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Review

Citri Reticulatae Pericarpium (Chenpi): Botany, ethnopharmacology, phytochemistry, and pharmacology of a frequently used traditional Chinese medicine

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ABSTRACT

Ethnopharmacological relevance: Citri Reticulatae Pericarpium (Rutaceae, CRP), commonly called as Chenpi (陈皮) in Chinese, is most frequently used as a qi-regulating drug in thousands of Chinese medicine prescriptions. CRP is found mainly in major citrus-producing areas such as the Guangdong, Guangxi, Sichuan, Fujian, and Zhejiang Provinces of China. Since thousands of years in China, CRP has been used widely in clinical practice to treat nausea, vomiting, indigestion, anepithymia, diarrhea, cough, expectoration, and so on. Currently, CRP is listed in the Pharmacopoeia of the People's Republic of China. The present paper reviews the botany, ethnopharmacology, phytochemistry, pharmacology, quality control, and toxicology of CRP.

Materials and methods: Information on CRP was gathered from various sources including the books on traditional Chinese herbal medicine; scientific databases including Elsevier, PubMed, and ScienceDirect; Baidu Scholar; CNKI; and others and from different professional websites.

Results: Approximately 140 chemical compounds have been isolated and identified from CRP. Among them, volatile oils and flavonoids are generally considered as the main bioactive and characteristic ingredients. CRP possesses wide pharmacological effects such as having a beneficial effect on the cardiovascular, digestive, and respiratory systems, antitumor, antioxidant, and anti-inflammatory properties; and a protective effect on the liver and nerve. Moreover, hesperidin is chosen as an indicator in the quantitative determination of CRP, and the quantity of aflatoxin in CRP must not exceed the standard limit mentioned in the pharmacopoeia.

Conclusions: In brief, CRP has a warming nature, and hence, it can be used in harmony with a lot of medicines. CRP not only exhibits its effects individually but also aids other medicines exhibit a better effect. CRP can be consumed with tea, food, alcohol, and medicine. Irrespective of the form it is being consumed, CRP not only shows a synergistic effect but also has strengths on its own. Modern pharmacological studies have demonstrated that CRP has marked bioactivities, especially on the diseases of the digestive and respiratory systems. The bioactivities of CRP are useful for its clinical application and provide prospects for the development of drugs as well as food and health products for people. Although CRP is a commonly used drug in the traditional Chinese herbal prescription, there is an urgent need for further research on its synergistic effect with other herbs based on the compatibility theory of TCM, which would further increase our understanding on the compatibility theory of TCM.

1. Introduction

Citri Reticulatae Pericarpium (CRP), commonly referred to as Chenpi (陈皮) in Chinese, is an orange-colored *Citrus reticulata* Blanco fruit peel. Since thousands of years in China, CRP has been most frequently used as a qi-regulating drug in traditional Chinese medicine (TCM) prescriptions for clinical treatment. The “Xing qi” (行气) effect of CRP, which ranges from internal to external effects, not only promotes

the circulation of qi (energy) throughout the body, thereby soothing our emotions including anger, irritability, and frustration, but also is widely used in a variety of “stagnation” characteristics of qi, such as food stagnation, with pain and distention symptoms. Furthermore, as described in the books on TCM, CRP is also regarded to drying dampness and resolving phlegm. Therefore, it is easy to see that CRP in the prescription has an extraordinary position, especially from a holistic view, and with regard to the concept of balance of qi-invigorating compound

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recipe (Ma, 1999; Su et al., 2008).

CRP is mainly used for the auxiliary treatment of external contraction, indigestion, abdominal fullness and distention, cough with expectoration of phlegm, weakened state of the body, and other diseases. In addition, CRP strengthens the spleen, relieves inappetence, lubricates the intestine, strengthens the bones, and enriches the kidney. CRP was registered in the first edition of the Chinese Pharmacopoeia (1953 version), and the latest edition (2015 version) contains more than 10% of Chinese patent medicines. Modern pharmacology studies indicate that CRP possesses wide pharmacological actions such as effects on the gastrointestinal and respiratory systems; antioxidant, anti-inflammatory, and anticancer activities; and protective effects on the liver and nerves.

Because of extensive pharmacological effects and universal folk use, researchers began focusing attention on CRP, gradually studying its chemical components. The main components are volatile oils, flavonoids, and alkaloids. In addition, it also contains a small quantity of microelements, vitamins, pectin, polysaccharide, etc. Among them, volatile oils and flavonoids have been the most studied and possess the best bioactivity. According to the Pharmacopoeia of China, hesperidin is now used as the official indicator to monitor the quality of the peel.

Despite many researchers conducting extensive research on the chemical composition and pharmacological effects and on the widespread ethnopharmacological use of CRP in China, most of these research focus on CRP itself. With the development of modern advanced technology, it is imperative to study the endogenous changes in CRP. On the other hand, CRP is a kind of TCM, which appears frequently in compound prescriptions. It has no justification for scientific research because of its abstract effect in regulating qi. Further study is needed on the mechanism of promoting absorption, transport, gastrointestinal regulation, flora change and other effects based on the compatibility theory of TCM. Therefore, in this review, we have a detailed description on CRP with reference to a variety of literature and websites. We expect that this review would provide a theoretical basis and valuable data for future in-depth studies and applications.

2. Botany and ethnopharmacology

2.1. Botany

CRP (Fig. 1A) is the dried pericarp derived from mature *Citrus*

reticulata Blanco and its cultivars, belonging to the genus *Citrus* and family Rutaceae. *C. reticulata* Blanco has been cultivated since more than 3000 years and is mainly distributed in the Guangdong, Guangxi, Sichuan, Fujian, and Zhejiang Provinces of China.

The cultivars of *C. reticulata* Blanco mainly include *C. reticulata* “Chachi” (茶枝柑), *C. reticulata* “Dahongpao” (大红袍), *C. reticulata* “Unshiu” (温州蜜柑), and *C. reticulata* “Tangerina” (福橘). Among the main CRP cultivars, the pericarp of *C. reticulata* “Chachi” (茶枝柑) is the best national product. Owing to the main production in the Xinhui or Sihui District of Guangdong Province in China, it is also known as Guang Citri Reticulatae Pericarpium (GCRP) (Xiong and Yan, 2012). In recent years, the phenomenon of fake and shoddy goods has become very common; hence, chemical composition and quality control of CRP of different origin has attracted increased attention of researchers and needs further relevant study.

Unlike the common orange, this kind of fruit has characteristics of slightly concave, obvious column marks. Sometimes it has a small navel, and sometimes there is a radiation ditch around the pedicle. Moreover, it has a horizontal diameter of 4.6–5.9 cm × 6.3–7.1 cm, weight of 100–138 g, and thickness of 2.7–3.3 mm; 15–25 seeds; and multiple embryos. CRP is cultivated only to obtain its peels as a TCM, and not as a food, because this orange tastes bitter, while their pericarps are thick and tough.

The ripe fruit is picked usually in late autumn and early winter, then its pericarps are shelled, and the pericarps are dried under ventilation or low temperatures. To prepare the CRP into a processed medicine, impurities must be removed, water must be sprayed, shredded, and desiccated. This product appears as irregular strips or as filaments. (Fig. 1B). The Chinese medicine theory believes that the longer the storage time, the better the quality. Hence, its storage period ranges from 1 year, 2 years, and 3 years to more than 10 years (Wang et al., 2015). The reason for this is the change in the amount of flavonoids and volatile oils. CRP, as shown in Fig. 1C, is stored for decades. The inner surface is light yellowish white, and the outer surface is orange-red or reddish-brown (Chen, 2015).

2.2. Ethnopharmacology

With an extensive scope for physiological and pharmacological effects, CRP has been traditionally used in China for centuries. It was initially recorded in the Variorum of Shennong's Classic of Materia



Fig. 1. (A) *Citrus reticulata* Blanco tree (B) fresh mature pericarps (C) dried mature pericarps (D-F) food and beverage containing CRP.

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