Establishment of energy-saving modes of dispersion and fractionation of pectin-containing powder

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Abstract – The research of dispersion and fractionation of pectin-containing powder is carried out in the work. Energy-saving modes of dispersion and fractionation processes are also determined.

Keywords – dispersion, fractionation, pectin-containing powder, energy-saving, rotor speed, dispersion of beet powder.

Introduction

The most convenient form for storage and use of dried fruits and vegetables is a powder form. The aggregate state of powders, their high moisture absorption capacity promotes to increase the speed of biochemical and diffusion processes by increasing the contact surface and interaction with other ingredients and provides maximum extraction of pectin, carotene, dyes and other biologically active substances, thus excluding the use of synthetic dyes and fillers in food products [1–4].

The main indicator that determines the scope of application of food powders is the degree of dispersion (grinding). The dispersion process is characterized by high energy costs, which are determined primarily by the properties of dried vegetable raw materials [5].

Purpose and task of the research

The purpose of the work is to conduct research on the dispersion and fractionation of dried plant materials and to determine the energy-saving regimes of these processes.

The task of the research is to develop optimal modes of dispersion of dried plant materials; to determine the dependence of the micromill performance and power consumption on the rotation speed of the dispersant rotor; to establish the influence of the load on the sieve and the scattering time on the fractionation process.

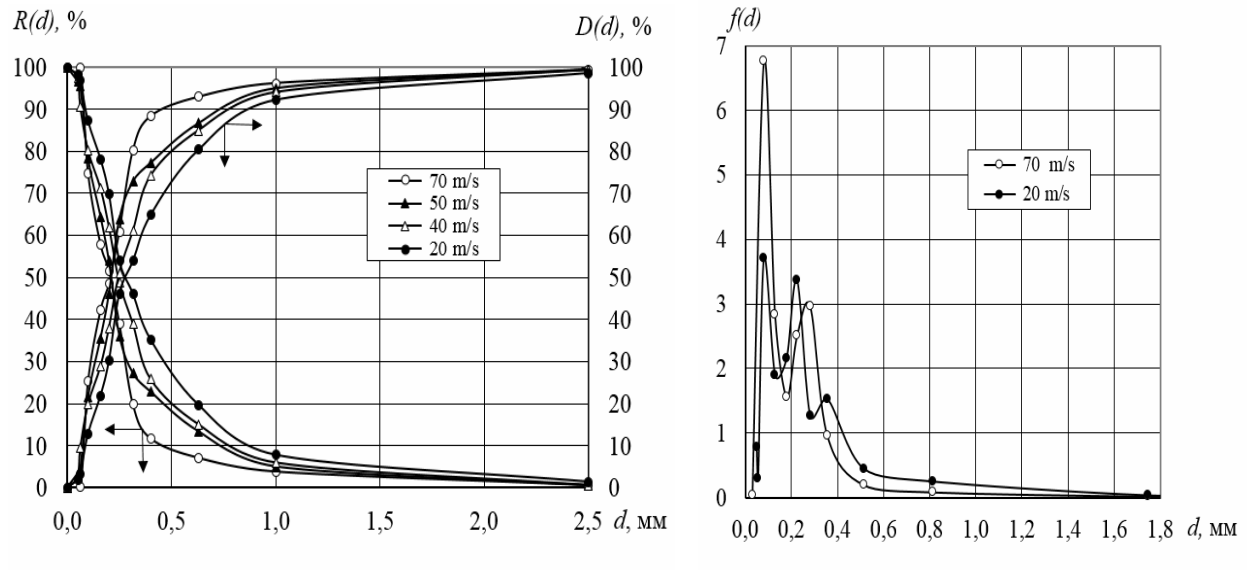
Objects, equipment and research methods

Dried beets with residual humidity W_r = 6…8% were used as objects of research. Studies of the dispersion process were performed on an 8 MM micromill, the coarse part was ground on a DESI disintegrator, the study of the dispersed composition of powders was carried out on the device 029 [5].

Results of investigations

The analysis of the existing methods of grinding and mills for its carrying out showed that the mills of a shock mode of action are the most suitable for dispersion of the dried vegetable raw materials. It is experimentally proven that increasing the speed of the disperser rotor from 20 to 70 m/s leads to a decrease in the equivalent diameter of the crushed particles and increase the powder dispersion by 35%. The optimal rotor operating speed is 50 m/s. At this speed, energy consumption for grinding dried materials is minimal.

Figure 1 shows the results of the influence of the rotor speed of the dispersant on the dispersion of beet powder in the form of integral and differential distribution curves by fractions.



a) b)

Figure 1. The influence of the rotor speed of the dispersant on the dispersion of beet powder in the form of integral (a) and differential (b) distribution curves by fractions.

One can see that beet powder, regardless of the rotor speed, has a clear maximum, which corresponds to the most probable diameter of the particles. As the rotor speed of the dispersant increases, the mass distribution function corresponding to the most probable distribution increases, i.e., the grinding of the particles is more uniform. Its maximum value corresponds to a rotor speed of 70 m/s, the minimum – 20 m/s; the maximum distribution is 0.08 mm. The distribution function curves at rotor speeds of 40 and 50 m/s are so similar that they are not provided in the graphic illustration for better clarity.

It is established that food powders from vegetable raw materials, including beet, consist of a mixture of particles of different sizes and shapes, which determine their physicochemical and technological properties. Our experience has shown that the particle sizes of powders used in food production should not exceed 0.25 mm. The results of experimental studies on fractionation depending on the load on the sieve and the scattering time show that the yield of the fine fraction of beet powder is more influenced by the scattering time, while the load on the sieve does not significantly affect the particle size distribution.

Figure 2 presents the integral and differential distribution curves of beet powder depending on the scattering time. As the scattering time increases, a larger mass of fine powder falls on the lower sieves and on the integral curves the median moves towards a smaller diameter. However, it is impractical to increase the process duration by more than 3 minutes, because if the scattering time is increased from 2 to 4 minutes, the mass of the fine fraction will increase by only 2…5% (the residue on the 0.25 sieve decreases from 34 to 29%).

On differential curves with increasing scattering time, the maximum of the function $f(d)$ moves to smaller d values. There is a bright maximum of the function $f(d)$, which is the particle size $d = 0.1$ mm, which confirms the data shown in Fig. 1. The yield of the fine fraction of beet powder according to the optimal modes of dispersion and fractionation is 62…65%.

Analyzing the results of fractionation depending on the duration of scattering and other food powders (in particular apple, carrot, pumpkin), it is proved that the regularity of the influence of the process duration on the particle size distribution is similar.

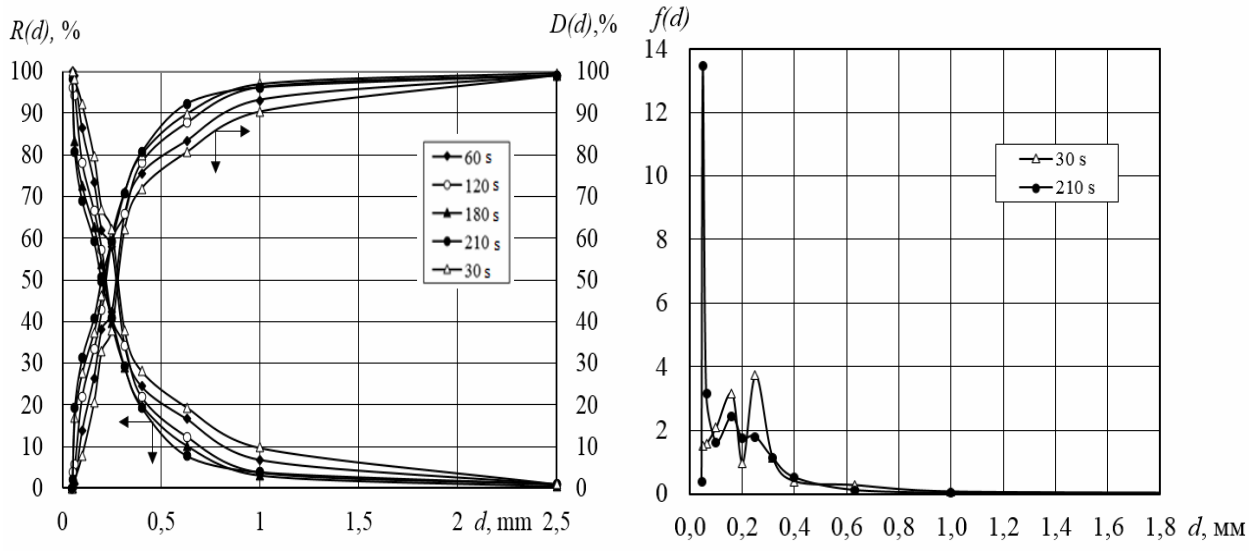


Figure 2. The integral (a) and differential (b) distribution curves of beet powder depending on the scattering time.

Conclusion

According to the results of the research, the optimal dispersion regimes, the dependence of micromill productivity and power consumption on the dispersant rotor speed, as well as the effect of load on the sieve and scattering time of beet powders on the fractionation process are determined.

On the basis of the conducted researches, energy-saving conditions of processes of dispersion and fractionation of pectin-containing powders and proper work of the corresponding equipment are defined.

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