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EXPERIMENTAL STUDY

Oxalate contents of commonly used Chinese medicinal herbs

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Accepted: October 16, 2014

Abstract

OBJECTIVE: To assess the total and soluble oxalate contents of commonly used Chinese medicinal herbs.

METHODS: Twenty-two Chinese medicinal herbs were extracted in both acid and water prior to determination of total and soluble oxalate, respectively. Oxalate was assayed in herbal extracts using a well-established enzymatic procedure.

RESULTS: Among the 22 medicinal herbs, there was significant variation in oxalate content; Houttuynia cordata contained the highest amount of soluble oxalate (2146 mg/100 g) and Selaginella doederleinii contained the lowest amount (71 mg/100 g).

CONCLUSION: The results indicated that different Chinese medicinal herbs, even from the same family, contain significantly different amounts of oxalate. In susceptible individuals, the use of medicinal herbs with the highest oxalate contents could increase risk of kidney stone formation.

Key words: Drugs, Chinese herbal; Oxalates; Kidney calculi

INTRODUCTION

Oxalate is a naturally occurring substance found in plants and in the human body. In chemical terms, oxalate belongs to a group of molecules called organic acids. Certain body tissues routinely convert other substances into oxalate, which is an end product of human metabolism. For example, vitamin C can be converted into oxalate. In addition to its endogenous synthesis, oxalate can also be absorbed into the body from various food sources. For example, fruits and vegetables such as kiwi, olives, beet greens, parsley, rhubarb, spinach, and Swiss chard are foods high in oxalate; others include wheat bran, almonds, cashews, sesame seeds, and foods which contain cocoa powder (Liebman, unpublished data). It is interesting to note that the leaves of a plant usually contain higher oxalate levels than its roots, stems, and stalks.

Several recent studies have reported the oxalate contents of a variety of foods. Grain-based flours are moderate sources of oxalate, with values ranging from 37 mg/100 g for brown rice flour to 269 mg/100 g for buckwheat flour. The range of total oxalate for nuts is 42 to 469 mg/100 g and for legumes is 4 to 80 mg/100 g of cooked weight.

Plant tissues contain soluble oxalate sources such as sodium and potassium oxalate and insoluble oxalate salts such as calcium and magnesium oxalate. The efficiency of oxalate absorption is an important determinant of whether the consumption of a particular food significantly increases urinary oxalate excretion. The type of oxalate salt present in food may be important because soluble oxalate appears to be more bio-available than insoluble oxalate.
leaves and stems. In the present study, we summarized the functions of 22 Chinese medicinal herbs that are commonly used by Chinese medical doctors to treat patients (where applicable, we indicate the comparable over-the-counter drug that can be purchased at a regular pharmacy. These 22 medicinal herbs are commonly used to cure a variety of problems, such as typical cough, head cold, pain, fever, skin diseases, high blood pressure, mucus, jaundice, diarrhea, poison ivy, and poison oak, and in some cases may be used to prevent or help treat cancer and heart disease. Chinese medicinal herbs are typically used in a 3:1 ratio; that is, patients cook herbs with three cups of water until one cup of the herbal water remains, which is then drunk. As food oxalate content is a predictor of urinary oxalate excretion, which in turn has been directly linked to kidney stone formation. The objective of this study was to assess the total and soluble oxalate content of typical Chinese medicinal herbs. We assumed that different Chinese medicinal herbs from the same families would contain very different amounts of soluble and insoluble oxalate.

**METHODS**

Twenty-two commonly used Chinese medicinal herbs were selected for this study, including Perilla frutescens, Nelumbo nucifera, Hedyotis diffusa, Heliotropium peruvianum, Siegesbeckia orientalis, Glechoma hederacea, Eupatorium cannabinum, Scutellaria barbata, Orthosiphon spiralis, Houttuynia cordata, Selaginella doederleinii, Plantago asiatica, Eclipta prostrata (Linn.), Leonurus artemisia, Folium Eriobotryae, Agastache, Schizonepeta, Folium Isatidis, Hypericum sampsonii, Taraxacum officinale, Artemisia indica, and Mentha arvensis. These medicinal herbs were obtained from Hung Kuo Shin Medicinal Herb, Inc. (Taiwan, China). The 22 Chinese medicinal herbs were first ground to a fine powder using a coffee grinder. Then, 0.5 g of ground, dry herb was placed into a 250-mL flask; 50 mL of HCL was then added to one set of weighed samples and 50 mL of distilled de-ionized water added to another set of samples. Extraction in acid yielded an estimate of total oxalate, whereas extraction in water yielded an estimate of soluble oxalate. Flasks were placed in an 80 °C shaking water bath for 30 min after which 50 mL of distilled ionized water was added to the solutions and mixed by swirling. Approximately 10 mL of the solutions were transferred into a 15-mL centrifuge tube. The samples were then centrifuged at approximately centrifugal force of 1778 × g for 10 min and filtered with Whatman filter paper #1 into storage containers. The oxalate contents of all samples were determined by an enzymatic procedure using an oxalate kit (Trinity Biotech, Jamestown, NY, USA). In this procedure, oxalate is oxidized to carbon dioxide and hydrogen peroxide by oxalate oxidase. The hydrogen peroxide then reacts with 3-methyl-2-benzothiazolinone hydrazone (MBTH) and 3-(dimethylamino) benzoic acid (DMAB) in the presence of peroxidase to yield an indamine dye that has an absorbance maximum at 590 nm. The following procedure was used:

**Sample preparation:** A 1.0-mL volume of herbal extracts was pipetted into labeled glass culture tubes. A 1.0-mL volume of sample diluent (containing Ethylenediaminetetraacetic acid (EDTA) and a 7.6 pH buffer) was pipetted into the glass culture tubes containing the herbal extract and mixed using a vortex. pH levels outside of the range 5.0-7.0 were adjusted to this range using 5.0 N NaOH. The diluted herbal extracts were poured into labeled sample purifier tubes (containing activated charcoal). Each tube was vortexed for a few seconds and then placed in a metal rack mounted on a shaker and mixed for 5 min. The tubes were then centrifuged for 10 min at approximately a centrifugal force of 1178 × g. Using a Pasteur pipette, an aliquot of the clear supernatants (at least 100 µL) was transferred from the purifier tubes into labeled microcentrifuge vials.

**Oxalate determination:** reagents A and B were allowed to reach room temperature. Reagent A contained DMAB (3.2 mmol/L), MBTH (0.22 mmol/L), and buffer (pH 3.1). Reagent B contained oxalate oxidase (Barley, 3000 u/L) and peroxidase (horseradish, 100 u/L). A 10-µL volume of de-ionized water (for the blank), oxalate standard, or the herbal extract supernatants were pipetted to predesignated wells in the microplate. A total of 200 µL of reagent A and 20 µL of reagent B were pipetted into each well and mixed by gently tapping one side of the microplate. After 5 min, the absorbance was read at 590 nm using a microplate reader (Model EL 311, Bio-Tek Instruments, Winooski, Vermont).

**RESULTS**

The functions of the 22 medicinal herbs are summarized in Table 1 and their average total and soluble oxalate contents are shown in Table 2. Among all 22 medicinal herbs, Nelumbo nucifera (Number 2 in the table), Houttuynia cordata (10), and Folium Eriobotryae (15) contained the highest total oxalate levels. Houttuynia cordata and Eclipta prostrata Linn. (13) contained the highest soluble oxalate levels. Houttuynia cordata contained the highest total and soluble oxalate levels (3204 and 2146 mg/100 g, respectively), and Selaginella doederleinii (11) contained the lowest levels of total and soluble oxalate (165 and 71 mg/100 g, respectively).

**DISCUSSION**

Twenty-two commonly used Chinese medicinal herbs were analyzed to determine their total and soluble oxalate contents. These herbs are used to treat typical prob-
lems such as cough, headache, head cold, pain, fever, skin diseases, blood pressure, excess mucus, jaundice, diarrhea, poison ivy, and poison oak, and may be used to prevent or help treat cancer and heart disease. The results showed that different Chinese medicinal herbs, even those from the same family, contain different amounts of oxalate. The total oxalate contents for the 22 herbs ranged from 165 to 3204 mg/100 g, which is much higher than the oxalate content of daily foods such as various flours (37 to 269 mg/100 g) and nuts (42 to 469 mg/100 g). Among all 22 medicinal herbs, Houttuynia cordata had the highest total and soluble oxalate content (3204 and 2146 mg/100 g, respectively). This Chinese herb is commonly used as a fresh herbal garnish. The leaf has an unusual taste that is often described as fishy, so it is

Table 1 Functions of each Chinese medicinal herb

| No. | Name                        | Function                                                                 | Over-the-Counter Drugs |
|-----|-----------------------------|--------------------------------------------------------------------------|------------------------|
| 1   | Perilla frutescens          | A. Uses: head cold, pain relief, coughing, anti gas, salad dressing and seasonings  |
|     |                             | B. Natural preservative                                                  | Tylenol                |
| 2   | Nelumbo nucifera            | A. Uses: sun stroke, diarrhea, anti germ, skin allergic                   | Imodium                |
|     |                             | B. Natural vitamin C, potassium, vitamin B6, phosphorus, copper, and manganese |                        |
| 3   | Hedyotis diffusa            | A. Uses: tonsillitis, throat, jaundice, pain relief, reduces swelling     | Theraflu               |
|     |                             | B. Natural diuretic                                                      |                        |
| 4   | Heliotropium peruvianum      | A. Uses: sun stroke, headache, sinus cancer, kidney infection, mucus relief | -                      |
|     |                             | B. Natural pain relief, diuretic                                         |                        |
| 5   | Siegesbeckia orientalis     | A. Uses: coughing, rash, anti-infection                                  | Benadryl               |
|     |                             | B. Natural blood pressure reducer                                        |                        |
| 6   | Glechoma hederacea           | A. Uses: diuretic, astringent, kidney diseases, indigestion               | -                      |
|     |                             | B. Natural high nitrogen content                                         |                        |
| 7   | Eupatorium cannabinum        | A. Uses: sun stroke, diarrhea, head cold, pain relief                    | Imodium                |
|     |                             | B. Natural anti infection                                                |                        |
| 8   | Scutellaria barbata          | A. Uses: pain relief, mucus remover, swollen reducer                     | Mucinex                |
|     |                             | B. Specially for angina, and asthma                                       |                        |
|     |                             | C. Natural diuretic                                                      |                        |
| 9   | Orthosiphon spiralis         | A. Uses: kidney stone, vesical calculus                                  | Advil or motrin        |
|     |                             | B. Natural diuretic                                                      |                        |
| 10  | Houttuynia cordata           | A. Uses: pneumonia, antiviral, antibacterial and antileukemic activities, odor remover |                        |
|     |                             | B. Uses: cooking seasonings                                              |                        |
| 11  | Selaginella doederleinii     | A. Uses: coughing, constipation, pneumonia, anticancer agent, cardiovascular diseases | Dimetapp               |
|     |                             | B. External use to stop bleeding                                         |                        |
| 12  | Plantago asiatica           | A. Uses: coughing, mucus, jaundice, bronchitis                            | Mucinex                |
|     |                             | B. Anti-histamine, anti-inflammatory                                      |                        |
| 13  | Eclipta prostrata (Linn.)    | A. Uses: bronchitis, chronic infected skin diseases, jaundice            | -                      |
|     |                             | B. Natural antiasthmatic, anti-latalent, vitamin A, volatile oil          |                        |
| 14  | Leonurus artemisia          | A. Uses: high blood pressure, poison ivy, poison oak, diuretic, oliguria  | Benadryl               |
|     |                             | B. Natural vision, menstrual aberration                                  |                        |
| 15  | Folium eriobotryae          | A. Uses: inflame, coughing, stomach flu                                  | Pedialyte              |
|     |                             | B. Natural antioxidant, vitamin B and C                                  |                        |
| 16  | Agastache                   | A. Uses: fever, diarrhea, angina                                         | Tylenol                |
|     |                             | B. Natural mint substitute                                               |                        |
| 17  | Schizonepeta                | A. Uses: headache, headcold                                              | Tylenol                |
|     |                             | B. Natural d-menthone, 1-pulegone, schizonepeta aside                    |                        |
| 18  | Folium Isatidis             | A. Uses: headache, tonsillitis, encephalitis, hepatitis B                 | Tylenol                |
|     |                             | B. Natural                                                               |                        |
| 19  | Hypericum sampsonii         | A. Uses: constipation, menstrual aberration                              | Dulcalax               |
|     |                             | B. Natural yellow gland                                                  |                        |
| 20  | Taraxacum officinale        | A. Uses: oliguria, rheumatism                                            | Lasix, osmitrol        |
|     |                             | B. Natural vitamin A and C, mineral, potassium                           |                        |
| 21  | Artemisia indica            | A. Uses: breast cancer, anti germ                                        | -                      |
|     |                             | B. Uses: salads and soups                                                |                        |
| 22  | Mentha arvensis             | A. Uses: headache, gasp, and asthma                                      | Xopenex                |
|     |                             | B. Natural peppermint                                                    |                        |
not enjoyed as universally as basil and mint. However, Houttuynia cordata has been used by Chinese scientists to tackle severe acute respiratory syndrome, as it is conventionally used to treat pneumonia. However, this herb should be used with caution for patients sensitive to oxalate; as it has high levels of total and soluble oxalate, ingestion is likely to lead to a marked increase in urinary oxalate because of the relatively high bioavailability of soluble oxalate.

In contrast, Selaginella doederleinii contains the lowest levels of total and soluble oxalate. This herb is used in Chinese medicine as a bactericide, an anticancer agent, and to treat cardiovascular diseases. As this medicinal herb can provide significant benefits and has low oxalate content, more research is recommended to assess its overall effectiveness as a therapeutic agent. Among the 22 Chinese medicinal herbs tested, the properties of some are of particular interest:

7-23 Eclipta prostrata (Linn.) is commonly used to treat bronchitis, chronic infected skin diseases, ringworm, and tinea versicolor. The juice from the stem can also be used to treat jaundice. This herb has the second highest soluble oxalate content (1218 mg/100 g) among the 22 herbs. Plantago asiatica has the second least soluble oxalate content (83 mg/100 g). Plantago species have been used since prehistoric times as herbal remedies. This herb has astringent, antitoxic, antimicrobial, anti-inflammatory, and antihistamine properties, and is also a demulcent, expectorant, styptic, and diuretic. Externally, a poultice of the leaves is useful for insect bites, poison ivy rashes, minor sores, and boils. It is also claimed to be able to cure snake bites.

Artemisia indica can be used in salads and soups. This herb can be added to glutinous rice dumplings to impart a pleasant color and flavor. Artemisia indica, after water extraction, has been found to inhibit the growth of a specific line of breast cancer cells. The soluble oxalate content is in the middle range (462 mg/100 g). This medicinal herb should be studied further because of its possible role in the inhibition of breast cancer.

In Asian cuisine, Nelumbo nucifera is used as a vegetable in soups and is popular in salads containing prawns, sesame oil, and coriander leaves. Its roots are rich in vitamin C, potassium, thiamin, vitamin B₆, phosphorus, copper, and manganese, and very low in saturated fat. This herb has a very low soluble oxalate content (211 mg/100 g); therefore, it could be used more widely as a salad ingredient to take advantage of its high nutrient content. Agastache is native to eastern Asia and North America. The flowers are usually white, pink, and purple and the

Table 2 Average total and soluble oxalate contents in 22 herbs (mg/100 g dry weight; means of n = 22)

| No. | Name                  | Family      | Parts analyzed | Total oxalate | Soluble oxalate |
|-----|-----------------------|-------------|----------------|---------------|-----------------|
| 1   | Perilla frutescens    | Lamiaceae   | Stems and leaves | 908           | 176             |
| 2   | Nelumbo nucifera      | Nelumbonaceae | Leaves         | 3066          | 211             |
| 3   | Hedychium diffusa     | Rubiaceae   | Stems          | 857           | 152             |
| 4   | Heliotropium peruvianum | Boraginaceae | Leaves         | 1503          | 719             |
| 5   | Siegesbeckia orientalis | Asteraceae  | Stems and leaves | 2034          | 165             |
| 6   | Glechoma hederacea    | Lamiaceae   | Stems and leaves | 1389          | 154             |
| 7   | Eupatorium cannabinum | Asteraceae   | Stems and leaves | 1003          | 110             |
| 8   | Scutellaria barbata   | Lamiaceae   | Stems and leaves | 258           | 123             |
| 9   | Orthosiphon spiralis  | Lamiaceae   | Stems and leaves | 499           | 197             |
| 10  | Houttuynia cordata    | Saururaceae  | Stems and leaves | 3204          | 2146            |
| 11  | Selaginella doederleinii | Selaginellaceae | Leaves       | 165           | 71              |
| 12  | Plantago asiatica     | Plantaginaceae | Stems and leaves | 511           | 83              |
| 13  | Eclipta prostrata (Linn.) | Asteraceae  | Stems and leaves | 521           | 1218            |
| 14  | Leonurus artemisia    | Lamiaceae   | Stems and leaves | 1332          | 429             |
| 15  | Folium eriobotryae    | Rosaceae    | Leaves         | 3203          | 93              |
| 16  | Agastache             | Lamiaceae   | Stems and leaves | 1482          | 340             |
| 17  | Schizonepeta          | Lamiaceae   | Stems and leaves | 213           | 134             |
| 18  | Folium isatidis       | Acanthaceae  | Leaves         | 569           | 127             |
| 19  | Hypericum sampsonii   | Hypericaceae | Leaves         | 192           | 101             |
| 20  | Taraxacum officinale  | Asteraceae   | Leaves and flowers | 168           | 104             |
| 21  | Artemisia indica      | Compositae  | Leaves         | 1340          | 462             |
| 22  | Mentha arvensis       | Lamiaceae   | Leaves         | 245           | 167             |
leaf tips can be eaten and made into teas. Its soluble oxalate content is in the middle range (340 mg/100 g). Leonurus artemisia, or Chinese motherwort, is one of the fifty fundamental herbs used in traditional Chinese medicine. This herb has been used for preventing postpartum hemorrhage after Caesarian section. It has been also used for menstrual disorders, delayed or absent menses, amenorrhea, endometriosis, fertility, lower abdominal pain, and postpartum abdominal pain due to blood obstruction. The leaves are a diuretic and are placed in water to relieve itching and painful shingles. The dried flowers are also used post-pregnancy to help expel the placenta after giving birth. The soluble oxalate content of this herb is 429 mg/100 g dried weight.

The flowers of Taraxacum officinale are often used to make wine. It has long been used in the UK to make a coffee-like drink and the plant was used by Native Americans as a medicine. The root is also a registered diuretic drug in Canada. The leaves are very high in vitamin A, vitamin C, and iron, containing more iron and calcium than spinach.

Hypericum sampsonii is used as a common treatment in homeopathy and to treat mild and moderate depression. However, high dosages of this herb should be avoided because of its high antibiotic content. This herb has a very low soluble oxalate content (101 mg/100 g dried weight).

Folium Eriobotryae has the third lowest soluble oxalate content and is often used to treat cough and asthma. This herb is bitter in taste and slightly cool in nature and has been used in combination with other medicinal herbs to treat whooping cough, nausea, and vomiting.

ACKNOWLEDGEMENTS

We would like to express our sincere thanks to Mrs. Su Huichi who provided us with the 22 Chinese medicinal herbs for this study.

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