Microbial Spoilage of Bakery Products and Its Control by Chemical Preservatives.

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ABSTRACT

Spoiled food may be defined as a food that has been damaged or injured so as to make it undesirable for human consumption. Bakery products are an important part of a balanced diet and a wide variety of such products can be found on supermarket shelves. However, bakery products, like many processed foods, are subject to physical, chemical and microbiological spoilage. While physical and chemical spoilage limits the shelf life of low and intermediate moisture bakery products, microbiological spoilage by bacteria, yeast and molds is the concern in high moisture products. Many industrially produced baked goods emerge from the baking process with a surface that is essentially sterile but post bake handling can quickly lead to fungal, microbial surface contamination as a result of exposure to airborne contaminants as well as equipment contact. This present review is focused on the microbial spoilage of bakery products and its control by preservatives. This review assesses the following topics: economical importance of bakery products, microbial spoilage of bakery products, and control of microbial growth in bakery products by using chemical preservatives.

Key words: Bakery products, Microbial spoilage, Bacteria, Fungi and Preservatives

INTRODUCTION

Bakery products and cereals are a valuable source of nutrients in our diet providing us with most of our food calories and approximately half of our protein requirements. The nutrients in bakery products are carbohydrates, proteins, lipids, vitamins and minerals. Bakery industry in India is the largest of the food industries with an annual turnover of about B 3000 crores. India is the second largest producer of biscuits after the USA. The biscuit industry in India comprises organized and unorganised sectors. Breads and biscuits form the major baked foods accounting for over 80 per cent of total bakery products produced in the country. The quantities of bread and biscuits produced are more or less the same.

Bakery products are considered as a source of carbohydrates because starch is the main chemical constituent [1]. Bakery products are subjected to spoilage problems. These include physical, chemical and microbial spoilage. Commercially produced and

properly handled bread generally lacks sufficient amounts of moisture to slow growth of any microorganisms except moulds. As normal cooking temperature destroys fungal spores, post-process contamination from airborne spores and contact with contaminated surfaces must be prevented.

Members of the genus Bacillus bring about bacterial spoilage of bread known as rope. This is of major economic importance to the baking industry. Ropiness which is the most important spoilage of bread after mouldiness occurs particularly in summer when the climatic conditions favour growth of bacteria. It is mainly caused by Bacillus subtilis but Bacillus licheniformis, Bacillus megaterium andBacillus cereus have also been associated with ropy bread. The incidence of wheat bread spoilage caused by Bacillus has increased during the last few years presumably because more bread is produced without preservatives and often raw materials such as bran and seeds are added. Spoilage of bread by rope formation may constitute a health risk, high numbers of Bacillus subtilis andBacillus licheniformis in foods may cause a mild form of food illness. Consumption of ropy bread has been associated with food-borne illness in reports from Canada and the United Kingdom.

The stability of bakery products against the attack by fungi is mainly due to preservatives. Preservatives help to reduce or prevent wastage of food through spoilage caused by microorganisms. Longer shelf life enables a greater variety of products to be kept in store and in the home. Sofos and Busta (1991)[2] reported that chemical preservatives can control the growth of molds by preventing the metabolism, by denaturing the protein of the cell, or by causing physical damage to the cell membrane.

Problems due to spoilage yeasts in bread usually result from post-baking contamination, slicing machines, bread coolers, conveyor belts and racks have been identified as sources. Yeast spoilage is characterized by visible growth on the surface of products. The most frequent and troublesome yeast is Pichia Burtonii, which is known as "chalk mould". This yeast can multiply rapidly on bread, with visible growth often apparent some time before mould occurs. Filamentous fungi are more common than yeast on British bread, since filamentous fungi are more easily recognized than yeast. The stability of bakery products against the attack by fungi is mainly due to preservatives. Preservatives help to reduce or prevent wastage of food through spoilage caused by microorganisms. Longer shelf life enables a greater variety of products to be kept in store and in the home.

ECONOMICAL IMPORTANCE OF BAKERY PRODUCTS:

Bakery products are an important source of nutrients viz., energy, protein, iron, calcium and several vitamins. Commercial bread and biscuits contain around 7.5 percent to 7.8 percent protein respectively. Bakery products are good targets for fiber enrichment. Fiber enrichment of several bakery products has

recently been tested using an ingredient containing 95 per cent short chain fructo-oligosaccharides. These soluble fibers are naturally found in many vegetables including wheat, rye, onion, Jerusalem artichoke, and are structurally close to sucrose, therefore behaving like sugar regarding theology.

The consumption of white bread has decreased in the last two decades in western societies while sales of whole wheat bran bread have increased due to health concerns. Sales of flat breads, especially pita bread, have been increasing in western societies due to migration of cultures and societies.

MICROBIAL SPOILAGE OF BAKERY PRODUCTS:

Microbiological spoilage is often the major factor limiting the shelf life of bakery products. Spoilage from microbial growth causes economic loss for both manufacturers and consumers. These losses could be due to many individual cases such as, packaging, sanitary practice in manufacturing, storage conditions and product turnover. Rachel Needham et al. (2004) [3] tested the microbial spoilage caused by bacteria, yeast and fungi and enzymic spoilage caused by lipoxygenase can be differentiated from one another and from unspoiled bread analogues after 48 hours using Cluster analysis, prior to signs of visible spoilage.

Bacterial spoilage:

Bacteria also have a potential to contaminate baked products although their growth is more restricted by low water activity and low pH. The spores of Bacillus subtilis for examples are heat resistant; 55 per cent remain active in amylase after 20 minutes at 65°C. This microorganism, which is present in raw ingredients, e.g., flour, sugar, and yeast, causes rope in bread [4]. Ropey bread is characterized by discoloration from brown to black, the release of a rotten fruit odor and having an extremely moist, stringy bread crumb [5]. This problem usually occurs in the summer season when the climate is warm and humid [4]. Ropiness can develop very rapidly under warm and humid conditions. So, it is a common problem in the warm climates of Mediterranean countries, Africa and Australia [6]A major source of Bacillus contamination is from the raw ingredients so ideally it would be profitable for bakeries to use only ingredients with low levels of contamination. Ropey bread is caused mainly by Bacillus subtilis but other species of bacillus are capable of causing rope and these include Bacillus licheniformis, Bacillus megaterium and Bacillus cereus [6]. Ropy spoilage in bread is first detected by an odour similar to that of pineapple. Later, the crumb becomes discoloured, soft and sticky to the touch, which makes the bread inedible. The deterioration of bread texture is due to slime being formed as a result of the combined effect of the proteolytic and amylolytic enzymes produced by some Bacillus strains that results in slime formation. This formation of rope problem, requires strict sanitary as well as good manufacturing practices designed to control the spores of Bacillus species. Preservatives such as propionate can

be used to eliminate this problem [7].

Staphylococcus aureus is one type of bacteria known to contaminate pie fillings. This microorganism has also been implicated in food poisoning outbreaks from cream filled bakery products [8]. Other bakery ingredients, such as chocolate, desiccated coconut and cocoa powder were found to be contaminated with Salmonella [8]

Yeast spoilage:

Yeast problems occur in bakery products. Wild yeast include Trichosporon variables, Saccharomyces, Pichia and Zygosaccharomyces. Saccharomyces sp. produce white spots in bread can be leading to the term chalk bread. Legan and Voysey (1981) [9].studied that the yeast problems in bakery products can be divided into two types: (a) visible yeast which grows on the surface of the bread in white or pinkish patches and, (b) fermentative spoilage associated with alcoholic and essence odors and hence osmophilic yeasts. Yeasts, which cause surface spoilage of bread, are mainly Pichiaburtonii("Chalk mold"). Contamination of products by osmophilic yeasts normally results from unclean utensils and equipment.

Mold spoilage:

Mould spoilage is a serious and costly problem for bakeries and use of preservatives is therefore an attractive means to diminish the spoilage and ensure food safety. Mold growth on bakery products is a serious problem that results in economic losses. Furthermore, losses of products due to mold spoilage are between 1 and 5 per cent depending on the type of product, season, and the method of processing [10]. According to Hickey (1998)[11], losses due to mold spoilage in the bakery industry average about 200 million pounds of product each year.

Mold spores are generally killed by the baking process in fresh bread and other baked products [23]. Therefore, for bread to become moldy, it must be contaminated either from the air, bakery surfaces, equipment, food handlers or raw ingredients after baking during the cooling, slicing or wrapping operations. The most common molds found in bakery products are: Rhizopus sp., Aspergillus sp., Penicillium sp., Moniliasp., Mucorsp. and Eurotiumsp.

EFFECT OF CHEMICAL PRESERVATIVES:

Marin et al. (2002) [12] used the hurdled technology approach to prevent fungal growth of common contaminants of bakery products including isolates belonging to the genera Eurotium, Aspergillus and Penicillium. Potassium sorbate was found to be the more suitable preservative to be used in combination with the common levels of pH and water activity.

Guynot et al. (2004)[13] applied a hurdle technology approach to control common mold species causing spoilage of intermediate moisture bakery products(Eurotium sp., Aspergillus sp., and Penicilliumcorylophilum) growing on a fermented bakery product analogue (FBPA). The factors studied included a combination of different levels of weak acid preservatives

(potassium sorbate, calcium propionate, and sodium benzoate; (0-0.3%), pH (4.5-5.5) and water activity (0.80-0.90). Potassium sorbate was found to be the most effective in preventing fungal spoilage of this kind of products at the maximum concentration tested (0.3%) regardless of water activity.

Sorbic acid and sorbates

Sorbic acid and its potassium salt, are recognized as effective anti mold agents, and have been considered historically safe for food use. Sorbic acid and potassium sorbate are "Generally Regarded As Safe (GRAS) for their use in food. Most groups of foods in which sorbate has been used commercially because of its antimicrobial activity include baked goods, cheese, cake, chocolate coatings, fish products, fruit, butter, salad, vegetables and wine. The usefulness of sorbic acid as a mold inhibitor in bakery products such as cakes, cake mixes, pies, pie fillings, doughnuts, etc. has been demonstrated by Gorton (1999)[14]. In general sorbic acid is effective against bacteria, and especially moulds and yeast. Ray and Bullerman (2001) 15 reported that potassium sorbate exhibited a great effect on the growth of Aspergillusniger and Penicillium species.

The level of sorbate used in bakery products ranges from 0.001-0.3 per cent [16], but higher levels may cause undesirable changes in taste and flavour. Sorbets are more than twice as effective as propionates in inhibiting mold growth in bakery products, but have an adverse effect on yeast, reducing loaf volume and making dough sticky and difficult to process. Ascorbyl Palmitate has also been successful in controlling mold growth without interfering in the fermentation process.

Propionic acids and its salts

Propionic acid, an aminocarboxylic acid is a naturally occurring organic acid and is an oily liquid with a slightly pungent, disagreeable rancid odour. Its salts are white, free flowing powders with a slight cheese like flavour[17] . This acid and its salt can be used to prevent the bacterial spoilage of bread known as rope caused by certain Bacillus sp. Several studies have also reported the effect of propionic acid and its salt on mold growth. Concentrations of propionate ranging from 8 to 12 percent have been reported effective in controlling mold growth on the surface of bakery products [17].

Marin et al. (2002)[18] tested the use of weak acid preservatives (potassium sorbate, calcium propionate, and sodium benzoate) to prevent spoilage by Aspergillusniger, Aspergillusflavus, and Penicilliumcorylophilum in analogs of a bakery product. Potassium sorbate has been found to be the most effective in preventing fungal spoilage of this kind of products at the maximum concentration tested (0.3%). Suboptimal doses (0.03%) of all preservatives tested led to an enhancement of growth of Aspergillus and Penicillium isolates.

CONCLUSION

The present review concludes the predominant efficacy of preservatives in bakery foods. Mold spoilage is still a major problem limiting the shelf life of many high

and intermediate moisture bakery products. Losses due to mold spoilage have been resulting in lost revenue to the baking industries. Therefore, methods to control mold growth and to extend shelf life of bakery products is of great economic importance to the baking industry.

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