

The distribution of these compounds is highly tissue-specific. Flowers, leaves, bran, and some coarse milling fractions generally contain higher concentrations of flavonoids and polyphenols than refined flour. This uneven distribution means that nutritional quality is closely connected with processing methods and fraction selection. In recent years, rutin content has become not only a nutritional trait but also an important target in breeding and metabolic regulation research, especially in Tartary buckwheat improvement programs focused on functional food development.

4 Processing Technologies and Food Applications

4.1 Traditional buckwheat foods in different cultures

Traditional buckwheat foods are not simply “coarse grain foods.” They developed through the interaction of climate, religion, ethnic dietary habits, and local processing techniques in different regions. In Japan, the most representative buckwheat food is soba noodles, which are mainly made from common buckwheat (*Fagopyrum esculentum*). Traditional soba usually contains a certain proportion of wheat flour because pure buckwheat dough lacks gluten and breaks easily during processing. According to the Japanese Ministry of Agriculture, Forestry and Fisheries, soba is regarded as a traditional regional food closely linked with local identity. In Nagano, Yamagata, and Hokkaido, soba is not only consumed as a daily staple food, but is also connected with tourism, hand-made noodle experiences, and seasonal festivals.

In Europe, especially in the Brittany region of France, buckwheat has long been known as “blé noir” or “sarrasin.” Common buckwheat flour is traditionally used to prepare savory galettes. Today, galettes are still promoted by regional tourism authorities as a typical local specialty food. In Eastern Europe and Slavic regions, roasted buckwheat groats are commonly processed into kasha, a porridge-like or rice-like dish made from whole buckwheat kernels. Compared with Japanese soba, these foods are relatively simple in processing, but they are highly filling and suitable for long-term storage, which matched the dietary needs of traditional agricultural societies in cold regions.

In South Asia, buckwheat has a different cultural role. During religious fasting festivals such as Navaratri and Shivratri, people in northern India commonly consume buckwheat flour known as kuttu ka atta. Since buckwheat is not classified as a conventional cereal grain in Hindu dietary practice, it can be consumed during fasting periods when grains are prohibited. Therefore, the cultural importance of buckwheat in this context comes not only from nutrition, but also from its acceptance within religious dietary systems. In Nepal, Bhutan, and Himalayan mountain regions, both common buckwheat and Tartary buckwheat (*Fagopyrum tataricum*) are used to prepare flatbreads, noodle soups, and local traditional foods. These products are closely associated with high-altitude agriculture, short growing seasons, and local mountain lifestyles.

4.2 Buckwheat flour and noodle processing technologies

The main challenge in buckwheat flour processing is that buckwheat proteins cannot form the three-dimensional elastic gluten network found in wheat dough. In wheat flour, glutenins and gliadins interact after water addition and kneading, producing a viscoelastic structure that gives dough strength and extensibility. Buckwheat proteins have relatively high nutritional quality, but they cannot provide the same structural support. As the proportion of buckwheat flour increases in noodles, pasta, and bread products, problems such as strand breakage, higher cooking loss, rough texture, and reduced elasticity become more common.

De Arcangelis et al. (2020) studied gluten-free buckwheat pasta and found that proper control of starch pre-gelatinization improved product structure and cooking quality. In the absence of a gluten network, buckwheat products rely more heavily on starch gelatinization, protein gel formation, or external structuring agents to maintain processing stability.

The particle size, dehulling degree, and milling method of buckwheat flour also strongly influence final product quality. Whole buckwheat flour retains more dietary fiber, minerals, and phenolic compounds, but it usually produces darker color and rougher texture, and may weaken dough-forming properties. Refined flour has better sensory acceptance, but some nutritional compounds are lost during processing. Sinkovič et al. (2021) analyzed