

different stone-milled fractions from common buckwheat and Tartary buckwheat and showed clear differences in mineral composition, nutritional value, and bioactive compound distribution among milling fractions. Their study demonstrated that flour fractionation can significantly affect the nutritional and functional quality of buckwheat foods.

4.3 Fermented buckwheat products and beverages

Buckwheat naturally has a strong cereal-like, nutty, and sometimes slightly bitter flavor. Some consumers consider the taste too heavy or coarse. Fermentation with lactic acid bacteria, yeasts, or mixed microbial cultures can modify sugars, proteins, and phenolic compounds in buckwheat substrates, improving acidity, aroma, and texture. Fermentation can also reduce the effects of certain antinutritional factors and promote the release of proteins and phenolic substances.

Matejčková et al. (2017) developed a fermented probiotic product using buckwheat substrate and *Lactobacillus rhamnosus*. Their results showed that buckwheat could support probiotic growth and maintain product stability during fermentation. Compared with traditional dairy-based probiotic foods, fermented buckwheat products have advantages such as being gluten-free, plant-based, and nutritionally complex. These characteristics make them suitable for lactose-intolerant individuals, vegetarian consumers, and people interested in gut health. Therefore, the significance of fermented buckwheat foods is not limited to flavor improvement or shelf-life extension; fermentation also increases the value of buckwheat as a functional food carrier.

Xiao et al. (2024) investigated the addition of Tartary buckwheat to kombucha fermentation systems. The study showed that Tartary buckwheat significantly increased total phenolics, total flavonoids, and rutin content in the beverage, while also improving DPPH and ABTS radical scavenging activity. This suggests that Tartary buckwheat not only contributes more phytochemicals to the fermentation system, but may also promote the release of bound phenolic compounds during microbial fermentation. After proper formulation adjustment, the addition of Tartary buckwheat did not significantly reduce sensory acceptance. Instead, its cereal and mild nutty aroma complemented the sweet-sour flavor of fruit kombucha, and some treatment groups achieved higher sensory scores than traditional kombucha products.

4.4 Gluten-free and functional food development

The value of buckwheat in gluten-free food development is not only related to the absence of gluten. Buckwheat also has higher nutritional density than many gluten-free products based mainly on corn starch, potato starch, or refined rice flour. Many commercial gluten-free foods meet the basic dietary needs of people with celiac disease or gluten sensitivity, but they are often low in protein, dietary fiber, and minerals, while producing relatively high glycemic responses.

The incorporation of buckwheat flour can significantly improve total phenolic content and antioxidant activity in gluten-free bread, while also enhancing protein, dietary fiber, and functional phytochemical composition compared with conventional starch-based gluten-free formulations (Brites et al., 2022). Both common buckwheat and Tartary buckwheat contain rutin, phenolic compounds, and antioxidant substances that help compensate for the “high starch and low nutritional density” problem common in many commercial gluten-free products. However, increasing the proportion of buckwheat flour also affects bread volume, crumb structure, and texture stability. Since buckwheat lacks a gluten network, dough gas retention becomes weaker. Industrial application therefore requires the use of hydrocolloids, composite starch systems, and optimized processing conditions to balance nutritional quality and processing performance.

Buckwheat has even greater potential in biscuits, cookies, and snack products. Compared with bread, these products depend less on gluten structure and can tolerate higher levels of buckwheat flour. Buckwheat flour can be blended with almond flour, oat flour, quinoa flour, or rice flour to improve flavor, texture, and nutritional composition. In many cases, the darker color and nutty flavor of buckwheat become sensory advantages rather than limitations, especially in low-sugar, high-fiber, plant-based, or functional snack products.