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Effect of Some Additions on Acrylamide Formation

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FOOD safety is a necessity for human health. However, achievement of this target faces difficult challenges, such as acrylamide (AA) formation in foods when exposed to high temperature during the food preparation process. Therefore, the main objective of this investigation is to study the impact of some additions on AA formation in toasted bread. Three formulas (F) were prepared: (F1) as a control, (F2) addition of a salt mixture (NaCl, CaCl2, $MgCl_2$ and KCl) at 0.5% to each and (F3) addition combination of hydrocolloids (alginic acid, pectin and xanthan gum) at 1% to each. The results indicated that salts caused AA reduction by up to 81.09%.While hydrocolloids led to AA inhibition up to 75.62%, (F2) contains 0.10g/100g sodium, so it is suitable for high blood pressure patients.(F3) contained 0.31g/100gphenylalanine,soitis appropriate for phenylketonuria patients. Also, (F3) is composed of gluten–free recipe, making it suitable for celiac patients. Sensory evaluation of (F1) is better than (F2and F3). Eventually, we recommend that the above treatments can be successfully utilized to mitigate AA formation.

Key words: Hydrocolloids, Toasted bread, Reducing (AA).

Introduction

Acrylamide AA is a crystalline solid produced by the reaction between the amino group of the amino acid (asparagine) and carbonyl groups of reducing sugars (e.g. glucose, fructose) and forms during the preparation of foods at a high temperature(more than 120^{o}C) such as frying, roasting, baking and grill (Schouten et al*.,* 2022). Acrylamide (C_3H_5NO) is a colorless, non- volatile crystalline solid, soluble in water and has a molecular weight of 71.08 kDa (g/mol). The main pathway of acrylamide formation is linked to the Millard nonenzymatic browning reaction (Weisshaar, 2004). IARC (1994) classified acrylamide as a potential carcinogen to humans (Group 2A) based on its carcinogenicity in rodents. The WHO (2002) endorsed this classification. The single (monomer) form of acrylamide is recently discovered to be present in food, which is toxic to the nervous system and a suspected carcinogen in humans because of gene mutation and DNA damage (SNFA, 2002; Mojska et al., 2010).

Several trials were conducted in order to reduce the acrylamide level in foods; these included optimization conditions treatments, such as addition salts (Elbassiony et al., 2020; Belkova et al., 2021) or addition of hydrocolloids in bakery products, either together or individually (Liu et al., 2020). Mousa (2021) discovered that adding Arabic gum AG to the cake inhibited the formation of AA significantly. All trials resulted in a significant reduction in acrylamide levels, and all additions were identified as promising inhibitors of AA formation, low cost and easily applicable.

Nowadays, there are foods named functional or dietetic that are prepared to meet the needs of special people who suffer from certain diseases such as diabetes, anemia, obesity, osteoporosis, celiac, hypertension, cardiovascular and phenylketonuria (PKU) side by side with/or alternative treatment or drugs (Patel, 2015). It is known that pan bread is one of the most important bakery products and it has a long shelf

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life. It is consumed daily all over the world. Pan bread (toast) is exposures to temperature (higher than 120^{o}C) during baking. It is necessary to find appropriate, practical and applicable solutions to decrease undesired AA, thereby, avoiding the health risk of AA. Accordingly, the purpose of the current research was (1) to assess the incorporation of some additions (salts and hydrocolloids) on AA formation in pan bread (toast), (2) to estimate sodium, amino acids and protein contents (3) to measure baking quality in soft bread and the sensory evaluation of soft and toasted bread.

Materials and Methods

Materials

Chickpea *(Cicer arietinum* L.) and rice (*Oryza sativa* L.) were obtained from the Field Crops Research Institute, Giza, Egypt. Wheat flour (72% extraction rate) was supplied from South Cairo Mills Company, Egypt. Salts (NaCl, $CaCl_2$, $MgCl_2$ and KCl) were provided by El-gomhouria Co., Cairo, Egypt. Hydrocolloids (alginic acid, pectin and xanthan gum) were purchased from Nore Industrial and Laboratory Chemicals, Giza, Egypt. Acrylamide standard (purity 99.5%) was exported from Sigma-Aldrich Chemical Company (St. Louis, MO, USA).Active dry yeast, corn starch, sugar, shortening and improving bread were procured from the local market. All chemicals used were of analytical grade.

Methods

Chickpea and rice flouring

Chickpea and rice were ground using a grinder (Moulinex 721 France) to pass through a 40 mesh sieve and packed in polyethylene bags and stored at – 4^{o}C until use**.**

Preparation of toasted bread

Toasted bread production was carried out according to the method described by Lazaridou et al.(2007). The formulas are shown in table (1) first, the powder hydrocolloids were dispersed in distilled water by stirring on a magnetic stirrer for 3 hours to obtained solution and active dry yeast "*Saccharomyces cerevisiae*" was dissolved in distilled warm water at 25^{o}C. Ingredients were put together in an automatic mixing bowl (Continental, Ambala, India) and the mixture was kneaded for 4 minutes at low speed and 2 minutes at high speed. The dough was fermented for 30 min at 30^{o}C under 85% relative humidity in a cabinet, then the dough was divided into 150 g pieces and shaped by the rounder and placed into lightly greased baking pans to prevent the loaves from sticking . Samples were placed in the fermentation cabinet for one hour and then proofed under the same conditions. After that, samples of baking were conducted in an electric oven (Zanolli, Italy) at 230^{o}C for 25 minutes. Pan bread samples were allowed to cool at room temperature (25±1^{o}C) for 3 hrs. Loaves, one half was left as untoasted bread (soft) to measure its quality and sensorial properties. The second half was toasted in a customary toaster as method of Belkova et al. (2021) whereas the samples were cutto slices (1.5 cm thick) via serrated knife and dried (roasted) at 170^{o}Cfor 10 minutes to achieve a visually golden yellow color (toasted bread) before being milled using a grinder, homogenized and packaged in polyethylene bags then frozen and submitted to chemical analyses.

Identification of acrylamide content

Samples (5.0 g) were extracted with 50mL of methanol (5%) and shacked by hand for 30 minutes. After centrifugation for 30 minutes at 9000 rpm, the supernatant solution was transferred to a 200 ml separating funnel and the aqueous layer was collected and used for analysis. The aqueous layer was centrifuged at 13000 rpm for 5 min. The pooled supernatant was filtered

TABLE 1. Formulation of pan bread blends (%).

Ingredients	F1	F2	F3	Ingredients	F1	F2	F3
Wheat flour (72%)	100	100	-	NaCl	2	0.5	2
Rice flour	-	-	50	$CaCl_2$	-	0.5	-
Corn starch	-	-	30	$MgCl_2$	-	0.5	-
Chickpea flour	-	-	20	KCl	-	0.5	-
Sugar	1	1	1	Alginic acid	-	-	1
Active dry yeast	1	1	1	Pectin	-	-	1
Improving bread	1	1	1	Xanthan gum	-	-	1
Shortening	2	2	2	Water	As dough needed		

through a0.2µ PVDF syringe filter. The C18 SPE column (strong cation exchange, 0.5-1.5g sorbent, 0.6 m equiv .g^{-1}) was conditioned with 5 ml methanol and the extract (2ml) was loaded with 5mlof water onto the column. The extracts were eluted with 2 ml of water. The eluent was collected for HPLC analysis. The samples were analyzed using HPLC (Hewlett Packard 1050) with a C18 column (250×4.6 nm, 5µ purity C18).The injectable volume was 20 µL. The separation was carried out using 80% methanol/water (v/v) with a flow rate of 1ml min-1 and the effluent of the column was continuously monitored with the UV detector at 254 nm (Geng et al., 2011).

Quantification of protein, sodium, pH and water activity (aw) values

Protein content (using Kjeldahl Apparatus, N5.75×), sodium content (using Atomic Absorption "Perkin–Elmer"2380, USA) pH (using knick pH meter with glass electrode Ingold U 456-Ku-57 and water activity(using WA meter – 160 A) were quantified as stated by AOAC (2010).

Estimation of amino acids

The samples were hydrolyzed in sealed tubes with 10mL HCL (6N) for 24hours at 110^{o}C in a sandy bath. The hydrolyzed samples were filtered through a 0.45µm nylon filter, evaporated at 40^{o}C in a rotary evaporator and then dissolved with 1 mL deionized water and evaporated once again in order to remove the traces of the acids. The residue was reconstituted in 1 mL of deionized water and then 20µL was injected into the amino acids analyzer (Eppendorf-LC3000, Biotronik, manital, Germany) for the determination of the amino acid composition of each sample. The amino acids were separated on a cation exchanger resin column (150mm2.6×mm i.d.,No.2619 resin) using citrate buffer at pH 2.2 a column temperature of 53^{o}C, a flow rate of 0.225mL/min and a post column reaction with ninhydrin (0.3mL/min ninhydrin flow rate) followed by a photometric detection at 570nm as described by Li et al. (2006).

Measuring quality of pan bread (soft

After 1 hour of baking quality samples were performed according to AACC (2000) as follows: Weight (g) using (decimal digital weighing scale), volume (cm3) by (rapeseed displacement) and specific volume throughout (dividing volume/weight).

Sensory evaluation of soft and toasted bread:

Samples were evaluated organoleptically by ten trained panelists from Food Technology Research Institute .Panelists were requested to assess the crumb color, crust color, taste, odor and crumb uniformity for soft and toasted bread according to method of Kulp et al. (1985).

Statistical analysis

The experimental data were subjected to an analysis of variance for a completely random design using a SAS (2000). Duncan's multiple range tests were used to determine the difference among means at the level of 0.05.

Results and Discussion

pH and water activity of toasted bread

Regarding the pH of toasted bread, the data in Table 2 indicated that the addition blend of salts more influence in lowering pH (5.10±0.04) than the addition of hydrocolloids (5.23±0.09) compared to control (without addition) (5.78±0.03).These results agree with Mestdagh et al., (2008).They found that the divalent cations calcium and magnesium induced a significant pH reduction. Also, they reported that lowering the pH of the soaking solution has been shown to stop the formation of the Schiff base (the nucleophilic amine group "NH^{2}" is converted to the non-nucleophilic protonated "NH^{3}") that leads to AA the formation. Furthermore, Pedreschi et al. (2004) suggested that the mitigation effect at low pH was attributed to the protonation of asparagine amino groups. This would block the nucleophilic addition of asparagine with a carbonyl compound, preventing the formation of the corresponding Schiff base, a key intermediate in the Maillard reaction and in the formation of AA. Besides, Jung et al. (2003) mentioned that any acid treatment (as addition alginic acid in formula 3) declines the pH of foods and results in the formation of Maillard associated substances and consequently drastically reduces AA content during frying and baking.

Respecting the water activity of toasted bread, the results in Table 2 showed that addition salts together had more impact on inhibition water activity (0.20±0.05) than addition hydrocolloids together (0.26±0.08) compared to control (without addition) (0.31±0.02). These results coincided with Stadler et al. (2002) who proved that AA formation decreased with low water activity. At the same time, Quarta & Anese, (2010) demonstrated that water activity in food plays a major role in reducing acrylamide formation.

TABLE 2. pH and water activity (a_w) of toasted bread.

Samples	pH	Water activity(a_w)
Formula 1	5.78±0.03[a]	**0.31±0.02[a]**
Formula 2	5.10±0.04[c]	**0.20±0.05[c]**
Formula 3	5.23±0.09[b]	**0.26±0.08[b]**

Values± standard deviation followed by the same letters in the same column are not significantly different at $p \le 0.05$

Effect of salts and hydrocolloids on acrylamide formation in toasted bread

Concerning the effect of different treatments on acrylamide formation in toasted bread, the results in Table 3 showed that the highest acrylamide content was found in the no treatment toasted control (201±7µg/kg) followed by formula 3 (49±5 µg/kg)and formula 2(38±4µg/k),while untoasted (soft) bread contained (28±3µg/kg) this data agrees with Grnaby et al.(2008). They found that toasted wheat bread contained (161 µg /kg) AA compared to untoasted bread (46µg/kg). Also, Becalski, (2003) found (290µg /kg) AA in toasted bread compared to (19µg/kg) in untoasted wheat bread, while Eerola et al. (2007) found that (111µg/kg) AA in toasted bread compared to (68µg/kg) in untoasted wheat bread. Meanwhile, Ahn et al. (2002) showed (260 µg/kg) in toasted wheat bread. The variation in the amount of AA formation may be due to different factors whereas Matthaus et al. (2004) and Taubert et al. (2004) declared that AA formation in foods is influenced by several factors and should be taken into account due to its importance, these factors include cultivated varieties of plants or crops , climate conditions, harvest time, fertilization, storage conditions, temperature, heating time, pH, water activity, moisture content and ratio of asparagine to reducing sugars in the raw materials.

Also, from Table 3, the addition combination of salts promoted AA attenuation up to (81.09%) more than hydrocolloids by up (75.62%) in toasted bread. These findings are consistent with those of Quarta&Anese (2010) who discovered that adding a 0.5% combination of CaCl2 and MgCl2 caused a 60% AA limitation in the biscuits. Acar et al. (2012) reported that using CaCl2 at (1.0%) reduced AA formation by up to 70% in cookies. Graf et al. (2006) noted that the addition $NaHCO_3$ at (2g) reduced AA by (70%) in biscuits. Also, Kukurova et al. (2009) found that $CaCl_2$, KCl and NaCl caused elimination AA formation by (90, 45 and 40%) respectively when salts were added individually at a concentration (0.1mmol/kg) into model system during baking at 90°C for 9 min. This may be due to the role of three salts in decreasing the water activity which influences the mechanism of acrylamide formation. These findings could be explained by Gökmen & Senyuva (2007) who reported that the supposed mechanism was that cations such as Ca^{+2} or Mg^{+2}interact with asparagine, hence, may increase the rate of glucose decomposition, while most asparagine remains unreacted, thus preventing the formation of the Schiff base and consequently of AA. Additionally, O'brien & Morissey, (1997) and stadler et al., 2004 elucidated that $CaCl_2$was more efficient in inhibiting AA formation than $MgCl_2$ and NaCl and demonstrated in all cases that the monovalent (Na^+, K^+), divalent (Ca^{+2}, Mg^{+2}) or trivalent (Fe^{+3}) cations rendered inhibition of AA formation**.** This cations might form complexes with amines and some intermediates of the Maillard reaction, such as acrylic acid a prevalently recognize precursor for forming AA. At the same time, the monovalent cations were less effective in reducing AA formation than the divalent or trivalent ones. Moreover, Kolek et al. (2007) suggested that the NaCl could accelerate AA elimination by decreasing the starting temperature of AA polymerization. Furthermore, Belkova et al. (2021) discovered that adding 2% $MgSO_4$ and NaCl individually reduced AA by up to 50% and 34%, respectively, in their experiment. Elbassiony et al., (2020) also stated that soaking potato chips in CaCl2 at 2% for 60 minutes reduced AA formation by 85.14%.

On the other hand, Zeng et al. (2010) found that pectin, alginic acid (50% reduction) and xanthan gum (20%) significantly minimized AA formation in chemical models when they were added at (2%,w/w). In addition, Passos et al.(2018) demonstrated that pectin reduces (67%) AA content by reducing the pH value of biscuit dough and hypothesized that pectin was able to increase water retention, thus inhibiting the

Maillard reaction, which resulted in the decrease of AA. Moreover, Liu et al. (2020) reported that the effectiveness of sodium alginate to attenuate acrylamide formation might be due to molecular movement and interactions between sodium alginate and acrylamide. In addition**,** Sadd et al. (2008) showed that AA formation mostly occurs in the outer crustlayer than in the inner crust of bread, while only a trace amount appears in the crumb regions of bread. An effect can be attributed to high rate of water loss via evaporation from the bread's surface. Also, Fredriksson et al. (2004) noted that prolonged fermentation time (at least one hour) was found to be suitable for AA reduction in bread. This may be due to yeast consuming asparagine during fermentation (0ver 80%) and fermentation causing the pH in the dough to drop due to release of carbon dioxide. On the other hand**,** Danuta et al. (2015) declared that chickpea are a new way to reduce the AA content. The lowering effect of the chickpea on AA may be due to the thermal stability of chickpea protein**.** Over and above, Miskiewicz et al. (2020) proved that adding 1% chickpea protein the greatest acrylamide reduction (41%) was found in the model system during baking at 180^0C. On the whole, it is evident that our results are within the safe limit. European Commission (2017) stated that the maximum permissible level of acrylamide is 100µg/kg for toasted bread. Its recommendation was used as a criterion or benchmark for the safe level of acrylamide in foods.

The functional nutritive properties of toasted bread

Sodium contents of toasted bread

Recently, it has been widely reported that high daily salt (sodium chloride) intake results in hypertension which is linked with cardiovascular diseases. The importance of sodium chloride reduction in the diet has been highlighted by recent legislations introduced by WHO (2012) which recommends a maximum salt (NaCl) intake is 5 g/day (about 1.96g sodium).

With regard to the sodium (Na) content of samples, the given data in Table 4 indicated that the lowest Na content was found in formula 2 which was recorded (0.10±06g/100g) compared to control which was found to be (0.64±0.21g/100g). The European Commission (2006) Categorized the content of sodium on labels as follows: product containing no more than (0.12g/100g) of sodium called low sodium, 0.04g/100g of sodium called very low sodium and 0.005g/100g of sodium called sodium free. It is noteworthy that our result in formula 2 is identical with low sodium as above mentioned. In addition, adding of NaCl with red Tara pods plays an important role in decreasing the acrylamide formation, as reported by Pedreschi et al. (2022).

Amino acids profile and protein content of toasted bread

Phenylketonuria (PKU) is dysfunctions caused by an inheritable problem in the phenylalanine (Phe) metabolism. In this metabolic disease, gene mutations in phenylalanine hydroxylase (PAH) result in phenylalanine accumulation that causes varying degrees of mental retardation. Accordingly, these patients should avoid eating all foods with a high content of phenylalanine. According to Hendriksz& Walter (2004), children can tolerate less than 500 mg of phenylalanine or 10 gm of protein in 24 hours. The results in Table 5 indicated that formula 3 was characterized by lower phenylalanine content (0.31g/100g) compared to control (0.56g/100g).

The Codex Alimentarius Commission (2000) defines gluten free foods as those consisting of ingredients which do not contain wheat, rye, barley, oats and their crossbreed varieties; these lead to celiac disease (CD), inflammation of the small intestine, leading to the mal absorption of several nutrients. The gluten level does not exceed 20mg/kg of food consumed in a day. Table 5 appeared to indicate that formula 3 had a minimum protein (5.96±0.58%) content compared with control (9.86±1.21%).

TABLE 3. Acrylamide content of samples:

Samples	Acrylamide (µg/kg)	Reduction (%)
Formula 1	201±7[a]	-
Formula 2	38±4[c]	**81.09**
Formula 3	49±5[b]	**75.62**

Values± standard deviation followed by the same letters in the same column are not significantly different at $p \leq 0.05$

TABLE 4. Sodium contents of toasted bread.

Samples	Sodium(g/100g)
Formula 1	0.64±0.21[a]
Formula 2	0.10±0.06[c]
Formula 3	0.53±0.09[b]

Values ± standard deviation followed by the same letters in the same column is not significantly different at p ≤ 0.05.

TABLE 5. Amino acids profile and protein content of toasted bread.

	Formula 1	Formula 2	Formula 3
Essential amino acids(EAA)(g/100g sample)			
Threonine	0.42	0.40	0.22
Valine	0.61	0.61	0.35
Isoleucine	0.44	0.42	0.26
Leucine	0.72	0.70	0.44
Histidine	0.30	0.31	0.15
Phenylalanine	0.56	0.54	0.31
Cystine	0.48	0.49	0.25
Methionine	0.23	0.21	0.11
Lysine	0.19	0.20	0.08
Total EAA	3.95	3.88	2.17
Non-essential amino acids(NEAA)(g/100gsample)			
Aspartic acid	0.89	0.86	0.60
Glutamic acid	1.92	1.88	1.04
Serine	0.51	0.49	0.29
Glycine	0.49	0.50	0.26
Arginine	0.98	0.97	0.46
Alanine	0.57	0.55	0.29
Proline	0.34	0.33	0.19
Tyrosine	0.77	0.77	0.25
Total NEAA	5.47	5.35	3.44
Total AA	9.42	9.23	5.61
Protein (%)	9.86±1.21a	9.70±0.92a	5.96±0.58b

Values ± standard deviation followed by the same letters in the same row is not significantly different at p ≤ 0.05.

Generally, it can be said that treated samples (formula 2 and 3) are not only characterized by a decrease in acrylamide but also may be appropriate for people with special needs who suffer from certain diseases such as hypertension (by low sodium) as formula 2, phenylketonuria (by low phenylalanine) and celiac (by gluten free) as formula 3.

Baking quality of soft bread

Baking quality is a concept used to judge the quality of protein and potential gluten gas retention of bakery products and the additives should not alter the quality Sadd et al. (2008). In relation to the baking quality of soft bread, the present results in Table 6 appeared that formula 3 possesses greater weight (140.25±2.28) than formula 2 (136.33±3.05) and formula 1 (135.96±3.51). Conversely, formula 3 is characterized by its lower volume (310.93±3.73) followed by formula 2 (440.25±4.22), thereafter formula 1(442.57±4.36). The increasing volume in formulas 1 and 2 might be due to higher gluten content in wheat flour than in formula 3. The decrease in volume of formula 3 could be attributed to the reduction in protein, thus dilution of gluten content (deficiency of gliadin and gluten in dough). Similar findings in volume loaves were found in the calculated specific volume. Our results can be supported by Acar et al. (2012)

they noticed that can use $CaCl_2$ at 1.0% in cookies without any influence on diameter and thickness**.** While, Lynch et al.(2009) showed that bread without salt has a significantly increased cell to total area ratio and thus a smaller number of larger air cells when compared to bread containing salt and added that using NaCl at levels from (1.2%) to (0.6%, 0.3% and 0%) no significantly affect the final bread quality, e.g. specific volume. Meanwhile, Kaur et al. (2011) mentioned that NaCl can be partially replaced with KCl, $MgCl_2$, $CaCl_2$, $MgSO_4$ and Na_2So_4 at (0, 25, 50 and 100%) level without having any adverse effect on dough rheology. Also, Barcenas and Rosell, (2006) and Lazaridou et al. (2007) revealed that addition of hydrocolloids, pectin and xanthan gum at 2% (w/w) to produce gluten free bread markedly increased the weight of loaves, this could be attributed to the high hydrophilic water retention of hydrocolloids which retarded crumb firming, thus extending shelf life (i.e. antistaling). While, volume has been decreasing, the reduction in volume was due to the dilution of the gluten matrix of dough which impairs carbon dioxide retention. The increase in water absorption may be due to the hydrophilic nature of hydrocolloids which are able to absorb and maintain water and decrease the free water molecules and amylopectin recrystallization, hence slowing the bread staling rate and increasing loaf weight.

Sensory evaluation of soft and toasted bread

Sensory evaluation is considered an important indicator of potential consumer preference. In spite of its short comings, it will retain one of the most reliable quality assessment techniques for food and food products in general and for bread and bakery products in particular Sadd et al. (2008). Related to sensory evaluation Table 7 summarizes the values of panelists. These values exhibited that the color crust, color crumb, taste, odor and symmetry of porosity in formula 3 (soft and toasted bread) were different significantly in comparison with formula 1 (control). In addition, the color of the crust, the color of the crumb and taste of formula 2 (soft bread) were significantly different in comparison with formula 1 (control). Besides color crumb and odor in formula 2 (toasted bread) different significantly in comparison with formula 1 (control). For instance, Lynch et al. (2009) found that an incremental reduction of NaCl from (1.2%) to (0.6%, 0.3% and 0%) caused high crumb hardness. Also, Mestdagh et al. (2008) deduced that the addition of $CaCl_2$ motivated a more crispy potato texture Nonetheless, Becalski (2003) assumed that the non-enzymatic Maillard reaction is sometimes preferred due to the formation of desirable characteristics such as flavor and brown color in roasted, baked, and fried foods. As well as, Charlton et al. (2007) successfully replaced (32.3%) of sodium chloride in bread using a mixture of $MgCl_2$, $CaCl_2$ and KCl. The bread was acceptable in texture, appearance, taste and baking quality. However, these effects are usually accompanied by decreased browning intensity and affect flavor formation. Over and above, Bassett et al. (2014) noticed that, NaCl can be replaced by $CaCl_2$:$CaCO_3$ (50%:50%) without having any adverse effect on dough rheology parameters and bread characteristics. Ca salts promoted lighter crumb and crust color. Ca increased hardness of upper crust and decreased hardness of lower crust. Besides, Reibner et al. (2019) observed that 50% NaCl was systematically substituted by different combinations of KCl, $MgCl_2$ and $CaCl_2$ without evoking negative sensory properties. On the other hand, Lazaridou et al. (2007) found that inclusion of pectin and xanthan at 2% (w/w) to prepare gluten free bread improve texture by slowing down the rate of retro gradation of starch. Crust color of the gluten free bread was lighter than control. This is attributed to increased levels of starch and low protein whereas browning of baked products depends on the presence of a sufficient amount of protein due to lack of melanoidins brown.

TABLE 6. Baking quality of pan bread (soft).

Samples	Weight(g)	Volume $(cm)^3$	Specific volume $(cm)^3/g$
Formula 1	135.96±3.51^b	442.57±4.36^a	**3.26±0.06^a**
Formula 2	136.33±3.05^b	440.25±4.22^a	**3.23±0.07^a**
Formula 3	140.25±2.28^a	310.93±3.73^b	**2.21±0.04^b**

Values ± standard deviation followed by the same letters in the same column is not significantly different at p ≤.05.

TABLE 7. Sensory evaluation of soft and toasted bread.

Parameters	Formula 1		Formula 2		Formula 3	
	Soft	Toasted	Soft	Toasted	Soft	Toasted
Color crust (20)	19.46 ±1.45[a]	19.28 ±1.46[a]	18.14 ±1.67[b]	19.26 ±2.07[a]	15.38 ±2.46[c]	16.28 ±1.50[c]
Color crumb (20)	19.89 ±1.31[a]	19.06 ±1.45[a]	17.38 ±1.72[b]	18.24 ±1.51[b]	16.42 ±2.38[c]	16.47 ±1.33[c]
Taste (20)	19.37 ±2.04[a]	19.47 ±1.37[a]	18.55 ±1.22[b]	19.41 ±1.75[a]	16.32 ±3.50[c]	14.29 ±2.06[d]
Odor (20)	19.95 ±1.94[a]	19.29 ±2.16[a]	19.80 ±2.12[a]	18.36 ±2.49[b]	14.10 ±2.93[d]	15.22 ±3.10[c]
Symmetry of porosity (20)	19.54 ±1.59[a]	19.30 ±2.01[a]	19.35 ±1.68[a]	19.23 ±1.20[a]	15.49 ±1.52[c]	16.92 ±1.36[b]

Values ± standard deviation followed by the same letters in the same row is not significantly different at $p \leq 0.05$.

Conclusion

Based on the aforementioned findings, it is possible to conclude that treatments are capable of lowering AA levels in toasted bread. Meanwhile, there is an urgent need to collaborate with scientists in exerting efforts to find technological strategies able to minimize AA formation in foods. Over and above, we should spread awareness among producers and consumers about the toxic effects of AA by means of mass media because consumers are becoming more health conscious and demand high quality food products. Last but not least, taking into consideration, experiments are easy to apply, low cost, maintain on quality properties and consumers acceptability.

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تأثير بعض الاضافات على تكوين الأكريلاميد

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سلامة الغذاء ضرورية لصحة الإنسان. ولكن تحقيق ذلك الهدف يواجه تحديات صعبة ومنها تكوين مادة الأكريلاميد عند التعرض لدرجات الحرارة المرتفعة اثناء عملية اعداد الطعام. يهدف هذا البحث إلى دراسة تأثير بعض الإضافات على تكوين الأكريلاميد فى خبز القوالب (التوست) ولذلك تم إعداد ثلاث عينات (١) كنترول. (٢) إضافة مزيج من أملاح (كلوريد الصوديوم وكلوريد الكالسيوم وكلوريد المغنسيوم وكلوريد البوتاسيوم) بنسبة (٥,٪) لكل منهم. (٣) إضافة مزيج من هيدروكلويدات (حمض الألجينك والبكتين وصمغ الزانثان) بنسبة (١٪) لكل منهم. أظهرت النتائج أن مزيج الأملاح أدى الى انخفاض الأكريلاميد بنسبة (٨١,٠٩٪) و مزيج الهيدروكلويدات أدى لخفض الأكريلاميد بنسبة (٧٥,٦٢٪) وأن العينة (٢) احتوت على (٠,٣١جم/ ١٠٠جم) من الصوديوم وهى تناسب مرضى ضغط الدم المرتفع وأن العينة (٣) احتوت على (٠,٣١جم / ١٠٠ جم) من حمض الفينيل الانين وهى تناسب مرضى الفينيل كيتونوريا ونفس العينة (٣) تناسب مرضى السيلياك لخلوها من جلوتين القمح . ومن حيث التقييم الحسى كانت العينة (١) أفضل من العينة (٢ و ٣) وبناءاً على ما سبق نوصى بالاستفادة من تلك المعاملات فى خفض الأكريلاميد لهذة الفئات الحساسة.