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REVIEW

ABOUT FOOD ADDITIVES AS IMPORTANT PART OF FUNCTIONAL FOOD

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ABSTRACT

The main characteristics and classification of food additives, which are common in the food production, have been described in the present review. The ways of food additives classification, source of nature, main antioxidants, food colouring, flavours, flavor enhancers, bulking agents, stabilizers, sweeteners which were collected from literature based on structural and biochemical characteristics with description of source and possible effects on human, organisms and environment have been presented.

Key words: food additives, antioxidants, sweeteners, stabilizers, bulking agents

INTRODUCTION

The EC Concerted Action on Functional Food Science in Europe (FUFOSE) proposed a working definition of functional food: a food that beneficially affects one or more target functions in the body beyond adequate nutritional effects in a way that is relevant to either an

improved state of health and well-being and/or reduction of risk of disease. It is consumed as part of a normal food pattern. It is not a pill, a capsule or any form of dietary supplement.

Practical examples of a functional food:

- a natural food such as fruit or grain which may or may not be modified by plant breeding or other technologies (e.g. lycopene-enhanced tomatoes, vitamin E-enriched vegetable oils, vitamin A-enriched rice);
- a food to which a component has been added (e.g. a spread with added phytosterols);
- a food from which a component has been removed or reduced (e.g. a yogurt with reduced fat);
- a food in which one, or several components, have been modified, replaced or enhanced to improve its health properties (e.g. a juice drink with enhanced antioxidant content, a yogurt with added prebiotic or probiotic) (Nazzaro *et al*., 2009).

As a Canadian comparison, Health Canada and Agriculture and Agri-Food Canada both define functional foods as, "similar in appearance to – or may be – conventional foods, are consumed as part of a usual diet, and are demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions" **(AAFC, 2007; Nielsen, 2005)**. Furthermore, functional foods are created through a variety of means, including:

- fortification with vitamins and/or minerals to provide added health benefits (e.g. fortified soy beverages and fruit juices with calcium);
- addition of bioactive ingredients (e.g., muffins with beta glucan, yogurts with probiotics and drinks with herb blends) or food additives;
- bioactive-component enhancement through plant breeding, processing, or special livestock feeding techniques (e.g., omega-3 eggs, milk and meat, canola oil high in carotenoids, and wheat with enhanced lutein levels) **(AAFC, 2007)**.

According to **Coppens *et al.* (2006)**, food supplements were nationally regulated in the EU until 2002, when the Food Supplements Directive 2002/46/EC came into effect. This directive provides a list of the vitamins and minerals that can be used in the manufacture of food supplements **(Coppens *et al.*, 2006)**.

The most known food additives are different antioxidants, bulking agents, food colouring, flavours, stabilizers, sweeteners and the aim of this review shortly describe their main characteristics and effects on human organism.

ANTIOXIDANTS

The main anthocyanins in fruits are glycosides of different anthocyanidins, mainly cyanidin, that are widespread and commonly contribute to the pigmentation of fruits. Citrus fruits differ in their flavonoid profiles from other fruit species, containing flavanones and flavones (hesperidin and naringenin) that are not common in other fruits **(Rice-Evans *et al.*, 1997)**.

The major polyphenolic constituents present in green tea are epicatechin, epigallocatechin, epicatechin-3-gallate and epigallocatechin-3-gallate. In addition to small amount of catechins, black tea contains thearubigins and theaflavins, which are the polymerised forms of catechin monomers and are the major components formed during enzymatic oxidation and the fermentation process **(Katiyar, 2003)**. The most abundant catechin in green tea, accounts for 65% of the total catechin content. A cup of green tea may contain 100–200 mg of epigallocatechin-3-gallate. The epicatechin (EC), (−) epicatechin-3-gallate (ECG), (−) epigallocatechin (EGC), (−) epigallocatechin-3-gallate (EGCG), (+) catechin, and (+) gallocatechin (GC) are present in higher quantities in green tea than in black or oolong tea, because of differences in the processing of tea leaves after harvest. For green tea, fresh tea leaves from the plant *Camellia sinensis* are steamed and dried to inactivate the polyphenol oxidase enzyme, a process that essentially maintains the polyphenols in their monomeric forms. Black tea, on the other hand, is produced by extended fermentation of tea leaves which results in the polymeric compounds, thearubigins and theaflavins (Graham, 1992).

Flavonoids have been reported to possess a wide range of activities in the prevention of common diseases, including coronary heart disease (CHD), cancer, neurodegenerative diseases, gastrointestinal disorders and others (**Gonzalez-Gallego *et al.*, 2007**). Flavonols - are found at high concentrations in **o**nions, apples, red wine, broccoli, tea, and *Ginkgo biloba* **(Terao, 2009)**. The most common in the American diet are Quercetin (70%), Kaempferol (16%), and Myricetin (6%) **(Haytowitz *et al.*, 2002; Witzemann, 1920-21)**.

Isoflavones, respectively genistein, daidzein, glycitein are found in soy and have an influence on bone health among postmenopausal women, together with some weak hormonal effects. Thus, depending on the estradiol concentration, they exhibit weak estrogenic or antiestrogenic activity **(Guoxin *et al.*, 1989)**.

Synthetic antioxidants such as butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) have been used as antioxidants since the beginning of this century.

Restrictions on the use of these compounds, however, are being imposed because of their carcinogenicity **(Mahdavi, Salunkhe, 1995)**.

SWEETENERS

Nowadays the most known from sweeteners additives are glycosides stevioside from plants *S. rebaudiana.* Leaf extract of *S. rebaudiana* promotes effects on certain physiological systems such as the cardiovascular and renal and influences hypertension and hyperglycemia. Its known that *Stevia* leaf extracts are safe to use and having antimicrobial, antibacterial, antiviral and anti-yeast activity **(Mishra et al., 2010)**. These activities may be correlated with the presence of antioxidant compounds **(Sytar et al., 2012)**. More recently, purified extracts of *S. rebaudiana* (Bertoni) Bertoni (Compositae) containing the sweet *ent*-kaurane-type diterpene glycosides stevioside and rebaudioside A have become popular as "dietary supplements" **(Kinghorn *et al.*, 2001)**. Sweetness of 1.0 g of dry stevia leaves in 100 ml water was equivalent to a sucrose solution containing 20 g of sucrose **(Mishra *et al.*, 2010)**. The antioxidant activity of the extracts of *Stevia* was synergistic when it was mixed with coffee and limejuice. Complete purification of *Stevia* leaf extracts to obtain pure glycosides is not necessary for it become a commercially acceptable sweetener **(Kaushik *et al.*, 2010)**.

STABILIZERS

Stabilizers, thickeners and gelling agents, like agar or pectin (used in jam for example) give foods a firmer texture. While they are not true emulsifiers, they help to stabilize emulsions. Pectic substances are complex high molecular mass glycosidic macromolecules found in higher plants. They are present in the primary cell wall and are the major components of the middle lamellae, a thin extracellular adhesive layer formed between the walls of adjacent young cells. In short, they are largely responsible for the structural integrity and cohesion of plant tissues **(Robards, Antolovich, 1997)**. Pectinases are a big group of enzymes that break down pectic polysaccharides of plant tissues into simpler molecules like galacturonic acids and their production occupies about 10% of the overall manufacturing of enzyme preparations. Pectinolytic enzymes are widely used in the food industry for juice and wine production **(Samuels A., 1999)**. Since pectic substances are a very complex macromolecule group, various pectinolytic enzymes are required to degrade it completely. These enzymes present differences in their cleavage mode and specificity being basically

classified into two main groups that act on pectin "smooth" regions or on pectin "hairy" regions **(Pedrolli *et al.*, 2009)**.

BULKING AGENTS

Bulking agents such as starch are additives that increase the bulk of a food without affecting its nutritional value. Starch or amylum is a carbohydrate consisting of a large number of glucose units joined by glycosidic bonds. This polysaccharide is produced by all green plants as an energy store. It is the most common carbohydrate in the human diet and is contained in large amounts in such staple foods as potatoes (24%), wheat (75%), maize (corn) (72%), rice (86%), and the root vegetables (potatoes (24%) and cassava) (Table 1) **(Eliasson, 2004)**.

Table 1 Content of starch in different plants

Name of plant	Part of plant	Content of starch	Content of sugar	References
Typha latifolia	dried rhizome	58 % (25-58%)	10%	**(Goering, 1968)**
Cetraria islandica	Vegetation part	Near 44% of lichen	-	**(Svihus, Holand, 2000)**
Glyceria	weevil	75%	-	**(Tylová *et al.*, 2008)**
Zea mays L.	seeds	71%	-	**(Zoebelein, 1996)**
Artocarpus altilis	dried pulp	80 % (60-80%)	14%	**(Narkhede *et al.*, 2011)**
Nymphaea alba	rhizome	40%	20,00%	**(Chittendon F., 1956)**
Avena	grain	60%	-	**(Chang *et al.*, 2001)**
Butómus umbellátus	rhizome	60%	-	**(Özbay and Alim, 2009)**
Trapa natans and Trapa bispinosa	nut	55%	-	**(Tulyathan *et al.*, 2005; Singh *et al.*,**

Name of plant	Part of plant	Content of starch	Content of sugar	References
				2009)
Ipomoea batatas L.	tubers	72%	-	**(Zoebelein, 1996)**
Sorghum	-	74%	-	**(Zoebelein, 1996)**
Manihot	-	77%	-	**(Zoebelein, 1996)**
Pisum	grain	40%	-	**(Zoebelein, 1996)**
Hordeum L.	grain	75%	-	**(Zoebelein, 1996)**
Solanum tuberosum	tubers	82%	-	**(Zoebelein, 1996)**
Oryza	grain	89%	-	**(Zoebelein, 1996)**
Secale	grain	72%	-	**(Zoebelein, 1996)**
Triticum L.	grain	74%	-	**(Zoebelein, 1996)**
Althaea officinalis L.	roots	37%	10%	**(Géciová and Babor, 1992)**
Sagittaria sagittifolia L.	tubers	35%		**(Guoxin *et al.*, 1989)**

Pure starch is a white, tasteless and odorless powder that is insoluble in cold water or alcohol. It consists of two types of molecules: the linear andhelical amylose and the branched amylopectin. Depending on the plant, starch generally contains 20 to 25% amylose and 75 to 80% amylopectin by weight **(Brown, Poon, 2005)**. Glycogen, the glucose store of animals, is a more branched version of amylopectin.

Starch is processed to produce many of the sugars in processed foods. Dissolving starch in warm water gives wheatpaste, which can be used as a thickening, stiffening or gluing agent. The biggest industrial non-food use of starch is as adhesive in the papermaking process (**Pagella *et. al.*, 2002**).

FOOD COLOURING

Food colouring, or colour additive, is any dye, pigment or substance that imparts colour when it is added to food or drink. They come in many forms consisting of liquids,

powders, gels and pastes. Food colouring is used both in commercial food production and in domestic cooking. Colour additives are used in foods for many reasons including (**Tennant, 2008, Rulis & Levitt, 2009):**

- offset colour loss due to exposure to light, air, temperature extremes, moisture and storage conditions;
- correct natural variations in colour;
- enhance colours that occur naturally;
- provide colour to colourless and "fun" foods.

Colour additives are recognized as an important part of many foods we eat **(Barrows *et al.*, 2003)**. Some of the food colourings have the abbreviation "FCF" in their names. This stands for "For Coloring Food" (US) **(Stratton, 1933)** or "For Colouring of Food" (UK) **(Cannon, 1988)**.

CONCLUSION

The review demonstrates that nowadays is presented many different plants sources of food additives with natural origin and also artificial food additives. However, the review points out a series of aspects which warrant attention e.g. that many substances have not been re-assessed for many years, although new data are accumulating in the scientific literature and in certain cases calls for a new assessment of their effects on human health. It is important that mechanism of use food additives take place in EU system of food industry, which ensures a systematic, periodic review of all permitted food additives.

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