Additives and their effect on wheat bread: A review

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Abstract

Due to urbanization, changing lifestyle and with growing disposable income has made bread a staple food in India. As the working spouses are increasing there is a change in eating pattern and preferences therefore, bread industry is flourishing with innovative ideas in bread formulation such as addition of food additives, antioxidants, combination and proportion of types of flour and other ingredients. Food additives are organic substances that are intentionally added to food in small quantity to improve the organoleptic properties and in extending shelf life. Food preservative is a class of food additive that help to prevent food spoilage by preventing the growth and proliferation of pathogenic microorganism. The widely used food additives in bread industry are natural preservative (ginger, dairy proteins and hydrocolloids), chemical preservative (calcium propionate, sodium propionate, sorbic acid etc.) and bio-preservatives (lactic acid bacteria, mesophilic, aerobic bacteria etc. The effect of these additives in bread are reviewed and the study is focused on assessing the effect of various food additives including preservatives which are incorporated at different concentrations and pH for improving the flavor, texture, color, shelf life and bread baking process.

Keywords: additives, preservatives, bread, baking.

1. INTRODUCTION

Bread is a staple food from past decades all over the world and wheat bread is most commonly consumed bread. Since bread is utilize as a basic potion of daily diet due to which its demand is increasing, therefore innovative ideas were generated to extend the shelf life as well various quality aspects of the bread in terms

of nutritive value, flavour, texture, loaf volume, antistaling effect etc.[1].In order to improve the quality, standard and safety of the bread, industries are incorporating various additives and preservatives such as chemical, natural and bio- preservatives. The major ingredients used in bread making are flout and water. Wheat flour is commonly used in the bread preparation because of its high gluten content which help in expansion of bread and give good acceptable texture to bread [2]. Bread is a yeast leavened product which is prepared by fermentation of wheat flour, sugars which are released from starch by the action of natural flour enzymes and yeasts and results in chemical interaction between various components in the food.

Nowadays, additives are becoming common in practices in baking industries. AccordingCodex Alimentarius [3] " Food additive means any substance not normally consumed as a food by itself and not normally used as a typical ingredient of the food, whether or not it has nutritive value, the intentional addition of which to food for a technological (including organoleptic) purpose in the manufacture, processing, preparation, treatment, packing, packaging, transport or holding of such food results, or may be reasonably expected to result (directly or indirectly), in it or its by-products becoming a component of or otherwise affecting the characteristics of such foods". The term does not include contaminants or substances added to food for maintaining or improving nutritional qualities.

The aim of the present study is about different additives used in bread and their effect on sensory characteristics, rheological and textural properties.

2. EFFECT OF FOOD ADDITIVES ON THE QUALITY OF BREAD

2.1 ACIDITY REGULATORS

FSSAI has given 2500 ppm maximum permissible limit of lactic and acetic acid. With respect to the longevity of commercial bread storage, different ways and means are explored to extend its shelf life with acidulants. In bread Sodium fumarate, Potassium malate, Sodium hydroxide, Acetic acid or Lactic acid are used as acidity regulators.

2.1.1 LACTIC ACID AND ACETIC ACID: The effect of lactic acid(0.20,0.40,0.60%) and acetic acid (0.20,0.40,0.60%) in combination with calcium propionate(0.20%) on the sensory characteristics and shelf was evaluated and it was found that 0.2% and 0.3% lactic acid in combination with 0.2% calcium

propionate were the most effective against microbial spoilage. It has been found that increasing quantity of acid, decreases the bread volume. Therefore, low concentration of lactic acid help provide better protection against microbial spoilage without affecting loaf volume[4].

2.2 EMULSIFIERS AND IMPROVERS

The bread improvers in varying amount can be added in wheat flour and dough to enhance certain characteristics of dough and the bread quality [5]. It consists of various types of dough additives which aids in improving the dough handling properties or sensory properties of bread or both. Additionally it also provides better gas retention which in turn minimize the amount of yeast required, decreases proof time and increases bread volume[6]. Flour treatment agents (also called improving agents, bread improvers, dough conditioners and dough improvers) are food additives which are combined with flour to improve baking functionality i.e. speed of dough rising, strength and workability of the dough [7].The improvers such as ascorbic acid, EDC-2000, (Etheylene Dough Conditioner), egg, STK (Screw Thread Kneading), and azodicarbonamide were used in bread and their effect was analysed. The bread with egg as improver gives better crumb texture, crust texture, flavour and aroma due to its high protein content and millard reaction which imparts characteristic flavour. The bread made with ascorbic acid as an improver is rated highest in general acceptance and volume of bread [7].

Emulsifiers are a group of substances used to obtain a stable mixture of liquids which otherwise would not mix. They are surface active agents which consist of hydrophilic and hydrophobic moieties. There are of two kinds ionic and non-ionic emulsifiers. Ionic emulsifiers used are salts of fatty acids (sodium stearoyl-2-lactate), phospholipids and proteins while non-ionic emulsifiers used are mono- and di-esters of propylene glycol and sorbitan ester [8]. In bread baking industry, they are used to enhance the water retention capacity, improve volume and viscoelastic properties of bread [9]. Certain emulsifiers are responsible for improving dough stability while others specifically soften the crumb of the bread [10].However, a study by Garzón et al.[11]showed that emulsifiers such as sodium stearoyllactylate (SSL), lecithin, diacetyl tartaric acid ester of monoglycerides (DATEM), distilled monoglyceride (DMG) and polyglycerol ester of fatty acids (PGEF) increases the dough volume maximally during proofing. Apart from this, they also escalate the number of bubbles integrated during mixing process. As DMG produced the largest bubbles due to which emulsifiers

tends to escalate the number of gas cells with lower size in the bread crumb, though have greater crumb firmness. So, this displayed different interactions between emulsifiers and gluten which influence protein polymerization during baking.

2.2.1 HYDROXYPROPYLMETHYCELLULOSE (HPMC)

Different hydrocolloids were also used as emulsifying agent and improver in bread. HPMC is a cellulosic ether obtained by chemically linking hydroxypropyl and methyl group to the β-1,4-D-glucan cellulosic backbone.This chemical modification leads to a water-solublepolymer with high surface activity and unique properties regarding its hydration characteristics in solution as well as during temperature changes [12]. Different hydrocolloids were also used as emulsifying agent and improver in bread. Study of Guarda et al.[13]stated the effect of hydrocolloids [sodium aliginate, xanthan, k-carrageenan and hydroxypropylmethycellulose (HPMC)] on fresh bread quality and its influence on bread staling and observed highest effect on bread specific volume, loaf volume, reduced crumb hardness, overall acceptability by addition of HPMC. The incorporation of HPMC in both partially baked breads and fully baked breads decreases the crumb hardness, reduces amylopectin retrogradation and also delays staling when stored at low temperature[14]. In addition to this, study byRustagi et al. [15]manifested that addition of hydrocolloids (HPMC) and whey protein concentrates can be used to formulate gluten free bread. As their presence in gluten free breads enhanced the overall quality (like texture, color, porosity) and overall acceptability.

2.2.2 DIACETYL TARTARIC ESTERS OF MONO-GLYCERIDES (DATEM)

DATEM is an ester of diacetyl tartaric acid mono and triglyceride. It is a type of oil- in- water anionic emulsifier that enhance the resistance and decrease the extensibility of dough [16,17]. It diminishes the size of the gas bubble that are formed in dough and thus, results in the formation of micro-structure in bread. In addition to this, its function as a crumb softener is related to the reaction with starch especially amylose and amylopectin molecules which play a cardinal role in retardation of staling. Movahhed et al.[9]investigated the effect of DATEM at four concentrations (0.25, 0.5, 0.75 and 1%) on sensory and staling properties of gluten free barbari bread. This reveals that DATEM at 1% concentration increases the shelf life and

decreases the hardness of bread with time significantly after 3 day of storage. Samples contained 1 and 0.75 % DATEM had better texture, chewiness and porosity.

The effect of Diacetyl Tartaric Esters of Mono-glycerides (DATEM) [0.25,0.5 and 0.75%] an emulsifier that has been widely used as a bread improver and a bio-emulsifiers (microbial lipase and phospholipase enzymes) in different concentration (10,30 and 50 ppm) are studied on bugget's physicochemical characteristics such as volume, crust colour, crumb texture and colour. According to Salehifar et al. [18] 0.75 % DATEM and all concentration of lipases increased the bread volume but phospholipases at 30 and 50 ppm decreases the bread volume. The bread crust is darker by addition of lipases and phospholipases as compared to DATEM. DATEM at 0.5% and 0.75% and 10 ppm lipase concentration, significantly reduced the firmness by addition of these surfactants. The staling rate of bread was also delayed when compared to the control. Highest retardation of staling was observed at level of 0.75% DATEM and 10ppm of lipases[18].

2.2.3 SODIUM STEAROYL LACTYLATE (SSL) AND MALTOGENIC AMYLASE (MALTO)

SSL improves both dough stability and crumb softening [16]. SSL is commonly used in breadmaking industry, particularly in pan loaves. For white breads, the amount of SSL ranges from 0.25-0.5g/100g flour[10]. Maltogenic amylase provide significant softness to bread and retain high level of crumb elasticity during storage without affecting bread volume or crumb structure[19].

2.2.4GLYCEROL MONOSTEARATE

Glycerol monostearate commonly called as monostearin. It is produced by process of glycerolysis of edible fats or oils or esterification with glycerin. In a study extruded starch and glycerylmonostearate were added at concentration of 0-15% and 0-4% respectively.Gycerylmonostearate at 4% concentration increases volume by 30% whereas only 12% increase in volume achieved by addition of extruded starch at concentration of 9-12% [20]. Bread baked by Addition of monostearin (4.1g/2100gfour) and emulgopan (6.2g/2100 g flour) improves the dough structure, porosity, humidity, elasticity, appearance of pores and bread volume and they also enhance the taste and odour of bread [21].Incorporation of GMS and SSL in pan bread improves the textures, general appearance, taste, odor, sponge, crust color, crumb color, distribution of crumb and overall acceptability as compared to control. Study also signifies that SSL exhibit better textural properties than GSM.

2.2.5 POLYOLS

Polyols or sugar alcohols are natural and nutritive group of reduced calorie sweeteners. “These are neither sugars nor alcohols; rather they are group of low digestive carbohydrates which can be used instead of sucrose” [22].The polyols i.e. glycerol, sorbitol and mannitol was incorporated at 2, 4, and 6% level and found that glycerol at 2% level shows maximum overall acceptability followed by sorbitol at 4% and mannitol at 4% level. There is increase in bake absorption, loaf height and loaf weight by addition of mannitol, sorbitol and glycerol. Loaf volume and specific volume decreases with increased level of polyols[22].

2.3 HYDROCOLLOIDS

Hydrocolloids (gums) is the group of homopolymer used in baking industry to improve the texture of the bread and enhances the moisture retention to prevent retrogradation,thus increases the storage quality of bread [23]. It is comprised of water soluble polysaccharides having a range of functional properties such as stability retarding the staling process,reduced cost, thus makes them suitable to the application of processing of bread [24].Hydocolloids are of great importance as it imparts gelling, stabilizing and thickening action in the baked goods. The most widely used polymers in the industry were alginates, carrageenans, agar, guar gum,xanthum gums [25].

The table 2focuseson the rheological behaviour of different bread samples. The effect of different additives on the dough rheology was summarized. Water absorption, dough development time, firmness, hardness, elasticity and anti-stalingcharacteristics of bread samples indicate variations due to the incorporation of additives in different concentration [23, 26].Hydrocolloids addition improves the stability and quality characteristics of the baked products and guar gum is considered to be best additive with respect to its softeningproperties imparted to bread crumb effect [23, 27].HPMC on 0.5% flour wt. basisaddition increases the overall acceptability of bread in terms of retarding the staling process and xantham (0.5% flour wt. basis) addition increases the dough stability [28].HPMC (hydroxyl propyl methylcellulose) is the better hydrocolloid due to its properties such as a bread improver and anti-staling effect on the fresh bread quality

[13].During fermentation, dough stability was improved by the addition of hydrocolloids(except xanthum) as they increases the specific volume, moisture retention and water activity of the baked goods. Xanthum and alginates both have pronounced effect on dough properties i.e.strengthening the dough.As HPMC and carrageenan reduces the firmness of bread crumb, it is therefore used as an improver in the bread baking process [29].

TABLE 1: Effect of emulsifier and improver

Additives	Characteristics of bread					
	Name	Concentration (%)	Loaf volume (cc)	Hardness (N)	Overall acceptability	Reference
Polyols	Glycerol	2	640.50cc	4.30	7.87	[22]
	Sorbitol	4	653.33	5.22	8.07	
	Mannitol	4	639.23	5.22	8.30	
Improvers	Ascorbic acid	-	3906.25cm^3		8.08	[30]
	Egg	-	2783.00cm^3		8.00	

	Azodiacarbonamide	-	3272.14cm^3		6.58	
	Ethylene dough conditioner	-	2662.00cm^3		7.17	
Emulsifier	Sodium stroyllactelate	0.75		8.88	9.2	[21]
	Emulgopan	0.30	398 cm^3 /100gm	-	-	

2.4 PRESERVATIVES

The code of Fedral Regulation [31] defines preservatives “as an antimicrobial agent used to preserve food by preserving growth of microorganism and subsequent spoilage”.

2.4.1 CHEMICAL PRESERVATIVES

Calcium propionate is produced by reaction between propionic acid and calcium hydroxide. It is an antifungal agent that is utilized in bread product to halt the black mold growth by destroying its reproduction and thus, substantially increases the shelf life of the bread

In Vazahacharickalet al.[32] study, calcium propionate preservative effect was examined at various pH (4, 5,6 and 7) and concentrations (5 and 10%) against *Rhizopusstolonifer*. To access the effect of calcium propionate at various pH and concentration solid media and sabouraud media were used. Growth area and turbidity method was used to evaluate the mould growth. Maximum inhibition was observed on low pH and at higher concentration (10%). In addition to this, preservative action of calcium propionate decreases with increase in pH. So, this may restrict its use in food materials that have high pH.

Preservative effect of calcium propionate against food spoilage was assessed at various concentrations (0.0%, 0.5%, 0.10%, 0.15%, 0.20%, and 0.25%), pH (4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5 and 8.0) and temperature (10 °C, 15°C, 20 °C, 30 °C, 35 °C, 40 °C, and 45 °C) respectively. So, maximum inhibition of mould growth (*Rhizopusstolonifer, Aspergillusniger, Penicilliumchrysogenum*and *Mucor*spp.) was observed at concentration 0.25%, pH 7.5 and at 20°C [33].

A study conducted by shahnawaz et al.[34] evaluated the impact of two preservatives i.e. calcium propionate (CP) and calcium lactate (CL) on the sensory parameters of bread at different temperatures (14 °C, 22 °C, 32 °C)results from the study manifested that Incorporation of CP and CL in bread at level 0.4g and 0.8 g at all temperatures has significant effect on the texture, appearance, flavour and palatability of bread while color of the bread is least affected. In case of shelf life of the bread, out of all storage temperatures, 14°C displayed extended shelf life (370hrs/15.44 days) . Furthermore, CP ranked highest in all parameters (like appearance, flavour, palatability and texture) followed by CL.

2.4.2 NATURAL PRESERVATIVES

Starch foam embedded with cinnamon essential oil could be used as natural and antifungal preservative in bread packing as it postponed the spoilage process from 3 to 6 days of bulky bread at room temperature [35].

In bread baking, salt (NaCl) is a basic ingredient and performing various functions such as stabilization of yeast fermentation rate, improving flavor, strengthening dough and increase in dough mixing [36]. Salt is added in bread because of three reasons are processing, sensory and preservation. Furthermore, it also intensify the color of the crust by controlling the yeast action on sugar due to which small amount of sugar is left for caramelization that improves crust color.In a study, salt solution was incorporated at four different concentration (0, 15, 30 & 50 ml) and gas production was assessed after every 10 min. (0-100 min.) of interval. This shows that gas production decreases as we increase the salt concentration because salt has retarding effect on yeast cell which in turn decreases the volume of the bread.

TABLE 2: Types of Gums and Their Effects on the Bread

Hydrocolloids	Concentration (%) on flour wt. basis	Water absorption capacity	Firmness (g force)	Hardness	Loaf volume (ml)	Dough stability (min)	Anti-staling	Elasticity (BU)	Reference

		(%)							
Guar Gum	1.00	64.5	2.86	-	820	5.20	-	74.6	[27]
	1.00	63.3±0.80	Reduced	-	325±4.50	13.5±0.50	Decreased	70±1.50	[23]
Carrageenan	0.1 0.5	65.2 65.6	-	No effect	-	7 4.7	Min. @0.1%	-	[13]
	02 0.5	62.1 62.5	-	-	- -	6.9 6.4	Staling retardation	-	[28]
HPMC (hydroxyl propyl methyl cellulose)	0.1 0.5	66.8 68.8	-	Min.@0.1%	Increased	7.5 11	Min.@0.1%	-	[28]
	0.2 0.5	65.4 67.1	-	No effect	-	7.8 6.9	Delayed staling	-	[13]
Alginates	0.1 0.5	66 67.8		Decreased	No effect		No effect	-	[28]
Xanthum	0.1 0.5	65.2 67	-	Increased	Improved @ 0.5%		Min. @ 0.1%	-	
	0.2 0.5	64.8 65.5	-	-	-	7.7 8.9	No effect	-	[13]
Arabic gum	1	60.5±0.40	Reduced	-	322±5.50	6.5±0.30	Decreased	60±0.80	[23]
Okra gum	13	62.8	Highest	-	Reduces	Decreases	-	-	

Min. = Minimum

Conclusion

From this review, it is concluded that addition of different types of additives in wheat bread showed positive effect on the physical properties of the bread. The additives positively affected the dough stability, loaf volume, high water absorption capacity and reduces the firmness of the bread crumb and staling properties

of bread. Different additives showed effect on different effect on varied concentration. Therefore, additives can be used to improve the quality of wheat bread and its shelf life in food industry.