

# Chemistry of Food Additives and Preservatives

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# Preface

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The incorporation of additives in food preparations has been in practice since time immemorial. Additives are used to perform various functions, for example, to impart or enhance flavour (taste) where it is not sharp enough to meet consumer's demand, to give foodstuffs a desired colour (look/appearance) or to increase the shelf life of the food (preservative role). Some additives perform as essential elements or nutritious supplements to cater for the diet deficiencies of specific groups of people; without such additives these individuals would suffer from some specific nutrient deficiency syndrome or malnutrition.

The tendency to incorporate additives in food products has increased lately, with the advent of many new types of additives on the market. Knowledge regarding food additives, how they are prepared, their compositions and how they work has become very important to those in the food industry and research and academic institutions. This book is therefore intended to address all these aspects of food additives, and is expected to be of interest to all stakeholders in academia and research.

The book covers the chemistry of selected food additives such as their chemical nature, the way in which they are incorporated in foods and the technology involved in their preparations and processing steps. The book also covers the mechanisms or modes of action for the active ingredients in each type and class of food additive and preservative; their physico-chemical characteristics which give them special qualities to be used in food processing; parameters used as indicators for the quality assurance of the products; structure-activity relationships; and their safety to consumers.

There has recently been concern about the possible toxicity of some food additives and food processes. This has led to either a total ban of some additives or maximum limits have been set and strict rules have been enforced to safeguard the health of consumer. This aspect has also been dealt with in this book, and the reported toxic additives are discussed as well as the analytical methods to determine the safety of various food additives. Standard methods for control, monitoring and quality assurance certification for food additives have been set in place by various regulatory bodies such as the European Union (EU) and the American Food and Drug Administration (FDA) to control the legality of use for all the additives. Methods for the monitoring of additives and their metabolites are also discussed.

The classes of food additives that are discussed in this book include: antioxidants and radical scavengers; emulsifiers; stabilisers, thickeners and vegetable gums; sweeteners; fragrances, flavourings and flavour enhancers; food acids and acidity regulators; colourings and colour retention agents; flour treatment/improving agents; anticaking agents; humectants; antifoaming agents; minerals and mineral salts; glazers; preservatives; nutraceuticals, nutrigenomics and nutrigenetics; probiotics; prebiotics; synbiotics and micro (bio) capsules.

This book is expected to be a valuable asset to scholars, especially those enrolled in postgraduate courses and research programs in the areas of food chemistry, food processing and food technology, and also to industrialists and researchers in related areas.

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# Introduction

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Food is one of the main basic human requirements of life and is sourced mainly from plants or animals (and other minor sources such as fungi e.g. mushroom and algae e.g. Spirulina). Generally, human foods are never consumed raw; rather, they undergo special processing treatments with or without heat to make them more palatable. The steps involved in the food processing treatments vary depending on the type of food being prepared. Where necessary, some nutritive additives essential for health are added. The process of adding additives in foods involves mixing together various ingredients before or during a heat-treatment step to give the food the intended flavour, taste, texture or appearance. To attain a balanced diet, it has been necessary to add to certain foodstuffs some ingredients missing in that particular diet such as salt, amino acids and vitamins. In cases where food is processed for future use or where there is a necessity to avoid spoilage by the action of microbes, special treatments such as smoking or salting are used to keep the food safe for long periods of time. The tendency to make foodstuffs more appealing and palatable has paved way for the incorporation of a variety of ingredients or some special treatments to impart a desired quality to foodstuffs. This tendency echoes the saying: 'people first eat with their nose, then with their eyes and finally with their mouths'. Aroma, flavour, taste and appearance are all equally important in the appeal of foods.

Food additives are substances incorporated in edible products in order to perform specific roles and functions, such as preservation of foodstuffs by either increasing shelf life or inhibiting the growth of harmful microbes. Other roles include imparting desired colour, odour or a specific flavour to food. Food additives may have a natural origin in the sense that they may be found existing naturally forming part of the indigenous components of the food, or they may be synthetic but replicas of substances found naturally in foodstuffs. They may also be entirely artificial, which implies that they are synthetically produced and are not copies of any compounds found in nature.

There are a number of additives and preservatives commonly used in foods including antioxidants, acids, acid regulators and salts, emulsifiers, colouring agents, minerals and vitamins, stabilisers, thickeners, gelling agents, sweeteners and preservatives. These different food additives have different roles to play in foods depending on their intended purpose. For instance, emulsifiers tend to give food a good texture as well as good homogeneity such that they make it possible for immiscible items such as water and oils to mix well without any separation, as is the case in ice-creams or mayonnaise (Suman *et al.* 2009). Stabilisers, thickeners and gelling agents provide strong texture and smoothness as well as an increase in viscosity (Quemener *et al.* 2000).

Sweeteners are important as flavours, although there are other types of sweetener flavours which perform an important function in the diets of consumers with health problems such as diabetes (Hutteau *et al.* 1998).

Nutritive additives such as minerals, vitamins, essential amino acids, etc., are added to particular food products where they are missing (Nayak and Nair 2003) or in foodstuffs

specifically intended for people with deficiency of such additives, for example milk for babies (Ikem *et al.* 2002). Other additives such as antioxidants are needed for the prevention of fat and oil rancidity in baked foods by inhibiting the effects of oxygen on foods and also preventing the loss of flavour, thereby maintaining food palatability and wholesomeness.

Acids and acidic regulators such as citric acid, vinegar and lactic acid are food additives to control food pH (levels of acidity or alkalinity) and they play an important role in the sharpening of flavours (Populin *et al.* 2007), as preservative (Brul and Coote 1999) and as antioxidants. Some acids and acid regulators tend to release acids only when they are subjected to a heat treatment such as with some bakery products (e.g. acids produced by the leavening agents react with baking soda to make the bakery products rise during the baking process).

Colouring and colour retention agents are added to foods to appease the eye of the consumer or beholder; they are also intended to maintain the colour of food in cases where it may fade (MacDougall 1999).

Generally speaking, the desire for a particular quality of food has resulted in the introduction of numerous additives with wide applications in different cultures and civilisations. Currently, many different types of food additives have been commercialised and are finding their way onto the markets worldwide (Baker 2010). This trend in business has contributed to the speedy growth in food processing and other related industries, where food additives are used *en masse*. The economic success of food additives has further encouraged the advent of new technologies in the processing of foods.

However, these new technologies and additives have brought other unwanted outcomes and are an issue of concern. Despite all the benefits and advantages of food additives and preservatives, there is still a potential danger of chemical adulteration of foods. Additives or preservatives in foods may themselves trigger other hormonal or chemical processes in the body that can generate negative physiological responses. The metabolites produced by additives may also cause side effects, because not all food additives enter the markets after being thoroughly studied to prove their safety (Skovgaard 2004). Although most food additives are considered safe, some are known to be carcinogenic or toxic. For these reasons, many food additives and preservatives are controlled and regulated by national and international health authorities. All food manufacturers must comply with the standards set by the relevant authorities without violating the maximum thresholds stated to ensure the safety of the final product to the consumers. In most cases, food processing industries must seek standard certification before using any new additive or preservative or before using any originally certified additive or preservative in a different way (Pinho *et al.* 2004; Skovgaard 2004).

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