What Lies in the Future of Tea Science in the Era of Genomics?

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Received: 15 Nov., 2011
Accepted: 10 Dec., 2011
Published: 18 Dec., 2011

Abstract Human being has been using tea as a beverage for thousands of years. Chinese tea is made of dried leaves from tea plants (*Camellia sinensis* (L.) Kuntze), while the British tea, which is called herbal tea, is a mixture of dried herbs from a variety of plants. Countless plants are used to make tea, but do the active compounds in these plants serve the same functions as typical tea leaves do? In fact, it is not yet known what exactly a cup of herbal tea contains. With the development of biotechnology and the arrival of the era of genomics, what lies in the path in the future development of tea science? In this paper, the author would like to propose some directions as the following: 1) the exploration at molecular level of what is inside a tea bag; 2) the study of a typical tea plant (*Camellia sinensis*) as a model plant for tea study; 3) Tea-nomics study based on new-generation of sequencing technology; 4) comparative metabolomics studies on biologically active compounds in tea; 5) identification based on pharmacology and toxicology.

With the advent of the genomics era, the mysteries in tea bags will slowly be deciphered; whether it is Chinese tea or English tea, tea will still be the most popular drink.

Keywords Tea; Herb tea; Tea plant (*Camellia sinensis* (L.) Kuntze); Tea science; Tea nomics; Tea-based nutraceutical and pharmaceutical

Usually, when Asians refer to tea, they mean brewing dried tea leaflets in a cup or pot. These tea leaves are picked up from tea plants and then processed and dried. The tea tree, *Camellia sinensis* (L.) Kuntze in the genus of *Camellia*, belongs to the family of Theaceae, and it is an evergreen flowering plant.

On the other hand, the Westerners refer tea or tea beverage to the watering tea, which is well-known as English tea, or British tea. The tea bag contains a mixture of a variety of dried powder or small parts of plant parts (root, stem, leaf, flower, fruit). The plant species contained in the mixture come from more than 25 families and 50 species at least; however, not all tea bags include real tea plants. Thus, this kind of British tea is often called herbal tea.

Tea originated from China. There already were records about tea thousands of years ago. Nowadays, tea becomes one of the most popular and popular drinks in the world.

Tea-ism, Cha Dao, or tea ceremony investigates planting, picking up, processing, making, and tasting of tea. It also includes the benefits to human health from tea; however, the tea ceremony is more like a traditional etiquette or religious feature rather than science. Globally, especially China and Japan in Asia have set up dedicated tea research institutions, and there are thousands of specialists working in tea research. In the last century, there have been huge developments and progresses made in tea science.

In the twenty first century, with the advent of the genomics era, what is the future of tea scientific research like? The author believes that the following aspects are the main directions of tea scientific researches.

1 DNA molecular identification of substances in the tea bags

With the development of modern molecular biology, the utilization of DNA markers facilitates the discovery of what is in tea bags. Stoeckle et al used DNA barcode technology on 146 kinds of tea bag products,
and showed that DNA barcoding, \textit{rbcL}, and \textit{mat K}, can effectively identify the difference between plant molecules in tea bags (Stoeckle et al., 2011). So far, no one can clearly say how many kinds of commercial herbal tea products there are, and how many of plant species can be used to make tea.

2 Tea tree as model plant in tea research

There is no doubt that the most authentic tea is made from leaflets of tea trees. For thousands of years, people have used tea as a long-term beverage in long-term drinking without any toxicity or allergies, which reveals that a variety of biochemical substances, such as polyphenolic catechins and methylxanthine caffeine are safe to humans. Tea tree is an evergreen flowering plant originating in the southwestern part of China and its neighboring countries such as Vietnam, Myanmar, Thailand, India etc. Tea tree, \textit{Camellia sinensis} (L.) Kuntze, belongs to the genus of \textit{Camellia} in the family of Theaceae. The species is divided into two subspecies: large-leaved variety, \textit{Camellia sinensis}, var. \textit{assamica}, is mainly distributed in tropical and subtropical areas, whereas small-leaved variety, named \textit{Camellia sinensis} var \textit{sinensis}, is mainly distributed in cold and high altitude areas. Using tea tree as a model plant can promote the development of tea studies, especially researches on herbal tea will be benefited first.

3 Tea-nomics study based on new-generation of sequencing technology

Metabolic pathways involving active substances in the tea are very complex, and these important secondary metabolic pathways such as the flavonoid biosynthetic pathway, theanine biosynthetic pathway, and caffeine metabolic pathways are difficult to be studied by using conventional chemical means. China stands in the forefront by using new-generation DNA sequencing technology as an effective way to study tea metabolome. Shi et al employed high-throughput illumine RNA sequencing technology to study the transcriptome of Chinese tea tree (shi et al., 2011), and obtained meta-data of transcriptome which might be sufficient for finding the genes of the main metabolic pathway (Ras et al., 2011). This study has significant values for further studies of gene expression, genomics and comparative genomics.

4 Studies of comparative metabolomics on active compounds in tea

English tea, or herbal tea includes a variety of plant species. The recognition of the secondary metabolites of these plants is a very difficult thing. What is the reason behind putting these herb plants into tea bags? Some of them might be used as a spice, but we do not know why some plants are included. It is very important to clarify the role of these plants in the inclusion of tea bags. With the development of genomics research in tea, tea tree as a model plant of tea studies is well recognized. The utilization of comparative metabolomics methods and strategies to study the metabolism of plants used in herbal teas becomes feasible. Metabolomics-driven studies on nutraceuticals and pharmaceuticals are receiving more and more attentions (Fujimura et al., 2011).

5 Identification and labeling based on molecular pharmacology and toxicology

In fact, many herbal tea plants have pharmacologically active compounds, and these substances may have a therapeutic effect or toxicity. Overdrinking, mislabeled products, or allergies can lead to serious illness or fatality. Thus, accurate labeling and clear claiming of pharmacological properties on the tea bag become an extreme important research topic. Research results reported by Stoeckle et al indicate that thirty percent of the herbal tea found on the market has unlabeled plant components in tea bags (Stoeckle et al., 2011), which definitely contain substances which are potentially harmful to consumers' health.

Conclusion

What is in your cup of tea? Not everyone of us can think of that. With the arrival of the genomics era, the mysteries in a tea bag can slowly be solved, no matter it is Chinese tea or English tea, or the so-called herbal tea; tea will still be one of people's most popular drinks.

Acknowledgement

Author greatly appreciated two anonymous reviewers for their reading and revising the manuscript. This work was supported by the Project Initiative of CISCC.

References

