Open Access Library Journal
2024, Volume 11, e11062
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Preservative Additives in Food Products Sold in Dakar Markets: Frequency and Diversity

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How to cite this paper: Kane, A., Diakhaté, P.A., Marone, A., Tamba, A., Sagna, C.G., Cissé, M., Diop, A. and Dieng, M. (2024) Preservative Additives in Food Products Sold in Dakar Markets: Frequency and Diversity. *Open Access Library Journal*, **11**: e11062.
https://doi.org/10.4236/oalib.1111062

Received: November 30, 2023
Accepted: January 5, 2024
Published: January 8, 2024

Abstract

The use of food additives in industrial production has the advantage of improving sensory properties, technological quality and extending the shelf life of foods. Among the most widely used additives are preservatives, which were added to food products to inhibit, slow down or destroy various types of microorganisms. However, the strong presence of these additives on the market is not without risks for human health, and should be controlled to guarantee food safety. Analysis of the risks associated with consumption of foods containing these preservatives requires, among other things, information on the frequency of use of these additives in various consumer products. The aim of this study is therefore to identify the preservatives present in industrial food products distributed in Dakar. The methodology adopted consists of a qualitative analysis based on the identification of additives from food labels. Investigations were carried out in 9 stores, 4 superettes and 2 supermarkets located in different districts of Dakar. The results revealed the presence of 10 preservative dominated by potassium sorbate (25%) and sodium benzoate (24%). These preservatives are of natural or industrial origin, and are most often used in combination in industrial products. For some identified preservatives such as sodium nitrite and potassium metabisulfite, health risks are associated with their consumption. It has also been noted that 2 to 6 preservative additives can be combined in the same food product to reinforce antimicrobial effects. This work shows the need for regular sanitary quality control of food products distributed in markets. The results of this study open up prospects for the development of information databases on food additives.

Subject Areas

Chemical Engineering & Technology

Keywords

Additives, Food Products, Market, Preservative, Risk

1. Introduction

Foodstuffs can be degraded through a variety of physical, chemical, enzymatic and microbiological reactions. These reactions contribute to high food losses during production, processing, storage and distribution [1] [2]. In addition, they can lead to the production of toxic substances such as free radicals and microbial toxins, which are responsible for serious food-related illnesses [3]. For centuries, man has used processes such as drying, salting, sugaring and fermenting to preserve foodstuffs. Moreover, in recent decades, with the rapid industrialization of the agri-food sector and scientific advances, natural and artificial substances known as additives have been widely used to preserve food stability. Among these additives are the preservatives used in foods to avoid microbial alternatives. In fact, preservatives guarantee microbial safety by inhibiting or destroying pathogens and food spoilage germs [4]. Preservatives can be substances of natural origin such as lactic acide, propionic acid and microbial enzymes such as lysozyme [5] or ovotransferrin [6]. Today, the use of preservatives, particularly those of artificial origin, is increasingly contested by consumers because of the many negative effects attributed to them. Some authors have suggested links between the consumption of foods containing preservatives such as benzoates and pathologies such as allergies and stunted growth in children [7]. So, although artificial additives dominate the market, new consumer trends are forcing manufacturers to find alternatives to their natural equivalents [8]. What's more, food regulatory authorities, in conjunction with industry and the scientific community, are regularly tightening regulations on the use of these substances to ensure consumer health safety. With this in mind, the EFSA, the FDA and the Codex Alimentarius Commission, through JECFA, regularly undertake studies to assess and re-evaluate the toxicity of certain preservatives [9] [10]. These assessments, which follow well-defined procedures [11], require, among other things, access to data relating to frequency in foods and their level of consumption by populations. However, in Senegal, few data on the presence of preservatives are available in the scientific literature. It is in this context that this study set itself the objective of completing the profile and frequency of preservatives in industrial food products marketed in Dakar.

2. Materials and Methods

The study concerned samples of labels of industrial foodstuffs marketed in Da-

kar over the period from October to December 2022. Data collection was carried out in Dakar, with the owners' approval, at 9 stores, 2 wholesalers, 4 petrol station minimarkets and one supermarket, in order to obtain a diverse range of products. The samples were made up of various food products covering most of the food products commonly distributed on the national market. These samples were grouped into 16 food categories based on the Codex classification of foods [12]. The number of samples for each category depended on the availability of the products concerned on the market and the presence of information on food additives.

The approach consisted in collecting this information from food product labels at randomly selected sales outlets, *i.e.* local stores, mini-markets, markets and supermarkets. The survey was carried out using a smartphone equipped with a digital camera for photographing product labels and a computer for data recording. The methodology applied is based on the identification of food additives from information on food packaging, as adopted in several studies [13] [14]. Indeed, standards and regulations governing the development of food products require information that objectively informs the consumers about food additives. Regulation (EU) No. 1169/2011 of the European Parliament on the provision of food information to consumers was published in the Official Journal of the European Union on November 22, 2011. Similarly, the General Standard on the Labeling of Prepackaged Foods specifies that the full list of ingredients is a mandatory label statement [15]. The data collection process involved checking whether the product contained at least one food additive of any type, in order to determine the profile of preservatives, and the proportion of all food additives in the listed products. To this end, a photo of the ingredients and the product name on the packaging was taken to avoid duplication.

Statistical data processing is carried out using Microsoft Excel (Version 2016). A qualitative approach was applied to identify the preservative profile of food products. The names of the substances on the labels and, above all, the indication of the function sought by the manufacturers made it possible to identify the additives in question by reference to the Codex standard [16].

The frequency of preservatives in the samples was calculated using the following formula:

$$Fp = \frac{Tp}{TA} \times 100$$

FP: Frequency of preservatives

TP: Total number of preservatives on food labels

TA: Total number of food additives on food labels

To determine this frequency of preservatives in a food category, the calculation takes into account the food additives present in this category. For the overall frequency (preponderance) of preservatives, the sum total of additives identified in all samples was considered.

3. Results

A total of 399 industrial food product labels (N) were collected from retail outlets in Dakar. These samples consisted of milk and milk products (6.3%; N = 25), fats (1.5%; N = 6), fruit and vegetables (10.8%; N = 43), confectionery (10%; N = 40), cereals and cereal-based products (8.2%; N = 30), bakery products (8.5%; 34), meat and meat products (6%; N = 24), bouillons, sauces and soups (18.3%; N = 73), beverages (18.5%; N = 74) and miscellaneous products (2.2%; N = 9). The latter products include savoury snacks, infant formula and ready meals.

In the samples surveyed, the frequency of preservative additives in the various food product categories varied (Figure 1). Compared with other additives, these substances are most prevalent in meat, meat products and poultry (26.2%), fruit and vegetables (17.5%) and broths, sauces and condiments (15.4%). They are also very common in fats and oils (12%) and beverages (10%). In other food categories, such as confectionery, cereals and bakery products their frequency is relatively low. Moreover, the presence of preservatives has not been noted on dairy product labels.

The results revealed the presence of 10 substances used as preservative additives on the various food products (Figure 2). These identified preservatives are dominated by potassium sorbate, which accounts for 25% of preservatives, sodium benzoate (24%), sodium nitrite (16%) and lactic acid (10%). Other identified preservatives are potassium metabisulfite (5%), sorbic acid (4%), acetic acid (3%), sulfur dioxide (2%) and calcium propionate (1%).

Among preservatives, potassium sorbate (E202) was found in 6 food categories (Table 1). It was found on mayonnaises, sauces and broths, soft drinks, sweet drinks and fruit juices. Potassium sorbate is also found in yoghurts, liquid milks, cereals and margarines. Sodium benzoate (E211) is the main preservative identified on beverages. This substance is found on soft drinks, fruit juices and fruit juice concentrates. Sodium benzoate is also found on mashed potatoes and

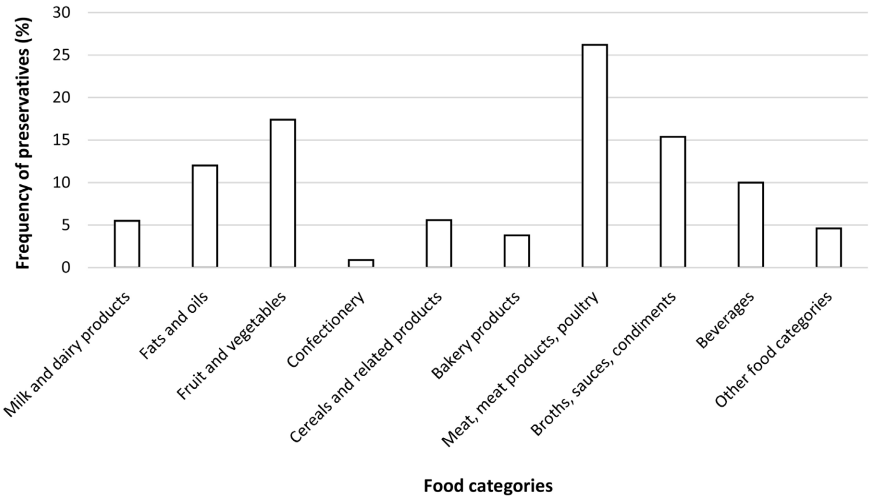

Figure 1. Frequency preservatives in relation to additives identified in different food categories.

Table 1. Preservative additives identified in food categories collected at market level.

Food categories Products collected	Preservative additives
Dairy and similar products Liquid milk, cheese, powdered milk, flavored milk, condensed milk	Sorbic acid (E200) Potassium sorbate (E202) Sodium benzoate (E211)
Fats and oils Butter, margarine	Potassium sorbate (E202) Sorbic acid (E200)
Fruits and vegetables Tinned fruit, mushrooms, jams, tinned vegetables, mashed potatoes	Lactic acid (270) Sodium metabisulfite (E223) Acetic acid (E260) Sodium benzoate (E211) Potassium sorbate (E202)
Confectionery Chocolate, hard candy, soft candy, spreads, chewing gum	Lactic acid (270)
Cereals and cereal products Cereals, desserts, wheat cakes	Lactic acid (E270) Sodium metabisulfite (E223) Potassium sorbate (E202) Calcium propionate (E282)
Bakery products Cookie, cake	Sodium metabisulfite (E223) Potassium sorbate (E202)
Meat, meat products, poultry Processed chicken, processed meat, processed poultry	Sodium nitrite (E250)
Salts, spices, soups, sauces, salads and protein products Broth, condiment, mayonnaise, mustard, sauce, vinegar, vinaigrette	Potassium sorbate (E202) Sodium benzoate (E211) Sodium metabisulfite (E223) Sorbic acid (E200) Sulfur dioxide (E220) Acetic acid (E260)
Beverages, excluding dairy products Soft drinks, hot drinks, sweet drinks, vegetable concentrates, fruit juice concentrates, fruit nectars	Sodium benzoate (E211) Potassium sorbate (E202) Sulfur dioxide (E220) Potassium metabisulfite (E224)
Prepared foods Prepared dishes	Sodium metabisulfite (E223) Sodium nitrite (E250)

flavored milk. Sodium nitrites (E250) are the only preservatives identified on samples of meat and meat products. These nitrites were also observed on an infant flour. Lactic acid (E270) is the main preservative found on canned vegetables. Lactic acid was also found on cereal bars and chewing gum. The use of potassium metabisulfite (E224) was noted in 6 food categories. Sodium metabisulfite is found on mustards in particular, and canned vegetables. Sodium metabisulfite is also found on cereal bars and cookies. Sorbic acid (E200) is identified

on samples of sauces, cheeses, milk powders and margarines. The least frequently encountered preservatives are acetic acid (E260) on sauces and purees, sulphur dioxide (E220) on fruit juice concentrates and a vinegar, and calcium propionate (E282) on a sample of wheat cake.

Our results highlighted the simultaneous use of several preservatives in the same food product (Table 2). In fact, among foods containing preservatives, 15% of food products containing them are made up of antimicrobial combinations ranging from 2 to 3 substances.

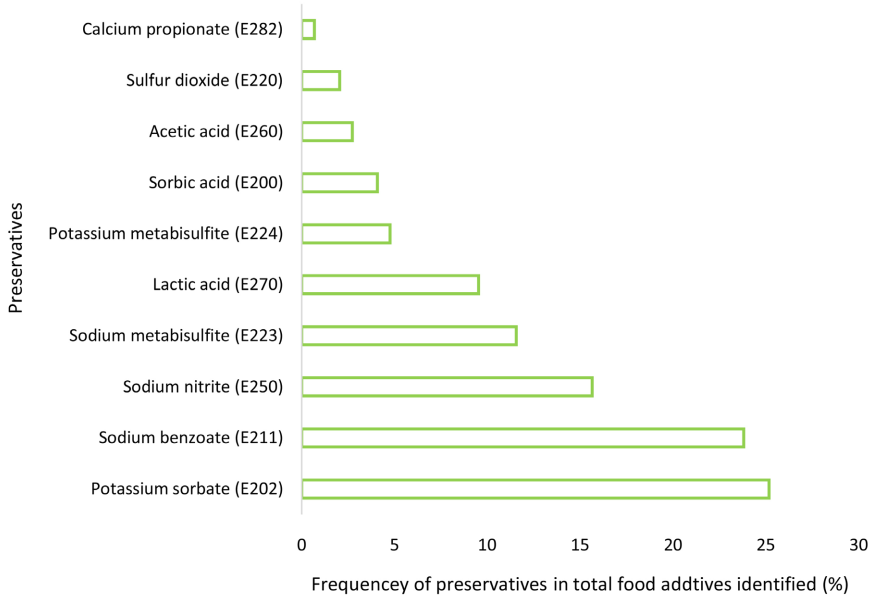

Figure 2. Frequency of the different types of preservatives identified on food labels.

Table 2. Preservatives combinations found in industrial food products.

Types of preservative combinations	Food products concerned
Potassium sorbate/Sodium benzoate/Acetic acid	Ketchup sauce
Sodium benzoate/Sulfur dioxide	Concentrate for fruit juices
Potassium sorbate/Sodium benzoate	Soft drinks, Mayonnaise, Fruit juices, Sweet drinks
Acetic acid/Sodium benzoate	Ketchup sauce
Sodium benzoate/Sorbic acid	Syrup
Potassium sorbate/Lactic acid	Sauce (crudité fines herbes flavor), Canned vegetables (Black olives)
Lactic acid/Sodium metabisulfite	Cereal (Peynirli), Canned vegetables
Potassium sorbate/Calcium propionate	Wheat cakes
Sodium benzoate/Acetic acid	Tomato purée
Acetic acid/Potassium sorbate/Sodium benzoate	Ketchup sauce

4. Discussion

Various antimicrobial substances are used by manufacturers to combat product spoilage and prevent the occurrence of food poisoning and toxin infections. Potassium sorbate is widely used by manufacturers as a bacteriostatic and fungistatic agent in a wide variety of food products [17] [18]. The antibacterial activity of this compound is thought to be associated with its carboxyl group and short hydrocarbon chain, which give it enhanced antimicrobial activity [19]. Benzoic acid and its calcium, sodium or potassium salts (E210 - 213) are used in the food industry as antibacterial and antifungal agents [20] [21]. Sodium nitrite is an additive widely used as an antimicrobial in meat, fish and cheese. Its strong ability to maintain and even enhance the red color of meat makes it an additive of choice in the meat products industry. However, sodium nitrite can react with amines to form highly carcinogenic nitrosamines. The use of this additive is therefore widely decried by consumers. Toxicological studies and re-evaluations have been carried out on several occasions to understand and reduce the risks associated with the consumption of this additive. Indeed, sodium nitrite is associated with an increased risk of breast cancer and prostate cancer [22] [23]. In addition, work is being carried out to find alternatives to the use of sodium nitrite in the production of processed meats. For example, the use of sorghum (Sorghum bicolor) red pigment powder in a traditional meat recipe has shown satisfactory results in maintaining a red/pink color similar to that provided by sodium nitrite [24]. Sodium metabisulfite is a highly effective antimicrobial, particularly in inhibiting the development of pathogens such as salmonella in plant products [25]. On the other hand, its excessive consumption could lead to the alteration of certain hematological parameters such as histo-splenic and gastric alterations [26]. Lactic acid is a natural antimicrobial additive used in several types of food such as fermented meats and dairy products, soft drinks, dressings and sauces [4]. The protective action of lactic acid is mainly due to the production of secondary compounds such as carboxylic acids, fatty acids, ethanol, carbon dioxide, hydrogen peroxide and bacteriocins [27]. In addition, this additive makes a major contribution to improving the sensory quality of foods through aroma production and acidity enhancement [27]. Potassium metabisulfite found in the samples is a sulfur compound. This substance is an effective antimicrobial for inhibiting bacterial growth in food products such as wine, dried fruit, pickled vegetables and vegetables in brine [4]. On the other hand, this substance is said to have genotoxic and cytotoxic effects [26]. Sulfur dioxide, also known as sulfur dioxide, is used in food protection as an antimicrobial agent, antioxidant and inhibitor of the enzymes involved in the Maillard reaction [4]. In health terms, sulfur dioxide can cause asthma attacks, diarrhea, nausea, gastric irritation, skin diseases, DNA damage and fetal abnormalities [7]. Acetic acid exerts a toxic effect resulting mainly from the dissociation of acetic acid within microbial cells, causing a drop in intracellular pH and metabolic disturbances [28]. Carbon propionate is a preservative often used to reduce spoilage in wheat-based products

such as bread [29]. In addition, one study suggested that the addition of calcium propionate to diets containing aflatoxin B1 appears to be effective in reducing toxicity [30]. Preservatives are often combined in foods for a variety of reasons including to improve the microbiological stability of industrial products. The antimicrobial and synergistic action of sodium benzoate, sodium nitrite and potassium sorbate has been demonstrated in vitro on strains of *Bacillus subtilis*, *Bacillus mycoides*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Aspergillus flavus*, *Fusarium oxysporum* and *Candida albicans* [31]. Another study also revealed the efficacy of the combination of lactic acid and potassium sorbate in inhibiting the development of *Listeria monocytogenes* in modified atmosphere chicken preservation [32].

5. Conclusion

This study highlighted the profile of preservatives in industrial food products distributed in the Dakar market. The results showed that the preservative additives present in these products are dominated by sodium benzoate and potassium sorbate most widely used substances. Other preservatives of artificial origin are also indicated on the food labels of industrial products. Some of these artificial products such as sodium metabisulfite raise concerns among consumers because of the many negative effects associated with them. As a result, a quantitative analysis of certain preservatives is required to assess compliance with the maximum concentrations authorized by manufacturers. What's more, in addition to the need to tighten controls and regulations on these additives, there is an urgent need to exploit the potential of safer, natural substances in the preservation of food products.

Conflicts of Interest

The authors declare no conflicts of interest.

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