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Review

Non-*Camellia* Tea in China: Traditional usage, phytochemistry, and pharmacology

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ABSTRACT

Non-*Camellia* Tea, as an integral part of Chinese tea culture for several centuries, is important to prevent chronic metabolic diseases. However, it was not systematically studied until academician Pei-gen Xiao defined it. Hereby, Non-*Camellia* Tea was reviewed systematically in definition, classification, traditional functions, chemical compositions, and pharmacology.

Contents

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1. Introduction

Non-*Camellia* Tea (Fig. 1), proposed by Pei-gen Xiao in 2011, is such Non-*Camellia* species as that have long been drunk to prevent diseases especially chronic metabolic diseases in the folk worldwide.

Traditionally, there are three oral medications that people rely on for survival and health care: food for taking daily energy, drugs for curing diseases, and masticators and drinks for preventing diseases. Among them, masticators and drinks started at least 9000 years ago, for example, the ancients chewed the poplar barks to prevent diseases in Scandinavia and Germany (Aveling & Heron, 1999), and the Chinese ancients chew or drink wild plant leaves to prevent diseases (Xiao et al., 2011). It is well known that tea is one of the examples in masticators and drinks medication with botanical sources from *Camellia* species, while Non-*Camellia* Tea is its counterpart.

In recent years, with the increasing demand of herbal medicines in global market, Non-*Camellia* Tea has attracted increasing attention. For example, Paraguay tea, the leaves of *Ilex paraguariensis* A. St.-Hil. (Aquifoliaceae) that grows in South American, is popular in the world (Hao et al., 2013); It has more than 400 years of drinking history in Argentina and South American, being extensively interested in Europe and America recently, and has significant health implications for human life in modern time. Juhua tea, the flowers of *Chrysanthemum morifolium* Ramat. (Compositae), growing in South China, has been used since the Ming Dynasty (1368–1644 A.D.). With the improvement of people's living standards, more functions have been found in Juhua tea (Zhang, 2007).

2. Traditional usage

There are 23 important kinds of Non-*Camellia* Tea in China, nine of which have over millennium history, including Big leaf kuding tea (*Ilex latifolia* Thunb.), Lianqiaoye tea (*Forsythia suspensa* (Thunb.) Vahl), Duosuike tea (*Lithocarpus litseifolius* (Hance) Chun), Gouqiye tea (*Lycium barbarum* L.), Zisu tea (*Perilla frutescens* (L.) Britton), Damai tea (*Hordeum vulgare* L.), Huangqin tea (*Scutellaria baicalensis* Georgi), Qingqianliu tea (*Cyclocarya paliurus* (Batalin) Iljinsk.) and Vine tea (*Ampelopsis grossedentata*), four with 500–1000 years history including Shiliang tea (*Chimonanthus salicifolius* S. Y. Hu), Luobuma tea (*Apocynum venetum* L.), Huanglianmu tea (*Pistacia chinensis* Bunge), and Jinyinhua tea (*Lonicera japonica*), and five less than 500 years, including Hubeihaitang tea (*Malus hupehensis* (Pamp.) Rehder), Juhua tea (*Dendranthema morifolium*), Laoying tea (*Litsea coreana* Lévl.), Xuedi tea (*Thamnolia subuliformis* (Ehrh.) W. Culb) and Jiegu tea (*Sarcandra glabra* (Thunb.) Nakai).

Non-*Camellia* Tea has five following therapeutic effects. The first is of clearing away evil heat, for example, Vine tea, Juhua tea, Kuding tea and Jinyinhua tea are mainly used for clearing away heat and removing toxic material. The second is of digestant, for example, Laoying tea and Damai tea can invigorate the stomach and promote digestion. The third is of diaphoretics, such as Shiliang tea and Zisu tea. The record of Zisu tea has been used for relieving exterior syndrome by dispersion. The fourth is of antirheumatics, for example, Jiegu tea that can dispel evil wind and activate collaterals. The fifth is of calming liver wind, such as Luobuma tea. Here attached is for the traditional uses of Non-*Camellia* Tea (Table 1).

3. Chemical compositions

Non-*Camellia* Tea contains flavonoids, polyphenols, terpenoids, volatile oils, phenylpropanoids, polysaccharides, etc., in which flavonoids and polyphenols are dominant compounds.

3.1. Flavonoids

Flavonoids are dominant compounds in most kinds of Non-*Camellia* Tea. For example, flavonoids are more than 10% in alcohol extract from Vine tea, Shiya tea, Duosuike tea, Shanlv tea, Laoying tea and Big leaf kuding tea, while less than 3% in alcohol extract of Jinyinhua tea, Gouqiye tea, Sanyehaitang tea, Luobuma tea and Lianqiaoye tea. Luteolin, rutin, kaempferol, quercetin, and apigenin are the bioactive compounds in Kuding tea, Vine tea, and Laoying tea (Chen & Ou, 2005; Li, Xu, Pen, Shi, & Xiao, 2011). Baicalein is a responsible compound in Huangqin tea, so dose hyperoside in Jinyinghua tea and Shanlv tea (Wang, 2010) (Fig. 2).

3.2. Polyphenols

Polyphenols are accounting for 25% of dry weight of tea, including catechin, *L*-epicatechin, gallocatechin, anthocyans, gallic acid, caffeic acid, and chlorogenic acid, responsible for anti-oxidant bioactivities (Fig. 3).

3.3. Terpenoids

Terpenoids are the major components in Non-*Camellia* Tea including Qingqianliu tea, Guangxi sweet tea, Shiya tea, Duosuike tea and Vine tea, e.g. triterpenoid saponins in Qingqianliu tea, rubusoside in Guangxi sweet tea (Kinghom, 1990). Typical terpenoid compounds are rubusoside, Ilexgenin B, oleanolic acid, ursolic acid, and friedelin (Fig. 4).

3.4. Volatile oils

Volatile oils are oily liquid with fragrance. β-elemene is the main component in Jiegu tea, accounting for 10% of dry tea (Wu, Zhang, Chen, Lou, & Lv, 2011). The content of perilla aldehyde in Zisu tea was 40–55% of dry tea (Wang, Deng, & Peng, 2000). Xuedi tea, Vine tea, Shanlv tea, Luobuma tea, and Huangqin tea also contain volatile ingredients. Volatile oils mainly contain linalool, dibutyl phthalate, and 2-octadecyloxy-ethanol (Fig. 5).

3.5. Alkaloids

Many types of Non-*Camellia* Tea contain caffeine such as Shiya tea, Duosuike tea, Qingqianliu tea and big leaf kuding tea. Calycanthine and berberine were isolated from Shiliang tea, and hordenine from Damai tea (Yang et al., 2007). Gouqiye tea contains glycine betaine, choline, atropine, and scopolamine, in which glycine betaine is about 5.1% of water extract (Dang et al., 2011) (Fig. 6).

3.6. Organic acids

Organic acids in Non-*Camellia* Tea are mainly composed of chlorogenic acid and gallic acid. Chlorogenic acid is rich in Jinyinhua tea and Lianqiaoye tea. It was also isolated from Luobuma

Fig. 1. Four kinds of Non-*Camellia* tea in China.
A: Jinyinhua tea (flowers of *Lonicera japonica* Thunb.) B: Juhua tea (flowers of *Dendranthema morifolium* (Ramat.) Tzvelev) C: Small leaf kuding tea (leaves of *Ligustrum robustum* (Roxb.) Blume) D: Vine tea (stems and leaves of *Ampelopsis grossedentata* (Hand.-Mazz.) W. T. Wang).

Table 1
Traditional uses of Non-*Camellia* tea.

Classifications	Names	Botanical sources	Popular areas in China	Traditional functions	References
Clearing away evil heat	Guangxi sweet tea	*Rubus suavissimus* S.Lee	Northwest of Guangxi	Clear away evil heat and remove toxic materials, promote the secretion of body fluid and moisten the lung, engender liquid and allaying thirst	Li, Su, & Su, 2002
	Vine tea	*Ampelopsis grossedntata* (Hand-Mazz) W. T. Wang	South of China	Clear away evil heat and remove toxic materials	Zhou, 1980
	Hubeihaitang tea	*Malus hupehensis* (Pamp.) Rehder	Hubei, Hunan, Jiangxi, and Jiangsu	Remove toxic materials and increase secretion of urine	Wang et al., 1999; Wang, 2009
	Duosuike tea	*Lithocarpus litseifolius* (Hance) Chun	Sichuan, Yunnan, Guangxi, etc.	Clear away evil heat, moisten the lung, nourish the liver and kidney	Quanguo Zhongcaoyao Huibian, 1987; Zhongyao Dacidian, 1977
	Gouqiye tea	*Lycium barbarum* L.	Guangdong, Jiangsu, and Xinjiang	Clear away evil heat, quench thirst, tonify deficiency, and benefit essence	Shi, 1995; Dong, 2006
	Big leaf kuding tea	*Ilex latifolia* Thunb.	Guangdong, Guangxi, Hainan, and Eastern China	Quench thirst, dissolve phlegm, increase secretion of urine	Li et al., 2011
	Small leaf kuding tea	*Ligustrum robustum* (Roxb.) Blume	Southwestern region	Clear away evil heat, increase secretion of urine	Li et al., 2011
	Sanyehaitang tea	*Potentilla freyniana* Bornm.	Hunan	Clear away evil heat, engender liquid and allay thirst	Wang, Meng, Mei, & Xiao, 2006
	Huanglianmu tea	*Pistacia chinensis* Bunge	Guangxi, Guangdong, Hunan, etc.	Clear away evil heat and remove toxic materiasl, and remove dampness	Yi, 2002
	Xuedi tea	*Thamnolia subuliformis* (Ehrh.) W. Culb or *Thamnolia vermicularis* (Sw.) Ach.ex Schaer.	Yunnan, Sichuan, and Shanxi	Clear away evil heat, relieve cough and tranquilization	Zhao, 2007;
	Jinyinhua tea	*Lonicera japonica* Thumb.	Guangxi, Guangdong, and Hunan	Clear away evil heat, dispel wind and heat from the body	Zhang, 2011; Yan et al., 2016
	Huangqin tea	*Scutellaria baicalensis* Georgi; *S. scordifolia* Fisch. ex Schrank; *S. amoena*. C. H. Wright; *S. viscidula* Bunge	The vast areas of northern China	Clear away evil heat and remove toxic materials	He et al., 2011
	Lianqiaoye tea	*Forsythia suspense* (Thunb.) Vahl	The vast areas of northern China	Clear away evil heat and remove toxic materials, dispel wind and heat from the body	Ren, 2007
	Shanlv tea	*Ilex hainanensis* Merr.	Guangxi	Clear away evil heat, engender liquid and allay thirst	Chen, 1983
	Shiya tea	*Adinandra nitida* Merr. ex H.L.Li	Guangxi and the surrounding areas	Clear away evil heat and remove toxic materials, engender liquid and allay thirst	Liu, Yang, Bai, Li, & Xiao, 2010
	Qingqianliu tea	*Cyclocarya paliurus* (Batal.) Iljinsk.	Xiushui of Jiangxi, Hunan, Fujian, Hubei, etc.	Clear away evil heat, engender liquid and allaythirst	Zhonghua Bencao, 1999
Digestant	Laoying tea	*Litsea coreana* Levl. Var. lanuginose *Actinodaphne cupularis* (Hemsl.) Gemble	Daloushan and surrounding areas, upper reaches of Yangtze river, Anhui	Invigorate the spleen and increase appetite	Li, 1995; Xiang, & Lu, 1998
	Damai tea	*Hordeum vulgare* L.	Qinghai, Jilin, etc.	Invigorate the spleen and increase appetite	Chen, & Cao, 1998
Diaphoretics	Shiliang tea	*Chimonanthus salicifolius* S. Y. H; *C. Zhejiangensis* M. C. Liu; *C. nitens* Oliv.	In the mountain area of southern Zhejiang, Anhui, Jiangxi	Dispell wind to relieve exogenous syndrome and regulate *qi*-flowing	Zhejiang Food and Drug Administration, 2005
	Juhua tea	*Chrysanthemum morifolium* Ramat.	South of China	Clear away evil heat and remove toxic materials, dispel wind and heat from the body	Zhang, 2007
	Zisu tea	*Perilla frutescens* L.Britt.	Jiangsu and Zhejiang	Relieve exterior syndrome by dispersion and regulate flow of qi	Wei, 2002
Antirheumatics	Jiegu tea	*Sarcandra glabra* (Thunb.) Nakai	At the junction of Hunan and Guizhou	Dispell wind and activate collaterals, clean the liver and brighten the eye	Pan et al., 2004
Calming liver wind	Luobuma tea	*Apocynum venetum* L.	The vast areas of northern China	Calm the liver to stop wind	Qian, Zhang, & Chen, 2002

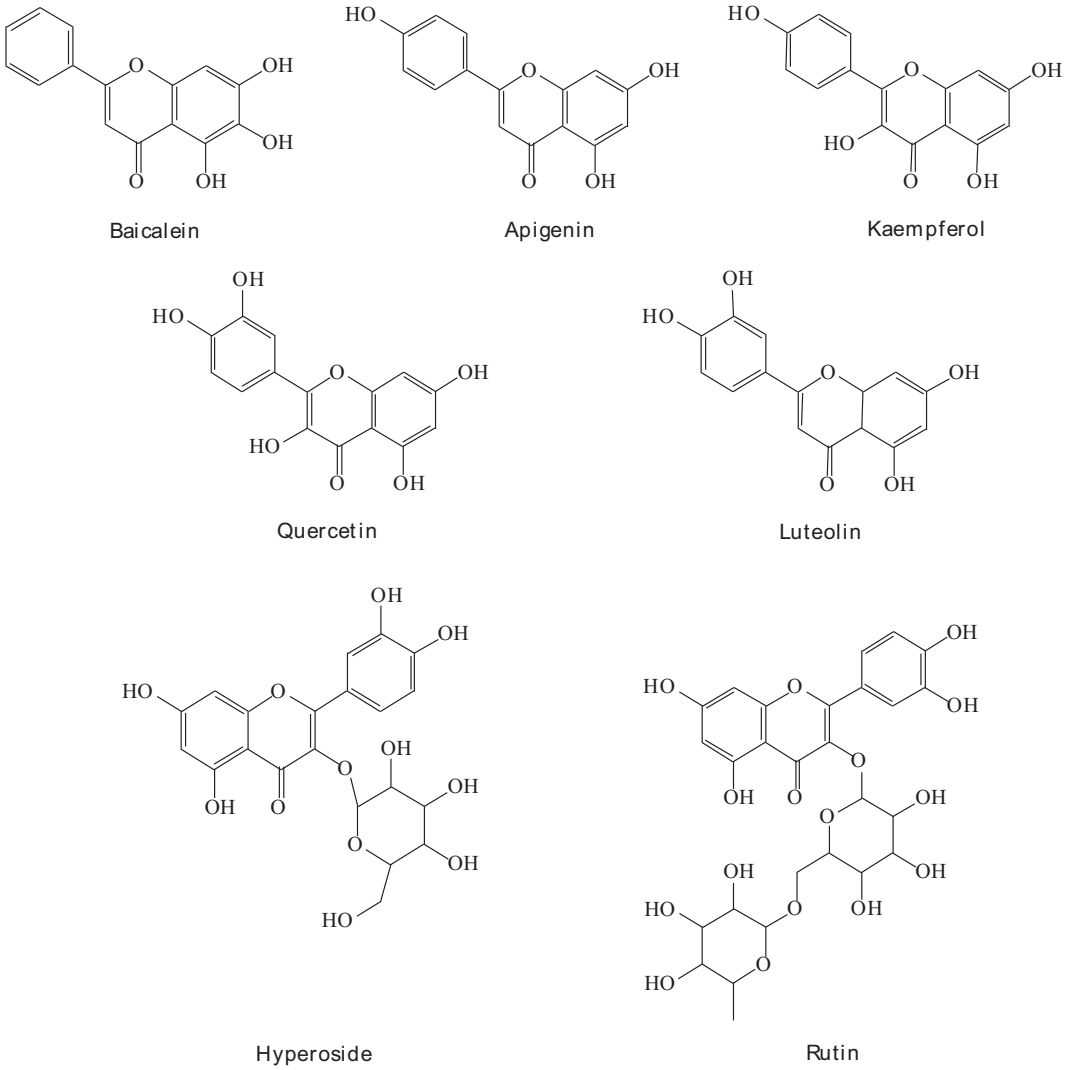

Fig. 2. Chemical structures of representative flavonoids from Non-*Camellia* tea.

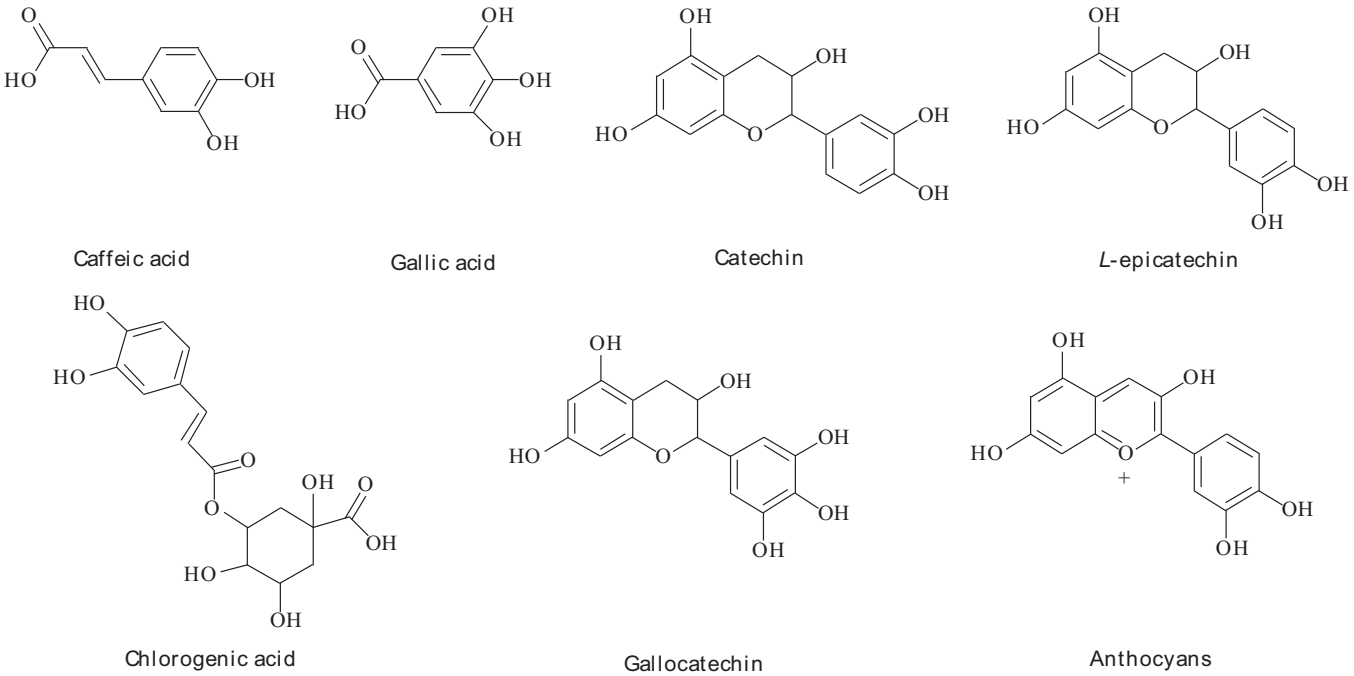

Fig. 3. Chemical structures of representative polyphenols from Non-*Camellia* tea.

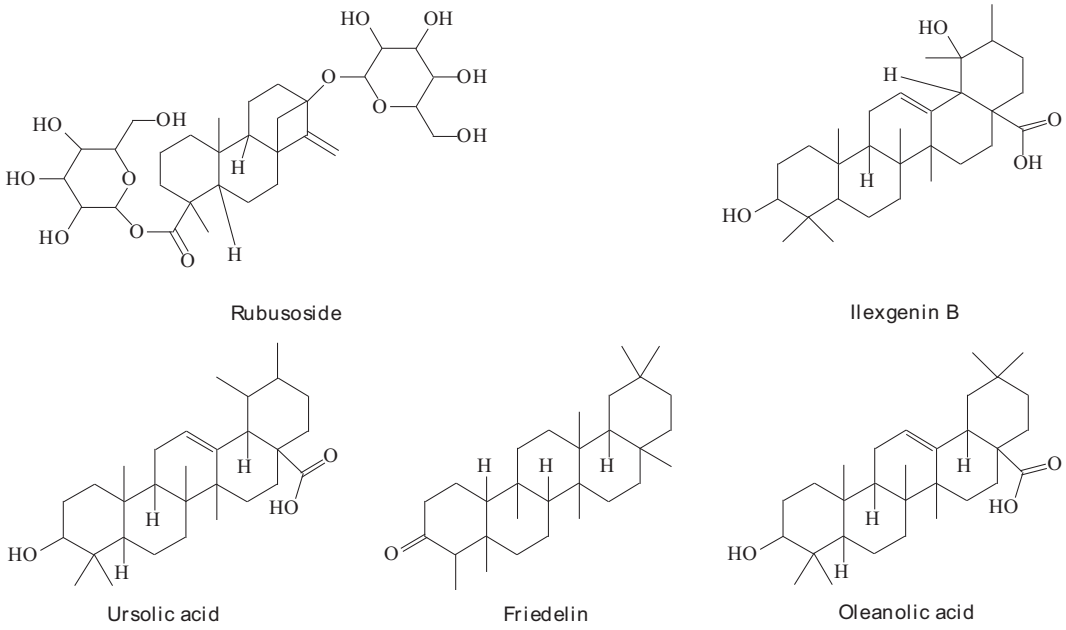

Fig. 4. Chemical structures of representative terpenoids from Non-*Camellia* tea.

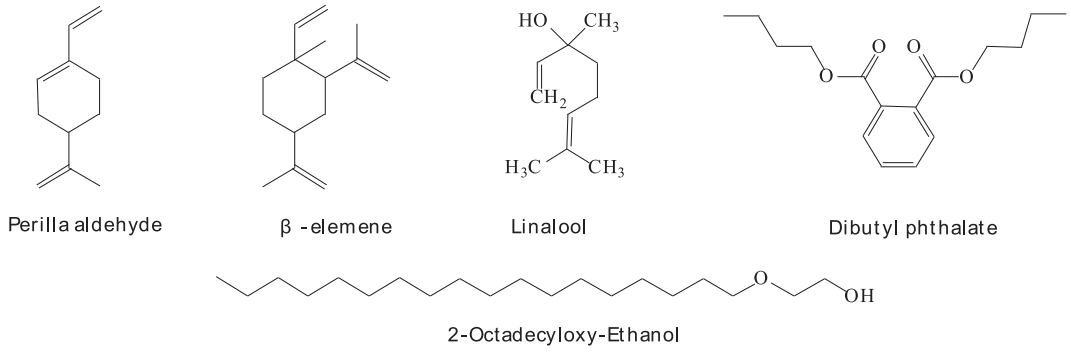

Fig. 5. Chemical structures of representative volatile oils from Non-*Camellia* tea.

tea, Huangqin tea, Juhua tea, and Shanlv tea. Vine tea and Huanglianmu tea have gallic acid. Other organic acids were isolated from Non-*Camellia* Tea, such as succinic acid, fumaric acid, benzoic acid, caffeic acid, ferulic acid, quinic acid, palmitic acid, stearic acid, and rosmarinic acid (Fig. 7).

3.7. Other compounds

More compounds have been isolated from Non-*Camellia* Tea recently, such as phenylpropenoids, tannin, steroids, polysaccharide, proteins, amino acids, anthraquinone, hormone and so on. β-sitosterol, daucosterol and sucrose were isolated from Jinyinghua tea and scopoletin, 6,7-dimethoxycoumarin, isofraxidin and 7-hydroxy-6-methoxy-coumarin from Shiliang tea (Bai et al., 2010). Jiegu tea contains scoparone. Luobuma tea contains lupeol, melissyl alcohol, inositol, phytol and so on. Phillyrin is an active ingredient in *Forsythia suspense* (Fig. 8).

4. Pharmacological activities

Non-*Camellia* Tea shows various pharmacological activities including anti-oxidant, antibacterial, antitumor, anti-inflammatory and antineoplastic bioactivities, regulation of hypotensive, hypolipidemic and hypoglycemic syndromes, immunological enhancement, and liver protection (Table 2). For example, Guangxi sweet tea (Xie & Wang, 2007) and Duosuike tea have good potential in the prevention and treatment of chronic metabolic diseases (Zhang, Ning, & Dong, 2011). Vine tea is a medicinal and edible plant in China due to its remarkable anti-inflammatory effect. Kuding tea has been widely used in China as health drink for over millennium history (Yi, Zhao, Peng, & Xiao, 2016). Ethanol extracts or total flavonoids from Laoying tea have potential in the preparation of anti-inflammatory drugs and treating fatty liver and alcoholic liver disease (Chen et al., 2004). Laoying tea is rich in edible red pigments, which is a good colorant for many foods (Xi, Wang, & Yao, 2015).

4.1. Anti-oxidant effect

Many chronic diseases such as cardiovascular disease, cancer, bone disease, Alzheimer's disease and so on, which are caused by oxygen free radicals. In order to effectively remove the free radicals, and resist aging and age-related diseases, the human body must ingest anti-oxidant every day. Non-*Camellia* Tea such

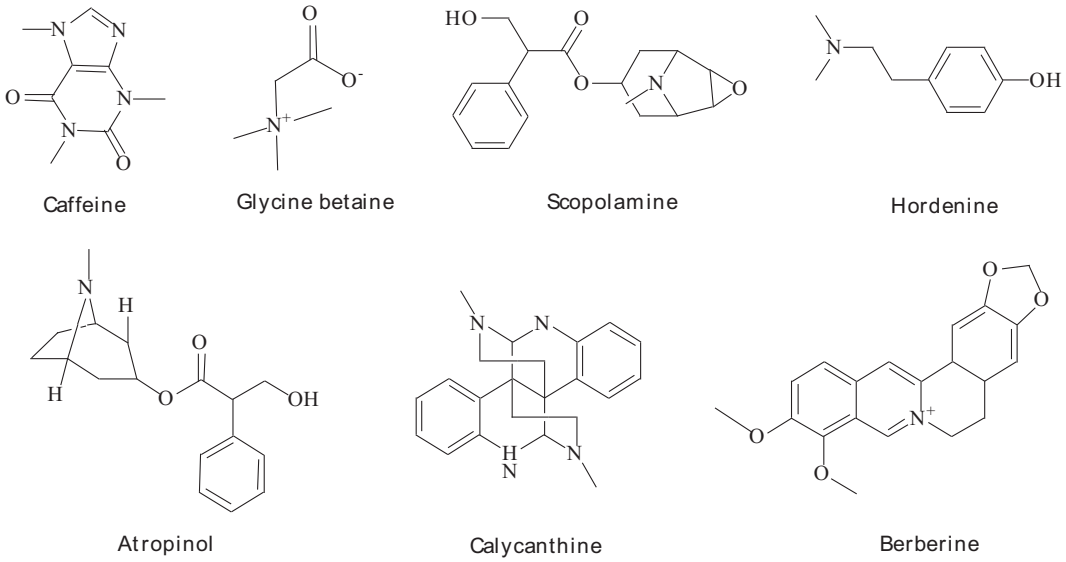

Fig. 6. Chemical structures of representative alkaloids from Non-*Camellia* tea.

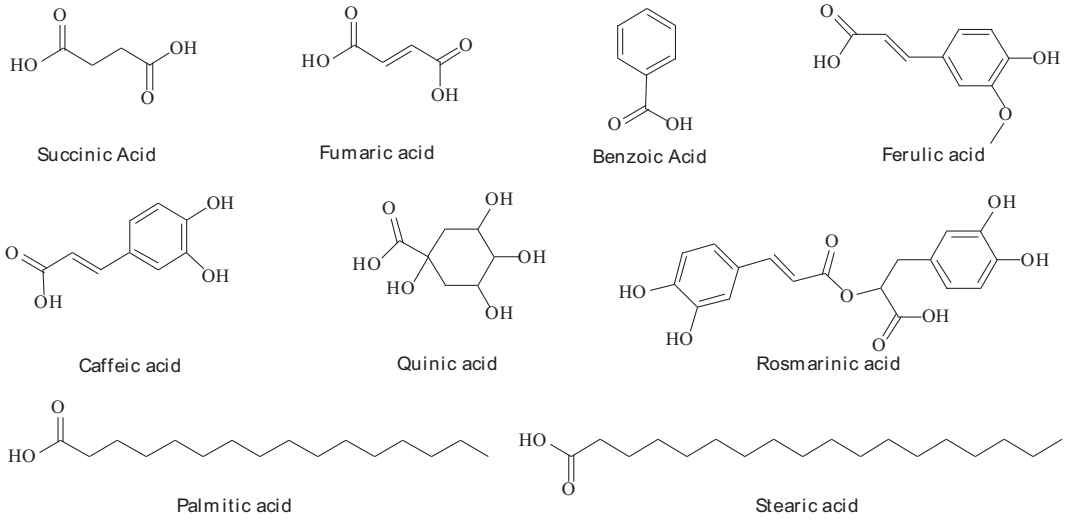

Fig. 7. Chemical structures of representative organic acids from Non-*Camellia* tea.

as Gouqiye tea, Kuding tea, Lianqiaoye tea, Shiya tea (Tang, Luo, & Yan, 2006) and Laoying tea (Ye, Yu, & Wang, 2004) has strong anti-oxidant effect, due to plenty of flavonoids and polyphenols in them. Daily drink is benefit to prevent the chronic diseases.

The total flavonoids extracted from Gouqiye tea have anti-oxidant activity, which are mainly in scavenging free radical and anti-lipid peroxidation, similar to Gouqizi (Yang et al., 2018). The principle of scavenging free radical is phenolic hydroxyls in those compounds, which can form stable free radical structures to interrupt chain reaction, and mechanisms of lipid peroxidation may be consistent with a study by Gulcin et al. (Gulcin et al., 2004). The anti-oxidation mechanism is mainly divided into two parts. One is for combining the hydrogen and oxygen free radicals (ROS) to terminate the chain reaction of lipid peroxidation, and the other is chelated with Fe^{2+} (Li et al., 2010). Polysaccharides, alkaloids and flavonoids isolated from Kuding tea in different oils and different temperatures have significant anti-oxidant properties. The flavonoids of Lianqiaoye tea can prevent lipid peroxidation by clearing free radicals, and protect the membrane system from damage. The flavonoids of Shiya tea have been proved to show a dose-dependent manner on anti-oxidant effectiveness. Those of Laoying tea have scavenging effect on diphenyl picryl hydrazinyl radical (DPPH) with a better dose-effect relationship. It can increase the activity of superoxide dismutase (SOD), glutathione peroxidase (GSH-PX) and decrease the content of malondialdehydebis (MDA) to protect or restore the function of β-cells.

4.2. Antibacterial effect

The widely use of antibiotics in the clinic leads to increasing drug-resistance. Discovery of new antibacterial drugs or reverse bacterial resistance from TCMs has become a research focus. Non-*Camellia* Tea is actually another important resource of drug discovery.

Flavonoids of Vine tea have inhibitory effect on *Escherichia coli* with the optimum inhibitory concentration of 25 μg/mL, *Staphylococcus aureus* of 50 μg/mL and *Bacillus subtilis* of 5 μg/mL. The

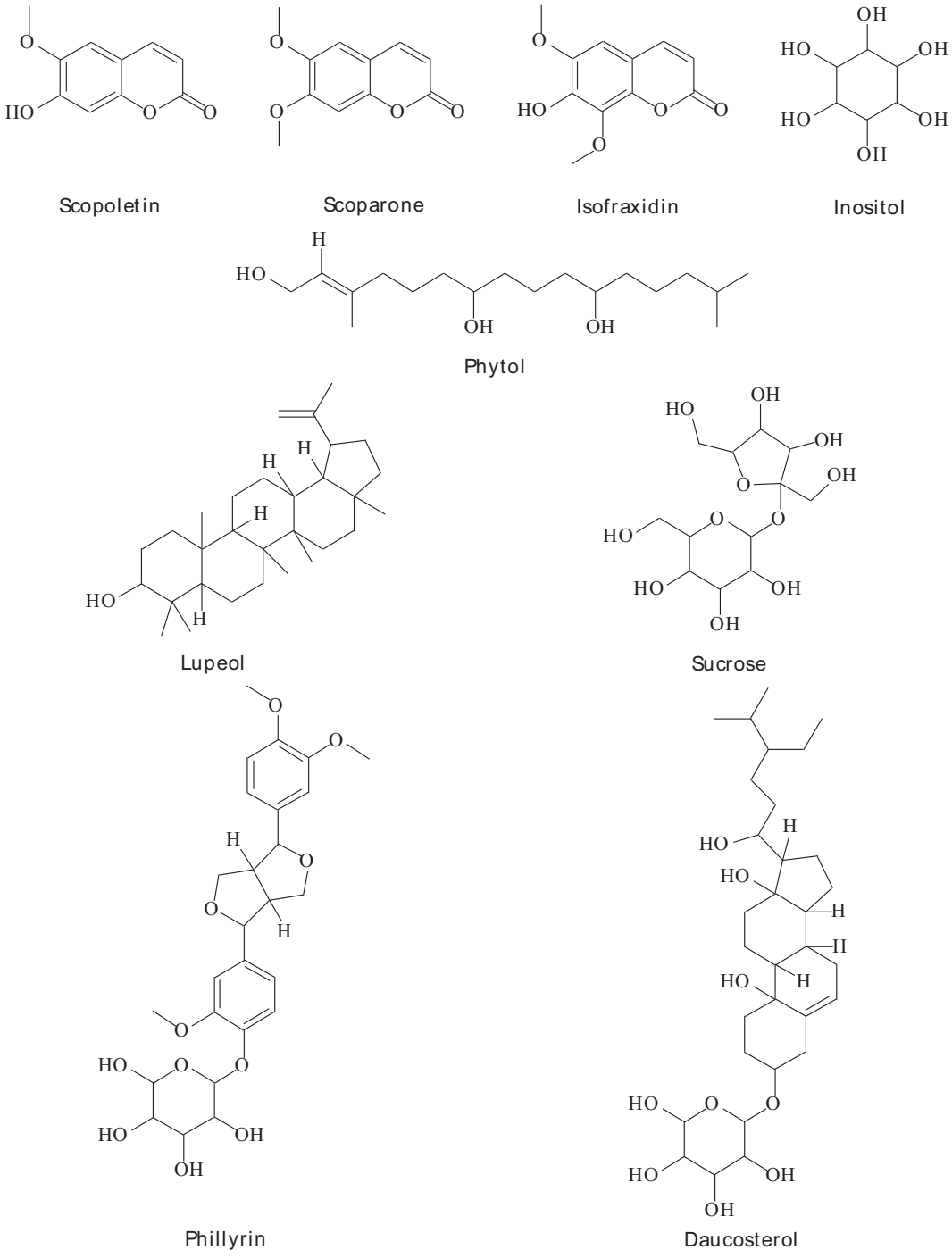

Fig. 8. Chemical structures of other compounds from Non-*Camellia* tea.

water extract from Kuding tea can inhibit against *Streptococcus pneumonia* at 25 mg/mL, *Streptococcus* at 12.5 mg/mL, *Corynebacterium diphtheria* at 50 mg/mL, *Neisseria catarrhal* at 200 mg/mL, *Staphylococcus aureus* at 100 mg/mL, *Pseudomonas aeruginosa* at 100 mg/mL, *Escherichia coli* at 100 mg/mL and *Shigella flexneri* at 50 mg/mL, respectively. Several scientific evidences showed that Kuding tea can cure fever and dysentery *in vitro* because of tannins. It has a great application prospect as a new anti-bacterial and anti-inflammatory drug. The water extract from Jinyinhua tea showed antibacterial activity against *Streptococcus mutans, Actinomyces, Bacteroides* and *Haemophilus*. Yu Jie et al. tested the antimicrobial activity of flavonoids from Shiya tea against *Staphylococcus aureus, Escherichia coli* and *Bacillus subtilis* at the concentration of 0.5%, 1%, and 1.5%, respectively, which was as same as potassium sorbate (Yu & Chen, 1997). The extract of Qingqianliu tea has antibacterial bioactivities against *Staphylococcus aureus, Bacillus subtilis* and *Escherichia coli*. Forty percent ethanol extract of Laoying tea has antibacterial bioactivities against *Bacillus anthracis, Staphylococcus aureus*, and *Bacillus subtilis*.

Aqueous and ethanol extracts from Shiliang tea showed antibacterial bioactivities against *Escherichia coli, Enterobacter aerogenes* and *Salmonella typhi* (Cheng & Fang, 2005). Ten percent of alcohol

Table 2
Pharmacological activities of Non-*Camellia* tea.

Pharmacological activities	Names	References
Anti-oxidant	Guangxi sweet tea, Vine tea, Hubeihaitang tea, Duosuike tea, Gouqiye tea, Big leaf kuding tea, Small leaf kuding tea, Huanglianmu tea, Xuedi tea, Jinyinhua tea, Huangqin tea, Lianqiaoye tea, Shiya tea, Qingqianliu tea, Laoying tea, Damai tea, Shiliang tea, Juhua tea, Zisu tea, Jiegu tea, Luobuma tea	Chen, Liu, & Han, 2007; Tang et al., 2006; Zhang, Fei, Wei, & Yan, 2008; Zhang et al., 2011; Huang, Zhao, Yin, & Yuan, 2007; Liu, & Xu, 2005; Zhang, Pan, Yang, & Mo, 2004; Liu, Xu, & Wang, 2008; Zhao, Zeng, Xiao, & Zhang, 2002; Wu, & Yang, 2007; Zhang et al., 2018; Hou, & Yang, 2005; Zhan, & Liang, 2010; Wu, Li, Zhao, Xu, & Li, 2017; Ye et al., 2004; Ji, & Guo, 2015; Cai, Cao, Wang, & Zhang, 2013; Huang et al., 2009; Hu, Zhang, Du, Wang, & Liu, 2007; Xu, 2007
Antibacterial	Vine tea, Hubeihaitang tea, Duosuike tea, Sanyehaitang tea, Huanglianmu tea, Jinyinhua tea, Huangqin tea, Lianqiaoye tea, Shiya tea, Qingqianliu tea, Shiliang tea, Juhua tea, Zisu tea, Jiegu tea	Zhou, Chen, Fang, & Wang, 2017; Fu, & Ma, 2015; He et al., 2012; Tan, Wen, & Xiao, 2002; Zou, Chen, Liu, Li, & Chen, 2011; Wu, & Yang, 2007; Yang, Wang, Wu, Kang, & Li, 2018; Duan, Zhang, Yang, & Li, 2005; Li, 2012; Huang, Ye, Huang, Ye, & Ye, 2006; Cheng, & Fang, 2005; Li, Wang, & Peng, 1997; Li, Wu, Zhen, & Yang, 2018; Jiang, Song, Huang, Lin, & Dai, 2000
Regulation of hypotention, hypolipidaemia, and hypoglycemia	Guangxi sweet tea, Vine tea, Hubeihaitang tea, Duosuike tea, Gouqiye tea, Big leaf kuding tea, Small leaf kuding tea, Sanyehaitang tea, Jinyinhua tea, Huangqin tea, Lianqiaoye tea, Qingqianliu tea, Laoying tea, Damai tea, Shiliang tea, Juhua tea, Luobuma tea	Xie et al., 2010a; Tan et al., 2001; Wang, 2009; Zhang, 2011; Yang, Wei, & Chen, 2009; Liu, & Xu, 2005; Zhang et al., 2004; Zhu et al., 2010; Wu, & Yang, 2007; Liu, Zhou, Su, & Zhu, 2009; Liu et al., 2009; Hou, & Yang, 2005; Huang et al., 2011; Duan, Zhang, Lu, & Liang, 2010; Sun et al., 2010; Xi et al., 2015; Xia, & Fen, 2010; Cheng, & Xu, 2015; Hua, Lv, & Zhang, 2006; Li et al., 2011; Han et al., 2009
Immunological enhancement and Anti-tumor effect	Guangxi sweet tea, Vine tea, Duosuike tea, Sanyehaitang tea, Xuedi tea, Jinyinhua tea, Huangqin tea, Lianqiaoye tea, Shiya tea, Qingqianliu tea, Laoying tea, Damai tea, Shiliang tea, Jiegu tea, Zisu tea, Jiegu tea, Luobuma tea	Xie, Chen, Luo, & Zhong, 2010b; Wu et al., 2010; Cui, Wang, & Dong, 2007; Zhen et al., 2009; Zhang, 2011; Chen et al., 2006; Li, 2004; Zhang, Zuo, & Dong, 2010; Gong, & Li, 2018; Chen, Tan, & Peng, 2017; Wu, & Yang, 2007; Li, 2006; Zhou, Wang, Shi, Xiong, & Fang, 2018; Liu, & Yang, 2006; Huang et al., 2004; Cheng, & Xu, 2015; Hao, Chen, Li, & Gao, 2017; Hu, Chen, Li, Cheng, & Li, 2007; Xia, & Fen, 2010; Cheng, & Xu, 2015; Jiang et al., 2001; Chen, Chen, & Chen, 2016; Li et al., 2018
Liver protection	Vine tea, Hubeihaitang tea, Jinyinhua tea, Huangqin tea, Lianqiaoye tea, Shanlv tea, Laoying tea, Luobuma tea	Zhou et al., 2018; Li, & Li, 2015; Wu, & Yang, 2007; Chen et al., 2017; Yang, & Liu, 2005; Ying, Wang, Wang, Bao, & Meng, 2015; Zhu, 2009; Yang et al., 2015
Anti-inflammatory	Guangxi sweet tea, Vine tea, Sanyehaitang tea, Xuedi tea, Jinyinhua tea, Huangqin tea, Laoying tea, Damai tea, Shiliang tea, Zisu tea, Jiegu tea, Luobuma tea	Wang et al., 2010; Lin, & Wu, 2006; Xu, Lin, Wu, & Peng, 2009; Han, & Peng, 2012; Yan et al., 2016; Yang, Liu, & Deng, 2009; Zhou, li, Wang, Wang, & Wang, 2010; Xia, & Fen, 2010; Zhu, & Liu, 2011; Lang, & Zhang, 2010; Jiang et al., 2000
Antineoplastic	Guangxi sweet tea, Vine tea, Jinyinhua tea, Huangqin tea, Shiya tea, Qingqianliu tea, Laoying tea, Shiliang tea, Juhua tea, Zisu tea, Jiegu tea	Wu et al., 2010; Zhen et al., 2009; Zhang, 2011; Wu, & Yang, 2007; Chen et al., 2017; Li, 2006; Zhou et al., 2018; Cheng, & Xu, 2015; Hao et al., 2017

extract of Zisu, stems and leaves from *Perilla frutescens* (L.) Britt. (Li, Wang, Zheng, & Li, 2003), showed strong inhibitory bioactivities against *Staphylococcus aureus, Escherichia coli, Enterobacter aerogenes* and *Penicillium chrysogenum*, and weak against *Proteus* species. In a word, although the traditional usage of Non-*Camellia* Tea is different, the pharmacological mechanisms are similar.

4.3. Regulation of hypotention, hypolipidemia, and hypoglycemia

Chemical synthesis drugs have significant effects, but they often have varying degrees of side effects. Non-*Camellia* Tea has a good function in hypolipidemia and hypoglycemia. Part of Non-*Camellia* Tea has the effect on hypotention with little side effects, which is suitable for long-term drinking. It has great potential in the prevention and treatment of chronic metabolic diseases, such as Guangxi sweet tea (Xie & Wang, 2007), Duosuike tea (Zhang et al., 2011), Shanlv tea (Fang & Wei, 2011), Qinqianliu tea (Huang et al., 2011; Zhang, Pan, Liu, & Yang, 2010), Laoying tea (Lv, Li, Jin, Zhang, & Wang, 2009; Sun et al., 2010) and Luobuma tea (Han et al., 2009; Li, Zhao, & Cui, 2011).

4.3.1. Hypolipidemic effect

4.3.1.1. Inhibition of lipid absorption. Non-*Camellia* Tea inhibits the body to absorb exogenous lipids and converse from cholesterol to cholic acid in the enterohepatic circulation, and it reduces the number of bile acid so as to achieve the purpose of reducing blood lipids (Jiang, 2008). Effects of different doses of total flavonoids from Huangqin tea on lipid metabolism in experimentally hyperlipidemic rats showed that it can significantly reduce the level of total cholesterol (TC), triglyceride (TG) and the concentration of low density lipoprotein cholesterol (LDL-C) in serum. It can also increase the concentration of high density lipoprotein cholesterol (HDL-C) and improve the activity of serum lecithin cholesterol acyltransferase (LCAT). This function may be enhanced by LCAT activity leading to promote excretion of fecal bile acids (Zhou, You, Su, & Zhu, 2009). Japanese scholars did some researches on hyperlipidemic rats with aqueous extract of Qingqianliu tea. They found that the *C. paliurus* extract (250 mg/kg) could lower the level of TG and have no significant effect on free fatty acids (FFA) levels, but it could inhibit the pancreatic lipase activity. We infer that the control of lipid absorption may inhibit the activity of pancreatic lipase.

4.3.1.2. Inhibition of synthesis of esters. Non-*Camellia* Tea has achieved the purposes of lowering the content of cholesterol and triglyceride through inhibiting the biosynthetic pathway in one or several links. Kuding tea, Laoying tea and the extracts of volatile oils, petroleum ether and *n*-butanol from Shiliang tea could reduce the level of TC and TG in the experimental hyperlipidemic mice (Chen & Liu, 2002; Shen & Li, 2002). Big leaf kuding tea can reduce the content of TC and cholesterol in mice (Wang, Tang, Xian, Tu, & Liu, 2005).

4.3.1.3. Reduction of hyperlipemia. Flavonoids and polyphenols reduce hyperlipemia mainly through anti-oxidant bioactivities. The extract of Lianqiaoye tea (1.5 g/kg) can delay the growth of the hyperlipidemic mice weight, reduce the increase of the heart index

abnormally, improve the activity of SOD and reduce the production of the MDA. It has a positive protective effect on hyperlipidemic mice (Hou & Yang, 2010). Moreover, tannins (0.81 g/kg) and flavonoids (0.16 g/kg) of Luobuma tea can effectively reduce the level of lipids and serum lipid peroxide (LPO), indicating that they play a role in regulation blood lipids.

4.3.1.4. Increasement of HDL, lower VLDL, and LDL. Kuding tea, Shanlv tea and Laoyin tea have significant efficacy on reducing serum level in TG, TC and LDL-C, increasing HDL-C. Kuding tea has the significant efficacy on reducing serum level in TG, TC, LDL, and HDL/LDL. It can lower the level of TG in liver tissue and reduce the abdominal weight. The water extract of Big leaf Kuding tea (2, 4, 6 g/kg) has a good function in reducing AI (LDL-C/HDL-C) and R-CHR (TC/HDL-C), and it shows a dose-dependent manner in improving the level of TG in serum (Pan, Xu, Peng, Qu, & Lu, 2004). The extract of Kuding tea has a good effect on two-kidney-one-clip (2K-1C) hypertensive rats (0.75 g/kg) and spontaneously hypertensive rats (0.94 g/kg), which are two important animal models on human essential hypertension (Chen & Li, 1995). The water extract of Jinyinhua tea can decrease cholesterol and atherosclerosis index of mice by gavage, improve the content of HDL-C and combine with cholesterol. Meanwhile, it can reduce blood glucose level through inhibiting Alloxan, but it has no effect on normal mice. Shanlv tea has a good efficacy on hyperlipidemia due to the responsible compounds flavonoids and triterpenoids.

4.3.2. Reduction of blood glucose

4.3.2.1. Protection of β-cells. Total flavonoids from Vine tea (100, 200, and 400 mg/kg) have hypoglycemic effect on diabetic mice. Phosphatase 1B (PTP1B) can reduce the content of MDA and decrease the level of blood lipid (TC/TG). It can also increase the activity of SOD in serum, and improve the insulin level in serum. This function may be connected to the reduction of β-cells injured by anti-oxidation (Zhong, Zhou, Chen, & Tan, 2003). The extract of polysaccharide from Qinqianliu tea (300, 450, and 600 mg/kg) has hypoglycemic effect and its mechanism may be related to the rapid scavenging free radicals and the protective effect of lipid peroxide on the islets (Zhang, Duan, & Lu, 2010).

4.3.2.2. Reduction of intestinal absorption of glucose and increasement of renal excretion of glucose. Phloridzin, a representative flavonoid, can reduce the blood glucose levels without increasing insulin secretion. Meanwhile, it can improve insulin resistance of the diabetic animal model (Ding & Cao, 2011). Duosuike tea and Hubei haitang tea contain phloridzin, accounting for up to 7% of dry tea weight (Fang, Yang, Li, Xiang, & Wang, 2007; Li, Wu, Niu, Zang, & Cun, 2009).

4.3.2.3. Improvement of body's sensitivity to insulin. Type 2 Diabetes Mellitus (T2DM) rats were treated with total flavonoids from Vine tea (400 mg/kg) for six weeks by intragastric administration. They found that the extract could significantly improve glucose tolerance, and the transcription level of T2DM was significantly up-regulated by detecting the expression of protein tyrosine Phosphatase 1B (PTP1B), while the transcription level was significantly down-regulated in normal rats (Sun et al., 2010). Wang (Wang, 2011) used Western Blotting to test skeletal muscle and found that the expression of PTP1B was significantly decreased compared with T2DM model group after using large dose of total flavonoids from Vine tea. The results indicated that the hypoglycemic effect may be related to decrease of PTP1B in liver and muscle, enhance insulin signaling and improve insulin sensitivity.

4.3.2.4. Regulation of lipid metabolism. Lv et al. (2009) reported that total flavonoids from Vine tea (100, 200, and 400 mg/kg) could improve impaired glucose tolerance in rats, and significantly reduce the level of fasting blood glucose, insulin, total cholesterol, TG, low-density lipoprotein, free fatty acids and leptin. Meanwhile, they also could increase the level of high-density lipoprotein, insulin sensitivity and improve insulin resistance. The mechanism is connected with regulation of lipid metabolism.

4.4. Immunological enhancement and antitumor effect

According to the investigation record of the Ministry of Health of China, malignant tumor has become the leading cause of death within urban and rural areas in China. It is a challenge to discover effective antitumor drugs and methods (Lu & An, 2008). Non-*Camellia* Tea has the great antitumor effect, specifically has the activity of immunological enhancement, for example, Guangxi sweet tea, Vine tea, Huangqin tea (Zhao, 2007), Kuding tea and Zisu tea. Human immunity improvement is supposed to be one of the mechanisms of antitumor effect.

Wu, Wu, Xie, and Chen (2010) found that total flavonoids of Guangxi sweet tea (62.5, 120, 250, and 500 μg/mL) could suppress proliferation of H22, S180, and L1210. The total flavonoids of Vine tea showed a dose-dependent manner on SGC-7901 tumor cells. It suggested that Vine tea might activate the signaling pathways of tumor cells to induce apoptosis of tumor cells, thus inhibiting the tumor growth (Zhen, Guo, Mao, & Tan, 2009). The decoction of Kuding tea can increase the number of plaque forming cells (PFC) in the spleen, and has the dose-effect relationship. The decoction can enhance the humoral immune function, which may be associated with Kuding tea. It can increase phagocytic function and may have the antagonism of non-specific tracheal smooth muscle Ca^{2+}, which can provide an experimental basis for further development and utilization of Kuding tea. The research showed that total flavonoids of Shiya tea had a good inhibition effect on sarcoma S180 in mice by feeding at the doses of 500 mg/kg and 200 mg/kg.

It is reported that perillyl alcohol isolated from Zisu tea could inhibit cancer and reduce the weight and size of tumor, leading to prolong the cell cycle of tumor (Zhang, Huang, & Zhao, 2006).

4.5. Liver protection

The liver is a detoxification organ. There is a strong demand for the treatment on liver disease. It is equally very important for healthy individuals to protect the liver. Non-*Camellia* Tea has the effect on liver protection, to some extent, even much safer than TCMs. There are some types of Non-*Camellia* Tea suitable for healthy individuals to drink every day, such as Vine tea (Kuang, Deng, & Xu, 2009), Jinyinhua tea, and Huangqin tea.

The total flavonoids from Vine tea (125, 250, and 500 mg/kg) significantly increased the levels of vitamin C, glutathione (GSH) and oxygen radical absorbance capacity (ORAC) in mice liver homogenates, alleviated the oxidative stress, enhanced the anti-stress ability of the body and reduced the occurrence of liver injury (Zhen et al., 2006). The triterpenoid saponins from Jinyinhua tea could protect the liver from injury. In addition, it can protect acute liver injury in mice induced by acetaminophen better than other kinds of Non-*Camellia* Tea. Its mechanism may induce the activity of liver glucuronidase through inhibiting cytochrome P-450 enzymes, which could strengthen the metabolism of acetaminophen in detoxification and reduce the toxic metabolites of acetaminophen. The total flavonoids from Huangqin tea have protective effect on liver injury, which can enhance the activity of scavenging free radicals, reduce lipid peroxidation, protect liver cells and maintain the integrity of membrane structure and

function. It is very important to screen anti-liver injury drugs for clinical application.

4.6. Anti-inflammatory

There is a natural toxin which has inflammatory effect in some organisms. Modern industry and life styles expose human beings to the "inflammatory" chemical substances, such as pesticide residues, alcohol and fried food (Liu, Liu, Roger, Peng, & Zhang, 2009). Anti-inflammatory drugs are the second major drugs following anti-infection drugs. Accordingly, the anti-inflammatory pharmacological effect of active ingredients of Chinese materia medica has become a popular research in the development of new drugs (Li & Zhu, 2012). The inflammatory reaction is to be effectively released by drinking Non-*Camellia* Tea every day.

The water extract of Guangxi sweet tea and total flavonoids of Laoying tea could significantly reduce the release of nitric oxide from peritoneal macrophages and up-regulate the transcription of iNOS mRNA, which resulted in anti-inflammatory effect (Wang, Yi, Chen, He, & Li, 2010).

Jinyinhua tea extract could attenuate sepsis through suppression of IL-1, IL-6, and TNF-α inflammatory factors (Yan, Meng, & Pu, 2016).

4.7. Other effects

Non-*Camellia* Tea also has analgesic (Hua & Ou, 2003), antiviral (Wang & Huang, 2003), antifatigue (Xie, Chen, Luo, & Zhong, 2010a), reducing weight (Jiang & Xu, 2000), and antipyretic effects (Wu & Yang, 2007) and other pharmacological activities. It is worthy to be further studied.

5. Discussion

Although Non-*Camellia* Tea, being used for centuries to prevent diseases, has been investigated in pharmacological activities and chemical compositions, it is still noteworthy in the following aspects.

First, original plants of Non-*Camellia* Tea are confusing and some adulterants are occurring in the market. For example, *Ligustrum henryi* Hemsley, *Ligustrum pedunculare* Rehder and *Ligustrum sinense* var. *myrianthum* (Diels) Hoefker are used as Small leaf kuding tea in some regions (Gu et al., 2011). The local supplies of Laoying tea include *Machilus chuanchieneneie* S. K. Lee and *Actinodaphne cupularis* (Hemsl.) Gamble (Wang, Qi, & Yao, 2010). Huangqin tea is from at least four original plants of the *Scutellaria* genus, for example *S. baicalensis* Georgi, *S. scordifolia* Fisch. ex Schrenk., *S. amoena* C. H. Wright, *S. viscidula* Bunge, etc. (He et al., 2011).

Second, there have been many studies on the toxicity of Non-*Camellia* Tea, but no toxicity has been reported. Many kinds of Non-*Camellia* Tea have been used to become new drugs, e.g. *Ilex hainanensis* is one of the ingredients of Shanlvcha Jiangya Capsule that is listed in National Health Insurance Directory at 2009. Fufang Luobuma Tablet, Luobuma Jiangya Tablet, Shanlameiye Granule have been used in clinic. However, most kinds of Non-*Camellia* Tea still remain at the basic level of research. It is necessary to establish the standardization of Non-*Camellia* Tea. At present, only Shiliang tea has been established in the GAP and SOP in Zhejiang Province, China.

Finally, a large amount of Non-*Camellia* Tea has not been studied systematically in pharmacology and action mechanisms. For example, Xuedi tea is studied in bioactivities and rarely in its mechanism. Damai tea and Shiya tea are not clear in active compounds and their mechanisms at cellular and molecular levels.

6. Conclusion

Non-*Camellia* Tea, which regarded as medicinal and edible plants, has shown reliable safety and validity. It can not only promote the study of tea cultural diversity in China, but also provide clues for the development of new drugs. As an intangible cultural heritage, Non-*Camellia* Tea needs to be investigated, which is helpful in understanding the history and culture of some ethnic minorities.

Conflict of interest

The authors declare no conflict of interest.

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