

(*Fagopyrum tataricum*) have shown that different milling fractions, including flour, semolina, bran, and husk layers, vary considerably in nutrient composition. Protein, lipid, mineral, and antioxidant-related compounds are unevenly distributed among these fractions, with bran and coarse fractions generally containing higher concentrations of nutritionally valuable compounds (Sinkovič et al., 2022) (Figure 1).

Buckwheat protein is especially important because it is naturally gluten-free and contains a relatively balanced essential amino acid profile compared with many cereal grains. However, its digestibility and functional properties may change depending on processing conditions and the surrounding food matrix. Dietary fiber further strengthens the value of buckwheat as a functional food ingredient. In both common buckwheat and Tartary buckwheat, fiber-rich fractions such as bran often contain higher levels of bioactive compounds than refined flour fractions. As a result, less refined buckwheat products are usually considered nutritionally superior to highly processed forms.



Figure 1 Representative samples of common buckwheat (*Fagopyrum esculentum* Moench) and Tartary buckwheat (*Fagopyrum tataricum* (L.) Gaertn.) whole grain and seven grain fractions obtained by traditional stone-milling (Adapted from Sinkovič et al., 2022)

3.2 Vitamins, minerals, and essential amino acids

Buckwheat is considered a good source of minerals such as magnesium, phosphorus, iron, zinc, and potassium. It also contains vitamins and has a more balanced amino acid composition than many refined cereal products. These nutritional advantages are especially important in gluten-free food systems, where products based mainly on rice flour or purified starches often show nutritional limitations.

Research on bread fortification demonstrated that the addition of buckwheat flour increased protein content, improved amino acid scores relative to wheat bread, and enhanced antioxidant properties as well as inositol phosphate levels (Kowalski et al., 2022). Both common buckwheat and Tartary buckwheat contribute nutritional benefits, although Tartary buckwheat is generally associated with higher levels of bioactive compounds. The amino acid quality of buckwheat proteins makes them valuable in the development of nutritionally improved gluten-free foods, where protein quality is often a major concern.

3.3 Bioactive compounds: rutin, quercetin, flavonoids, and polyphenols

The biological value of buckwheat is closely related to its flavonoid composition. Rutin is the best-known compound, but the phytochemical profile of buckwheat is much more complex. In addition to rutin, buckwheat contains quercetin, orientin, isoorientin, vitexin, isovitexin, phenolic acids, fagopyritols, D-chiro-inositol derivatives, bioactive peptides, and other specialized metabolites. Tartary buckwheat usually contains much higher rutin concentrations than common buckwheat, which is one reason why Tartary buckwheat is more frequently studied for medicinal and functional food applications. However, processing conditions and the activity of endogenous rutinase can strongly influence rutin retention in final products (Wang et al., 2024).