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Review

# Chemical constituents and pharmacological activities of medicinal plants from *Rosa* genus

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ABSTRACT

The genus *Rosa* (Rosaceae family) includes about 200 species spread in the world, and this genus shows unique advantages in medicine and food. To date, several scholars concentrated on compounds belonging to flavonoids, triterpenes, tannins, polysaccharide, phenolic acids, fatty acids, organic acids, carotenoids, and vitamins. Pharmacological effects such as antineoplastic and anti-cancer properties, anti-inflammatory, antioxidant, liver protection, regulate blood sugar, antimicrobial activity, antiviral activity, as well as nervous system protection and cardiovascular protection were wildly reported. This article reviews the chemical constituents, pharmacological effects, applications and safety evaluations of *Rosa* plants, which provides a reference for the comprehensive utilization of medicine and food resources and gives a scientific basis for the development of medicinal plants of the genus *Rosa*.



**Contents**



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## 1. Introduction

In the field of Chinese medicine, substances that are both food and Chinese medicinal materials are called "medicine and food homologous substances". Academician Peigen Xiao also interprets "medicine and food homology" as "dual use of medicine and food", which enriches the connotation of the theory of medicine and food homology (Yang, Su, & Chen, 2021). The genus *Rosa* has high edible and medicinal value with a long history of application. This genus is one of the most widespread members of the Rosaceae family with more than 200 species in the temperate and subtropical zones of the northern hemisphere (Ayati et al., 2018), mainly distributed in Asia, Europe and North America. And there are 82 species of *Rosa* in China. The genus *Rosa* is regarded as one of the most important ornamental species (Cunja et al., 2016). The fruits of *Rosa canina* L., *Rosa laevigata* Michx., *Rosa davurica* Pall. and *Rosa odorata* var. *gigantea* (Coll. et Hemsl.) Rehd. et Wils can also be further processed into food for consumption. Among the medicinal plants of the genus *Rosa*, there are more than ten widely studied medicinal plants and long history of clinical use. These medicinal plants are *Rosa rugosa* Thunb. (Ayati et al., 2018), *R. canina* (Ayati et al., 2018), *Rosa damascena* Mill. (Ayati et al., 2018), *R. laevigata* (Zhang et al., 2012), *Rosa chinensis* Jacq. (Luo et al., 2020), *R. davurica* (Ma et al., 2013), *Rosa multiflora* Thunb. (Jiang et al., 2020), *Rosa cymosa* Tratt. (Ji, Xia, Xu, & Zhu, 2020), *R. odorata* var. *gigantea* (Huang, 2015), *Rosa roxburghii* Tratt. (Chen & Kan, 2018), *Rosa davidii* Crep. (Yu, Yang, & Tang, 2000), and *Rosa soulieana* Crep. (Huang, 2015), respectively. Among them, *R. rugosa* and *R. laevigata* belong to medicine and food homologous plants. In the history of folk application, *R. rugosa* can relieve liver and stomach pain in China (Tursun et al., 2016). In the food industry, *R. rugosa* is mainly represented by jam and tea. Rose pigment can be used as a food additive and has health care functions at the same time. *R. laevigata* is mainly distributed in Guangdong and Anhui Provinces in China, which has the function of securing essence and reducing urination (Zhang et al., 2012). At present, the edible development of *R. laevigata* is still limited to beverages, health wine brewing, and dried fruits. As the national flower of Iraq, *R. canina* cures pulmonary abscess (Taghizadeh et al., 2016). *R. damascena* is the main rose variety grown in Bulgaria, which has the effect of relieving spasm (Latifi, Ghannadi, & Minaiyan, 2015). *R. chinensis*, called the queen of flowers, was used to treat women with menstrual disorders (Luo et al., 2020). The fruit of *R. davurica* is the kind of natural food, and its flower and root could treat diarrhea as medicine (Tong et al., 2016). *R. multiflora*, mostly grown in east China, shows a diuretic effect (Zhang et al., 2008). As one of the main sources of "Jin Ying Gen", *R. cymosa* has anti-swelling and analgesic effects (Wang et al., 2019). The roots of *R. odorata* var. *gigantea*, named "Gu-Gong-Guo" in folk medicine of Yi nationality, could treat diarrhea, bacillary dysentery and other diseases (Lv et al., 2021). *R. roxburghii*, also known as "Ci Li" mainly distributed in Southwest China, has the effect of improving digestion (Wu et al., 2020).

So far, phytochemistry analysis have reported that their effective and nutritional components are mainly contains 61 flavonoids, 83 triterpenes, 75 tannins, 10 phenolic acids, 10 polysaccharides, eight fatty acids, eight organic acids, 15 carotenes and two vitamins. Therefore, flavonoids, triterpenes, and tannins are the main active components of this genus. Modern pharmacological studies have also confirmed that the genus *Rosa* exhibit a wide range of bioactivities and nutrition, such as antineoplastic and anti-cancer properties, anti-inflammatory activity, liver protect, antioxidant, regulating blood sugar (Nadpal et al., 2016), antimicrobial activity, antiviral activity, nervous system protection (Ayati et al., 2018), and cardiovascular protection.

Natural products have been the source of most active ingredients of medicines. The active ingredients sourced from herbs are increasingly valued as raw materials in the preparation of modern medicines and herbal preparations (Zhang et al., 2012). In the research of *Rosa* medicinal plants, there are many reports on the chemical composition, but there are few descriptions on their bioactivity and the mechanism of action which needs to be further explored. At present, the research on the development of functional foods of *Rosa* plants is still in its infancy, and there is still a lot of work to be done in the development of new products. In this study, chemical constituents, bioactivities, and safety as well as ethnopharmacological application of genus *Rosa* were reviewed, which is expected to provide a reliable basis for the further development and utilization of *Rosa* plant resources to develop into medicinal and food homologous products.

## 2. Chemical constituents

The plants of genus *Rosa* not only has great ornamental value and commercial use, but also displays good biological activity and nutrition due to its many chemical constituents. Up to now, the main chemical constituents isolated from a dozen of medicinal plants of the genus *Rosa* are flavonoids, triterpenes, tannins, phenolic acids, polysaccharides, fatty acids, organic acids, carotenoids and vitamins.

### 2.1. Flavonoids

Flavonoids, as a kind of important natural products, are the main active ingredients in medicinal plants of the genus *Rosa*. A total of 61 components (Table 1) were isolated from *Rosa* genus, including four flavones (**1**–**4**), 39 flavonols (**5**–**43**), five flavanones (**44**–**48**), one dihydrochalcone (**49**), one biflavone (**50**) and 11 anthocyanins (**51**–**61**), which indicated that flavonols are the main constituents of flavonoids in the plants of genus *Rosa*, and its main aglycones are quercetin and kaempferol. Many flavonoids were respectively isolated from *R. laevigata*, *R. canina*, *R. rugosa* and *R. roxburghii*. Among them, the content of total flavonoids in the fruits of *R. laevigata* was highest, and measured as 80.5% based on the chemical reactions and colorimetric method. The main components were quercetin, kaempferide and isorhamnetin in this plant, and these contents were respectively determined as 3.11%, 2.72% and 1.49% using the HPLC analysis (Zhang et al., 2012). Besides, the LC-MS/MS analysis of flavonoids revealed that quercitrin was the most dominant in water and methanol extracts of fresh *R. canina* hips, accounting for about (40.4 ± 1.3) and (95.2 ± 3.29) μg/g of dry weight (dw) respectively (Nadpal et al., 2016). Hyperoside, isoquercitrin and kaempferol-3-rutinoside are three main ingredients in the flavonoids from *R. rugosa* and the total content of them was calculated as (57 ± 1.0)% (Zhang et al., 2017). In addition, the average content of total flavonoids in fresh fruits of *R. roxburghii* has been determined as 6.8 g/kg (Mansouri et al., 2013). So far, it was reported that flavonoids were isolated from eight medicinal plants in genus *Rosa*, and the contents of flavonoids are mostly

**Table 1**
Flavonoids found in genus *Rosa*.

| Compound class | No. | Compounds | Species | Refs. |
|---|---|---|---|---|
| Flavones | **1** | Luteolin | *R. canina* | (Ayati et al., 2018) |
| | **2** | Apigenin | *R. rugosa* | (Cunja et al., 2016) |
| | **3** | Apigenin 7-O-glucoside | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Cunja et al., 2016) |
| | **4** | Nebadensin | *R. davidii* | (Yu et al., 2000) |
| Flavonols | **5** | Kempferol | *R. rugosa*, *R. canina*, *R. damascena* | (Ayati et al., 2018; Cunja et al., 2016; Zhang et al., 2013) |
| | **6** | Rutin | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Cunja et al., 2016; Zhang et al., 2013) |
| | **7** | Quercetin | *R. rugosa*, *R. canina*, *R. damascena* | (Akram et al., 2020; Zhang et al., 2013) |
| | **8** | Hyperoside | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Cunja et al., 2016) |
| | **9** | Tiliroside | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Cunja et al., 2016) |
| | **10** | Myricetin | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Cunja et al., 2016) |
| | **11** | Isorahmnetin-3-rhamnoside | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Cunja et al., 2016) |
| | **12** | Kaempferol-7-*O*-glucoside | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Cunja et al., 2016) |
| | **13** | Kaempferol-3-*O*-glucoside (astragalin) | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Cunja et al., 2016) |
| | **14** | Kaempferol-3-*O*-glucuronide | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Cunja et al., 2016) |
| | **15** | Kaempferol-7-*O*-(6″-gallate)-glucoside | *R. chinensis* | (Luo et al., 2020) |
| | **16** | Kaempferol-3-*O*-rhamnoside | *R. chinensis* | (Luo et al., 2020) |
| | **17** | Quercetin-3-arabinofuranoside | *R. rugosa* | (Ayati et al., 2018; Cunja et al., 2016) |
| | **18** | Quercetin-3-arabinopyranoside | *R. rugosa* | (Ayati et al., 2018; Cunja et al., 2016) |
| | **19** | Quercetin-3-galactoside | *R. rugosa* | (Ayati et al., 2018) |
| | **20** | Quercetin-3-glucuronide | *R. rugosa* | (Ayati et al., 2018) |
| | **21** | Quercetin-3′-glucuronide | *R. rugosa* | (Ayati et al., 2018; Cunja et al., 2016) |
| | **22** | Quercetin-3-rhamnoside | *R. rugosa* | (Ayati et al., 2018) |
| | **23** | Quercetin-7-*O*-(5″-gallate)-arabinoside | *R. rugosa* | (Ayati et al., 2018) |
| | **24** | Quercetin-3-*O*-xyloside | *R. rugosa* | (Ayati et al., 2018) |
| | **25** | Quercetin-3-*O*-glucoside | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Nadpal et al., 2016) |
| | **26** | Isorhamnetin 3-*O*-rutinoside | *R. rugosa* | (Ayati et al., 2018) |
| | **27** | Spiraeoside | *R. rugosa* | (Ayati et al., 2018) |
| | **28** | Quercetin-3-*O*-(2″-*O*-galloyl)-*β*-*D*-glucuronide 6″-methyl ester | *R. davurica* | (Ma et al., 2013) |
| | **29** | Isoquercitrin | *R. rugosa* | (Zhang et al., 2017) |
| | **30** | Kaempferol-3-xyloside | *R. chinensis* | (Luo et al., 2020) |
| | **31** | Kaempferol 7-*O*-*β*-*D*-glucopyranoside | *R. rugosa* | (Niu et al., 2014) |
| | **32** | Kaempferol 4′-*O*-*β*-*D*-pyranoside | *R. davurica* | (Sun, 2016) |
| | **33** | Kaempferol-4′-*O*-glucosid | *R. davurica* | (Sun, 2016) |
| | **34** | Quercetin-3-*O*-*α*-*L*-rhamnopyranoside | *R. davurica* | (Sun, 2016) |
| | **35** | Kaempferol-3-*O*-rutinoside | *R. rugosa* | (Mikanagi, Saito, Yokoi, & Tatsuzawa, 2000) |
| | **36** | Kaempferol-3-*O*-arabinoside | *R. chinensis* | (Luo et al., 2020) |
| | **37** | Quercetin-4′-*O*-*β*-*D*-glucosid | *R. rugosa* | (Liu, 2013) |
| | **38** | Robinin | *R. rugosa* | (Liu, 2013) |
| | **39** | Quercetin-3-*O*-*β*-*D*-sophoroside | *R. chinensis* | (Wang et al., 2012) |
| | **40** | Quercetin-7-*O*-*β*-gentobioside | *R. chinensis* | (Wang et al., 2012) |
| | **41** | Kaempferol-3-*O*-*β*-*D*-sophoroside | *R. chinensis* | (Wang et al., 2012) |
| | **42** | Potengriffioside | *R. chinensis* | (Huang, 2015) |
| | **43** | Kaempferol-7-*O*-(5″-gallate)-arabinoside | *R. chinensis* | (Luo et al., 2020) |
| Flavanones | **44** | Hesperidin | *R. rugosa*, *R. canina* | (Ayati et al., 2018) |
| | **45** | Taxifolin | *R. laevigata* | (Gruenwald, Uebelhack, & More, 2019) |
| | **46** | Liquiritigenin | *R. laevigata* | (Zhang et al., 2012) |
| | **47** | Dihydrogenistein | *R. rugosa* | (Niu et al., 2014) |
| | **48** | Pinocembrin 7-*O*-*β*-*D*-glucoside | *R. rugosa*, *R. chinensis* | (Chen, Tan, Xiao, He, & Zhu, 2013; Liu, Song, Jiang, Cao, & Yan, 2015; Q. Zhao, Liu, Li, & Chen, 2012) |
| Dihydrochalcone | **49** | Phlorizin | *R. laevigata* | (Li, 2013) |
| Biflavone | **50** | Amentoflavone | *R. canina* | (Nadpal et al., 2016) |
| Anthocyanins | **51** | Pelargonidin 3-glucoside | *R. chinensis*, *R. canina* | (Cunja et al., 2016; Mikanagi et al., 2000) |
| | **52** | Cyanidine-3-glucoside | *R. chinensis*, *R. canina* | (Cunja et al., 2016; Mikanagi et al., 2000) |
| | **53** | Peonidin 3-glucoside | *R. chinensis*, *R. canina* | (Cunja et al., 2016; Mikanagi et al., 2000) |
| | **54** | Pelargonidin 3,5-diglucoside | *R. chinensis*, *R. canina* | (Cunja et al., 2016; Mikanagi et al., 2000) |
| | **55** | Cyanidin 3,5-diglucoside | *R. chinensis*, *R. canina* | (Cunja et al., 2016; Mikanagi et al., 2000) |
| | **56** | Peonidin 3,5-diglucoside | *R. chinensis*, *R. canina* | (Cunja et al., 2016; Mikanagi et al., 2000) |
| | **57** | Cyanidin 3-rutinoside | *R. chinensis*, *R. canina* | (Cunja et al., 2016; Mikanagi et al., 2000) |
| | **58** | Peonidin 3-rutinoside | *R. chinensis*, *R. canina* | (Cunja et al., 2016; Mikanagi et al., 2000) |
| | **59** | Cyanidin 3-sophoroside | *R. chinensis*, *R. canina* | (Cunja et al., 2016; Mikanagi et al., 2000) |
| | **60** | Cyanidin-3-*O*-coumarylglucoside-5-glucoside | *R. chinensis*, *R. canina* | (Cunja et al., 2016; Mikanagi et al., 2000) |
| | **61** | Peonidin-3-*O*-coumarylglucoside-5-glucoside | *R. chinensis*, *R. canina* | (Cunja et al., 2016; Mikanagi et al., 2000) |

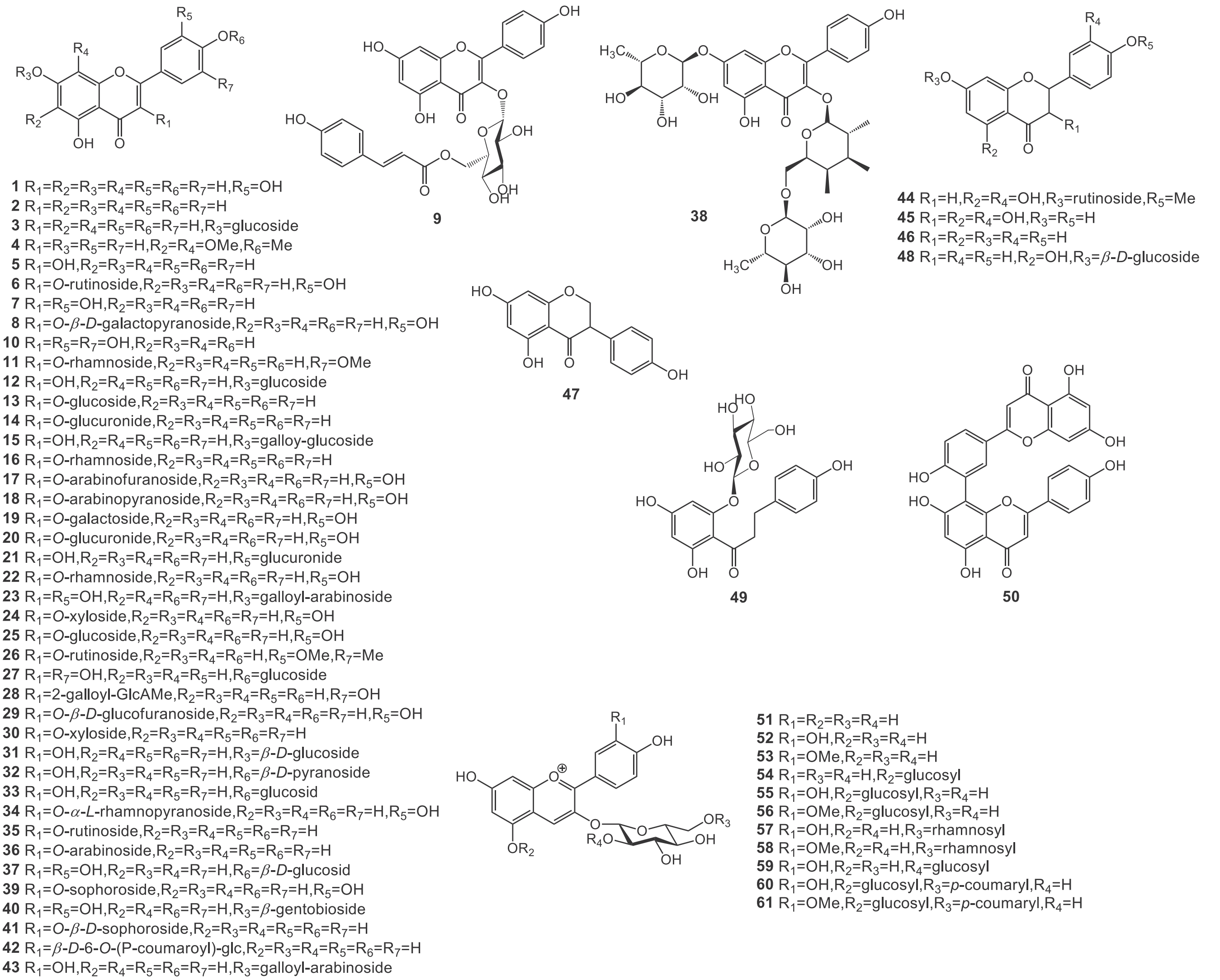


**Fig. 1.** Chemical structures of flavonoids isolated from *Rosa* genus.

reported in *R. laevigata*, *R. rugosa*, and *R. canina*. The chemical structures of all flavonoids found in the genus *Rosa* were shown in Fig. 1.

## 2.2. Triterpenoids

Triterpenoids and their glycosides, another major active ingredient, are widely distributed in many plants of genus *Rosa.* At present, triterpenoids were mainly found in the roots, leaves and fruits of *R. laevigata* (Tian et al., 2019; Yan et al., 2013; Yu et al., 2000), roots of *R. multiflora* (Jiang et al., 2020), roots of *R. odorata* var. *gigantea* (Lv et al., 2021), and fruits of *R. soulieana* (Huang, 2015). The main skeletons of triterpenoids in genus *Rosa* are pentacyclic triterpenoids. To date, 83 triterpenoids (Table 2) have been found in *Rosa* genus, which are mainly divided into three types: 58 ursanes (**62**–**119**), 16 oleananes (**120**–**135**) and nine lupanes (**136**–**144**). Many triterpenoids are reported in genus *Rosa*, but still fewer compounds with novel structures. Recently, a novel structure triterpenoid was found with E ring as split ring from the leaves of *R. laevigata* (Huang, 2015), which was first reported new 19-oxo-18,19-seco-ursane-type triterpenes in *Rosa* and exhibited anti-inflammatory activities at concentrations in the range 0.5–50 μg/mL *in vitro*. Furthermore, a triterpene with good anti-inflammatory activity was also reported in *R. laevigata* var. *leiocapus*, which designated as rosanortriterpene C. This compound belongs to the nortriterpenoids and against the production of nitric oxide (NO) in RAW264.7 cells stimulated by lipopolysaccharide (LPS) with $IC_{50}$ values of (10.35 ± 0.92) μmol/L (Tian et al., 2019). There are many studies on isolation and structure elucidation, but relatively few in content determination, which are only reported in *R. odorata* var. *gigantea* and the hips of *Rosa*. The content of triterpenoid was 1.93% in roots of *R. odorata* var. *gigantea* determined by colorimetry (Ma, Liu, & Yin, 2010). Triterpenoid content in rosehips from *Rosa* was analyzed by HPLC, and betulinic acid was 36–772 mg/kg, oleanolic acid was 66–1723 mg/kg, and ursolic acid was 37–2531 mg/kg, respectively (Bhave, Schulzova, Chmelarova, Mrnka, & Hajslova, 2017). Their chemical structures of triterpenoids in genus *Rosa* were showed in Fig. 2.

## 2.3. Tannins

Tannin is a kind of polyphenol substance, which exists in seeds, rhizomes and peels of the genus *Rosa* plants. According to the chemical structure of tannins, it can be divided into two categories: hydrolyzable tannins and condensed tannins. In recent years, seventy-five tannins (Table 3) were isolated from *Rosa* genus, including 58 hydrolyzable tannins (**145**–**202**) and 17 condensed

**Table 2**
Triterpenes found in genus *Rosa*.

| Compound class | No. | Compounds | Species | Refs. |
|---|---|---|---|---|
| Ursane | **62** | Ursolic acid | *R. cania* | (Gruenwald et al., 2019) |
| | **63** | Tormentic acid | *R. rugoa*, *R. cymosa* | (Cheng et al., 2016; Huang, 2015) |
| | **64** | 2α, 19α-dihydroxyurs-3-*O*-acetiltormentic acid | *R. multiflora* | (Jiang et al., 2020) |
| | **65** | 1α, 2α, 3α, 20β-tetrahydroxyurs-13(18)-en-28-oic acid | *R. multiflora* | (Jiang et al., 2020) |
| | **66** | 2α, 3α, 20β, 23-tetrahydroxyurs-13 (18)-en-28-oic acid | *R. cymosa* | (Ji et al., 2020; Jiang et al., 2020) |
| | **67** | 2β, 3α, 20β, 23-tetrahydroxyurs-13(18)-en-28-oic acid | *R. cymosa* | (Ji et al., 2020) |
| | **68** | 2-oxo-3β, 19α, 23-trihydroxyurs-12-en-28-oic-acid- 28-*O*-β-*D*-glucopyranosyl ester | *R. odorata* var. *giganta* | (Lv et al., 2021) |
| | **69** | 2α,3α,19α,22α-tetrahydroxyurs-12-en-28-oic acid | *R. cymosa* | (Fan et al., 2020) |
| | **70** | 2,19α-dihydroxy-3,11-dioxo-24-norursa-1,4,12-trien-28-oic acid (rosanortriterpene B) | *R. laevigata* | (Tian et al., 2021) |
| | **71** | 2α,3β,12β,23-tetrahydroxy-19-oxo-18,19-seco-urs-13(18)-en-28-oic acid (laeviginA) | *R. laevigata* | (Yan et al., 2013) |
| | **72** | 2α,3β,12β,23-tetrahydroxy-19-oxo-18,19-seco-urs-13(18)-en-28-*O*-β-*D*-glucopyrano-side (laeviginB) | *R. laevigata* | (Yan et al., 2013) |
| | **73** | 2α,3β,23-tri-hydroxy-19-oxo-18,19-seco-urs-11,13(18)-dien-28-*O*-β-*D*-glucopyranoside (laevigin C) | *R. laevigata* | (Yan et al., 2013) |
| | **74** | 3,24-dinor-2,4seco-ursane triterpene (rosanorposide C) | *R. laevigata* | (Tian et al., 2019) |
| | **75** | 1α,2α,3β,19α-tetrahydroxyurs-12-en-28-oic acid | *R. laevigata* | (Huang, 2015) |
| | **76** | 2α,3α,19α,23-tetrahydroxyurs-12-en-28-oic acid | *R. laevigata* | (Huang, 2015) |
| | **77** | 2α,3α,19α-trihydroxyurs-12-en-28-oic acid | *R. laevigata* | (Huang, 2015) |
| | **78** | 2α,3β,19α,23-tetrahydroxyurs-12-en-28-oic acid | *R. laevigata* | (Huang, 2015) |
| | **79** | 19α-hydroxyasiatic acid-28-*O*-β-*D*-glucopyrannoside | *R. laevigata* | (Huang, 2015) |
| | **80** | Euscaphic acid | *R. laevigata* | (Huang, 2015) |
| | **81** | 2α-hydroxyursolic acid | *R. laevigata* | (Huang, 2015) |
| | **82** | Pomolic acid | *R. laevigata* | (Huang, 2015) |
| | **83** | 2α,3α-dihydroxyurs-12-en-28-oic acid | *R. laevigata* | (Huang, 2015) |
| | **84** | 2α,3β,19α-trihydroxyurs-12-en-28-oic acid | *R. laevigata* | (Huang, 2015) |
| | **85** | 2α,3α,23-trihydroxyurs-12-en-28-oic acid | *R. laevigata* | (Huang, 2015) |
| | **86** | 2α,19α-dihydroxy-3-oxo-urs-12-en-28-oic acid | *R. laevigata* | (Huang, 2015) |
| | **87** | 2α,3β,19α-trihydroxyurs-12-en-28-oic acid β-*D*-glucopyranosyl ester | *R. laevigata* | (Huang, 2015) |
| | **88** | 2α,3α,19α-trihydroxyurs-12-en-28-oic acid β-*D*-glucopyranosyl ester | *R. laevigata* | (Huang, 2015) |
| | **89** | 2α,3β,19α,23-tetrahydroxyurs-12-en-28-oic acid β-*D*-glucopyranosyl ester (Niga-ichigoside F1) | *R. laevigata* | (Huang, 2015) |
| | **90** | Niga-ichigoside F2 | *R. laevigata* | (Huang, 2015) |
| | **91** | 2β,3β,19α-trihydroxyurs-12-en-28-oic acid | *R. laevigata*, *R. cymosa* | (Huang, 2015) |
| | **92** | Sericoside | *R. cymosa*, *R. multiflora* | (Huang, 2015) |
| | **93** | Ilexoside B | *R. cymosa*, *R. odorata* var. *gigantea* | (Huang, 2015) |
| | **94** | 1β,3β,19α-trihydroxy-2-oxo-urs-12-en-28-oic acid | *R. soulieana* | (Huang, 2015) |
| | **95** | 1α,2α,3β,19α-tetrahydroxyurs-12-en-28-oic acid | *R. soulieana* | (Huang, 2015) |
| | **96** | 1β,2α,3α,19α-tetrahydroxyurs-12-en-28-oic acid | *R. soulieana* | (Huang, 2015) |
| | **97** | 19α-ursofic acid | *R. soulieana* | (Huang, 2015) |
| | **98** | 2α,3β,19α,24-tetrahydroxyurs-12-en-28-oic acid | *R. soulieana* | (Huang, 2015) |
| | **99** | 2α,3α,24-trihydroxyurs-12,18-dien-28-oic acid β-*D*-glucopyranosyl ester | *R. laevigata* | (Yuan et al., 2008) |
| | **100** | 2α,3α,23-trihydroxyurs-12,19(29)-dien-28-oic acid β-*D*-glucopyranosyl ester | *R. laevigata* | (Yuan et al., 2008) |
| | **101** | 3β,19α,23-trihydroxy-2-oxo-12-ursen-28-oic acid (cymosic acid) | *R. cymosa* | (Wu et al., 2014) |
| | **102** | 3β,19α-dihydroxy-2-oxo-12-ursen-28-oic acid | *R. cymosa*, *R. odorata* var. *gigantea* | (Huang, 2015; Lv et al., 2021; Wu et al., 2014) |
| | **103** | 2α,19α-dihydroxy-3-oxo-12-ursen-28-oic acid | *R. cymosa* | (Wu et al., 2014) |
| | **104** | 2α,3α-dihydroxyurs-12,18-dien-28-acid | *R. laevigata* | (Dai, 2016) |
| | **105** | 1β-hydroxy-2-oxopomolic acid | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **106** | Fupenzic acid | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **107** | 2α,3α,19α-trihydroxy-11-oxo-urs-12-en-28-oic acid | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **108** | 2α, 3α-dihydroxyursa-12, 19 (29)-dien-28-oic acid | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **109** | Alpinoside | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **110** | 2α, 3β-dihydroxyurs-12, 19 (29)-dien-28-oic acid 28-*O*-β-*D*- glucopyranoside | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **111** | 3β-[(*R*-*L*-arabinopyranosyl)oxy]-20β-hydroxyursan-28-oic acid δ-lactone | *R. laevigata* | (Zeng et al., 2011) |
| | **112** | Cecropiacic acid | *R. cymosa*, *R. odorata* var. *gigantea* | (Huang, 2015; Lv et al., 2021) |
| | **113** | 2α,3α-dihydroxyurs-12,19-dien-28-oic acid 28-*O*-β-*D*-glucopyranoside rosamultic acid | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **114** | Rubuside B | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **115** | 2α,3α-dihydroxyurs-12,18-dien-28-oic acid 28-*O*-β-*D*-glucopyranosyl ester | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **116** | 2α,3β-dihydroxyurs-12,-18-dien-28-oic acid 28-*O*-β-*D*-glucopyranosyl ester | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **117** | Acetylursolic acid | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **118** | 2α-*O*-acetyltormentic acid | *R. laevigata* | (Dai et al., 2016) |
| | **119** | 2α,3β,11α,19α-tetrahydroxyurs-12-en-28-oic acid-β-*D*-glucopyranosyl ester | *R. laevigata* | (Li et al., 2021) |

(*continued on next page*)

**Table 2** (*continued*)

| Compound class | No. | Compounds | Species | Refs. |
|---|---|---|---|---|
| Oleanane | **120** | Oleanolic acid | *R. canina* | (Gruenwald et al., 2019) |
| | **121** | 2,19α-dihydroxy-3,11-dioxo-24-norolean-1,4,12-trien-28-oic acid (rosanortriterpene A) | *R. laevigata* | (Tian et al., 2021) |
| | **122** | 2α,3β,23,30-tetrahydroxyoleanolic-13(18)-en-28-*O*-β-*D*-glucopyranoside (laevigin D) | *R. laevigata* | (Yan et al., 2013) |
| | **123** | 3-*O*-*trans*-*p*-coumaroyl maslinic acid | *R. laevigata* | (Huang, 2015) |
| | **124** | 3-*O*-*cis*-*p*-coumaroyl maslinic acid | *R. laevigata* | (Huang, 2015) |
| | **125** | 2α,3α,19α,23-tetrahydroxyolean-12-en-28-oic acid | *R. laevigata*, *R. soulieana* | (Huang, 2015) |
| | **126** | 2α,3α,23-trihydroxyolean-12-en-28-oic acid | *R. laevigata*, *R. soulieana* | (Huang, 2015) |
| | **127** | Maslinic acid | *R. laevigata*, *R. soulieana* | (Huang, 2015) |
| | **128** | β-amyrin | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **129** | Sericoside | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **130** | Sericic acid | *R. soulieana*, *R. odorata* var. *gigantea* | (Huang, 2015; Lv et al., 2021) |
| | **131** | 2α,3β,19α-trihydroxyolean-12-en-28-oicacid-β-*D*-glucopyranosyl ester arjunetin | *R. cymosa* | (Huang, 2015) |
| | **132** | 19α-OH-3β-*E*-feruloyl corosolic acid | *R. laevigata* | (Li et al., 2017) |
| | **133** | Arjunic acid | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **134** | Rusaic acid B | *R. odorata* var. *gigantea* | (Lv et al., 2021) |
| | **135** | 2α,3α,19α,24-tetrahydroxyolean-12-en-28-*O*-β-*D*-glucopyranoside | *R. roxbunghii* | (Li et al., 2016) |
| Lupane | **136** | Betulinic acid | *R. laevigata* | (Huang, 2015) |
| | **137** | 2α,3β-dihydroxylup-20-en-28-oic acid | *R. laevigata* | (Huang, 2015) |
| | **138** | 2α,3β-dihydroxylup-20-en-28-acid methyl ester | *R. laevigata* | (Huang, 2015) |
| | **139** | 3-*O*-*trans*-*p*-coumaroyl alphitolic acid | *R. laevigata* | (Huang, 2015) |
| | **140** | 3-*O*-*cis*-p-coumaroyl alphitolic acid | *R. laevigata* | (Huang, 2015) |
| | **141** | 2α,3β,23-trihydroxylup-20(29)-en-28-oic acid | *R. laevigata* | (Huang, 2015) |
| | **142** | 2α,3β,24-trihydroxylup-20(29)-en-28-*O*-β-*D*-glucopyranoside | *R. laevigata* | (Dai, 2016) |
| | **143** | 2α,3β,23-trihydroxylup-12,18-dien-28-acid | *R. laevigata* | (Liu, Zhang, & Jin, 2013) |
| | **144** | Methyl betulinate | *R. cymosa* | (Chen, Li, Zhou, Wang, & Jiang, 2016) |

tannins (**203**–**219**). Therefore, hydrolyzed tannins are the dominant type of tannins which mainly exists in flowers of *R. chinensis* (Luo et al., 2020), flowers of *R. rugosa* (Ayati et al., 2018), roots of *R. cymosa* (Yoshi, Fenga, & Takuro, 1993), roots of *R. multiflora* (Marmol, Sanchez-de-Diego, Jimenez-Moreno, Ancin-Azpilicueta, & Rodriguez-Yoldi, 2017; Park et al., 2011; Park et al., 2010), and fruits of *R. laevigata* (Yoshida, Tanaka, & Chen, 1989). Many reports on tannins in *R. chinensis*, mainly focus on antioxidant capacity. An online system (HPLC-DAD-ESI-IT-TOF-MS-TACD) was established to test active antioxidant of tannins in *R. chinensis*, which accounted for >60% total antioxidant activity. Among them, ellagitannins contributed over 50% of the total antioxidant activity (Luo et al., 2020). Additionally, epicatechin as a monomer compound in condensed tannins was found in *R. canina*, while its content in this plant was not detected previously. The content of epicatechin in water, methanol extracts of fresh rose hips, and water, methanol extracts of air-dried rose hips were (2.35 ± 0.07), (2.92 ± 0.10), (1.72 ± 0.06) and (4.74 ± 0.20), respectively (Nadpal et al., 2016). Tannin is the most isolated ingredients in *Rosa*, and other tannins need to be further studied, the chemical structures of tannins in *Rosa* reported now were showed in Fig. 3.

### 2.4. Small-molecule phenolic acids

Phenolic acid is a kind of organic acid containing phenolic ring. Only ten small-molecule phenolic acids were reported in the genus *Rosa*, and their structures were elucidated as gallic acid (**220**) (Ayati et al., 2018; Davoodi et al., 2017), protocatechuic acid (**221**) (Ayati et al., 2018), methyl gallate (**222**) (Ayati et al., 2018), Salicylic acid (**223**) (Ayati et al., 2018), Methyl gallate 3-*O*-β-glucoside (**224**) (Ayati et al., 2018; Marmol et al., 2017), vanillic acid (**225**) (Marmol et al., 2017), ferulic acid (**226**) (Nadpal et al., 2016), *p*-hydroxybenzoic acid (**227**) (Nadpal et al., 2016), syringic acid (**228**) (Jimenez et al., 2017) and caffeic acid (**229**) (Jimenez et al., 2017), which were mainly obtained from hips of *R. chinensis*, *R. canina* and *R. damascena*. It was shown that gallic acid and protocatechuic acids were the most dominant phenolic acids in extract of *R. canina* using LC-MS/MS technique analysis and their contents in water and methanol extracts of fresh *R. canina* hips are about (11.3 ± 0.64), (1.86 ± 0.09) μg/g and (9.79 ± 0.39), (8.04 ± 0.32) μg/g of dw respectively (Nadpal et al., 2016). By analysis using HPLC, the content of methyl gallate 3-*O*-β-glucoside can reach 1.34 mg/g, and the recorded quantity of salicylic acid (0.26–1.7 mg/g) in *R. canina* is potentially safe for people's health (Ayati et al., 2018). Besides, through HPLC analysis, the concentrations of vanillic acid, syringic acid and caffeic acid were (0.26 ± 0.03), (0.11 ± 0.01) and (0.002 ± 0.001) μg/g respectively in *R. canina* (Jimenez et al., 2017). The research on phenolic acid content mostly focuses on *R. canina*, further research is needed on the chemical composition and content determination of small phenolic acids in this genus. And their chemical structures were showed in Fig. 4.

### 2.5. Polysaccharides

In recent years, natural polysaccharides have been widely studied for their combat oxidative stress. At present, ten kinds of polysaccharides have been reported in the genus *Rosa*. Selenium containing polysaccharides (Se-RLFP) (**230**) (Liu et al., 2018) and acid polysaccharide (PPRLMF-2) (**231**) (Zhan et al., 2020) were found in fruits of *R. laevigata*. Se-RLFP-1 was mainly composed of mannose, glucose, galactose and xylose, while Se-RLFP-2 was consisted of mannose, rhamnose, glucose, galactose and xylose. And PPRLMF-2 with a triple-helix conformation. RDPA1 (**232**) (Tong et al., 2016) were obtained in *R. davurica*, which could significantly inhibit human neutrophil migration evaluated and reduced *in vivo*

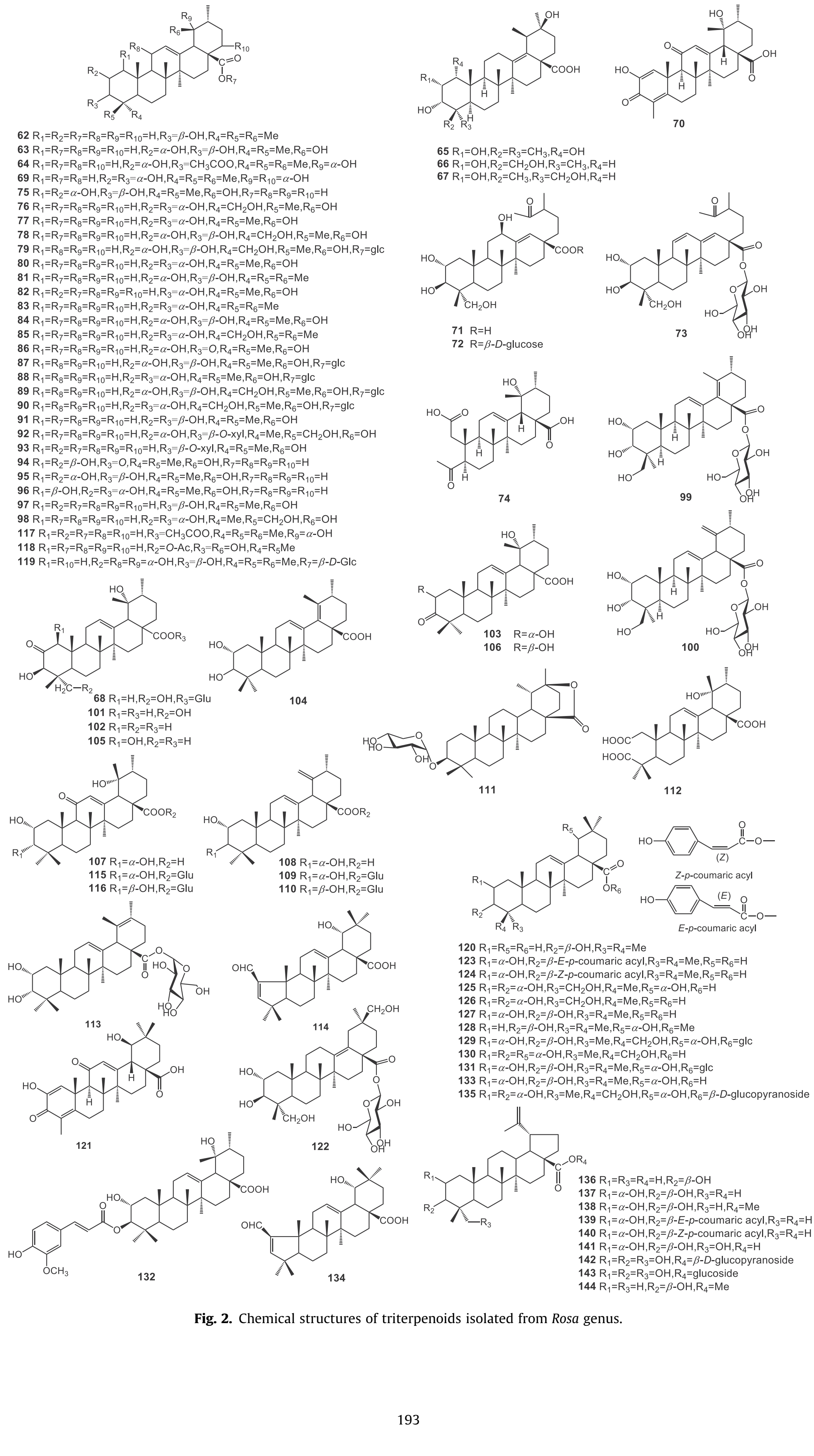


**Fig. 2.** Chemical structures of triterpenoids isolated from *Rosa* genus.

**Table 3**
Tannins found in genus *Rosa*.

| Compound class | No. | Compounds | Species | Refs. |
|---|---|---|---|---|
| Hydrolysable tannins | **145** | Di-galloylhexoside I | *R. chinensis*, *R. canina* | (Luo et al., 2020) |
| | **146** | 3-di-galloyl glucoside-4,5-dihydroxybenzoic acid | *R. chinensis*, *R. canina* | (Luo et al., 2020) |
| | **147** | 3-galloyl glucoside-4,5-dihydroxybenzoic acid | *R. chinensis*, *R. canina* | (Luo et al., 2020) |
| | **148** | Tetra-galloylglucoside | *R. chinensis*, *R. canina* | (Luo et al., 2020) |
| | **149** | Di-galloylhexoside II | *R. chinensis*, *R. canina* | (Luo et al., 2020) |
| | **150** | Ellagic acid | *R. canina* | (Marmol et al., 2017) |
| | **151** | Tellimagrandin I | *R. rugosa*, *R. canina* | (Ayati et al., 2018) |
| | **152** | Tellimagrandin II | *R. rugosa*, *R. canina* | (Ayati et al., 2018) |
| | **153** | Rugosin A | *R. chinensis* | (Luo et al., 2020) |
| | **154** | Rugosin B | *R. chinensis* | (Luo et al., 2020) |
| | **155** | Rugosin A methyl ester | *R. chinensis* | (Luo et al., 2020) |
| | **156** | Rugosin B methyl ester | *R. chinensis* | (Luo et al., 2020) |
| | **157** | Rugosin B isomer I | *R. chinensis* | (Luo et al., 2020) |
| | **158** | Rugosin B isomer II | *R. chinensis* | (Luo et al., 2020) |
| | **159** | Rugosin B isomer III | *R. chinensis* | (Luo et al., 2020) |
| | **160** | Tellimagrandin I isomer | *R. chinensis* | (Luo et al., 2020) |
| | **161** | Tellimagrandin II isomer | *R. chinensis* | (Luo et al., 2020) |
| | **162** | Rugosin B methyl ester isomer IV | *R. chinensis* | (Luo et al., 2020) |
| | **163** | HHDP glucoside I | *R. chinensis* | (Luo et al., 2020) |
| | **164** | HHDP glucosideII | *R. chinensis* | (Luo et al., 2020) |
| | **165** | HHDP glucosideIII | *R. chinensis* | (Luo et al., 2020) |
| | **166** | HHDP glucoside IV | *R. chinensis* | (Luo et al., 2020) |
| | **167** | Rugosin C | *R. chinensis* | (Luo et al., 2020) |
| | **168** | Ellagic acyl-*O*-tellimagrandin II | *R. chinensis* | (Luo et al., 2020) |
| | **169** | Davurica M1 | *R. davurica* | (Li Wang, 2006) |
| | **170** | *L*-asparagine-rugosin B | *R. chinensis* | (Luo et al., 2020) |
| | **171** | Pedunculagin | *R. rugosa* | (Yoshida, Chen, Hatano, Fukushima, & Okuda, 1987) |
| | **172** | Stachyurin | *R. rugosa* | (Yoshida et al., 1987) |
| | **173** | Potentillia | *R. rugosa*, *R. laevigata* | (Yoshida et al., 1989) |
| | **174** | Stachyurin | *R. roxbunghii* | (Yoshida et al., 1987) |
| | **175** | Methyl gallate 3-*O*-*β*-*D*(6′-*O*-galloyl) glucopyranoside | *R. rugosa* | (Park, Young, & Lee, 1993) |
| | **176** | SanguiinH-2 | *R. rugosa* | (Olech et al., 2019; Yoshida et al., 1987) |
| | **177** | Casuarictin | *R. rugosa*, *R. davurica* | (Wang, 2006; Yoshi et al., 1993) |
| | **178** | RocymosinA | *R. rugosa* | (Yoshida et al., 1987) |
| | **179** | SanguiinH-4 | *R. rugosa*, *R. laevigata* | (Olech et al., 2019; T Yoshida et al., 1989) |
| | **180** | *p*-Hydroxybenzoic acid-4-*O*-*β*-*D*-glucopyranoside | *R. laevigata* | (Li, 2013) |
| | **181** | Methyl 3-*O*-(*β*-*D*-glucopyranosyl) gallate | *R. chinensis* | (Zhao et al., 2012) |
| | **182** | Benzyl-6′-*O*-galloyl-*β*-*D*-glucopyranoside | *R. chinensis* | (Zhao et al., 2012) |
| | **183** | (+)-guibourtinidol-(4*β*,8)-epicatechin | *R. odorata* var. *gigantea* | (Zhao, 2012) |
| | **184** | (+)-Taxifolin-3-*O*-*β*-apio-*D*-furanoside | *R. davurica* | (Wang, 2006) |
| | **185** | Rugosin D | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Yoshida et al., 1987) |
| | **186** | Rugosin E | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Li et al., 2017) |
| | **187** | Rugosin F | *R. roxbunghii* | (Yoshida et al., 1987) |
| | **188** | Roshenin A | *R. rugosa* | (Yoshida, Feng, & Okuda, 1992) |
| | **189** | Roshenin B | *R. rugosa* | (Yoshida et al., 1992) |
| | **190** | Roshenin C | *R. rugosa* | (Yoshida et al., 1992) |
| | **191** | Roshenin D | *R. rugosa* | (Yoshida et al., 1992) |
| | **192** | Roshenin E | *R. rugosa* | (Yoshida et al., 1992) |
| | **193** | Sanguiin H-6 | *R. rugosa* | (Yoshida et al., 1992) |
| | **194** | Agrimoniin | *R. rugosa* | (Yoshida et al., 1989) |
| | **195** | Agrimonic acid A | *R. rugosa* | (Yoshida et al., 1989) |
| | **196** | Agrimonic acid B | *R. rugosa* | (Yoshida et al., 1989) |
| | **197** | Roxbin A | *R. roxburghii* | (Yoshida et al., 1987) |
| | **198** | Roxbin B | *R. roxburghii* | (Yoshida et al., 1987) |
| | **199** | Davuriciin D1 | *R. roxbunghii*, *R. davurica* | (Wang, 2006; Yoshida et al., 1987) |
| | **200** | Davuriciin D2 | *R. davurica* | (Wang, 2006) |

**Table 3** (*continued*)

| Compound class | No. | Compounds | Species | Refs. |
|---|---|---|---|---|
| | **201** | Lambertiannin A | *R. rugosa* | (Yoshida et al., 1987) |
| | **202** | Davurica T1 | *R. davurica* | (Wang, 2006) |
| Condensed tannins | **203** | Catechin | *R. multiflora* | (Marmol et al., 2017) |
| | **204** | Epicatechin | *R. multiflora* | (Marmol et al., 2017) |
| | **205** | Ent-guibourtinidol-(4$\beta$ → 6)-catechin | *R. multiflora* | (Park et al., 2011; Park et al., 2010) |
| | **206** | Ent-fisetinidol-(4$\beta$ → 6)-catechin | *R. multiflora* | (Park et al., 2011; Park et al., 2010) |
| | **207** | (6*S*,7*S*,8*R*)-2-(3,4-dihydroxyphenyl)-6-(4-hydroxyphenyl)-8-(2,4-dihydroxyphenyl)-2,3-*trans*-6,7-*cis*-7,8-*trans*-3,4,7,8-tetrahydro-2*H*,6*H*-pyrano [2,3-f] chromene-3,7,9-triol | *R. multiflora* | (Park et al., 2011; Park et al., 2010) |
| | **208** | Procyanidin trimer | *R. cymosa* | (Yoshi et al., 1993) |
| | **209** | ProcyanidinB3-3-*O*-gallate | *R. cymosa* | (Yoshi et al., 1993) |
| | **210** | 8-acetic acid-catechin | *R. laevigata* | (Li, 2013) |
| | **211** | Fisetinidol(4$\alpha$ → 8)-catechin | *R. laevigata* | (Li, 2013) |
| | **212** | Guibourtinidol(4$\beta$ → 8)-catechin | *R. laevigata* | (Li, 2013) |
| | **213** | Fisetinidol(4$\beta$ → 8)-catechin | *R. laevigata* | (Li, 2013) |
| | **214** | Epiguibourtinidol-(4$\alpha$ → 8)-catechin | *R. laevigata* | (Li, 2013) |
| | **215** | Dehydrodicatechin A | *R. laevigata* | (Li, 2013) |
| | **216** | (-)-epigallocatechin | *R. odorata* var. *gigantea* | (Zhao, 2012) |
| | **217** | Procyanidin B-1 | *R. laevigata* | (Xu, Yuan, & Du, 2003) |
| | **218** | Procyanidin B-2 | *R. cymosa* | (Yoshi et al., 1993) |
| | **219** | Procyanidin B-3 | *R. multiflora* | (Park et al., 2011) |

neutrophil infiltration. Thus, RDPA1 could be considered as a potential candidate for developing a novel anti-inflammatory agent. $\beta$-Glucans (**233**) (Olech et al., 2019), pectic bee pollen polysaccharide (RBPP-P) (**234**) (Li et al., 2017), RRPS-1 (**235**) and RRPS-2 (**236**) (Zhang et al., 2019) were discovered in petals, leaves, hips, and achenes of *R. rugosa*, RRTP1-1 (**237**) (Chen & Kan, 2018), RTFP (**238**) (Wang, Li, Huang, & Fu, 2020) were found in fruits of *R. roxburghii*, and pectic polysaccharide (**239**) (Ognyanov et al., 2016) were derived from hip fruits *R. canina*. At present, the research on polysaccharides mainly focuses on the biological activities such as anti-inflammatory and antioxidant. However, the polysaccharides in *Rosa* need to be further studied.

### 2.6. Organic acids and fatty acids

Organic acids were found in genus *Rosa* were listed as follows: citric acid (**240**), malic acid (**241**), quinic acid (**242**), tartaric acid (**243**), shikmic acid (**244**), fumaric acid (**245**), oxalic acid (**246**) and succinic acid (**247**) (Ayati et al., 2018). Additionally, a small amount of fatty acids were also gained from genus *Rosa*, such as palmitic acid (**248**), linolenic acid (**249**), linoleic acid (**250**), oleic acid (**251**), stearic acid (**252**), arachidonic acid (**253**) (Ayati et al., 2018; Marmol et al., 2017), arachidic acid (**254**) and erucic acid (**255**) (Ayati et al., 2018). The major fatty acid in all rose hip species are palmitic acid and linoleic acid (Ayati et al., 2018). In fruits of wild rose species including *R. canina* and *R. rugosa*, the total content of linoleic acid, oleic acid, palmitic acid and stearic acid accounted for 97% of seed oil through GC examination. In seed oil of *R. canina*, the content of linoleic acid, linolenic acid and oleic acid was 19.37%, 54.05% and 19.50% by the AOAC methods, respectively (Marmol et al., 2017). Their chemical structures were showed in Fig. 5.

### 2.7. Others

In addition to the above ingredients, there are some other components such as carotenoids and vitamins. At present, only 15 carotenes (**256**–**270**) and two vitamins (**271**–**272**) are reported (Table 4). Vitamin C in rose hips has a wide range of concentration. It was reported that the concentration of hips is (101 ± 1) μg antioxidant/g dry fruit of vitamin C in *R. canina* (Jimenez et al., 2017). The amount of vitamin C in *R. canina* extracts ranged from 0.56 to 3.73 mg/g of dw, and the highest content of vitamin C in *R. canina* water extract of dried hips (31.48 mg/100 g of fresh fruit), which was lower than its amount in mild-temperature-dried full ripe rose hips (211 mg/100 g fresh fruit) (Nadpal et al., 2016). Moreover, carotenoid is a dietary antioxidant, which represents mainly lycopene, $\beta$-carotene, and only traces of lutein and zeaxanthin in rosehips. But carotenoids in *R. multiflora* belong to the category of low antioxidant, and ranged from 32 mg/kg to 167 mg/kg for $\beta$-carotene and from 21 mg/kg to 141 mg/kg for lycopene (Bhave et al., 2017). Their chemical structures were showed in Fig. 6.

## 3. Pharmacological effects

With the development of economy and the improvement of people's living standards, many chronic diseases such as cancer, chronic inflammatory diseases, hyperglycemia, cardiovascular and cerebrovascular diseases, neurological diseases, etc. have rapidly increased (Hajat, Kaufman, Rose, Siddiqi, & Thomas, 2010). There is the theory of preventive treatment of disease from traditional Chinese medicine (TCM) in China. It has been recorded in the *Compendium of Materia Medica* of Ming Dynasty that *R. chinensis* and *R. laevigata* can be used as medicine. *R. chinensis* has the effect of removing blood stasis and activating blood circulation, and *R. laevigata* can secure essence and reduce urination. Also, *R. rugosa* was mentioned in *A Supplement to Compendium of Materia Medica*, and its effect is to soothe the liver and relieve depression. Now, *R. chinensis*, *R. rugosa* and *R. laevigata*, named "Yuejihua", "Meiguihua" and "Jinyingzi" in Chinese, in TCM, are also included in *Chinese Pharmacopoeia*. As the saying goes, diet cures more than the medicine. People soak the flowers of *R. chinensis* and the flowers of *R. rugosa* in water in their daily life for promoting blood circulation, relieving pain and for beauty, anti-inflammatory and throat moistening, respectively. Some people drink a little of the "Jinyingzi" wine every day for tonifying kidney which is used to improve kidney deficiency.

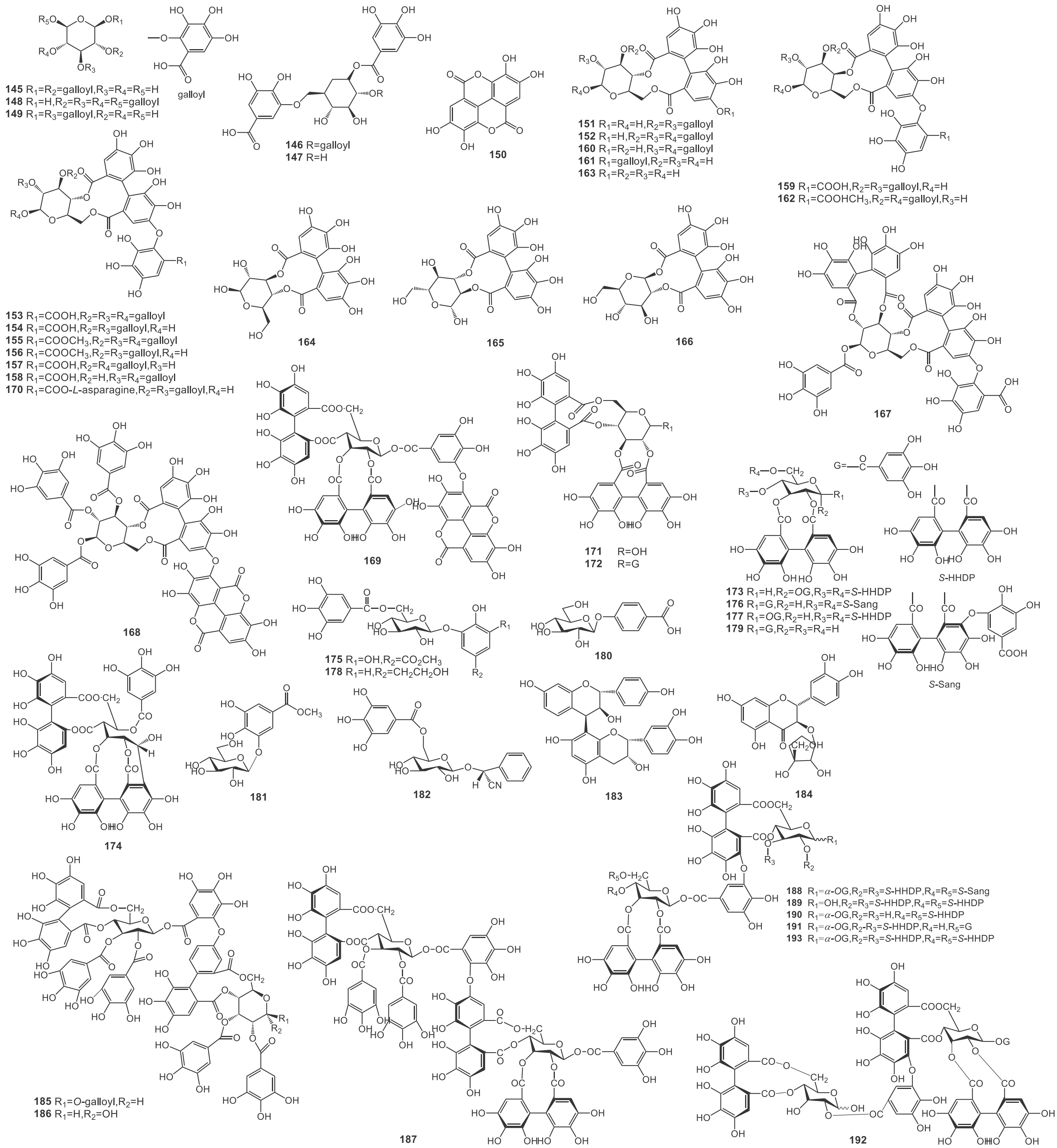

**Fig. 3.** Chemical structures of tannins isolated from *Rosa* genus.

According to related literatures, this genus has antineoplastic and anti-cancer properties, anti-inflammatory, antioxidant, liver protect, regulate blood sugar, antimicrobial effect, antiviral activity, nervous system protection and cardiovascular protect, and can be used to treat arthritis, diabetes, depression and other diseases. The plants of medicine and food homology have unique advantages for preventive treatment of disease such as improving chronic diseases and delaying aging (Gong et al., 2020).

### 3.1. Antineoplastic and anti-cancer properties

The occurrence of cancer and tumor is a chronic and gradual process. In recent years, *Rosa* plants have been reported to have antineoplastic and anti-cancer properties, which can effectively inhibit the growth and metastasis of cancer cells, promote the apoptosis of cancer cells, and play different roles in tumor therapy. For example, alcohol extract of *R. cymosa* fruits may fight leukemia;

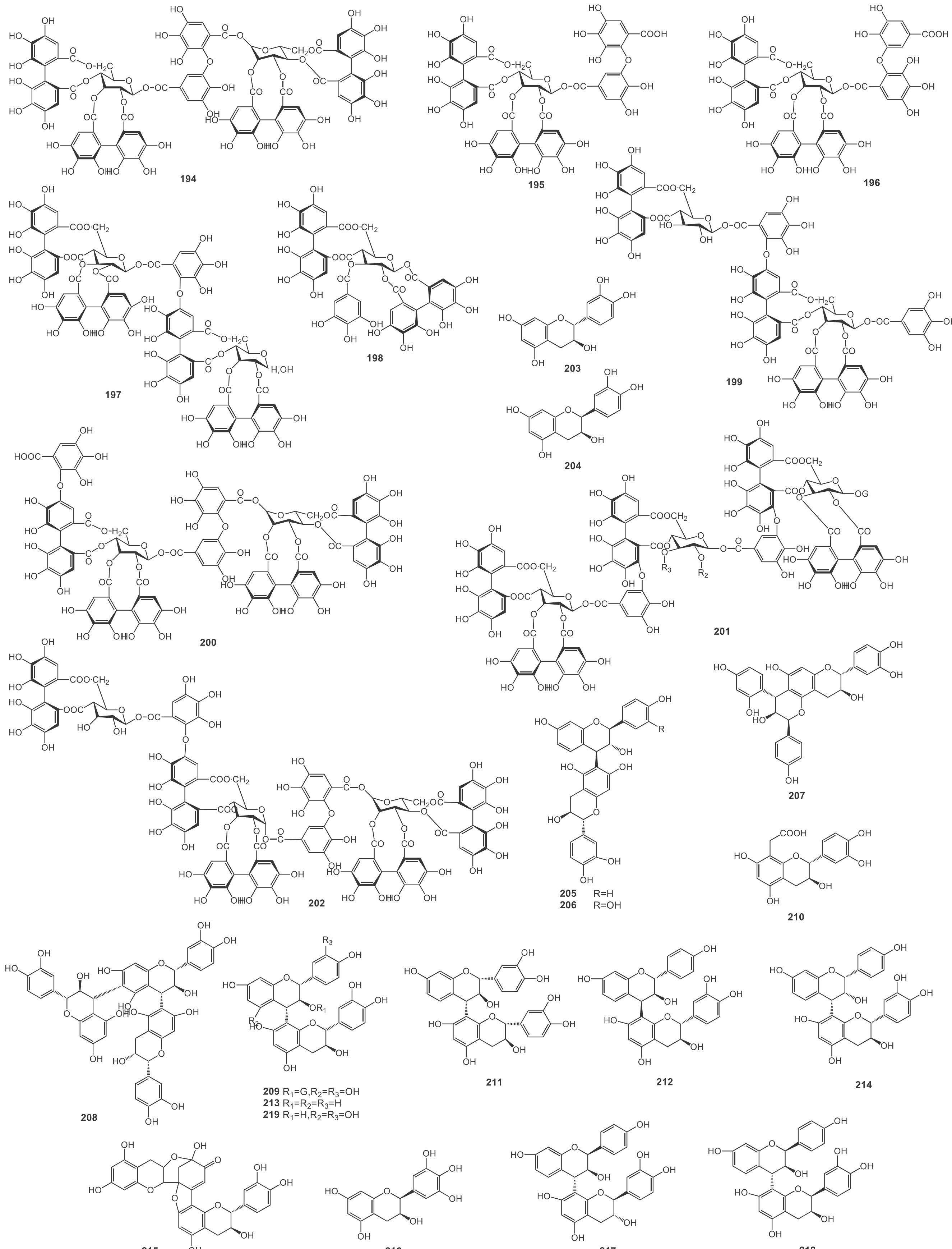


**Fig. 3** (*continued*)

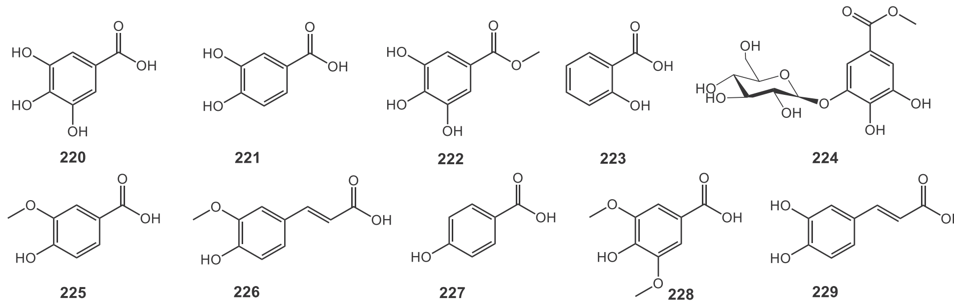


**Fig. 4.** Chemical structures of small-molecule phenolic acids isolated from *Rosa* genus.

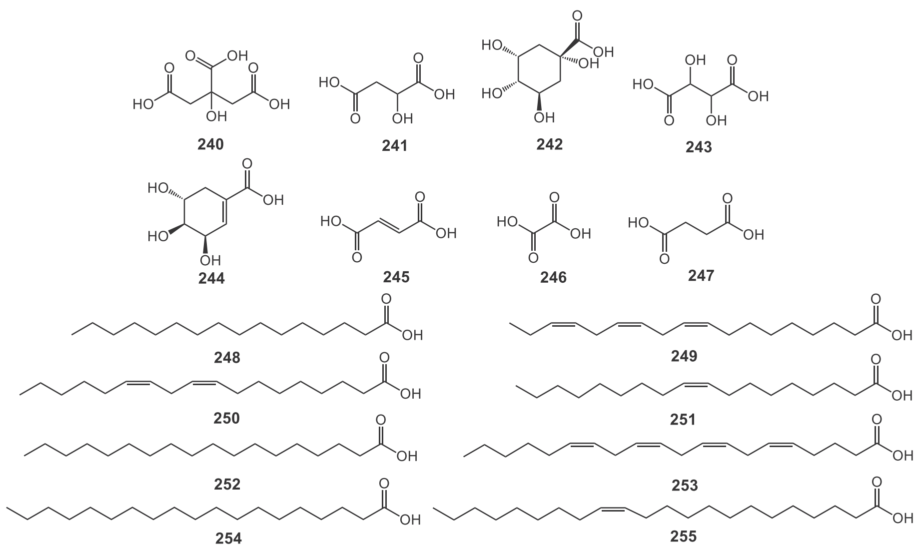


**Fig. 5.** Chemical structures of organic acids and fatty acids isolated from *Rosa* genus.

**Table 4**
Other compounds found in genus *Rosa*.

| Compound class | No. | Compounds | Species | Refs. |
|---|---|---|---|---|
| Carotenoids | **256** | Lycopene | *R. canina* | (Ayati et al., 2018; Marmol et al., 2017) |
| | **257** | *β*-carotene | *R. canina* | (Ayati et al., 2018; Marmol et al., 2017) |
| | **258** | Lutein | *R. canina* | (Ayati et al., 2018) |
| | **259** | Rubixanthin | *R. canina* | (Ayati et al., 2018) |
| | **260** | Zeaxanthin | *R. canina* | (Ayati et al., 2018) |
| | **261** | Neochrome | *R. canina* | (Wan et al., 2018) |
| | **262** | Xanthophyll | *R. rugosa* | (Wan et al., 2018) |
| | **263** | (13*Z*)-violaxanthin | *R. rugosa* | (Wan et al., 2018) |
| | **264** | (9*Z*)-violaxanthin | *R. rugosa* | (Wan et al., 2018) |
| | **265** | (all-*E*)-violaxanthin | *R. rugosa* | (Wan et al., 2018) |
| | **266** | Antheraxanthin | *R. rugosa* | (Wan et al., 2018) |
| | **267** | Lutein epoxide | *R. rugosa* | (Wan et al., 2018) |
| | **268** | (13*Z*)-*β*-carotene | *R. rugosa* | (Wan et al., 2018) |
| | **269** | (all-*E*)-*β*-carotene | *R. rugosa* | (Wan et al., 2018) |
| | **270** | (9*Z*)-*β*-carotene | *R. rugosa* | (Wan et al., 2018) |
| Vitamines | **271** | Ascorbic acid (vitamin C) | *R. canina*, *R. damascene*, *R. davurica* | (Akram et al., 2020; Ayati et al., 2018; Nadpal et al., 2016) |
| | **272** | Tocopherols (vitamin E) | *R. rugosa*, *R. canina* | (Ayati et al., 2018; Bhave et al., 2017; Fattahi, Niyazi, Shahbazi, Farzaei, & Bahrami, 2017) |

*R. cymosa* fruits polysaccharides protect against ovarian cancer. Besides, flavonoids, oleanane triterpenes and other components in *Rosa* also have a certain effect on bladder cancer, prostate cancer and lung cancer.

Assessed antileukemic activity of the ethanolic extract of *R. cymosa* fruits by inhibiting the tumor growth of human lymphoblastic leukemia Molt-4 cells in the xenograft animal model, which proves that the ethanolic extract of *R. cymosa* fruits

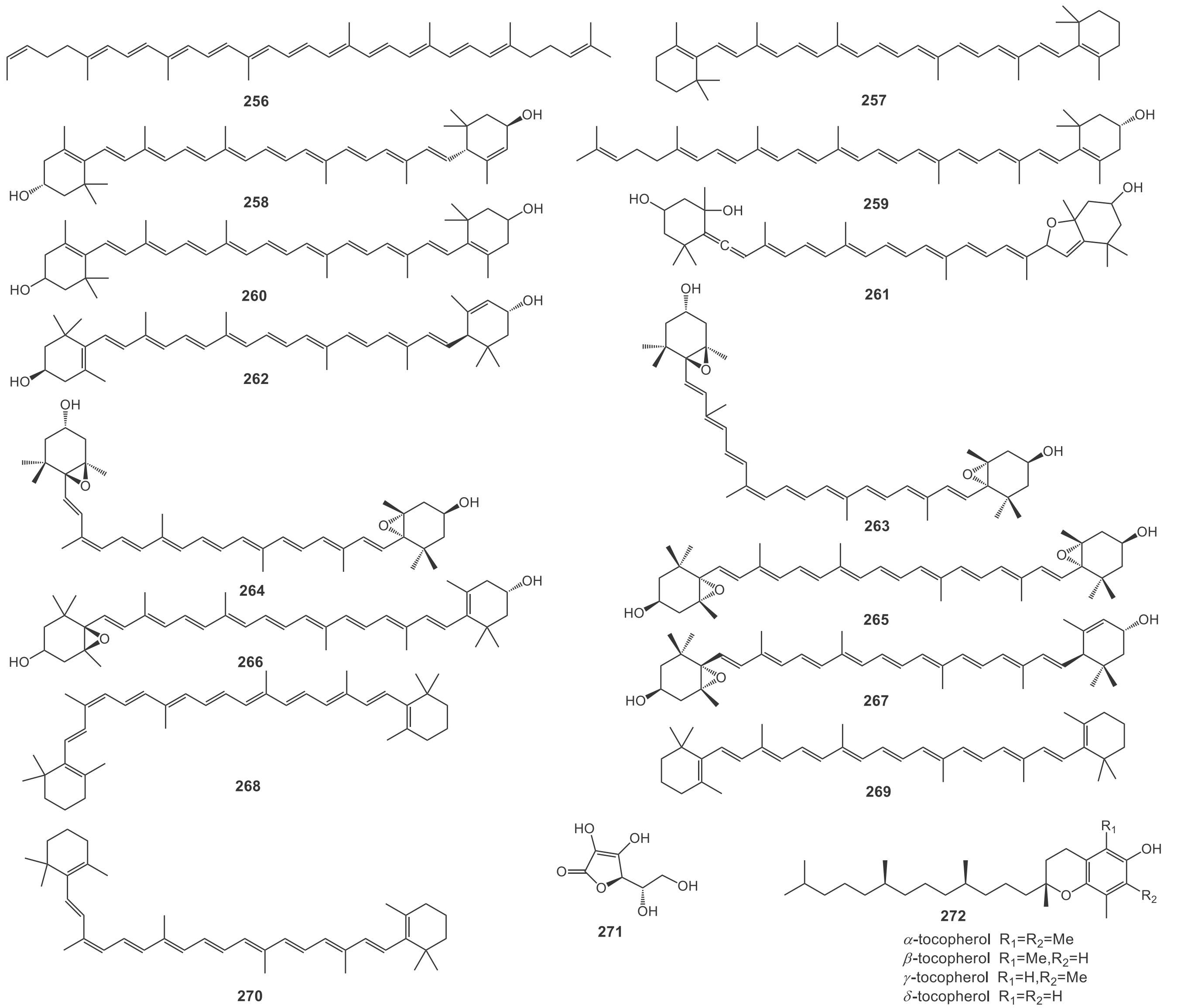


**Fig. 6.** Chemical structures of other compounds isolated from *Rosa* genus.

(150 μg/ml) exhibited antileukemia effect through reactive oxygen species (ROS) and endoplasmic reticulum (ER) stress-mediated apoptosis leading to Molt-4 cell death via the overexpression of phosphatase and tensin homolog (PTEN) and the dysregulation of PI3K/Akt and Jak/Stat 3 signaling pathways (Wang et al., 2019). Epithelial ovarian cancer A2780 cell incubation with crude polysaccharides extracted from *R. roxburghii* (200 and 400 μg/ml) led to a decreased expression of matrix metalloprotease-9 (MMP-9), which indicated crude polysaccharides induced strong cytotoxicity on epithelial ovarian cancer cell line and reduced cell migration (Chen et al., 2014). In addition, flavonoids in the genus *Rosa* have a good inhibitory effect on tumors and cancer cells. Among *Rosa* plants, *R. rugosa, R. chinensis, R. laevigata, R. canina* are rich in flavonoids. Apigenin inhibited proliferation of bladder cancer T24 cells, induced apoptosis and G2/M cycle arrest, and inhibited migration and invasion of T24 cells, which play the role by inhibiting PI3K/PDK/Akt pathway, regulating Bcl-2 protein and inducing apoptosis in T24 cells (Zhu, 2016). Naringin (200 and 400 μmol/L) could significantly inhibit the proliferation, adhesion, invasion and migration of gastric cancer SGC-7901 cells *in vitro*, and reduce the expression of MMP-2 and MMP-9 in gastric cancer cells. (Jia et al., 2016). Quercetin is a competitive MMP-9 inhibitor, which can induce the decrease of MMP-9 activity, and lead to the decrease of MMP-9 mRNA, MMP-9 protein and TGF-$\beta$1 protein expression, and ultimately plays an important role in the apoptosis of lung cancer A549 cells (Zhao & Zhang, 2015). Luteolin (80 μmol/L) can significantly induce apoptosis and cell cycle arrest of human non-small cell lung cancer (NSCLC) cell line A549. Its possible molecular mechanism is to up-regulate JNK phosphorylation, then activate mitochondrial apoptosis pathway and inhibit NF-κB into the nucleus so that it unable to exert transcriptional activity (Hu, Cai, Hu, Lu, & Cao, 2012). The inhibitory effects of oleanane triterpenes on tumors and cancers have also been reported. Arjunic acid, as a potent chemotherapeutic agent for NSCLC, can induce apoptosis of A549 and H460 non-small cell lung cancer cells via JNK mediated ER stress apoptotic pathway, activated Bax and phosphorylation of c-Jun N-terminal kinases (JNK), and also attenuated the expression of pro-caspase3 and Bcl-2, upregulated the expression of endoplasmic reticulum (ER) stress proteins such as IRE1α, ATF4, p-eIF2α, and C/EBP homologous protein (CHOP) (Joo et al., 2016).

*Rosa* plants are an important source of anti-tumor active drugs, the inhibitory effect on tumors and cancer cells is mainly reflected in the regulation of relevant signaling pathways, adjusting protein

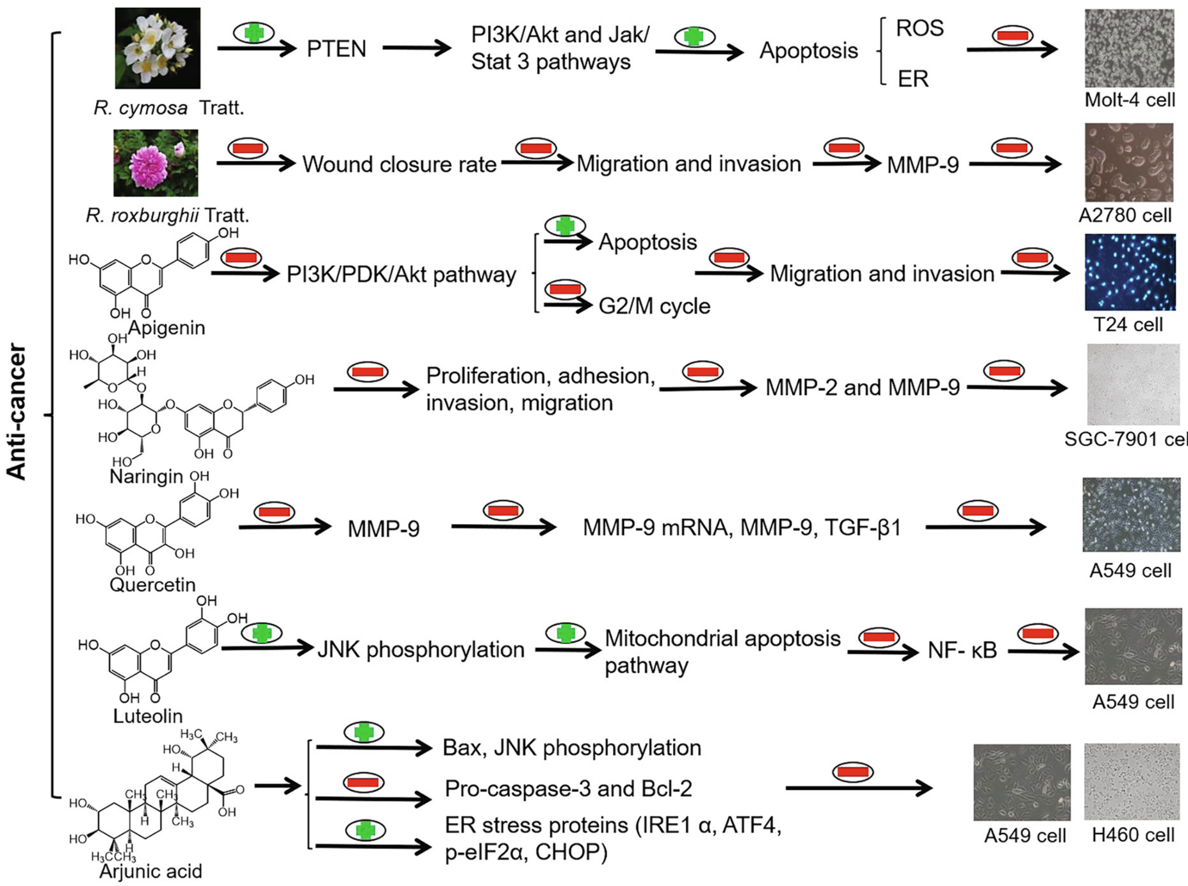


**Fig. 7.** Anti-cancer effects of some natural ingredients from *Rosa*.

expression, reducing the migration and transcription of cancer cells, and increasing apoptosis (Fig. 7). In recent years, more and more flavonoids and triterpenoids have been reported in anti-cancer, indicating that these components have a certain pharmacodynamic material basis. In-depth research on the prevention and treatment of cancer from the roots of Chinese medicine and food of the genus *Rosa* is of far-reaching significance.

### *3.2. Anti-inflammatory activity*

Inflammation is a guarding mechanism against different harmful stimuli (Tursun et al., 2016). Clinically, non-steroidal anti-inflammatory drugs are commonly used to treat inflammation, but their adverse effects, such as gastrointestinal irritation, platelet dysfunction, and nephrotoxicity, become potential threatens to patients' health (Yan et al., 2013). Therefore, it has become the focus of current research to develop effective anti-inflammatory ingredients from natural plants, especially medicine and food homologous plants.

The flowers of *R. rugosa*, named "Meiguihua" in Chinese, were soaked in water as a tea drink to improve the body health care. The research report showed that the phenolic compounds extract of *R. rugosa* (PRE) significantly inhibited production of nitric oxide (NO), prostaglandin E2 (PGE2), TNF-α, IL-6, and IL-1β, as well as expression of their synthesizing enzymes, inducible nitric oxide synthase (iNOS) and cyclooxygenase 2 (COX-2) in LPS-induced RAW 264.7 macrophages. PRE also inhibited activity of mitogen-activated protein kinases (MAPK) as well as nuclear factor-kappa B (NF-κB) signaling pathway (Tursun et al., 2016). *In vivo* testing of carrageenin-induced rat paw edema model, the extracts of *R. canina* fruits significantly inhibit the carrageenin-induced rat paw edema by gavage, and the anti-inflammatory power is similar to that of indomethacin. Moreover, the treatment with a higher dose (200 mg/Kg) of the extract shows a more pronounced anti-inflammatory effect (Lattanzio et al., 2011). In addition, *R. canina* preparations display potent anti-inflammatory activities in terms of treating osteoarthritis. The mechanisms include the reduction of pro-inflammatory cytokines and chemokines, reduction of NF-κB signaling, inhibition of pro-inflammatory enzymes, including COX1/2, 5-LOX and iNOS, reduction of C-reactive protein levels, reduction of chemotaxis and chemoluminescence of PMNs, and inhibition of pro-inflammatory metalloproteases (Gruenwald et al., 2019). *R. damascena* hydroalcoholic extract (250, 500, 1000 mg/kg) and *R. damascena* volatile oil (100, 200, 400/kg) have an effect on ulcerative colitis induced by acetic acid in rats by gavage, and only the lowest doses of *R. damascena* volatile oil could alleviate the colitis indices (Latifi et al., 2015). The flavonoids of *R. roxburghii* Tratt (FRT) have protective effects on against γ-radiation-induced apoptosis and inflammation in mouse thymus cells *in vivo* and *in vitro*. FRT (30 or 60 mg/kg) was administered orally enhanced radioprotection at least partially by regulating ICAM-1, IL-6, and TNF-α/NF-κB in order to ultimately reduce inflammation (Xu et al., 2018). A polysaccharide (RDPA1) from *R. davurica*, which have inhibitory effects on neutrophil migration. RDPA1 (200 μg/ml) could significantly inhibit human neutrophil migration, reduced *in vivo* neutrophil infiltration in the peritonitis mice and blocking capacity of the interaction between β2 integrins and their endogenous ligand ICAM-1, which mediates neutrophil migration on the endothelium (Tong et al., 2016). Besides, isorhamnetin, 3-*O*-methylated metabolite of quercetin, signifi-

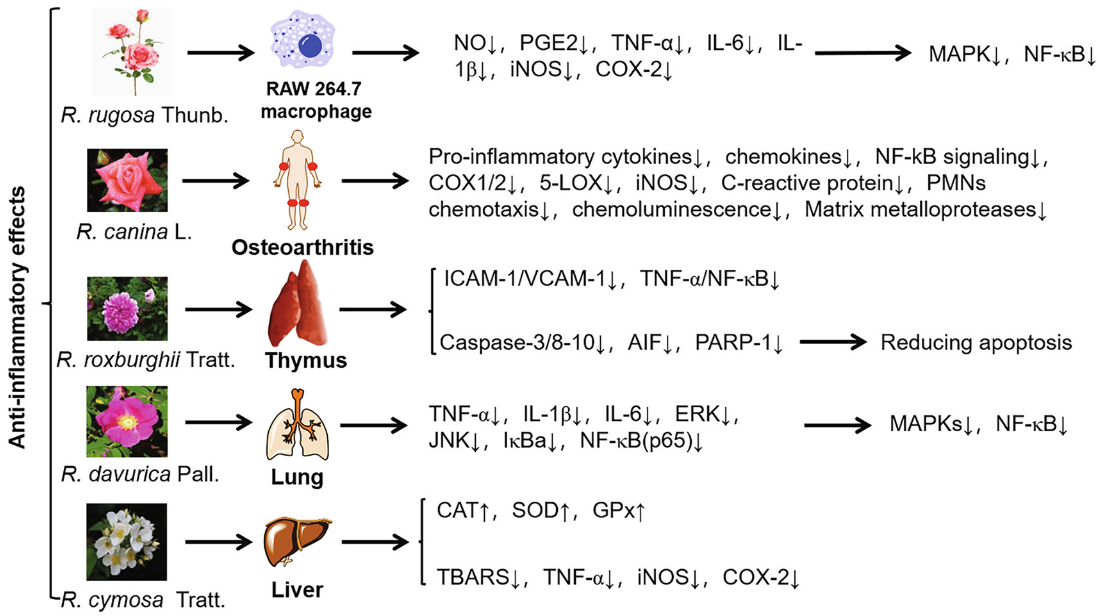


**Fig. 8.** Anti-inflammatory effects of some medicinal plants from genus *Rosa*.

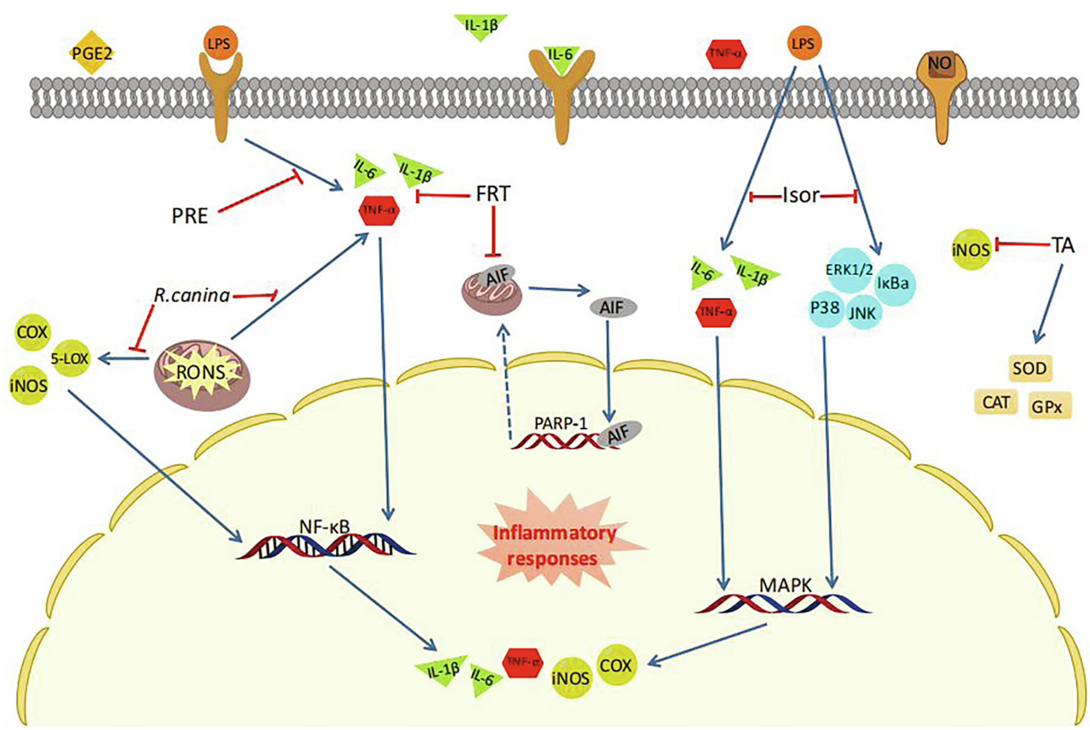


**Fig. 9.** Anti-inflammatory mechanism and pathways of genus *Rosa*. (PRE: Extract of *R. rugosa*; FRT: Flavonoids of *R. roxburghii*; Isor: isorhamnetin; TA: tormentic acid).

cantly inhibited LPS-induced secretion of TNF-α, IL-1β and IL-6 *in vitro* and *in vivo*, and the results showed that isorhamnetin (30, 60 mg/kg) had a protective effect on an LPS-induced acute lung injury model via intragastric administration (Chi et al., 2016). Tormentic acid (2.5 mg/kg) have an anti-inflammatory effect *in vivo* by i.p. treated. It exhibits anti-inflammatory effect by increasing the levels of catalase (CAT), superoxide dismutase (SOD) and glutathione peroxidase (GPX) in the liver, which decreased the levels of thiobarbiturate reactants (TBARS), NOS and COX-2 in mouse paw edemas (Chang et al., 2011).

The secondary metabolites from medicine food homology plants, such as flavonoids, triterpenoids, tannins and polysaccharides have been shown to have anti-inflammatory properties with few side effects. These compounds are found in *R. rugosa*, *R. canina*, *R. damascena*, *R. roxburghii*, *R. davurica* and other *Rosa* plants. The anti-inflammatory mechanism is mainly inhibition of inflammatory factors (TNF-α, IL-1β, IL-6), inflammatory mediators (NO, PGE2) secreted by macrophages and regulation of related inflammatory signaling pathways MAPK as well as NF-κB (Tursun et al., 2016) (Figs. 8 and 9).

### 3.3. Antioxidant properties

Medicine and food homologous Chinese medicine can improve the abnormality of mitochondrial energy metabolism educe abnormal immune response and inflammation, and improve the body's disease resistance by reducing the generation of oxidative stress. The most important part of the oxidation process is the production of active oxygen, and excessive production of active oxygen can damage internal organs. (Olech et al., 2019). *Rosa* plants are the source of natural antioxidants. Flavonoids and polysaccharides in *R. roxburghii*, *R. laevigata*, and *R. damascena* can prevent the excessive production of ROS and inhibit the occurrence of oxidative stress.

The antioxidant activity of polysaccharides from *R. roxburghii* leaves (RLP) was reported used response surface methodology. The purified polysaccharide components RLP showed notable DPPH radical and ABTS radical scavenging abilities, which suggest the potential application of RLP as antioxidants or pharmaceuticals (Wu et al., 2020). Two Se-enriched polysaccharides (Se-RLFP-1 and Se-RLFP-2) were purified from the fruits of *R. laevigata* by DEAE cellulose and Sephadex G-200 column chromatography. *In vitro* antioxidant assay results revealed that Se-RLFP (0.8 mg/mL) showed radical scavenging activities against ABTS and DPPH, alleviated $H_2O_2$ induced oxidative stress and apoptosis in SH-SY5Y cells (Liu et al., 2018). Salicylic acid method and pyrogallol autooxidation method were used to observe the scavenging effect of total flavonoids from *R. laevigata* on hydroxyl radical and superoxide anion. Total flavonoids had good antioxidant activity, and the scavenging capacity of hydroxyl radical (·OH) and superoxide anion radical ($O^{2-\cdot}$) was positively correlated with their concentrations, indicating that they had a certain anti-aging effect (Su, Wei, Huang, Huang, & Luo, 2015). Procyanidins (0.1 g/L) were extracted from *R. laevigata* and grape skin, compared with the scavenging effects of the two purification solutions on hydroxyl radical, superoxide anion radical and nitrite systems, as well as the inhibition effects on lipid oxidation system. The antioxidant effects of procyanidins in *R. laevigata* were stronger than those in grape skin (Chen et al., 2013). Oral 500, 1000, 200 mg/kg/day *R. damascena* extract in different time periods could inhibit aluminum-induced oxidative stress in rats, which were proved by improving antioxidant capacity and reducing oxidative conditions in rats receiving aluminum chloride, increasing the GST activity, reversing the activity of catalase and myeloperoxidase, and reinforcing the antioxidant defense system (Zahedi-Amiri, Taravati, & Hejazian, 2019). In addition, apigenin (25 μmol/L) can up-regulate the transcription of HO-1, GCLC, and GCLM genes in rat hepatogenic cells through the ERK2/NRF2/ARE signaling pathway, and inhibit *tert*-butyl hydrogen peroxide-induced oxidative stress (Huang et al., 2013). The antioxidant activity of chlorogenic acid isomer monomer and the synergistic antioxidant activity of binary mixed system were studied by evaluating the water-soluble and fat-soluble systems, such as ABTS free radical scavenging ability, FRAP ferrous ion reducing ability and β-carotene bleaching inhibition ability. It was found that chlorogenic acid has good antioxidant effect (Yang, 2016).

Aging is a normal life phenomenon, which is a natural degeneration process of various functional activities of the body as the body ages. The number of aging related diseases such as coronary heart disease, Alzheimer's disease and diabetes has been increasing, which has become one of the major problems threatening human life and health (Jin, Sun, & Liu, 2021). Many age-related inflammatory factors such as TNF-α, IL-6, and IL-1β are abnormally expressed in aging organisms (Figueira et al., 2016); oxidative stress indicators such as SOD, MDA, CAT, and ROS are unbalanced in expression (Liguori et al., 2018). The accumulation of reactive oxygen species is an important cause of aging-related diseases, and most medicinal and edible Chinese medicine have antioxidant activity (Li, Wang, Li, & Feng, 2019). *Rosa* genus is considered a natural source of antioxidants due to its rich polyphenols, polysaccharides, vitamins C, vitamins E, and so on (Marmol et al., 2017). According to the above, the *Rosa* plants are closely related to the medicine and food. Their anti-oxidant and anti-aging effects are mainly scavenging DDH radicals and ABTS radicals to reduce cell oxidative stress and apoptosis caused by various damages. Besides, it also regulates the expression of related genes and proteins through the Nrf2 signaling pathway to reduce oxidative stress and achieves anti-aging effects. Among the medicinal plants of the *Rosa* genus, medicinal and edible traditional Chinese herbs with strong anti-oxidant ability have a bright future in the development of anti-aging drugs and health products.

### 3.4. Liver protection

Liver disease is a common cause of death in the world and drug-induced hepatotoxicity is a frequent cause of liver injury (Dong et al., 2013). In recent years, the research on liver injury is more focused on *R. laevigata* and *R. damascene*, and it is worth mentioning that *R. laevigata* belongs to homologous plant of medicine and food. Its effective chemical components are total flavonoids and total saponins, which have a certain protective effect on liver injury.

Both total flavonoids (TFs) and total saponins from *R. laevigata* can protect against liver injury. In a mouse model of hepatotoxicity induced by $CCl_4$, TFs (200 mg/kg) significantly decreased carbon tetrachloride ($CCl_4$) induced elevation of serum aspartate transaminase (AST) and alanine transaminase (ALT) activities, inhibited inflammation response by decreasing pro-inflammatory cytokines and NF-κB express as well as apoptosis by inhibiting the Fas/FasL and mitochondrial pathways (Zhang et al., 2013). In LPS-induced liver injury in mice, *R. laevigata* TFs (200 mg/kg) markedly reduced serum ALT, AST, TG (total triglyceride), and TC (total cholesterol) levels and relative liver weights after intragastric administration, suppressed the nuclear translocation of NF-κB, decreased the expression levels of IL-1β, IL-6, HMGB-1 (high -mobility group box 1), and COX-2 by activating FXR and FOXO3a (forkhead box O3) against inflammation (Dong et al., 2018). The effects and possible mechanisms of TFs against hepatic ischemia/reperfusion (I/R) injury were studied in a 70% partial hepatic warm ischemia rat model. Gavage of TFs at the doses of 200 mg/kg alleviated oxidative stress caused by I/R injury, inhibited TLR4/MyD88 and activated Sirt1/Nrf2 signaling pathways, and blockaded the TLR4 pathway by TFs inhibited NF-κB and AP-1 transcriptional activities and inflammatory reaction (Tao et al., 2016). The total saponins from *R. laevigata* fruit (RLTS) with purity >70% have protective effect on acute liver injury induced by $CCl_4$. RLTS at the doses of 300 mg/kg, has significant protective effect against $CCl_4$-induced hepatotoxicity through RLTS decreased serum ALT and AST activities. In addition, RLTS remarkably increased the levels of SOD, CAT, GSH-Px, GSH and decreased MDA, iNOS and NO levels in liver, down-regulated the protein expression of CYP2E1, ATF6, GRP78, EIF2, COX-2, NF-κB, p53, Caspase-3, Caspase-9, Cytokeratin 18 and the levels of MAPKs phosphorylation, up-regulated Bcl-2 expression, and markedly decreased the gene expression of TNF-α, IL-6, Fas/FasL and Bax (Dong et al., 2013). The standardized extract of *R. damascena* (200 mg/kg/day) have a beneficial effect on animal model of nonalcoholic fatty liver disease (NAFLD) by oral administration, which significantly reduced the elevations of serum TG, cholesterol, LDL and hepatic enzymes (Davoodi et al., 2017). Phenolic compounds, as the active ingredients of genus *Rosa*, showed anti-oxidative stress effect, inhibited pro-inflammatory cytokines, and modulatory effect on inflammatory signaling pathways. Gallic acid and quercetin were two major representative phenolic compounds. Gallic acid has a positive effect on paracetamol induced hepatotoxicity by inhibiting lipid peroxidation and reducing the anti-inflammatory activity of TNF-α. Quercetin suppressed cholesterol and liver fat accumulation and improved systemic parameters related to metabolic syndrome.

A large number of studies have shown that medicine and food homologous Chinese medicine, such as *R. laevigata*, can be applied as a promising candidate of liver protection and its hepatoprotective effects mainly include improving antioxidant status, reducing the expression of inflammatory factors and inflammatory mediators, regulating enzyme activity and so on.

### *3.5. Regulation of blood sugar*

Diabetes mellitus (DM), called "Xiao Ke Zheng" in traditional Chinese medicine, is a serious metabolic disease caused by defective insulin secretion, insulin resistance, or a combination of both. In the prevention and treatment of diabetes, the theory of medicine and food homology is considered to be a low-cost, safe and stable curative strategy (Gong et al., 2020). *Rosa* plants, such as *R. rugosa*, are rich in flavonoids, triterpenoids, tannins, polysaccharides and other chemical components, which have potential hypoglycemic activities, and have little adverse effects.

In rat model of high fat diet feeding in combination with streptozotocin (STZ) injection, polyphenol-enriched extract (75 mg/kg and 150 mg/kg) of *R. rugosa* (RPE) was administered orally can control dyslipidemia in diabetic rats. This result suggested that hepatic total cholesterol (TC) and triglyceride (TG) were significantly reduced, lipoprotein lipase (LPL) and liver lipase (HL) were significantly increased. The levels of alanine transaminase (ALT) and aspartate transaminase (AST) were decreased in the serum, the expression of FGF21 was increased in the liver tissue and hepatic cell line 1c1c7 and the signals of p-AMPK, p-ACC, ACC, p-SIRT, and PGC-1α were significantly induced in the liver by RPE (Liu et al., 2018). *R. canina* fruit extract has an antihyperglycemic effect in streptozotocin-induced diabetic rats. *R. canina* fruit extract (250 and 500 mg/kg) was administered orally to ameliorate the high levels of blood glucose, improve islets necrotic and regenerate pancreatic islet cells, and decrease the complications of diabetes by reducing plasma triglycerides levels (Taghizadeh et al., 2016). The extract (0.1 mg/mL and 1 mg/mL) of *R. canina* fruits have a protective activity on STZ-induced death in pancreatic β-cells (βTC6 cells). It cannot prevent pathological condition induced by STZ, which results in DNA damage of β-cell and cytotoxicity, but significantly increased proliferation of βTC6 cell line (Fattahi et al., 2017). It was found that a hot-water extract of rose hip at a dose of 100 mg/kg body weight/day could exert anti-prediabetic effect in a rat model. Rose hip extract attenuated impaired glucose tolerance, impaired insulin secretion, and preserved pancreatic β-cell function, consequently preventing or delaying the onset of diabetes (Chen, Aikawa, Yoshida, Kawaguchi, & Matsui, 2017). In addition, flavonoids, phenolic acids and triterpenoids also regulate hyperglycemia to some extent. Quercetin at a concentration of 20 μmol/L enhanced the basal and insulin stimulated uptake of glucose in a dose-dependent manner via the activation of the protein kinase B (Akt) and AMP-activated protein kinase (AMPK) pathways, the underlying mechanism also involved the suppression of nuclear factor-κB (NF-κB) signaling and the nitric oxide (NO)/inducible nitric oxide synthase (iNOS) system through the two independent signaling pathways of Akt and AMPK (Dai et al., 2013). Gallic acid, the concentration of 6.25 μg/mL, can improve glucose uptake in insulin-resistant mouse hepatocytes, decrease hyperglycemia by oral administration. And GA may be helpful in alleviating insulin resistance in the liver via suppression of hepatic inflammation and ameliorating abnormalities in hepatic glucose metabolism via suppression of hepatic gluconeogenesis and enhancement of the glycogenesis and glycolysis pathways in high-fructose diet induced diabetic rats. (Huang, Chang, Wu, Shih, & Shen, 2016). The combination therapy of oleanolic acid and metformin could significantly reduce blood glucose and insulin levels in the db/db diabetic mouse model by intragastric administration. This combination therapy improved glucose and insulin levels by increasing glycogen-synthesized mRNA expression and Akt phosphorylation, decreasing protein expression levels of G-6-Pase, Pepck1, Torc, as well as mTOR and CREB phosphorylation (Wang et al., 2015).

At present, many hypoglycemic drugs are usually used to treat T2DM, such as insulin, rosiglitazone, metformin and so on. However, chemical drugs have the disadvantage of toxicity and resistance (Wang et al., 2020). The hypoglycemic ingredients in the medicine and food homology have a great effect on the treatment of diabetes. Many studies have demonstrated the potential hypoglycemic activity of flavonoids, phenolic acids and triterpenoids in medicine and food homologous plants, which provided a basis for searching the active components with less toxic and side effects from *Rosa* plants.

### *3.6. Antimicrobial activity*

A variety of components extracted from *Rosa* plants had shown potential antimicrobial activity (Ma et al., 2020). Strictinin isomers from the ethyl acetate extract of roots of *R. roxburghii* (Ci Li Gen) (1 MIC, 2 MIC and 4 MIC) against *Escherichia coli* were oxidative stress and protein synthesis disorder, which inhibited the activity of the enzymes required for bacterial growth and metabolism (Ma et al., 2020). In an infection model of *Listeria monocytogenes*, the ethanolic extract of *R. damascena* could inhibit the growth of *L. monocytogenes* in different organs, and successfully restrict spread of pathogens, which was supported by normal counts of leucocytes, neutrophils, and lymphocytes (Batool, Kalsoom, Akbar, Arshad, & Jamil, 2018). The root extract of *Rosa odorata* var. *gigantea* has inhibitory effect on intestinal pathogenic bacteria. The MIC of different polar extraction of the roots of *Rosa odorata* var. *gigantea* to enterotoxigenic *E. coli*, Shigella bacteria, *Salmonella typhimurium*, *Salmonella choleraesuis*, *Salmonella enteritidis* and enterotoxigenic *Staphylococcus aureus* toxin were measured by tube dilution method. The *n*-butyl alcohol-extracted part and acetidin-extracted part of extraction of the roots of *Rosa odorata* var. *gigantea* show potential antimicrobial activities against the testing strains, and their MIC were 39–156 μg/ml and 156–625 μg/ml, respectively (Yan, Gao, Duan, Dong, & Liu, 2012). Besides, it was reported (Marmol et al., 2017) that there is a relationship between antioxidant capacity and antimicrobial potential of rose hip extract. The mechanism of action is an energy deprivation caused by a hyperacidification of plasma membrane interface that disrupts $H^+$-ATPase.

The genus *Rosa* has been widely used in folk medicine in a few countries as an antimicrobial agent, and these antimicrobial active product are considered safe (Zivkovic et al., 2016). Current research on the antibacterial activity of *R. roxburghii*, *R. damascena* and other plants is of great significance for the better development of medicines with the same food and medicine.

### *3.7. Antiviral activity*

The treatment of virus-related diseases has always been a difficult problem. So far, there is no good treatment for HIV, HnNn and other viruses. Therefore, many scholars began to search for active ingredients from natural products, combined with the modern research of "medicine and food homology" Chinese medicine, to explore the commonality of the antiviral effects of the medicinal plants of the *Rosa* genus. There are antiviral components in *Rosa*, among which triterpenoids and flavonoids are more reported.

Olenolic acid, a representative triterpene found in many plants of the genus *Rosa*, inhibited the HIV-1 replication in cultures of human peripheral mononuclear cells (PBMC) and of monocyte/-macrophages (M/M), and the $EC_{50}$ values are 22.7 μmol/L, 24.6 μmol/L and 57.4 μmol/L for *in vitro* infected PBMC, naturally infected PBMC and M/M, respectively (Mengoni et al., 2002). Derivatives with olenolic acid as the lead compound are highly friendly to HA protein, block the HA-sialic acid receptor, make the virus unable to attach to cells, and have broad spectrum activity against oseltamivir and amantadine-resistant viruses (Yu et al., 2014). Betulinic acid, other triterpene distributed in *R. laevigata*, has antiviral activity to Herpes simplex virus Ⅰ type with the $EC_{50}$ of 30 μg/mL (Ryu, Lee, Lee, Kim, & Zee, 1992). And it can also inhibit HIV-1 replication with the $EC_{50}$ value of 1.4 μmol/L (Fujioka et al., 1994), inhibit HIV-1NL4-3 (X4-HIV-1) and HIV-1JRCSF (R5-HIV-1) with $IC_{50}$ of 0.04 and 0.002 μg/mL, respectively. Therefore, betulinic acid can be used as a potential therapeutic agent for HIV-1 (Theo et al., 2009). Besides, kaempferol, one flavonoid, reduces the maturation of infectious progeny virus by slowing down the viral protease and avoids the binding of gp120 to CD4 to inhibit HIV infection (Akram et al., 2020). 2-phenylethanol-*O*-*β*-*D*-glucopyranoside filtered from methanol extract of *R. damascena* reduces HIV-1IIIB and HIV-1MN activity and works permanently with gb 120. (Akram et al., 2020).

TCM has always been an important means to prevent viruses. Among them, TCMs of the same kind of medicine and food have the advantages of high safety, clear efficacy, and easy use by patients. At present, *Rosa* plants have been reported to have antiviral activity. The above research results provide reference for the research and development of antiviral drugs with medicine and food homologous plants.

### 3.8. Nervous system protection

Common neurological disorders include Alzheimer disease, epilepsy, Parkinson's disease and so on. Medicine and food homologous Chinese medicine have certain therapeutic or adjuvant therapeutic effects on neurological diseases, with good tolerance and low toxicity characteristics (Zhang, Zhao, & Cui, 2021). Flavonoids, phenolic acids, polyphenols and other chemical components in the genus *Rosa* have certain protective effects on the nervous system, which can provide a basis for the development of drugs and food in the protection of the nervous system.

There are studies showed that *R. damascena* extract caused suppression of neural atrophy in animal models and improvement of brain function, affected cognitive impairment of dementia patients significantly and have significant effects on improving depression and behavioral problems. It also affected refining amyloidal deposits in brain tissue positively and caused complete elimination of symptoms of cognitive dysfunctions (Esfandiary et al., 2018). The hydroalcoholic extracts (1 g/kg bw daily) of *R. damascena* was administered by gavage have an effect on learning and memory in male rats consuming a high-fat diet (HFD), which can prevent cognitive impairment caused by the consumption of an HFD. The extract can remove ROS, improve the memory defect of rats, increase the level of acetylcholine and enhance the memory effect of rats (Rezvani-Kamran et al., 2017). The extract (50, 100, and 200 mg/kg) also improved convulsions, reduced the formation of dark neurons by oxidative stress, thereby protects the nervous system (Marmol et al., 2017).

Besides, the methanolic extract of *R. canina* at dose 1 g/kg can treat cognitive function in heat stress-exposed rats by gavage, which significantly reduced reactive oxygen levels, enhanced enzymatic antioxidant defense system and down-regulation of TNF-α, and up-regulation of pre- and post-synaptic proteins. Meanwhile, this extract alleviated cortisol levels in serum and HSP70 and c-Fos in the hippocampal homogenate (Erfani et al., 2019). It is also reported that monomeric compounds in genus *Rosa* also have a protective effect on the nervous system. Luteolin in *R. canina* at 1 μmol/L, 2.5 μmol/L and 5 μmol/L concentration-dependently attenuated the LPS induced decrease in [$^3$H] dopamine uptake and loss of tyrosine hydroxylase-immunoreactive neurons in primary mesencephalic neuron–glia cultures, and inhibited LPS-induced activation of microglia and excessive production of TNF-α, NO and superoxide in mesen cephalic neuron–glia cultures and microglia-enriched cultures (Chen et al., 2008). Gallic acid (200 mg/kg) in *R. chinensis* has a neuroprotective effect on 6-hydroxydopamine-induced oxidative stress by enhancing the antioxidant defense of the brain by oral gavage, and significantly increased the passive avoidance memory, total thiol and GPx contents and also decreased MDA levels (Mansouri et al., 2013).

Most neurological diseases are closely related to inflammation and oxidation. Flavonoids and other active components in *Rosa* plants can effectively reduce the production of reactive oxygen species and inflammatory factors, providing a direction for finding natural medicines for neurological diseases.

### 3.9. Cardiovascular protection

Cardiovascular disease has become the highest mortality of human disease, which led to the emergence of a large number of drugs for the treatment of cardiovascular disease, and unfortunately, there are also adverse effects of treatment. *Rosa* plants have the characteristics of low toxicity, small side effects, and significant effects in the treatment of cardiovascular disease. In particular, certain medicinal and edible plants such as *R. rugosa* have good effects and can be used as raw materials for drug and food development.

Flavonoids can reduce endothelial cell dysfunction, improve capillary fragility and inhibit the oxidation of low-density lipoprotein through their antioxidant and anti-inflammatory effects, so as to protect the cardiovascular system (Sun, 2008). Flavonoids (40, 60 and 80 μg/mL) from *R. roxburghii* (FRRT) have an impact on doxorubicin (DOX)-induced autophagy of myocardial cells in a cardiotoxicity model in mice. The results showed that FRRT inhibited autophagy by downregulating the content of LC3-II and up-regulating that of P62, meanwhile controlled DOX-induced cardiotoxicity by inhibiting autophagy (Yuan, Wang, Chen, & Cai, 2020). *R. rugosa* flavonoids (RRF) at a dose of 600 mg/kg reduced myocardial infarct size (MIS) and inhibited activity of plasma myocardial enzymes, decreased the translocation of p65 from the cytoplasm into the nucleus and reduced the expression of the pro-inflammatory cytokines, IL-6 and IL-1β. Moreover, RRF increased the activities of the enzymes associated with antioxidation, SOD and TEAC, and mRNA expression of NOX2; RRF inhibited the phosphorylation of JNK and p38 MAPK, which alleviated myocardial ischemia reperfusion injury in mice (Zhang et al., 2017). In addition, some compounds isolated from *Rosa* have also been reported to protect cardiovascular. Isorhamnetin at a dose of 100 μmol/L inhibited the mitochondria-dependent or intrinsic apoptotic pathway, and also decreased expression and activity of Caspase-3 and Caspase-8. Furthermore, it specifically inhibited FAS/FASL expression, suppressed nuclear factor-kappa B nuclear translocation, and has a certain protective effect on oxygen–glucose deprivation induced cytotoxicity after methylglyoxal treatment on primary human brain microvascular endothelial cells (Li et al., 2016). Gallic acid exerted a vasorelaxant effect by inducing the production of NO in human umbilical vein endothelial cells, inhibiting angiotensin-I converting enzyme with $IC_{50}$ value of (37.38 ± 0.39) μg/mL (Kang et al., 2015). In the isolated rat thoracic aorta, gallic acid exerted a relaxant effect during the concentrations from 0.4 to 10 mmol/L in both endothelium-intact and endothelium-denuded aortic rings, and made L-type calcium channels inhibit extracellular calcium influx. Relaxing thoracic aortic vessels and alleviating hypertension are completed through endothelium-dependent and non-dependent ways, which can effectively protect the cardiovascular system (de Oliveira et al., 2016).

Flavonoids and phenolic acids in medicine and food homologous plants, such as *R. rugosa*, can improve cardiovascular diseases by relaxing blood vessels, relieving hypertension, and reducing the expression of pro-inflammatory cytokines. Therefore, eating more foods rich in flavonoids in the daily diet is conducive to the prevention and treatment of cardiovascular diseases (Sun, 2008). At the same time, these reported biological activities provide a basis for future production of related products.

## 4. Safety evaluation

Ancient medical books not only recorded a large number of food drugs, but also discussed the methods and contraindications of their administration, reflecting the importance of the ancients on the safety of food and medicine products. It provides a valuable reference for the current research on diet therapy and health care (Song et al., 2020). Medicine and food homologous plants have unique advantages in curing diseases with good safety, low toxicity, and less gastrointestinal responses. *R. laevigata* have received widespread attention as TCMs with the same food and medicine. The safety of natural products have been reported occasionally in recent years (Zhang et al., 2012). For the safety evaluation of *Rosa* plants, only *R. laevigata*, *R. canina* and *R. damascena* were reported. Therefore, it is necessary to provide safety evaluation of nature products before use.

The fruits of *R. laevigata* widely used in China for a long time (Liu et al., 2019), are usually considered to be nontoxic because of their natural origin. After 90 d of oral administration, the subchronic toxicity of total flavonoids from *R. laevigata* fruits was determined in the rats. Through the examination of ophthalmic, body weight and other indicators revealed that no toxic signs of the TFs at the doses of 0.5 and 1 g/kg/day were observed. But the TFs could cause mild side effects at the dose of 1 g/kg/day in males and females. Thus, the dose of 0.5 g/kg/day for male and female were selected as the no-observed-adverse-effect level (Zhang et al., 2012). The dosage of human is 5.81 g/day converted by the dosage of total flavonoids in *R. laevigata* of rats. Then, combined with the fact that the extraction ratio of TFs reported in the above literature is 5.85%, it can be concluded that it is safe for human to take 68.35 g/day of *R. laevigata*, and this dose is much higher than the dose (6–12 g) specified in *Chinese Pharmacopoeia*, so the daily dosage of *R. laevigata* is safe.

It is reported that various safety studies have been performed for the most common used rosehips of *Rosa* spp. In order to evaluate the safety, an acute toxicity study (Cheng et al., 2016) of an aqueous and an ethanol extract of rosehips from *R. canina* has been done in mice and rats. Subcutaneous administration of a decoction equivalent to 0.25–0.75 g of crude rosehip to the rodents and administration of the decoction into the dorsal lymph sac of the frogs were both well tolerated. Ethyl acetate and *n*-butanol fractions of the ethanol extract of rosehips from *R. canina* displayed no acute toxicity at doses up to 919 mg/kg in mice (Deliorman Orhan, Hartevioglu, Kupeli, & Yesilada, 2007). An 80% acetone extract from *R. canina* hips and seed at doses up to 50 mg/kg or seed at doses up to 25 mg/kg in mice did not affect food intake and did not show any obvious toxic effects (Ninomiya et al., 2007). Besides, some clinical trials (Ayati et al., 2018) have reported that rose hip *R. canina* can cause loose stools, flatulence, and mild gastrointestinal discomfort. In streptozotocin induced diabetic rats, *R. damascena* hydrosol containing 1515 mg/L total volatiles were introduced to rats orally for 45 d, which ameliorated hematologic, hepatic, renal functions, attenuated hyperglycemia, and decreased the advanced glycation end-product formation in a dose-dependent manner. Thus, *R. damascena* hydrosol exerts significant protective properties in diabetes mellitus and has no toxic effect on all studied systems in healthy test groups (Demirbolat et al., 2019).

Chinese herbal medicine have been attracting more and more attention because of their high efficiency and low toxicity (Liu et al., 2019). However, the current research on the safety of edible plants in *Rosa* is relatively weak. Most people believe that the food and medicine homologous varieties will not produce adverse reactions and ignore the problems of their own usage and dosage, leading to the destruction of body functions (Wang et al., 2021). The above safety evaluation of *Rosa* plants also proves that it is reasonable to develop safe and effective natural products of medicinal plants for the treatment of diseases.

## 5. Application

*Rosa* plants are used as health food and medicine all over the world because they are rich in a variety of effective chemical components and biological activity. The genus of *R. chinensis* (flowers, leaves, roots), *R. rugosa* (petals), *R. laevigata* (fruits, leaves, roots), *R. cymosa* (roots), *R. canina* (fruits), *R. damascena* (flowers, hips), *Rosa odorata* var. *gigantea* (roots, stems), etc. are all commonly used Chinese herbal medicines in various places, each with special effects. Among them, only *R. rugosa* and *R. laevigata* belong to medicine and food homologous plants. Moreover, the mature *Rosa* fruits are rich in vitamin C, which can be used to make fruit wine and tea, such as *R. davurica*, *R. multiflora* and so on. Fig. 10 shows the application of some *Rosa* plants in medicine, food and homology of medicine and food. It is precisely because of the existence of a variety of active ingredients in *Rosa* plants that it has a good pharmacological effect. Based on the previous description, in terms of anti-cancer, the active ingredients that play a role are apigenin, naringin, quercetin, luteolin and arjunic acid; Polysaccharide, isorhamnetin and tormentic acid have good anti-inflammatory activity; Flavonoids and polysaccharides also have anti-oxidation and anti-aging effects; Flavonoids and saponins can protect liver damage caused by different factors; Moreover, flavonoids, phenolic acids and triterpenoids also regulate hyperglycemia to some extent; Flavonoids also play an indispensable role in the treatment of cardiovascular disease.

In China, *R. laevigata*, *R. rugosa* and *R. chinensis* have been admitted in *Chinese Pharmacopoeia*. The Ministry of National Health of China has rated the fruit of *R. laevigata* a new food resource, and has now developed it as a third-generation wild fruit food. At present, this fruit is extensively used as a foodstuff, such as nourishing oral liquid, fruit wine, fruit juice and so on (Li, Yuan, & Wu, 2021). The root of *R. laevigata* recorded in the *Compendium of Materia Medica*, is widely used in traditional Chinese medicine and has been made into Chinese patent medicine, such as "San Jin Pian", "Jin Ji Jiao Nang", and "Fu Ke Qian Jin Pian", which are used to treat wet dreams, uterine prolapse, urinary frequency and incontinence and other diseases of urinary system (Tian et al., 2019). Changshu Tablet is made from the root of *Rosa odorata* var. *gigantea*, a folk medicine of Yi nationality named "Gu-Gong-Guo" with the effect of clearing intestines and stopping dysentery. It is mainly used

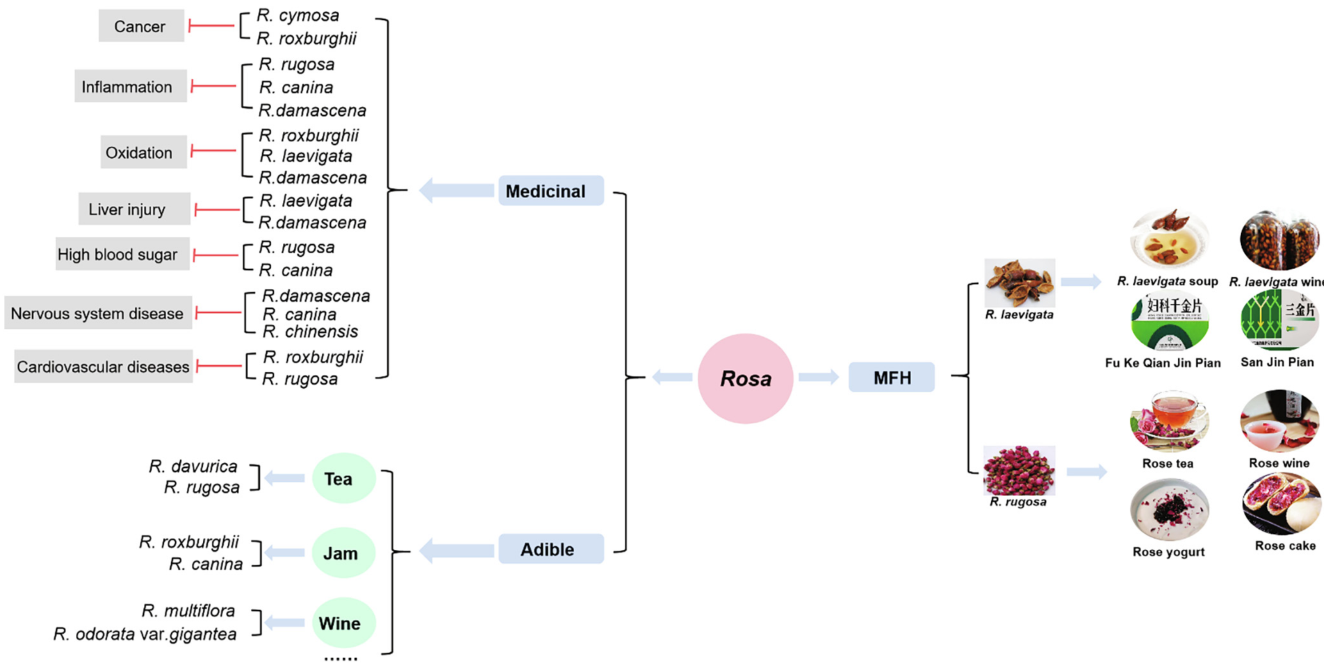


**Fig. 10.** Application of *Rosa* plants in medicine, food and medicine and food homology (MFH).

for enteritis and dysentery caused by dampness and heat accumulation in the large intestine (Bai et al., 2012). The buds of *R. rugosa* could be used to activate *qi* and relieve depression, harmonize the blood and relieve pain. *R. rugosa* is rich in protein, unsaturated fatty acid, VC and other nutrients, which can prevent aging and arteriosclerosis after consumption. At present, there are many *R. rugosa* products on the market, such as rose wine, rose cake, rose jam and so on (Zong & Zhang, 2017). As one of the edible flowers in China, *R. chinensis* is rich in polyphenols and is a good source of natural antioxidants. Products such as health tea and cakes developed with *R. chinensis* petals as raw materials are becoming more and more popular (Zhang, Xu, Sun, & Shi, 2021). The dried flowers of *R. chinensis* could be used to disperse stagnated liver *qi* and relieve depression and disperse stagnated liver *qi* for relieving *qi* stagnation. "*Zhong Hua Ben Cao*" is a book compiled by the China Administration of Traditional Chinese Medicine that comprehensively summarizes the traditional pharmacy of the Chinese nation for more than 2000 years. According to its records, the roots of *R. roxburghii* (Ci Li Gen) used to treat chronic gastritis, stomachache, acute enteritis, diarrhea, and white diarrhea (Ma et al., 2020). According to the report (Mahboubi, 2016), the decoction of flowers *R. damascena* are used as cardiotonic agent in Iranian. Rose water was used as antiseptic agent and antispasmodic agent. The decoctions of dried rose water were used as diuretic. It was also reported (Akram et al., 2020) that rose flowers are made into nervine tonic prescribed to treat depression. In addition, *R. damascena* has traditionally been used as hypnotic, cough suppressant, anti-inflammatory and anti-ulcer, mild laxative (Latifi et al., 2015). In addition, *Rosa* plants have high commercial value and are used in the production of spices, perfumes and rose essential oil. Bulgaria, Turkey and Morocco are the main producers of rose essential oil in the world (Mahboubi, 2016). Serbs usually make purée and jam from *R. canina*. In a few regions, *R. canina* are also used in making syrup, jam and flour (Ayati et al., 2018).

How to combine the genus of *Rosa* plants with the theory of medicine and food homology to serve the public is a challenge and difficulty in the development of resources of this genus. Using medicine and food homology varieties as the main choice for functional foods can guarantee the safety and therapeutic effect of functional food products (Graziose, Lila, & Raskin, 2010). However, according to literature reports, most of the applications in genus *Rosa* are focused on simple processing of plants, such as soups, juices, extracts, etc., and few of them are produced into finished products. Only by integrating Chinese medicine theory into modern food technology and developing medicine and food homologous products can promote the progress of the medicine and food industry.

## 6. Conclusion and prospect

Since medicine and food homologous plants have great advantages in the prevention and treatment of chronic diseases such as cancer and diabetes, as well as delaying aging, people have begun to shift their focus to medicine and food homology. The medicinal plants of the genus *Rosa* have many active ingredients, wide pharmacological effects, and low toxic and side effects in the treatment of chronic diseases, which have attracted the attention of countries all over the world. Owing to the many advantages of this genus of plants, people make them into medicines and foods for consumption. The present review gave the summary of chemical constituents, biological activities, safety research and application, and tries to find Chinese medicine that conforms to the theory of medicine and food homology. However, the study on the chemical constituents of the genus *Rosa* is not enough, which is only limited to several plants such as *R. rugosa*, *R. canina*, *R. damascena*, *R. laevigata* and *R. chinensis*, and lacks of in-depth study on the chemical constituents of the genus. In addition, the medicinal plants of this genus have anti-cancer, anti-cardiovascular disease, anti-inflammatory, anti-oxidant and anti-diabetic effects, but there is little research on the mechanism of medicine action, toxicology and ethnopharmacological application. In the future research, it is necessary to further describe the active ingredients or active parts, study the pharmacodynamic components and clarify the quality markers, develop medicine and food homologous products, expand the application, so as to solve related diseases in the world.

The genus *Rosa* has a vast untapped potential in terms of undescribed constituents that may have promising biological activities and may provide an important reference for the comprehensive development and utilization of medicine and food resources.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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