



This project received funding from the European Union's Horizon 2020 Research and Innovation program under Grant Agreement n° 727848.



WHEAT caryopsis (*Triticum durum*; *Triticum vulgare*), caryopsis photo and profile

Industrial production processes of flours from modern varieties compromise their nutritional qualities and have negative health effects in individuals with food intolerance.

Contents

A **caryopsis**, or grain, is a dry indehiscent **fruit**, a monocarpellate specific to the Gramineae family. It is made up of an outer husk (the fibrous **seed capsule**), composed of several layers of cells rich in cellulose. Underneath the seed capsule we find the **seed** itself – the endocarp, whose outer layer is made up of so-called **aleurone** cells and whose inner portion, called the **endosperm starch**, is rich in starch and proteins. At one of the extremities of the caryopsis is located the **germ**, which is very rich in oil, vitamins and minerals. With respect to the entire caryopsis, the germ indeed contains 12% of total minerals, 64% of vitamin B1, 26% of vitamin B2 and 21% of vitamin B6.

Flours The milling industry bases its operations on the possibility of mechanically separating the endosperm from the other parts of the caryopsis. Milling of the wheat produces flours suitable for their further transformation into pasta, bread and other baked goods. The quality of milled grains is linked both to the quality of the wheat used and to the milling techniques, and hence to the type of mill employed (**stone or cylinder**).

Flour is the product obtained from milling and **sifting** the wheat, which is freed from the seed capsule and from impurities. The sifting ratio of flour is indicated by the quantity produced (in kg) for every 100 kg of wheat.

The sifting process determines the various types of industrial flours suitable for different uses. The most refined flour, called "**superfine**", is composed almost exclusively of starch and gluten proteins; it is poor in soluble proteins, vitamins and fiber. In **industrial milling**, the germ is always removed from the caryopsis. This choice is due to the latter's high content of lipids and enzymes, which promote rancidification processes. By decreasing the degree of refining, one obtains flours which are less white but richer in secondary components: cellulose, fibers, oils and complex proteins. Whole grain flour, which contains the germ, is the most complete type from a nutritional point of view.

Flour quality and health

Over time, regular consumption of flour containing high-tenacity gluten (which comes, for example, from modern "high-strength" varieties for industrial use) causes intolerance to this protein. Epidemiologic studies have shown a considerable increase in gluten sensitivity (GS), whose common symptoms are abdominal bloating, joint pain and migraines. In addition, there has been an increase in early manifestations of celiac disease, an intestinal disorder linked to consumption of gluten in individuals with genetic predisposition.

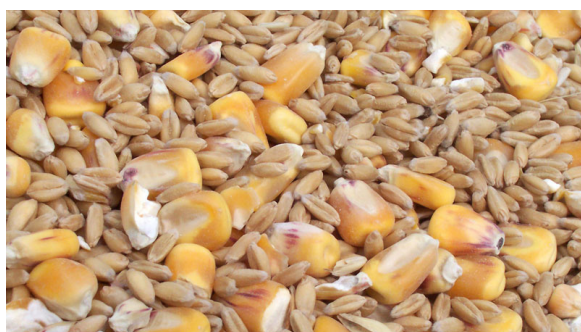
Flours obtained from local varieties do not contain less gluten than "modern" types; rather, they have fewer epitopes, the antigens responsible for the chronic inflammatory state of the intestinal epithelium.

Consumption of "more complex" flour types from local wheat varieties – which were selected before the advent of industrialized agriculture and stone-milled according to artisanal methods, with less refining – has positive health effects. This is because caryopses are composed not only of starch and proteins but also of other biologically active substances, such as polyphenols (flavonoids, lignans and isoflavonoids), carotenoids, tocopherols and fiber. In particular, these substances activate metabolic responses for the protection and the reduction of inflammation,

which is a precursor of complex and chronic pathologies (including cardiovascular diseases and diabetes); they improve sugar and fat metabolism by reducing their absorption velocity; and they are richer in essential amino acids, inulin and antioxidants.

Gluten

Gluten represents roughly 80% of the total proteins of endosperm starch. Through the hydration of flour, gliadins and glutenins join to form chemical bonds. Gliadins bind together to form tenacious fibrils, which give gluten its extensible character. Glutenins bind together to produce fibers, which in their hydrated state form a stable and very cohesive structure, which resists extension. Starch granules and air cavities become trapped in the mesh structure, allowing the diffusion of the CO₂ produced by dough fermentation.



Caryopsis

Rheological trials

In industrial transformation, it is important to first verify the suitability of different flours for different uses (bread, cookies, etc.). For this reason, several tests have been perfected that determine their technological characteristics.

Falling number (FN) is used to evaluate alpha-amylase activity: this number is inversely proportional to amylase activity, with an optimal value of 250. FN > 300 indicates very weak alpha-amylase activity; for 200 < FN < 250, activity is "normal", while FN < 200 denotes very high activity.

Farinograph This instrument provides information on the quantity of water necessary to produce optimal consistency and on the duration of the dough's stability.

Chopin Alveograph This tool measures strength and extensibility through the plasticity reactions of the flour. The resulting graph indicates three levels of a dough: its resistance to stretching (P), its extensibility (L) and its strength (W). The P/L alveograph ratio is a quite important datum, while the W value indicates the flour's strength. In industrial production, a W level equal to or greater than 250 and a P/L ratio above 0.80 designate a strong flour (for bread and pasta), while W below 180 and P/L below 0.5 denote a weak flour (for cookies).

FLOUR: STAGES IN OBTAINING FLOUR FROM CARYOPSES

- CLEANING: the process of removing dust and contaminants from other seeds by means of vacuuming and winnowing, followed by storage.
- CONDITIONING: a further cleaning stage is followed by humidification (conditioning), in which water is added. This operation serves to facilitate the separation of the endosperm from the husk.
- MILLING: this stage is carried out with cylinder and stone mills; with the former, the flour be may be milled a second time.
- SIFTING: the milled wheat is gradually sifted to obtain flours of various degrees of fineness by using different sieves and meshes.

References

Health-promoting phytochemicals of Italian common wheat varieties grown under low-input agricultural management