When east meets west: the relationship between yin-yang and antioxidation-oxidation

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ABSTRACT **Ancient traditional Chinese medicine (TCM) has effectively relied on the theory of yin-yang balance in diagnoses and treatments of diseases and disorders for more than 2000 years. However, in eastern society, yin-yang is regarded as an incomprehensible ideology without definite physical meaning. Consequently, the yin-yang balance in medicine has not been studied by modern scientific means. In the western world, yin-yang balance is often misunderstood as a religious belief or a principle of lifestyle. Herein, we attempted to define the physical meaning of yin-yang in TCM by correlating it with biochemical processes. We propose that yin-yang balance is antioxidation-oxidation balance with yin representing antioxidation and yang as oxidation. Our proposal is partially supported by the fact that the yin-tonic traditional Chinese herbs have, on average, about six times more antioxidant activity and polyphenolic contents than the yang-tonic herbs. Our hypothesis opens an avenue to systematically study the yin-yang balance and its health implications with the use of modern biochemical tools.—Ou, B., Huang, D., Hampsch-Woodill, M., Flanagan J.A. When east meets west: the yelationship between yin-yang and antioxidation-oxidation. *FASEB J.* 17, 127–129 (2003)**

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Nearly 150 years ago Antoine Lavoisier, a pioneer oxygen chemist, pointed out "animals that respire are true combustible bodies that burn and consume themselves" (1). The biological combustion, albeit much more elegant and complex than that of an automobile, produces harmful intermediates called reactive oxygen species (ROS). Just like that of an automobile producing nitric oxide and nitric dioxide (NO_2) to pollute our atmosphere, the excess ROS in the body can lead to cumulative damage of protein, lipid, and DNA, resulting in so called "oxidative stress." Fortunately, living creatures have a highly complicated antioxidant defense system composed of enzymes and vitamins to counteract the damaging power of ROS. The oxidative stress, defined as "the imbalance between oxidants and antioxidants in favor of the oxidants potentially leading to damage" (2), has been suggested to be the cause of aging and various diseases in humans. Hence, in modern western medicine, the balance between antioxidation and oxidation is believed to be a critical concept for maintaining a healthy biological system (3–4). Note that a similar concept of balance called yin-yang has existed in traditional Chinese medicine (TCM) for more than 2000 years. Such balance was first described in the Chinese medical treatise *Su Wen* (translated as *Plain Questions*, part of *The Yellow Emperor's Classic of Internal Medicine*) written 2500 years ago (5). The author of *Su Wen* writes, "the imbalance of yin-yang was the cause of all diseases, and a good doctor will observe the patient's complexion, feel the pulse, and thus take the first step in determining if it is a yin or yang disease." The yin and yang, however, does not have any concrete physical meaning within the modern scientific scope, and thus there is no equivalent term in western medicine to express this dichotomy. In TCM, yin-yang is a term to express the dual opposite qualities of matter. Maintaining yin and yang in harmony is akin to attaining the homeostatic state. Those with counteractive properties like water, coldness, stillness, inhibition, and darkness pertain to yin and those with proactive properties, such as fire, heat, movement, brightness, outward, and upward direction belong to yang. Logically, antioxidation processes that prevent the overoxidation (stress) can be called yin and energy-generating oxidation processes naturally belong to yang. From this point of view, there may be a strong correlation between the yin-yang balance of TCM and the modern theory of oxidation-antioxidation balance. Our study reported here reveals that such a correlation is supported, at least, by the trend of antioxidant properties of Chinese herbal medicine.

MATERIALS AND METHODS

Chinese herbs were purchased from a TCM store in Chinatown in Boston, MA. The herbs were dried and ground to powders. One gram of the powders was weighed, placed in a centrifugal tube, and mixed with 50% acetone in water (20 mL). The mixture was shaken for 1 h on an orbital shaker at 400 rpm. The mixture was centrifuged, and the liquid portion was separated and tested for oxygen radical absorbance

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capacity assay and total phenolic assay according to published procedure (6–8).

RESULTS

We selected 24 authentic and representative Chinese herbs according to their properties described in *Zhong Hua Ben Cao*, an authoritative book on Chinese herbs (9). Among which, 12 have the property of compensating the deficiency of yin or suppressing the symptom of heat-fire (yang). For simplification purposes, we refer to these herbs as yin-tonic herbs. The other 12 are those that boost yang or suppress yin (**Table 1**). We call these herbs yang-tonic herbs. In this study, we used the oxygen radical absorbance capacity (ORAC) assay to evaluate the antioxidant properties of the selected Chinese herbs (6). The samples with higher ORAC values are more potent radical chain-breaking antioxidants. This assay uses fluorescence to measure inhibition of damage to fluorescein by the peroxide radical, one of the most common ROS in vivo. The ORAC assay has been used to measure the antioxidant capacity from a wide range of biological samples and pure compounds to fruits, vegetables, and animal tissues (7). We also measured the total phenolic content in these herbal samples using the Folin-Ciocalteu method (8), and these results are also shown in Table 1.

DISCUSSION

As shown in Table 1, the antioxidant activities of the yin-tonic herbs have the high ORAC values ranging from 433 to 1939 μmol Trolox equivalent (TE)/g. Particularly, for the well-known yin-tonic herbs such as *Rhizoma coptidis* (Huánglián), *Radix scutellariae* (Huángqín), and *Radix et rhizoma rhei* (Dàhuáng), their ORAC values are comparable to or even higher than that of pure vitamin C (2000 μmol TE/g) and E (1162 μmol TE/g) (10). In sharp contrast, when compared to herbs with yin property, the yang-tonic herbs have much lower ORAC values ranging from 16 to 243 μmol TE/g, demonstrating that the yang-tonic property of these herbs is unlikely related to their antioxidant activity. The effective components of yang-tonic herbs are very unlikely to be simply oxidants. It is of interest to know how the phytochemicals in yang-tonic herbs work to boost the energy metabolism efficiency. From Table 1, it is also evident that the yin-tonic properties always

TABLE 1. *Antioxidant activity and total phenolics of traditional Chinese herbs*[a]

Herb name in Chinese pinying	Latin name	ORAC[b] (μmol TE/g)[c]	Total phenolics (mg GAE/g)[d]
Yin-tonic herbs			
Huángbó	*Cortex phennodendri*	433	15.2
Liánqiào	*Fructus forsythiae*	450	28.8
Dānpí	*Cortex moutan*	473	56.6
Yīnchén	*Herba artemisiae scopariae*	521	18.3
Hángbáijú	*Fros chrysanthemi*	525	25.0
Jīngyínghuā	*Flos lonicerae*	760	46.1
Qīnghào	*Herba artemisiae annuae*	841	39.1
Huánglián	*Rhizoma coptidis*	855	17.7
Dānshēng	*Radix salviae miltiorrhizae*	1248	54.3
Shègān	*Rhizoma belamcandae*	1672	51.3
Huángqín	*Radix scutellariae*	1684	85.0
Dàhuáng	*Radix et rhizoma rhei*	1939	127.3
Yang-tonic herbs			
Fùzhǐ	*Radix aconiti lateralis preparata*	16	1.4
Fángfēng	*Radix saposhnikoviae*	42	3.8
Dǎnshēng	*Radix codonopsis*	47	4.5
Báizhǐ	*Radix angelicae dahuricae*	83	4.3
Gǒují	*Rhizoma cibotii*	112	8.9
Yìzhìrén	*Fructus alpineae oxyphyllae*	113	8.4
Tùshīzhǐ	*Semen cuscutae*	174	7.4
Xùduàn	*Radix dipsaci*	193	12.2
Guìzhī	*Cortex cinnamomi*	214	11.9
Xìxīng	*Herba asari*	235	10.5
Ròucóngróng	*Herba cistanches*	235	16.7
Gǎoběng	*Rhizoma ligustici*	240	8.7
Xiānmáo	*Curculigo orchioides*	243	10.3

[a] The herbs were purchased from local Chinese herb store and vacuum-dried to constant weight. [b] ORAC, oxygen radical absorbance capacity; [c] μmol TE/g, micromol Trolox equivalent per gram; [d] mg GAE/g, milligram gallic acid equivalent per gram. Margin of error is ± 15%.

Figure 1. Proposed chemical meaning of yin-yang balance.

contain higher total phenolic level than do the yang-tonic herbs, albeit there is no linear response between total phenolics and ORAC values. This is understandable because different phenolic compounds have very different antioxidant activity, which is dependent on the chemical structure of the phenolic compounds (11). One simple example is 4-methylphenol (C_7H_7OH) and butylated hydroxytoluene (BHT). Both of them contain one phenol group, but BHT is an excellent antioxidant whereas 4-methylphenol is not. The method used for total phenolic content is structurally insensitive, whereas the ORAC value is structurally sensitive. Thus the *quantity* of phenolic compounds in a sample does not necessarily have a linear correlation with its antioxidant *activity* represented by ORAC values. The phenolic compounds are responsible for most of the antioxidant activity in plants (12). Studies have shown that the effective compositions of the yin-tonic herbs are mainly flavonoids (9), which are phenolic compounds with strong antioxidant activity (11). In addition, some of them are known to have anti-inflammatory properties (13). In TCM theory, the inflammation is a typical symptom of excessive yang (or fire).

TCM, including Chinese herbal medicine, has been studied to a certain extent by means of modern science. Hitherto, however, there is virtually no study on the chemical nature of yin-yang. The clear trend of antioxidant activity supported the hypothesis that yin in TCM refers to antioxidation process, whereas yang relates to oxidation process. The ancient yin-yang balance is very similar to the modern antioxidation-oxidation balance as illustrated in **Fig. 1**, in which both TCM and current medical theory agree that the dynamic balance of yin-yang or antioxidation-oxidation is pivotal to health and disease prevention. Our hypothesis opens a new avenue for using modern biochemical science to study TCM theory. On the other hand, we can also learn from the empirical observations accumulated for over 2000 years by the clinical practices of generations of TCM doctors. Many questions can be raised. For example, how do the yang-tonic herbs work? Do patients who are weak in yin according the TCM show a high oxidative stress level or vice versa? If so, then how can we use the modern physical or chemical techniques to tell if one's yin and yang is (im)balanced? Can the oxidative stress biomarkers and/or antioxidant status in biological fluid be used as an indicator? Furthermore, can we assemble an instrumental diagnostic system or a chemical assay package to comprehensively measure "yin" and "yang"—a "yin-yang meter" in replacement of the ancient way of diagnosis by manually putting the fingers on the pulse (14)? It is not surprising that the yin-yang balance in TCM is more complex than what we have observed in this study. Our results presented here shed some light on the myth of yin-yang. The road to understanding the yin-yang is very long, and we will keep searching for answers. FJ

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