

## **Abstract**

One of the unfavourable phenomena occurring during the processing of bulk materials is caking. This phenomenon occurs when agglomerates begin to form in powders. Caked material is a sign of poor product quality and is associated with an increased risk of microbiological contamination. The presence of unwanted agglomerates in the stored material carries serious consequences, related to the risk of damage to the walls of the silo, which can even lead to cracking and collapse of the entire structure.

Classical methods of testing bulk materials of plant origin focus on the evaluation of their chemical parameters, physical parameters, as well as the study of their technological properties. The storage conditions of the powder have a significant influence on the above parameters. Among the most important physical factors affecting changes in the properties of bulk materials, especially those of technological importance such as flowability, is a moisture content. Incorrectly adjusted humidity of powder storage can result in reduced flowability and caking of the material. Increased moisture content also results in the risk of microbiological contamination development. In studies on caking, there is still no answer to the question of whether microorganisms can be a factor in the formation of undesirable agglomerates. In addition, the growing interest in bulk materials, as well as the need for strength testing and determination of the agglomeration index, generates the need to search for new measurement techniques.

Therefore, the interdisciplinary topic of assessing the influence of fungi on caking in two powders of agricultural origin, i.e. wheat flour and potato starch, has been undertaken in this dissertation. The influence of moisture content and the presence of fungal microorganisms on the phenomenon of caking has been studied. In the first stage of the study, the material was stored at a relative humidity of 100%. Then a punch test was performed to measure the strength of the caked material and the degree of contamination by fungal microorganisms was determined by colony counting. The experiment had been conducted until mould growth was observed on the surface of the sample. In the second stage of the study, the strength of the agglomerated material was measured and the degree of fungal contamination development was assessed. In this case, the samples were stored at a relative humidity of 75%. This experiment has been conducted for five months. In the next stage of the research, the strength of consolidated food powder samples subjected to consolidation has been determined using a new measurement method and bench for determining strength and degree of caking. A new

measurement procedure has been also developed. The design of the device is based on a modified penetration test and involves measuring the force of pulling the rod out of the consolidated material sample.

The results obtained in the first two stages of the study made it possible to assess the influence of microorganisms on the agglomerate formation process of wheat flour and potato starch. The microbiological analysis made it possible to demonstrate the relationship between the activity of microorganisms and the changes in the strength recorded during the puncture test. Differences were observed in the results obtained for wheat flour and potato starch agglomerates. The results of the preliminary study have become the reason for the creation of a new test stand, enabling the measurement of force changes during the pulling out of the measuring rods with the simultaneous possibility of consolidating the powder with the load and the possibility of moistening the sample. It has been shown that changes in the strength of starch under load are the result of increasing consolidation time. A significant influence on the changes in strength is played by the moisture content in which the material was subjected to consolidation. Analysis of the oscillations observed during the measurements of the rod pulling out force provided information about the effect of time consolidation on the slip-stick phenomenon.

**Keywords:** caking, agglomeration, powder storage, bulk materials, the strength of materials, fungal contamination of bulk material, quality of food powders, punch test, pulled-based method