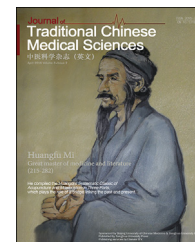


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Property combination patterns of traditional Chinese medicines



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KEYWORDS

Property combination;
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Abstract *Objective:* In this study, the property combinations (PCs) of single herbs, two-herb combinations, and multi-herb prescriptions were studied to determine that the property-combination patterns will be associated with these three levels.

Method: By calculating the prescription PC weight, we analyzed the PCs of the single herb coptis rhizome, the two-herb combination of coptis rhizome and scutellaria root, and the classic prescriptions Coptis Decoction to Resolve Toxicity, White Tiger Decoction to Resolve Toxicity, and Peony Decoction, all three of which contain coptis and scutellaria.

Results: Calculated results show that cold-bitter-lung, cold-bitter-heart, and cold-bitter-stomach are present in both Coptis Decoction and White Tiger Decoction and have the highest PC weights. The weights of coptis and scutellaria in Peony Decoction differs from in their weights in Coptis Decoction and White Tiger Decoction, in that the PCs of highest weights in Peony Decoction are cold-bitter-spleen, cold-bitter-liver, cold-bitter-large intestine, cold-sour-liver, and cold-sour-spleen.

Conclusion: This novel method for exploring the properties and compatibilities of traditional Chinese herbs helps validate the combination theories of herbs. Application of this method may be valuable in designing new efficacious herbal prescriptions.

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Introduction

Property combination (PC) is an expression that refers to several principles related to traditional Chinese herbs and explain the synergistic relationship among a set of herbs in a formula (prescription).¹ Property-combination pattern (PP) refers to application of multiple combinations of herbs with equivalent or near-equivalent actions in traditional Chinese medicine (TCM) prescriptions.² Recent research on Chinese herbal theory has included theoretical analysis,^{3,4} experimental research,^{5–7} and data mining.^{8,9} We previously studied the PCs of single herbs, two-herb combinations, and multi-herb prescriptions.¹⁰ Because PCs exist in these three levels, it follows that PPs will be associated with these three levels as well. In this study, we analyzed the PCs of the single herb coptis rhizome (*Coptis chinensis* Franch.), the two-herb combination of coptis rhizome and scutellaria root (*Scutellaria baicalensis* Georgi), and the classic prescriptions Coptis Decoction to Resolve Toxicity (*huang lian jie du tang*), White Tiger Decoction to Resolve Toxicity (*bai hu jie du tang*), and Peony Decoction (*shaoyao tang*), all three of which contain coptis and scutellaria.

Methods

Property combination (PC) is a specific amalgamation of the characteristics, or properties, of herbs. These properties are the four natures, five tastes, and channel entered. The four natures are cold, hot, warm, cool, and neutral. The five tastes are sour, bitter, sweet, pungent, salty. Channels that herbs can enter are the heart, liver, spleen, lung, kidney, pericardium, stomach, bladder, large intestine, small intestine, gallbladder, and triple energizer. There are 420 possible PCs. Using the PC as a basic unit, we weighted assumptions of PCs from a single herb, a two-herb combination, and multi-herb prescriptions, and analyzed the relationship among PPs at these three levels.

Assumptions of prescription property combination weight

The integrity of an herbal prescription is based on TCM theory and PC is an inherent characteristic of prescriptions. The concept of prescription PC weight refers to the relative weight of PCs with in a prescription or a class of prescription. This metric can be calculated by adding the relative weights of the PCs. By comparing their values, the hierarchy of the PC in a prescription or class of prescriptions can be determined, which contributes to a better synergy among herbal compounds in a prescription.

Computational method for prescription property combination weight

To calculate the prescription PC weight, each herb in a prescription is represented by $X_1, X_2, X_3 \dots X_i$. The dose of each herb is represented by $Q_1, Q_2, Q_3 \dots Q_j$. The PCs in each prescription is represented by $Y_1, Y_2, Y_3 \dots Y_j$. A matrix is then created with i rows and j columns in an X, Y configuration. Using an arbitrary value of $X_m Y_n$, if the herb

X_m contains the PC Y_n , then it is assigned 1, if it does not contain Y_n , then it is assigned 0. The formula Z_n to calculate the weights of PC of the number Y_n is:

$$Z_n = (X_m Y_n \times Q_m) / Q_m,$$

where m ranges from 1 to i .

Data sources

The property data were sourced from *Divine Husbandman's Classic of the Materia Medica* (later Han dynasty) and *Chinese Pharmacopoeia (2010 edition)*.¹¹ Information on Coptis Decoction to Resolve Toxicity was sourced from *Arcane Essentials from the Imperial Library (752)*, information on White Tiger Decoction to Resolve Toxicity was from *Standards for Diagnosis and Treatment (1602)*; and information on Peony Decoction was from *Collection of Writings on the Mechanisms of Disease, Suitability of Qi, and the Safeguarding of Life as Discussed in Basic Questions (1186)*.

Results and discussion

Property combinations of herbs and prescriptions investigated

The PCs of the single herb, two-herb combination, and multi-herb prescriptions were calculated. The PCs of coptis were cold-bitter-heart, cold-bitter-spleen, cold-bitter-stomach, cold-bitter-liver, cold-bitter-gallbladder, and cold-bitter-large intestine (Fig. 1). The PCs of the two-herb combination of coptis and scutellaria included the PCs of coptis plus the PCs of scutellaria, which were cold-bitter-lung, cold-bitter-gallbladder, cold-bitter-spleen, cold-bitter-large intestine, cold-bitter-small intestine (Fig. 2). The weights of each PC in the prescriptions were added and divided by the sum of the total weight of the prescription. Then, the weight of each PC was obtained for each prescription (Figs. 1–5). Thus, cold-bitter-lung, cold-bitter-heart, and cold-bitter-stomach are present in both Coptis Decoction and White Tiger Decoction and have the highest PC weights. The weights of coptis and scutellaria in Peony Decoction differs from in their weights in Coptis Decoction and White Tiger Decoction, in that the PCs of highest weights in Peony Decoction are cold-bitter-spleen, cold-bitter-liver, cold-bitter-large intestine, cold-sour-liver, and cold-sour-spleen.

Actions of heat-clearing and toxicity-resolving property combinations of individual herbs and multi-herb prescriptions

The herb coptis is bitter, cold, and enters the heart, spleen, stomach, liver, gallbladder, and large intestine channels. Thus, it has the PCs of cold-bitter-heart, cold-bitter-spleen, cold-bitter-stomach, cold-bitter-liver, cold-bitter-gallbladder, and cold-bitter-large intestine (Fig. 1). Its bitter taste eliminates dampness and purges pathogenic fire, and its cold nature clears heat. The PC of cold-bitter-heart clears heat in the blood. The spleen governs upward

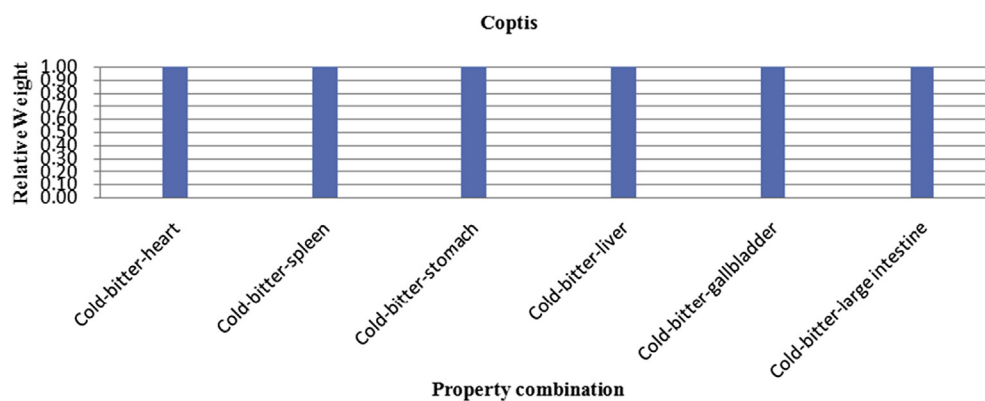


Fig. 1 Property combination weights of coptis.

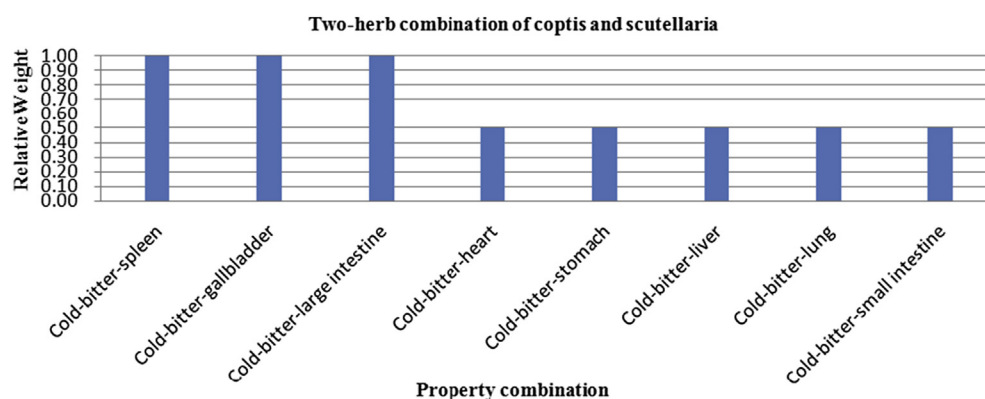


Fig. 2 Property combination weights of two-herb combination of coptis and scutellaria.

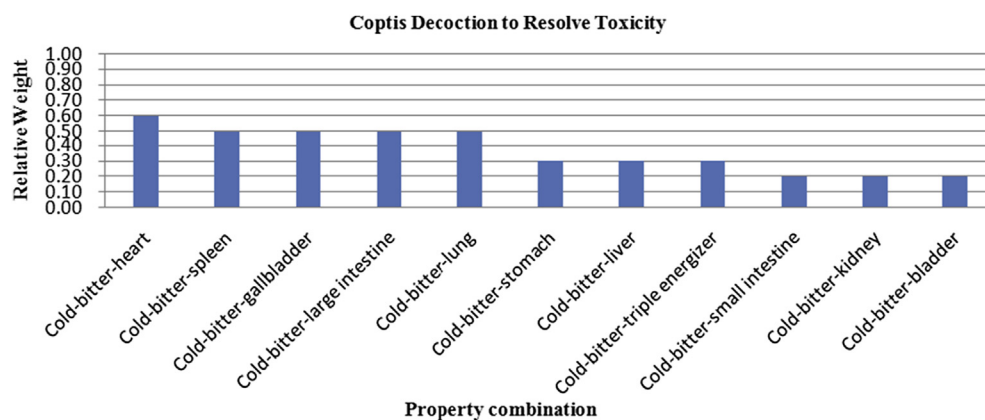


Fig. 3 Property combination weights of Coptis Decoction to Resolve Toxicity.

movement of the pure, and the stomach governs downward movement of the impure. Thus the PCs of cold-bitter-spleen and cold-bitter-stomach clear heat, stop vomiting, eliminate dampness, and transform turbidity. The liver controls dispersion, so cold-bitter-liver and cold-bitter-gallbladder clear liver-fire, normalize gallbladder function, and resolve jaundice. The large intestine adjusts body fluid, so the PC of cold-bitter-large intestine dries dampness and relieves diarrhea. Therefore, coptis clears heat, dries dampness, and detoxifies, and can be used to treat distention and fullness from damp-heat, vomiting, gastric

reflux, diarrhea, jaundice, exuberance of heart fire, carbuncles and boils, vomiting of blood, and bleeding from the nose caused by excessive heat in the blood. Coptis combined with other herbs can have a variety of effects with different compatibility characteristics in terms of clearing heat and resolving toxicity, but its used with scutellaria is most common.

Scutellaria, like coptis, is bitter and cold. The channels scutellaria enters are the lung, gallbladder, spleen, stomach, liver, large intestine, and small intestine. It has the PCs of cold-bitter-lung, cold-bitter-spleen, cold-bitter-

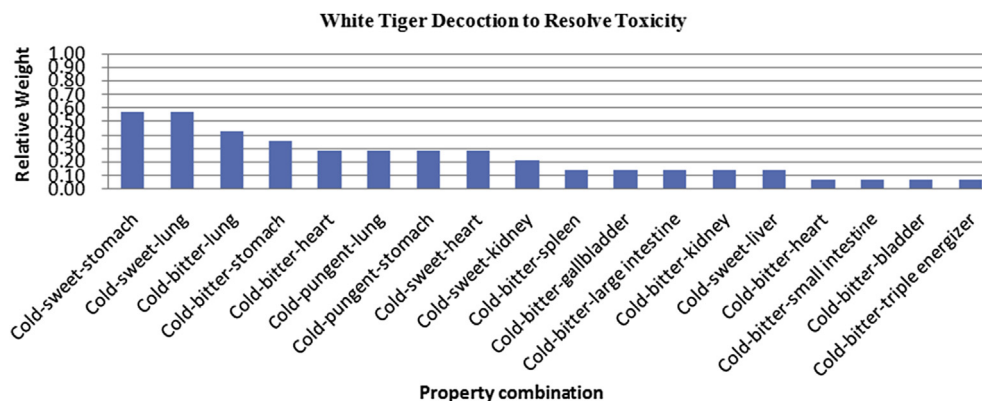


Fig. 4 Property combination weights of White Tiger Decoction to Resolve Toxicity.

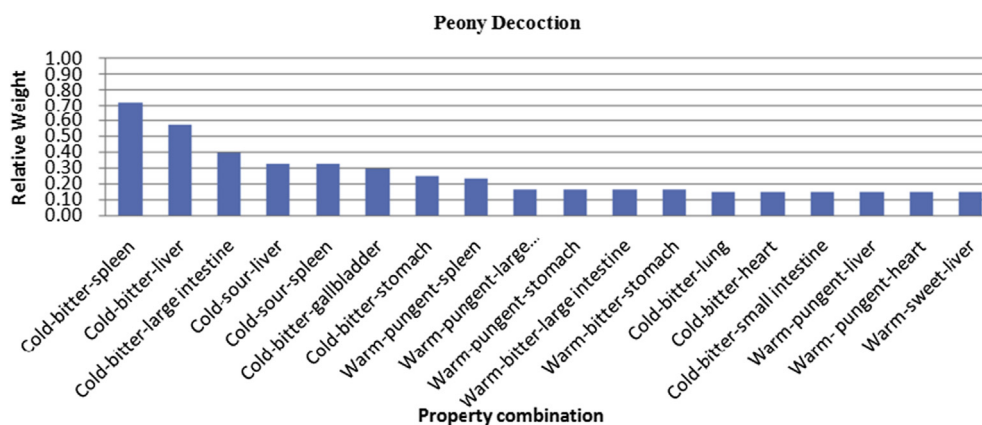


Fig. 5 Property combination weights of Peony Decoction.

gallbladder, cold-bitter-large intestine, and cold-bitter-small intestine. Aside from equivalent PCs, the cold-bitter-lung PC of scutellaria clears heat, purges the lung, and relieves sore throat and cough. Therefore, scutellaria can be used to treat damp-warmth, distention and fullness from damp-heat, diarrhea, jaundice, cough from lung-heat, high fever, urinary frequency, carbuncles, and boils. Coptis and scutellaria act synergistically to clear heat, dry dampness, purge fire, and detoxify.

Coptis is compatible with scutellaria in many prescriptions. Coptis Decoction to Relieve Toxicity is a classic heat-clearing and detoxifying formula and is composed of coptis (9 g), scutellaria (6 g), phellodendron bark (*Phellodendron chinense* C.K.Schneid.; 6 g), and gardenia fruit (*Gardenia jasminoides* J.Ellis; 9 g). This prescription is widely used to treat syndrome patterns of excessive heat, fire-toxicity, or exuberant heat in the triple energizer. The primary PCs of this prescription are cold-bitter-heart, cold-bitter-spleen, cold-bitter-gallbladder, cold-bitter-large intestine, and cold-bitter-lung (Fig. 3). These are the same PCs of the two-herb combination of coptis and scutellaria (Fig. 2), have the actions of clearing heat, drying dampness, and resolving toxicity. Cold-bitter-heart is the common PC for coptis and gardenia. The heart governs the blood vessels, and cold nature and bitter taste clear heat and drains fire, thus, cold-bitter-heart functions drain heat and fire in the blood, clear heart fire, calm restlessness and

stop vomiting. Cold-bitter-lung is a common PC in scutellaria and gardenia, and functions to clear lung-heat, relieve cough, resolve toxicity, and reduce phlegm. Therefore, the primary action of Coptis Decoction is to clear heat and resolve toxicity and its secondary action is to dry dampness and drain heat-toxin in the triple energizer. Furthermore, since PC weight has a direct relationship with an herb's dose in a prescription, if, for example, the dose of phellodendron is increased, its PC weight changes, and the fire purging and urination promoting action of the PCs of cold-bitter-kidney and cold-bitter-bladder is strengthened. This promotes extraction into the urine of heat and toxin, and combined with the heat-fire draining effect of the PC of cold-bitter-triple energizer, the action of clearing the lower energizer's toxic heat is enhanced.

White Tiger Decoction to Relieve Toxicity is formed from the combination of the herbs in Coptis Decoction with five other herbs. Thus, the herbs and their doses in White Tiger Decoction are: gypsum (12 g), cooked rehmannia [*Rehmannia glutinosa* (Gaertn.) DC.; 6 g] ophiopogon tuber [*Ophiopogon japonicus* (Thunb.) Ker-Gawl.; 6 g], anemarrhena rhizome (*Anemarrhena asphaloides* Bunge; 3 g), trichosanthes root (*Trichosanthes kirilowii* Maxim.; 3 g), coptis (3 g), scutellaria (3 g), and gardenia (3 g). Cold-sweet-stomach, cold-sweet-lung, cold-bitter-lung, cold-bitter-stomach, and cold-bitter-heart are the primary PCs of White Tiger Decoction. The cold-bitter-lung, cold-bitter-

stomach, and cold-bitter-heart are the equivalent PCs of coptis and the coptis and scutellaria two-herb prescription, which have the actions of clearing heat, drying dampness, and resolving toxicity. Cold-sweet-stomach and cold-sweet-lung are the common PCs of gardenia, anemarrhena, trichosanthes, and ophiopogon. Sweet taste is said to tonify deficiency and moisten dryness, and cold nature has the function of clearing heat. Thus, the PC of cold-sweet-stomach has the action of draining stomach-heat, generating fluid and quenching thirst, and the PC of cold-sweet-lung has the action of clearing lung-heat, moistening the lung to relieve cough. Thus, these two PCs have the actions of draining excessive heat of the lung and stomach, moistening dryness and generating fluids. Coptis Decoction has the function of clearing heat, generating fluids and draining fire-toxin and is often prescribed for rash and other skin symptoms due to patterns of heat-toxin.

Peony Decoction is also a heat-clearing and toxicity-resolving formula. Peony Decoction is comprised of nine herbs: peony root (*Paeonia lactiflora* Pall.; 20 g), tangkuei (9 g), coptis (9 g), scutellaria (9 g), rhubarb root and

rhizome (*Rheum palmatum* L.; 6 g), betel nut (*Areca catechu* L.; 5 g), aucklandia root (*Aucklandia lappa* DC.; 5 g), licorice root (*Glycyrrhiza uralensis* Fisch.; 5 g), and cinnamon bark [*Cinnamomum cassia* (L.) J.Presl; 2 g]. The primary PCs of Peony Decoction are cold-bitter-spleen, cold-bitter-liver, cold-bitter-large intestine, cold-sour-liver, and cold-sour-spleen (Fig. 4). The PCs of cold-bitter-spleen, cold-bitter-liver, and cold-bitter-large intestine are the equivalent PCs of coptis (Fig. 1) and the two-herb prescription of coptis and scutellaria (Fig. 2), which have the actions of clearing heat, drying dampness, and resolving toxicity. The PCs of peony root are cold-sour-liver and cold-sour-spleen. Cold nature has the function of clearing heat and sour taste has the function of astringing yin. Thus, the PC of cold-sour-liver astringes yin, nourishes blood, softens the liver, and alleviates pain. When cold-sour-liver is combined with cold-sour-spleen, these two PCs function to regulate the liver and spleen and alleviate pain. When tangkuei's action of nourishing the blood, promoting blood circulation, activating qi for alleviating pain, and activating blood for treating pus in the stool are added,

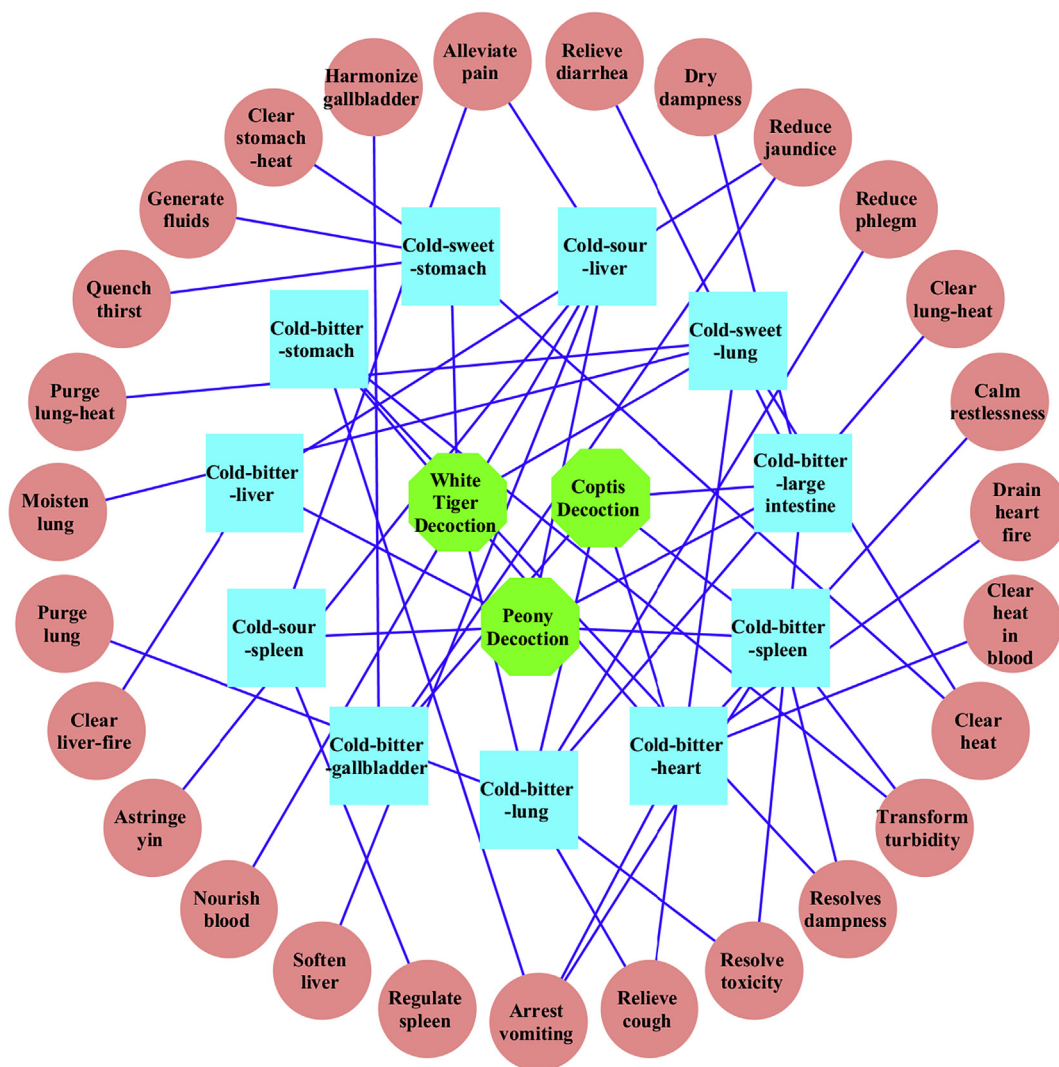


Fig. 6 Property combination-action network. Note: Prescriptions are represented by green octagons. Property combinations are represented by blue squares. Actions are represented by red circles.

Peony Decoction is commonly prescribed to treat damp-heat pattern dysentery.

Therefore, based on our discussion of the PCs of coptis, coptis and scutellaria, Coptis Decoction, White Tiger Decoction, and Peony Decoction, a PC-action network schema was created (Fig. 6).

Conclusions

Similarities of property combinations in single herbs, a two-herb combination, and multi-herb prescriptions were studied. This novel method for exploring the properties and compatibilities of traditional Chinese herbs helps validate the combination theories of herbs, which date to pre-modern times. Application of this method may be valuable in designing new efficacious herbal prescriptions.

Author contributions

Y.W. and Y.Q. conceived and designed the project. Y.H. and J.S. designed and performed experiments. Y.H. wrote the paper. Y.W. read and approved the final manuscript.

Conflicts of interest

The authors declare no conflict of interest.

Acknowledgments

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