Comparison of anti-oxidant activities of seventy herbs that have been used in Korean traditional medicine*

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Abstract

Many herbs have been used as therapeutics in Korean traditional medicine. In view of their clinical indications, anti-oxidant activity may contribute to their pharmacological effects. However, anti-oxidant information on these plants has not been available. In this study, seventy herbs which have been used in Korean traditional medicine were selected and screened for anti-oxidant activity using their water extracts. The anti-oxidant activity was assessed by their ability to inhibit three oxidation reactions; luminol/Fenton reagent, 2, 7-dichlorodihydrofluorescein (DCHF)/Fenton reagent and DCHF/peroxynitrite. In each assay, 70 herbs were divided into two groups; anti-oxidant group which inhibited the respective oxidation reaction and was majority (about 60 herbs), and pro-oxidant group which enhanced the oxidation reaction but was minority (more or less 10 herbs). When the herbs were listed in the order of their anti-oxidant strength, the orders obtained from each assay were found to be quite similar. The upper top rankers (more or less 10 herbs) in each assay showed strong activity compared to the others. The uppermost rankers in each assay were *Rubus coreanus Miquel/ Rubus schizostylus* (覆盆子), *Schisandra chinensis Baillon/ Schizandra chinensis* (五珠子) and *Terminalia chebula Retzius/ Terminalia chebula* (河子). Of the pro-oxidant herbs, about 4-5 herbs were strongly pro-oxidant, which enhanced the control oxidation reactions to 150-300%. But the meaning of this observation is not known since few of them in one assay were also anti-oxidant in other assays. The results obtained in the present study may serve as information for understanding pharmacological effects of these herbs and developing new drugs from them.

Key Words: Anti-oxidants, herbs, chemiluminescence, peroxynitrite, Fenton reagent

Introduction

Free radicals such as reactive oxygen species (ROS) and reactive nitrogen species (RNS) are produced as byproducts in aerobic metabolism, and have been implicated in the pathogenesis of many diseases, which include cancer, atherosclerosis, diabetes mellitus, hypertension, inflammation and aging (Bagchi *et al.*, 1995; Halliwell & Gutteridge, 1984; ¹Lee *et al.*, 2000a; Wallace, 1999).

Nature has provided man with antioxidant defense system, which is an armamentarium with enzymes and compounds that can remove free radicals (Catapano *et al.*, 2000; Eder *et al.*, 2002; Libby, 2002). Imbalance between production and elimination of free radicals leads to oxidative stress, which damages cells and eventually causes diseases. Therefore, maintenance of antioxidant activity is important in prevention of the above mentioned free radical-associated diseases and aging.

Many plants have been used for centuries in Korean traditional medicine as anti-inflammatory agents, analgesics, emmenagogues, antispasmodics, sedatives or health-improving agents (Bent & Ko 2004; Liu, 2003; Zanon *et al.*, 1999). These therapeutic uses suggest that the diseases for which these herbal plants were used appear to be associated with oxidative stress and thus, anti-oxidant action may play some roles in their therapeutic actions. A large number of substances of plant origin have been found to act as antioxidants by scavenging ROS and RNS, and some of them have therapeutic potentials for free radical associated disorders (Hausladen & Stamler, 1999; ²Lee *et al.*, 2000b). Therefore, it is meaningful to assess anti-oxidant activity of the plants used in the herbal medicine either to elucidate the mechanism of their pharmacological actions or to provide information on anti-oxidant activity of these herbal plants.

In the present study, 70 herbs that have been used traditionally in Korean herbal medicine were selected and evaluated for their

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antioxidant activities. The anti-oxidant activity was assessed using water extracts of these plants because when these plants are used for patients, infusions prepared by boiling them in water are given to patients.

Materials and Methods

Chemicals

Ferrous chloride hexahydrate and hydrogen peroxide (H₂O₂) were purchased from Kanto Chemical, and 5-amino-2, 3-dihydro-1, 4-phthalazinedione (luminol) and 2, 7-dichlorodihydrofluorescein (DCHF) were from Sigma and sodium peroxynitrite from Cayman.

Herbs

Seventy herbs were selected from the literatures describing pharmacological actions and clinical uses of plants (Nakatani, 2000; Zheng & Wang, 2001; Zhu, 1998) and obtained from Kyung Dong herbal market in Seoul. The herbal plants purchased were identified by Dr. Gyu-Mahn Jeong at the Botanical Garden, Kyunghee University. Herbarium voucher specimens were prepared and deposited at the herbarium of the Professional Graduate School of Oriental Medicine, Kyunghee University in Seoul.

Water extracts of herbs

Parts of each herb used for the patients in the traditional medicine such as leaves, roots, flowers, seeds, fruits, barks or sclerotium of each herbal plant were dried and crushed. One hundred grams of the crushed part was placed into 1 liter of distilled water and boiled for 3 hours. Water was then collected by filtration. The remaining herb residue was boiled again in 1 liter of newly added water for 3 hours and then water was collected by filtration. The two water parts collected by filtration were combined, concentrated to 10 ml and filtered through a 0.45 µm Millipore filter. The filtrate was used as a water extract for assessing the anti-oxidant activity of the herb.

Anti-oxidant activity assay using chemiluminescence

Anti-oxidant activity of each water extract was assayed by its ability to inhibit chemiluminescence produced from luminol on its oxidation by H₂O₂/Fe⁺⁺ (Fenton reaction) (Zhu *et al.*, 1994). Briefly, luminol (10 mM) was mixed with 30 mM H₂O₂, 0.5 mM FeCl₂ and PBS, pH 7.4 in the absence or presence of various volumes of each water extract. Total volume was 2 ml. Reaction was started by adding H₂O₂ last and allowed at 37°C. After 10 min, chemiluminescence was measured using a chemiluminescence analyzer (Biolumet LB 9505, Berthold, Germany). In a preliminary experiment, control chemiluminescence (produced in

the absence of the herbal extracts) was linearly increased up to 10 min and thus the chemiluminescence measured at 10 min was used for the comparison of anti-oxidant activities. The anti-oxidant activity was expressed by a reciprocal of the volume of the water extract required to inhibit the control chemiluminescence to 50% (1/50% inhibitory volume; 1/IV₅₀).

Anti-oxidant activity assay using oxidation of DCHF by Fenton reagent

Anti-oxidant activity may differ depending upon assay systems used and thus, to get correct results, it should be assayed by more than one assay system. Therefore, each water extract was also assessed by fluorescence produced from DCHF (2, 7dichloro-dihydrofluorescein) on its oxidation by Fenton reaction (Jakubowski & Bartoz, 2000). Briefly, 50 µM DCHF was mixed with 60 mM H₂O₂, 0.75 mM FeCl₂ and PBS, pH 7.4 in the absence or presence of each water extract (5 µl) in 96 well plates. Total volume was 200 µl. Reaction was started by adding 60 mM H₂O₂ last, allowed at 37°C for 10 min and then fluorescence was measured using a spectrofluorimeter (F-MAX-0200-1300, Molecular Devices) at ex. 485 nm and em. 535 nm. In a preliminary experiment, the control fluorescence (produced in the absence of water extract) was linearly increased up to 10 min and thus, the fluorescence was measured at 10 min after the reaction was started. The anti-oxidant activity was expressed by % inhibition of the control fluorecence [(control fluorescenceexperimental fluorescence)/control fluorescence×100].

Anti-oxidant activity assay using oxidation of DCHF by peroxynitrite

Anti-oxidant activity of each water extract was assayed by another system, i.e. oxidation reaction of DCHF by sodium peroxynitrite. DCHF (0.5 mM), sodium peroxynitrite (0.5 mM) and sodium phosphate buffer (0.3 M) were incubated in the absence or presence of each water extract (5 µl) in 96-well plates at 37°C for 10 min. Total volume was 200 µl. Reaction was started by adding sodium peroxynitrite and then fluorescence was measured using a spectrofluorometer (F-MAX-0200-1300, Molecular Devices) at ex. 485 nm and em. 535 nm. In a preliminary experiment, the control fluorescence (produced in the absence of water extract) was linearly increased up to 10 min and thus, the fluorescence was measured at 10 min after the reaction was started. The anti-oxidant activity was expressed by % inhibition of the control fluorescence [(control fluorescence-experimental fluorescence)/control fluorescence×100].

Statistical analysis

As described above, antioxidant activities of 70 herbs were measured by three assay systems; luminol/Fenton reagent, DCHF/Fenton reagent and DCHF/peroxynitrite. The reproducibility of

antioxidant activity by each of the three assay systems were tested by intraclass correlation coefficients (ICC) using SPSS 12.0 computer program. In this analysis, the data of proxidant 11 herbs measured by luminol/Fenton reagent were excluded because the measured chemiluminescence values $(10^8 \sim 10^9 \text{ range})$ were too large compared to those observed in other assay systems.

Results

Description of the herbal plants used in this study

Table 1 contains the information of the herbs used in the present study; names, voucher specimen number and parts of the plants used in the anti-oxidant assays. In Korean traditional

medicine, when these herbs are used for patients, parts shown in the Table 1 of the respective plants are boiled in water and infusions prepared are given to the patients orally. For the convenience, serial number was given to each herb.

Anti-oxidant activities assessed by Fenton reagent-induced chemiluminescence

Firstly, anti-oxidant activities of the herbs were assessed by measuring their abilities to inhibit chemiluminescence emitting from luminol on its oxidation by Fenton reagent (H₂O₂/Fe⁺⁺). Volume of water extract of each herb to inhibit chemiluminescence to 50% (IV₅₀) was determined and the reciprocals of IV₅₀ (1/IV₅₀) of the respective herbs are shown in Fig. 1; the larger the value of 1/IV₅₀ indicates the stronger its anti-oxidant

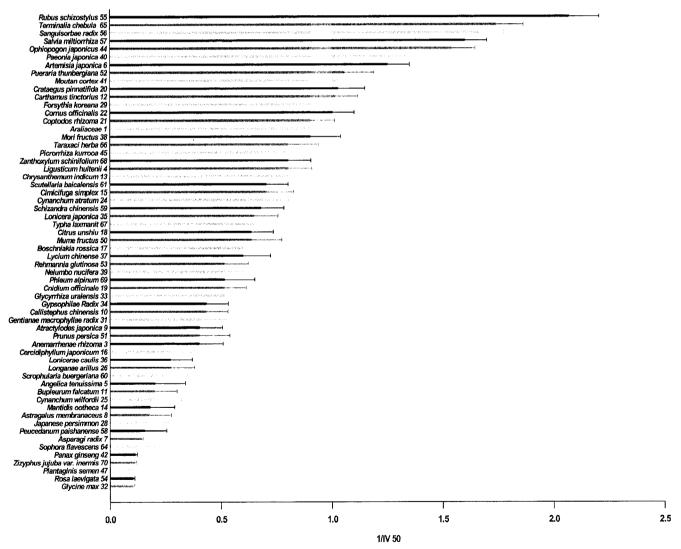


Fig. 1. Anti-oxidant activities of herbs used in Korean traditional medicine assessed by inhibition of chemiluminescence emitting from luminol/Fenton reagent reaction. Water extracts of seventy herbs were prepared and each of water extracts was assayed by measuring the inhibition of chemiluminscence produced from luminol on its oxidation by Fenton reaction. Luminol (10 mM) was mixed with 30 mM H₂O₂, 0,5 mM FeO₂ and phosphate, pH 7.4 in the absence or presence of various volumes of each water extract. Total volume was 2 ml and reaction was started by adding H₂O₂ last and allowed at 37°C. After 10 min, chemiluminescence was measured using a chemiluminescence analyzer. Of the 70 herbs, 60 were shown to inhibit the chemiluminescence. The anti-oxidant activity was expressed by a reciprocal of the volume of the water extract required to inhibit the control chemiluminescence observed in the absence of water extract to 50% (1/50% inhibitory volume; 1/IV₅₀), 1/IV₅₀ of 60 herbs are presented in this figure in the order of their magnitude. Numbers given at each herb are the serial numbers shown in Table 1,

Table 1. Information on the herbal plants used in this study

Bupleurum falcatum Linne / Bupleurum falcatum (株計) BF-1 Root Carthamus Intochrius Linne / Carthamus Intochrius (北花) CT-1 Flower Chrysantherum indicium Linne / Chrysantherum (根盤) CC-1 Stem Cistanche deserticola Y. C. Ma / Boschniakia rossica (南花智) CD-1 Stem Cistanche deserticola Y. C. Ma / Boschniakia rossica (南花智) CD-1 Bark Cistanche deserticola Y. C. Ma / Boschniakia rossica (南花智) CD-1 Bark Cistanche deserticola Y. C. Ma / Boschniakia rossica (南花智也) CD-1 Bark Cistanche Makine / Christium officinale (川湾) CD-1 Bark Cistanche Makine / Christium officinale (川湾) CD-1 Stem Cortisum difficiale Makine / Copticolos inizorne (根盤) CD-1 Stem Cortus officinales Sobold et Zucarda / Corsus difficialis (山茱萸) CD-1 Stem Cortus officinales Sobold et Zucarda / Corsus difficialis (山茱萸) CD-1 Stem Cortus officialis Sobold et Zucarda / Corsus difficialis (山茱萸) CD-1 Stem Cortus difficialis Sobold et Zucarda / Corsus difficialis (山茱萸) CD-1 Root Cyranchum airdum Eliapo / Cyranchum airdum (日涵) CD-1 Root Cyranchum airdum (日涵) CD-1 Full Pull Dioscores batelas Decadere / Discores batelas (山茱萸) DD-1 Full Pull Dioscores batelas Decadere / Discores batelas (山茱萸) DB-1 Root Euryale force Stebstuby / Japanese periamono (太丘 大萸) GB-1 Root Euryale force Stebstuby / Japanese periamono (太丘 大萸) GB-1 Root Cyranchum wificialismu Lindely / Forsythis koreans (茱萸) GB-1 Root Gyriphia viridissimu Lindely / Forsythis koreans (茱萸) GB-1 Root Gyriphia viridissimu Lindely / Forsythis koreans (茱萸) GB-1 Root Gyriphia uralensis Fischer / Glycyrinhiza uralensis (甘菜) GB-1 Root Gyriphia in Makiner / Gyriphia Pulla (長藤) Pulla Root Gyriphia pulla (長藤) Pulla Root Gyriphia pul	Scientific names / Crude drug names	Voucher specimen numbers	Plant parts used for assay
Anamarkana asptodolokios Burger / Anemarkanae rhizoma (知音) Angle os gipas Notar / Lipusicum Indicani (常報) AG1 Root Angelos gipas Notar / Lipusicum Indicani (常報) AG1 Root Affarmias annua Limer / Anamisa japonica (正常) Aspangi reducinama (最多) AT1 Root Antarias annua Limer / Anamisa japonica (正常) Aspangi reducinama annua Limer / Anamisa japonica (正常) AA2 Sean Aspangia continenterisa Memil Aspangi reducinama (百円) Anamisa japonica (正常) AA2 Root Ashaqaisa membranaocas Burger / Ashaqaisa Markatika Ba-1 Root Anacas Burger / Ashaqaisa Indicania (日本) Root Carhamas tincatus Limer / Chrysathanas indonus (日本) CT1 Flower Carhamas tincatus Limer / Chrysathanas indonus (日本) CT1 Flower Chrysathanama indicum Limer / Chrysathanama indicum (日本) CT1 Flower Chrysathanama indicum (日本) CT1 Flower Chrysathanama indicum Limer / Chrysathanama indicum (日本) CT1 Flower Chrisdiana indicum Limer / Chrysathanama indicum (日本) CT1 Sean Collaboration Grassia (日本) CT1 Flower Chrisdiana (日本) CT1 Flower Chrisdiana (日本) CT1 Flower Chrisdiana (日本) Carcidiphyllum japonicum (日本) CT1 Sean Chrisdiana (日本) CAC (日本) Chrisdiana (日本) CAC (日本) Chrisdiana (日本) (日本) GRassiana (日本) CT1 Sean GRassiana (日本) CT1 S	Acanthopanax sessiliflorum Seeman / Araliaceae (五加皮)	AS-1	Stem
Angelice gigas Nokal / Lipusticum Interial (報答) AT-1 Root Angelice Interusiania Air Angelica Interusiania (書本) AT-1 Root Angelica Interusiania (書本) AT-1 Root Angelica Interusiania (書本) AT-1 Root Angelica Interusiania (本代学) AC-1 Root Asparagua cochinchimensia Merrill / Asparagua (本代学) AC-1 Root Asparagua cochinchimensia Merrill / Asparagua (本代学) AC-1 Root Asparagua Sembranaceasa (文字) AL-1 Stem Antracylodes Japonica (Activum / Antracylodes Japonica (日本代) AL-1 Stem Antracylodes Japonica Kortzum / Antracylodes Japonica (日本代) AL-2 Root Antracylodes Japonica Kortzum / Antracylodes Japonica (日本代) AL-2 Root Antracylodes Japonica (日本代) Altracylodes Japonica (日本代) AL-2 Root Carthernus Interiologia Univer J Cartharius Interiologia (日本代) AL-2 Root Cartharius Interiologia Univer J Cartharius Interiologia (日本代) AL-2 Root Cartharius Interiologia University (本代) AL-2 Root Cartharius Interiologia University (本代) Altracylodes Japonica (日本代) Altracylodes Japonica (Artharius Interiologia University (Artharius Cartharius Interiologia University (Artharius Interiologia University (Artharius Interiologia University (Artharius Interiologia University Interiologia University (Artharius Interiologia University (Artharius Interiologia University Interiologia University (Artharius Interiologia University In	Alisma orientale Juzepczuk / Alisma canaliculatum (澤瀉)	AO-1	Stem
Argenica larunisarian Nakair / Angorica ternaisarian (義中) 지지-1 Root Artemisia annua Linne / Antomisia annua Linne / Challistephus chienesia (宗世) Al-1 Stem Antomisia Bargar / Antomisia (Ref) Al-1 Root Antomisia Bargar / Antomisia (Ref) BF-1 Root Bupleurum falcatum (Ref) BF-1 Root Bupleurum falcatum (Ref) BF-1 Root Christophus Linne / Challistephus chienesia (Ref) CT-1 Flower Christophus Linne / Challistephus chienesia (Ref) CT-1 Flower Christophus India Challistephus (Ref) CT-1 Stem Leaf Clinical Linne / Challistephus chienesia (Ref) CT-1 Stem Leaf Clinical Burne / Christophus sinpolex (FHR) CT-1 Stem Leaf Clinical phenolelicile Komarov / Christophus sinpolex (FHR) CT-1 Stem Clinical Linne / Christophus sinpolex (FHR) CT-1 Stem Clinical Linne / Christophus sinpolex (FHR) CT-1 Stem Clinical Linne / Christophus	Anemarrhena asphodeloides Bunge / Anemarrhenae rhizoma (知母)	AA-1	Root
Arbarougus cochinchinensis Marmil / Asprangi radix (天門冬) A.A2	Angelica gigas Nakai / Ligusticum hultenii (當歸)	AG-1	Root
Asparagus occhrichinensis Mernil / Asparagir rodix (天門金) Alt-1 Root Astragulus membranesus Burge / Astragulus membranesus (北川) AJ-1 Stem / Artacytodes Ignocia Kolotzumi / Attacytodes Ignocia Kolotzumi / Astragulus Kolotzumi Indica Multipa / CC-1 Flower Chrysarthermum indicam Litria / Chrysarthermum indicam Litria / Chrysarthermum indicam Litria / Chrysarthermum indicam Litria / Stem. Leaf Christianesia Sussiane / Amdridis codrece (Bebt) CC-1 Stem Christianesia Sussiane / Amdridis codrece (Bebt) CC-1 Stem Christianesia Sussiane / Astragulus Astragulus (Bebt) CC-1 Stem Christianesia Christianesia (Jacoba Kolotzumi (BE) CC-1 Stem Christianesia (Astragulus Christianesia Christianesia (Jacoba Christianesia Christianesia Christianesia Christianesia Christianesia (Jacoba Christianesia Christianes	Angelica tenuissima Nakai / Angelica tenuissima (藥本)	AT-1	Root
Astragalus membranaceus Bunge / Astragalus membranaceus (黄耆) All-1 Stem Alradyckoles japonica Noticumi / Anadyckoles japonica (白元) All-1 Stem Root Alradyckoles japonica Noticumi / Anadyckoles japonica (白元) All-2 Root Bupleurum falcatum (世紀) BP-1 Root Bupleurum falcatum (世紀) BP-1 Root Carthamus tinchorus Linne / Carthamus Inchorus (日本) Cinnachus Anadycki (日本) CL-1 Stem Leaf Cinnachus Inchorus Linne / Carthaffirm Japonicum (日本) Cortain Carthamus Inchorus Linne / Carthaffirm Japonicum (日本) Cinnachus Linne / Carthaffirm Japonicum (日本) Cinnachus Carthamus Cinnachus Inchorus Cinnachus Cinnachus Anadych / Cintus unshiu (日本) Cultum difficiale (日本) Cultum difficiale (日本) Cultum officiale (日本)	Artemisia annua Linne / Artemisia japonica (靑蒿)	AA-2	Stem
Atractylodes japonica Koldzumi / Atractylodes japonica (日本)	Asparagus cochinchinensis Merrill / Asparagi radix (天門冬)	AC-1	Root
Aractylodes (ances D.C. / Callistephus chinensis (美光) Bupleurum falcaturu Linne / Bupleurum falcatum (吳明) CT-1 Flower CT-1 Flower CT-1 Flower Chrysanthemum indicum Linne / Chrysanthemum indicum (日知) Carthamus Indicus Linne / Chrysanthemum indicum (日知) CI-1 Stem. Leaf Curnichiga simplex (子祖) Circlinaphanencelerisia Komareov / Chrisolityas simplex (子祖) Circlinaphanum Linne / Chrysanthemum indicum (日知) Circlinaphanum Cassia Blume / Carcidiphylum piporicum (桂生) Circlinaphanum Markovich / Circlina urshini (神泉) Cul-1 Stem Circlina Blume / Carcidiphylum piporicum (桂生) Cridiagus pinnatifică Burge var. typica Schneideri Carteegus pinnatifică (山東) Cridiagus pinnatifică Burge var. typica Schneideri Carteegus pinnatifică (山東) Corus officinalis Sebolat et Zuccarimi / Corus officinalis (山東東) Corus officinalis Sebolat et Zuccarimi / Corus officinalis (山東東) Corus officinalis Sebolat et Zuccarimi / Corus officinalis (山東東) Corus officinalis Sebolat et Zuccarimi / Corus officinalis (山東東) Corus officinalis Sebolat et Zuccarimi / Carus officinalis (山東東) Corus officinalis Sebolat et Zuccarimi / Carus officinalis (山東東) Corus officinalis Sebolat et Zuccarimi / Cyanchum atratum (白语) Corus officinalis Sebolat et Zuccarimi / Cyanchum atratum (白语) Corus officinalis Sebolat et Zuccarimi / Cyanchum atratum (白语) Corus officinalis Sebolat et Zuccarimi / Cyanchum atratum (白语) Corus officinalis Sebolat et Zuccarimi / Cyanchum atratum (白语) Corus officinalis Sebolat et Zuccarimi / Cyanchum atratum (白语) Corus officinalis Sebolat et Zuccarimi / Cyanchum atratum (白语) Corus officinalis Sebolat et Zuccarimi / Cyanchum atratum (白语) Dioscorea batatas Decaine / Dioscorea batatas (山東) Del Full Roct Gentalia Dura / Gestrodia et Zuccarimi / Explipia Carus (日本) Del Full Roct Corus	Astragalus membranaceus Bunge / Astragalus membranaceus (黃耆)	AM-1	Root
Bupleurum falcatum Linne / Bupleurum falcatum (株計) BF-1 Root Carthamus Intochrius Linne / Carthamus Intochrius (北花) CT-1 Flower Chrysantherum indicium Linne / Chrysantherum (根盤) CC-1 Stem Cistanche deserticola Y. C. Ma / Boschniakia rossica (南花智) CD-1 Stem Cistanche deserticola Y. C. Ma / Boschniakia rossica (南花智) CD-1 Bark Cistanche deserticola Y. C. Ma / Boschniakia rossica (南花智) CD-1 Bark Cistanche deserticola Y. C. Ma / Boschniakia rossica (南花智也) CD-1 Bark Cistanche Makine / Christium officinale (川湾) CD-1 Bark Cistanche Makine / Christium officinale (川湾) CD-1 Stem Cortisum difficiale Makine / Copticolos inizorne (根盤) CD-1 Stem Cortus officinales Sobold et Zucarda / Corsus difficialis (山茱萸) CD-1 Stem Cortus officinales Sobold et Zucarda / Corsus difficialis (山茱萸) CD-1 Stem Cortus officialis Sobold et Zucarda / Corsus difficialis (山茱萸) CD-1 Stem Cortus difficialis Sobold et Zucarda / Corsus difficialis (山茱萸) CD-1 Root Cyranchum airdum Eliapo / Cyranchum airdum (日涵) CD-1 Root Cyranchum airdum (日涵) CD-1 Full Pull Dioscores batelas Decadere / Discores batelas (山茱萸) DD-1 Full Pull Dioscores batelas Decadere / Discores batelas (山茱萸) DB-1 Root Euryale force Stebstuby / Japanese periamono (太丘 大萸) GB-1 Root Euryale force Stebstuby / Japanese periamono (太丘 大萸) GB-1 Root Cyranchum wificialismu Lindely / Forsythis koreans (茱萸) GB-1 Root Gyriphia viridissimu Lindely / Forsythis koreans (茱萸) GB-1 Root Gyriphia viridissimu Lindely / Forsythis koreans (茱萸) GB-1 Root Gyriphia uralensis Fischer / Glycyrinhiza uralensis (甘菜) GB-1 Root Gyriphia in Makiner / Gyriphia Pulla (長藤) Pulla Root Gyriphia pulla (長藤) Pulla Root Gyriphia pul	Atractylodes japonica Koidzumi / Atractylodes japonica (白朮)	AJ-1	Stem
Carthamus tinctorius Linne / Carthamus tinctorius (礼正)	D Atractylodes lancea D.C / Callistephus chinensis (蒼朮)	AJ-2	Root
Chrysanthernum indicum Linne / Chrysanthernum indicum (世海)	1 Bupleurum falcatum Linne / Bupleurum falcatum (柴胡)	BF-1	Root
Paratenodera sinensis Saussure / Mantidis ootheca (義義朝) CZ-1 Stem. Leaf Cimichiga heraclefolia Komarov / Cimichiga simplex (刊版) CH1 Root Ciriamchiga heraclefolia Komarov / Cimichiga simplex (刊版) CC-1 Stem Cistanche deserticola Y. C. Ma / Boschniakia rossica (阿茂智) CD-1 Stem Cistanche deserticola Y. C. Ma / Boschniakia rossica (阿茂智) CD-1 Stem Cidrus unshiu Markovich / Citrus unshiu (開度) CD-1 Root Cidrus unshiu Markovich / Citrus unshiu (開度) CD-1 Root Crateagus pinnatifida Burge var. typica Schneider Crateagus pinnatifida (山道) CP-1 Seed Coglis japonica Makino / Coptodos rhizome (菁達) CD-1 Stem Corticogus pinnatifida Burge var. typica Schneider Crateagus pinnatifida (山道) CD-1 Stem Corticogus pinnatifida Burge var. typica Schneider Crateagus pinnatifida (山道) CD-1 Stem Corticogus pinnatifida Burge var. typica Schneider Crateagus pinnatifida (山道) CD-1 Stem Corticogus pinnatifida Burge var. typica Schneider Crateagus pinnatifida (山道) CD-1 Stem Corticogus pinnatifida Burge var. typica Schneider Crateagus pinnatifida (山道) CD-1 Stem Corticogus pinnatif	2 Carthamus tinctorius Linne / Carthamus tinctorius (紅花)	CT-1	Flower
Cimicifuga heracleifolia Komarov / Cimicifuga simplex (丹葉) CC-1 Stem Colambronorum cassia Blumo / Corcidiphyllum japonicum (性き) CC-1 Stem Colambro deserticide Y C. Me A Boschniaka resisca (段茂智) CD-1 Stem Cilrus unshiu Markovich / Citrus unshiu (豫度) CU-1 Bark Curius unshiu Markovich / Citrus unshiu (豫度) CU-1 Bark Curius unshiu Markovich / Citrus unshiu (豫度) CD-1 Root Cartaegus pinnatifida Bunge vs. typica Schneider/ Crateagus pinnatifida Cuba CD-1 Stem Corrus officinalis Siebold et Zuccarini / Corrus officinalis (山连東) CD-1 Fruit Couscuta chinensis Lamark / Cuscuta japonica Chois. (第桂子) CC-2 Seed Cyranchum artatum Bunge / Cyranchum wilfordi (日音鳥) CW-1 Root Dimocarpus longan Lour / Longanae arillus (後間内) DL-1 Fruit Dioscorea batatas Decisine / Dioscorea batatas (山東) DB-1 Root Bunge ferox Salishury / Japanese persimon (英仁) EF-1 Seed Fursythia viridissima Lindley / Forsythia koreana (達對 GE-1 Stem Gestroide letta Blume / Gastroide letta (天宙) Gertinane macrophyllae Pallas / Gentinane macrophyllae Pallas / Gentinane macrophyllae Pallas / Gentinane macrophyllae Pallas / Gentinane macrophyllae radix (養茶) GM-1 Root Gyvormiza uralensis Fischer / Gyvyrmiza uralensis (世来) GM-2 Seed Gyvyrmiza uralensis Fischer / Gyvyrmiza uralensis (世来) Lonicera japonica Thurberg / Lonicera japonica (全捷で) LU-1 Root Cyraspinia cluthaminae Mique / Gypsophilae Radix (後來等) LU-2 Stem Lonicera japonica (全捷で) Lunicera japonica (全捷で) PL-1 Root Lonicera japonica (全捷で) Lonicera japonica (全捷で) PL-1 Root Palma intribecera / Lonicera japonica (全捷で) PL-1 Root Palma intribecera / Lonicera japonica (全捷で) PL-1 Root Palma intribecera / Lonicera japonica (全港で) PL-1 Root Palma intribecera / Lonicera japonica (全港で) PL-1 Root Palma intribecera Lama intribecera (日本で) Plant	B Chrysanthemum indicum Linne / Chrysanthemum indicum (甘菊)	CI-1	Flower
Cinnamormum cassia Blume / Cercidiphyllum japonicum (桂金)	Paratenodera sinensis Saussure / Mantidis ootheca (桑表蛸)	CZ-1	Stem, Leaf
Cistanche deserticola Y. C. Ma / Boschniakie rossica (英茂馨)	5 Cimicifuga heracleifolia Komarov / Cimicifuga simplex (升麻)	CH-1	Root
Citrus unshiu Markovich / Citrus unshiu (陳史) CU-1 Bark Cndidum difficiale Makino / Cnidum difficiale (川声) CO-1 Root Crateagus pinnatifida Bunge var. typica Schneider/ Crateagus pinnatifida (山主) CO-1 Sead Coptis japonica Makino / Coptodos rhizome (黄度) CJ-1 Stem Corus difficialis Silabolf at Zuccarini / Corrus difficialis (山茱萸) CO-1 Fruit Cuscuta chirensis Lamark / Cuscuta Japonica Chois. (秀緒子) CO-2 Sead Cymanchum atratum Bunge / Cymanchum wilfordi (白首音) CW-1 Root Cymanchum wilfordi Hemsley / Cymanchum wilfordi (白首音) CW-1 Root Dimocarpus longan Lour / Longanea anilus (能態肉) DL-1 Fruit Dioscorea batatas Decaisne / Discocrea batatas (山葉魚) DL-1 Fruit Pruit Root Dimocarpus longan Lour / Longanea enilus (能態肉) DL-1 Fruit Gastrodia elata (正成) Dimocarpus longan Lour / Longanea potatas (山葉魚) BB-1 Root Euryale ferox Salisbury / Japanese persimnon (次亡) EF-1 Sead Gastrodia elata Blume / Gastrodia elata (天龍) GB-1 Stem Gentiana macrophylla Pallas / Gentlanae macrophyllae radix (茱萸) GB-1 Stem Gentianae macrophyllae Pallas / Gentlanae macrophyllae radix (茱萸) GM-1 Root Glycine max Merill / Glycine max (豆豉) GM-2 Sead Glycymhza uralensis (甘草) GU-1 Root Glycspophia oldmariana Mique / Cypsophiae Radix (银珠朝) GU-1 Root Lonicera japonica Thunberg / Lonicera (金銀花) Lu-1 Flower Lonicera japonica Thunberg / Lonicera (毛球市) Lu-1 Root Lonicera japonica Thunberg / Lonicera (毛球市) Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) Penana antoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) Penana ginseng C. A. Meyer / Panax ginseng (人等) PG-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PR-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PR-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PR-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PR-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PR-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PR-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix	6 Cinnamomum cassia Blume / Cercidiphyllum japonicum (桂皮)	CC-1	Stem
Cridium officinale Makino / Cridium officinale (川芎) CO-1 Root Crategus pinnetifida Bunge var. typica Schneider/ Crategus pinnetifida (山査) CP-1 Seed Copils japonica Makino / Coplodos rhizome (黄連) CJ-1 Stem Cornus officinalis Slebold et Zuccanin / Comus officinalis (山茱萸) CO-1 Fnuit Cuscuta chinensis Lamark / Cuscuta Japonica Chois. (菟桂子) CC-2 Seed Cynanchum atratum Bunge / Cynanchum atratum (白間) CA-1 Root Cynanchum witlordi Hemsley / Cynanchum witlordi (白菌島) CW-1 Root Dimocarpus longan Lour / Longanae arillus (徳服肉) DL-1 Fnuit Dioscorae batatas Decalare / Dioscorae batatas Decalare / Dioscorae batatas (他庭内) DE-1 Root Euryale ferox Salisbury / Japonese persimmon (交亡) EF-1 Seed Footythia vindissma Lindley / Forsythia koreana (徳報) FV-1 Fnuit Gastrodia elata Blume / Gastrodia elata (天龍) GE-1 Stem Gentiana macrophyllae Pallas / Gentianae macrophyllae radix (姜菜) GM-1 Root Glycine max Memill / Glycine max (豆蔻) Glycymtriza uralensis (甘草) GU-1 Root Clycymtriza uralensis (甘草) GU-1 Root Clycymtriza uralensis (甘草) GU-1 Root Clycymtriza uralensis (甘草) GU-1 Root Clycyspaphilae olthamiana Miquel / Glysophilae Radix (熊珠朝) GO-1 Root Clyciner japonica Thumberg / Lonicera japonica (金銀石) LJ-1 Flower Lonicera japonica Thumberg / Lonicera eaulis (念冬) LJ-2 Stem Lyclum chinense Miller / Lyclum chinense (特尼子) LC-1 Root Mous aba Linne / Mori fructus (兔桂子) LD-1 Root Paenae Gaentner / Nelumbo nucifera (蚕子肉) PS-1 Root Paenae notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PS-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PS-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PS-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PS-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PS-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PS-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PS-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PS-1 Root Pinnatogae Residual Linne / Plantaginis semen (重節)	Cistanche deserticola Y. C. Ma / Boschniakia rossica (肉蓯蓉)	CD-1	Stem
Crataegus pinnetifida Bunge var. typica Schneider/ Crataegus pinnatifida (山査)	B Citrus unshiu Markovich / Citrus unshiu (陳皮)	CU-1	Bark
Coptis japonica Makino / Coptodos rhizome (青連) CD-1 Stem Comus officinalis (山茱萸) CO-1 Finit Comus officinalis Stebold et Zuccarini / Comus officinalis (山茱萸) CO-1 Finit Cuscuta chinensis Lamark / Cuscuta japonica Chois. (養計子) CC-2 Seed Cypranchum atratum Bungo / Cynanchum atratum (白蚕) CA-1 Root Cynanchum willfordii Hemsley / Cynanchum willfordi (白音鳥) CW-1 Root Dimocarpus longan Lour / Longanae anilus (龍眼萸) DL-1 Finit Dioscorea batatas Decaisne / Discocrea batatas (山壌) DB-1 Root Euryale ferox Salisbury / Japanese persimon (交仁) EF-1 Seed Forsythia viridissima Lindley / Forsythia koreana (連磐) FV-1 Finit Gastrodia elata Blume / Gastrodia elata (天殿) GE-1 Stem Gentiane macrophyllae Pallas / Gentianae macrophyllae radix (東光) GM-1 Root Glycine max Merril / Glycine max (豆豉) GM-2 Seed Glycyrrhiza uralensis Fischer / Glycyrniza uralensis (甘草) GU-1 Root Glycine max Merril / Glycine max (豆豉) GM-2 Seed Glycyrrhiza uralensis Fischer / Glycyrniza uralensis (日幸) GO-1 Root Lonicera japonica Thunberg / Lonicera japonica (金銀花) LU-1 Flower Loricera japonica Thunberg / Lonicera (金銀花) LU-1 Root Marus alba Linne / Mon fructus (桑秸干) MA-1 Finit Paeoria Israfiticosa Andrews / Moutan cortex (牧丹皮) PS-1 Root Panax rollera Gaether / Nelumbo nucitera (圖干肉) NN-1 Finit Paeoria Israfiticosa Andrews / Moutan cortex (牧丹皮) PS-1 Root Panax ginseng C. A. Meyer / Panax ginseng (Amy F. H. Chen / Nologinseng radix (三七) PN-1 Root Panax rologinsengs (Burly F. H. Chen / Nologinseng radix (三七) PN-1 Root Pinis Rovicera is ginseng (Amy F. H. Chen / Nologinseng radix (三七) PN-1 Seed Pinis Root Pinis Rovicera (Briton var. acuta (Thunb.) Kudo / Ophiopogon japonicus (蘇葉) PK-1 Seed Pinis Root Pinis Rovicarini / Mume fructus (孫稅干) PR-1 Seed Pinis Root Pinis Rovicarini / Mume fructus (孫稅干) PR-1 Seed Pinis Root Pinis Rovicarini / Mume fructus (烏橘干) PN-1 Seed Pinis Root Pinis Rovicarini / Mume fructus (烏橘) PN-1 Seed Pinis Robota Ohwi / Pueraria thunbergiana (雋栻) PInis Root Pinis Robota Ohwi / Pueraria (bata Ohwi / Pueraria (thunbergiana (雋斌) PI-1 Finit Pueraria loba	Cnidium officinale Makino / Cnidium officinale (川芎)	CO-1	Root
Comus officinells Siebold at Zuccarini / Comus officinalls (山茱萸) CO-1 Fruit Cuscuta chinensis Lamark / Cuscuta japonica Chois. (宪持干) CC-2 Seed Cynanchum atratum Bunge / Cynanchum atratum (白霞) CW-1 Root Cynanchum willordii Hemsley / Cynanchum willordii (白霞) CW-1 Root Dimocarpus longan Lour / Longanae arillus (龍腹肉) DL-1 Fruit Dioscorea batatas Decaisne / Discoorea batatas Decaisne / Discoorea batatas Decaisne / Discoorea batatas (山東) DB-1 Root Euryale ferox Salisbury / Japanese persimmon (茨仁) EF-1 Seed Forsythia viridissima Lindley / Forsythia koreana (遠離) FV-1 Fruit Gastrodia elata Blume / Gastrodia elata (天育) GE-1 Stem Gentiana macrophylla Pallas / Gentianae macrophyllae radix (東元) GM-2 Seed Glycymtiza uralensis Fischer / Glycymtiza uralensis (甘草) GU-1 Root Glycymtiza uralensis Fischer / Glycymtiza uralensis (甘草) GU-1 Root Lonicera japonica Thunberg / Lonicera eaulis (尼老) LJ-1 Flower Lonicera japonica Thunberg / Lonicera eaulis (尼老) LJ-2 Stem Lycium chinense Miller / Lycium chinense (特杞干) LC-1 Root Morus alba Lime / Mori fructus (東格干) MA-1 Fruit Paeoria lactifilora Pallas / Paeoria japonica (白西東) PL-1 Seed Paeoria lactifilora Pallas / Paeoria japonica (白西東) PL-1 Root Panax girseng (人帝) PG-1 Root Picrortiza kurroa Bertiham / Picrortiza kurroa (胡茱萸) PR-1 Seed Picrorciza kurroa Bertiham / Picrorciza kurroa (胡茱萸) PR-1 Seed Picrorciza kurroa Bertiham / Picrorciza kurroa (胡茱萸) PR-1 Seed Picrorciza kurroa Bertiham / Picrorciza kurroa (胡茱萸) PR-1 Seed Picrorciza kurroa Bertiham / Picrorciza kurroa (胡茱萸) PR-1 Seed Picrorciza kurroa Bertiham / Picrorciza kurroa (胡茱萸) PR-1 Seed Polygonatum sibiricum Redoute / Polygonatum odoratum var. puriflorum (黃藕) PS-1 Seed Polygonatum sibiricum Redoute / Polygonatum odor	Crataegus pinnatifida Bunge var. typica Schneider/ Crataegus pinnatifida (山査)	CP-1	Seed
Comus officinalis Siebold et Zuccarini / Comus officinalis (山茱萸) CC-2 Seed Custa chinensis Lamark / Cuscuta japonica Chois. (褒語子) CC-2 Seed Cynanchum atratum Bunge / Oynanchum atratum (白窗) CM-1 Root Oynanchum willordii Hemsley / Cynanchum willordii (白音鳥) CW-1 Root Dimocarpus longan Lour / Longanae arillus (龍暖肉) DL-1 Fruit Dioscorea batatas Decaisne / Discorea batatas Decaisne / Discorea batatas Decaisne / Discorea batatas Checisne / Discorea batatas (山東) DB-1 Root Euryale ferox Selisbury / Japanese persimmon (交仁) EF-1 Seed Forsythia vindissima Lindley / Forsythia koreana (遠碧) FV-1 Fruit Gastrodia elata Blume / Gastrodia elata CTRI Gentiana macrophyllae Pallas / Gentianae macrophyllae radix (東京) GM-1 Root Glycymbia max (巨窗) GM-2 Seed Glycymbia uralensis Fischer / Glycymbiae Radix (銀柴利) GO-1 Root Glycymbiae oldhamiena Miquel / Cypsophilae Radix (銀柴利) GO-1 Root Lonicera japonica Thunberg / Lonicera eaulis (忌冬) LJ-2 Stem Lycium chinense Miller / Lycium chinense (桃杞子) LC-1 Root Morus abla Linne / Mori fructus (寒稚子) MA-1 Fruit Palas / Paeonia japonica (白芍萸) PL-1 Seed Paeonia lactiflora Pallas / Paeonia japonica (白芍萸) PL-1 Seed Paeonia lactiflora Pallas / Paeonia japonica (白芍萸) PL-1 Root Panax ginseng (人参) PG-1 Root Picrorrhiza kurroa (杨祥美) PR-1 Seed Polygonatum sibiricum Redoute / Polygonatum odoratum var. puriflorum (黄韓) PS-1 Seed Polygonatum sibiricum Redoute / Polygonatum odoratum var. puriflorum (黄韓) PS-1 Fulla Pu	Coptis japonica Makino / Coptodos rhizome (黃連)	CJ-1	Stem
Cuscuta chinensis Lamark / Cuscuta Japonica Chois. (克絲子) CC-2 Seed Cynanchum atratum Bunge / Cynanchum atratum (白薇) CA-1 Root Cynanchum wiltordii Hemsley / Cynanchum wiltordi (白意) CW-1 Root Dimocarpus Iongan Lour / Longanae arillus (龍眼閃) DL-1 Fruit Dioscorea batatas Decaisne / Disocorea batatas (山東) DB-1 Root Euryale ferox Salisbury / Japanese persimmon (芡仁) EF-1 Seed Forsythia viridissima Lindley / Forsythia koreana (龍東) GE-1 Stem Gastrodia elata (北東) GB-1 Root Gastrodia elata (北東) GB-1 Root Gastrodia elata (北東) GB-1 Root Gistrodia elata (北東) GB-1 Root Gistrodia elata (元素) GB-1 Root Giycrimiza uralensis (古華) GB-1 Root Giycrimiza uralensis (古華) GB-1 Root Giycrimiza uralensis Fischer / Glycrymiza uralensis (甘草) GB-1 Root Lonicera japonica Thunberg / Lonicera japonica 企銀花) LJ-1 Flower Lonicera japonica Thunberg / Lonicera eculis (忍令) LJ-2 Stem Lycium chinense Miller / Lycium chinense Miller / Lycium chinense (枸杞子) MA-1 Fruit Nelumbo nucliera Gaertner / Nelumbo nucliera (蓬干肉) NN-1 Fruit Paeonia lactiflora Pallas / Paeonia japonica (白芍菜) PB-1 Root Panax notoginsengs (ቤ北朴) F. Chen / Notoginseng radix (三七) PN-1 Root Panax notoginsengs (ቤ北朴) F. Chen / Notoginseng radix (三七) PN-1 Root Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (海松子) PK-2 Root Pinus koraiensis Siebold et Zuccarini / Nume fructus (烏橘) PP-1 Fruit Pinus persica Batsch / Prurus persica (楊代一) PP-1 Fruit Pinus persica Batsch / Prurus persica (楊代一) PP-1 Fruit Pinus persica Batsch / Prurus persica (楊代一) PP-1 Fruit Pinus persica Batsch / Prurus persica (楊代一) PP-1 Fruit Pinus persica Batsch / Prurus persica (楊代一) PP-1 Fruit Pinus persica Batsch / Prurus persica (楊代一) PP-1 Fruit Pinus persica Batsch / Prurus persica (楊代一) PP-1 Fruit Pinus persica Batsch / Prurus persica (楊代一) PP-1 Fruit Pinus persica Batsch / Prurus persica (楊代一) PP-1 Fruit Pinus Pinus Ruma (Batsch) PP-1 Fruit Pinus Pinus Pinus Ru	Comus officinalis Siebold et Zuccarini / Cornus officinalis (山茱萸)	CO-1	
Cynanchum utlordii Hemsley / Cynanchum wiltordi (白百角) CW-1 Root Cynanchum wiltordi (白百角) CW-1 Root Dimocarpus longan Lour / Longanae arillus (離限内) DL-1 Fruit Dioscorea batatas Decaisne / Discocrea batatas (山東) DB-1 Root Euryale ferox Salisbury / Japanese persimmon (交仁) EF-1 Seed Forsythia viridissima Lindley / Forsythia koreana (連敷) FV-1 Fruit Gastrodia elata Blume / Gastrodia elata (足職) GE-1 Stem Gentiana macrophylla Pallas / Gentianae macrophyllae radix (秦艽) GM-2 Seed Glycyrmiza uralensis Fischer / Glycyrmiza uralensis (甘草) GU-1 Root Glycine max Merrill / Glycine max (豆豉) GW-2 Seed Glycyrmiza uralensis Fischer / Glycyrmiza uralensis (甘草) GU-1 Root Lonicera japonica Thunberg / Lonicerae caulis (忍冬) LJ-2 Stem Lycium chinense (制モイ) LC-1 Root Morus alba Linne / Mori fructus (秦悟子) MA-1 Fruit Nelumbo nucifera (蚕干肉) MN-1 Fruit Paeonia lactiflora Pallas / Paeonia japonica (古芍東) PL-1 Seed Paeonia sitfruticosa Andrews / Moutan cortex (牧丹取) PS-1 Root Panax ginseng C. A. Meyer / Panax ginseng (人苓) PG-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PN-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PN-1 Root Panax macroa selfentar / Pinus koralensis (海径子) PG-1 Root Panax motoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PN-1 Root Panax mibricum Redoute / Polygonatum odoratum var. pluriflorum (黄精) PS-1 Seed Poria cocco Wolf / Prina soralensis (海径子) PR-1 Seed Poria cocco Wolf (白茯苓) PC-1 Root Pinus koralensis (bach Prunus persica Batsch / Prunus persica (楊代一) PP-1 Fruit Punus Persica Batsch / Prunus persica (楊代一) PP-1 Fruit Punus presica Batsch / Prunus persica (楊代一) PP-1 Fruit Punus Punus persica Batsch / Prunus persica (楊代一) PP-1 Fruit Punus Punus persica Batsch / Prunus persica (楊代一) PP-1 Fruit Punus Punus persica Batsch / Prunus persica (楊代一) PP-1 Fruit Punus	Cuscuta chinensis Lamark / Cuscuta japonica Chois. (菟絲子)		
Cynanchum wilfordii Hemsley / Cynanchum wilfordii (白首島) CW-1 Root Dimocarpus longan Lour / Longanae arillus (総限内) DL-1 Fruit Dioscorea batalata Decaisne / Discocree batalata (世史) DE-1 Root Euryale ferox Salisbury / Japanese persimmon (英仁) EF-1 Seed Forsythia viridissima Lindley / Forsythia koreana (遠観) FV-1 Fruit Gastrodia elata Blume / Gastrodia elata (天龍) GE-1 Stem Gentiana macrophyllae radix (秦艽) GM-1 Root Glycine max Mernil / Glycine max (豆豉) GM-2 Seed Glycyrhiza uralensis (甘草) GM-2 Seed Glycyrhiza uralensis (甘草) GM-1 Root Glycine max Mernil / Glycine max (豆豉) GW-2 Seed Glycyrhiza uralensis (甘草) GU-1 Root Glycine max Miquel / Gypsophilae Radix (銀柴胡) GO-1 Root Lonicera japonica Thunberg / Lonicera japonica (金銀花) LJ-1 Flower Loricera japonica Thunberg / Lonicera (超表花) LJ-2 Stem Lycium chinense Miller / Lycium chinense (枸杞干) LC-1 Root Morus alba Linne / Mori fructus (桑柑干) LC-1 Root Morus alba Linne / Mori fructus (桑柑干) NN-1 Fruit Paeoria lactiflora Pallas / Paeoria japonica (古秀瑛) PL-1 Seed Paeoria suffruticosa Andrews / Moutan cortex (牧丹皮) PS-1 Root Panax ginseng C. A. Meyer / Panax ginseng (人参) PG-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PN-1 Root Parlax kurroa Bentham / Picrorrhiza kurroa (精養運) PK-1 Stem, Leaf Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (海松子) PK-2 Root Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (海松子) PC-1 Root Prunus mure Siebold et Zuccarini / Pinus koraiensis (海松子) PC-1 Root Prunus mure Siebold et Zuccarini / Mure fructus (馬楠) PC-1 PC-1 Root Prunus persica Batsch / Prunus persica (桃仁) PP-1 Fruit Pcuraria lobata Ohwi / Pueraria thunbergiana (葛根)	• • • • • • • • • • • • • • • • • • • •		
Dimocarpus longan Lour / Longanae arillus (龍眼時) Dioscorea batatas Decaisne / Discocrea batatas (山東) Dioscorea batatas Decaisne / Pruit Gastrodia elata (月曜) Dioscorea batatas Dume / Gastrodia elata (月曜) Dioscorea batatas Dume / Gastrodia elata (月曜) Dioscorea batatas Decaisne macrophyllae radix (秦艽) Dioscorea batatas Decaisne macrophyllae radix (秦艽) Dioscorea batatas Decaisne macrophyllae radix (秦‡건) Dioscorea batatas Decaisne in Fruit Plower Dioscorea (秦‡건) Dioscorea batatas Decaisne in Pruit Plower Dioscorea (秦‡건) Dioscorea batatas Decaisne in Pruit Plower Dioscorea (秦‡건) Dioscorea batatas Decaisne in Pruit Plower Dioscorea (李茂) Dioscorea batatas Decaisne in Pruit Plower Dioscorea (李茂) Dioscorea batatas Placenia japonica (白芍菜) Plus Paeonia lactiflora Pallas / Paeonia japonica (白芍菜) Plus Paeonia suffruicosa Andrews / Moutan cortex (牧丹皮) Plus Pilla frutescens L. Britton var. acuta (Thunb) Kudo / Ophiopogon japonicus (蘇葉) Dirus koraiensis Siebold et Zuccarini / Pinus koraiensis (清社子) Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (清社子) Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (清社子) Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (清社子) Pinus persica Batsch / Prunus persica (桃仁) Prunus persica Batsch / Prunus persica (桃仁) Prunus persica Batsch / Prunus persica (桃仁) Punus nume Siebold et Zuccarini / Mume finctus (烏梅) Punus nume Siebold et Zuccarini / Mume finctus (烏梅) Punus nume Siebold et Zuccarini / Mume finctus (烏梅) Punus nume Siebold et Zuccarini / Mume finctus (烏梅) P			
Dioscorea batatas Decaisne / Disocorea batatas (山美) Euryale ferox Salisbury / Japanese persimmon (交仁) Euryale ferox Salisbury / Japanese persimmon (交仁) Er-1 Seed Forsythia viridissima Lindley / Forsythia koreana (連軸) FV-1 Gastrodia elata Blume / Gastrodia elata (天麻) Gertiane macrophylla Pallas / Gentianae macrophyllae radix (秦艽) Gycine max Merill / Glycine max (豆豉) Glycine max Merill / Glycine max (豆豉) Glycyrrhiza uralensis Fischer / Glycyrrhiza uralensis (甘草) Gysophila oldhamiena Miquel / Gypsophilae Radix (鐵柴胡) GO-1 Root Coricera japonica Thunberg / Lonicera japonica (金銀花) Lu-1 Lonicera japonica Thunberg / Lonicerae caulis (忍冬) Lycium chinense Miller / Lycium chinense (特紀子) Morus alba Linne / Mori fructus (桑椹子) Nelumbo nucifera Gaertner / Nelumbo nucifera (蓬子肉) NN-1 Paeonia lactiflora Pallas / Paeonia japonica (白芍薬) Paeonia suffruticosa Andrews / Moutan cortex (牧丹皮) Panax ginseng C. A. Meyer / Panax ginseng (人蔘) Panax ginseng C. A. Meyer / Panax ginseng (人蔘) Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) Penilla frutescens L. Britton var. acuta (Thunb.) Kudo / Ophiopogon japonicus (蘇菜) Pirus koraiensis Siebold et Zuccarini / Pinus koraiensis (海松子) Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (海松子) Poria cocos Wolf / Poria cocos Wolf (白茯苓) Prunus murme Siebold et Zuccarini / Murme fructus (烏梅) Prunus persica Batsch / Prunus persica (桃仁) Prunus persica Batsch / Prunus persica (桃仁) Prunus persica Batsch / Prunus persica (桃仁) Pueraria lobata Ohwi / Pueraria thunbergiana (禹禄)			
Euryale ferox Salisbury / Japanese persimmon (英仁) EF-1 Seed Forsythia viridissima Lindley / Forsythia koreana (連雜) FV-1 Fruit Gastrodia elata Blume / Gastrodia elata (天庭) GE-1 Stem Gentiana macrophyllae Pallas / Gentianae macrophyllae radix (秦艽) GM-1 Root Glycine max Merill / Glycine max (豆豉) GM-2 Seed Glycymtiza uralensis Fischer / Glycymtiza uralensis (甘草) GU-1 Root Gypsophila oldhamiena Miquel / Gypsophilae Radix (鏡梁朝) GO-1 Root Lonicera japonica Thunberg / Lonicera japonica (金銀花) LJ-1 Flower Lonicera japonica Thunberg / Lonicera eaulis (忍冬) LJ-2 Stem Lycium chinense Miller / Lycium chinense (4847-) LC-1 Root Morus alba Linne / Mori fructus (桑椹子) MA-1 Fruit Nelumbo nucifera (결里子放) NN-1 Fruit Paeonia lactiflora Pallas / Paeonia japonica (白芍藥) PL-1 Seed Paeonia suffruticosa Andrews / Moutan cortex (牧丹皮) PS-1 Root Panax ginseng C. A. Meyer / Panax ginseng (人蔘) PG-1 Root Panax ginseng (Burk) F. H. Chen / Notoginseng radix (三七) PN-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PN-1 Root Pictorrhiza kurroa Bentham / Picrorrhiza kurroa (胡黃蓮) PK-1 Stem, Leaf Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (海松子) PK-2 Root Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (海松子) PC-1 Root Prunus mura Siebold et Zuccarini / Murne fructus (烏梅) PC-1 Root Prunus persica Batsch / Prunus persica (桃仁) PP-1 Fruit Pueraria lobata Ohwi / Pueraria thunbergiana (養根)			
Forsythia viridissima Lindley / Forsythia koreana (連縣) FV-1 Fruit Gastrodia elata Blume / Gastrodia elata (天底) GE-1 Stem Gertiana macrophylla Pallas / Gentianae macrophyllae radix (秦艽) GM-1 Root Glycine max Merrill / Glycine max (豆豉) GM-2 Seed Glycyrrhiza uralensis Fischer / Glycyrrhiza uralensis (甘草) GU-1 Root Glycyrrhiza uralensis Fischer / Glycyrrhiza uralensis (甘草) GU-1 Root Lonicera japonica Thunberg / Lonicera japonica (金雞花) LJ-1 Flower Lonicera japonica Thunberg / Lonicera japonica (金雞花) LJ-2 Stem Lycium chinense Miller / Lycium chinense (枸杞子) LC-1 Root Morus alba Linne / Mori fructus (桑椹干) MA-1 Fruit Nelumbo nucifera Gaertner / Nelumbo nucifera (蓮子內) NN-1 Fruit Paeonia lactiflora Pallas / Paeonia japonica (白芍藥) PL-1 Seed Paeonia suffruticosa Andrews / Moutan cortex (牧丹皮) PS-1 Root Panax ginseng C. A. Meyer / Panax ginseng (人苓) PG-1 Root Panax ginseng C. A. Meyer / Panax ginseng (人苓) PG-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PN-1 Root Picrorrhiza kurroa Bentham / Picrorrhiza kurroa (胡黃蓮) PF-1 Root Picrorrhiza kurroa Bentham / Picrorrhiza kurroa (胡黃蓮) PK-1 Seed Polygonatum sibiricum Redoute / Polygonatum odoratum var. pluriflorum (黃精) PS-1 Seed Polygonatum sibiricum Redoute / Polygonatum odoratum var. pluriflorum (黃精) PS-1 Seed Prunus mume Siebold et Zuccarini / Mume fructus (烏楠) PP-1 Fruit Puraria lobata Ohwi / Pueraria thunbergiana (簑根) PL-2 Seed			
Gastrodia elata Blume / Gastrodia elata (天庭) GE-1 Stem Gentiana macrophylla Pallas / Gentianae macrophyllae radix (秦艽) GM-1 Root Glycine max Merrill / Glycine max (豆豉) GM-2 Seed Glycyrrhiza uralensis Fischer / Glycyrhiza uralensis (甘草) GU-1 Root Gypsophilae Radix (銀柴胡) GO-1 Root Lonicera japonica Thunberg / Lonicera japonica (金銀花) LJ-1 Flower Lonicera japonica Thunberg / Lonicera caulis (忍冬) LJ-2 Stem Lycium chinense Miller / Lycium chinense (枸杞子) MA-1 Fruit Nelumbo nucifera Gaertner / Nelumbo nucifera (蓮子內) NN-1 Fruit Paeonia lactiflora Pallas / Paeonia japonica (白芍薬) PL-1 Seed Paenia suffruticosa Andrews / Moutan cortex (牡丹皮) PS-1 Root Panax ginseng C. A. Meyer / Panax ginseng (人蔘) PG-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PN-1 Root Picrorrhiza kurroa Bentham / Picrorrhiza kurroa Bentham / Picrorrhiza kurroa Bentham / Picrorrhiza kurroa Bentham / Picrorrhiza kurroa (胡斉蓮) PK-1 Seed Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (海松子) PA-1 Seed Polygonatum sibiricum Redoute / Polygonatum odoratum var. pluriflorum (黃精) PS-1 Seed Poria cocos Wolf / Poria cocos Wolf (白茯苓) PC-1 Root Prunus mume Siebold et Zuccarini / Mume fructus (鳥精) PM-1 Pn-1 Fruit Pueraria lobata Ohwi / Pueraria thunbergiana (葛禄) PL-2 Seed			
Gentiana macrophylla Pallas / Gentianae macrophyllae radix (秦艽) GM-1 Root Glycine max Merrill / Glycine max (豆豉) GM-2 Seed Glycyrrhiza uralensis Fischer / Glycyrrhiza uralensis (甘草) GU-1 Root Gypsophila oldharniana Miquel / Gypsophilae Radix (銀染朝) GO-1 Root Lonicera japonica Thunberg / Lonicera japonica (全銀花) LJ-1 Flower Lonicera japonica Thunberg / Lonicera caulis (忍冬) LJ-2 Stern Lycium chinense Miller / Lycium chinense (枸杞子) LC-1 Root Morus alba Linne / Mori fructus (桑椹子) MA-1 Fruit Nelumbo nucifera (蚕虫们ae (白芍栗) PL-1 Seed Paeonia lactiflora Pallas / Paeonia japonica (白芍栗) PL-1 Seed Paeonia suffruticosa Andrews / Moutan cortex (牧丹皮) PS-1 Root Panax ginseng C. A. Meyer / Panax ginseng (人蔘) PG-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PN-1 Root Picrorrhiza kurroa Bentham / Picrorrhiza kurroa (胡黄蓮) PK-1 Stern, Leaf Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (海松子) PA-1 Seed Polygonatum sibiricum Redoute / Polygonatum odoratum var. pluriflorum (黄藕) PS-1 Seed Poria cocos Wolf (白茯苓) PC-1 Root Prunus mume Siebold et Zuccarini / Mume fructus (烏橋) PM-1 Firuit Prunus persica Batsch / Prunus persica (桃仁) PP-1 Firuit Pueraria lobata Ohwi / Pueraria thunbergiana (婁根)			
Glycine max Merrill / Glycine max (豆豉) GM-2 Seed Glycyrrhiza uralensis Fischer / Glycyrrhiza uralensis (甘草) GU-1 Root Gypsophila oldhamiana Miquel / Gypsophilae Radix (銀柴朝) GO-1 Root Lonicera japonica Thunberg / Lonicera japonica (全銀花) LJ-1 Flower Lonicera japonica Thunberg / Lonicerae caulis (忍冬) LJ-2 Stem Lycium chinense Miller / Lycium chinense (特紀子) LC-1 Root Morus alba Linne / Mori fructus (桑椹子) MA-1 Fruit Nelumbo nucifera (蓮王肉) NN-1 Fruit Paeonia lactiflora Pallas / Paeonia japonica (白芍薬) PL-1 Seed Paeonia suffruticosa Andrews / Moutan cortex (牧丹皮) PS-1 Root Panax ginseng C. A. Meyer / Panax ginseng (人蔘) PG-1 Root Perilla frutescens L. Britton var. acuta (Thunb.) Kudo / Ophiopogon japonicus (蘇葉) PF-1 Root Picrorrhiza kurroa Bentham / Picrorrhiza kurroa (胡黃蓮) PK-1 Seed Picrorrhiza kurroa Bentham / Picrorrhiza kurroa (胡黃蓮) PK-1 Seed Polygonatum sibiricum Redoute / Polygonatum odoratum var. pluriflorum (黃輔) PS-1 Seed Poria cocos Wolf / Poria cocos Wolf (白茯苓) PC-1 Root Prunus murne Siebold et Zuccarini / Murne fructus (烏橘) PM-1 Sclerotium Prunus persica Batsch / Prunus persica (桃仁) PP-1 Fruit Pueraria Ibnate Ohwi / Pueraria thunbergiana (養根) PL-2 Seed			
Glycyrrhiza uralensis Fischer / Glycyrrhiza uralensis (甘草) GU-1 Root Gypsophila oldharniana Miquel / Gypsophilae Radix (銀柴胡) GO-1 Root Lonicera japonica Thunberg / Lonicera japonica (金銀花) LJ-1 Flower Lonicera japonica Thunberg / Lonicerae caulis (忍冬) LJ-2 Stem Lycium chinense Miller / Lycium chinense (枸杞子) LC-1 Root Morus alba Linne / Mori fructus (桑椹子) MA-1 Fruit Nelumbo nucifera Gaertner / Nelumbo nucifera (蓮子肉) NN-1 Fruit Paeonia lactiflora Pallas / Paeonia japonica (白芍藥) PL-1 Seed Paeonia suffruticosa Andrews / Moutan cortex (稅丹皮) PS-1 Root Panax ginseng C. A. Meyer / Panax ginseng (人吞皮) PG-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PN-1 Root Perilla frutescens L. Britton var. acuta (Thunb.) Kudo / Ophiopogon japonicus (蘇葉) PF-1 Root Picrorrhiza kurroa Bentham / Picrorrhiza kurroa (胡黃蓮) PK-2 Root Pilantago asiatica Linne / Plantaginis semen (車前子) PA-1 Seed Polygonatum sibiricum Redoute / Polygonatum odoratum var. pluriflorum (黃精) PS-1 Seed Poria cocos Wolf / Poria cocos Wolf (白茯苓) PC-1 Root Prunus mume Siebold et Zuccarini / Mume fructus (烏楊) PM-1 Sclerotium Prunus persica Batsch / Prunus persica (桃仁) PP-1 Fruit Pueraria lobata Ohwi / Pueraria thunbergiana (養根)			
Gypsophila oldhamiana Miquel / Gypsophilae Radix (観柴胡) GO-1 Root Lonicera japonica Thunberg / Lonicera japonica (金銀花) LJ-1 Flower Lonicera japonica Thunberg / Lonicerae caulis (忍冬) LJ-2 Stem Lycium chinense Miller / Lycium chinense (枸杞子) LC-1 Root Morus alba Linne / Mori fructus (桑锥子) MA-1 Fruit Nelumbo nucifera Gaertner / Nelumbo nucifera (蓮子肉) NN-1 Fruit Paeonia lactiflora Pallas / Paeonia japonica (白芍薬) PL-1 Seed Paeonia suffruticosa Andrews / Moutan cortex (牧丹皮) PS-1 Root Panax ginseng C. A. Meyer / Panax ginseng (人蔘) PG-1 Root Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) PN-1 Root Perilla frutescens L. Britton var. acuta (Thunb.) Kudo / Ophiopogon japonicus (蘇葉) PF-1 Root Picrorrhiza kurroa Bentham / Picrorrhiza kurroa (胡黄蓮) PK-1 Stem, Leaf Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (海松子) PK-2 Root Polygonatum sibiricum Redoute / Polygonatum odoratum var. pluriflorum (黃精) PS-1 Seed Poria cocos Wolf / Poria cocos Wolf (白茯苓) PC-1 Root Prunus mume Siebold et Zuccarini / Mume fructus (烏梅) PM-1 Sclerotium Prunus persica Batsch / Prunus persica (桃仁) PP-1 Fruit Pueraria lobata Ohwi / Pueraria thunbergiana (褒根) PL-2 Seed			
Lonicera japonica Thunberg / Lonicera japonica (全銀花) LJ-2 Stem Lonicera japonica Thunberg / Lonicerae caulis (忍冬) LJ-2 Stem Lycium chinense Miller / Lycium chinense (枸杞子) Morus alba Linne / Mori fructus (桑椹子) Nelumbo nucifera Gaertner / Nelumbo nucifera (蓮子肉) NN-1 Fruit Paeonia lactiflora Pallas / Paeonia japonica (白芍藥) Paeonia suffruticosa Andrews / Moutan cortex (牧丹皮) Panax ginseng C. A. Meyer / Panax ginseng (人蔘) Panax notoginsengs (Burk) F. H. Chen / Notoginseng radix (三七) Perilla frutescens L. Britton var. acuta (Thunb.) Kudo / Ophiopogon japonicus (蘇葉) PF-1 Root Pirorrhiza kurroa Bentham / Picrorrhiza kurrooa (胡黃蓮) PK-1 Stem, Leaf Pinus koraiensis Siebold et Zuccarini / Pinus koraiensis (海松子) Poria cocos Wolf / Poria cocos Wolf (白茯苓) Prunus mume Siebold et Zuccarini / Mume fructus (烏楠) Prunus persica Batsch / Prunus persica (桃仁) Pueraria lobata Ohwi / Pueraria thunbergiana (養根) PL-2 Seed			
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Rehmannia glutinosa Liboschitz var. purpurea Makino / Rehmannia glutinosa (地黃) RG-1 Root	• , ,		

Table 1. continued

	Scientific names / Crude drug names	Voucher specimen numbers	Plant parts used for assay
54	Rosa laevigata Michaux / Rosa laevigata (金櫻子)	RL-1	Root
55	Rubus coreanus Miquel / Rubus schizostylus (覆盆子)	RC-1	Fruit
56	Sangusorba officinalis L. / Sanguisorbae radix (地楡)	SO-1	Fruit
57	Salvia miltiorrhiza Bunge / Salvia miltiorrhiza (丹蔘)	SM-1	Root
58	Saposhnikovia divaricata Schiskin / Peucedanum paishanense (防風)	SD-1	Root
59	Schisandra chinensis Baillon / Schizandra chinensis (五味子)	SC-1	Fruit
60	Scrophularia buergeriana Miquel / Scrophularia buergeriana (玄蔘)	SB-1	Root
61	Scutellaria baicalensis Georgi / Scutellaria baicalensis (黃芩)	SB-2	Root
62	Sepia(Platysepia) esculenta Hoyle / Sepiae os (海螵蛸)	SB-2	Fruit
63	Sesamum indicum Linne / Sesamum indicum (黑脂麻)	SI-1	Root
64	Sophora flavescens Aiton / Sophora flavescens (苦蔘)	SF-1	Stem
65	Terminalia chebula Retzius / Terminalia chebula (訶子)	TC-1	Fruit
66	Taraxacum platycarpum H. Dahlstedt / Taraxaci herba (蒲公英)	TP-1	Stem, Leaf
67	Typha orientalis Presl / Typha laxmanit (蒲黃)	TO-1	Fruit
68	Zanthoxylum piperitum De Candolle / Zanthoxylum schinifolium (山椒)	ZP-1	Seed
69	Zizyphus jujuba Miller / Phleum alpinum (酸棗仁)	ZJ-1	Fruit
70	Zizyphus jujuba Miller var. inermis Rehder / Zizyphus jujuba var. inermis (大椎)	ZJ-2	Fruit

activity. Of total 70 herbs, 60 suppressed the chemiluminescence and were grouped as anti-oxidant herbs although there were big differences in their activities. Interestingly, 10 herbs enhanced the chemiluminescence (Fig. 2) and were grouped as pro-oxidant since they accelerated the ROS-induced chemiluminescent reaction although the accelerating mechanism was not clearly explained. Of the anti-oxidant 60 herbs, 7 herbs in particular

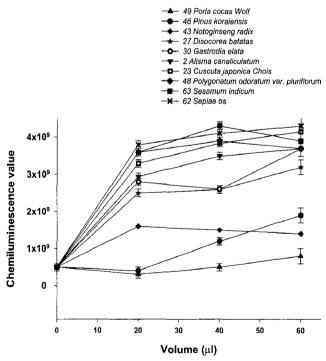


Fig. 2. Pro- oxidant activities of herbs used in Korean traditional medicine assessed by stimulation of chemiluminescence emitting from luminol/Fenton reagent reaction. The experimental conditions were the same as in Fig. 1, Of 70 herbs, 10 shown in the figure stimulated the chemiluminescence. The results are CPM (count per minute) of chemiluminescence by water extracts of each herb, Numbers given at each herb are the serial numbers shown in Table 1,

showed much higher anti-oxidant activities than the others, which were Rubus coreanus Miquel/ Rubus schizostylus (覆盆子)<55>, Terminalia chebula Retzius/ Terminalia chebula (訶子)<65>, Salvia miltiorrhiza Bunge/ Salvia miltiorrhiza (地楡)<56>, Salvia miltiorrhiza (丹蔘)<57>, Perilla frutescens L. Britton var. acuta (Thunb.) Kudo/ Ophiopogon japonicas (蘇葉)<44>, Paeonia lactiflora Pallas/ Paeonia japonica (自芍藥) <40>, Artemisia annua Linne/ Artemisia japonica (青蒿)<6>, [the numbers in < > are the serial numbers in Table 1]. On the other hand, of 10 herbs in Fig. 2, seven herbs exhibited the strongly enhanced chemiluminescence, which were Sesamum indicum Linne/ Sesamum indicum (黑脂麻)<63>, Cuscuta chinensis Lamark/ Cuscuta japonica Chois. (菟絲子)<23>, Alisma orientale Juzepczuk/ Alisma canaliculatum (澤瀉)<2>, Gastrodia elata Blume/ Gastrodia elata (天麻)<30>, Polygonatum sibiricum Redoute/ Polygonatum odoratum var. pluriflorum (當歸)<48>, Dioscorea batatas Decaisne/ Disocorea batatas (山藥)<27> and Sepia (Platysepia) esculenta Hoyle/ Sepiae os (海螵蛸)<62>.

Anti-oxidant activities assessed by Fenton reagent-induced fluorescence

Secondly, anti-oxidant activities of the herbs were assessed by measuring their abilities to inhibit fluorescence produced from DCHF on its oxidation by Fenton reagent. The inhibition % of the fluorescence by the herbal extracts was determined and presented in the order of magnitude in Fig. 3. The higher inhibition % indicates the stronger anti-oxidant activity. Similar to the results of the chemiluminescence (Fig. 1 and 2), most of them (59 herbs) inhibited the fluorescence (Fig. 3) but some (11 herbs) enhanced the fluorescence (Fig. 4). The former were grouped as anti-oxidant and the latter as pro-oxidant although there were wide ranges in the inhibiting and enhancing activities,

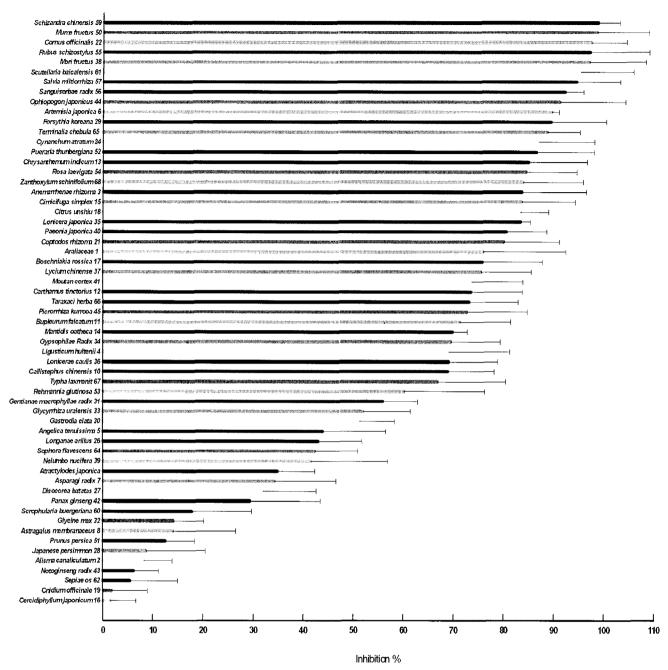


Fig. 3. Anti-oxidant activities of herbs used in Korean traditional medicine assessed by inhibition of fluorescence emitting from DCHF/Fenton reagent reaction. The anti-oxidant activities of 70 herbs were assessed using oxidation of DCHF by Fenton reagent, DCHF (50 μ M) was mixed with 60 mM H₂O₂, 0,75 mM FeCl₂ and PBS, pH 7,4 in the absence or presence of each water extract (5 μ I) in 96 well plates. Total volume was 200 μ I and reaction was started by adding 60 mM H₂O₂ last, allowed at 37°C for 10 min and then fluorescence was measured. Of the 70 herbs, 59 were shown to inhibit the fluorescence. The anti-oxidant activity was expressed by % inhibition of the control fluorescence [(control fluorescence-experimental fluorescence)/control fluorescence × 100]. Numbers given at each herb are the serial numbers shown in Table 1.

respectively. Of 59 herbs in Fig. 3, upper 10 showed more than 85% inhibition, which were Schisandra chinensis Baillon/Schizandra chinensis (五味子)<59>, Prunus mume Siebold et Zuccarini/ Mume fructus (烏梅)<50>, Cornus officinalis Siebold et Zuccarini/ Cornus officinalis (山茱萸)<22>, Rubus coreanus Miquel/ Rubus schizostylus (覆盆子)<55>, Morus alba Linne/Mori fructus (桑性子)<38>, Scutellaria baicalensis Georgi/Scutellaria baicalensis (黃芩)<61>, Salvia miltiorrhiza Bunge/Salvia miltiorrhiza (丹蔘)<57>, Sangusorba officinalis L./Sanguisorbae radix (地楡)<56>, Perilla frutescens L. Britton var.

acuta (Thunb.) Kudo/ Ophiopogon japonicus (蘇葉)<44>, Artemisia annua Linne/ Artemisia japonica (青蒿)<6>. Of 11 herbs in Fig. 4, five herbs showed significant enhancement of fluorescence, which were Crataegus pinnatifida Bunge var. typica Schneider/ Crataegus pinnatifida (山査)<20>, Sesamum indicum Linne/ Sesamum indicum (黑脂麻)<63>, Zizyphus jujuba Miller/ Phleum alpinum (酸棗仁)<69>, Pinus koraiensis Siebold et Zuccarini/ Pinus koraiensis (海松子)<46>, Saposhnikovia divaricata Schiskin/ Peucedanum paishanense (防風)<58>.

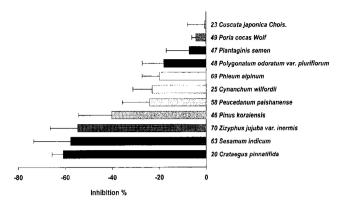


Fig. 4. Herbs which stimulated fluorescence emitting from DCHF/Fenton reagent reaction. The experimental conditions were the same as in Fig. 3. Of the 70 herbs, 11 were shown to stimulate the fluorescence. The results are % stimulation by each herb, Numbers given at each herb are the serial numbers shown in Table 1.

Anti-oxidant activities assessed by peroxynitrite-induced fluorescence

In addition to ROS, nitric oxide (NO'), a reactive nitrogen species (NOS), plays important roles in both physiological and pathological conditions. In pathological conditions NO' can damage cells in the form of ONOO- (peroxynitrite). Therefore, anti-oxidant activities of the herbs were assessed by their abilities to inhibit ONOO-induced oxidation. In this experiment, DCHF/ONOO reaction was used. In Fig. 5, the inhibition % by each herb was presented in the order of the magnitude. In this assay system, all of the herbs except two inhibited the fluorescence and 8 herbs in particular showed more than 80% inhibition, which are *Terminalia chebula Retzius/ Terminalia chebula* (河子)<65>, *Rubus coreanus Miquel/ Rubus schizostylus*

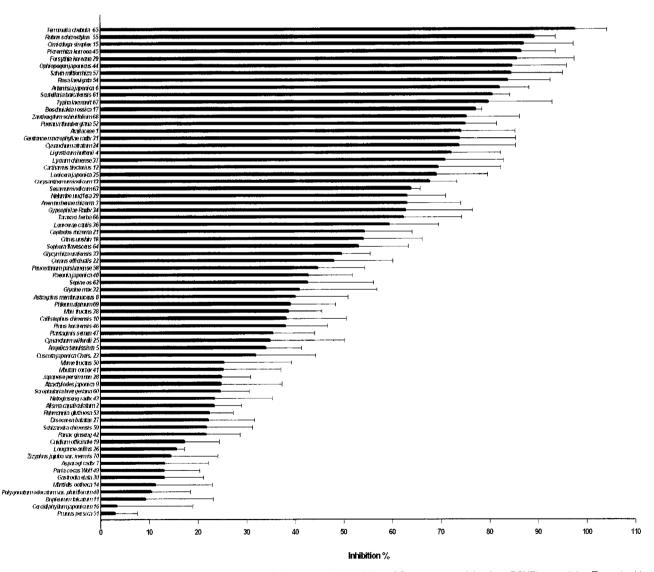


Fig. 5. Anti-oxidant activities of herbs used in Korean traditional medicine assessed by inhibition of fluorescence emitting from DCHF/peroxynitrite. The anti-oxidant activities of the 70 herbs were assessed using oxidation of DCHF by peroxynitrite, DCHF (0,5 mM), sodium peroxynitrite (0,5 mM) and , sodium phosphate buffer (0,3 M) were incubated in the absence or presence of aech water extract (5 μl) in 96-well plates at 37°c for 10 min. Total volume was 200 μl and reaction was started by adding sodium peroxynitrite and then fluorescence was measured using a spectrofluorimeter. Of the 70 herbs, 59 were shown to inhibit the fluorescence. The anti-oxidant activity was expressed by % inhibition of the control fluorescence [(control fluorescence-experimental fluorescence)/control fluorescence ×100]. Numbers given at each herb are the serial numbers shown in Table 1.

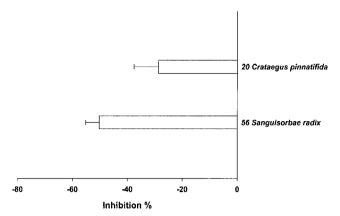


Fig. 6. Herbs which stimulated fluorescence emitting from DCHF/peroxynitrite reaction. The experimental conditions were the same as in Fig. 5. Of the 70 herbs, 2 were shown to stimulate the fluorescence. The results are % stimulation by each herb. Numbers given at each herb are the serial numbers shown in Table 1.

(覆盆子)<55>, Cimicifuga heracleifolia Komarov/ Cimicifuga simplex (升麻)<15>, Picrorrhiza kurroa Bentham/ Picrorrhiza kurroa (胡黃蓮)<45>, Forsythia viridissima Lindley/ Forsythia koreana (連翹)<29>, Perilla frutescens L. Britton var. acuta (Thunb.) Kudo/ Ophiopogon japonicus (蘇葉)<44>, Salvia miltiorrhiza Bunge/ Salvia miltiorrhiza (丹麥)<57>, Rosa laevigata Michaux/ Rosa laevigata (金櫻子)<54>. The two herbs that enhanced the fluorescence were Sangusorba officinalis L./ Sanguisorbae radix (地楡)<56>, Crataegus pinnatifida Bunge var. typica Schneider/ Crataegus pinnatifida (山査)<20> (Fig. 6).

Discussion

In order to obtain more correct information, the anti-oxidant activity of 70 herbs was assessed by 3 oxidation reactions, which were luminal oxidation by Fenton reagent, DCHF oxidation by Fenton reagent and DCHF oxidation by peroxynitrite. Of the 70 herbs, most of them inhibited the oxidation reaction. It means that majority showed anti-oxidant activity. The anti-oxidant herbs selected by each assay were presented in Fig. 1, 2 and 5 in terms of the order of anti-oxidant strength. The results shown in each of three figures were not the same but showed significantly similar tendency (ICC for the data obtained from three assay systems; 0.506 (95% CI: 0.242~0.689). For example, the upper 10-15 rankers of high activity in one assay (ex. Fig. 1) were also shown at upper level in other two assays (ex. Fig. 3 and Fig. 5) and vice versa.

Similarly, the lower 10-15 rankers in one assay were also shown at lower levels in the lists of other two assays or in the pro-oxidant lists of other two assays. Thus, each result obtained from three assays can be useful information on anti-oxidant activities of these plants. However, a few exceptional results, if any, were also found. For example, Crataegus pinnatifida Bunge var. typica Schneider/ Crataegus pinnatifida (山蚕)<20> which was 10th ranker in luminol/Fenton reagent assay (Fig. 1) exhibited pro-oxidant activity in the assays of DCHF/Fenton

reagent (Fig. 4) and DCHF/peroxynitrite (Fig. 6). Rosa laevigata Michaux/ Rosa laevigata (金櫻子)<54> which had almost no activity (59th ranker) in luminol/Fenton reagent assay (Fig. 1) showed rather strong anti-oxidant activity in DCHF/Fenton reagent (Fig. 3) and DCHF/peroxynitrite assays (Fig. 5). Sangusorba officinalis L./ Sanguisorbae radix (地楡)<56> was strong anti-oxidant in the assays using luminol/Fenton reagent (Fig. 1) and DCHF/Fenton reagent (Fig. 3) but showed pro-oxidant activity in the DCHF/peroxynitrite assay (Fig. 6). The crude water extracts of the herbs used for the assays contained a variety of substances, which may be the reason for these conflicting results.

One thing to note here is that in all three assay systems, we found that some herbs augmented the radical reactions, i.e. pro-oxidant. We do not know whether this action can occur in vivo and can harm patients in the clinical use of these plants. Although we do no know its meaning or significance now, however, the pro-oxidant activity of these plants may be new information we should pay attention to, particularly in relation to their side effects or toxicities.

In the present study, about 10 herbs in each assay were found to have strong anti-oxidant activity compared to other plants and some of them were overlapped. At present, we do not know how this anti-oxidant action relates to the clinical actions of these plants described in the ascent literatures. The uppermost ranker in each assay was Rubus coreanus Miguel/ Rubus schizostvlus (覆盆子), Schisandra chinensis Baillon/ Schizandra chinensis (五 味子) and Terminalia chebula Retzius/ Terminalia chebula (訶子), respectively. Rubus coreanus Miquel is known as raspberry. It contains an abundance of sugars, vitamins, minerals, and polyphenols (Bushman et al., 2004; Siriwoharn et al., 2004) and was reported to have anti-inflammatory, antinociceptive, anti-gastropathic and anti-rheumatic effects (Erdemoglu et al., 2003; Nam et al., 2006). Its uses as alcoholic or non-alcoholic beverages have been popularly increased. Based upon its strong anti-oxidant activity, it is highly recommendable to expand its uses. Schisandra chinensis Baillon/ Schizandra chinensis (五味 子) has been used for inflammatory liver diseases and the extract of this plant prevented CCl₄-induced liver damage (Chang, 2003), suggesting that its pharmacological effect is related to its anti-oxidant activity. This herb contains schizandrol and its related compounds, which contain phenolic -OH and -OCH3 (Chang, 2003) and possibly another strong anti-oxidant compounds. Thus, it is needed to find new compounds from this herb and also to develop its use in various forms of beverages. Terminalia chebula Retzius/ Terminalia chebula (河子) had been prescribed mainly for gastrointestinal disorders such as nausea, vomiting, diarrhea and intestinal distension (Chang, 2003) but nowadays, it does not seem to be prescribed often. Recent studies (Monika et al., 2005) showed that this herb have antibacterial, antidiabetic, antioxidative and radioprotective activities (Gandhi & Nair, 2005; Koteswara & Nammi, 2006; Naik et al, 2005; Rani & Khullar, 2004) and another study reported that it contains

anti-oxidant compounds such as gallic acid and quercetin (Nakatani, 2000). Regarding its strong anti-oxidant action, it seems to be worth further developing its use in medicine and food industry.

In the present study, attempts were made first to assess and compare the anti- and pro-oxidant actions of the commonly used herbs in Korean traditional medicine. The results obtained are expected to serve as information for understanding their pharmacological effects, developing new drugs from these herbs, searching natural anti-oxidants or expanding its uses as various forms of beverages.

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