

Preface

Plant-based drugs face unusual challenges during their journey from farm to pharmaceuticals. In the case of cannabis, a considerable additional complexity is derived from regulatory concerns, depending on the countries of production and marketing. Cannabis is one of the oldest plants cultivated for the purpose of food, medicinal and ritual use or as intoxicant drug for millennia. In the last few decades, cannabis has gained a lot of interest and popularity in the general public as well as in research community, not only because of its abuse potential but also because of its new emerging therapeutic potential to treat a variety of new disease conditions. Since the discovery of its principal psychoactive compound Δ^9 -Tetrahydrocannabinol (Δ^9 -THC) by Prof. Raphael Mechoulam and Yechiel Gaoni in 1964, cannabis research, by and large had been revolving around Δ^9 -THC and its derivatives. However, in recent years, cannabidiol (CBD), a non-psychoactive compound in cannabis is drawing a lot of attention due to its therapeutic potential in childhood epilepsy and other disorders. The methods of drug delivery, however, are a challenging issue in cannabis based drugs.

The purpose of “*Cannabis sativa* L. Botany and Biotechnology” is to present in a single volume the comprehensive knowledge and experiences of renowned researchers and scientists in the field of cannabis research. Each chapter is independently written by experts in their field of endeavor ranging from cannabis plant, species debate, its therapeutic potentials, constituents and their biosynthesis, use of modern biotechnology in conservation, propagation and enhancement of cannabis production to contaminants of concern in cannabis for the quality control of biomass product.

The subject, whether genus *Cannabis* contains single species (*Cannabis sativa* L.) with several subspecies and/or varieties, or several distinct species, has been a matter of debate for a long time. The book begins with an introductory chapter on classification of *Cannabis* in relation to agricultural, biotechnological, medical and recreational utilization (Chap. 1, Ernest Small) and history of cannabis as medicine with a special note on nineteenth century Irish physicians and correlations of their observations to modern research (Chap. 2, Ethan Russo) followed by *Cannabis* botany and horticulture (Chap. 3, Chandra et al.), *Cannabis sativa* and *Cannabis*

indica versus “Sativa” and “Indica”—a nomenclature debate (Chap. 4, John M. McPartland), morpho-anatomy of marijuana for its identification (Chap. 5, Raman et al.), and chemical and morphological phenotypes in *Cannabis* (Chap. 6, Grassi and McPartland). In the next two chapters the discussion is focused on the constituents of cannabis with special focus on cannabinoids, modern methods of cannabinoids analysis (Chap. 7, Radwan et al.) and their biosynthesis (Chap. 8, Sirikantaramas and Taura).

The plant cannabis and its crude preparations have been used as natural therapeutic agents since ancient times. Its early therapeutic properties have been referenced back in 2900 BC, where the Chinese emperor Fu-Hsi references marijuana as a popular medicine. The next group of chapters is focused on the pharmacological and therapeutic potential of phytocannabinoids (Chap. 9, Cascio et al.), cannabinoid CB2 receptor mechanism (Chap. 10, Onaivi et al.), therapeutic properties of cannabidiol, a compound of interest these days (Chap. 11, Brian Thomas) and allergenicity to *Cannabis* (Chap. 12, Ajay P. Nayak et al.).

Biotechnology plays an important role in propagation, conservation and improvement of medicinal plants. *In vitro* propagation provides a means of robust multiplication of disease free, chemically consistent batches of desirable plant material which is a basic demand of the pharmaceutical industry. On the other hand, *in vitro* propagation also opens the door for alterations and modifications in chemical constituents of plants by using genetic engineering. Chapters 13–21 provide an in-depth discussion on *in vitro* propagation efforts, genetic and metabolic engineering, manipulation of beneficial secondary metabolites through induction of polyploidy, endophytes and physical and chemical elicitation in *Cannabis* plants. Chapter 13 (Lata et al.) summarizes the state-of-the-art research being done in the field of cannabis micropropagation, while in Chap. 14 (Wahby et al.) and Chap. 16 (Feeney and Punja) focus is laid on different gene-transfer technologies using hairy root cultures of *C. sativa*. Chapter 15 (Onofri and Mandolino), Chap. 17 (Mansouri and Bagheri), Chap. 18 (Karlova et al.) and Chap. 19 (Punja et al.) highlight the genomics and molecular markers, induction of polyploidy and its effects, classical and molecular cytogenetics and genetic diversity associated to *Cannabis*, respectively. Chapter 20 (Kusari et al.) describes cannabis endophytes and their application in breeding and physiological fitness, whereas Chap. 21 (Gorelick and Bernstein) is focused on chemical and physical elicitation for enhanced cannabinoid production.

Quality of biomass is a key parameter for the safety and efficacy of any phytopharmaceutical compound. Like any other agricultural crop, cannabis biomass can be contaminated by several factors such as heavy metal, microbes, pesticide, etc. These contaminants may be passed on by previous crop or from a pesticide or herbicide spray drift from adjacent field or plants may be grown in a contaminated soil. For the quality and efficacy of cannabis biomass product, the concluding chapter (Chap. 22, McPartland and McKernan) of this book discusses contaminants of concern in cannabis.

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Oxford, MS, USA

Suman Chandra
Hemant Lata
Mahmoud A. ElSohly



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Chandra, S.; Lata, H.; ElSohly, M.A. (Eds.)

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