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Development of an efficient approach to dehull canola seeds on industrial scale

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Background:

Canola is a high functionality crop with high oil (38%-43%) and protein (27%-30%) content. It's commonly used for oil extraction, and the by-product, canola meal, is a good source of protein for both humans and animals. However, the hull is rich in insoluble fibre that greatly affects digestibility. Dehulling before oil extraction can increase product value by removing this fibre.

Objective:

Developing a new dehulling approach that can remove the hull while preserving the kernel's integrity, thereby avoiding any oil loss caused by broken kernels or transfer to the hull. A comprehensive model is developed to simulate and analyse the behaviour of canola during the dehulling processes using milling machine shear and compression.

Methods:

Observing the dehulling process in real-time is difficult due to its instantaneous happening, and measuring internal stresses caused by mechanical effects is challenging due to the biological cell structure. To overcome these problems, the finite element method (FEM) has been widely used as an effective tool for modelling objects, predicting stress, and analysing behaviour, making it a valuable method for obtaining information about the dehulling process. The 3D FEM model consisting of two rollers and a canola seed between them was developed to simulate two dehulling processes: compression and shear. During the compression process, the left roller rotated clockwise while the right roller rotated anticlockwise, resulting in compression forces on the contact area. During the shear process, both rollers rotated either clockwise or anticlockwise, resulting in one compression and one shear force on the contact area. The hull was simplified as an annulus covering the kernel.

Results:

The simulation results show that the shear dehulling process outperforms the compression process due to the two different directional forces that allow the seed to rotate between the rollers, resulting in even stress distribution along the hull. Furthermore, the dehulling mechanisms differ between the two methods: compression forces only crack the seed at the contact area, while shear forces weaken and remove the hull altogether. The compression model also reveals that increasing compression displacement results in plastic deformation from the contact area into the core of the kernel. This indicates that compression forces can cause the kernel to break into pieces from the inside, leading to greater oil loss. On the other hand, the shear force causes less damage to the kernel, indicating that it is a better option for preserving kernel integrity and minimizing oil loss.

Conclusions:

Dehulling canola seeds before oil extraction improves the quality and colour of the crude oil and increases the protein content in the by-product, canola meal, from 35% to 50%, while reducing the fibre content from 11% to 6%. The scientific significance of this research may improve our understanding of the mechanism behind the behaviour of seeds in different dehulling processes. The technology to be developed will have strong impact to the capacity of producing the products such as human-consumed oil, biofuel, and canola meal in the world market. This research will also contribute to the sustainability of agriculture and food production.