Bull. Fac . Agric., Cairo Univ., 71: 307-315(2020) .

PRODUCTION OF SAFE AND HEALTHY PRETZELS

(Received: 28.10.2020)

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ABSTRACT

Pretzels product is very popular snack food for different age stage specially children. The effect of different alkali caustic solutions, substituting wheat flour (ex. rate 72%) with corn and rice flour at (50:50) percentage and addition of three spices (turmeric 2%, paprika 2%, and chili 1.5%) on pH, mineral content, chemical composition, sensory evaluation, texture and water activity as storage quality of product, percentage of the recommended dietary allowances (RDA%), and economic pretzel cost were examined. The KOH (1.5%) as caustic solution was preferred for cooking step at pH and mineral content. While a typically pH recorded for pretzels treated with KOH was approximate 7 for dough, which decrease by baking to around pH 5. Sensory evaluation showed that the control and rice turmeric had the highest value for overall score. Chemical composition recorded significant values for protein ranging the from 3.01 to 3.86. Ash, fat and calories had the highest value in corn paprika pretzels. Also KOH solution had a good effect on pretzels quality (color, texture). Additional KOH as caustic solution had good effect on mineral content for all samples especial K content. Mg and Ca were high in corn and rice paprika pretzels. The keeping quality for pretzels indicated there was no high change in value (texture, water activity a_W) during storage periods for 3 months. The percentage of the recommended dietary allowances (RDA %) are provided from 100g of product for children (7-10) years indicated that all samples provide body with10- 12 % protein, 20% calories, 20- 24% of Fe, 8- 18% of Ca and 29- 63% of Mg. The cost of pretzels ranged between 2.50 and 3 L. E. /100g This study indicated that corn and rice pretzels treated with KOH solution were healthy functional snacks with low input cost.

Key words: *Pretzels; different caustic solutions; spices; parameter quality.*

1. INTRODUCTION

Pretzels are acknowledged as a healthy snack and are gaining popularity around the world. The pretzel production process includes dough mixing, forming/shaping using an extruder at low pressure, cooking in a hot alkali solution, and baking. The baking process is divided into two steps: (1) first rapid baking at high temperature and (2) a slower, and lower temperature for drying to reduce moisture content to < 4% (Seetharaman, 2014). Pretzel represents a major, growing portion of snack worldwide. The sales in the United States alone exceed 1-2 billion in 2001(Seetharaman *et al*., 2002). Research on pretzels is particularly lacking with respect to the properties of raw materials or processing parameters that influence final product qualities from the perspective of consumers. Practically, no research has been done in these areas since hard pretzels were introduced into America in hard pretzel manufacturing, including processing methods (Rooney and Rooney, 2001).

Sodium is used as NaCl and NaOH in different steps for processing pretzels. Sodium can be bad for health. According to the *Dietary Guidelines for Americans*, diets higher in sodium are associated with an increased risk of developing high blood pressure and increased risk of hypertension and related cardiovascular diseases. This situation led to a trend of Dietary sodium intake (DSI) reduction by decreasing the use of common salt (NaCl) in the regular diet and/or by increasing dietary potassium intake (DPI). Most children and adults consume too much sodium, as the major component of salt in foods they eat. Foods high in sodium include processed and convenience foods, processed meat, soups, and some snack foods. This was the reason why the World Health Organization

(WHO) issued a "strong recommendation" about the upper sodium intake which was set at 2.0 g/d, which is equivalent to 5.0 g/d of salt (NaCl) (WHO, 2012a). The Daily Value (DV) for sodium is less than 2,300 milligrams (mg) per day, the Daily Value (DV) for potassium is 4,700 mg per day. Its is recommended to use the Nutrition Facts label to compare and choose foods to get 100% DV of potassium on most days (WHO, 2012b).

Maize (*Zea mays*) is rich in energy and good quality protein, the pericarp fraction contains 77.7- 84.6% dietary fiber (Cho *et al*., 2014). Also, Rice (*Oryza sativa*) is the second cereal crop in Egypt after wheat (Abdelaal and Thimany, 2019). These are good sources of pretzels (Paykary *et al*., 2016). Doweidar, (2006) reported that chemical composition of white rice and corn flour contains 7.72 and 8.49 protein, 90.74 and 87.01 carbohydrate, 0.68 and 2.14 fat, 0.48 and 1.20 crude fiber, and 0.38 and 1.16 ash, respectively.

Curcuma or turmeric (*Curcuma longa* L.) is a rhizomatous monocytyledonous perennial herbaceous member of the ginger family (Zingibera). Curcuma contains 60-70% carbohydrate, 8.6% protein, 5-10%, fat, 7% fiber, 3-5%, curcumoid (50-70% curcummin, as active component in turmeric) and up to 5% essential oil and resins (Goel and Aggarwal, 2010).

Red peppers *(Capsicum annuum* L.) are one of the most important spices, widely cultivated and used all over the world. This crop is widely consumed as fresh vegetable or condiment and used for pharmaceutical and cosmetic purposes. The amounts and characteristics of flavoring, coloring and especially pungent principles of Capsicum fruits are important quality parameters. Their strong pungency has been attributed to capsaicinoids, of which capsaicin and dihydrocapsaicin constitute more than 80% (Giuffrida *et al*., 2013). Furthermore, red pepper is an excellent source of ascorbic acid and polyphenols, particularly flavonoids, quercetin and luteolin. Thus, all the mentioned compounds show antioxidant activity as potential action against certain cancers, stimulate the immune system, prevent cardiovascular diseases and delay the aging process, amongst other biological activities (Guil-Guerrero *et al*., 2006). In fact, large red bell pepper contains over 300% of the daily value (DV) for this nutrient (Chuah *et al*., 2008). Cepanec *et al*., (2017) reported that the application of spices or herbs, their extracts, and various vegetables as taste improvers in potassium chloride (KCl)-based salt substitutes is not a new idea. Among them, many common seasoning herbs, their extracts, as well as vegetables in finely milled powderous form have been used: (i): Seasoning herbs: turmeric (*Curcuma longa* L.); (ii) Vegetables: red capsicum and chili pepper (*Capsicum annuum* L.); and (iii) Miscellaneous mixtures of these ingredients.

The present study aimed to produce functional pretzels by using KOH caustic solution as alternative alkali solution instead of NaOH solution. Corn, rice flour and different spices *i.e* turmeric, paprika and chill were used to produce healthy pretzels formula and pretzels products were evaluated chemically, organoliptically and economically.

2. MATERIAL AND METHODS

2.1. Materials

Wheat flour (*Triticum aestivom* L.) (72%) extraction rate was obtained from Al-Salam-Company for Milling and Baking, Cairo, Egypt. Baking Ingredients: yeast, sugar, corn starch, corn oil, corn flour (*Zea mays*), rice flour (*Oryza sativa*), red capsicum (paprika) and chili pepper (*Capsicum annuum* L.), turmeric (*Curcuma longa* L.) and salt were obtained from the local market Giza, Egypt.

- All chemicals used in the experiment were of analytical grade.

2.2. Methods

2.2.1. Preparation of samples

Preparation of six blends from corn and rice flour were mixed with wheat flour (ex. rate 72%) at percentage of 50:50%, and adding for blend separately 2% turmeric or 2% paprika or 1.5% chili. The formulas of the blends used for production pretzels are shown in Table (1).

2.2.2. Preparation of caustic solution

Three solutions were prepared as caustic solutions of NaOH (1%); KOH (1.5%); and $CaCO_3$ (2%).

2.2.3. Production of pretzels

Pretzel samples were produced according to Seetharaman *et al*. (2004) method as follows:

Flour (100g), fat (20g), sugar (one g), yeast (one g), turmeric (2g) or paprika (2g) or chili (1.5g) separately and salt (one g) were mixed for one min. The water (50% flour basis) was added and remixed for 4min to form dough. The dough was left to rest for 20 min then shaped. The shaped pretzel passed through a dipping solution (1 % sodium hydroxide or 1.5 % potassium

Table (1): Formulas of blends of corn/ rice used for the production of pretzels.

Ingredients	Corn blend (g/100g)			Rice blend (g/100g)			Control blend
	C1	C2	C3	R1	R2	R3	
Corn/Rice flour	**50**	**50**	**50**	**50**	**50**	**50**	**-**
Wheat flour	**50**	**50**	**50**	**50**	**50**	**50**	**100**
Yeast	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Sugar	1	1	1	1	1	1	1
Oil	**20**	**20**	**20**	**20**	**20**	**20**	**20**
Salt	1	1	1	1	1	1	1
Turmeric powder	**2**	**-**	**-**	**2**	**-**	**-**	**-**
Paprika powder	**-**	**2**	**-**	**-**	**2**	**-**	**-**
Chili powder	**-**	**-**	**1.5**	**-**	**-**	**1.5**	**-**
Water	**52**	**52**	**51**	**52**	**52**	**51**	**50**

hydroxide or 2% sodium carbonate separately) at 95 C̊ for 10- 15 sec. the produced pretzel was baked at 180 C̊ for 10 min then 93 C̊ for 30 min. The prepared pretzels were cooled and then packed in polyethylene bags until further analysis and storage for 3 months.

2.2.4. Proximate analysis: Moisture, protein, fat, crude fiber, and ash contents of the raw materials and treatments were determined according to the methods of AOAC (2005). Determination of total carbohydrates was calculated by difference.

2.2.5. Determination of minerals: Minerals contents (Na, K, Ca, Mg, Zn, and Fe) were determined using methods of **AOAC (2005).** Perkin Elmer (Model 3300, USA) Atomic Absorption Spectrophotometer was used to determine these minerals.

2.2.6. Sensory evaluation: Different treatments of produced pretzel were organoleptically evaluated for general appearance, color, crispiness, flavor and overall score by using 10 panelists according to the method of Khan and Nowsad (2012).

2.2.7. Determination of water activity (aw): The water activity was measured with a Rotronic (model Hygrolab3 made in Switzerland). The ground sample of pretzels in zero time and during storage periods (3 months) was filled in the plastic cups approach the top and the Hygroplam probe was inserted in these cups. After almost three to four minutes the display showed the water activity reading, along with temperature (Piga *et al*., 2005).

2.2.8. Texture analysis: Texture analyzer (Brookfield CT3 No. M08-372-C0113, USA) was used to measure the texture profile of pretzels at zero time and during storage in terms of hardness (N), adhesiveness (mj) of the samples according to the method described by Meullenet *et al*., (1998).

2.2.9.Determination of pH: The pH was measured using a pH meter (Hanna Instruments, FC200B, USA).

2.2.10.The economical evaluation of pretzels

The economic cost of pretzels were calculated for the raw materials (corn flour, rice flour, ete…) price and production cost.

2.2.11.Statistical analysis

The Data were analyzed using CoStat, version 3.03 for personal computers according to Ott, (1988). The tests used ANOVA test and descriptive statistics test. A treatment effect was assumed to be statistically significant at $P < 0.05$

3. RESULTS AND DISCUSSION

3.1. Effect of different caustic solution on minerals content

The effect of different caustic solutions (NaOH, KOH, and $CaCO_3$) as treatment for pretzel on minerals content of control pretzel sample (wheat flour 100%) are shown in Table (2).

Table (2): Effect of different caustic solutions on minerals content of control pretzel (mg/100g).

Sample	Na	K	Ca	Mg	Zn	Fe
1	651.33	200.29	59.78	65.33	2.06	1.19
2	513.73	328.43	61.28	57.06	2.14	1.82
3	612.15	140.89	133.37	65.97	2.6	1.29
caustic solution with 1) NaOH; 2) KOH; and 3) $CaCO_3$						

Sodium is essential for cellular homeostasis and physiological function. Excess dietary sodium has been linked to elevations in blood pressure (BP). Salt sensitivity of BP varies widely, but certain subgroups tend to be more salt sensitive. The mechanisms underlying sodium-induced increases in BP are not completely understood but may involve

alterations in renal function, fluid volume, fluid-regulatory hormones, the vasculature, cardiac function, and the autonomic nervous system. Recent pre-clinical and clinical data support that even in the absence of an increase in BP, excess dietary sodium can adversely affect target organs, including the blood vessels, heart, kidneys, and brain (Farquhar *et al*., 2015). Table (2) shows that sample 1 was the highest in Na content (651.33mg/100g) which used sodium hydroxide as caustic solution in pretzel production. The high sodium content in diet may be due to increase elevate the blood pressure as mentioned by Farquhar *et al*. (2015). Thus KOH was pre ferd as the caustic solution (sample 2) in the following pretzel producing as shown later which was the lowest content of sodium (513.73 mg/100 g). Calcium is the main source of the building blocks of bones and teeth. The data show that, calcium content was high in sample 3 which was treated with CaCO3 solution as a source of calcium, then sample 2. Sample 1 was the lowest sample in calcium content. Zinc and magnesium are essential for normal growth, development of the immune response and participating as a factor for more than 300 enzymes (Salgueiro *et al*., 2002). Data in Table (2) show that Zn and Mg increased in sample 3 as a result of raw material in that samples. Iron has several vital functions in the body, it serves as a carrier of oxygen to the tissues, as a transport medium for electrons within cells and as an integrated part of important enzyme system in various tissues (FAO/WHO, 2004). The data in Table (2) revealed that Fe content was high in sample 2 (1.82 mg/100 g) containing KOH solution, then sample 3 (1.29 mg/100 g) and sample 1(1.19 mg/100 g).

3.2. Effect of different caustic solutions on the pH of pretzel dough and after baking

Table (3) shows the effect of different caustic solutions on pH of pretzel dough and after baking of the control pretzel sample (100% wheat). The data indicated that treatment with NaOH as caustic solution had the highest value of pH for dough (8.2), while treatment with KOH as caustic solution had the lowest value of pH for dough and after baking (7.11& 5.32). Meanwhile, treatment with CaCO3 had the highest value of pH for sample after baking (6.36). This may be due to the used NaOH as caustic solution increased pH in dough and final product. This result agrees with West and Christopher, (2002) who reported that the surface pH on a traditionally made soft pretzel is alkaline because of a necessary caustic bath or cook step.

Table (3): Effect of different caustic solutions on pH of pretzel dough and after baking of the control pretzel.

sample	pH in dough	pH in product
1	8.2 a ±0.01	5.97 b ±0.02
2	7.11 c ±0.05	5.32 c ±0.04
3	7.68 b ±0.03	6.36 a ±0.14
L.S.D(0.05)	**0.06**	**0.13**
Control with caustic solution 1) NaOH; 2) KOH; and 3) $CaCO_3$		

Means in the same column with different letters are significantly different ($p \leq 0.05$).
Each mean value is followed by ± SE (standard error).

3.3. Effect of KOH as a Caustic solution on pH of pretzel dough and after baking of rice and corn blends

The effect of KOH as a caustic solution on pH of pretzel dough and products from rice and corn blends with wheat flour at percentage (50%: 50%) are shown in Table (4).

From Table (4) it could be concluded that all dough samples were around pH 7, while the sample 2 recorded the highest value of pH (7.16), and the lowest value of pH in dough was 6.59 for sample 4. Whereas the highest pH value of products (after baking) was 5.44 in sample 4. However, the lowest value of pH was 5.25 for sample 5. From the above results, it could be concluded that corn flour acompanied by turmeric had alkalized effect when KOH used was as caustic solution for dough, while decreased pH in the final product may be due to

Table (4): Effect of KOH as a Caustic solution on the pH of pretzel dough and after baking.

Treatments	pH in dough	pH in product
1	7.11 a ±0.05	5.32c±0.04b
Blends from Corn		
2	7.16 a ±0.02	5.31 bc ±0.03
3	7.09 a ±0.02	5.53 a ±0.01
4	6.59 c ±0.67	5.44 b ±0.06
Blends from Rice		
5	7.1 a ±0.02	5.25 c ±0.06
6	7.11 a ±0.02	5.4 b ±0.04
7	6.87 b ±0.18	5.39 b ±0.02
L.S.D(0.05)	**0.12**	**0.07**
1) Cont.; blends from corn(2:Turmeric; 3: paprika; 4: Chili); blends from rice(5:Turmeric; 6: paprika; 7: Chili		

Means in the same column with different letters are significantly different ($p \leq 0.05$).
Each mean value is followed by ± SE (standard error).

release CO_2 gas from active yeast during baking temperature effect on pH in the final product. The results are in agreement with Johnson *et al*. (1980) who reported that an alkaline solution added to corn increased its yellowness, pH, and flavor with simultaneous darkening.

3.4. Sensory evaluation of pretzel produced from corn and rice blends

In a preliminary study the sensory scores of the pretzel with NaOH, KOH and CaCO3 solutions were tested. The KOH solution had a good effect on pretzel quality, thus, we selected KOH solution to produce pretzels with corn and rice flour which may be good for panelists.

Sensory quality attributes of pretzel expressed by panelists are presented in Table (5).

Significant differences were found in crispness, color, flavor, general appearance and overall scores for the produced samples. The crispness for all samples ranged between 9.5 and 8, the highest value was noticed for control (1), then sample 3 (corn paprika pretzel) and sample 5 (rice turmeric pretzel), but the lowest value was for samples 2, 4 and 7. Concerning color, the panelists preferred the control sample followed by sample 3 then sample 2 and sample 5. The flavor had the highest value for samples 1, 2, 3 and 4 (9), while the low value was for samples 5, 6 and 7 (8). The highest of overall score value was noticed in the control sample, then 2, 3 and 5 samples without significant difference between them. The lowest value of overall score was noticed in sample 7 (rice chili pretzel). Yao *et al*. (2006) suggested that the color that developed on pretzel surface was not due to pigments present in the flour but was contributed by the reaction within or between the starch and protein hydrolysis derivatives during baking.

3.5. Chemical composition of pretzel produced from corn and rice blends and different spices

The data in Table (6) show that moisture content of all pretzel samples ranged from 4.18 % to 6.23 % and the highest value was noticed for control sample. Such increment in moisture may be due to the high protein content in wheat flour which absorbed more water than starch. The protein in all pretzel samples ranged from 3.01 % to 3.86 %. The highest value was noticed in the control sample but the lowest value was noticed in sample 6 (rice paprika pretzel). Significant difference in fat content was observed between pretzel samples and could be pronounced in sample 7 (rice chili pretzel) followed by sample 3 (corn paprika pretzel) and the lowest value was noticed in the control sample. Crude fiber significantly increased in samples 4 then sample 7 These samples contained corn chili flour and rice chili flour respectively which they had more fiber compared to wheat flour. There was little difference in total carbohydrates and calories among all pretzel samples as shown in Table (6).

According to FAO (1992), protein content of maize ranges from 8 to 11%, a variety of snack foods widely consumed by Nigerians are made of low-protein cereals with lysine and tryptophan as limiting amino acids that are essential for human nutrition. Protein quality of rice surpasses that of wheat and corn while it is just inferior to oats. Also, rice protein is hypoallergenic and contains good quantity of lysine. Thus it may act as a suitable ingredient for infant food formulations while adding variety to the restricted diets of children with food allergies (Gurpreet and Sogi, 2007). Amino acid profile of rice protein was better than casein and

Table (5): Sensory evaluation of pretzel.

Sample	Crispness	Color	Flavour	General appearances	Overall Score
1	9.5 a ±0.03	10.0 a ±0.0	9.0 a ±0.0	10.0 a ±0.0	38.5 a ±0.32
Blends from Corn					
2	8.0 d ±0.54	9.0 c ±0.32	9. 0 a ±0.32	9.0 c ±0.32	34.92 b ±0.8
3	9.0 b ±0.0	9.4 b ±0.38	9.0 a ±0.0	8.0 d ±0.32	35.41 b ±0.38
4	8.0 d ±0.32	8.0 e ±0.0	9.0 a ±.032	9.0 c ±0.32	34.0 c ±0.32
Blends from Rice					
5	9.0 b ±0.32	9.0 c ±0.0	8.0 b ±0.32	9.5 b ±0.32	35.5 b ±0.32
6	8.5 c ±0.32	8.5 d ±0.32	8.0 b ±0.0	9.0 c ±0.32	33.92 c ±0.2
7	8.0 d ±0.0	8.0 e ±0.32	8.0 b ±0.0	8.0 d ±0.32	32.0 d ±0.45
LSD 5%	**0.4**	**0.3**	**0.23**	**0.3**	**0.5**
1) Cont.; blends from corn(2: Turmeric; 3: paprika; 4: Chili); blends from rice(5: Turmeric ; 6: paprika; 7: Chili					

Means in the same column with different letters are significantly different ($p \leq 0.05$). Each mean value is followed by±SE.

Table (6): Chemical composition of pretzel on dry weight basis.

Sample	Moisture %	Protein %	Ash %	Fat %	Crude Fibre %	Total Carbohydrates %	Calories Kcal/100g
1	6.23 a ±0.0	3.86 a ±0.01	2.61 b ±0.01	4.81 g ±0.01	0.77 f ±0.0	87.95 a ±0.01	410.53 d ±0.01
Blends from Corn							
2	4.87 b ±0.01	3.61 b ±0.02	1.67 e ±0.01	5.59 d ±0.0	1.91 d ±0.02	87.22 a ±0.04	413.63 c ±0.04
3	4.48 f ±0.0	3.2 d ±0.1	2.8 a 1±0.01	7.11 b ±0.0	2.14 c ±0.01	84.74 abc ±0.1	415.75 b ±0.1
4	4.18 g ±0.0	3.54 b ±0.02	2.43 d ±0.02	6.31 c ±0.01	2.43 a ±0.01	85.29 ab ±1.4	412.11 b ±1.4
Blends from Rice							
5	4.77 c ±0.0	3.04 e ±0.07	2.58 b ±0.02	5.44 f ±0.01	1.81 e ±0.01	87.13 a ±0.07	409.64 d ±0.07
6	4.55 e ±0.01	3.01 e ±0.02	2.51 c ±0.01	5.54 e ±0.01	2.15 c ±0.14	86.79 ab ±0.06	409.06 d ±0.06
7	4.63 d ±00	3.44 c ±0.01	2.50 c ±0.05	7.17 a ±0.06	2.28 b ±0.03	84.61 bc ±1.32	416.73 a ±1.32
LSD 5%	**0.01**	**0.08**	**0.03**	**0.04**	**0.09**	**1.17**	**1.17**

1) Cont.; blends from corn(2: Turmeric; 3: paprika; 4: Chili); blends from rice(5: Turmeric; 6: paprika; 7: Chili

Means in the same column with different letters are significantly different ($p \leq 0.05$).
Each mean value is followed by ± SE (standard error).

soy protein isolate in fulfilling the amino acid requirements for 2–5 years old children (Wang *et al*., 1999).

3.6. Mineral content in pretzel produced from corn and rice blends and different spices

Table (7) revealed that the Na content in control pretzel (mg/100g), was low when using KOH caustic solution as compared with NaOH caustic solution as shown in the previous Table 2. Sodium recorded the highest value in corn turmeric pretzel (604.38); and the lowest value for corn paprika pretzel (503.29). Potassium has a role in heart health, so we prefer KOH caustic solution, potassium recorded the highest value in sample 7(rice chili pretzel). The data revealed that the Ca, Mg and Fe content were high in corn paprika pretzel, then rice paprika pretzel. But the corn chili pretzel was the lowest sample in Ca and Mg content. Table (7) revealed that Zn content was almost the same in corn turmeric and rice chili pretzel. The corn chili pretzel was the lowest one in Zn content.

3.7. Keeping quality in pretzels produced from two blends (corn& rice) and different spices

The moisture of final product, usually controlled at 2–4%, for product quality and shelf life. Pretzels with too low moisture tend to be very fragile during packing and transportation, while pretzels high in moisture content become stale during storage and thus will not be accepted by consumers. The data presented in Table (8) showed hardness and water activity of pretzels made from two blends (corn& rice) and different spices. The table indicated that there were no high change in value between zero and the end of storage period for hardness; where the highest value recorded was in blends of corn with chili spice for zero time and after storage (43.66& 30.15 N, respectively). Adhesiveness recorded high value after storage period for corn blends and the highest value was recorded for corn paprika pretzel (7.50mj). Moreover, the water activity recorded values between (0.428-0.502) in all treatments; where its data indicated that don't high change in value during storage period. Hence the highest value for water activity (0.502) recorded in sample turmeric rice after storage (3 months). These results may be due to the presence of amorphous granules starch keeping as low moisture content.

3.8. The recommended dietary allowances for pretzels (RDA %)

The percentages of the recommended dietary allowances (RDA %) are provided from 100g of produced pretzels for children (7- 10 years) are shown in Table (9). It could be observed that all values of RDA% for protein ranged from 10.75% to 13.79%. This increase in RDA% of protein in control pretzels may be due to high protein content in wheat flour than rice flour and corn flour**.** Meanwhile, RDA% for calories was almost the same values. Concerning RDA% for Fe and Ca was the highest values in corn pretzels than control and rice pretzels.

Among pretzels samples, corn or rice paprika caused an increase in RDA % values of Fe, Ca and Mg, this increase in RDA% may be due to

Table (7): Mineral content in pretzel produced from corn and rice blends and different spices (mg/ 100g).

Sample	Na	K	Ca	Mg	Zn	Fe
1	513.73	328.43	61.28	57.06	2.14	1.82
Blends from Corn						
2	604.38	302.63	105.97	50.5	2.48	2.11
3	503.29	357.86	149.17	107.82	1.85	2.41
4	581.92	367.65	62.04	49.29	1.29	2.12
Blends from Rice						
5	552.05	282.75	83.99	74.10	1.42	2.02
6	548.95	392.45	124.3	102.38	1.56	2.32
7	556.89	394.61	70.15	85.78	2.33	2.11

1) Cont.; blends from corn(2: Turmeric; 3: paprika; 4: Chili); blends from rice(5: Turmeric; 6: paprika; 7: Chili

Table (8): Keeping quality for pretzel produced from corn and rice blends and different spices during storage periods (3 months).

Samples	Period storage	Hardness(N)	Adhesiveness(mJ)	a_W in Z.T	Ċ	a_W in As	Ċ
(Cont. KOH)	**Z.T**	**31.46**	**0.00**	0.430	22.12	-	-
	AS	**26.37**	**0.00**	-	-	0.472	22.15
Blends from Corn							
Turmeric	**Z.T**	**26.13**	**0.20**	0.430	22.08	-	-
	AS	**22.19**	**0.40**	-	-	0.474	22.08
Paprika	**Z.T**	**15.30**	**0.00**	0.428	22.10	-	-
	AS	**15.30**	**7.50**	-	-	0.483	22.06
Chili	**Z.T**	**43.66**	**0.10**	0.428	22.13	-	-
	AS	**30.15**	**0.30**	-	-	0.481	22.11
Blends from Rice							
Turmeric	**Z.T**	**31.04**	**0.10**	0.440	22.13	-	-
	AS	**21.59**	**0.30**	-	-	0.502	22.13
Paprika	**Z.T**	**34.61**	**1.10**	0.440	22.1	-	-
	AS	**26.63**	**0.80**	-	-	0.495	22.08
Chili	**Z.T**	**23.58**	**0.00**	0.433	22.12	-	-
	AS	**22.15**	**0.00**	-	-	0.487	22.12

Z.T: zero time ; AS: After storage a_w: water activity

Table (9): The recommended dietary allowances for pretzels (RDA %).

RDA %					
Samples	**Protein(28g)**	**Calories(2000Kcal)**	**Fe(10mg)**	**Ca(800mg)**	**Mg(170mg)**
1	13.79	20.52	18.2	7.66	33.56
Corn blends					
2	12.89	20.68	21.1	13.19	29.71
3	11.43	20.79	24.1	18.65	63.42
4	12.64	20.79	21.2	7.75	28.99
Rice blends					
5	10.86	20.48	20.2	10.5	43.59
6	10.75	20.18	23.2	15.54	60.22
7	12.29	20.99	21.1	8.77	50.46

1) Cont.; blends from corn(2: Turmeric; 3: paprika; 4: Chili); blends from rice(5: Turmeric; 6: paprika; 7: Chili

According to: **Food and Nutrition Board, Institute of Medicine and National Academies (2004).** Dietary reference intakes (DRIs).

the high content of Fe, Ca and Mg of paprika than turmeric and chili.

3.9. Economic evaluation for pretzel

The production cost of 100g pretzels ranged between 2.50 and 3 L.E. The cost of pretzels could be justified to consumer by increasing of their potential health benefit.

Conclusions

Pretzels are very popular snack food for children and adults, therefore the effect of different alkali caustic solution and supplementary mixture of corn and rice flour instead of wheat flour with different spices to produce healthy pretzels. The results concluded that KOH as caustic solution is preferred for cooking step instead of NaOH solution. Control and rice pretzels had the highest value for overall score with considerable significant protein. In addition to KOH solution had a good effect on pretzels quality such as color, sensory characteristics (texture and color).Also KOH solution caused improving storage period for 3 months. Water activity values indicated that the pretzels with KOH solution were in the safe range to 3 months.

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أنتاج بريتزل صحى وأمن

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ملخص

يعتبر البريتزل من المقرمشات الغذائية المحببة لمختلف الأعمار خاصة الأطفال. تم فى هذه الدراسة تقييم تأثير محاليل غمر قلوية مختلفة، وتأثير إستبدال دقيق القمح استخلاص 72% بدقيق كلا من الذرة والأرز بنسبة (50:50) وأضافة ثلاث أنواع من التوابل (كركم 2%، بابريكا 2%، شطة 1.5%) وتأثير ذلك على محتوى الحموضة، المعادن، التركيب الكيماوى، التقييم الحسى، (القوام، النشاط المائى) كجودة تخزينية للمنتج وتقييم التكلفة الاقتصادية للبريتزل. أظهر محلول هيدروكسيد البوتاسيوم (1,5%) كمحلول غمر انه أفضل معاملة طبخ على محتوى الحموضة والمعادن، وكانت درجة ال pH المثلى فى البريتزل المعامل بهيدروكسيد البوتاسيوم 7 فى العجائن، بينما انخفضت بعد الخبز الى 5 . سجل التقييم الحسى أعلى قيم فى كلا من بريتزل الكنترول، ألأرزبالكركم والذرة بالبابريكا. سجل التركيب الكيماوى قيم معنوية حيث ترواح البروتين من 3.01 الى 3.86، وسجل أعلى قيم فى محتوى كلا من الرماد، الدهن و السعرات الحرارية فى بريتزل الذرة بالبابريكا. كما تميز محلول هيدروكسيد البوتاسيوم بكونه أحسن تأثير على جودة البريتزل خاصة اللون والقوام. كما كان له تأثير جيد على محتوى المعادن لكل العينات خاصة محتوى البوتاسيوم وزيادة محتوى كلا من الماغنسيوم والكالسيوم فى بريتزل كلا من الذرة, الأرز بالبابريكا. دلت جودة الحفظ (الجودة التخزينية) للبريتزل على أنه لاتوجد فروق معنوية لكل من القوام، النشاط المائى خلال فترة التخزين لمدة 3 شهور. كما دلت النسبة الموصى بها خاصة للأطفال (7- 10) سنوات ان البريتزل المنتج يمد الجسم ب 10- 12% من احتياجاته اليومية من البروتين، 20% من السعرات الحرارية، 20-24% من الحديد، 8- 18% من الكالسيوم و 29- 63% من الماغنسيوم. تراوحت تكلفة البريتزل 2.5- 3 جنيها لكل 100جرام. نستخلص من الدراسة أنه أمكن انتاج بريتزل من دقيق كلا من الذرة و الأرز ودقيق القمح والتوابل والمعامل بهيدروكسيد البوتاسيوم كمنتج وظيفى صحى وبتكلفة منخفضة.