

## Recent patents on the application of bioactive compounds in food: a short review

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Food bioactive compounds are natural components that have biological activity and in some instances provide nutritional value. They play an important role in the community health and safety due to confirmed roles in human growth and development, besides reducing disease risks. The use of bioactive compounds needs the use of appropriate and standard extraction methods of these compounds. In the industrial food category, food and beverages, nutraceuticals and animal feed products have the fastest growing, with strong consumer interest in energy enhancing, anti-aging, general well-being properties and relaxing products. The increased interest for these products could benefit both consumers and the industry, through contributions to improve consumers' quality of life, adding value to industrial residues and generating more patents in these sectors.

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### Introduction

During the last two decades the food industry has invested a lot of efforts in research and development of healthier and more nutritious food [1]. These foods are frequently referred as functional, when they comprise nutritional components required for human's healthy survival, or nutraceuticals, when the aim is to treat/prevent a disease or disorder [2], with various reported bioactive functions (e.g., antioxidants, antimicrobials, immunomodulators, hypocholesterolemic, etc.), many times due to the incorporation of functional enzymes,

probiotics, prebiotics, fibers, phytosterols, peptides, proteins, isoflavones, saponins, phytic acid, etc. [3].

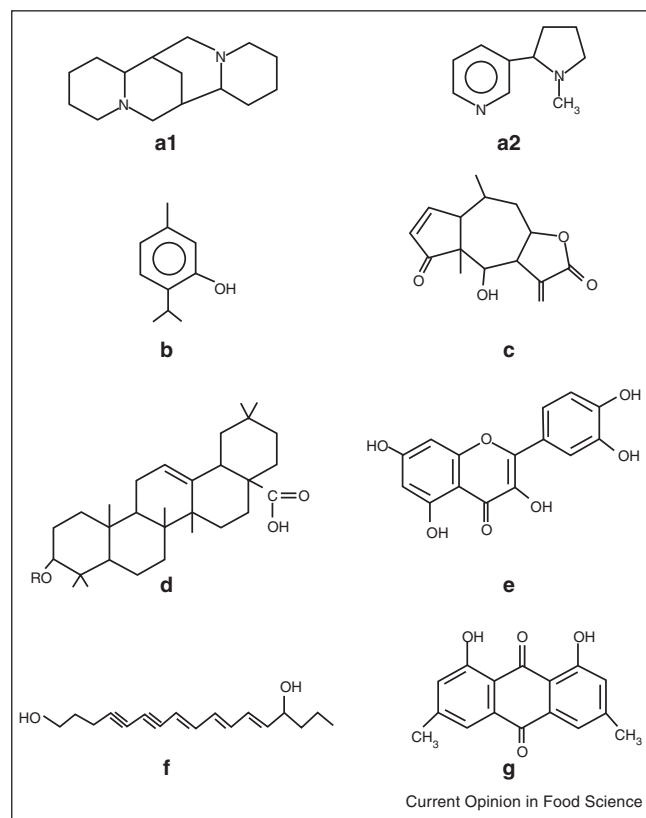
Several agricultural and industrial residues represent a great alternative as raw material of bioactive compounds production and have been studied as sources of potentially safe natural additives with antimicrobial and/or antioxidant properties for the food industry [4].

Plant extracts containing bioactive compounds can be used as functional food ingredients or to production of medicines and cosmetics [5]. Currently, more than 80% food active compounds and more than 30% drugs are produced from bioactive natural products [6]. The bioactive compounds are produced as secondary metabolites, defined as substances that have effect on biological systems [6,7], which are divided into three main categories (Figure 1): terpenes and terpenoids, alkaloids and phenolic compounds [7].

Usually, bioactive compounds are recovered from different natural sources by solvent extraction technique [8]. Important factors in the process are solvent type, extraction time and temperature [9]. Solvents or co solvents with different polarities such as ethanol and water [5,10,11] and/or organic solvents [4,6,7] can be employed for solid–liquid extractions in heat–reflux systems. Furthermore, non-conventional methods (ultrasound, pulsed electric field, enzyme digestion, extrusion, microwave heating, ohmic heating, supercritical fluids) are more environment friendly due to decreased use of synthetic and organic chemicals and reduced operational time, enhancing extract yield and quality [9].

The compounds extracted are directly added into the food to develop a product. Sometimes, the delivering system can be required to ensure the effectiveness of the compound, avoiding the destruction and oxidation due to some environmental factors (light and oxygen for instance) and/or masking the overall sensory desirability of the food product [8]. In this sense, microencapsulation technique (by spray drying, freeze drying, spray cooling, extrusion, coacervation, liposome entrapment, co-crystallization, emulsion, etc.) can be used in the food industry as a promise for functional bioactives compounds for foods production [8,12].

Figure 1



Structures of plant bioactive compounds: alkaloids (**a1,a2**), monoterpenes (**b**), sesquiterpenes (**c**), triterpenes, saponins, steroid (**d**), flavonoids (**e**), polyacetylenes (**f**), polycetides (**g**).  
Source: Azmir *et al.* [5].

This paper reviews the latest published studies and issued patents on bioactive compounds application in food. For the search of this information different websites have been used, such as The Web of Knowledge, Google patents, Espanecet and Free patents online. In order to evaluate the impact of the application of bioactive compounds in food in terms of issued patents, the evolution in the number of patents from January 2011 until May 2015 was obtained from the Web of Knowledge. This data base obtains the information from the Derwent Innovations Index<sup>SM</sup> and covers over 14.3 million basic inventions from 40 worldwide patent-issuing authorities. The search was performed using 'Bioactive Compounds' as a keyword. Subsequently, this search was refined by the keyword phrases 'bioactive food', 'bioactive feed' or 'bioactive nutraceutical'. Three hundred twenty patents on the application of Bioactive Compounds in food were published in the last five years, and a clear trend in the issuance of patents in different areas was observed: the bioactive compounds for food (61.22%), feed (31.63%) and nutraceutical (7.15%) use.

Examples of recent patents on bioactive compounds application to food and beverages, nutraceuticals and animal feed industries are specified and discussed.

### Patents on the field

Recent patents on the application of bioactive compounds in food industries are shown in Table 1, where some description of these patents can be found. A summary of these patents and their areas of applications are described below.

### Food and beverages industry

The food industry has intensified bioactive compounds identification in foods due to increased interest by consumers for healthier products, for example, polyphenols in white wine, caffeine in coffee, chlorogenic acid in coffee bark, quercetin derived from plant sources and glucoraphanin, which is present in broccoli [13–15,16\*].

Bioactive compounds may be related to different properties and health benefits, such as antioxidant compounds (phenolic compounds, chlorogenic acids and lactones, keratin) [13–15,17\*,18,21] which can be used as foodstuffs and nutritional supplements, fermented foods which are able to retain the original nutritional ingredients and incorporate some active ingredients that contribute to consumers' health [19\*,20], foods that incorporate plants powder (e.g., *Cruciferae*) for food supplements or additives use [16\*], and the incorporation of glycolysis inhibitor for preventing and reduce obesity as food sweetener [21], for example.

Furthermore, the beverage industry also uses bioactive compounds to provide antioxidant properties or increase its nutritional value. Zhang and Mutilangi [18] patented a stable beverage obtainment containing polyphenols particles dispersion, developing a methodology for the bioactive dispersion in water. Hongtao *et al.* [19\*] patented a beverage containing glutinous rice fermented solid residue and blueberry residue, as components capable of retaining the original nutritional ingredients and some physiologically active ingredients from raw materials.

In this area, the trend is the bioactive compounds production by extraction from residual food sources. For example, residues with antioxidant and antibacterial properties generated in white wines production (pulp, skin and seeds), which are rich in polyphenols compounds [13] and residues for preventing physiological aging and oxidative processes generated from coffee production (bark), which are rich in caffeine and chlorogenic acids [17\*].

### Nutraceutical industry

Nutraceuticals are beneficial due to their inherent health advantages, disease prevention and/or treatment, and thus are suited well for developing novel food supplements, functional foods and medicinal foods [22,23]. New

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