1]

This plant is distributed in the subtropical area of the Yangtze River in China, according to the investigations in phytochemistry on *Radix Semiaquilegiae*, various biologically active compounds have been founded. In addition, in TCM, the plant is mainly applied for the treatment of tumor and mastitis in clinical practice. This review aims to systematically summarise the published literatures related to the chemical constituents of S. *Radix* and to provide information as a basis of further development and utilization of this herbal resource.

Clinically used to treat acute mastitis with honey sometimes[2-8], *Radix Semiaquilegiae* contains a variety of chemical compositions and cyanoglycosides as the main components shows significant medicinal activity. [9].

Monomeric compounds from *Radix Semiaquilegiae* can inhibit the activity of cholinesterase [10], and have the anti-inflammatory[11] and anti-tumor activity in vitro [12-15]. Alkaloid fractions of *Radix Semiaquilegiae* have inhibitory effect on mouse sarcoma S_{180} [16], while the water layer and the n-butanol layerer of *Radix Semiaquilegiae* have antioxidaive

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activity[17].

2 Phytochemistry

The advancement of analysis technologies has allowed many studies on *Semiaquilegia adoxoides* to reveal numbers of phytochemicals, including alkaloids, diterpenes, cyano compounds and nitro compounds, lactones, coumarins, lignins, glycosides, sterols and others.

2.1 Alkaloids

To date, four alkaloids have been isolated and identified from *Radix Semiaquilegiae* (Table 1, Figure 1), namely thalifendine (1), semiaquilegine A (2), magnoflorine (3), and berberine (4), respectively. The structures of Thalifendine and Semiaquilegine A have been elucidated by NMR spectroscopic analysis.

Table 1　Alkaloids

No.	Name	Molecular Formula	Physical state
1	Thalifendine	$C_{19}H_{16}NO_4$	Yellow needle[18]
2	Semiaquilegine A	$C_{19}H_{24}NO_4$	White powder[19]
3	Magnoflorine	$C_{20}H_{24}NO_4$	+ Yellow amorphous powder[20]
4	Berberine	$C_{20}H_{18}NO_4$	Yellow needle[21]

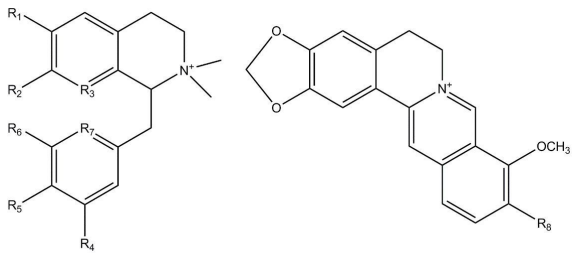

Figure 1　Structures of compounds from *Radix Semiaquilegiae* (Alkaloids)

2.2 Diterpenes

Two diterpenes have been isolated from EtOH extraction fraction of the root of *Semiaquilegia adoxoides*, namely *E*-semiaquilegin and *Z*-semiaquilegin, respectively (Table 2, Figure 2).

Table 2　Diterpenes

No.	Name	Molecular Formula	Physical state
4	*E*-semiaquilegin	$C_{38}H_{46}O_9$	White amorphous powder[22]
5	*Z*-semiaquilegin	$C_{38}H_{46}O_9$	White amorphous powder[23]
6	Semiaquilegoside A	$C_{26}H_{38}O_9$	Colorless needle crystal[24]

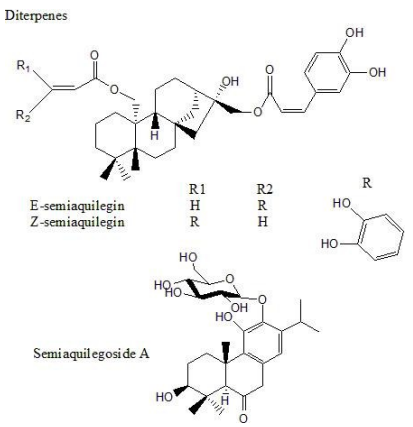

Figure 2　Structures of compounds from *Radix Semiaquilegiae* (diterpenes)

2.3 Cyano compounds and nitro compounds

Cyano compounds and nitro compounds are the main characteristic components of *Radix Semiaquilegiae*. Up to now, 11 compounds with cyano and nitro have been obtained and identified from this herb. These compounds have the similar molecular configuration (Table 3). Their chemical structures are shown in Figure 3.

2.4 Lactones and coumarins

Lactones and a coumarins compounds were found in *Radix Semiaquilegiae* (Table 4). Their structures are shown in Figure 4.

Table 3　Cyano compounds and nitro compounds

No.	Name	Molecular Formula	Physical state
7	lithospermoside	$C_{14}H_{19}NO_8$	White amorphous powder[25]
8	(*Z*)-6*α*-(*β*-*D*-glucosyloxy)-4*α*,5*α*-dihydroxy-2-cyclohexene-1,*α*-acetonitrile	$C_{14}H_{19}NO_8$	White amorphous powder[20]
9	Menisdauri	$C_{14}H_{19}NO_7$	White amorphous powder[20]

(续表)

No.	Name	Molecular Formula	Physical state
10	ehretioside	$C_{14}H_{17}NO_7$	Colorless needle crystal[26]
11	thalictricoside	$C_{19}H_{27}NO_{12}$	Colorless needle crystal[26]
12	4-[*β*-*D*-apiofuranosyl-(1→6)-*O*-*β*-*D*-glicopyranosyloxy] phenylacetonitrile	$C_{19}H_{25}NO_{10}$[26]	
13	(1*E*, 4*α*, 5*β*, 6*α*)-4,5,6-trihydroxy-2-cyclohexen-1-ylideneacetonitrile	$C_8H_9NO_3$	White amorphous powder[26]
14	2-(*β*-*D*-glucopyranosyloxy)-4-hydroxybenzeneacetonitrile	$C_{14}H_{17}NO_7$	white needles[27]
15	-4-Hydroxy-1-(2-nitroethyl)benzene 4-O-(6′-O-*β*-*D*-xylopyranosyl)-*β*-*D*-sitosterol	$C_{19}H_{27}NO_{12}$	White powdered crystal[23]
16	4-hydroxy-2-*β*-*D*-glucopyranosyl oxyphenylacetonitrile	$C_{14}H_{17}NO_7$	Ehretioside B[26]
17	4-[*β*-*D*-xylopyranosyl-(1→6)-O-*β*-*D*-glucopyranosyl oxy]-1-(2-nitroethyl)benzene		White amorphous powder[28]

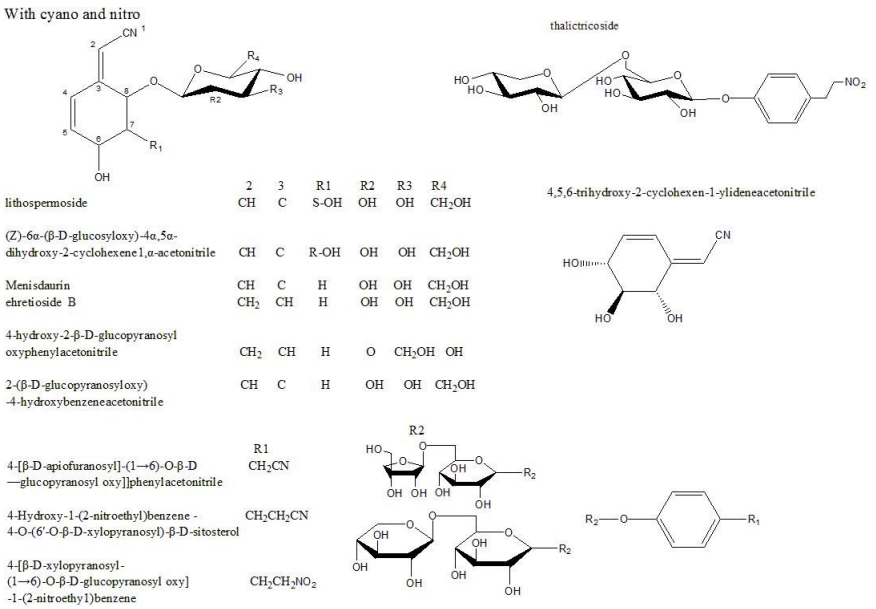

Figure 3　Structures of compounds from *Radix Semiaquilegiae* (cyanos and nitros)

Table 4　Lactones and coumarins

No.	Name	Molecular Formula	Physical state
18	Griffonilide	$C_8H_8O_4$	Colorlessprismy crystal[25]
19	Aquilegiolide	$C_8H_8O_3$	white needles[22]
20	Menisdaurilide	$C_8H_8O_3$	white needles[22]
21	4,6-dimethoxy-5-methyl-2H-Pyran-2-one	$C_8H_{10}O_4$	white needles[11]

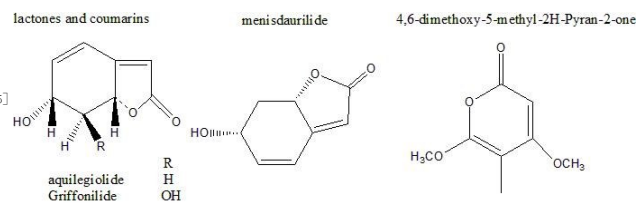

Figure 4　Structures of compounds from *Radix Semiaquilegiae* (lactones and coumarins)

2.5　Others chemical constituents

Radix Semiaquilegiae contains organic acids, including octanedioic acid, fumaric acid and palmitic acid. The root of this plant contains a lot of phenolic acids, such as hexanoic acid, octanoic acid, nonanoic acid, myristic acid, pentadecanoic acid and heptadecanoic acid (Table 5). Their structures are shown in following Figure 5.

There are also some lignins, glycosides[30-31], sterols and others in the plant. Genistein, an active ingredient, can increase the activity of gemcitabine in vivo and in vitro against pancreatic cancer[32].

Table 5　Phenolic acids

No.	Name	Molecular Formula	Physical state
24	4-hydroxybenzaldehyde	$C_7H_6O_2$	Colorless crystal[24]
25	4-hydroxybenzoic acid	$C_7H_6O_3$	Colorless crystal[24]
26	3-hydroxy-4-methoxybenzoic acid	$C_8H_8O_4$	Colorless crystal[28]
27	2,4-dihydroxybenzoic acid	$C_7H_6O_4$	Colorless crystal[22]
28	Bis(2-ethylhexyl) phthalate	$C_{24}H_{38}O_4$	Yellow syrup[28]
29	Dibutyl terephthalate	$C_{16}H_{22}O_4$	Yellowishneedles[28]
30	Methyl 2-(2,4-dihydroxyphenyl) acetate	$C_9H_{10}O_4$	Colorless crystal[22]
31	Ferulic acid	$C_{10}H_{10}O_4$	Light yellow crystalline powder[29]
32	2-propenoic acid,3-(4′-hydroxyphenyl)-(4″-carboxyl)-phenyl ester	$C_{16}H_{12}O_5$	Colorless needles[24]
33	4-(bromomethyl)-2-hydroxybenzoic acid	$C_8H_7BrO_3$	Brown red needle crystal[24]
34	5-(2-hydroxyethyl)-2-*O*-*β*-glucosylohenol	$C_{14}H_{20}O_8$	Colorless needles[29]
35	Salidroside	$C_{14}H_{20}O_7$	Colorless needles[24]
36	*p*-Hydroxyphenethylalcohol	$C_8H_{10}O_2$	Whtie crystal[22]
37	3,4-dihyroxybenzoic acid	$C_7H_6O_4$	White to micro-brown needle[11]
38	*p*-*β*-*D*-glucosyloxybenzoic acid	$C_{13}H_{16}O_8$	Whtie needle[11]
39	Monordicophenoide A	$C_{18}H_{24}O_{12}$	Brown gum-like substance[26]

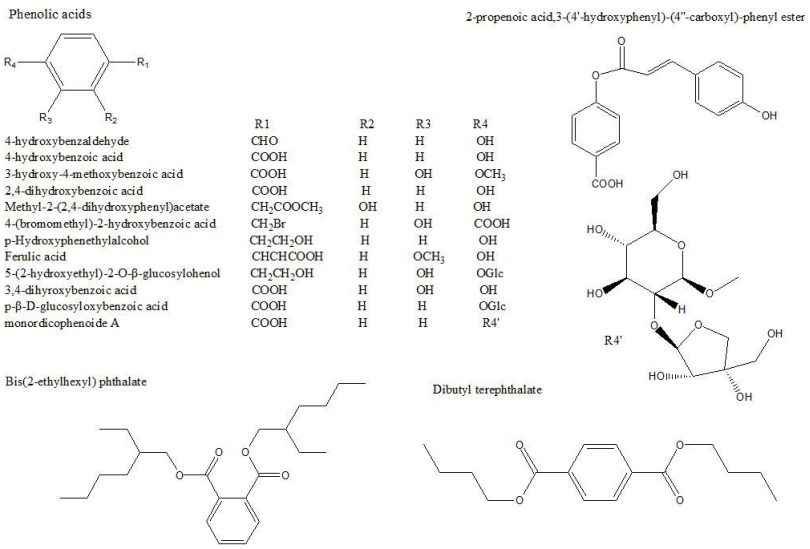

Figure 5　Chemical Compositions of Phenolic Acids from *Radix Semiaquilegiae*

3　Conclusion

Modern pharmacological studies have shown that *Radix Semiaquilegiae* has anti-inflammatory, cytotoxic and other activities, with thegreat potential in the pharmaceutical field. The results of phytochemistry indicated that the major components of *Radix Semiaquilegiae* are phenolic acids, cyano compounds and nitro compounds which exhibit multiple pharmacological effects. In addition, the bioactive components and their corresponding pharmacological activities should be investigated systematically in order to optimize the development and utilization of this herbal resource.

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