

Food Industries By-Products as Modulators of Gut Microbiota: Challenges and Perspectives

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Nowadays, special attention is being given to the study of the brain-gut axis focusing on the gut microbiota and on how it can influence the health of human beings or even cause various diseases. Researchers worldwide have been evaluating the gut microbiota and how specific diets can significantly affect its composition.

It is known that the human large intestine is an extremely active fermentation site and is inhabited by different bacterial species, reaching their highest concentrations in the colon [1]. Not only does the composition of this bacterial ecosystem vary substantially among individuals, it is also dynamic and susceptible to changes induced by dietary factors and diverse disease conditions [1]. A balanced gut microbiota composition confers benefits to the host, whereas microbial imbalances are associated with metabolically mediated disorders [1]. There is now mounting evidence from studies on humans and germ-free mice that supports these speculations [2]. Microflora that play an important physiological role in the adult colon are *Bacteroides*, which constitute around 30% of all bacteria in the gut, followed by *Clostridium*, *Prevotella*, *Eubacterium*, *Ruminococcus*, *Fusobacterium*, *Peptococcus*, and *Bifidobacterium*. *Escherichia* and *Lactobacillus* are also present, but to a lesser extent [3,4].

It has been reported that diet has a major influence on gut microbiota, thus, levels of *Prevotella* are enriched in people who have had a high-fiber diet and in those whose diet is dominated by plant-derived polysaccharide foods such as maize and cassava [4]. By contrast, the microbiota of people with a long-term diet rich in

animal protein and saturated fat has more Bacteroides [4]. Fiber content of the diet can explain these changes [5].

Phytochemicals, and particularly polyphenols, have been suggested to affect the relative viability of colonic bacterial groups, implying that dietary modulation with polyphenols may play a role in reshaping the gut microbial community and enhance host-microbial interactions to provide beneficial effects [6]. Thus, polyphenols could be considered to have a prebiotic action. The prebiotic effect is defined as the selective stimulation of growth and/or activity of one or more microbial species in the gut microbiota that confer health benefits to the host [7].

Food industries produce large quantities of by-products, which are an environmental problem if they do not enter in the so-called circular economy. The production of fruit juices, wine and beer are examples of industrial processes that generate considerable amounts of by-products, like diverse types of pomace, which can be used as potential raw-materials to extract bioactive compounds, mostly polyphenols, a potential source of prebiotics.

Several studies have reported the prebiotic potential and the consequent beneficial impact on gut microbiota composition of brewer spent grain [8], cranberries [9], wine pomace [10] and other polyphenol-rich dietary sources [4,6].

The food industries should now try to develop new and improved products that reuse those by-products. Since natural-derived products are commonly better accepted by the consumers due to their perceived safety, together with the known beneficial effects to the gut microbiota and consequently to human health, a major challenge will be the design of industrial strategies capable of extracting bioactive compounds from by-products or including them in finished food products.

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