

Ontology for medicinal materials based on traditional Korean medicine

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ABSTRACT

Summary: We are constructing an ontology for traditional Korean medicine, and we started with medicinal materials to express the relationships between patients' symptoms, diseases and treatments. Biological materials and mineral resources have been used traditionally for patient treatments. The ontology includes various data related to these materials, such as their scientific names, parts of materials used, effectiveness and related oriental organ of the human body.

Availability: <http://tkm.kiom.re.kr/ontology/TraditionalKoreanMedicine.rdf-xml.owl> (10–20 s using Internet Explorer.)

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1 MOTIVATION

Although the knowledge systems of traditional medicine and modern medical science differ, comparative studies and applied approaches are valuable. Symptoms are practically identical from a patient's point of view, apart from cultural and linguistic differences. Patients' symptoms and the prescribed treatments are important fields with which to link modern medical science to traditional medicine.

For these purposes, we are constructing an ontology of traditional Korean medicine (TKM) for symptoms, diseases and treatments, and we are starting out by focusing on the knowledge of medicinal materials in traditional treatments.

For traditional Chinese medicine (TCM), the following related works have been done. Zhou *et al.* (2004) stored a Unified TCM Language System (UTCMLS) in relational databases, but it is not shared on the Web. To overcome the problem of semantic heterogeneity and to encode the domain knowledge in a reusable format, an integrated approach to developing and applying the large-scale domain ontology was proposed (Chen *et al.*, 2007 and Mao *et al.*, 2008); however, this ontology is not available to the public. The Chinese herbal database (www.tcmbasics.com/materiamedica.htm) is available in plain text, but only 116 herbs are currently

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Table 1. Example of medicinal material data

Items	Examples	Items	Examples
Names	麻黃 麻黃 (Ma Hwang) Ephedrae Herba	Reference	神農本草經 (Shin Nong Bon Cho Kyung) (Do, 6th century)
Scientific name	<i>Ephedra sinica</i> Stapf	Nature	Warm (溫)
Medicinally useful part	Stalk like grass (草質莖)	Flavor	Hot and slightly bitter (辛微苦)
Alias	龍沙 (Yong So)	Toxicity	extremely, slightly, mild, etc.
Contraindication	Weakness or exterior deficiency	Meridian Entry	Lung, bladder (肺, 膀胱)
Effect	Promotes sweating to dissipate cold (發汗散寒)	Major Indication	Common cold by wind-cold (風寒感冒)

included; the botanical names used in China are listed in this database.

We included more medicinal materials in China and Korea. This resource is available to the public and viewable in the Web Ontology Language. It will be available in a public ontology repository as soon as it is ready.

2 IMPLEMENTATION

We used Protégé (protege.stanford.edu) for the design of the ontology. We then extracted individual medicines and their property values and wrote them using Jena (jena.sourceforge.net). Knowledge was acquired by domain experts without using natural language processing. More than 60 000 triples were extracted verbatim from the *Korean Pharmacopoeia* (Korea Food and Drug Administration, 2008), traditional medical books and textbooks adopted by most Korean universities. Errors in the extraction and writing processes have not been measured so far.

2.1 Medicinal materials and properties

We have acquired data about traditional medicinal materials, as shown in Table 1, from the literature.

Most medicinal materials are biological materials, but by-products of living things and mineral resources are also used. Chinese, Korean and Latin names; scientific names; the medicinal part used; family names; nature; flavor; toxicity; meridian entries;

Table 2. Botanical names for Acanthopanax Cortex in the Korean and Chinese Pharmacopoeias

Botanical names	Pharmacopoeia		Textbooks		
	Korean	Chinese	A	B	C
<i>Acanthopanax sessiliflorum</i> Seeman	•		•	•	•
<i>Acanthopanax gracilistylus</i> W.W. Smith		•	•	•	
<i>Acanthopanax chiisanensis</i> Nakai et al.				•	

A, *Herbal Medicine Study* (Joint Text Compilation Committee, 2004); B, *Shin's Herbal Medicine Study* (Shin,G., 1988); C, *Clinical Herbal Medicine Study* (Shin,M., 1997).

Table 3. Examples of indication

Indication	Materials
泄瀉 (diarrhea)	葛根, 雄黃
久瀉 (protracted diarrhea or chronic diarrhea)	訶子, 黨參 et al.
小兒食積泄瀉 (infantile retention of undigested food and diarrhea)	蕪荑
脾虛泄瀉 (diarrhea due to hypofunction of the spleen)	乾栗, 菟絲子, 蓮子肉

effectiveness; and the chief virtue of the medicinal materials are included in this ontology.

Compared to the Chinese Herbal Database, the most basic property types are similar and the property values of many medicinal materials used in Korea are similar to those of the materials used in China. However, the scientific names of the original materials are quite different according to their local characteristics.

To clarify the difference between Korean and Chinese medicines, the names of the original material in the languages of the two countries, including the botanical, zoological and mineralogical names, have been included. Chinese data was acquired by referring to the *Chinese Pharmacopoeia* (Chinese Pharmacopoeia Commission, 2005). More than 800 materials between the two countries are included (Table 2).

2.2 Indication: mapping symptoms and disease

Most medicinal treatments of TKM use a combination of a number of medicinal materials that are known as formulas. Even so, each medicinal material has information pertaining to the curing symptoms or particular conditions that indicate the advisability or necessity of a specific medical treatment or procedure. An indication of a medicinal material can be a disease, a pattern or a symptom. Essentially, a material is recorded to treat complex cases, including compound symptoms, symptoms by a certain disease or pattern, symptoms or diseases due to a certain cause and a disease that exists given in a particular condition of a patient, among others.

These complex cases from materials cannot be simply mapped onto a single disease or symptom. It is necessary to understand the effect and functions of a material and the treatment method of a disease pattern (Table 3).

2.3 Translation of the property values into English

The property values of individual medicines, including the names, were written in Chinese and Korean first and were then translated

into English in reference to the *Korean-English Dictionary of Oriental Medicine* (Compilation Committee of Dictionary, 2004) and the *WHO International Standard Terminologies on Traditional Medicine in the Western Pacific Region* (World Health Organization, 2007). Values in Chinese or Korean that are recorded in neither the dictionary nor the standard will be translated by domain experts of traditional medicine and by medical information experts.

3 DISCUSSION AND CONCLUSION

Most terms and concepts from oriental medicine, including TKM, must be understood and mapped out carefully. Moreover, the knowledge represented in this ontology must be interpreted with an understanding of oriental medicine. Every value in it is from written records, but the representation does not include everything.

The contents represented as RDF triples in this ontology are facts based on the books used, but some combined knowledge may express incorrect information. Studies of the measurement and correction of these entries are required.

Plants, animals and minerals can be connected to a proper ontology, and the treatment information should be linked to the disease ontology of traditional medicine as well as to the disease ontology of modern medical science. Knowledge of medicinal treatments in traditional medicine will be useful due to their relationship to diseases, and this knowledge should be supported by analyses of the relationships between traditional diseases and modern diseases. By comparing other traditional medicines and applying clinical data, knowledge from relevant books can be assessed and a model for it can be modified practically.

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