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Economic botany collections: A source of material evidence for exploring historical changes in Chinese medicinal materials

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ABSTRACT

Ethnopharmacological relevance: Many Chinese medicinal materials (CMMs) have changed over centuries of use, particularly in terms of their botanical identity and processing methods. In some cases, these changes have important implications for safety and efficacy in modern clinical practice. As most previous research has focused on clarifying the evolution of CMMs by analyzing traditional Chinese materia medica ("*bencao*") literature, assessments of historical collections are needed to validate these conclusions with material evidence.

Aim of the study: Historical collections of Chinese medicines reveal the market materials in circulation at a given moment in time, and represent an underexploited resource for analyzing the evolution of Chinese herbal medicines. This study compares specimens from a rare collection of CMMs from the 1920s with contemporary market materials; by highlighting examples of changes in botanical identity and processing that remain relevant for safe clinical practice in the modern era, this work aims to stimulate further research into previously unexplored historical collections of Chinese medicines.

Materials and methods: 620 specimens of CMMs that were collected from Chinese pharmacies in the Malay peninsula in the 1920s were examined macroscopically and compared with current pharmacopoeia specifications and authentic contemporary samples. These historical specimens, which are stored in the UK in the Economic Botany Collections (EBC) of Royal Botanic Gardens Kew, were morphologically examined, photographed, and compared to authentic CMMs stored at the Bank of China (Hong Kong) Chinese Medicines Center at Hong Kong Baptist University, as well as authentic herbarium-vouchered specimens from the Leon Collection (LC) at the Kew EBC. Case studies were selected to illustrate examples of historical changes in botanical identity, used plant parts, and processing methods.

Results: This investigation confirmed that confusion due to shared common names and regional variations in the botanical identity of certain CMMs has been a persistent issue over time. Additionally, historical changes in processing methods and the plant parts used were observed for some CMMs. In some cases, these changes have direct implications for the safe clinical practice of Chinese medicine.

Conclusions: This preliminary assessment illustrated the significant potential of collections for clarifying historical changes in CMMs. More research is needed to investigate pre-modern collections of CMMs, including a more comprehensive assessment of the holdings in the Kew EBC and other European collections that have not yet been explored from the perspective of Chinese medicine.

1. Introduction

Chinese herbal medicine has been extensively documented for nearly 2000 years, and many individual Chinese medicinal materials (CMMs) have been used continuously from ancient times to the present. However, some CMMs have changed over time, particularly in terms of their botanical identity, processing methods, and growing conditions (Zhao et al., 2012). These changes have influenced safety, quality, and efficacy for centuries and continue to have important implications for practitioners in the modern era.

The use of many CMMs preceded the arrival of modern taxonomy in China, and traditional Chinese drug names often represent "plant

Abbreviations: CMM, Chinese Medicinal Material (plural=CMMs); TCM, Traditional Chinese Medicine; HP, Hooper Collection; EBC, Economic Botany Collection; AA, aristolochic acid; CP, Chinese Pharmacopoeia

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complexes" that include more than one species (Linares and Bye, 1987). In China, Latin scientific names only began to be systematically applied for the botanical identification of CMMs in the early 20th century (Zhao and Chen, 2014), and significant research is thus necessary to identify which species were in use during different historical periods.

The current state of knowledge surrounding the historical prevalence of various accepted species and adulterants remains incomplete in Chinese herbal medicine (Chen and Huang, 2005). Most previous research to evaluate historical changes has largely focused on *bencao* literature, which refers to pre-modern Chinese texts that focus on the origins, properties, and effects of medicinal substances. By combining contemporary field research with *bencao* literature review, the historical evolution of Chinese medicinal materials (CMMs) has been well summarized in Chinese publications such as *Chinese Medicinal Varieties: Theory and Use* by Xie (2008). However, many of the conclusions supported by *bencao* literature research have not yet been confirmed by assessing physical samples from pre-modern collections of CMMs.

As early collections provide valuable material evidence that complements literature-based research, more work is needed to systematically investigate pre-modern collections of CMMs. By comparing the CMMs found in pre-modern collections with current pharmacopoeia specifications and authentic contemporary specimens, it is possible to compare modern CMMs with the materials used in earlier eras.

1.1. Previous research on historical collections of CMMs

A variety of publications have attempted to clarify the historical development of CMMs based on the botanical illustrations and morphological descriptions found in ancient *bencao* texts (Xie, 2008; Chen and Huang, 2005). Additionally, contemporary research has shown that many CMMs that are currently prone to confusion in terms of botanical identity can be traced to historical changes, regional differences, and shared common names (Zhao et al., 2006b; Zhao, 2007).

Beyond the context of modern field research and literature review, physical specimens from ancient collections of CMMs have been analyzed using a variety of techniques, including macroscopic identification, microscopic identification, and chemical analysis. For example, 60 CMMs were originally included in the Shōsōin collection in Japan, which has been preserved since 756 CE; of the 38 intact specimens that survived, all but one specimen has been identified (Shibata, 1999; Sashida et al., 2009). Microscopy has been successfully used to identify specimens of Chinese herbal medicines recovered from a 900-year-old shipwreck site in Quanzhou Bay (Chen et al., 1979), and the discovery of nine herbal materials excavated from the Mawangdui tombs in China led to numerous publications with significance for early Chinese medical history (Chen and Li, 2009; Lu and Lo, 2015). However, previous research into ancient specimens of CMMs has been limited by the small number of known collections.

In a recent investigation at the Natural History Museum in London, members of our research group identified 84 CMMs in Sir Hans Sloane's nearly 300-year-old collection of "vegetable substances" (Zhao et al., 2015). These specimens revealed differences in the processing methods and specifications of several commonly used CMMs, and helped to clarify the botanical identity of some historical materials that are easily confused in the contemporary market. The integration of historical specimens complements our previous research into commonly confused Chinese medicines in regional markets such as Hong Kong (Zhao et al., 2006a) and the USA (Brand and Zhao, 2014), as well as the evolution of medicinal processing (Guo et al., 2015).

In addition to the Sloane Collection at the Natural History Museum, London is also home to a unique collection of pre-modern CMMs that are stored in the Economic Botany Collections (EBC) of the Royal Botanic Gardens Kew. In addition to a large modern collection of approximately 4500 accessions of herbarium-vouchered authentic CMMs (herein referred to as the Leon Collection), the Kew EBC features early collections of medicinal materials from around the world. Notably, the EBC features at least 1,268 samples of CMMs that were collected between the early 1800s and 1929, most of which have not been systematically assessed. Among the holdings relevant to Chinese medicine is a collection known as the "Hooper Collection" (HC), which includes 620 botanical, mineral, and animal drugs that were acquired from Chinese pharmacies in the Malay peninsula in 1924; this collection was the focus of our research.

2. Materials and methods

The HC results from an early European attempt to identify the diverse range of CMMs employed in Chinese pharmacies during the British Colonial Era (Hooper, 1929), and stands out as the only Kew EBC collection that attempts to represent the range of CMMs found in trade at a specific time and place. The HC specimens were acquired from Chinese pharmacies in Malaya by the botanist Isaac Henry Burkill, who served as the Director of the Singapore Botanic Gardens from 1912 to 1924, and were then curated into the EBC in London in 1929. Thus, the HC represents a "time capsule" for investigating the early 20th century Chinese herbal market in the Malay peninsula.

An initial attempt by David Hooper to identify the items in this collection was summarized and published in 1929 in *The Gardens' Bulletin: Straits Settlements*, in a monograph entitled "On Chinese Medicine: drugs of Chinese pharmacies in Malaya" (Hooper, 1929). In his effort to identify the substances, Hooper consulted numerous contemporary sources and referenced comparative samples of CMMs collected by Porter Smith and Daniel Hanbury that were stored at the Museum of the Pharmaceutical Society in the UK (Hooper, 1929).

The majority of the samples in the HC contain original labels that feature Chinese characters, and most of the samples with Chinese labels can be linked to Hooper's textual analysis, which described 456 drugs and included both Latin and Chinese names. Hooper's text also appears to include entries for specimens that no longer contain original Chinese labels, as well as a variety of mineral and animal drugs that are no longer present in the HC. While the samples that contain original Chinese labels are nearly certainly primary samples that Burkill collected in the Malay/Singapore region, the provenance of the samples in the HC that lack Chinese labels is less definitive. This latter group likely includes both original samples from Burkill as well as comparison CMM specimens from the Museum of the Pharmaceutical Society that Hooper used in the identification process (Smith, 1871; Hooper, 1929). These two groups of specimens were thus evaluated separately.

The specimens (and their corresponding text) were first examined macroscopically at Kew by Eric Brand, a Chinese medicine practitioner with training in the morphological identification of CMMs, with additional support from Christine Leon, a botanist with training in CMM identification. Photographs of the samples were then further evaluated by members of our research team with extensive expertise in CMM identification (Ran Huang, Zhongzhen Zhao, and Ping Guo). Vouchered CMM reference specimens from the Leon Collection at Kew (part of the EBC collection) and authenticated crude drug samples at the Bank of China (Hong Kong) Chinese Medicines Center at Hong Kong Baptist University were used for comparison during the process of identification. The original specimens were retained in the Kew EBC, and were evaluated based on the current specifications of the Chinese Pharmacopoeia Commission (2015) and contemporary professional textbooks focused on macroscopic identification of CMMs (Kang, 2003; Zhao and Chen, 2014).

The samples were further evaluated based on their Chinese nomenclature and the identifications made by Hooper in 1929 were reviewed. After an initial assessment, specimens that could not be morphologically identified due to degradation from prolonged storage