Analysis of the Influence of Different Drying Methods on the Active Ingredients of Fresh Medicine

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Abstract

The heating area of the material is large and the thermal efficiency is high, but it is necessary to control the suitable drying temperature of different medicinal materials to preserve the effective ingredients. Different kinds of Chinese medicine need different drying conditions to fulfill good drying requirements. Natural drying in the shade is one of the traditional drying methods, which takes a long time and is easily affected by the weather. The water volatilizes slowly. It is prone to mildew and discoloration during the drying process. However, it can better preserve the volatile oil components of Chinese medicine. The hot-air drying machine has lower requirements. The medicinal materials have a large heating area and high thermal efficiency, but it is necessary to control the appropriate drying temperature of different medicinal materials in order to preserve the active ingredients of the medicinal materials; it is not suitable for medicinal materials that stick and bind easily. The microwave drying method possesses superiority in drying some valuable medicinal materials such as Renshen (Radix et Rhizoma Ginseng) and Lurong (Cornu Cervi Pantotrichum), and the effective ingredients are preserved at a high degree; it can also achieve the purpose of killing enzymes and protecting glycosides and have a good bactericidal effect, but it is not suitable for Chinese medicines containing heat-sensitive ingredients, because it will destroy most of the proteins, amino acids, and peptides of Chinese medicine and result in the loss of efficacy. The far-infrared drying method is suitable for drying thin-layer medicinal materials and is friendly to the environment. Freeze-drying can preserve the active ingredients very well and greatly retain the efficacy, but it has obvious limitations in preserving some Chinese medicinal materials that need to kill enzymes and protect glycosides; besides, the cost is relatively high and the drying time is long.

Keywords

- fresh medicine
- drying method
- natural drying
- hot-air drying
- microwave drying
- far-infrared drying
- freeze-drying

Introduction

China has a long history of the resources of Chinese materia medica. Drying is one of the indispensable operations in the processing of Chinese medicinal materials, with the purpose of reducing the moisture content to a specified limit.[1] Generally, the moisture content of Chinese medicinal materials is controlled at 7 to 13%.[2] Low moisture content of Chinese medicinal materials will cause them to shrink, become brittle, and break easily; Chinese medicinal materials with an excessive moisture content may become prone to insects and mold due to which the effective ingredients may

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get decomposed and deteriorated, which will seriously affect the efficacy and cause wastage of Chinese medicine resources.[3] According to *Enlightening Primer of Materia Medica (Ben Cao Meng Quan)*, "all Chinese medicinal materials should be stored carefully. If there is still moisture after they are dried in the shade, dried under the blazing sun or baked, they will inevitably decay and mildew." This explains the importance of dryness for the storage of Chinese medicinal materials. The main drying methods of modern Chinese materia medica include natural drying in the shade, hot-air drying, microwave drying, far-infrared drying, freeze-drying, etc.[4]

Natural Drying in the Shade

The method of natural drying in the shade is a method with simple operation and low cost. However, the medicinal materials are exposed and easily contaminated during the drying process. Deng et al[5] measured the salvianolic acid B contents of Danshen (Radix et Rhizoma Salviae Miltiorrhizae) dried with different drying methods and found that Danshen (Radix et Rhizoma Salviae Miltiorrhizae) dried naturally in the shade had the highest content of the salvianolic acid B which has important pharmacological effects on the heart, brain, liver, and kidney. Therefore, natural drying in the shade has a good preservation effect on the active ingredients of Danshen (Radix et Rhizoma Salviae Miltiorrhizae). He et al[6] applied different drying methods for ginkgo leaves: drying indoor, drying under the sun, baking at a constant temperature of 80°C, drying at the temperature of 100°C for 30 min. They found that natural drying in the shade can effectively reduce the content of ginkgolic acid, toxicity, and side effects, such as the excessive expansion of human capillary network, and can guarantee the content of flavonoid lactones as the medicinal ingredients of ginkgo leaves. Li and Du[7] found that aromatic Chinese medicinal materials contain much volatile oil and exposure to the sun of which should be avoided. Natural drying in the shade can ensure the content of volatile oil in Chinese medicinal materials. The method of natural drying in the shade can better preserve the volatile components of Chinese medicinal materials, but the drying time is longer and Chinese medicinal materials are prone to mold and deterioration.

Hot-Air Drying

The hot-air drying method is to make hot-air evaporate the water vapor on the surface of the materials using a circulating fan and a heating system. As the hot air of hot air drying has a certain temperature gradient from inside to outside[8], the hot air drying temperature of different medicinal materials is different, and it is the key factor affecting the quality of medicinal materials. Yuan et al[9] designed the low-temperature group (40°C, 50°C, and 60°C), medium-temperature group (70°C, 80°C, and 90°C), and high-temperature group (100°C, 110°C, and 120°C) to dry the Juhua (Flos Chrysanthemi). The results showed that the content of chlorogenic acid decreased under low-temperature conditions, while the content of it increased at 60° to 70°C, indicating that the drying temperature should be clarified when applying the hot-air drying method. Xie et al[10] explored the effects of different drying methods (drying in the shade, drying under the sun, drying at 55°C, and drying at 80°C) on the contents of total saponins and saponins A of Shanglu (Radix Phytolaccae). They pointed out that total saponins of Shanglu (Radix Phytolaccae) is are both the active and toxic components. The results showed that hot-air drying at 55°C was the best for drying Shanglu (Radix Phytolaccae), which can reduce toxicity while retaining the effective ingredients. Hot-air drying is simple and easy. The drying process is not affected by external factors. The drying effect is influenced by the drying temperature. Especially for Chinese medicinal materials with high sugar content, volatile oils, greases, and powder, the temperature should not be too high to prevent their softening and discoloration by mucus extravasation, volatilization of volatile oil, or oil overflow.[7]

Microwave Drying

Microwave drying means to use penetrating electromagnetic radiation waves with a wavelength of 1 to 1,000 mm and a frequency of 300 to 300,000 MHz to make the heated object itself as a source of heat to dry uniformly from the inside to the outside.[11] Zhang et al[12] dried fresh Renshen (Radix et Rhizoma Ginseng) using three different drying methods: natural drying, 60°C oven drying, and 625W microwave drying. They found that microwave-dried Renshen (Radix et Rhizoma Ginseng) had the highest recovery rate of ginsenosides and the appearance was round and full, which was comparable to fresh ones and contained more active ingredients. In addition, Ma and Chen[13] summarized the broad prospects of microwave drying in the field of Chinese materia medica sterilization and pointed out the limitations of microwave drying in the drying and sterilization of Chinese materia medica containing heat-sensitive components (amino acids, proteins, peptides, etc.). Shi et al[14] found that the greater the microwave power, the shorter the drying time of Juhua (Flos Chrysanthemi), and the chlorogenic acid and total flavonoids in Juhua (Flos Chrysanthemi) would gradually increase. They concluded that microwave drying was the best way to ensure a higher content of flavonoids, vitamin C, and soluble sugars, but higher power and longer drying time would destroy heat-sensitive components. The microwave drying method has a uniform drying effect and a certain sterilization effect. However, it is not suitable for the preservation of heat-sensitive active ingredients in medicinal materials. The content of active ingredients after drying is affected by power and drying time.

Far-Infrared Drying

The far-infrared drying method converts electrical energy into far-infrared radiation. The radiation is absorbed by the molecules of the Chinese medicinal materials and the collision of internal microscopic particles is accelerated, which causes the object to heat up and water vapor to evaporate after thermal diffusion, thereby drying Chinese medicinal

materials.[15] Liu et al[16] used far-infrared radiation to dry Jinyinhua (Flos Lonicerae Japonicae). It shortened the drying time and simultaneously maintained chlorophyll and chlorogenic acid. The far-infrared wavelength is short and the penetration depth is low, which is suitable for drying and sterilizing thin-layer medicinal materials. Far-infrared drying heats up the object faster. Similar to hot-air drying, attention should be paid to controlling the drying temperature of different Chinese medicinal materials to ensure the contents of active ingredients.

Freeze-Drying

Freeze-drying, also called vacuum freeze-drying, is a drying method in which the water is sublimated from the solid under low-pressure conditions after the material is completely frozen.[17] Freeze-drying is performed under vacuum and low-temperature conditions, which has great advantages for the drying of easily oxidized and high heat-sensitive Chinese medicinal materials and can preserve the activity of medicinal ingredients to a great extent.[18] Cai et al[19] compared the contents of chlorogenic acid and luteolin in bake-dried Juhua (Flos Chrysanthemi) and vacuum freeze-dried Juhua (Flos Chrysanthemi). They found that the contents of chlorogenic acid and luteolin in freeze-dried Juhua (Flos Chrysanthemi) were much higher than those in bake-dried ones. However, the low temperature of freeze-drying also limited the inhibitory effect on enzyme activities of some Chinese materia medica. For example, the amygdalin of Kuxingren (Semen Armeniacae Amarum) needs to be protected by killing the activity of synaptase so as to ensure the content of active ingredients in Kuxingren (Semen Armeniacae Amarum).[20] Freeze-drying is an ideal modern drying method for Chinese materia medica.[21] It can better preserve the active ingredients of Chinese materia medica and maintain their closeness to the content of active components in fresh medicinals, but it takes a longer time and costs more.

Discussion

China has a long history of Chinese medicinal material drying, and there are multiple drying methods. Besides, the drying of different kinds of Chinese medicinal materials requires different drying conditions to fulfill good drying requirements. Natural drying in the shade is one of the traditional drying methods, which takes a long time and is easily affected by the weather. The water volatilizes slowly. It is prone to mildew and discoloration during the drying process. However, it can better preserve the volatile oil components of Chinese medicinal materials.[22] The hot-air drying machine has lower requirements. The heating area of the material is large and the thermal efficiency is high, but it is necessary to control the suitable drying temperature of different Chinese medicinal materials to preserve the effective ingredients; it is not suitable for Chinese medicinal materials that stick and bind easily. The microwave drying method possesses superiority in drying some valuable Chinese medicinal materials such as Renshen (Radix et Rhizoma Ginseng) and Lurong (Cornu Cervi Pantotrichum), and the effective ingredients are preserved at a high degree; it can also achieve the purpose of killing enzymes and protecting glycosides[21] and have a good bactericidal effect, but it is not suitable for Chinese medicinal materials containing heat-sensitive ingredients, which will destroy most of the proteins, amino acids, and peptides and result in the loss of efficacy.[23,24] Far-infrared drying method is suitable for drying thin-layer Chinese medicinal materials, and is friendly to the environment.[25] Freeze-drying can preserve the active ingredients very well and greatly retain the efficacy, but it has obvious limitations in preserving some Chinese medicinal materials that need to kill enzymes and protect glycosides; besides, the cost is relatively high and the drying time is long.

The drying of Chinese medicinal materials is to preserve the active ingredients. The freeze-drying method can preserve the active ingredients well and ensure good efficacy. However, freeze-dried dry products cannot completely replace fresh medicines. Fresh medicines have more active ingredients than dry products and have better medicinal effects. Fresh medicines have irreplaceable clinical effects in the treatment of miscellaneous clinical diseases and critical illnesses.[26] Fresh Shengjiang (Rhizoma Zingiberis Recens) is stronger than Ganjiang (Rhizoma Zingiberis) in anti-vomiting and antipyretic effects[27]; fresh Machixian (Herba Portulacae) has better antibacterial effects on Staphylococcus aureus and Shigella bacillus than the dry one.[28] Hong recorded in his book named *Handbook of Prescription for Emergency (Zhou Hou Bei Ji Fang)* that the juice of fresh Qinghao (Herba Artemisiae annuae) was used to treat malaria, while dry Qinghao (Herba Artemisiae annuae) had poor effects in treating malaria. Fresh medicine still has a great advantage in clinical treatment.

Credit Authorship Contribution Statement
Yang Jianqin: Fliterature collection, collation and writing the original draft. **Mingsan Miao:** Funding acquisition, proposing the idea, and improving the draft.

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Conflict of Interest
The authors declare no conflict of interest.

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