5 Nutritional Value and Feed Utilization

5.1 Nutritional composition of buckwheat straw, grain, and by-products

Buckwheat grains contain starch, protein, lipids, minerals, and moderate amounts of dietary fiber, making them suitable as both energy and protein feed resources. Common buckwheat (*Fagopyrum esculentum*) is more frequently used in grain-based feed formulations because of its relatively mild flavor and broader cultivation scale, whereas Tartary buckwheat (*Fagopyrum tataricum*) has attracted more attention for functional feed applications due to its high flavonoid content, especially rutin. In contrast, buckwheat bran, hulls, and processing by-products contain higher levels of cellulose, hemicellulose, lignin, and phenolic compounds. Although their digestibility is lower than that of grains, these by-products still have value in ruminant roughage systems and in the development of functional feed additives. Tartary buckwheat by-products are particularly rich in rutin, quercetin, and other polyphenols, which may help regulate oxidative stress, intestinal microbiota, and inflammatory responses in animals.

The use of buckwheat straw as roughage is mainly limited by its relatively high degree of lignification and fiber accumulation. Untreated straw is hard in texture, has poor palatability, and is not easily degraded by rumen microorganisms. This is one reason why buckwheat straw has not been widely utilized in animal production systems for a long time. Cao et al. (2023) investigated the effects of extrusion processing on the physical structure, chemical composition, and in vitro ruminal digestibility of buckwheat straw (Figure 2). Their results showed that extrusion treatment changed the structural characteristics of the straw, reduced hardness and chewiness, and improved water-holding capacity and ruminal degradation performance. The treatment also increased the accessibility of structural carbohydrates to rumen microorganisms, suggesting that suitable physical processing can improve the feeding value of buckwheat straw.

Different buckwheat components therefore have different feeding roles. Grains are more suitable as energy and protein sources in compound feed and may partially replace conventional cereal ingredients. Bran and hulls are more appropriate as sources of dietary fiber, antioxidant compounds, and phytochemicals. Straw should preferably enter roughage systems after extrusion, fermentation, alkalization, or microbial treatment. Compared with major feed crops such as maize, wheat, and soybean, buckwheat does not have a clear advantage for large-scale substitution. However, it has more specific value in specialty feeds, functional feed additives, and regional circular agriculture systems, especially in mountainous areas where cultivated buckwheat species are already part of traditional farming systems.

5.2 Digestibility and feed efficiency in livestock

Buckwheat grains contain relatively high-quality proteins and minerals, but the higher levels of fiber and phenolic compounds in hulls, bran, and some by-products may influence nutrient digestion and absorption. In studies involving weaned piglets, Cui et al. (2019) evaluated the combined effects of Tartary buckwheat flavonoids and Lactobacillus plantarum. The combination improved growth performance, nutrient digestibility, antioxidant status, and fecal microbial composition in weaned piglets. Their findings suggested that Tartary buckwheat flavonoids do not function simply as nutrient sources. Instead, they may support animal performance through antioxidant activity and regulation of intestinal microecology. This is especially important in weaned piglets because intestinal barrier function is still unstable during the post-weaning stage, and oxidative stress together with microbial imbalance can negatively affect growth and health.

Buckwheat has also been studied in poultry nutrition. Chowdhury and Koh (2018) examined the effects of buckwheat-based diets on phytase activity and nutrient digestibility in broiler chickens. Birds fed buckwheat-containing diets showed significantly higher natural phytase activity in the digestive tract, particularly in the crop and gizzard. The increased phytase activity promoted phytate degradation and released bound phosphorus, calcium, and other minerals, thereby improving phosphorus bioavailability and ileal nutrient digestibility. Compared with conventional corn–soybean meal diets, the buckwheat diets increased phosphorus digestibility and also improved the apparent digestibility of crude protein and several amino acids. The study indicated that buckwheat can function as a natural phytase source under low-phosphorus feeding conditions and