

## Progress of Chemical Components and Biological Activities of *Lonicera Maackii*

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### ABSTRACT

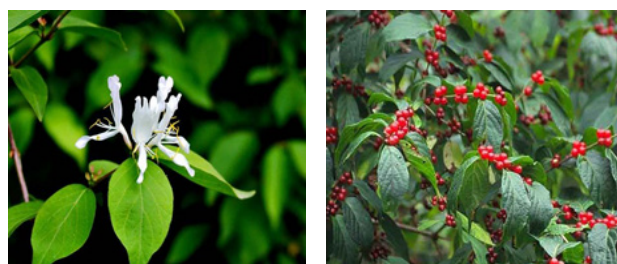
*Lonicera maackii* is a shrub belonging to the family Caprifoliaceae. Its fruits, leaves and flowers contain many kinds of biological compounds together with a wide spectrum of biological activities. Some chemical components together with biological activities have been studied and reported. This review briefly describes the progress of the chemical components and biological activities of *Lonicera maackii*, for providing a reference for the researchers.

### KEYWORDS

*Lonicera Maackii*; Chemical Components; Biological Activities.

### INTRODUCTION

*Lonicera maackii* (Rupr.) Maxim (Amur honeysuckle in English, gold and silver wood in Chinese, Figure 1) is a kind of deciduous shrub belonging to the family Caprifoliaceae and is native to temperate Asia in northern and western China, Mongolia, Japan, Korea, and Southeastern Russian. In China, *Lonicera maackii* is an important ornamental plant and street trees, widely planted because of its fragrant flowers, long flowering period and attractive red fruits. The leaves and flowers of *Lonicera maackii* possess distinct antibacterial activity and the roots of *Lonicera maackii* also possess antibacterial activity and been used for treatment for malaria disease [1]. The aqueous extraction of the roots of *Lonicera maackii* exhibits effective activities of anti-inflammatory[2], removing fever and immune system, granules can be used to treat pulmonary fever bronchitis in children caused by bacteria [3]. In this mini-review, we briefly describe the progress of the components and biological activities of *Lonicera maackii* to provide a reference for the researchers.



**FIGURE 1:** The picture of flowers and fruits of *Lonicera maackii*.

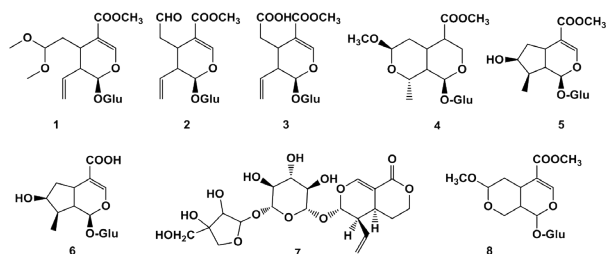
### Chemical components of *Lonicera maackii*

It is reported that there are many kinds of bioactive compounds in fruits, flowers and leaves of *Lonicera maackii*, which contain iridoids, triterpenes, volatile oils, flavonoids, phenylpropanoids, etc..

### Iridoids

Guangshu Wang et al. [4] obtained cleaved seloganin dimethylacetal (1), seloganin (2) and secoxyloganin (3) from the fruits alcohol extract of *Lonicera maackii*. Shengjie Yuan [5] isolated 7S-O-methylmorroneiside (4), loganin (5), loganin acid

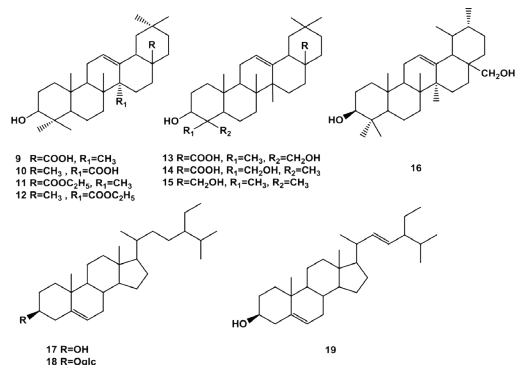
(6), 6'-O-β-D-apiofuranosyl sweroside (7) from the fruits of *Lonicera maackii*. Heng Zhu et al. [6] identified morronside, (8) loganin and secoxyloganin from the flowers of *Lonicera maackii*. The structures of the related compounds listed in **Figure 2**.



**Figure 2:** The structures of the related iridoids.

### Triterpenes

Some triterpenes were isolated from the fruits of *Lonicera maackii*, which were oleanolic acid (9), 3β-hydroxyolean-12-en-27-oic acid (10), ethyl ursolic acetate (11), 3β-hydroxyolean-12-en-27-oic acid ethylester (12), isohederagenin (13), hederagenin (14), erythrodiol (15), urusol (16), β-sitosterol (17), β-daucosterol (18), stigmasterol (19) [7-9]. The structures listed in **Figure 3**.



**Figure 3:** The structure of the related triterpenes.

### Volatile oils

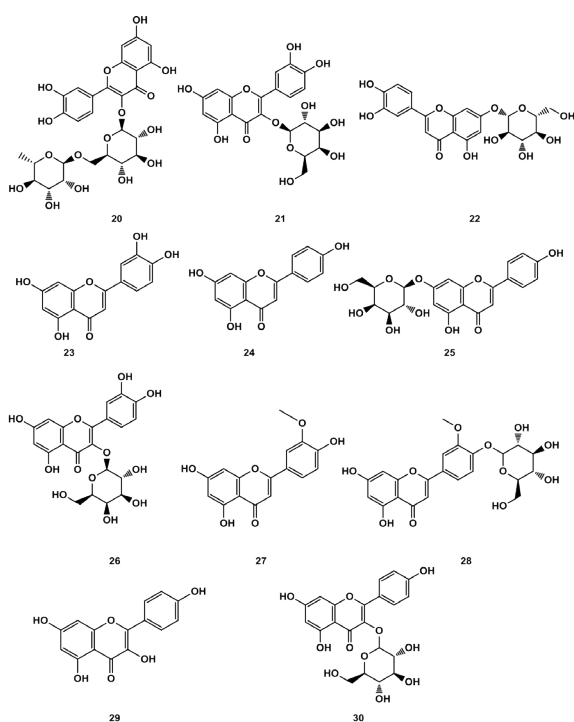
Xiaoling Ji et al. [10] identified thirty-two compounds from the essential oil extracted from the fruits of *Lonicera macckii* by GC-MS., and the methylhexyl hydroperoxide was in the highest amount of all detected compounds and accounting for 1.31% of the volatile oil. Some complex molecular structure such as digitoxin, 9-[2',2'-dimethyl propionyl hydrazone]3,6-dichloro-2,7-bis[2-[diethylamino]ethoxy]fluorine, cholest-22-en-21-ol, 3, 5-dehydro-6-methoxy valerate were also detected in this study. Some simple compounds: such as hexane, 2,4-dimethylpentane, 2-dimethyl-3-methylbicyclo[2,2,1]hexane, 7,7-trimethyl-bicyclo[4,1,0]hex-3-ene, 1-methyl-4-isopropylbenzene, heptadecyl-trichlo-

rosilane, 1-iodo-2-methylolane, O-alkenylhydroxylamine, 1,1,3α-7-tetramethyl-1α,2,3,3α,4,5,6,7β-octahydro-1-hydrocyclopropanol[α]decene, (2E)-2-dodecanoic acid, 2,6,10-trimethyltetradecane, pentadecane, methyl 12,15-octadecadienoate, 11,14-octadecadienoic acid methyl ester, 12,15-octadecadienoic acid methyl ester, 2-(7-acetylheptadecanyloxy)- tetrahydropyran, 9,12-heptadecadienoic acid glycerol (2,3-ditrimethylsilyl)ether, [2Z,5Z]-2,5-pentadecanol, 7-methyl-Z-hexadecyl carbonate, [2E,6E]-10,11-epoxy-7-ethyl-3,11-dimethyl-2,6-tetradecanoic acid methyl ester, 3-heptyloxymethyl-7-methoxy-benzofuran-2-one, 2-methyl-2-pentadecanethiol, methylene bis[6-tert-butyl] p-cresol, 2-ethanol octadecyl ether, 2-[[trimethylsilyl]oxy]-1-[[trimethylsilyl]oxy]methyl]ethyl[9E,12E,15E]9,12,15-octa-decatrienoic acid ester, 10-octadecenoic acid, 3,7-Dimethyl-3-ethyl-7-tert-butyl-hexadecane, 2-bromo- octadecanoic acid, phthalic acid mono[2-ethylhexyl] ester were also detected . Jinying Li et al.[11] identified 16 components from mature fruits of *Lonicera maackii* including aldehydes(2-hexenal, phenylacetaldehyde, nonanal, decanal, β-cyclocitral), alcohols [ trans-2-hexen-1-ol, linalool, phenethyl alcohol, (-)-terpinen-4-ol], terpenes (3-heptene), alkanes (dodecane, tridecane, hexadecane), ester [(2,6,6-Tri-methyl- 2-hydroxycyclohexylidene)acetic acid lactone] , acid(trans-2-hexenyl-hexanoate)and ketones(damascenone, geranylacetone), the first two classes of compounds accounted for a high mass fraction of 55.80% and 28.48%, respectively. Guangshu Wang et al. [12] obtained the essential oil from the dry buds of *Lonicera macckii* and confirmed 18 components by GC-MS, the detected compounds were: 1-(2,6,6-trimethyl-1,3-cyclohexanedieryl)-2-butene-1-one, 1,1,6-trimethyl- 1,2,3,4-tetrahydro-naphthalene, tetradecane, 1-ethyl-2,3-dimethylbenzene, (-) farnesene, pentadecane, hexadecane, octadecane, phytane, nonadecane, hexadecanoic acid, eicosane, heneicosane, docosane, methyl behenate, nonacosane, methyl lignocerate, which account for 70.4% of the total volatile oil. Xinyan Gao et al. [13] obtained the volatile components from the flowers and fresh leaves of *Lonicera macckii* using the Soxhlet extraction method, and confirmed their components by GC-MS. The detected compounds were: ethanedioic acid dimethyl ester, 6-chloro-6-methyl-bicyclo[3.1.0] hexane, (Z)-3-methyl-4-undecene, (E)-ethyl-3-hexenyl carbonate, p-xylene, cyclohexanol, 2,3-dimethyl-3-hexanol, benzaldehyde, cis-octahydro-pentalene, hexanoic acid-4-hexenyl-1-ester, 5-ethyl-2-furaldehyde, benzeneacetaldehyde, 5-(1-methyl-propyl)-nonane, 2,7,10-trimethyl-dodecane, 1,2,3,4-tetramethyl-benzene, naphthalene, 2-(1-methyl-ethyl)-cyclohexanol, cantharidin, 3,7-dimethyl-2,6-nona- dien-1-ol, (6-hydroxy-methyl-2,3-di-

methyl-phenyl)-methanol, 3,5-dimethyl-benzoic acid methyl ester, 3,5-bis(1,1-dimethyl-ethyl)-phenol, 3-(2,6,6-trimethyl-1-cyclohexenyl)-2-propen-1-ol, 2,3-dihydro-4,4-dimethyl-indole-4-ol-2-one, (-)-isolongifolol methylether, (-)-isolongifolol, 2-hydroxy-4,4,8-trimethyl-5-tricyclo [6.1.1.0(2,6)]-2(6)-decene, imiprothrin, *D*-bicuculline, scoparone, picrotoxin, 2,4,7,14-tetramethyl-4-vinyl-tricyclo [5.4.3.0(1,8)] tetradecan-6-ol, dibutyl phthalate. Xinyan Gao et al [14] also obtained the following components from the fresh fruits of *Lonicera maackii*: 3-(2-methoxyethoxymethoxy)-2-methyl-1-pentaol, 2,7,10-trimethyl-dodecane, 2,4-bis(1,1-dimethylethyl)-phenol, benzoic acid-2,6-bis[(trimethylsilyloxy)-trimethylsilyl ester, 7-chloro-1,3-dihydro-5-phenyl- 1-(trimethylsilyl)-3-[(trimethylsilyloxy)-2H-1,4-benz-odiazepin-2-one, benzoic acid-2,5-bis(trimethylsiloxy)-trimethylsilyl ester, benzoic acid-2,5-bis(trimethylsiloxy)-trimethylsilyl ester, benzoic acid- $\alpha$ -3,4-tris [(trimethylsilyloxy) -trimethylsilyl ester, pentacosane, tetracosane, dot riacontane, (Z,Z)-9-hexadecenoic acid-9-octadecenyl ester, octadecanoic acid-2-(hexadecyloxy) ethyl ester, 1,2-cinnolinedicarboxylic acid-1,2,3,5,6,7,8,8a-octahydro- 4-trimethylsilyloxy-diethyl ester.

## Flavonoids

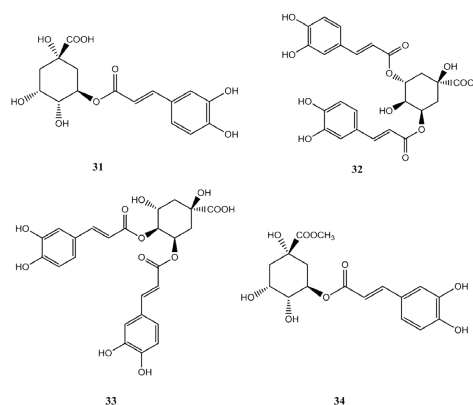
Heng Zhu et al. [6] identified flavonoids such as rutin (20), hyperoside (21), luteolin (22) from the flowers of *Lonicera maackii*. Luteolin (23), apigenin (24), apigenin-7-glucoside (25), hyperoside (26), chrysoerol (27), chrysoerol-4'-glucoside (28), kaempferol (29) and kaempferol-3-glucoside (30) were isolated from the leaves of *Lonicera maackii* by Junli Ma [15,16]. The *Lonicera maackii* fruit is one of the main parts where total flavonoids exist in. The structures of the related compounds listed in Figure 4.



**Figure 4:** The structures of the related flavonoids.

## Phenylpropanoids

Heng Zhu et al.[6] identified phenylpropanoid compounds such as chlorogenic acid (31), isochlorogenic acid A (32), isochlorogenic acid C (33) from the flowers of *Lonicera maackii* by HPLC-DAD-ESI-Q-TOF/MS. Junli Ma [15,16] isolated chlorogenic acid and methyl chlorogenic acid (34) from the leaves of *Lonicera maackii*. The structures of the related compounds listed in **Figure 5**.



**Figure 5:** The structures of the related phenylpropanoids.

## Other components

In addition to the above-mentioned components, other compounds have also been discovered in the fruits of *Lonicera maackii*, such as benzy -*O*- $\beta$ -*D*-xylopyranosyl-(1 $\rightarrow$ 6)- $\beta$ -*D*-glucopyranoside [4], 1,3-dihydroxypropyl (9*Z*, 12*Z*) -octadeca-9, 12-dienate, 1,3-dihydroxypropyl (9*E*, 12*E*)-octadeca-9, 12-dienate, 3, 7-dimethyl-3, 8-dihydrooctene, (*E*)-2, 6-dimethylocta-2, 7-dien-1-ol, 1-acetyl-2-methyl-5-(2-vinylloxiran-2-yl) pentanester, tripalmitin, glucose, sucrose [8, 9].

## BIOLOGICAL ACTIVITIES

It was reported that the extractions from the leaves of *Lonicera maackii* exhibited antibacterial, antipyretic-analgesic effects and improved the immunity. The extractions of the roots of *Lonicera maackii* possess higher activities with antibacterial, anti-inflammatory, removing the fever, treatment of malarial disease, and improving the immunity. The extractions of fruits of *Lonicera maackii* exhibited higher anticancer, protective liver, reducing blood sugar and treatment of cardiovascular disease.

## Antioxidant Activity

Yingchen Wang [17] reported that the polysaccharides in fruits of *Lonicera maackii* can effectively scavenge hydroxyl radicals, superoxide anion radicals and DPPH radicals, the scavenging ability is positively correlated with the concentra-

tions, which indicated that the polysaccharides in the fruits of *Lonicera maackii* possess the antioxidant activity. Shumei Li et al. [18] reported that the flavonoids in fruits of *Lonicera maackii* possess distinct antioxidant activity and the antioxidant ability is more superior to vitamin E. Chlorogenic acid in *Lonicera maackii* is also a good *in vitro* antioxidant [19].

### Antitumor activity

Duowu Chai [20] reported that the rough extractions in fruits of *Lonicera maackii* exhibited higher antitumor activity, and the ethyl acetate extraction is more active than other extractions. Oleanolic acid exhibited higher anticancer activity against liver cancer cell lines 7721 and leukemia HL-60 with the inhibition of 57.35% and 55.23% respectively. The anti-tumor effect of oleanolic acid is expressed in various stages of tumor development, including inhibition of tumor development, inhibition of tumor growth, and induction of tumor cell differentiation. It can also effectively inhibit angiogenesis, tumor cell invasion and metastasis. Kasai et al. [21] found that chlorogenic acid can inhibit the increase of 8-OH-dG in DNA induced by 4-nitroquinoline-1-oxide (a carcinogen formed by oxygen free radicals) through constructing a rat carcinogenesis model. Rutin components in *Lonicera maackii* can induce the apoptosis of HepG2, and also inhibit the colon cancer and colorectal cancer [22].

### Antibacterial activity

Qian Ren et al. [23] reported that the extractions of *Lonicera maackii* exhibited higher antibacterial activity, the antibacterial sequence of the extractions was leaf > bud > stem bark. Xinyan Gao et al. [11] reported that the extractions from the fresh leaves of *Lonicera maackii* exhibited higher antibacterial activity against *E. coli*, *Bacillus subtilis* and *Staphylococcus aureus* with the  $IC_{50}$ s: 0.039, 0.099 and <0.0119g/mL. Yanwu Hu et al. [24] reported that all different solvents extractions of *Lonicera maackii* contain antibacterial ingredients and the antibacterial effect is synergistic action of all antibacterial ingredients.

### Protective liver

The oleanolic acid and iridoid in fruits of *Lonicera maackii* possess protective effects on the liver. Xinjiang Gong et al. [25] constructed a cyclophosphamide-induced liver injury model and carried out experiments. It was found that oleanolic acid could inhibit the activities of alanine aminotransferase, aspartate aminotransferase and lactate dehydrogenase in mice serum caused by liver injury, and increases the MTT value of hepatocytes, indicating that oleanolic acid had anti-cyclophosphamide-induced hepatocyte injury activity in rats. Reisman et al. [26] reported that oleanolic acid can activate the nuclear accumulation of Nrf2 and induce Nrf2-dependent

genes, thus protecting the liver from acetaminophen-induced hepatotoxicity. Hui Su [27] established a model of liver injury induced by carbon tetrachloride in mice and conducted experiments, the results showed that the total iridoid glycosides in *Lonicera maackii* fruits could significantly reduce the elevated alanine aminotransferase and aspartate aminotransferase in the serum of mice with liver injury and revealed that the total iridoid glycosides of *Lonicera maackii* fruits had significant hepatoprotective activity.

### Reducing blood sugar

Su Hui [27] constructed alloxan-induced hyperglycemia model and adrenaline model, by comparing normal and hyperglycemia model mice, it was found that high dose group (4 g/kg total iridoid glycosides) had significant hypoglycemic effect, while the high dose group (4 g/kg total iridoid glycosides) and middle dose group (2 g/kg total iridoid glycosides) could significantly antagonize the increase of blood sugar induced by adrenaline. The monomeric substance loganin which obtained from the *Lonicera maackii* fruit was studied and found to significantly alleviate the increase of blood glucose in alloxan-induced hyperglycemia mice, but not as good as the treatment of total iridoid glycosides. Linpu Xie [28] constructed a streptozotocin-induced hyperglycemia rat model to study the effect of oleanolic acid on insulin and hepatic glycogen content in hyperglycemic rats—it was found that high dose group (100 mg/kg) had significant hypoglycemic effect, not only reduced fasting blood glucose in hyperglycemic rats, but increased serum insulin and liver glycogen content as well.

From the above review, we found that although some studies about the chemical components and biological activities of *Lonicera maackii* have been carried out, the results are simple and further studies need to be carried out. These years, our research group carried out the drug design, synthesis, isolation of the plant medicines and their biological evaluation. The fruits of *Lonicera maackii* are attractive and eaten by birds, whether it can be eaten by human? So we will carry out the further studies about the chemical components and biological activities of the fruits, leaves and flowers of *Lonicera maackii* in subsequent work.

### ACKNOWLEDGEMENTS

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