Mariusz Soszka
Nutrition Advisor

Ostrówek

Micronization

Among the many processing operations that significantly affect the physical and chemical properties of components in feed rations and compound feeds, micronization deserves attention. Widely used for decades in the food industry, this technology is increasingly applied to feed materials and compound feed production worldwide, and more recently on a broad scale in Poland.

To increase digestibility, bioavailability, and safety of feed materials, processing is often required. In addition to cleaning, dehulling, grinding, conditioning, pelleting, and expanding, micronization is being adopted more widely as a method for upgrading seeds for both food and feed purposes. Developed by the UK company Micronizing in the 1970s, the method rapidly gained popularity—initially in the food sector and later in feeds. By 1986 approximately 150 lines had been sold. Today, numerous micronizers operate globally, making micronization one of the most common techniques for upgrading seeds.

What Is Micronization?

Micronization is a thermal treatment applied to food—and increasingly feed—raw materials. Whole or pre-processed (e.g., dehulled or ground) cereal grains, oilseeds, extraction meals, and other feed materials are exposed to infrared radiation with a wavelength of 1.8–3.4 µm. The radiation excites the material's molecules, inducing vibration and friction, which rapidly raise temperature and internal steam pressure within particles. The material temperature rises to about 90 °C within 50 s, to 110–130 °C within 90 s, and with longer exposure can reach 230–250 °C. Exposure is short—typically 45–90 s depending on the material. Cereal grains irradiated for ~50 s achieve starch gelatinisation. After leaving the micronizer, the product is rapidly cooled and commonly flaked.

Micronization belongs to HTST (high-temperature, short-time) processes: the material is heated for tens of seconds to high temperature (above 130 °C) and then cooled.

Micronizer Line — Basic Design

A standard line includes: infeed equipment, feed hopper, conveyor belt transporting material through the heating zone, IR emitters, and downstream equipment for cooling, size reduction, and conveying to further processing or bagging. Prior to the micronizer, material is often thoroughly cleaned and moistened to 17–20%, then irradiated for 45–90 s. After cooling, it is typically flaked and conveyed onwards. A standard line includes: infeed equipment, feed hopper, conveyor belt transporting material through the heating zone, IR emitters, and downstream equipment for cooling, size reduction, and conveying to further processing or bagging. Prior to the micronizer, material is often thoroughly cleaned and moistened to 17–20%, then irradiated for 45–90 s. After cooling, it is typically flaked and conveyed onwards. Cereal grains, for example, are irradiated for about 50 seconds, after which starch gelatinization occurs in the kernels. Upon leaving the micronizer, the feed material is rapidly cooled and most commonly flaked.

Micronization belongs to the group of processes known as HTST (high temperature–short time), i.e., the feed material is heated for several tens of seconds to a high temperature (above 130 °C) and then cooled.

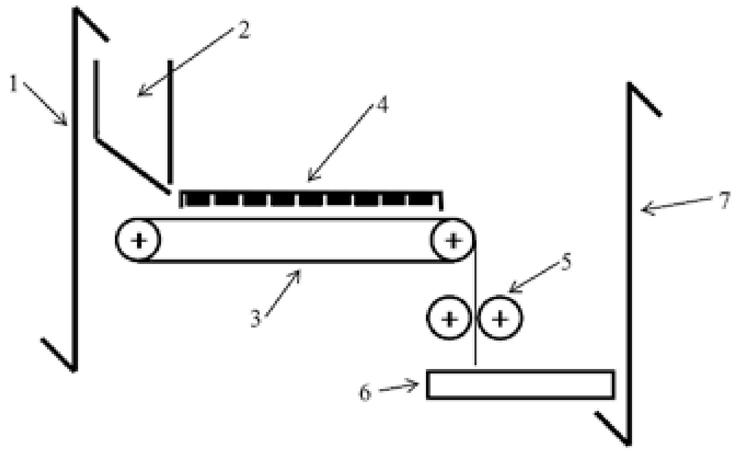
Micronizer design

A standard micronization line consists of several basic elements, including: equipment delivering the feed material to the micronizer, a feed hopper, a belt conveying the feed material through the heating zone, infrared emitters, and assemblies of machines and devices for cooling and size reduction of the feed material, as well as for conveying it to subsequent production stages or to bagging.

Before the feed material is introduced into the micronizer, it is often thoroughly cleaned and moistened to 17–20%, after which the moistened material is carried by a conveyor to the micronizer hopper and from the hopper into the unit, where it is exposed to radiation for 45–90 s. Upon leaving the micronizer, the hot feed material enters a cooler for rapid cooling and then most commonly passes to flaking rolls and on to the production line.

In many cases, the individual components of a micronization line are highly advanced machines and devices. The description presented here is, of course, a simplified schematic.

Fig. 1. Micronizer schematic:



1 — bucket elevator; 2 — feed hopper; 3 — belt conveying the feed material through the heating zone; 4 — infrared radiation source; 5 — flaking rolls; 6 — cooling conveyor; 7 — conveyor to the bagging machine.

Infrared radiation sources

In micronization, infrared radiation emitted by specialised infrared emitters is used; depending on the type and level of sophistication of the micronizer, these are most commonly heated ceramic plates or electric emitters. By energy source, emitters can be divided into electric and gas-fired. In electric emitters, radiant energy is generated from heat produced in a resistive heating element by electric current. In gas emitters, radiant energy arises from gas combustion. The key element of a gas emitter is a ceramic plate with fine perforations. A gas–air mixture is supplied to the plate through dedicated lines; after passing through the perforations, it combusts, raising the plate-surface temperature to 850–900 °C and causing infrared emission.

Among electric emitters, lamp-type units with tungsten filaments and reflectors are most common. Studies show that such emitters convert up to 65% of input power into infrared radiation. Modern micronizers also employ quartz emitters with tungsten filaments and halogen lamps.

Emitters can additionally be classified as follows:

- by shape: point, linear, and planar;
- by spectral range and filament temperature: emitters of dark radiation (filament temperature ≤ 1000 °C) and bright radiation (filament temperature > 1000 °C);
- by method of radiation generation: thermal, luminescent, and laser;
- by spectral character: non-selective and selective.

Applications

As one might expect, micronization—like any advanced processing of feed materials—entails a considerable cost; therefore, compound-feed manufacturers carefully analyse the effects, costs, and the advisability of its use. In the feed industry, it has long been considered appropriate to apply micronization in specialist feeds, particularly prestarters, dietary and high-energy feeds, and muesli-type mixes. Micronization is also successfully used to process full-fat oilseeds, mainly soy. It is likewise applied as a treatment to reduce antinutritional substances and to prevent the development of fungi and moulds in all types of feed materials.

Physicochemical changes in raw materials subjected to micronization

Feed materials subjected to micronization undergo fundamental transformations due to infrared radiation, which raises temperature and the vapour pressure within the kernels. According to available research, micronization results in:

- a decrease in the mechanical strength of the seed coats due to rupture of cell walls;
- complete starch gelatinisation;
- destruction of antinutritional constituents;
- improved digestibility of starch and protein;
- denaturation and inactivation of enzymes: urease, lipase, amylase, trypsin inhibitor;
- increased stability of feed materials;
- sterilisation (destruction of bacteria, viruses, moulds, and yeasts).

The magnitude of these effects depends on the properties of the processed feed material and on the duration and parameters of treatment. Collectively, they enhance the safety and hygienic quality of feed materials, improve palatability and feed intake, and increase digestibility—thereby accelerating growth and improving feed efficiency.

Metabolisable energy (ME)

Studies show that micronized feed materials exhibit a higher metabolisable energy content than the same untreated feed materials.

Table 1. Change in the energy content of cereals as a result of micronization (Zawiślak, 2004).

Feed material	Untreated grain (MJ ME)	Micronized grain (MJ ME)
Wheat	12.9	14.4
Barley	11.5	13.7
Maize	14.3	15.75

Energy is, as we know, currently the most expensive component of a compound feed, and its value derives from the amount of available carbohydrates—mainly starch—and fat supplied by the mix. Cereals play a virtually primary role in balancing diets for livestock. They contribute a substantial content of minerals and valuable energy in the form of starch. It should be noted, however, that the starch present in raw, untreated grains is largely unavailable and poorly assimilated, especially by young animals whose gastrointestinal tract is not yet fully developed and whose enzymatic system is still maturing.

Prestarter mixes, despite a high inclusion of animal-derived products, also contain cereals, full-fat pulses, and extraction meals, all of which contain starch. Subjecting these components to micronisation causes starch gelatinisation—i.e., disruption of its particles through destruction of granule structure and opening of molecular chains previously bound in a tightly packed, highly branched arrangement. Infrared emitters cause the starch to soften, swell, crack, and gelatinise. This enables the starch particles to be converted into easily accessible simple sugars and disaccharides that are much more readily digested by young animals. As a result, the feed material becomes more palatable and is taken more willingly, while starch is markedly better digested and absorbed.

Table 2. Change in the level of starch digestibility (%) in cereals as a result of micronisation (data provided by Michel company Śmigło).

Feed material	Untreated (%)	Micronized (%)
Barley	35	98
Wheat	28	90
Maize	43	92

Micronization also increases the amount and availability of fat in the intestinal lumen of animals, because the high processing temperature inactivates lipases and lipoxygenases in the processed feed material—enzymes responsible for lipid degradation.

Protein

Total crude-protein content is essentially unchanged, but—as with most thermal processes—the amount of digestible protein increases (by ~10% and more in high-protein materials). High temperature breaks intermolecular bonds (between amino acids) without destroying amino acids, unfolding proteins and improving utilisation. Micronizer performance and operator expertise are key to quality.

Processing temperature causes protein denaturation—particularly useful for oilseeds, cakes, and extraction meals—and inactivates enzymes and antinutritional factors. In soy, urease activity is eliminated and trypsin inhibitors are deactivated, increasing trypsin activity and protein hydrolysis. Micronization imparts a pleasant, ‘nutty’ flavour, improving intake.

Summary

To improve production outcomes, feed manufacturers adopt advanced processing to enhance digestibility and bioavailability. Although not inexpensive, micronization benefits health and performance—especially in pigs (notably piglets)—where it has long been used in Western Europe and, more recently, in Poland. Micronized products offer higher nutritive value and digestibility, superior palatability, and microbiological safety.