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Breakage behaviour of black pepper seed under compression test in cryogenic condition: Numerical analysis

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The cryogenic grinding technique is principally used to obtain high quality of black pepper powder, and the grinding method comprises a combination of different forces. The knowledge of the microstructure of black pepper seeds, under simple compression test, aids in understanding its breakage characteristics. In this study, DEM (Discrete Element Method) was used to simulate the deformation and breakage characteristics of the seed under the cryogenic condition in single particle uniaxial compression test. Hertz-Mindlin with Bonding contact model was used to bond particles with a finite-sized glue bond. Accordingly, a virtual spherical seed (whole particle) to be broken was represented as the cluster of small spherical fraction particles cemented with the finite-sized glue bond. The whole particle was made of a cluster of 255 fraction particles based on the analysis of X-ray micro-computed tomography image of the black pepper seed, and a range of bond parameters was tested by compressing it in between the steel plates. Deformation and breakage properties of the black pepper seeds were also analyzed by physical experiments under standard test conditions (similar to numerical simulations). The qualitative findings: maximum failure force, failure strain, and failure time of physical experiments and numerical simulations were compared to get the calibrated set of bond parameters. Force-deformation curve observed in the real experiments was in good agreement with the numerically analyzed curve for calibrated set of bond parameters. Overall, this study could successfully simulate breaking characteristics of black pepper seed in cryogenic condition, and the results may help researchers in predicting particle breakage characteristics in the cryogenic milling operation.

Biography

Gurveer Kaur is a Research Scholar in Food Process Engineering since 2015 at Agricultural and Food Engineering Department in IIT Kharagpur. She completed her MTech in Food Process Engineering from IIT Kharagpur. Her research interest is mainly on development of low calories dairy products for diabetic and health conscious persons.

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