

Preservatives used for control of fungal spoilage of bread

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ABSTRACT

Bread has been a staple human diet since historical times. Generally, loaves of bread are baked fresh daily in local bakeries, but commercial brands of processed and packaged sliced bread, which comprise a sizable chunk of the urban sales of bread, do come with shelf life of few days. Bread, having a short shelf life like all bakery products, loses its desired texture and taste characteristics upon storage and is also subject to spoilage by fungi. To avoid this spoilage and increase shelf life of the product, natural and chemical preservatives are added. This communication deals with natural and chemical preservatives added to dough to delay spoilage of bread by fungi.

Keywords: Antifungal activity, Bread, Preservatives, Calcium propionate, Butylated Hydroxytoluene (BHT), ascorbic acid.

INTRODUCTION

Bread has been a staple diet of man since historic times a fact that is well documented in the history of mankind and is believed to have originated even before the advent of agriculture (Kim, 2013). Traditionally, loaves of bread were prepared using flour, sugar, yeast; and baked daily in baking pans. Quality of bread depends on several factors encompassing method of preparation of dough, baking conditions, packaging and sanitary conditions during the processes. Freshness also depends on various features comprising flavour, appearance, crispness of bread-crust, volume of bread and hardness of crumb, of which taste is of paramount importance as criterion of acceptability to consumers (Plessas *et al.*, 2011). Breads, as all bakery products have a short shelf life (Arendt *et al.*, 2007) and lose freshness during storage, indicated by loss of desirable characteristic flavour, texture, taste and acceptable appearance to consumers, accompanied by increase in hardness of crumb; all commonly referred to as staling of the bread (Heenan *et al.*, 2008) and are also subject to spoilage by fungi

namely molds, yeasts as well as bacteria (Mentes *et al.*, 2007). Modern manufacturing technology has freed us of the task of laborious baking of our bread as was done in earlier times and has yielded a processed pre-packaged product with a prolonged shelf life. This extended shelf life is mainly due to the use of chemicals that inhibit microbial growth. Both natural and artificial preservatives used in bread to prevent early spoilage by molds. Preservatives and packaging accompanied by storage of the product in ideal recommended conditions make loaves last for three to four days. Various preservatives are used to inhibit growth of molds and keep off spoilage in almost all processed food products and bread as a pre-packaged processed food commodity is no exception.

Fungal spoilage of bread:

A large share of spoilage of bread is generally attributed to activity of molds, followed by yeasts. The culprit organisms actually responsible for spoilage of bread are limited to a small group comprising species of *Aspergillus*, *Penicillium*, *Mucor*, *Rhizopus*, and in some cases, *Fusarium*, *Chrysonilia*, *Hyphopichia*, *Saccharomyces* and other yeasts which are all more or less common in display of such spoilage activity all over the world (Unachukwu and Nwakanma, 2015; Ravimannan *et al.*, 2016). These fungi prefer starchy substrates, and bread along with other bakery products are ideal for their amylolytic properties. Banwart (2004), describing the sequence of arrival of the fungi responsible for the spoilage reported *Mucor* and *Rhizopus* as initial colonizers on loaves, followed by *Aspergilli* and *Penicillium*. In addition to their visible growth indicating spoilage, fungi are responsible for the development of characteristic flavour and producing carcinogenic mycotoxins and allergenic compounds in bread, which were traced back to exist from the cereal grain stage (Versilovskis and Bartkevics, 2012; Gimenez *et al.*, 2014), however, in spite of contamination, bakery products were reported to cause food poisoning in relatively rare cases (Cook and Johnson, 2010).

Preservatives used for inhibition of fungal spoilage:

To avoid spoilage and ensure an extended shelf life, preservatives are incorporated during processing of bread to inhibit the growth of molds. Application of furnace heat during baking of the bread kills and

inactivates the molds that may be present in dough and other ingredients (Ponte and Tsen, 1978). Secondary contamination during cooling, slicing, packaging and storage till consumption exposes the bread to airborne molds which contaminate the bread and this is where the role of preservatives begins. Chemical Preservatives have no nutritional value and can actually be harmful to health. Chemical preservatives currently used in packaged sliced bread available in Indian market are listed along with their reported side effects in Table 1. Calcium propionate is the most common class II preservative used in bread (Vazhacharikal *et al.*, 2015). It has been known to cause side effects such as stomach ulcers, behavioral irritability in children and headaches. Butylated Hydroxytoluene (BHT) is a synthetic chemical that is added to bread as a preservative. It slows down the autoxidation rate of ingredients that causes deterioration in the taste or color. It is known to produce problems upon ingestion such as abdominal pain, confusion, dizziness, nausea and vomiting. It has long term toxic effects on lungs, liver and kidneys. Sulfur Dioxide is regularly used in bread for its properties as a preservative and antioxidant. It is mixed with the flour and serves as its bleaching agent. Though it increases the shelf life, it is harmful to individuals suffering from asthma and sulfite sensitivity (food for life, 2017).

Dalmasso (1985) partly connected longer shelf life of bread to chemicals of the likes of potassium sorbate, sodium sorbate and sodium benzoate that inhibit mold growth. Wang *et al.*, (2004) studied the effects of commercial fungicides on wheat, analysing various quality parameters and flour processing properties, inclusive of baking quality. Shahnawaz *et al.*, (2012) carried out a comparative study of calcium propionate and calcium lactate as preservatives for bread. Inhibition of yeasts by some preservatives also prevents bread dough from rising properly thereby affecting quality of the product. The list of permitted chemical preservatives for bread apparently differs in different parts of the world (Govt. of Canada, 2017) with calcium or sodium propionate, sorbic acid or its sodium, potassium or calcium salts, acid calcium phosphate, sodium diacetate, ammonium bicarbonate and acid sodium pyrophosphate permitted singly or in combination in India (fssai, 2011)

Alternatives to chemical preservatives:

Nielsen and Rios (2000) investigated the effect of various essential oils of plant origin on the fungi that commonly spoil bread; reporting mustard, cinnamon, clove and garlic oils to be most potent in inhibiting the growth of spoilage microorganisms. Lotfinia *et al.* (2013) used starch foam containing vegetable oil to prevent mold growth and improve shelf life of packaged bread where cinnamon oil, absorbed to foam starch micro particles, acts as antimicrobial agent. The study showed fungal growth on bread to reduce with increasing concentration of cinnamon oil. Starch foam powders containing 1000 and 1500 ppm of cinnamon essential oil in bulky bread packages inhibited the growth of microorganisms for six days.

Habeebulla (2013) compared ginger and honey as natural preservatives in bread and reported honey to best suit the purpose and suppress molds. Among natural compounds, there are essential oils and herbal extracts that are gaining interest as preservatives in recent years.

Incorporation of a small percentage of milk solids increases moisture retention after baking, thus retarding formation of moisture film between the bread crust and the wrapper. Milk solids-free bread releases its moisture more rapidly from crust to the air space within the wrapper. Humidity was shown to be an important factor in the rate of growth of molds (Fustier *et al.*, 1998). Bakery sanitation was found to be more important in reducing mold related troubles than the process of baking and cooling. Packaging system can be considered as an operative part in food production lines, because of its ability of improving food safety and prolonging food's shelf life. Even addition of Biofilms in the packaging bags adds natural preservatives to the packing material instead of chemicals to the fresh bread. The compounds used in active packaging come from plants such as clove, which have natural antimicrobial properties (Caio *et al.*, 2014). The edible films are placed inside the plastic bags used to store bread, and the researchers have found that bread remains mould-free for 15 days at room temperature. Such techniques could be used on a larger scale where natural preservatives can be used in either the bread loaf itself or inside the packaging bags.

Gamma radiation of flour was reported to reduce the microbial spore load without affecting baking quality (Agundez-Arvizu *et al.*, 2006) while microwave treatment was reported to significantly increase the shelf life of bread for long periods of storage (Lakins *et al.*, 2008). Berni and Scaramuzza (2013) recommended ethanol to avoid or slow down fungal spoilage of bakery products, while Lafarga *et al.* (2013) successfully experimented with chitosan as a bioactive preservative. Safe bio-preservatives were tested to partly replace and reduce the amount of chemical preservatives in bread (Ryan *et al.*, 2008). Application of such bio-preservatives, eliminating side effects of chemical preservatives, is an upcoming field of research aimed at preserving freshness and extending shelf life of packaged sliced bread to few weeks (Barman *et al.*, 2017). Denkova *et al.* (2014) reported success in production of bread with longer shelf life, without using preservatives, by slightly increasing the proportion of sourdough starter. Giannone *et al.* (2016) reported an innovative sanitizing treatment comprising hydrogen peroxide and silver solution to reduce spoilage of bread by yeasts. Axel *et al.* (2017) reviewed and suggested consumer friendly and ecologically sustainable preservation techniques as alternatives to chemical preservatives in bread.

CONCLUSION

Having come a full circle, today, consumers are again demanding preservatives derived from natural sources due to their ability to deliver the required shelf life and allay harmful effects of chemical and synthetic preservatives. Since 1980's, bread industry all over the world has put in great efforts to reduce the number of additives and synthetic preservatives and produce natural fresh bread, however class II preservatives such as calcium propionate continue to be used in Indian bread. Breads containing chemical preservatives are a matter of concern and should be controlled to achieve healthy life style. Active principles from the natural sources giving comparable preservative effect need to be explored and incorporated in baking technology for avoiding harmful side effects of chemical preservatives and achieving long term health benefits. These natural preservatives may even be studied for their

enhancement of freshness characteristics of the bread and prove to be the better choice in the market. The findings of this investigation indicated that novel natural preservatives and bioactive preservatives hold the future in replacement of chemical preservatives in the bread and bakery industry.

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