Chapter 11
Artemisinin: A Versatile Weapon from Traditional Chinese Medicine

Thomas Efferth

Abstract Traditional Chinese medicine (TCM) commands a unique position among all traditional medicines because of its 5000 years of tradition. Our own interest in natural products from TCM was triggered in the 1990s by sesquiterpene lactones of the artemisinin type from Artemisia annua L. The first description of the Chinese herb Artemisia annua L. (qinghao, Sweet wormwood) dates back to 168 B.C.E. Artemisinin (qinghaosu) was identified in 1972 as the active antimalarial constituent of Artemisia annua L. Artemisinin and its derivatives are used for the treatment of malaria. As shown in recent years, this class of compounds also shows activity against cancer cells, schistosomiasis, and certain viruses, i.e., human cytomegalovirus, hepatitis B and C virus, and bovine viral diarrhea virus. Interestingly, the bioactivity of artemisinin seems to be even broader and also includes the inhibition of other protozoa such as Leishmania, Trypanosoma, and Toxoplasma gondii, as well as some trematodes, fungi, yeast, and bacteria. The analysis of its complete profile of pharmacological activities, as well as the elucidation of molecular modes of action and the performance of clinical trials, will further elucidate the full potential of this versatile weapon from nature against diseases.

Keywords Artemisinin · Cancer · Chemotherapy · Malaria · Pharmacognosy · Schistosomiasis · Traditional Chinese medicine · Viral infections

Abbreviation

TCM Traditional Chinese medicine
11.1 Introduction

Traditional Chinese medicine (TCM) comprises medicinal products from plants, animals and minerals, acupuncture, moxibustion, and other practices. Herbal prescriptions consist of a varying number of different medicinal plants and are used as extracts, decoctions, concoctions, and teas. Among all traditional medicines, TCM commands a unique position because of its 5000 years of tradition. Hence, it can be assumed that many ineffective prescriptions have disappeared over time. Until recently, TCM has been frequently regarded with some skepticism by Western academic medicine. On the other hand, prominent examples of isolated therapeutics derived from Chinese plants are established in modern medicine without being treated with the same reluctance as traditional herbal products. Among them are the ion channel blocker tetrandrine (*Stephania tetrandra*), the CNS stimulator ephedrine (*Ephedra sinica*), and the well-known anticancer agents camptothecin from *Camptotheca acuminata* and paclitaxel from *Taxus chinensis*. Since natural products represent a valuable source of drug discovery and development, there has been a recently thriving interest in chemically characterized compounds derived from TCM [1–3].

Our own interest in natural products from TCM was triggered in the 1990s by sesquiterpene lactones of the artemisinin type from *Artemisia annua* L. [4]. Apart from artemisinin, which is the focus of this chapter, we analyzed phytochemical and molecular biological aspects of natural products derived from TCM. The modes of action were studied on known compounds with still unknown cellular and molecular mechanisms such as arsenic trioxide, homoharringtonine, cephalotaxine, berberine, cantharidin, curcumin, luteolin, scopeletin, isoscopoletin, ascaridin, the quinolones 1-methyl-2-undecyl-4-quinolone, 1-methyl-2-trideca-dienyl-4-quinolone and evo-carpine, the indoloquinazoline alkaloids rutaecarpine and evodiamine, and four geranylated furocoumarines [5–19]. Furthermore, novel natural products were isolated and identified from plants derived from TCM, some of which showed growth inhibitory activity against cancer cells, i.e., tetracentronsine, a new indole alkaloid (3-(2-hydroxyethyl)-1H-indole-5-O-beta-D-glucopyranoside), and two new phenol derivatives, 3-{2-[beta-glucopyranosyl]oxy}-4,5-(methylenedioxy)phenyl propanoic acid and methyl 3-{2-[beta-glucopyranosyl]oxy}-4,5-(methylene-dioxy) phenylpropanoate, two new alpha-tetralone (= 3,4-dihydronaphthalen-1(2H)-one) derivatives, berchemiaside A and B, a new flavonoid, quercetin-3-O-(2-acetyl-alpha-L-arabinofuranoside), and a diprenylated indole, (E)-3-(3-hydroxy-methyl-2-butenyl)-7-(3-methyl-2-butenyl)-1H-indole [20–22].

11.2 Use of Artemisinin in Traditional Chinese Medicine

The first description of the Chinese herb *Artemisia annua* L. (*qinghao*, sweet wormwood) dates back to 168 B.CE. The plant was mentioned in the prescriptions for 52 diseases in the Mawangdui tomb of the Han dynasty. The next historical tradition is from the year 1086, written by Shen Gua. In the “Handbook of Prescriptions for...