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EFFECT OF EMULSIFIER CALCIUM STEAROYL LACTATE ON CHARACTERISTICS OF BREAD

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ABSTRACT

Bread is a baked food product made of flour or meal that is moistened, kneaded, and sometimes fermented. Bread is a staple food that is made from a flour, yeast, water, sugar, preservatives, fat, gluten and bread improver. The character of bread depends heavily on the formation of a gluten network which traps gas from yeast fermentation and makes the formation of a cellular crumb structure which, after baking, confers texture and eating qualities quite different from other baked products. The bread improver plays a significant role in bread making. In this study, bread improver was formulated using ascorbic acid, soya flour, xanthan gum, calcium sulphate along with emulsifier. Emulsifiers enhance the stability of the dough, increase the softness and extend the shelf life of the bread.

The experiment was carried out at RVS Technical Campus, Coimbatore in 2021. In this study, calcium stearoyl lactate was used as emulsifier. Eight trials were conducted by varying the level of emulsifiers Calcium stearoyl lactate (CSL) ranging from 1g to 4.5 g along with formulated bread improver. Bread with good texture, colour, proofing and machinability were achieved as a result of various trials. Among the trials, trial with 2.5 g of CSL 1000^{-1} g of Maida was found to be effective in terms of machinability of the dough, proofing time, baking time and softness of the bread. The major losses in bread industry is due to the bread staling. However, the addition of emulsifier CSL retarded the action of staling and increased the shelf life of the bread. The addition of CSL also increased the proofing time that resulted in increased volume of the bread. Increasing CSL concentration beyond 2.5 g 1000^{-1}g of Maida resulted in fluctuation of proofing time and improper structure during baking.

(Key words: Bread, bread improver, emulsifier, calcium stearoyl lactate, dough, shelf life)

INTRODUCTION

The baking industry is now an important part of the nation's manufacturing landscape. The company's current annual revenue is expected to exceed 2000 crores. Despite the reality that many small and large scale organized units produce both biscuits and breads, the most of bakery items in India are manufactured by unorganized localized family groups. Previously considered a sick person's diet, bakery products are now staple in the diet of India's large majority (Akande *et al*., 2010). The phrase 'bread' is used to describe such a wide variety of objects with different textures, sizes, shapes, crusts, colours, eating characteristics, softness and flavors that the categories of 'excellent' and 'bad' quality save to the person evaluating them.

The basic ingredients in making of bread recipes are yeast, flour, water and salt. Optional additives include sugar,fat, milk products, malt products, oxidants (such as potassium bromated and ascorbic acid), surfactants and antimicrobial agents. The addition of fat to the bread softens its texture, extends its freshness and shelf life (Kim *et al*., 2012). Oxidizing chemicals such as potassium bromate, potassium iodate, ascorbic acid and azodicarbonamide are used at ppm levels to improve loaf volume, dough strength and softness. Surfactants are mainly used to make antistaling agents. Calcium propionate is also used to prevent the development of mold and fungal infections (Williams and Pullen, 2007).

The use of additives to standardize flour in terms of gluten strength, colour and fermentability has become increasingly significant. Several chemicals such as emulsifiers, oxidants and enzymes are employed to enhance the quality of bread. The term 'bread improver' refers to a group of ingredients that can be included to flour to improve behavior of dough in turn bread quality (Rojas *et al*., 1999). The term is widely used to describe the mixing of a number of elements at low concentrations with a 'carrier' substance that will have functional properties but involves dispersal and makes a compound material easier to handle (Collar *et al*., 1999).

Processing aids like hydrocolloids (Ward and Andon, 2002), emulsifiers, enzymes and other chemicals have been used to improve dough properties to meet high scale manufacturing and customer need for greater homogeneity, quality and shelf life. These ingredients are required to improve the dough's attributes as well as the fresh product's final quality (Davidou *et al*., 1996).

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Emulsifiers are active surfactants compounds which are employed in making of bread to stabilise dough (Guarda *et al*., 2004), which is a thermodynamically unstable system by reacting with gluten proteins (Davidou *et al*., 1996). In this work, bread improver is formulated with the following ingredients, namely, ascorbic acid, calcium sulphate, xanthan gum (Shittu *et al*., 2009), soya flour and emulisifier. In this work, calcium stearoyl lactate is used as an emulsifier. Emulisfiers help in better stabilisation of dough, gas development, gluten formation and even texture (Schenz, 1995).

Lactic acid, stearic acid and calcium hydroxide are the main ingredients in CSL. The primary source of lactic acid is bacterial fermentation of carbohydrates (glucose, sucrose, corn, cane sugar, etc). By saponifying triglycerides with hot water, stearic acid is produced from fats or oils. CSL can aid in delaying the stiffness of starch gels by minimising granule swelling and solubilization (Twillman and White, 1988). This leads to increase mixing tolerance, faster dough formation, greater gas retention, larger loaves, improved texture and a longer shelf life. In this study, calcium stearoyl lactate was added with the formulated bread improver. The effect of emulsifier on different characteristics of bread was studied.

MATERIALS AND METHODS

Raw materials

Maida was purchased from SMT traders. Sugar was purchased from Sakthi sugars. Ascorbic acid, xanthan gum, soya flour, calcium sulphate, calcium propionate, shortening, dry yeast and gluten of reputed brand were purchased online. Calcium stearoyl lactate was procured from the online market. The experiment was carried out at RVS Technical Campus Coimbatore in 2021.

Bread making process

Initially, all the ingredients (flour, sugar, salt, shortening, calcium propionate, soya flour, xanthan gum, calcium sulphate, ascorbic acid, water, gluten, calcium stearoyl lactate) were measured and weighed. In the planetary mixer, dry ingredients were mixed together for about 2 minutes. After 2 minutes, water was added to the dry ingredients. The dough was kneaded for about 10 minutes, until gluten network was achieved. Vanaspathi and emulsifier were added to the dough at the end of 5 minutes. Once the desired gluten network was obtained, the dough was taken out and divided into equal portions. For 1 kg of flour, nearly 1.9 kg dough was obtained. It was divided into six portions and placed in 250 g bread moulds. The moulds were placed in proofing chamber for fermentation. It nearly took about 3 to 4 hours. Once complete fermentation was done, the moulds were placed in baking oven. The baking temperature was 200ÚC for 24 minutes. After baking, the breads were de-panned from the moulds and allowed to cool at room temperature. The cooling time was about 8 hours. After cooling, the breads were sliced and packed.

Trials were conducted by varying the proportions of emulsifier with formulated bread improver. Emulsifiers added into the flour at different ratios to formulated bread improver.

Analysis of flour

Chemical characteristics namely moisture, protein, total ash, wet gluten, dry gluten, crude fiber (IS 1155) were analyzed using standard procedures. They were carried out under AOAC Methods of the Association of Official Chemists (Anonymous,1990). Alkaline Water Retention Capacity (AWRC) was carried out according to the Quality testing of Flour (Matz, 2012) and bakery method (IS 14765-2000). Dough rising capacity test was carried out according to the Quality testing of Flour and bakery (IS 1320).

Analysis of bread

Water activity was carried out according to the IS standard procedure (IS 18787:2017).Protein was determined using the Kjeldhal method (IS 7219:1973).Carbohydrtae was estimated using anthrone test under AOAC procedures. Moisture, crude fiber, fat and yeast and mold were analysed under the procedure recommended by the scientist Egan (1981).

Table 1. Trials using calcium stearoyl lactate emulsifier

Sr.no.	Ingredients(g)	T-1	T-2	T-3	T-4	T-5	T-6	T-7	T-8
1	Maida	1000	1000	1000	**1000**	1000	1000	1000	1000
2	Sugar	250	250	250	**250**	250	250	250	250
3	Salt	14	14	14	**14**	14	14	14	14
4	Calcium propionate	5	5	5	**5**	5	5	5	5
5	Shortening	10	10	10	**10**	10	10	10	10
6	Gluten	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-
7	**CSL**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**
8	Soya flour	1	1	1	**1**	1	1	1	1
9	Calcium sulphate	1	1	1	**1**	1	1	1	1
10	Xanthan gum	1	1	1	**1**	1	1	1	1
11	Ascorbic acid	1	1	1	**1**	1	1	1	1
12	Dry yeast	20	20	20	**20**	20	20	20	20

This table provides data about trials which are carried for the preparation of bread using calcium stearoyl lactate emulsifier.

Texture profile analysis

As a mechanical method, Texture Profile Analysis was applied. This method has been successfully given to sponge cakes by Young (2012), which have a structure comparable to bread crumb (Scherer and Sapel, 1998). Bread slices (15 mm thickness) were used in the tests, with one slice placed on the table of the Stable Micro System TA - XT2 testing equipment at a time. The test protocol was as follows: a 35 mm diameter acrylic disc was used to compress the slice up to 25% of its thickness, then the probe was retracted to zero force. After a 10-second interval, the probe was driven into the crumb again, this time up to 25% of the real thickness, which is often less than the original 15 mm. The force-time diagram was used to quantify hardness, cohesiveness,springiness, chewiness and gumminess (Lambert-Meretei *et al*., 2010).

Colour characteristics

Colour measurements of bread was carried out using Hunter colour analysis, based on L*, a*, and b* readings as provided by a Hunter colorimeter (Model, NR60CP 3NH Technology Co., LTD) optical sensor recommended by Young (2012). The flour was placed in a glass chamber.L*, a*, and b* are located above the light source and were covered with a white plate.Color values were taken down. The lightness is represented by the L* value, which ranges from 0 to 100. The a* number indicates how red-green the colour is with a greater positive a* value signifying more red. A greater positive b* value suggests more yellow, while a lower positive b* value indicates more blue.

Total color difference (ÄE) was calculated by applying the equation:

$$ÄE=[(L_s-L)^2+(a_s-a)^2+(b_s-b)^2]^{1/2}$$

Evaluation of final product

The dimensions of the bread namely area, volume, height, specific volume was measured.

Bread area (cm^2)

Bread area was measured (cm^2).

Volume (cm^3)

Bread volume was measured (cm^3).

Height (cm)

Height was measured by ruler (cm).

Specific volume (cm^3/g)

Specific volume was calculated as per the following equation,

Specific volume (cm^3/g) = Volume (cm^3) / Weight (g)

Shelf life

Shelf-life study was carried out for bread samples for 12 days at ambient temperature once in four days time interval. The following parameters were checked in the shelf life study namely, taste, hardness, dryness, flavor and fungal contamination.

RESULTS AND DISCUSSION

In the process of bread making, the flour plays a vital role which changes the product depending on its parameters. Based on the gluten, the protein network containing glutenin and gliadin makes the bread soft and even texture. It also determines the proofing time of the dough and water absorption. When water absorption is high, dough becomes more flowable and formation of gluten network. The analysis of flour (maida) is done to determine the moisture, ash, gluten, protein and crude fiber.

Moisture content of the flour is measured to ensure the shelf life of the flour and to avoid contamination. When the moisture increases, the flour gets contaminated .Gluten of the flour should be checked to make the desired product. Usually wet gluten lies between 29-36. Ash content determines the mineral content in the flour (Moonen and Bas, 2014).Dough raising capacity is the measure of increase in the dough after proofing time. Alkaline water retention capacity is the quantity of alkaline water held by water after centrifugation (Van Nieuwenhuyzen, 1976).

In calcium stearoyl lactate, it forms sticky dough and requires additional amount of water. Gluten network found to be thick and less extensibility (Van Nieuwenhuyzen, 1976).

With calcium stearoyl lactate emulsifier, several trials were carried out. It is found to be the one ,used in very precise quantity. The desired product obtained in trial no.4 with 2.5 g 1000^{-1} g of flour(Fig 4).Bread has good textural properties(Fig 5),even colour, enhanced shelf life ,improved slicing and less keyholes (Naji-Tabasi and Mohebbi, 2015).

Bread prepared from calcium stearoyl lactate showed high moisture due to presence of calcium which enhanced the water activity of bread. Protein content was also higher in comparison to other breads (Handojo *et al*., 2021). Adding emulsifiers ,increasing emulsifier concentration and proofing time improved the porosity of bread (Gmez *et al*., 2004). It could be the result of increased air incorporation into dough with longer proving times and a high ability of the emulsifier amylose complex to hold gas (Baratto *et al*., 2015).CSL has high moisture and is preferred as a dough strengthener since it outperforms SSL and the completed product does not require a soft crumb or a precisely symmetrical loaf shape.CSL has high amount of yeast and mold count due to the presence of high moisture (Vargas and Simsek, 2021).

Bread hardness was reduced by increasing emulsifier content and proofing time. However, the effect of CSL was more dramatic, resulting in a five-fold reduction in bread hardness. It could be owing to the interaction of amylose with emulsifiers, which caused retrogradation to be delayed and hardness to diminish. Increased proofing time resulted in increased CO_2 generation, increased porosity and decreased hardness (Tebben *et al*., 2022).

Colour characteristics of bread using different emulsifiers. Colour parameters (L*, a*,b* and ÄE) of bread were evaluated using Hunter colour lab and the results are

tabulated. The use of emulsifiers boosted bread lightness (L*), which might be attributed to emulsifiers good influence on bakery product lightness. The acceptability of any food product is influenced by the colour change that occurs after heat treatment. Colour changed in the bread due to browning reaction, starch reterogradation during baking.

Hardness, gumminess, and chewiness were all greatly reduced by the addition of CSL. A crucial factor in determining bread ageing is springiness, which measures how much the gel structure is compromised by the initial compression. CSL's impact is most likely a result of the way it strengthens dough (Garzón *et al*., 2018). At the junction of gluten and starch, dough-strengthening emulsifiers can create liquid films with a lamellar structure (Bel *et al*., 2018). They increase gluten's capacity to form a film that traps the gas produced by the yeast, proportioning an increase in volume (Krog, 1981). A soft, delicate crumb texture distinguishes stearoyl lactylate-containing loaves (Sluimer, 2005). The bread crumb's "closed" features were retained with the increased volume provided by CSL.

Figure 1. ough in mixer

Figure 2. Mixed dough

Figure 3. Gluten network

Figure 4. Trial 4

Figure 5. Sliced bread of trial 4

Table 2. Quality characteristics of flour

S.No	Parameters	Test method	Unit	Result
1.	Moisture	IS1155	$g100^{-1}g$	9.77
2.	Total ash	IS1155	$g100^{-1}g$	0.46
3.	Wet gluten	IS1155	$g100^{-1}g$	34.56
4.	Dry gluten	IS1155	$g100^{-1}g$	11.78
5.	Gluten deformation Index	IS21445-2	mm	4.00
6.	Glutenic Index	IS21445-2	-	49.00
7.	Protein	IS1155	$g100^{-1}g$	11.52
8.	Crude fiber	IS1155	$g100^{-1}g$	1.10
9.	Dough raising capacity	IS 1320 (1988)	%	26.86
10	Alkaline water retention capacity	IS 14765(2000)	g	2.50

This table provides information on the quality characteristics of flour

Table 3. Quality attributes of bread made using calcium stearoyl lactate

Sr.No.Parameters	Test method	Unit	Result
1. Moisture	IS1155	$g100^{-1}g$	31.51
2.Yeast &mould count	IS5403	$CFUg^{-1}$	20.00
3.Water activity	IS18787	-	0.90
4. Protein	IS7219	$g100^{-1}g$	2.91
5.Carbohydrate	AOAC 9693	$g100^{-1}g$	18 g
6. Fat	IS 1224-2	$g100^{-1}g$	3.5 g
7. Crude fiber	IS10226-2	$g100^{-1}g$	1.4 g

The above table provides information on the quality characteristics of bread made using calcium stearoyl lactate

Table 4. Colour characteristics of bread prepared from CSL emulsifier

Emulsifier	L*	a*	b*	ÄE
CSL	80.25	0.026	17.18	41.97

Table 5. Texture profile analysis of bread using CSL emulsifier

Emulsifiers	Hardness(N)	Cohesiveness(N)	Adhesiveness(N)	Springiness(N)	Chewiness(N)
Calcium stearoyl lactate	14.08	0.996	0.027	0.935	4.673

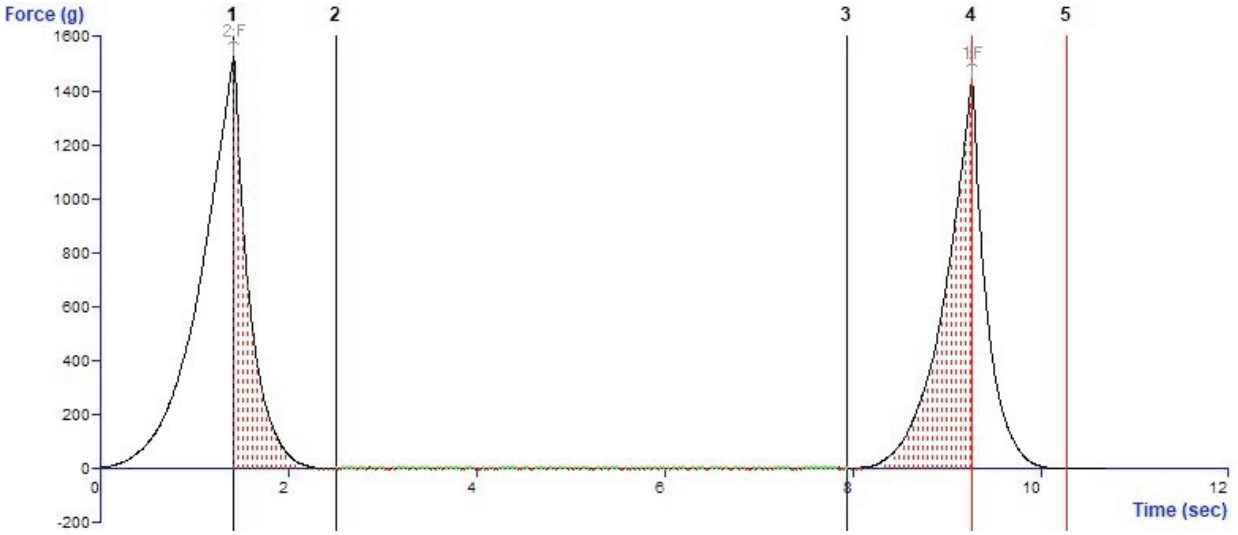

Figure 6. Texture profile analysis of bread using calcium stearoyl lactate

The area of bread is 144 cm^2. Volume and height of bread was 1008 cm^3 and 7 cm. Specific volume of bread was 4.03 $cm^3\ g^{-1}$. Bread was evenly baked, had good proofing, aroma, even coloured and texture. Slicing can be done without disintegration. Shelf life of the bread was studied. No fungal formation was seen till 15 days.

Breads were prepared using bread improver with calcium stearoyl lactate emulsifier. Emulsifiers generally increase concentration of dough, proofing time and texture of bread. The inclusion of an emulsifier affects all sensory qualities, including crumb colour, crust colour, taste, smell, and staling, as well as complete acceptability. However, proofing time had no effect on almost all sensory characteristics. Emulsifier addition increased lightness, whereas increasing emulsifier concentration and proofing time improved porosity. Long proofing times ensure that the emulsifiers have a good effect on fresh bread properties such as volume and crumb quality. When compared to bread made with shortening, emulsifiers made the crumb less firm. It was concluded that shortening and emulsifiers alter firmness in different ways. CSL makes the bread more soft and maintains the bread from staling as it has anti-staling effect. Bread remained free from fungal infections up to 15 days. But the usage of CSL should be more precise in comparison with other emulsifiers. Flour characteristics were studied .Good gluten network provides the soft dough and even textured product. Quality attributes of bread prepared from different emulsifiers were studied. This study provides information about colour and texture of bread made from emulsifier. Emulsifier addition increased the mixing property, proofing, texture of dough and also increased the bread volume, texture and prevented staling of bread.

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