Evaluation of physical properties by using acoustic resonance phenomena for porous food materials

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Abstract

For porous foods such as breads, sponge cakes and whipped creams, their qualities depend on porous properties such as "bulk density" and "texture". However, appropriate method of quantifying them is not well known. We have proposed a novel method for measuring volumes and porous properties of foods by using Helmholtz acoustic resonance phenomenon. In this study, a Helmholtz resonance technique was employed to predict the airflow resistance of layers of granular materials, namely glass beads, brown rice, soybean, adzuki beans and corn kernels. Each granular sample was placed on the tube mouth of an open-type Helmholtz resonator. The resonant frequency was determined by measuring the electric impedance of a loudspeaker that was installed in the resonator and driven by a chirp signal linearly sweeping from 90 to 220 Hz for 6.0 s. For a changing sample layer thickness, the resonant frequency was measured, and the specific airflow resistance was calculated by measuring the static pressure drop required for N2 gas to flow through the layer at a constant velocity of 0.042 m/s. When the thickness of the layer was fixed, the Helmholtz resonant frequency decreased as the specific airflow resistance increased, regardless of the kind of granular material.

Key words: Helmholtz resonance; specific airflow resistance; layer of granular material; dissipation of acoustic energy