Thermophysical properties and porous properties of Soybean under microwave drying mechanical equipment

Abstract: The temperature and quality changes of Soybean samples during microwave drying were measured in real time by using microwave drying machine test system. The variations of physical properties such as density, thermal conductivity, specific heat and thermal diffusivity of samples with different moisture content during drying were analyzed. From the point of view of porous media, the variations of pore properties such as porosity, fractal dimension, pore diameter and specific surface area in different drying nodes (100%, 85%, 70%, 55%, 40%) were studied. Law.

By changing the microwave heating power, the influence of microwave power on the heat and mass transfer of samples is analyzed. The results showed that during the microwave drying process, a dense membrane was formed in the cortex cells of soybean, which hindered the water migration. When the moisture content was reduced to 30%, the coke appeared inside the sample, and then the cells in the center collapsed completely. But the density of the whole drying process is not large, and the reduction is about 5 kg /m3. The thermal conductivity increases first and then decreases, reaching a maximum when the moisture content is 60%, and the internal temperature tends to be more uniform with the decrease of the moisture content. With the drying process, porosity and pore fractal dimension increase, and pores become more and more complex. The change of temperature in drying process has obvious phase, and the direction of heat transfer and moisture transfer is consistent. In the early stage of drying, the higher the microwave power (0.6 kW, 0.8 kW, 1.0 kW), the faster the sample temperature rises to 100 C. At this time, the internal temperature is higher than the surface temperature, while the internal and external temperature is basically constant in the late stage of drying, but the size relationship between the two is more complex than the previous stage.
Key words: soybean; microwave drying; thermophysical properties; porous medium characteristics; temperature distribution

Soybean microwave drying equipment

. Since only the outer surface of the material is in direct contact with the outside air, water evaporation can only be carried out on the surface of the material, and the water near the surface will evaporate first. As the drying progresses, the epidermal cells gradually form a dense film, and only when the vapor pressure evaporated from the inside is sufficient to penetrate the film can the water be transferred to the outside world. At the initial stage of drying, the water content in the sample is high, and the steam pressure is high. As a result of extrusion and water loss, the cells break more, the pore channels increase significantly, and the pore complexity increases. With the drying process, the water content decreases gradually. As the internal pore space increases and the steam pressure decreases gradually, the cells break.

The loss rate also decreases. At this time, the internal pore channels are basically opened, and the complexity of the pore decreases. Therefore, the increase of porosity and fractal dimension is slower than the previous period. During the whole process of microwave drying, the pore diameter increased continuously, the maximum and minimum pore diameter increased to about 90 and 7 micron, which were 3.0 and 2.3 times larger than the initial pore diameter, respectively. This is because after dehydration, the cells adhere to each other, forming a larger area of cell adhesion, so the cells are no longer closely aligned, in addition, the internal steam can not spread to the outside in time, filling in the pores between cells, due to the role of pressure to expand the scope of the pores.

Conclusion From the analysis of the thermophysical properties and porous media properties of soybean microwave drying, the main conclusions are as follows:

(1) Carrot surface cells are smaller, and the middle cells are larger. During microwave drying, the surface cells gradually form a dense film, which prevents water loss. Some of the cells inside collapse and rupture due to dehydration and compression. When the moisture content was 30%, slight scorching occurred in the inner part. When the moisture content was 15%, almost all the cortical cells were broken and the inner tissue was carbonized seriously.

(2) The decrease of water content and volume resulted in the fluctuation of soybean density during the whole experiment, but the overall change was not significant, only reduced to less than 5.00 kg/m3. The variation of thermal conductivity with water content basically conforms to cubic curve, which increases first and then decreases. The peak value appears at 60% water content, and then decreases due to cell rupture and water content reduction. In addition, the thermal diffusivity increases with the decrease of water content, whereas the specific heat decreases linearly.

(3) The fractal dimension of carrot is non-integer, which can be used as porous media to analyze the heat and moisture transfer characteristics of soybean. The porosity increases with the drying process. The end of drying is about 2 times that of the early drying stage. When the drying mass is 40% of the initial mass, the maximum and minimum pore diameters increase to about 3.0 times and 2.3 times of the fresh state, respectively, because of the cell rupture and the change of pore diameter. The specific surface area decreased slowly with the decrease of water content 902 Jiangsu Agricultural Journal Volume 34, Phase 4, 2018, and almost constant at the late drying stage of 0.58.

(4) In the early stage of microwave drying, the temperature rise rate was positively correlated with the microwave power. It only took 40 seconds to rise to 100 C under 100% (1.0 kW) power. The temperature changes in the whole drying process are mainly divided into heating section, constant temperature section, cooling section and re constant temperature section. The direction of heat migration and water migration is the same from inside to outside. In the early stage of drying, the internal temperature is higher, but the relationship between surface temperature and central temperature becomes more complex in the late stage of drying.