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Original Article

The effects of adding selected emulsifiers and plant alpha-amylase on some rheological, physical, and sensory properties of Libyan Tannour bread

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Abstract

The production of Tannour bread involves the use of whole wheat flour that is manually flattened and baked. To enhance its properties, a combination of emulsifiers, namely a mixture of mono and diglycerides (E471) and sodium alginate (E400), were added into the flour at different concentrations between 0.25% and 0.75% of the flour's weight. Research indicates an observable improvement in the rheological, physical, and sensory characteristics of the dough. Furthermore, the inclusion of plant alpha-amylase (α-amylase) at a proportion of 5 - 15 g/100 kg flour also contributed to the reduction of tensile strength required to slice fresh Tannour bread. The optimal outcome was observed with the use of E472 at 0.75%. For stored Tannour bread, E472 at 0.75% and α-amylase at 15 g resulted in the least increase in tensile strength over time. Although the use of E400 improved rheological and physical characteristics, its efficacy was inferior to that of E472 and α-Amylase. Overall, the organoleptic characteristics showed significant enhancement, with the highest improvement observed with the use of E472 and α-Amylase at different levels.

Keywords: Arabic bread, emulsifiers, colloids, whole wheat flour and amylase enzymes

Introduction

Emulsifiers and amylases have played a role in bread quality enhancement in terms of texture, size and color. However, the amount of these additives required to improve bread quality characteristics is a crucial issue, as the final product's quality and price depend on these criteria (Stampfli *et al.*, 1995; Rosell *et al.*, 2001; Katina *et al.*, 2007; Duran *et al.*, 2001). Flat bread made from whole wheat flour (100%) and consisting of a single layer, is one of the oldest types of bread known in Libya and is called Tannour bread (oven or kiln bread). Tannour bread is still used in Libya, especially in rural and mountainous areas, because of its ease of preparation, its distinctive flavor, as well as the low cost of production of about 25% compared to other types of bread. Emulsifiers are usually added to commercial breads to improve the properties of the dough during manufacturing processes. Mono-and Diglycerides, as well as lecithin, are known as dough enhancers and antistaling bread crumb softener (Aust *et al.*, 1992; Tebben *et al.*, 2022). In recent years, there has been an interest in studying this type of

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bread from some researchers in the Republic of Iran, where Tannour bread is considered one of the oldest types of bread and is still consumed today and is called tafloon bread (Koocheki *et al.*, 2009). Farvili *et al.,* (1995) studied the effect of using types of emulsions (sodium stearoyl-2-lactylate (SSL), glycerol mono stearate (GMS-90), di-acetyl tartaric acid esters of monoglycerides (DATEM) on the quality of a type of two-layer bread like Arabic bread, but smaller in size, called Pita bread, which is widely available in most European markets, and found that all the emulsifiers used improved the quality of bread in terms of consistency and reduced crumbly when bending bread or cutting it into pieces using hands. Azizi *et al.*, (2003) studied the effect of using emulsifiers on the rheological properties of some types of flat bread, and it was found that the percentage of water absorption increased significantly by using surfactants alone or mixed with other components, in addition, it was noted that these materials led to a delay in the staling rate for bread samples studied. Nowadays, the consumer does not want or prefer artificial additives in bread he consumes, so the use of enzymes is considered opportune and very important as an accepted and safe material for the baking industry (Morita, 1997; Harada *et al.*, 2000; Qian *et al.*, 2021). Using α-amylase enzymes from a fungal or plant source alone or by mixing them with other colloidal compounds had a positive effect on the texture of chapati bread (Sidhu *et al.*,1997). Alginates, which are colloidal substances, are widely used in the food industry, for their significant effect on the rheological properties and texture of pastes. Alginates are used for their water absorption potential and has been exploited in food processing, such as the manufacture of custard cream (Kohajdová *et al.*, 2009) .

The main objective of this work is to study the effect of adding different levels of mono- and diglycerides E471 and sodium alginate E400 as emulsifiers, as well as plant α-amylase enzyme which extracted from barley malt, on some physical, rheological, and sensory properties of Tannour bread.

Materials and Methods

This study was carried during 07/14 at Greggs Plc., Newcastle upon Tyne. Whole wheat flour of commercial soft wheat grain (Sovereign) of the type Triticum, was supplied by ADM Milling Sovereign (UK, EU), moisture content 13.4%, protein 13.1%, fat 1.92%, ash 0.76%, wet gluten 29.2% and Falling number 397 seconds. The milling was done using the Buhler laboratory mill (Buhler Co., Uzwil, Switzerland) (Sayaslan *et al.*, 2006). The values obtained were expressed on dry weigh bases. Active dry yeast (Saccharomyces cerevisiae) was obtained from the local market. The mixture of mono-and Di-Glycerides of fatty acids, commercially known as E472, as well as sodium alginate known as E400, have been used in various proportions ranging from 0.25 – 0.75% by weight of flour as flour improvers. The plant enzyme α-amylase, extracted from malt barley, was used as a flour improver in proportion of 5-15 g/100 kg of flour weight. Emulsifiers and the enzyme were obtained from the English bakery company (Gregg's plc).

Properties of the dough:

The effect of emulsions and α-amylase on the dough was estimated using Brabender farinograph and the Brabender Amylograph model OHG, Duisburg, Germany, according to the method approved by the American Association of Cereal Chemists (AACC, 2000).

The criteria that were estimated by using farinograph were: water absorption ratio to obtain a homogeneous dough for 500 Brabender units (BU), dough development time (DDT), which is the time required to reach the best consistency of the dough. Stability is the difference in time, to the nearest half-minute, between the point where the top of the curve first intercepts the 500 B.U. line (arrival time), and the point where the top of the curve leaves the 500 B.U. line (departure time) and the Mixing Tolerance Index (MTI), which is the difference in Brabender Units from the top of the curve at the peak to the top of the curve measured five minutes after the peak is reached. The MTI is an indication of the mixing tolerance of flour; and MTI value of 30 B.U. or less is rated very good to excellent for hard wheat flours. A flour with a MTI greater than 50 B.U. indicates less tolerance and often indicates more difficulties during mechanical handling and makeup of the dough. The test was performed on the three different levels of both emulsions and enzyme with 8 replicates.The amylograph device was used to study the kneading behavior of flour through 60g of flour containing optional ingredients and mixed with 450 ml of distilled water. The mixture was well mixed until all condensation was removed from it, and it was transferred to the basin of the amylograph device set at a temperature of 25 ° C and heated to 95 ° C at a rate of 1.5 minutes, it was installed at this temperature for 15 minutes and then cooled to 50 °C at the same rate. The most important parameters that were estimated were: the viscosity value (recorded by the Amylograph curve), which is the maximum peak of the curve estimated based on Brabender units before it starts to retreat, as well as the gelatinization temperature was estimated.

Preparation of Tannour bread samples:

The dough was prepared in the traditional kneading method, which is 100% flour, 1% sunflower oil, 1% Salt, 0.5% active dry yeast, an appropriate amount of water according to the farinograph, in addition to the suggested ratio of emulsifiers or enzyme.The conditions of the baking process were as follows: the weight of the dough used to make the loaf ranged from 300-350 g, primary fermentation time was 60-90 minutes, the second fermentation period was 10-15 minutes while the final fermentation period was less than a minute. The oven temperature was 300±20 ° C using the electric oven amono Dx oven 145-104t1, baking time 25 minutes (Azizi *et al.*, 2003). The resulting Tannour bread after cooling was placed in polyethylene bags and stored at room temperature, evaluated after 1, 24, 48 and 72 hours after baking.

Evaluation of Tannour bread:

Hardness is an important criterion for assessing the quality of bread, where hardness is associated with weight loss and some organoleptic characteristics (Kohajdová *et al.*, 2009). This study adopted the hardness index (Tensile force) as one of the quality indicators in both physical and sensory evaluation.

Tensile strength test (Tensile force):

To estimate the tensile properties, slices of bread with dimensions of 90X18X7 mm were cut from the middle of the Tannour bread sample using a metal mold. The slices of Tannour bread were then exposed to a tensile strength test using the Texture Analyzer (TA-X plus) (Stable micro system, Surrey, UK). The slices of bread were placed between two probes, the first probe connected to a movable arm, and the other arm connected to a fixed base. The distance between the arms was 50 mm and the speed of tension by the moving arm was 50 mm/min. The force used to cut bread slices was expressed in newton's (N). An average of 8 replicates for each type of Tannour bread were used to calculate the variables in this study. This method has been used and documented in many previous studies (Gujral *et al.*, 2004; Shalini *et al.*, 2007; Kohajdová *et al.*, 2009).

Sensory tests:

Eight panelists, who have undergone extensive training, and whose expertise in the field of baking spans for more than a decade, all of whom are currently employed by the esteemed English bakery company, Greggs plc. In order to accurately and meticulously evaluate the various sensory characteristics of the subject matter, an unnumbered scale of considerable length, measuring a total of 15 centimeters, was deemed most suitable and was thus implemented. This particular scale was selected due to its unique ability to generate a wide range of readings, thereby avoiding the repetition of any given numbers, and ultimately increasing the probability of obtaining a normal distribution of data, a methodology that has been widely endorsed by numerous researchers in this particular field, including Thybo *et al.*, (2006). Each of the eight judges was presented with a fresh sample of Tannour bread, of each type, which served as a comparison sample (Control) through which bread samples were evaluated at each stage of the testing process. In order to measure the degree of consumer acceptance of various types of bread, the judges were asked to evaluate and rate a number of factors, including shape, hardness, chew ability, flavor, and general acceptance from the sensory evaluation and subsequently compared with those obtained from the physical tests, in order to ascertain any potential correlations and/or discrepancies between those parameters.

Statistical analysis

The effects of the addition of mono-diglycerides (E472) and sodium alginate (E400), was analyzed at four different concentrations (0%, 0.25%, 0.50%, and 0.75%) relative to the weight of the whole wheat flour. Also, four different levels of α-amylase, at 0 g/100 kg flour, 5 g/100 kg flour, 10 g/100 kg flour, and 15 g/100 kg flour, were added to the flour in a randomized design of the experiment. For comparing averages and estimating the interaction between the various treatments, the Duncan multiple comparison test (with a significance level of ($P<0.05$) was compared by using statistical program Minitab 16. Furthermore, the relationship between the treatments was analyzed and evaluated through the utilization of simple regression analysis (multi-variable regression), Microsoft Excel was used for creating the graphs.

Results and discussion

The effect of emulsifiers and α-amylase on the dough properties

Water absorption ratio:

The results displayed in table (1) showed that water absorption increased with Datem level from 61.26% to 62.13% for 0.25 and 0.75% respectively. The rise in water absorption was significantly different with control. The addition of E400 in different concentrations (0.25, 0.50 and 0.75%) showed an increase in water absorption from 62.18, 62.28 and 62.57% respectively with no significant difference. The results of this study regarding E471 emulsion were similar to previous studies carried by Koocheki *et al.*, (2009), Watson *et al.*, (1986), and Azizi *et al.*, (2003). The results of the addition plant α-amylase enzyme at levels of 5, 10, and 15 g/100 kg flour showed no significant effect when compared to the control as shown in table (1).

The dough development time:

The dough development time (DDT) or (peak time) is the time needed for the curve to reach maximum dough consistency and is usually the highest point on the curve when the curve is centered on the 500 B.U. Table (1) shows that the dough development time (DDT) increased with the addition of both E472 and E400 by (0.25 and 0.50%), DDT increased from 2.39 to 2.50 minutes and from 2.44 to 2.52 minutes respectively. Emulsifier E472 recorded the highest dough development time when added at 0.50%, which was significantly different with both control samples as well as with the addition at 0.25 and 0.75%. For the dough containing the E400 a significant difference was recorded for DDT when added by 0.50% compared to control sample, as well as for the other proportions used from the same emulsion. Results in table (1) showed that when E400 was added by 0.75%, the DDT decreased significantly compared to the time when the emulsion was added by 0.50% (from 2.52 to 2.46 minutes). Results of the current study shown in Table (1) showed that the addition of the enzyme plant α - amylase at a ratio of 5, 10 and 15 g/100 kg flour significantly reduced the DDT compared to control sample, and it was indicated that negative correlation between amylase enzyme and DDT) as shown in t table (1).

Dough stability:

The stability level of the dough was observed to be significantly affected by the addition of various proportions of E472 and E400. According to the data presented in table (1), the maximum stability of the dough was obtained when E472 was added in quantities of 0.50 and

0.75%, resulting in a stability time of 2.58 minutes. When 0.25, 0.5 and 0.75 of % E472 were added, stability time recorded 2.42, 2.54 and 2.43 respectively, these results were similar to the results found by Stampfli *et al.*, (1996), Collar *et al.*, (1999), Azizi *et al.*, (2003), and Koocheki *et al.*, (2009).

Mixing Tolerance Index (MTI):

Results in table (1) showed that the MTI decreased significantly when adding both E472 and E400. The addition of E472 by 0.50 and 0.75% Were recorded MTI 115 and 109 BU respectively.

Viscosity and gelatinization temperature:

Results showed that the levels used for both E472 and E400 significantly affected ($P<0.05$) the characteristics of dough, as shown in table (1). Gelatinization temperature increased with the increase in the level of emulsion used, and the peak viscosity increased with the increase in the emulsion ratio and ranged from 586.6 to 693.1 BU units. The highest viscosity peak recorded at the addition of E400 by 0.75%.

The use of the plant α amylase had an effect in reducing the time required for the development of the paste, while increasing the gelatinizing temperature, while its effect on the absorption rate was not significant compared to the control sample as well as the case between the different enzyme ratios. These results agreed with Khalil *et al.*, 2000; Miyazaki *et al.*, 2004 and Koocheki *et al.*, 2009. The effect of using plant α-amylase on the rheological properties of the dough is due to the hydrolysis the glycosidic bonds α (1-4) form the amylose and amylopectin chains, , producing dextrins with low molecular weight.

Table 1. Effect of adding emulsifiers and Plant alpha-amylase on the rheological properties of Tannour bread dough using whole wheat flour .

Treatments	water absorption (%)	dough development time minute	Stability minute	Mixing tolerance index BU	viscosity BU	gelatinization temperature C
Control	59.72±1.72^{b}	2.36±0.05^{c}	2.28±0.04^{c}	129.6±1.92^{a}	526.3±11.0^{d}	60.03±1.02^{b}
E472 0.25%	61.26±0.71^{a}	2.39±0.02^{bc}	2.51±0.03^{b}	123.3±2.25^{b}	586.6±5.60^{c}	60.76±0.55^{ab}
E472 0.50%	61.56±0.86^{a}	2.50±0.05^{a}	2.58±0.02^{a}	115.5±2.33^{c}	621.9±12.5^{b}	61.43±1.03^{a}
E472 0.75%	62.13±0.47^{a}	2.42±0.02^{b}	2.58±0.01^{a}	109.9±2.30^{d}	660.0±17.53^{a}	60.85±0.77^{ab}
overall average	61.16	2.42	2.49	119.60	598.70	60.77
variance(P)	0.00	<0.001	<0.001	<0.001	<0.001	0.03
E400 0.25%	62.18±0.74^{a}	2.44±0.03^{b}	2.42±0.03^{b}	121.8±2.60^{b}	594.5±12.05^{c}	61.20±0.98^{ab}
E400 0.50%	62.28±0.66^{a}	2.52±0.02^{a}	2.54±0.04^{a}	120.4±2.39^{b}	656.9±12.23^{b}	61.34±0.84^{ab}
E400 0.75%	62.57±0.51^{a}	2.46±0.03^{b}	2.43±0.03^{b}	109.3±2.12^{c}	693.1±13.1^{a}	63.56±0.49^{a}
overall average	61.69	2.44	2.42	120.30	617.70	61.53
variance(P)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
αAmylase 5g	60.66±0.58^{a}	2.29±0.02^{b}	2.13±0.04^{b}	143.75±1.91^{b}	320.6±9.43^{b}	61.60±1.05^{b}
αamylase 10 g	60.68±0.38^{a}	2.24±0.02^{c}	2.12±0.03^{b}	154.75±2.12^{a}	228.1±7.04^{c}	62.40±0.71^{ab}
αamylase 15gm	61.10±1.05^{a}	2.15±0.03^{d}	2.03±0.06^{c}	156.25±1.99^{a}	206.3±15.06^{d}	63.12±0.68^{a}
overall average	60.53	2.26	2.14	146.09	320.30	61.79
variance(P)	0.09	<0.001	<0.001	<0.001	<0.001	<0.001

Lactobacillus could grow at 15 & 45 °C, and 6.5% NaCl, produce NH_3 from arginine, and ferment glucose, and produce CO_2. A group 62 strains, from a total 142 LAB isolates, were determined, and found to have cocci in pairs, growth at 15 but not at 45°C, and produce NH_3 from arginine, but not CO_2 from glucose. Therefore, this group was considered as the genus of *Lactococcus* (43.66%). A quantity of 7 strains from the total were coccoid to oval in pairs or chains, Gram-positive, absence of catalase, growing at 45 but not 15 °C, also, unable to grow at 6.5% NaCl, producing NH_3 and not CO_2 gas from glucose. Thus, this group belonged to the genus of *Streptococcus* (4.93%). In addition, 4 isolated strains and 2.82% of the total strains were identified as *Leuconostoc* species. Strains displayed positive Gram reaction, catalase negative, grew at 15°C but not at 45 °C, growing at 6.5% NaCl, produced gas CO_2 from glucose and could not utilize arginine for NH_3 production.

The illustration of distribution at the genus level of the 146 LABs identified from the Laban' samples are shown in Figure 1. Close and similar results were reported by researchers from Pakistan, Bangladesh, and Egypt, where they isolated LAB, genera including: *Leuconostoc*, *Lactococcus*, *Lactobacillus*, *Enterococcus*, *Streptococcus* from a traditional fermented milk (Abd El Gawad *et al.*, 2010; Harun-ur-Rashid, *et al.*, 2007; Savadogo *et al.*, 2004).

Sugar fermentation tests, including raffinose, arabinose, lactose, and cellobiose, Harrigon (1998) have been applied to find the most frequently-occurring *lactobacillus* species in 69 isolated *Lactobacillus*. The results of this study revealed *Lactobacillus delbrueckii* ssp. *lactis* (62.32%) followed by *Lactobacillus plantarum* (31.88%) and (5.80%) not identified (Table 4).

Furthermore, other selected LAB isolates were identified by API CH 50 test (Table 5) as *Lactococcus lactis* ssp. *lactics*, *Lactobacillus pentosus*, *Lactobacillus brevis* and *Leuconostoc mesenteroides* ssp. *cremoris*. The fermented dairy products manufacturing industry has been using *Lactobacillus* and *Streptococcus* as a starter culture of fermented milk. On the other hand, conventionally, the most likely hypothesis is that *Lactobacillus* and *Streptococcus* cooperate metabolically during the milk traditional fermentation process. However, the results reported indicate that these two genera are competitive and reach a dynamic equilibrium during milk fermentation.

Effect of emulsifiers and α amylase on the quality of fresh Tannour bread

Tensile strength:

Results in table (2) showed that the Tannour bread with the incorporation of E472 and E400 has exhibited the weakest tensile strength resistance when compared to the control sample. The control sample exhibited a tensile strength of 3.42 N during the first hour of storage, indicating that the Tannour bread has commenced the hardness stage post-baking. The addition of E472 has considerably diminished the tensile strength necessary for slicing bread by 3.20, 2.99, and 2.79 N at 0.25, 0.50, and 0.75% emulsion inclusion levels, respectively. This reduction in strength has positively influenced the sponginess and palatability of Tannour bread for up to 24 hours of storage time at room temperature. The addition of E400 at 0.25% concentration has a negative effect on the tensile strength of the bread compared to the control sample. Furthermore, as the concentration of E400 increased from 0.50 to 0.75%, the tensile strength escalated from 3.25 to 3.27 N. The results presented in table (2) showed that the use of E472 and E400 led to decrease the strength required to cut the Tannour bread slice by 0.75% and 0.25%, respectively. Additionally, the tensile strength of the bread increased with an increase in storage time, where the control sample recorded a maximum strength of 3.69 N after 48 hours of storage at room temperature. In contrast, Tannour bread with 0.75% E472 recorded a tensile strength of 2.80 N and is significantly different from the remaining samples after 48 hours of storage. Both control and emulsion containing Tannour bread samples exhibited a loss of the brittle characteristic of the bread surface, this refers to loss moisture and starch retro gradation that is known as the important factors causing crumb firmness. However, Tannour bread samples containing E472 showed the lowest tensile strength after 72 hours of storage. The effect of incorporating emulsions in reducing tensile strength is a result of their absorption on the surface of starch grains during the storage period, allowing them to act as anti-staling agents based on the surface tension properties they possess (Pisesookbunterng *et al.*, 1983). Moreover, E472 forms a complex with amylose molecules, hindering the decline of amylose to its initial pre-gelatinization state, thereby retarding the hardening or staling of bread crumb (Purhagen *et al.*, 2012; Ma *et al.*, 2022). This study also investigated the impact of incorporating the plant α-amylase enzyme in various concentrations (5, 10, and 15 g / 100 kg flour) on the tensile strength of Tannour bread during distinct storage periods, as illustrated in Figure (1). The findings indicate that an increase in the enzyme concentration leads to a decrease in the force required to cut the bread slice. This reduction is evident in the case of fresh bread and bread stored for 24 hours, where the tensile strength declines linearly from 3.42 to 2.74 N.

Previous research has extensively highlighted the role of α-amylase enzyme in impeding the formation of dextrins during the baking process. The enzyme breaks down these dextrins into fermentable sugars while concurrently enhancing the dough's ability to retain gas (Martin *et al.*, 1991; León *et al.*, 2002; Durán *et al.*, 2001). The present study's results are consistent with prior research, indicating that adding the plant α-amylase enzyme to Tannour bread dough yields similar effects to non-flat bread. Moreover, the outcomes align with those of a study conducted by Koocheki *et al.*, (2009). Therefore, it can be inferred that the incorporation of the plant α-amylase enzyme in Tannour bread dough can lead to improvements in its quality, particularly in terms of the tensile strength during different storage periods.

Table 2. Effects of adding emulsifiers and enzyme α Plant amylase on the tensile strength of Tannour bread during different storage periods.

Treatments	1 hour	24 hours	48 hours	72 hours
	Tensile strength Newton	Tensile strength Newton	Tensile strength Newton	Tensile strength Newton
Control	**3.42±0.26[a]**	**3.24±0.04[a]**	**3.69±0.04[a]**	**3.64±0.05[bc]**
E472 0.25%	**3.20±0.39[ab]**	**2.91±0.04[d]**	**3.58±0.04[b]**	**3.59±0.03[d]**
E472 0.50%	**2.99±0.38[bcd]**	**2.99±0.05[c]**	**3.19±0.03[d]**	**3.40±0.03[e]**
E472 0.75%	**2.79±0.27[cd]**	**2.69±0.02[f]**	**2.80±0.04[e]**	**3.20±0.03[f]**
E400 0.25%	**3.07±0.41[bc]**	**2.83±0.04[e]**	**3.17±0.03[d]**	**3.68±0.03[ab]**
E400 0.50%	**3.25±0.46[ab]**	**2.96±0.04[cd]**	**3.67±0.06[a]**	**3.70±0.03[a]**
E400 0.75%	**3.27±0.38[ab]**	**3.14±0.07[b]**	**3.56±0.04[b]**	**3.68±0.03[ab]**
α-amylase 5g	**3.16±0.35[ab]**	**2.91±0.03[d]**	**3.38±0.04[c]**	**3.60±0.04[cd]**
α-amylase 10g	**3.12±0.39[b]**	**2.91±0.03[d]**	**3.20±0.04[d]**	**3.69±0.03[ab]**
α-amylase 15g	**2.74±0.29[d]**	**2.69±0.03[f]**	**2.77±0.03[e]**	**3.14±0.03[g]**
overall average	**3.10**	**2.93**	**3.30**	**3.53**
variance (P)	***<0.001***	***<0.001***	***<0.001***	***<0.001***

values in the same column for the same treatment that share one letter have no significant differences at ($p<0.05$).

Bread Sensory Evaluation:

The results of the statistical analysis in Table (3) showed that all organoleptic characteristics scores were higher than 13 for Tannour bread samples containing a percentage of E472 and E400 emulsion as well as a percentage of the plant α-amylase enzyme.

The results in Table (3) showed that there are significant differences between tannour bread containing E472 and E400 with control, except bread that contains 0.25% of E400. Table (3) shows that the freshness of a loaf of bread improved with adding of E 472 at a concentration of (0.025-0.50%) and the amylase enzyme at a concentration of (10 and 15 g/100 kg of flour) when compared with control, the chewing quality of the loaf improved when adding E 472 at a concentration of (0.025-0.50%) followed by the amylase enzyme at a concentration of (10 and 15 g/100 kg of flour) and finally the control, as well as the general acceptance of loaf, the best results were recorded for E472, followed by E400, and finally for control sample.

Correlation coefficient between sensory, rheological, and physical characteristics:

Table 4 shows the relationship between sensory, rheological and physical properties, the relationship between the tensile strength required to cut a loaf was a negative relationship (r2=-94) with freshness of loaf, as well as the relationship between tensile strength with general acceptance was negative correlation (r2=-84).

Table 3. Effect of adding emulsifiers and Plant amylase on some sensory properties of Tannour bread during different storage periods.

Treatments	Shape	Freshness	Chewability	Flavor	General quality
Control	12.81±0.54[c]	12.15±0.55[d]	12.87±0.36[d]	13.24±0.12[e]	12.60±0.40[e]
E472 0.25%	14.31±0.34[ab]	14.73±0.16[a]	14.48±0.37[ab]	14.32±0.30[bc]	14.19±0.18[c]
E472 0.50%	14.82±0.17[a]	14.66±0.19[ab]	14.69±0.22[ab]	14.54±0.17[ab]	14.84±0.10[a]
E472 0.75%	14.66±0.87[a]	14.29±0.13[b]	14.31±0.20[b]	14.20±0.13[c]	13.51±0.40[d]
E400 0.25%	13.23±0.24[c]	13.47±0.30[c]	14.23±0.53[b]	13.37±0.12[de]	13.50±0.19[d]
E400 0.50%	14.03±0.67[b]	13.68±0.17[c]	13.60±0.18[c]	13.37±0.11[de]	13.53±0.25[d]
E400 0.75%	14.01±1.61[b]	13.81±1.71[c]	13.40±0.11[c]	13.18±0.23[e]	13.53±0.19[d]
α-amylase 5g	13.89±0.31[b]	14.39±0.28[ab]	14.52±0.19[ab]	14.49±0.23[abc]	14.66±0.20[ab]
α-amylase 10g	14.62±0.31[a]	14.40±0.28[ab]	14.78±0.17[a]	14.65±0.17[a]	14.84±0.11[a]
α-amylase 15g	14.71±0.34[a]	13.67±0.25[c]	14.24±0.21[b]	13.65±0.13[d]	14.44±0.15[bc]
overall average	14.11	13.93	14.11	13.90	13.96
variance (P)	<0.001	<0.001	<0.001	<0.001	<0.001

Values in the same column for the same treatment that share one letter have no significant differences at (P< 0.05)

Table 4. The relationship between the sensory properties and the rheological and physical properties of Tannour bread

property	Ab	Rt	Con	Kn	Vis	Gt	Ts	Sh	Frh	Cw	Flv
Rt	0.39										
Con	0.45	0.48									
Kn	-0.55	-0.37	-0.54								
Vis	0.65	0.56	0.59	-0.85							
Gt	0.54	0.28	0.12	-0.57	0.62						
Ts	-0.44	-0.57	-0.81	0.62	-0.57	-0.19					
Sh	0.30	0.40	0.78	-0.59	0.52	0.17	-0.68				
Frh	0.37	0.32	0.80	-0.53	0.48	0.23	-0.94	0.79			
Cw	0.22	0.19	0.66	-0.28	0.14	-0.02	-0.71	0.54	0.73		
Flv	-0.01	0.01	0.69	-0.22	0.02	-0.17	-0.54	0.67	0.73	0.75	
Ga	0.22	0.39	0.68	-0.33	0.28	0.18	-0.87	0.67	0.81	0.71	0.71

Shape =sh, Freshness= Frh, Chewability = Cw, Flavor = Flv, General quality= Ga, water absorption = Ab, dough development time= Rt, Kn, Mixing tolerance=Kn , viscosity= Vis, gelatinization temperature = Gt, Tensile strength= Ts

Conclusion

The present study has demonstrated the potential of utilizing emulsifiers in the production of Tannour bread with the aim of enhancing the rheological and physical characteristics of the dough. The results indicated that the optimal degree of freshness was achieved by incorporating E472 at 0.25, 0.50, and 0.75%. Furthermore, the incorporation of α-amylase enzyme at 5, 10, and 15 g/100 kg of flour has substantially preserved the freshness of bread. However, in terms of overall acceptability, the use of the enzyme at a concentration exceeding 10 g/100 kg of flour has adversely affected consumer acceptance. Although the addition of E400 has contributed to some extent towards enhancing the rheological properties of the dough, the lowest levels compared to E472, and the plant-α-amylase enzyme were observed at the concentrations employed.

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تأثير استخدام بعض أنواع المستحلبات المختارة وألفا الأميليز النباتي على بعض الخواص الرويولوجية والفيزيائية والحسية لخبز التنور الليبي

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المستخلص

خبز التنور، هو ذلك النوع من الخبز المُصنع من دقيق القمح الكامل ويُسطح بطريقة يدوية ومن تم يُخبز نوعان من المستحلبات، خليط الجليسريدات الأحادية والثنائية "E472" وآلجينات الصوديوم (Sodium alginate)"E400" تم إضافتهم لدقيق القمح الكامل بمستويات مختلفة تراوحت ما بين 0.25 – 0.75% من وزن الدقيق. أيضا تمت إضافة إنزيم ألفا أميليز النباتي لدقيق القمح الكامل بنسبة 5 – 15 غ/100كغ دقيق. نتائج الدراسة أظهرت أن استخدام هذه المستحلبات قد ساهمت في تحسين الخصائص الريولوجية للعجينة، الخصائص الفيزيائية والمتمثلة في قوة الشد اللازمة لقطع شريحة الخبز، وكذلك الحال بالنسبة للخصائص الحسية. إنزيم ألفا أميليز النباتي أيضاً تم إضافته لدقيق القمح الكامل بنسبة 5 – 15 جم/100كجم دقيق. قوة الشد المطلوبة لقطع شرائح خبز التنور الطازجة انخفضت بشكل ملحوظ باستخدام E472، E400 و α- أميليز. أفضل طزاجة لخبز التنور سُجلت عند استخدام E472 بنسبة 0.75%، بالنسبة لقوة الشد في حالة خبز التنور المخزن فقد ازدادت طردياً مع زيادة مدة التخزين، و بالرغم من ذلك E472 بنسبة 0.75% و α - أميليز بنسبة 15جم سجلت أقل زيادة مقارنة مع النسب الأخرى المستخدمة. بالنسبة لاستخدام E400 فقد سجل تحسن على الصفات الريولوجية والفيزيائية مقارنة مع العينة القياسية، ولكنها أقل كفاءة مقارنة مع كل من E472 و α - أميليز. الخصائص الحسية بشكل عام سجلت تحسن بشكل ملحوظ مقارنة مع العينة القياسية، ولكنها كانت أفضل عند استخدام E472 و- α أميليز بمستوياتهم المختلفة.

الكلمات الدالة: الخبز العربي، المستحلبات، الغرويات، دقيق القمح الكامل وإنزيمات الأميليز.

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