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## Utilisation of agri-food by-products as sources of functional food ingredients in sub-Saharan Africa

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### Abstract

Food processing in most sub-Saharan African countries is semi-mechanized resulting into generation of abundant agri-food by-products. The by-products are produced at the household or community level during primary processing activities like milling, peeling, drying, brewing, and oil extraction. However, these agri-food by-products are frequently underutilized, discarded as waste or downgraded to low-value uses due to lack of knowledge and technology resulting into loss of potentially valuable resources. Despite, the growing recognition of the potential of agri-food by-products, previous studies have explored their utilization from isolated perspectives such as food ingredients, wastewater treatment and food security. Whilst these studies provide valuable insights, they often miss to capture the synergies and trade-offs within the Water-Energy-Food (WEF) nexus. Therefore, a systematic review was carried out to identify major agri-food by-products and their utilisation pathways that can contribute to water sustainability, renewable energy production and food security (WEF nexus). A systematic literature search was conducted in three main data bases, PubMed, Science direct and Google Scholar for studies published between 2020 and 2026 focusing on Agri-food by-products. The review followed PRISMA 2020 guidelines and 57 eligible studies met the inclusion criteria and were included in the review. The synthesis indicated that residues like cereal brans/husks, roots and tuber peels, fruit peels/kernels, oil-seed residues, and brewery extracts are the main by-products produced within most households in sub-Sahara Africa. The review highlighted that these agri-food by-products contain higher bioactive concentrations than edible fractions contributing to food and nutrition security. In addition, these by products can be converted into biogas to produce renewable source of energy (biogas) for the poor resourced farmers as well as contributing to wastewater treatment using products like biochar and biosorbents. Therefore, instead of focusing on a single benefit of the agri-food by-products there is need to integrate them within the Water-Energy-Food (WEF) nexus framework to ensure efficient resource use and combined benefits in a sustainable manner that support the African communities. However, knowledge and technical gap exist which need to be addressed by raising awareness, government support on technical training and development of technologies that are tailor made for African communities.

**Keywords:** Agri-food by products, circular economy, functional food ingredients, gender equity, small-holders, sub-Saharan Africa