Available online at www.sciencedirect.com

Integrative Medicine Research

journal homepage: www.imr-journal.com

Review Article

Pharmacognostic outlooks on medical herbs of Sasang typology

Su Hye Lim[a,b], *Eun Sang Jeon*[b,c], *Jeongyun Lee*[d], *Sang Yun Han*[b], *Han Chae*[b,*]

[a] *Department of Pharmacognosy, Faculty of Pharmacy, Istanbul University, Istanbul, Turkey*
[b] *Division of Longevity and Biofunctional Medicine, School of Korean Medicine, Pusan National University, Busan, Korea*
[c] *Department of Complementary and Alternative Medicine, Medipol University, Istanbul, Turkey*
[d] *Korea Institute of Oriental Medicine, Daejeon, Korea*

ARTICLE INFO

Article history:
Received 28 March 2017
Received in revised form
27 June 2017
Accepted 28 June 2017
Available online 8 July 2017

Keywords:
medical herb
personalized medicine
pharmacognosy
Sasang typology

ABSTRACT

The purpose of this study was to review the pharmacognostic characteristics of Sasang type-specific medical herbs and suggest biological mechanisms that might be related to the personalized treatment of the East.

Major compounds and their pharmacological activities of medical herbs for each Sasang types were systematically reviewed. The pharmacognostic characteristics of its main compounds were systematically analyzed with previous studies and three web-based databases.

Sasang type-specific medical herbs were selected, and biological effects of their phytochemicals were reviewed from the pathophysiological features of each Sasang types. Phenolics were dominant in Tae-Yang type-specific herbs, iridoids and triterpenes with antipyretic and diuretic effects were in So-Yang type-specific, saponins (triterpene saponins and steroidal saponins) with antitussive effects were in Tae-Eum type-specific, and monoterpene and sesquiterpenes with stomachic effect were in So-Eum type-specific herbs.

Pharmacognostic understandings on Sasang type-specific medical herbs with consideration of type-specific pathophysiological features were provided for the first time. This study would contribute to in-depth understandings on the pathophysiology of Sasang typology and integration of East-Asian and Western personalized medicine.

* *Corresponding author.* Division of Longevity and Biofunctional Medicine, School of Korean Medicine, Pusan National University, 30 Jangjeon-dong, Geumjeong-gu, Busan 50610, Korea.
E-mail address: han@chaelab.org (H. Chae).

http://dx.doi.org/10.1016/j.imr.2017.06.005

1. Introduction

Personalized medicine for improving efficacy and safety has been a major topic of medicine for thousands of years[1–3] since four humoral types of Hippocrates and Galen[4] and five phase and Yin-Yang based typology of traditional East-Asian medicine;[2] however, those were just a coarse draft without details for pathophysiology, diagnostics, and type-specific medical treatments.

The Sasang typology is a person-centered personalized medicine dividing people into four Sasang types of Tae-Yang (TY), So-Yang (SY), Tae-Eum (TE), and So-Eum (SE) by Jema Lee in his book, *Longevity and Life Preservation of the Eastern Medicine* (1894, 1900);[5] this book provides type-specific guideline for safe and effective medical herbs and acupuncture treatment.[1,6] It is a reinterpretation of traditional East-Asian medicine based on biopsychosocial traits with the support of thousand years of clinical experience and Confucius personality studies in Korea.[1,6,7]

There have been extensive Sasang typology studies on psychological traits,[8] physical characteristics,[9,10] genetic,[3] and clinical[9,11] standpoints. As for the psychological perspectives, Eysenck's extraversion,[12] Gray's behavioral activation and inhibition system (BAS and BIS),[13] Cloninger's novelty seeking (NS) and harm avoidance (HA),[14] and Chae's Sasang personality questionnaire (SPQ)[7,8] were reported to be useful for describing each Sasang types, and the SY Sasang type has high Extraversion, high BAS and low BIS, high NS and low HA, and high SPQ; however, the SE Sasang type is on the contrary. The obesity-related body mass index (BMI) and thyroid hormonal activity-related ponderal index (PI) were reported be valuable for physical characteristics, and the TE Sasang type has high BMI and PI, whereas the SE Sasang type has low BMI and PI.[1,7,9,10].

As for the biological mechanism for Sasang typology, autonomic reactivity[11] including hypothalamus–pituitary gland–adrenal axis reactivity[10] was suggested. The sympathetic reactivity increases with the order of TE, SY, SE, and TY, and the parasympathetic reactivity decreases with the same order. Along with these, the TE Sasang type reportedly has a higher prevalence of hypertension, diabetes, obesity, and metabolic diseases, and the SE Sasang type is associated with diseases from anxiety and emotional instability.[9,12,15]

Additionally, the pathophysiological symptoms are pivotal pattern identification system for Sasang typology, and the Sasang Digestive Function Inventory (SDFI) was reported to be clinically useful for discriminating the TE and SE Sasang types.[15] The SDFI measures the sturdiness of digestive system and its function and negatively correlates with functional dyspepsia.[15]

However, studies on mechanism of Sasang type-specific treatments were not sufficient even with proven clinical usefulness[16–20] because the study on pathophysiological predispositions of each Sasang types[11] and clinical study with complex herbal compound require sophisticated and tedious step-by-step approach.

Therefore, this study would review pharmacognostic characteristics of Sasang type-specific medical herbs which would provide physical, chemical, biochemical, and biological properties of herbal medicine with natural origin;[21,22] this would provide robust theoretical background for studying the mechanism of Sasang type-specific treatments.

The term pharmacognosy is derived from two Greek words "pharmakon" and "gnosis" which mean drug and to acknowledge, and it approaches medicinal herbs with their major constituents of phenolics, alkaloids, and terpenoids as secondary metabolites or phytochemicals.[23] With the development of modern technology of extraction, isolation, purification, and diagnostic methods, lead compounds from plants contributed to the development of modern drugs[24] such as aspirin from salicylic acid.[25] We would evaluate previous studies[7,14,26–30] regarding Sasang type-specific medical herbs and systematically review their major compounds and phytochemicals and its pharmacognostic activities with the help of previous studies and web-based databases.[31–33].

This study would provide an understanding on Sasang type-specific medication from pharmacological perspectives and foundation for the integration of Eastern and Western personalized medicine in the near future.

2. Methods

2.1. *Selection of Sasang type-specific medical herbs*

Frequently used type-specific medical herbs of Sasang typology were selected with Longevity and Life Preservation in Eastern Medicine and Dong-Mu-Yoo-Go Yak-Sung-Ga. Their pharmacognostic features were reviewed with textbooks of herbal medicine, three web-based databases, and previous studies.[26,34]. Three databases included Up-to-date of Pharmacognosy,[31] Pharmacological function of traditional medical herbs,[32] and Search for Pharmacognostic Information Database.[33]

2.2. *Pharmacognostic property of Sasang type-specific medical herbs*

We systematically reviewed the pharmacological properties of Sasang type-specific medical herbs in perspectives of phytochemicals or secondary metabolites of natural plants, animals, and minerals.[35] Type-specific medical herbs of each Sasang types were classified into three groups of phytochemicals of terpenoids, phenolics, and alkaloids, and the pharmacological properties of each Sasang type-specific medical herbs were investigated with previous studies on its dominant chemicals.

Plant metabolites are produced by their metabolism and classified into primary and secondary metabolites. Primary metabolites, such as carbohydrates, lipids, amino acids, and nucleic acids are crucial for the growth of plants, whereas secondary metabolites, such as alkaloids, terpenoids, and phenolics, play a defensive role against herbivores and harmful ecological environment[36,37] and exhibit pharmacological activities as main compounds of medicinal herbs.[38] The phytochemicals have been used for various pharmacologic activities, such as antioxidant, antimicrobial, immunostimulant, anti-inflammatory, and anticancer,[36] and can be

Table 1 – List of Sasang type-specific medical herbs.

Sasang type	Type-specific medical herbs
Tae-Yang	*Acanthopanax sessiliflorum, Actinidia arguta, Chaenomeles sinensis, Phragmites communis, Pinus densiflora, Prunus japonica,Vitis vinifera*
So-Yang	*Akebia quinata* var. *polyphylla, Alisma orientalis Anemarrhena asphodeloides, Aralia continentalis, Coptis japonica, Cornus officinalis, Euphorbia kansui, Gardenia jasminoides* var. *grandiflora, Lycium chinense, Ostericum koreanum, Paeonia suffruticosa, Phellodendron amurense, Plantago asiatica, Polyporus umbellatus, Poria cocos, Rehmannia glutinosa, Saposhnikovia divaricata, Schizonepeta tenuifolia, Trichosanthes kirilowii Tussilago farfara Gypsum fibrosum* (inorganic drug)
Tae-Eum	*Acorus gramineus, Angelica dahurica, Angelica tenuissima, Asparagus cochinchinensis, Castanea crenata, Chrysanthemum indicum, Cimicifuga heracleifolia, Coix lacryma-jobi, Dimocarpus longan, Dioscorea tenuipes, Ephedra sinica, Gingko biloba, Liriope platyphylla, Morus alba, Nelumbo nucifera, Platycodon grandiflorum, Polygala tenuifolia, Prunus armeniaca, Pueraria lobata, Raphanus sativus, Rheum palmatum, Schizandra chinensis, Scutellaria baicalensis Ulmus pumila, Zizyphus jujuba*
So-Eum	*Aconitum carmichaeli, Allium fistulosum, Amomum villosum, Angelica gigas, Astragalus membranaceus, Atractylodes japonica, Aucklandia lappa, Cinnamomum cassia, Citrus unshiu, Cnidium officinale, Croton tiglium, Cyperus rotundus, Glycyrrhiza uralensis, Paeonia lactiflora, Panax ginseng, Perilla frutescens, Pinellia ternate, Pogostemon cablin, Polygonum multiflorum, Zingiber officinale, Zizyphus jujube*

divided into three major groups of terpenoids, phenolics, and alkaloids.[38]

Terpenoids have diverse groups with more than 23,000 structures, they are the biggest group in the secondary metabolites,[38] and include volatile compounds to attract or expel other animals with their aroma like citronellal, thymol.[36] Terpenoids use isoprene as a building block and are subdivided into monoterpenes, sesquiterpenes, diterpenes, triterpenes, tetraterpenes, polyterpenes, steroid derived from triterpenes and saponins derived from triterpenes, and steroids. Iridoids are a subclass of monoterpenes.[37]

Phenolic compounds, which are famous for their antioxidant property, are easily found in tea, coffee, berries, fruits, and vegetables, such as rutin, quercetin, and hesperidin.[35] Their antioxidant property has been regarded to protect human beings from oxidative stress and free radical-mediated diseases.[38] Phenolics have hydroxylated aromatic rings in common and could be divided into phenylpropenes, coumarins, flavones, flavanones, flavonols, flavanes, isoflavones, anthocyanins, anthraquinones, stilbenes, lignans, and tannins.

Alkaloids, derived from the word of alkaline, are one of the most active secondary metabolites described as organic basic nitrogen-containing structures,[36] and some of them are neutral and weakly acid.[38] Most alkaloids are toxic with bitter taste. They have a long history in medication; some of them like morphine and ephedrine exhibit strong pharmacological activities. Alkaloids contain one or several nitrogen atoms in their structures and are divided into three major groups of true alkaloids, proto alkaloids, and pseudo alkaloids.[37,39]

3. Results

We selected and analyzed 7 medical herbs for TY type, 22 for SY type, 26 for TE type, and 21 for SE type (Table 1). One SY type-specific drug of *Gypsum fibrosum* is inorganic, not from plants, and two herbs (*Lycium chinense* and *Rehmannia glutinosa*) are used as two different drugs (Lycii cortex, Lycii fructus, Rehmanniae radix, and Rehmanniae radix preparat) in SY type.

3.1. *TY type-specific medical herbs and their pharmacognostic properties*

Seven TY type-specific medical herbs are divided into four phenolic drugs, one terpenoid drug, and two other drugs. Although there were few numbers of TY type-specific medical herbs for analyzing and drawing conclusion,[30] their pharmacological activities might be categorized as protecting liver, boosting immune system, and reducing oxidative stresses (Table 2).

The biggest group in TY type-specific drugs is phenolics consisting of phenylpropene, flavone, lignan, and stilbene. Phenolic compounds are characterized by their antioxidant, anti-inflammatory, and other biological activities.[37] Under the category of phenolics, some of the lignan compounds have hepatoprotective property (silymarin from *Silybum marianum*), which is used to treat chronic hepatitis and live cirrhosis.[35] Stilbenes acts as phytoalexin, which is a part of defense systems protecting plants against diseases,[40] and resveratrol from *Vitis vinifera* is one of the stilbene compounds acting as a strong antioxidant agent.[39] In phenolics, hepatoprotective and immunostimulant,[41,42] antioxidant and anti-inflammatory,[43] antioxidant and anti-inflammatory,[37] and anti-inflammatory[44] effects were exhibited.

The terpene drug of TY type-specific herbs also exhibits its hepatoprotective property. In terpenoids, ursolic acid and euscaphic acid from Chaenomelis fructus have hepatoprotective and anti-inflammatory effects.[45] In other groups, amygdalin and prunasin from Pruni semen showed antitussive effect,[37] and asparagine from Phragmitis rhizoma showed diuretic and antipyretic activities.[39]

3.2. *SY type-specific medical herbs and their pharmacognostic properties*

Twenty-two SY type-specific medical herbs would be classified into 13 terpenoid drugs, 3 phenolic drugs, 3 alkaloid drugs, and 3 other drugs. Secondary metabolites of SY type-specific herbs showed antipyretic, anti-inflammatory, and diuretic properties as shown in Table 3.

The major group in SY type-specific herbs is terpenoids, and iridoids and triterpenes are dominant in this group. Triterpenes have a wide spectrum of biological activi-

Table 2 – Pharmacognostic properties of Tae-Yang type-specific medical herbs.

Class	Names of compounds and medical herbs	Pharmacological activities
Terpenes		
Triterpenes	Ursolic acid, euscaphic acid (Chaenomelis fructus)	Hepatoprotective and anti-inflammatory[1]
Phenolics		
Phenylpropenes,	Eleutheroside B (Acanthopanacis cortex)	Hepatoprotective and immunostimulant[2,3]
Flavones	Quercetin (Actinidiae fructus)	Antioxidant and anti-inflammatory [4]
Lignans	Eleutheroside E (Acanthopanacis cortex)	Immunostimulant[2,3]
Stilbenes	Resveratrol (Vitis radix)	Antioxidant and anti-inflammatory[5]
	Pinosylvin (Pini lignum)	Anti-inflammatory[6]
Others		
Cyanogenic glycosides	Amygdalin, prunasin (Pruni semen)	Antitussive[5]
Amino acids	Asparagine (Phragmitis rhizoma)	Diuretic and antipyretic[7]

Table 3 – Pharmacognostic properties of So-Yang type-specific medical herbs.

Class	Names of compounds and medical herbs	Pharmacological activities
Terpenes		
Monoterpenes	Menthone, pulegone (Schizonepetae spica)	Diaphoretic and anti-inflammatory[7]
Diterpenes	Kaurenoic acid (Araliae continentalis radix)	Antirheumatic, analgesic, and diuretic[8,9]
Triterpenes	Alisol A (Alismatis rhizoma)	Hypolipidemic and diuretic[10]
	Pachymic acid (Poria)	Diuretic and stomachic[7,11]
	3,29-Dibenzoyl karounitriol (Trichosanthis semen)	Expectorant[12,13]
Triterpene saponins	Akeboside (Akebiae caulis)	Diuretic and antimicrobial[14,15]
Steroidal Saponins	Timosaponin (Anemarrhenae rhizoma)	Antipyretic, anti-inflammatory, and antimicrobial[8,16]
Triterpene steroid	Euphorbone (Euphorbiae kansui radix)	Purgative[17]
Steroid	Ergosterol(Polyporus)	Diuretic[12]
Iridoids	Aucubin (Plantaginis semen)	Diuretic, antitussive, and expectorant[18]
	Gardenoside, geniposide (Gardeniae fructus)	Anti-inflammatory and antipyretic[12]
	Catalpol (Rehmanniae radix)	Hypoglycemic, sedative, and immunostimulant[12,19].
	Morroniside, loganin (Corni fructus)	Antioxidant immunostimulant[20]
Phenolics		
Phenylpropenes,	Paeonol (Moutan radicis cortex)	Antipyretic and antioxidant[12]
Coumarins	Imperatorin, isoimperatorin (Osterici radix)	Analgesic, anti-inflammatory, and diuretic[7,9]
	Imperatorin, bergapten (Saposhnikoviae radix)	Antipyretic and analgesic[12,21]
Alkaloids		
	Berberin (Phellodendri cortex)	Antimicrobial and antipyretic[7,8,12,16,21]
	Berberine (Coptidis rhizoma)	Antimicrobial and antipyretic[8,12,21]
	Kukoamine (Lycii cortex)	Antipyretic and hypotensive[8,12,21]
Others		
Inorganics	CaSO4·2H2O (Gypsum)	Antipyretic[8,22]
Furan compound	5-hydroxymethyl-2-furaldehyde (Rehmanniae radix preparat)	Hemopoietic[16,23]
Non-protein amino acids.	Betaine (Lycii fructus)	Hepatoprotective[12,21]

ties and exhibit cytotoxic and diuretic properties with bitter tastes.[35] Triterpenoid group of SY type-specific herbs are used for inflammations and arthritis for their anti-inflammatory, diuretic, and analgesic properties. In terpenoids, diaphoretic and anti-inflammatory,[39] antirheumatic, analgesic, and diuretic,[46,47] hypolipidemic and diuretic,[48] diuretic and stomachic,[39,49] expectorant,[50,51] diuretic and antimicrobial,[33,35] antipyretic, anti-inflammatory, and antimicrobial,[32,46] purgative,[52] diuretic,[50] diuretic, antitussive, and expectorant,[53] anti-inflammatory and antipyretic,[50] hypoglycemic, sedative, and immunostimulant,[50,54] and antioxidant and immunostimulant[55] activities were reported.

In phenolics, antipyretic and antioxidant,[50] analgesic, anti-inflammatory, and diuretic,[39,47] and antipyretic and analgesic[31,50] properties were reported. Coumarins are aromatic and used for anti-inflammatory, diuretic, and antimicrobial properties,[37] and some of them exhibit an anticoagulant property as warfarin.[35] Among secondary metabolites, iridoids, alkaloids, and coumarins exhibit strong therapeutic activities.[56,57] Iridoid compounds of harpagoside in *Harpagophytum procumbens* are used for infections, inflammations, and rheumatism, and some iridoids have an extremely bitter taste and used for dyspepsia and lack of appetite.[37]

In alkaloids, antimicrobial and antipyretic[31,32,39,46,50] as well as antipyretic and hypotensive[31,46,50] properties were found. In other groups, hemopoietic,[32,58] hepatoprotective,[31,50] and antipyretic[46,49] effects were found.

3.3. *TE type-specific medical herbs and their pharmacognostic properties*

Twenty-six TE type-specific medical herbs are divided into 11 terpenoid drugs, 8 phenolic drugs, 4 alkaloid drugs, and 3 other drugs. Saponin groups (triterpene saponins and steroidal saponins) hold a dominant position and TE type-specific med-

Table 4 – Pharmacognostic properties of Tae-Eum type-specific medical herbs.

Class	Names of compounds and medical herbs	Pharmacological activities
Terpenes		
Sesquiterpenes	Bilobalide (Ginkgonis semen)	Antitussive[7,12]
	Handelin, chrysanthelide (Chrysanthemi flos)	Anti-inflammatory and antimicrobial[7,8]
	Tussilagone (Farfarae flos)	Antitussive[8,24]
Triterpenes	Cycloartane-type triterpene (Cimicifugae rhizoma)	Anti-inflammatory and osteoprotective[16,25]
Triterpene saponins	Platycodin (Platycodonis radix)	Anti-inflammatory and antitussive[12,21]
	Jujuboside A (Zizyphi semen)	Sedative[7,16]
	Polygalasaponin (Polygalae radix)	Expectorant and antitussive[21,24]
Steroidal Saponins	Dioscin (Dioscoreae rhizoma)	Antidiabetic and immunomodulatory[26]
	Spicatoside A (Liriopis tuber)	Anti-asthmatic and anti-inflammatory[16,27]
	Asparasaponin (Asparagi tuber)	Antitussive and anti-inflammatory[7]
Steroids	β-sitosterol, stigmasterol (Ulmi cortex)	Anti-inflammatory and antimicrobial[8,24]
Phenolics		
Phenylpropenes,	Beta −asarone, alpha- asarone (Acori graminei rhizoma)	Sedative and spasmolytic[7,15]
Coumarins	Oxypeucedanin, imperatorin (Angelicae dahuricae radix)	Anti-inflammatory and anti-nociceptive[12,21]
Flavones	Mulberrin, morusin(Mori radicis cortex)	Diuretic and hypotensive[7,28]
	Baicalin, wogonin (Scutellariae radix)	Anti-inflammatory and anti-allergic[21,29]
Isoflavones,	Puerarin(Puerariae radix)	Anti-diarrhea and cardioprotective [21,30]
Anthraquinones,	Sennoside, rhein (Rhei radix et rhizoma)	Purgative[21,31]
Lignans	Schizandrin, gomisin (Schizandrae fructus)	Anti-asthmatic and antioxidant[8,12]
Tannin	Corilagin, ellagic acid (Longanae arillus)	Sedative[32]
Alkaloids	Ephedrine, pseudoephedrine (Ephedrae herba)	Anti-asthmatic and sympathomimetic[8,24,33]
	Coixol (Coicis semen)	Anti-obesity[34,35]
	Sinapine(Raphani semen)	Antihypertensive and antitussive[36,37]
	Armepavine,nuciferine (Nelumbinis semen)	Hepatoprotective and anti-obesity[21]
Others		
Cyanogenic glycosides	Amygdalin (Armeniacae semen)	Anti-inflammatory and anti-asthmatic[8,38]
Non-protein amino acids.	Betaine (Castaneae semen)	Prophylactic[39]
Phthalide	Ligustilide, buthylphthalide (Angelicae tenuisimae radix)	Anti-inflammatory and analgesic[12,40]

ical herbs showed anti-inflammatory, anti-asthmatic, and antitussive properties as shown in Table 4.

In terpenoids, saponins (triterpene saponins and steroidal saponins) hold a dominant position, and sesquiterpenes is the next. Medical herbs containing saponins are generally used for expectorant and antitussive and immunostimulant agents as platycodin in *Platycodon grandiflorum*.[35,59] Saponin drugs and sesquiterpene drugs in TE type-specific herbs are used as antitussive and expectorant agents. There were antitussive,[39,50] anti-inflammatory and antimicrobial,[39,46] antitussive,[46,60] anti-inflammatory and osteoprotective,[32,61] anti-inflammatory and antitussive,[31,50] sedative,[32,39] expectorant and antitussive,[31,60] antidiabetic and immunomodulatory,[62] anti-asthmatic and anti-inflammatory,[32,63] antitussive and anti-inflammatory,[39] and inflammatory and antimicrobial[46,60] properties in this group.

Phenolic drugs of TE type-specific herbs exhibited antitussive, sedative, anti-inflammatory, hypotensive, and anti-allergic effects. In phenolics, sedative and spasmolytic,[33,39] anti-inflammatory and anti-nociceptive,[31,50] diuretic and hypotensive,[39,64] anti-inflammatory and anti-allergic,[31,65] anti-diarrhea and cardioprotective,[31,66] purgative,[31,67] anti-asthmatic and antioxidant,[46,50] and sedative[68] properties were found.

Alkaloid compounds in TE type-specific herbs exhibited metabolism regulating properties against hypertension and obesity. In alkaloids, anti-asthmatic and sympathomimetic,[46,60,69] anti-obesity,[70,71] antihypertensive and antitussive,[71,72] and hepatoprotective and anti-obesic[31] properties were shown. In other groups, anti-inflammatory and anti-asthmatic,[46,73] prophylactic,[74] and anti-inflammatory and analgesic[50,75] effects were reported.

3.4. *SE type-specific medical herbs and their pharmacognostic properties*

Twenty-one SE type-specific medical herbs are classified into 13 terpenoid drugs, 5 phenolic drugs, 1 alkaloid drug, and 2 other drugs. As a whole, SE type-specific medical herbs tend to have stomachic, sedative, spasmolytic, and anti-inflammatory properties as provided in Table 5.

Monoterpenes and sesquiterpenes (essential oils) are the biggest part of SE type-specific medical herbs; furthermore, they are the main constituents of essential oils exhibiting gastro-protective, sedative, spasmolytic, and antimicrobial activities[37,76] and are dominant in this group. Triterpene saponins exhibit immunostimulant and tonic properties as ginsenosides and astragalosides.

In terpenoids, sedative and spasmolytic,[31,39] antipyretic and stomachic,[46,50] stomachic and antiulcer,[46,50] diuretic and stomachic,[46,50] stomachic, anti-emetic, and spasmolytic,[39,46] sedative and anti-inflammatory,[39,77] stomachic and secretory,[78] stomachic and antitumor,[39,46] purgative,[32,39] tonic and adaptogenic,[31,79] immunostimulant,[31,39,50] anti-inflammatory and antiulcer,[39] and sedative and neuroprotective[80] properties were reported.

The phenolics are reported to have cardiovascular regulating properties. In phenolics, anti-emetic and antitussive,[39,81] anti-inflammatory and cardiovascular-disease-lowering,[82] blood circulation-promoting and spasmolytic,[46,83] and stomachic and antioxidant[39,84] properties were reported.

Table 5 – Pharmacognostic properties of So-Eum type-specific medical herbs.

Class	Names of compounds and medical herbs	Pharmacological activities
Terpenes		
Monoterpenes	Albiflorin, paeoniflorin (Paeoniae radix)	Sedative and spasmolytic[7,21]
	Perillaldehyde, perilla alcohol (Perilla herba)	Antipyretic and stomachic[8,12]
	Bornyl acetate (Amomi fructus)	Stomachic and antiulcer[8,12]
Sesquiterpenes	Atractylon, atractylodine (Atractylodis albae rhizoma)	Diuretic and stomachic[8,12]
	Zingiberene,β-bisabolene (Zingiberis rhizoma)	Stomachic and anti-emetic, spasmolytic[7,8]
	Cyperene, cyperol (Cyperi rhizoma)	Sedative and anti-inflammatory[7,41]
	Patchouli alcohol (Pogostemonis herba)	Stomachic and secretory[42]
	Costunolide (Aucklandiae radix)	Stomachic and antitumor[7,8]
Diterpenes	Cocacinogen (Crotonis semen)	Purgative[7,16]
Triterpene saponins	Ginsenoside (Ginseng radix)	Tonic and adaptogenic[21,43]
	Astragalosides (Astragali radix)	Immunostimulant[12,21]
	Glycyrrhizin (Glycyrrhizae radix)	Anti-inflammatory and antiulcer[7]
	Zizyphus saponin(Zizyphi fructus)	Sedative and neuroprotective[44]
Phenolics		
Phenylpropenes	Homogentisic acid, 3,4-Dihydroxybenzaldehyde (Pinelliae tuber)	Antiemetic and antitussive[7,45]
	Cinnamic acid, cinnamaldehyde (Cinnamomi ramulus)	Anti-inflammatory and cardiovascular-disease-lowering[46]
Coumarins	Decursin, decursinol (Angelicae radix),	Promoting blood circulation and spasmolytic[8,47]
Flavanones	Hesperidin (Citri unshii pericarpium)	Stomachic and antioxidant[7,48]
Alkaloids	Aconitine (Aconiti radix)	Cardiotonic and analgesic[43]
Others		
Phthalide	Ligustilide, cnidilide (Cnidii rhizoma)	Anti-inflammatory and analgesic[12,40]
Non-protein amino acids.	Allicin, diallyl-disulfide. (Allii radix)	Antioxidant and antimicrobial[49]

In alkaloids, aconitine from *Aconiti radix* showed cardiotonic and analgesic effects.[79] In other groups, antioxidant and anti-inflammatory[85,86] and antioxidant and antimicrobial[87] properties were reported.

4. Discussion

The Sasang typology is a unique personalized medicine of Korea and suggests type-specific guideline for safe and effective use of medical herbs;[1,27] however, outlooks of pharmacognosy based on the phytochemicals have not been applied to understand the characteristics of Sasang type-specific medical herbs.[28] We summarized Sasang type-specific medical herbs (Table 1) and systematically reviewed their pharmacognostic effects (Tables 2–5) in this study.

Phenolics were dominant in the TY type-specific herbs, whereas terpenoids were prevailing in other Sasang type-specific herbs. Iridoids and triterpenes with antipyretic and diuretic effects were the foremost in SY type-specific herbs, saponins (triterpene saponins and steroidal saponins) with antitussive effects were frequent in TE type-specific herbs, and monoterpenes and sesquiterpenes with stomachic effect were frequent in SE type-specific herbs.

The pathophysiology of Sasang typology have been extensively examined, and several hypotheses might be explained with pharmacognostic outlook here.[8–11] The TY Sasang type was reported to have the highest sympathetic reactivity and low threshold for BAS.[11] In this study, with a limited number of medical herbs, TY type-specific medical herbs have biological activities of protecting liver function, boosting immune system, and reducing oxidative stress that might be caused by the activated response to stimuli from environment (Table 2). These characteristics of TY type-specific herbs come along with their dominant compounds, such as lignans, stilbenes, and terpenes.

The SY Sasang type is an extroverted, Yang-temperament, and active person with activated BAS and strong musculoskeletal body.[7,8]. In this study, secondary metabolites of SY Sasang type-specific medical herbs have strong therapeutic effects from the antipyretic, diuretic, anti-inflammatory, and anti-rheumatic properties that support elevated musculoskeletal activities of the SY type and sustain Yin functions of the body for balancing with stimulated Yang functions.[11] The anti-inflammatory and diuretic activities were reported to be frequent in SY type-specific medical herbs in previous studies (Table 3).[88] These features of SY type-specific herbs would be explained from their prevailing constituents of iridoids and triterpenes.

The TE Sasang type was reported to have a higher prevalence of hypertension, diabetes, obesity, and metabolic disease and a lower sympathetic activity than others.[9,12,15] Alkaloid compounds of TE type-specific medical herbs exhibit metabolism-regulating properties against obesity and hypertension. Saponins and other terpenoids of TE type-specific medical herbs were used as antitussive and expectorant agents. Anti-inflammatory, anti-asthmatic, and antitussive properties were common in TE type-specific medical herbs as shown in Table 4. These results are in accordance with previous studies[89] that the TE type-specific medical herbs have antitussive, expectorant, and diaphoretic effects and might be related with lowered sympathetic reactivity and impaired or less activated lung function, as described by Jema Lee.[10,11]

The SE Sasang type is an introverted and Yin-temperament person with lean body shape from activated BIS. Furthermore,

they are reported to have prolonged and elevated sympathetic reactivity that might lead to frequent problems with dyspepsia, low digestive function, and anxiety.[9,12,15] The SE type-specific medical herbs have stomachic, sedative, spasmolytic, and anti-inflammatory properties for the dominance of monoterpene and sesquiterpene compounds (Table 5). Monoterpene and sesquiterpene compounds are constituents of essential oils, and one of the previous studies showed that the SE type-specific medical herbs are usually aromatics helping digestive dysfunction and suppressing stress-related responses.[11,15,90]

The Sasang typology is a successfully systematized traditional person-centered personalized medicine dividing people into four Sasang types and suggesting safe and effective use of medical herbs, and homeopathy might be the medical theory of European countries with same idea. Homeopathy considers a patient as a whole person with his/her typical physical, emotional, mental, constitutional, biographical, and environmental aspects[91,92] and provides type-specific description with better safety and efficacy as the Sasang typology does.[93] For example, the aconitine from *Aconiti radix* is a SE Sasang type-specific medical herb for heating up the body and boosting digestive function, and in homeopathy, aconitine is used for treating anxiety of aconite type patients.[94]

However, as for the substantial differences to be acknowledged, the Sasang typology divides humans into four types depending on their psychological and pathophysiological characteristics and uses type-specific medical herbs in combination to strengthen their clinical effects. On the contrary, homeopathy labels patients with clinical responses to one specific medical drug, which resulted in tens of homeopathic types and prescribes one specific medicine only for one patient. Detailed comparison between Sasang typology and homeopathy from pharmacognostic perspectives is needed for the development of integrative personalized medicine with medical herbs.

This study might have limitations for generalization of the results since we could not fully cover the pharmacognostic effects of all the Sasang type-specific medical herbs in here for the lack of reported studies. The pharmacological effects of minor compounds of each medical herb and that of type-specific decoctions are guaranteed to be examined. The systems biology would be needed for the elucidation of pharmacological effects in Sasang typology that prescribes decoctions made with several type-specific herbs in combination. And, although the cold-hot subgroup differentiation of Sasang typology is pivotal for the clinical practice, it was not reflected in this review.

In this study, the pharmacognostic characteristics of Sasang type-specific medical herbs were systematically reviewed according to their chemical compounds and biological properties, and those were discussed with Sasang type-specific pathophysiological mechanisms for the first time. Though pharmacognostic studies on clinical effects of type-specific herbal mixture or formula is guaranteed, this study would provide foundations for pharmacology of Sasang typology and help in understanding the characteristics of Sasang type-specific herbs from the Western pharmacognostic view.

Conflicts of interest

The authors have no conflicts of interest to declare.

Acknowledgments

This work was supported by a 2-year Research Grant of Pusan National University.

REFERENCES

1. Chae H, Lyoo IK, Lee SJ, Cho S, Bae H, Hong M, et al. An alternative way to individualized medicine: psychological and physical traits of Sasang typology. *J Altern Complement Med* 2003;9:519–28.
2. Kang KR, Hwang SM, Park SJ, Chae H. A comparative study on traditional constitutional medicine in the world. *Korean J Orient Med* 2009;15:35–43.
3. Sohn K, Jeong A, Yoon M, Lee S, Hwang S, Chae H. Genetic characteristics of sasang typology: a systematic review. *J Acupunct Meridian Stud* 2012;5:271–89.
4. Stelmack RM, Stalikas A. Galen and the humour theory of temperament. *Pers Individ Dif* 1991;12:255–63.
5. Lee JM. *Longevity and Life Preservation in Eastern Medicine*. Seoul: Lee J.M.; 1894.
6. Lee SJ, Cloninger CR, Cloninger KM, Chae H. The temperament and character inventory for integrative medicine. *J Orient Neuropsychiatry* 2014;25:213–24.
7. Lee SJ, Park SH, Cloninger CR, Kim YH, Hwang M, Chae H. Biopsychological traits of Sasang typology based on Sasang personality questionnaire and body mass index. *BMC Complement Altern Med* 2014;14:315.
8. Chae H, Lee S, Park SH, Jang E, Lee SJ. Development and validation of a personality assessment instrument for traditional korean medicine: sasang personality questionnaire. *Evid Based Complement Alternat Med* 2012;2012:657013.
9. Lee MS, Sohn K, Kim YH, Hwang MW, Kwon YK, Bae NY, et al. Digestive system-related pathophysiological symptoms of Sasang typology: Systematic review. *Integr Med Res* 2013;2:39–48.
10. Chae H, Kown Y. Best-fit index for describing physical perspectives in Sasang typology. *Integr Med Res* 2015;4:20–8.
11. Han YR, Lee HB, Han SY, Kim BJ, Lee SJ, Chae H. Systematic review of type-specific pathophysiological symptoms of Sasang typology. *Integr Med Res* 2016;5:83–98.
12. Chae H, Park SH, Lee SJ, Koh KC. Sasang typology from a personality perspective. *J Korean Orient Med* 2004;25:151–64.
13. Lee SJ, Kim SH, Lim N, Ahn MY, Chae H. Study on the difference of BIS/BAS scale between Sasang types. *Evid Based Complement Alternat Med* 2015;805819:805819.
14. Park SH, Kim MG, Lee SJ, Kim JY, Chae H. Temperament and character profiles of sasang typology in an adult clinical sample. *Evid Based Complement Alternat Med* 2011;2011:794795.
15. Lee M, Bae NY, Hwang M, Chae H. Development and validation of the digestive function assessment instrument for traditional Korean medicine: Sasang digestive function inventory. *Evid Based Complement Alternat Med* 2013;2013:263752.
16. Cho NH, Kim JY, Kim SS, Lee SK, Shin C. Predicting type 2 diabetes using Sasang constitutional medicine. *J Diabetes Invest* 2014;5:525–32.

17. Park SH, Kim MG, Lee SJ, Kim JY, Chae H. Temperament and character profiles of sasang typology in an adult clinical sample. *Evid Based Complement Alternat Med* 2011;2011:794795.
18. Lee TG, Koh B, Lee S. Sasang constitution as a risk factor for diabetes mellitus: A cross-sectional study. *Evid Based Complement Alternat Med* 2009;6:99–103.
19. Park SJ, Bae YC, Choi NR, Ryu SY, Kwon YM, Joo JC. Clinical study on constitutional herbal tea for treating chronic fatigue. *J Pharmacopuncture* 2014;17:55.
20. Cho NH, Kim JY, Kim SS, Shin C. The relationship of metabolic syndrome and constitutional medicine for the prediction of cardiovascular disease. *Diabetes Metab Syndr* 2013;7:226–32.
21. Tyler VE, Brady LR, Robbers JE. *Pharmacognosy*. Philadelphia: Lea & Febiger; 1988.
22. Evans WC. *Trease and Evans' pharmacognosy*. Philadelhpia: Elsevier Health Sciences; 2009.
23. Bruneton J. *Pharmacognosy, phytochemistry, medicinal plants*. Paris: Lavoisier publishing; 1995.
24. Heinrich M, Barnes J, Gibbons S, Williamson EM. *Fundamentals of pharmacognosy and phytotherapy*. Churchill Livingstone: Elsevier Health Sciences; 2012.
25. Rainsford KD. *Aspirin and the Salicylates*. London: Butterworths; 2013.
26. Park SS. The study on the DongMuYooGo YakSungGa. *J Sasang Const Med* 2001;13:8–27.
27. Kim JY, Pham DD. Sasang constitutional medicine as a holistic tailored medicine. *Evid Based Complement Alternat Med* 2009;6:11–9.
28. Lim J, Lee SK, Koh BH, Song IB. A study on the pharmacology of Sasang constitutional medicine. *J Sasang Const Med* 2004;16:44–52.
29. Jung BY, Koh BH, Song IB. Literature review on the Sasang type-specific medical herbs (1). *J Sasang Const Med* 1995;7:169–261.
30. Jung BY, Koh BH, Song IB. Literature review on the Sasang type-specific medical herbs (2). *J Sasang Const Med* 1995;7:135–80.
31. Korean Medicine Convergence Research Information Center. Up-to-date of Pharmacognosy. http://www.kmcric.com/database/herb_searc. Accessed March 1, 2017.
32. Korean Traditional Knowledge Portal, Pharmacological function of traditional medical herbs. http://www.koreantk.com/ktkp2014/medicine/list-by-index.page. Accessed March 1, 2017.
33. Ministry of Food and Drug Safety and National Institute of Food and Drug Safety Evaluation. Search for Pharmacognostic Information Database. https://www.mfds.go.kr/herbmed/index.do?nMenuCode=7. Accessed March 1, 2017.
34. Lim J, Lee SK, Koh BH, Song IB. A study on the pharmacology of Sasang constitutional medicine. *J Sasang Const Med* 2004;16:44–52.
35. Ji OP. *Pharmacognosy*. Seoul: Sungunkwn University Press; 2009.
36. Saxena M, Saxena J, Nema R, Singh D, Gupta A. Phytochemistry of medicinal plants. *J Pharmacogn Phytochem* 2013:1.
37. Wink M. Modes of action of herbal medicines and plant secondary metabolites. *Medicines* 2015;2:251–86.
38. Kabera JN, Semana E, Mussa AR, He X. Plant secondary metabolites: biosynthesis, classification, function and pharmacological properties. *J Pharm Pharmacol* 2014;2:377–92.
39. Kim JW. *Pharmacognosy*. Seoul: Dongmyungsa; 2006.
40. Hasan MM, Cha M, Bajpai VK, Baek KH. Production of a major stilbene phytoalexin, resveratrol in peanut (Arachis hypogaea) and peanut products: a mini review. *Rev Environ Sci Bio* 2013;12:209–21.
41. Choi JM, Ahn JB. Functional properties of 50% methanol extracts from different parts of *Acanthopanax sessiliflorus*. *Korean J Food Sci Technol* 2012;44:373–7.
42. Dewick PM. *Medicinal natural products*. Chichester, UK: John Wiley & Sons, Ltd; 2009.
43. Han BH, Choi SE, Lee MW. Anti-oxidative and nitric oxide production inhibitory activities of phenolic compounds from the fruits of Actinidia arguta. *Nat Prod Sci* 2006;12:221–5.
44. Macickova T, Drábiková K, Nosal R, Bauerová K, Mihalova D, Harmatha J, et al. In vivo effect of pinosylvin and pterostilbene in the animal model of adjuvant arthritis. *Neuro Endocrinol Lett* 2009;31:91–5.
45. Park SY, Yang EJ, Park EJ, Shin BS, Na DH, Song KS. Quantitative analysis of ursolic acid and euscaphic acid in Chaenomelis Fructus by HPLC-evaporative light scattering detection. *Bull Korean Chem Soc* 2014;35:2210–2.
46. Kim JH, Kim YS, Lee SH, Lee KS, Choi GY, Chung SI, et al. *Chemical components of herbal medicines in Ungok Herbology*. Jeonju: Woosuk Press; 2016.
47. Lee MK, Hung TM, Min BS, Lee I, Na M, Woo MH, et al. Quantitative determination of diterpenoids from the roots of Aralia cordata. *Nat Prod Sci* 2009;15:50–4.
48. Qiang Y, Zhang XX, Liu H, XU YR. Chemical constituents of Alisma orientalis. *Chem Nat Compd* 2014;49:1143–5.
49. Li B, Ding YX, Dou DQ, Ran XK, Xu YB, Li LH, et al. Diuretic Ingredients of Poria coco. *Int J Pharm* 2015;11:130–6.
50. Kim HC. *Herbal Pharmacology*. Paju: Gipmundang; 2008.
51. Wang Z, Xie P. *Monographs for quality evaluation of chinese crude drugs*. N.Y: World Scientific; 2015.
52. Zhu YP. *Chinese Materia Medica: Chemistry, Pharmacology and Applications*. N.Y: CRC Press; 1998.
53. Goda Y, Kawahara N, Kiuchi F, Hirakura K, Kikuchi Y, Nishimura H, et al. A guanidine derivative from seeds of Plantago asiatica. *J Nat Med* 2009;63:58–60.
54. Zhang RX, Li MX, Jia ZP. Rehmannia glutinosa: review of botany, chemistry and pharmacology. *J Ethnopharmacol* 2008;117:199–214.
55. Park EB, Kim HS, Shin SY, Ji IA, Kim JH, Kim SG. Antioxidant activity of Cornus officianalis extracts obtained by four different extraction technique. *J Life Sci* 2012;22:1507–14.
56. Tundis R, Loizzo MR, Menichini F, Statti GA, Menichini F. Biological and pharmacological activities of iridoids: recent developments. *Mini Rev Med Chem* 2008;8:399.
57. Rohini K, Srikumar P. Therapeutic role of coumarins and coumarin-related compounds. *J Thermodyn Catal* 2014;2013.
58. Han JH, Park BR. Study on the componential changes of Rehmannia Radix Preparata by steaming and hot-air drying. *Korean J Orient Physiol Pathol* 2011;25:823–9.
59. Shibata S. Saponins with Biological and Pharmacological Activity. In: Wagner H, Wolff P, editors. *New Natural Products and Plant Drugs with Pharmacological, Biological or Therapeutical Activity*. Berlin: Springer-Verlag; 1977.
60. Kim DH, Kim HM, Ryu JH, Um JY, Kim SC, Yang JH. *Pharmacology of Korean Medicine*. Seoul: Shinil Books; 2010.
61. Lee JH, Cuong TD, Kwack SJ, Seok JH, Lee JK, Jeong JY, et al. Cycloartane-type triterpene glycosides from the rhizomes of Cimicifuga heracleifolia and their anticomplementary activity. *Planta medica* 2012;78:1391–4.
62. Kim S, Shin S, Hyun B, Kong H, Han S, Lee A, et al. Immunomodulatory effects of Dioscoreae Rhizome against inflammation through suppressed production of cytokines via inhibition of the NF-κB pathway. *Immune Netw* 2012;12:181–8.
63. Lee YC, Lee JC, Seo YB, Kook YB. Liriopis tuber inhibit OVA-induced airway inflammation and bronchial

hyperresponsiveness in murine model of asthma. *J Ethnopharmacol* 2005;101:144–52.
64. Kim KT, Shin MC, Kim HH, Cho CW, Lee WJ, Woo ER, et al. Specification and analysis of multiple marker compounds for quality control of Mori Cortex Radicis by HPLC. *Bull Korean Chem Soc* 2015;36:117–22.
65. Kim K, Kim L, Rhee Y, Lee S, Choi J, Ko H. Analysis on research trend of studies related with Scutellariae Radix in Korea. *Korean J Orient Physiol Pathol* 2011;25:1095–101.
66. Zhang Z, Lam TN, Zuo Z. Radix Puerariae: an overview of its chemistry, pharmacology, pharmacokinetics, and clinical use. *J Clin Pharmacol* 2013;53:787–811.
67. Aichner D, Ganzera M. Analysis of anthraquinones in rhubarb (Rheum palmatum and Rheum officinale) by supercritical fluid chromatography. *Talanta* 2015;144:1239–44.
68. Yang B, Jiang Y, Shi J, Chen F, Ashraf M. Extraction and pharmacological properties of bioactive compounds from longan (Dimocarpus longan Lour.) fruit—a review. *Food Res Int* 2011;44:1837–42.
69. Chen WL, Tsai TH, Yang CC, Kuo TB. Effects of ephedra on autonomic nervous modulation in healthy young adults. *J Ethnopharmacol* 2010;130:563–8.
70. Choi EK, Cho YJ, Yang HJ, Kim KS, Lee IS, Jang JC, et al. Coix seed extract attenuates the high-fat induced mouse obesity via PPARγ and C/EBPα a downregulation. *Mol Cell Toxicol* 2015;11:213–21.
71. Kim IK, Min SY, Kim JH. Effect of the combination of total saponin of Red Ginseng and Coisis semen for the prevention and treatment of obesity. *J Korean Oriental Med* 2009;30:17–25.
72. Sham TT, Yuen AC, Ng YF, Chan CO, Mok DK, Chan SW. A review of the phytochemistry and pharmacological activities of Raphani semen. *Evid Based Complement Alternat Med* 2013:2013.
73. Do JS, Hwang JK, Seo HJ, Woo WH, Nam SY. Antiasthmatic activity and selective inhibition of type 2 helper T cell response by aqueous extract of semen armeniacae amarum. *Immunopharm Immunot* 2006;28:213–25.
74. Servillo L, Giovane A, Casale R, Balestrieri ML, Cautela D, Paolucci M, et al. Betaines and related ammonium compounds in chestnut (Castanea sativa Mill.). *Food Chem* 2016;196:1301–9.
75. Nam JW, Kang U, Seo EK. Chemical Constituents of the Radices of Angelica tenuissima. *Chem Nat Compd* 2014;50:529–30.
76. Rozza AL, Pellizzon CH. Essential oils from medicinal and aromatic plants: a review of the gastroprotective and ulcer-healing activities. *Fundam Clin Pharmacol* 2013;27:51–63.
77. Uhm JT, Bae SY, Park KS, Kim KS. A study on effects of Cyperus rotundus L. essential oil inhalation on stress relaxation with HRV, EEG. *Symposium of Korean Medicine*. Vol. 22. Institute of Taejeon Uni; 2014:81–92.
78. Chen X, He B, Li X, Luo J. Effects of herba Pogostemonis on gastrointestinal tract. *Zhong Yao Cai* 1998;21:462–6.
79. Ramawat KG, Merillon JM. *Natural Products*. New York: Springer; 2013.
80. Jiang JG, Huang XJ, Chen J. Separation and purification of saponins from Semen Ziziphus jujuba and their sedative and hypnotic effects. *J Pharm Pharmacol* 2007;59:1175–80.
81. Han J, Jo S, Lee M, Baek S, Park S. Contents of homogentisic acid and 3,4-dihydroxybenzaldehyde in the Pinellia ternate by various processing method and its safety estimate. *Korean J Orient Physiol Pathol* 2004;18:846–53.
82. Rao PV, Gan SH. Cinnamon: a multifaceted medicinal plant. *Evid Based Complement Alternat Med* 2014;2014:642942.
83. Zhang WL, Zheng KY, Zhu KY, Zhan JY, Bi CW, Chen JP, et al. Chemical and biological assessment of angelica roots from different cultivated regions in a chinese herbal decoction danggui buxue tang. *Evid Based Complement Alternat Med* 2013:1–10.
84. Bigoniya P, Singh K. Ulcer protective potential of standardized hesperidin, a citrus flavonoid isolated from Citrus sinensis. *Rev Bras Farmacogn* 2014;24:330–40.
85. Jeong JB, Park JH, Lee HK, Ju SY, Hong SC, Lee JR, et al. Protective effect of the extracts from Cnidium officinale against oxidative damage induced by hydrogen peroxide via antioxidant effect. *Food Chem Toxicol* 2009;47:525–9.
86. Bae KE, Choi YW, Kim ST, Kim YK. Components of rhizome extract of Cnidium officinale Makino and their in vitro biological effects. *Molecules* 2011;16:8833–47.
87. Chang TC, Jang HD, Lin WD, Duan PF. Antioxidant and antimicrobial activities of commercial rice wine extracts of Taiwanese Allium fistulosum. *Food Chem* 2016;190:724–9.
88. Kim JY, Kim KY. A research on the classification of herbal medicines based on the Sasang constitution (Soyangin Part). *J Sasang Const Med* 2001;13:1–7.
89. Kim JY, Kim KY. A research on the classification of herbal medicines based on the Sasang constitution (Taeumin and Taeyangin Part). *J Sasang Const Med* 2002;14:1–9.
90. Kim JY, Kim KY. A research on the classification of herbal medicines based on the Sasang constitution (Soeumin Part). *J Sasang Const Med* 2001;13:8–16.
91. Bellavite P. Homeopathy and integrative medicine: keeping an open mind. *J Med Person* 2015;13:1–6.
92. Poitevin B. Integrating homoeopathy in health systems. *Bull World Health Organ* 1999;77:160–6.
93. An SW, Cho HS. Study on comparison of homeopathy with Sasang constitutional medicine in basic priciples from the literature. *J Sasang Const Med* 1996;8:165–90.
94. Borrel M. *60 Tips: Allergies*. London: Hachette Illustrated; 2004.