



## The effect of the using corn flour level and additive type on quality of corn bread

Halis Gürbüz Kotancılar<sup>1</sup>, Hilal Güdük<sup>1</sup>, Kimya Seyyedcheraghi<sup>1</sup>

<sup>1</sup>Department of Food Engineering, Faculty of Agriculture, Ataturk University, 25240, Erzurum

### MAKALE BİLGİSİ

Geliş Tarihi: 09.10.2018  
Kabul Tarihi: 18.12.2018  
Elektronik Yayın Tarihi: 31.12.2018  
Basım: 15.01.2019

### ABSTRACT

The effects of different levels of corn flours and additives on traditionally produced (in the Black Sea Region) corn bread's quality parameters were studied; the breads containing different levels of corn flour (0%, 10%, 20%, 30%, 40%, 50%, 75%, 100%) in flour formulation were produced as two different additives type [(10% whole egg, 10% butter and 5% yogurt combination and without addition (control)]. As a result, the additive, one of the main variation sources, was found to have a high very significant ( $p \leq 0.01$ ) effects on mass, volume, specific volume,  $L^*$  and  $a^*$  color values of crumb, and crust of bread and the moisture values of crumb (0, 1 and 2. days). Besides, the same variation source was also found to have a high very significant ( $p \leq 0.01$ ) effects on sensorial appearance, porosity, texture, volume, color of crust, color of crumb, chewiness, taste, aroma, overall acceptability, and hardness, cohesiveness, elasticity, chewiness, and gumminess parameters measured on 0, 1 and 2 days. parameters. Also corn flour variant had a highly significant ( $p \leq 0.01$ ) effects on the mass, volume, specific volume,  $L^*$  and  $a^*$  color values of crust,  $a^*$  color value of crumb, the moisture values of crumb and sensorial appearance, porosity, texture, volume, color of crust, color of crumb, chewiness, aroma, and overall acceptability, hardness (0, 1, and 2. day), cohesiveness (day 1), elasticity (day 0), chewiness (day 0, and 2), gumminess (day 0, 1, and 2) and significant ( $p \leq 0.05$ ) effects on cohesiveness (day 0, and 2) and cohesiveness (day 2) parameters. Also analyze of variance indicated that the interaction between addition and amount of corn flour was significantly ( $p \leq 0.01$ ) in most traits.

**Key words:** Corn flour, corn bread, textural properties, sensory analysis.

## 1. Introduction

According to the Turkish food codex bread and bread varieties (Communiqué No: 2012/2). Cornbread; according to the technique at least 20% corn flour or cornmeal is added to the wheat flour and the bread is produced [1]. Grains have high energy content depending on the amount of carbohydrate. In addition to this, the satisfaction of the grain products is another important feature. They are neutral in terms of taste and aroma, and with this feature, they have become food items that can be renewed without being tired of their age [2]. Corn is an important plant which is used both in human nutrition and in the animal feed ration. In the world, most of it is used as animal feed. It can also be used in making bread, popcorn, cornflakes, corn oil and corn syrup. Starch and oil are very important types of corn grain. From 100 kg of corn grain yield, 77 kg of starch, 2 kg of sugar, 9 kg of protein, 5 kg of oil and 7 kg of other ingredients may be obtained [3]. [4], investigated the effect of wheat, wild oat, corn and pea husk on bread qualities and determined the chemical composition. It has been found that the ratio of total dietary fiber (90.3%), neutral detergent fiber (Fibrous materials consisting of hemicellulose, cellulose, lignin, cutin and silicon, which are insoluble in neutral detergent solutions) (87.6%) and hemicellulose (65.2%) is higher in corn cobs compared to other dietary fiber sources and wheat kernels cobs [5].

The gluten protein of the wheat grain endosperm, which gives a characteristic structure to the dough made from wheat flour cannot be found in corn grain. Gluten is responsible for viscoelastic properties of dough. Occurs a strong dough structure in resulting interaction of gluten with each other [6]. The increase in viscoelastic properties of the wheat flour paste is attributed to the gluten content of the flour [7]. The higher the gluten content of the wheat flour, the higher the viscoelastic properties of the dough will be obtained [8]. When the bread is made from corn alone a strong dough structure cannot be formed because corn flour does not have this protein. The main storage protein of corn is the zein constitutes 45-50% of the protein in maize. Due to negative nitrogen balance and low solubility in water, zein insulation cannot be used directly for human consumption [9].

The properties of the inner part of the bread being formed at the desired quality, the effects of improving the properties of the inner part of the oil, and during their

doughing and processing; depends on the solid fractions that can be found solid at the paste temperature [10]. The shortening, especially the dough, must be sufficiently solid during the final fermentation that the inclusion of solid crystalline fractions is necessary to have a positive effect on bread characteristics [11]. The use of yogurt in making bread positively affects the rheological properties of the dough, the volume of bread size, specific volume size, crust color, bread texture and coloring [12]. [13], they investigated the effect of dried egg yolks and phospholipase A2 on the rheological properties of wheat dough were investigated. With the addition of eggs, the dough softness decreased while the farinograph increased the dough development time and the dough stability. In the combination addition of egg yolk and phospholipase A2 was added, it was found to be significantly more effective than the formulation in which egg yolk was not included. When phospholipase A2 was added to the yolk of the fried egg, the gluten network structure of the dough increased.

The aim of this study, the effects of different levels of corn flours and additives types on corn bread's quality parameters.

## 2. Materials and methods

### 2.1. Materials

Corn flour was obtained from Trabzon. In this study wheat flour was used as flour. In addition, eggs, butter, yoghurt, salt and wet yeast were also supplied from the market, also the water was obtained from Atatürk University drinking water network.

### 2.2. Method

#### 2.2.1. Corn bread production

Bread were produced according to AACC-10/09 (1983) direct pastry process with and without additives in Grain Products Application Laboratories of Atatürk University Faculty of Agriculture Department of Food Engineering. In unadulterated formulations, 100 g of flour was added to 3% yeast, 1.5% salt and water detected in farinograph at the following ratios.; addition of water to the additive formulations at a rate determined in farinograph in 100 g flour based on 3% yeast, 1.5% salt, 5% yoghurt, 10% butter, 10% egg (as a whole) and Table 1.

The ingredients in the formulation were kneaded in the kneader for 5 minutes and then cut into 160 g masses and rounded off and then left for 30 minutes in the main fermentation chamber in a fermentation cabinet with a relative humidity of 75-80% and a temperature of 30°C. Ventilated doughs were left to rest at 75-80% relative humidity and 30 minutes at 30 ° C, after which they were placed in the trough. All the dough was incubated at 90% relative humidity and 30 minutes at 30 ° C for the final fermentation, followed by 25 minutes at 225°C.

**Table 1.** Water quantities % determined in farinograph of flours used in the experiment

Corn flour additive level (%)	Amount of water determined in farinograph (%)
0	60,0
10	56,5
20	54,5
30	53,0
40	50,0
50	48,0
75	Unidentified (%48)
100	Unidentified (%48)

### 2.2.2. Analyzes made on cornbread samples

Determination of the bread mass, size measurement, to determine the specific size of the bread [2] was based. Measurements of color intensity in the bread and its crumbs, crumb and crust determination of moisture content [14] were based. Sensory analysis was performed according to [15]. Determination of texture properties of the bread.

The method described by [16] for the texture analysis which has been modified. An SMS texture analyzer (Stable Micro System, model TA-Xt. plus, England) was used in conjunction with a 75 mm diameter probe for texture analysis of the bread and the textural properties of the center of the bread under the following conditions were determined to be two parallels. After the bread were made, they were cooled for one 1 hours and then placed in polyethylene bags and stored at room temperature for 2 days. Initial measurements (day 0) were made for one hour after the bread was removed from the oven. At the end of

the specified periods, the bread was cut into 2.5 cm thick slice in a special slicing cabinet and then cut into 2.5x2.5x2.5 cm size to center exactly the center of the bread.

The hardness, cohesiveness, elasticity and chewiness parameters which are closely related to the sensory properties were measured and the gumminess value was calculated [17].

### 2.2.4. Statistical analysis

In order to response of two different additives type [(10% whole egg, 10% butter and 5% yogurt combination and without addition (control)], eight different levels (0%, 10%, 20%, 30%, 40%, 50%, 75% and 100%) of corn flour the experiment was carried out as factorial experiment with completely randomized design of two replications. Analysis of variances carried out by SPSS program (SPSS 1999). Duncan Multiple Comparison Test was used to measure the statistical differences between treatment methods and controls ( $P \leq 0.01$ ) [18].

## 3. Results

### 3.1. Bread mass, volume and specific volume values of bread added to different levels of corn flour

In the present study analysis of variance (Table 2) indicated that there were significantly ( $P \leq 0.01$ ) affected by differences additive type, different levels of corn flour and their interaction based on the 1<sup>st</sup> and 2<sup>nd</sup> recurrences of the bread mass, volume, and specific volume.

The results of mean comparison of mass, volume and specific volume for additive type showed that the highest mean were observed in additive with 135.12 (g), 476.56 (ml) and 3.52 (ml/g) respectively, whereas the lowest was in without additive with 133.74 (g), 355.31 (ml) and 2.66 (mL/g) respectively. Based on amount of corn flour application, the highest means of mass, volume and specific volume were obtained that %40 with 137.23 g, 0.00% with 603.75 ml and 0.00 (control) with 4.54 ml/g application respectively, whereas the lowest was observed in 100% amount of corn application with 130.17 g, 241.25 ml, and 1.86 mg/l respectively. The result exhibited that

corn flour concentration application increased from 0.0 to 100.0%, volume and specific also increased (Table 2).

Analysis of variance displayed that there were significantly two-way interactions between additive type  $\times$  amount of corn flour ( $P \leq 0.01$ ) (Table 2). According to interaction effects of additive type and amount of corn flour, the highest mass, volume and

### 3.2. Crust color and inner color in the cornbread to different levels of corn flour and addition type

According to Table 3 there were significantly ( $P \leq 0.01$ ) affected by additive type, different levels of corn flour and their interaction based on crust color (such as; L, a and b except of amount of corn flour in b parameters) and Inner (such as; a except of amount of corn flour in L parameters and additive type, amount of corn flour and their interaction).

The results of mean comparison of crust and inner color (L, a and b) for additive type presented that the highest means were observed in without additive with 69.51, additive with 13.73, without additive with 32.05 respectively, whereas the lowest parameters were in additive with 51.95, without additive with 6.65 and additive with 31.55 in crust color respectively, while in inner color (L and a) the highest means were observed in additive with 64.77 in L parameters and without additive with -0.23 respectively, also the lowest was revolved that without additive with 64.56 in L parameters and a parameters with -1.26 in additive application. Based on amount of corn flour application, the highest means of crust and inner color (L, a and b) were achieved that the crust color in L parameters in %100 with 72.38, a parameters in 0.00% with 13.82 and b parameters in 100.0% with 49.64 respectively, while in inner color in L, a and b parameters at 100.0% consuming of corn flour with 68.45, 1.13 and 45.48 respectively. Whereas the lowest above parameters was observed in 0.00% amount of corn with 55.10 in L parameters in crust color, 100.0% amount of corn with 3.18 in a

specific in additive + %40 amount of corn flour (137.48 g), additive + %0.0 amount of corn (612.50 ml) and additive + %0.0 amount of corn (4.55 ml) respectively was achieved, but the lowest of traits above was obtained in additive + 100.0% amount of corn (129.79 g), without additive + 75.0% amount of corn (182.50) and without additive + 75.0% amount of corn (1.37%) respectively (Table 2).

parameter in crust color and 0.00% amount of corn with 27.44 in b parameters in crust color, whereas the lowest parameters in inner color in L (20.0% with 62.60), a (%30 with -1.70) b (0.0% with 15.69) was obtained (Table 3).

Analysis of variance showed that there were significantly two-way interactions between additive type  $\times$  amount of corn flour ( $P \leq 0.01$ ) in all parameters except b in inner color (Table 3). According to interaction effects of additive type and amount of corn flour, the highest value in L parameters in crust color was obtained in without additive + 100.0% (77.11) amount of corn flour but the lowest was achieved in additive + 40.0% (43.24%) application. While in a parameter, the highest value was accomplished in additive + 0.00% (17.67) application but the lowest was in without additive + 75.0% (1.91) application. As well as, the highest value in b parameter was realized in additive + 100.0% (50.51), but the lowest was obtained in additive + 40.0% application. Also according to Table 3, the highest value in L parameters in inner color was obtained in without additive + 100.0% (70.59) amount of corn flour but the lowest it was achieving in with additive + 00.0% (60.53%) application. While, in a parameter the highest value was obtained in additive + 100.0% (0.56) application but the lowest was in additive + 30% (-2.13) application (Table 3).

**Table 2.** Effect of different additive types and amount of corn flour on mass, volume and specific volume in the corn bread.

Addition	Amount of corn flour (%)	Mass(g)	Volume (ml)	Specific volume (ml/g)
Additive	0.00	134.72 c <sup>1</sup>	612.50 a	4.55 a
	10.0	137.42 c	587.50 b	4.28 b
	20.0	134.75 c	540.00 c	4.01 c
	30.0	135.29 bc	535.00 c	3.96 c
	40.0	137.84 a	497.50 d	3.61 d
	50.0	137.62 ab	435.00 e	3.16 e
	75.0	133.55 c	322.50 f	2.42 f
	100.0	129.79 d	282.50 g	2.18 g
	Average	135.12 a	476.56 a	3.52 a
Without additive	0.00	131.52 cd	595.00 a	4.53 a
	10.0	132.17 c	527.50 b	3.99 b
	20.0	132.91 bc	410.00 c	3.09 c
	30.0	135.75 a	370.00 d	2.73 d
	40.0	136.62 a	312.50 e	2.29 e
	50.0	136.61 a	245.00 f	1.79 f
	75.0	133.82 b	182.50 g	1.37 h
	100.0	130.55 d	200.00 g	1.54 g
	Average	133.74 b	355.31 b	2.66 b
Average (amount of corn flour)	0.00	133.12 d	603.75 a	4.54 a
	10.0	134.80 bc	557.50 b	4.13 b
	20.0	133.83 cd	475.00 c	3.55 c
	30.0	135.52 b	452.50 d	3.34 d
	40.0	137.23 a	405.00 e	2.95 e
	50.0	137.11 a	340.00 f	2.48 f
	75.0	133.68 cd	252.50 g	1.89 g
	100.0	130.17 e	241.25 h	1.86 g
	F value (additive type) A		31.05 <sup>2**</sup>	1252.00 <sup>**</sup>
F value (Amount of corn flour) A		22.24 <sup>**</sup>	2090.00 <sup>**</sup>	2056.00 <sup>**</sup>
F value (A × A)		6.132 <sup>**</sup>	68.00 <sup>**</sup>	86.00 <sup>**</sup>

<sup>1</sup>The averages shown by the same letter are statistically different from each other (P ≤ 0.05).

<sup>2\*\*</sup>: Significant at P ≤ 0.01, \*: Significant at P ≤ 0.05, ns: Non-significant at P ≥ 0.05.

**Table 3.** Effect of different additive types and amount of corn flour on the crust and inner color in the corn bread.

Addition	Amount of corn flour	Crust			Inner		
		L <sup>3</sup>	a <sup>3</sup>	b <sup>3</sup>	L	a	b
Additive	0.00	45.85 bc <sup>1</sup>	17.67 a	26.65 d	65.55	-1.56 bc	15.37
	10.0	45.58 bc	16.01 b	23.78 ef	64.54	-1.99 cd	19.54
	20.0	50.17 b	16.56 ab	28.92 c	64.53	-1.94 cd	23.70
	30.0	46.06 bc	16.33 b	25.00 e	64.39	-2.13 d	26.98
	40.0	43.24 c	14.67 c	22.40 f	64.31	-1.93 cd	29.61
	50.0	50.31 b	15.56 bc	28.97 c	64.17	-1.43 b	36.14
	75.0	66.71 a	8.67 d	46.16 b	64.35	0.30 a	43.09
	100.0	67.66 a	4.37 e	50.51 a	66.31	0.56 a	47.61
	Average	<b>51.95 b</b>	<b>13.73 a</b>	<b>31.55 b</b>	<b>64.77 a</b>	<b>-1.26 b</b>	<b>30.25</b>
Without additive	0.00	64.35 c	9.98 a	28.24 de	60.53 d	-0.99 c	16.02
	10.0	68.47 bc	9.08 a	24.51 f	60.99 d	-0.97 c	19.25
	20.0	66.61 c	8.78 a	27.47 e	60.67 d	-1.16 c	23.74
	30.0	67.49 bc	8.58 ab	28.08 de	66.72 b	-1.28 c	29.03
	40.0	67.89 bc	7.11 bc	29.65 cd	64.43 c	-0.96 c	32.17
	50.0	72.05 b	5.79 c	31.14 c	66.07 b	0.12 b	36.38
	75.0	72.08 b	1.91 d	38.56 b	66.47 b	1.73 a	41.57
	100.0	77.11 a	2.00 d	48.78 a	70.59 a	1.71 a	43.34
	Average	<b>69.51 a</b>	<b>6.65 b</b>	<b>32.05 a</b>	<b>64.56 b</b>	<b>-0.23 a</b>	<b>30.19</b>
Average (amount of corn flour)	0.00	55.10 c	13.82 a	27.44	63.04	-1.27 c	15.69
	10.0	57.02 c	12.54 b	24.14	62.76	-1.48 cd	19.40
	20.0	58.39 bc	12.67 b	28.19	62.60	-1.55 cd	23.72
	30.0	56.77 c	12.45 b	26.54	65.56	-1.70 d	28.00
	40.0	55.56 c	10.89 c	26.02	64.37	-1.44 cd	30.89
	50.0	61.18 b	10.67 c	30.06	65.12	-0.66 b	36.26
	75.0	69.40 a	5.29 d	42.36	65.41	1.01 a	42.33
	100.0	72.38 a	3.18 e	49.64	68.45	1.13 a	45.48
	F value (additive type) A		39.00 <sup>2**</sup>	165.00 <sup>**</sup>	471.05 <sup>**</sup>	11.37 <sup>**</sup>	179.69 <sup>**</sup>
F value (Amount of corn flour) A		564.00 <sup>**</sup>	1115.00 <sup>**</sup>	2.89 <sup>ns</sup>	0.27 <sup>ns</sup>	285.10 <sup>**</sup>	0.016 <sup>ns</sup>
F value (A × A)		10.00 <sup>**</sup>	12.00 <sup>**</sup>	26.28 <sup>**</sup>	9.05 <sup>**</sup>	3.57 <sup>*</sup>	1.92 <sup>ns</sup>

<sup>1</sup>The averages shown by the same letter are statistically different from each other (P ≤ 0.05).

<sup>2\*\*</sup>: Significant at P ≤ 0.01, \*: Significant at P ≤ 0.05, ns: Non-significant at P ≥ 0.05.

<sup>3</sup>L (light color-Dark color), a (+a: Red, -a: Green) and b (+b: Yellow, -b: Blue)

### 3.3. Moisture values in the cornbread to different levels of corn flour and addition type

Analysis of variance (Table 4) indicated that there were significantly ( $P \leq 0.01$ ) affected by differences additive type, different levels of corn flour and their interaction based on the 0<sup>th</sup>, first and second moisture of the bread.

The results of mean comparison of 0<sup>th</sup> first and second moisture for additive type showed that the highest mean were observed in without additive with 42.73%, 38.23%, and 36.49% respectively, whereas the lowest were in additive with 35.98%, 31.43% and 29.79 respectively. Based on amount of corn flour application, the highest means of 0<sup>th</sup>, first and second moisture was obtained that 0.00% with 41.0%, 0.00% with 39.03% and 10.0% with 36.48% application respectively, whereas the lowest was detected in 100% amount of corn application with 37.73%, 32.35 and 30.35% respectively. The result displayed that

corn flour concentration application increased from 0.0 to 100.0%, the 0<sup>st</sup>, 1<sup>st</sup> and 2<sup>nd</sup> moisture also decreased (Table 4).

Analysis of variance displayed that there were significantly two-way interactions between additive type  $\times$  amount of corn flour ( $P \leq 0.01$ ) (Table 2). According to interaction effects of additive type and amount of corn flour, the highest 0<sup>st</sup>, 1<sup>st</sup> and 2<sup>nd</sup> moisture value in without additive + %75.0 amount of corn flour (43.10%), without additive + %0.0 amount of corn (41.50%) and without additive + %10.0 amount of corn (38.40%) respectively was achieved, however the lowest of traits above was obtained in additive + 100.0% amount of corn (32.45), additive + 75.0% amount of corn (27.45%) and additive + 100.0% amount of corn (25.60) respectively (Table 4).

**Table 4.** Effect of different additive, without additive types and amount of corn flour on moisture in the corn bread.

Addition	Amount of corn flour	Moisture (%)		
		0 <sup>th</sup> day	1 <sup>st</sup> day	2 <sup>nd</sup> day
Additive	0.00	39.75 a <sup>1</sup>	36.55 a	34.45 a
	10.0	39.25 b	34.15 b	34.55 a
	20.0	37.95 c	33.00 bc	29.50 b
	30.0	37.40 d	31.30 c	30.70 b
	40.0	35.00 e	31.95 c	30.70 b
	50.0	33.35 f	28.85 d	26.70 c
	75.0	32.65 g	27.45 d	26.10 c
	100.0	32.45 g	28.15 d	25.60 c
	<b>Average</b>	<b>35.98 b</b>	<b>31.43 b</b>	<b>29.79 b</b>
Without additive	0.00	42.25 a	41.50 a	37.75 a
	10.0	42.70 a	39.00 b	38.40 a
	20.0	42.65 a	38.40 b	37.55 ab
	30.0	42.85 a	37.25 b	37.00 ab
	40.0	42.45 a	37.85 b	35.85 abc
	50.0	42.85 a	37.05 b	34.30 c
	75.0	43.10 a	38.20 b	36.00 abc
	100.0	43.00 a	36.55 b	35.10 bc
	<b>Average</b>	<b>42.73 a</b>	<b>38.23 a</b>	<b>36.49 a</b>
Average (amount of corn flour)	0.00	41.00 a	39.03 a	36.10 a
	10.0	40.98 a	36.58 b	36.48 a
	20.0	40.30 b	35.70 bc	33.53 b
	30.0	40.13 b	34.28 cd	33.85 b
	40.0	38.73 c	34.90 c	33.28 b
	50.0	38.10 d	32.95 de	30.50 c
	75.0	37.88 d	32.83 de	31.05 c
	100.0	37.73 d	32.35 e	30.35 c
<b>F value (additive type) A</b>		2439.00** <sup>2</sup>	426.00**	389.00**
<b>F value (Amount of corn flour) A</b>		52.00**	23.00**	24.00**
<b>F value (A <math>\times</math> A)</b>		67.00**	5.1.00**	6.60**

<sup>1</sup> The averages shown by the same letter are statistically different from each other ( $P \leq 0.05$ ).

<sup>2</sup>\*\* : Significant at  $P \leq 0.01$ , \* : Significant at  $P \leq 0.05$ , ns: Non significant at  $P \geq 0.05$ .

**Table 5.** Effect of different additive types and amount of corn flour on sensory (appearance, pore, texture, volume, shell color, inner color, chewing, aroma, taste, general acceptability) in the corn bread.

Addition	Amount of corn flour	Appearance	Pore	Texture	Volume	Shell Color	Inner Color	Chewing	Aroma	Taste	General Acceptability
Additive	0.00	8.88	9.00	9.00	9.00	8.63	8.75	9.00	8.38	8.38	8.88
	10.0	8.25	8.75	8.25	8.63	8.38	8.25	8.38	8.25	8.25	8.50
	20.0	8.13	8.00	8.13	7.38	7.50	8.13	7.88	8.38	8.25	8.00
	30.0	7.50	7.50	7.50	7.38	7.38	7.25	7.75	7.63	7.50	7.50
	40.0	7.38	7.13	7.75	6.75	7.13	7.63	7.63	7.63	7.25	7.13
	50.0	6.50	7.00	6.25	6.38	6.75	6.63	7.00	7.75	7.50	6.75
	75.0	5.88	4.50	5.50	4.00	5.63	5.38	5.75	6.75	6.75	5.38
	100.0	4.00	4.00	5.38	3.75	4.25	4.38	4.75	6.25	6.25	4.75
	<b>Average</b>	<b>7.07 a<sup>1</sup></b>	<b>6.99 a</b>	<b>7.22 a</b>	<b>6.66 a</b>	<b>6.96 a</b>	<b>7.05 a</b>	<b>7.27 a</b>	<b>7.63 a</b>	<b>7.52 a</b>	<b>7.11 a</b>
Without additive	0.00	6.93	7.50	7.00	6.50	6.00	6.88	7.13	6.13	6.00	6.13
	10.0	6.63	6.75	6.50	6.38	6.00	6.63	6.75	6.38	6.25	6.50
	20.0	6.88	6.63	6.00	6.13	5.75	6.38	6.13	6.50	6.00	5.63
	30.0	6.00	6.13	5.75	5.75	5.50	6.00	5.63	6.13	6.00	5.88
	40.0	5.13	5.38	5.88	4.25	5.13	6.00	5.50	6.25	5.63	5.25
	50.0	4.50a	3.75	4.25	3.38	4.88	4.88	4.00	5.75	6.00	4.75
	75.0	1.38	1.50	3.25	1.13	1.38	3.38	2.88	5.25	5.00	3.25
	100.0	1.50	1.38	2.50	1.13	1.50	2.63	2.63	4.25	4.50	3.00
<b>Average</b>	<b>4.87 b</b>	<b>4.88 b</b>	<b>5.14 b</b>	<b>4.33 b</b>	<b>4.52 b</b>	<b>5.35 b</b>	<b>5.08 b</b>	<b>5.83 b</b>	<b>5.67 b</b>	<b>5.05 b</b>	
<b>Average (amount of corn flour)</b>	0.00	7.91 a	8.25 a	8.00 a	7.75 a	7.32 a	7.82 a	8.07 a	7.26 a	7.19 a	7.51 a
	10.0	7.44 ab	7.75 ab	7.38 ab	7.51 ab	7.19 b	7.44 ab	7.57 ab	7.31 a	7.25 a	7.50 a
	20.0	7.50 ab	7.32 ab	7.07 ab	6.76 ab	6.63 a	7.26 a	7.01 ab	7.44 a	7.13 a	6.82 ab
	30.0	6.75 abc	6.82 abc	6.63 b	6.57 bc	6.44 a	6.63 ab	6.69 abc	6.88 ab	6.75 ab	6.69 a
	40.0	6.26 bc	6.25 bc	6.82 ab	5.50 cd	6.13 a	6.82 ab	6.57 bc	6.94 ab	6.44 ab	6.19 ab
	50.0	5.50 c	5.38 c	5.25 c	4.88 d	5.82 a	5.76 bc	5.50 cd	6.75 ab	6.75 ab	5.75 b
	75.0	3.63 d	3.00 d	4.38 dc	2.57 e	3.51 a	4.38 cd	4.32 de	6.00 bc	5.88 ab	4.32 c
	100.0	2.75 d	2.69 d	3.94 d	2.44 e	2.88 a	3.51 d	3.69 e	5.25 c	5.38 b	3.88 c
<b>F value (additive type) A</b>		55.00 <sup>**2</sup>	33.00 <sup>**</sup>	53.00 <sup>**</sup>	83.00 <sup>**</sup>	99.00 <sup>**</sup>	20.00 <sup>**</sup>	51.00 <sup>**</sup>	72.00 <sup>**</sup>	33.00 <sup>**</sup>	43.00 <sup>**</sup>
<b>F value (Amount of corn flour) A</b>		20.00 <sup>**</sup>	16.00 <sup>**</sup>	13.00 <sup>**</sup>	33.00 <sup>**</sup>	22.00 <sup>**</sup>	8.50 <sup>**</sup>	12.8 <sup>**</sup>	6.3 <sup>**</sup>	2.20 <sup>**</sup>	9.50 <sup>**</sup>
<b>F value (A × A)</b>		1.48 <sup>ns</sup>	0.52 <sup>ns</sup>	0.21 <sup>ns</sup>	070 <sup>ns</sup>	1.40 <sup>ns</sup>	0.04 <sup>ns</sup>	0.33 <sup>ns</sup>	0.26 <sup>ns</sup>	0.13 <sup>ns</sup>	016 <sup>ns</sup>

<sup>1</sup>The averages shown by the same letter are statistically different from each other ( $P \leq 0.05$ ).

<sup>2\*\*</sup>: Significant at  $P \leq 0.01$ , \*: Significant at  $P \leq 0.05$ , ns: Non-significant at  $P \geq 0.05$ .

### 3.4. Sensory analyzes in the cornbread to different levels of corn flour and addition type

In the present study analysis of variance (Table 5) showed that there were significant ( $P \leq 0.01$ ) affected by differences additive type, different levels of corn flour and their interaction based on sensory analyzes characterizes of the bread.

The results of mean comparison sensory analyzes characterizes such as appearance, pore, texture, volume, shell color, inner color, chewing, aroma, taste, general acceptability for additive type displayed that the highest mean were observed in additive with 7.07, 6.99, 7.22, 6.66, 6.96, 7.05, 7.27, 7.63, 7.52 and 7.11 respectively, while the lowest was in without additive with 4.87, 4.88, 5.14, 4.33, 4.52, 5.35, 5.08, 5.83, 5.67 and 5.05 respectively at the above characterize. Based on amount of corn flour application, the highest means of analyzes characterizes such as appearance, pore, texture, volume, shell color, inner color, chewing, general acceptability were detected that 0.00% to 7.91, 8.25, 8, 7.75, 7.32, 7.82, 8.07, 7.51 with respectively however at aroma (7.25) and taste (7.25) it was observed in 10.0%. The lowest appearance, pore, texture, volume, shell color, inner color, chewing, aroma, taste, general acceptability was detected in 100% amount of corn application with 2.75, 2.69, 3.94, 2.44, 2.88, 3.51, 3.69, 5.25, 5.3 and 3.88 respectively. The result displayed that corn flour concentration application increased from 0.0 to 100.0%, the sensory analyzes characterize also decreased (Table 5).

Analysis of variance displayed that there were no significant two-way interactions between additive type  $\times$  amount of corn flour ( $P \geq 0.01$ ) (Table 5).

### 3.5. TPA properties of corn flour powdered bread of hardness, cohesively, elasticity, chew ability and gumminess values in the cornbread bread to different levels of corn flour and addition type

characterize, analysis of variance (Table 6) displayed that there were significant differences between With regard to 0<sup>th</sup>, first and second TPA mostly parameters such as; hardness, cohesively, elasticity, chew ability and gumminess between additive type, different levels of corn flour and their interaction on the bread.

The results of mean comparison of 0<sup>st</sup> TPA for additive type in the highest mean of hardness and gumminess parameters showed that were observed in without additive

with 15.99 and 5.14 respectively, whereas the lowest was in additive with 5.27, 1.84 and 29.79 respectively, in addition to the highest mean of cohesively, elasticity parameters were observed in additive type with 0.42 and 0.79 whereas the lowest it was at without additive with 0.47 and 0.73 respectively. Also, the results of the mean comparison of first TPA for additive type in the highest mean of cohesively and gumminess parameters showed that were detected in without additive with 0.38 and 4.57 respectively, whereas the lowest was in additive with 0.28 and 1.46 respectively. While, the results of the mean comparison of second TPA for additive type in the highest mean of elasticity and chew ability parameters were observed in additive with 0.61 and 0.60 respectively, whereas the lowest was in without additive with 0.43 and -0.29 respectively, in addition to the highest mean of hardness, cohesively and gumminess parameters were observed in without additive type with 25.46, 0.30 and 5.87 whereas the lowest it was at additive with 8.51, 0.20 and 1.03 respectively.

Based on amount of corn flour application, the results of mean comparison of 0<sup>st</sup> TPA for additive type in the highest mean of hardness in 75.0% with 26.32, in cohesively 0.0% with 0.60, in elasticity at 0.00 with 0.94, in chew ability at 50% with 3.52 and in gumminess 100.0% with 8.09 were observed respectively, whereas the lowest was in 0.0% with 1.39, 75% with 0.21, 75% with 0.58, 0.0% with 0.78, 0.0% with 0.82 respectively all the maintained parameters. Also, the results of mean comparison of first TPA for corn flour application, the highest mean of hardness in 100.0% with 45.92, in cohesively 10.0% with 0.50, in elasticity at 0.00 with 0.91, in chew ability at 50% with 2.78 and in gumminess 75.0% with 6.91 were observed respectively, whereas the lowest was in 100.0% with 0.08, 100.0% with -0.51, 100% with -1.44, 0.0% with 0.88, 0.0% with 2.85 respectively all the maintained parameters. While based on amount of corn flour application, the results of mean comparison of 2<sup>st</sup> TPA for additive type in the highest mean of hardness in 100.0% with 9.94, in cohesively 10.0% with 0.44, in elasticity at 0.00 and 10.0% with 0.90, in chew ability at 50% with 3.25 and in gumminess 75.0% with 12.78 were observed respectively, whereas the lowest was in 0.0% with 2.85, 100% with 0.04, 100% with -0.56, 100.0% with -1.65, 0.0% with 1.08 respectively all the maintained parameters.



**Table 6.** Effect of different additive, additive free types and amount of corn flour on TPA properties (hardness, cohesively, elasticity, chew ability, and gumminess) in the corn bread.

Addition	Amount of corn flour	0 <sup>th</sup> day					1 <sup>st</sup> day					2 <sup>nd</sup> day				
		Hardness	Cohesively	Elasticity	Chew ability	Gumminess	Hardness	Cohesively	Elasticity	Chew ability	Gumminess	Hardness	Cohesively	Elasticity	Chew ability	Gumminess
Additive	0.00	1.57 e <sup>1</sup>	0.54 a	0.93 a	0.78 de	0.84 d	2.25 e	0.33	0.87	0.64	0.73 c	2.95 d	0.37	0.87	0.96	1.10 ab
	10.0	1.68 e	0.52 ab	0.92 a	0.79 de	0.87 d	2.19 e	0.44	0.88	0.84	0.96 bc	2.57 d	0.49	0.88	1.10	1.26 ab
	20.0	2.24 de	0.36 bc	0.88 a	0.72 e	0.81 d	3.21 e	0.41	0.82	1.08	1.31 bc	3.88 d	0.18	0.83	0.62	0.77 ab
	30.0	2.13 de	0.51 ab	0.89 a	0.96 cde	1.08 d	3.24 de	0.30	0.82	0.81	1.00 bc	3.74 d	0.28	0.80	0.85	1.06 ab
	40.0	3.77 d	0.48 ab	0.82 b	1.49 bc	1.80 c	4.44 d	0.30	0.78	1.03	1.32 bc	7.34 c	0.00	0.85	0.00	0.001 b
	50.0	6.06 c	0.44 abc	0.77 b	2.05 ab	2.66 b	9.28 c	0.22	0.70	1.42	2.06 ab	12.41 b	0.19	0.79	1.92	2.47 a
	75.0	10.92 b	0.20 d	0.61 c	1.35 cd	2.21 bc	12.08 b	0.11	0.32	0.64	1.35 bc	9.94 bc	0.07	0.21	0.09	0.61 ab
	100.0	13.78 a	0.32 cd	0.47 d	2.10 a	4.42 a	22.56 a	0.13	-0.61	-1.76	2.96 a	25.22 a	0.04	-0.34	-0.74	1.00 ab
	<b>Average</b>	<b>5.27 b</b>	<b>0.42 a</b>	<b>0.79 a</b>	<b>1.28</b>	<b>1.84 b</b>	<b>7.40 b</b>	<b>0.28 b</b>	<b>0.57 a</b>	<b>0.59 a</b>	<b>1.46 b</b>	<b>8.51 b</b>	<b>0.20 b</b>	<b>0.61 a</b>	<b>0.60 a</b>	<b>1.03 b</b>
	Without additive	0.00	1.22 d	0.66 a	0.96 a	0.77 b	0.80 d	1.72 f	0.60 a	0.95	0.97	1.02 c	2.74 f	0.40	0.93	0.98
10.0		2.47 d	0.60 ab	0.92 ab	1.35 b	1.46 d	2.48 ef	0.55 a	0.91	1.24	1.37 c	2.96 f	0.39	0.91	1.03	1.13 c
20.0		3.71 d	0.57 ab	0.89 bc	1.92 b	2.12 d	5.03 ef	0.49 a	0.82	2.04	2.49 bc	7.82 e	0.32	0.83	2.01	2.47 c
30.0		4.93 d	0.56 bc	0.84 c	2.31 b	2.76 d	8.49 e	0.44 a	0.73	2.73	3.74 bc	8.98 e	0.43	0.74	2.84	3.83 c
40.0		11.44 c	0.47 cd	0.72 d	3.88 a	5.37 c	14.51 d	0.38 a	0.67	3.71	5.53 bc	17.72 d	0.15	0.78	2.08	2.67 c
50.0		20.29 b	0.40 d	0.62 e	4.99 a	8.06 b	25.23 c	0.29 a	0.56	4.14	7.43 b	29.90 c	0.26	0.59	4.57	7.78 b
75.0		41.71 a	0.21 e	0.54 f	4.77 a	8.76 b	44.71 b	0.28 a	-0.14	-2.90	12.47 a	58.87 b	0.42	-0.54	-13.28	24.96 a
100.0		42.18 a	0.29 e	0.35 g	4.21 a	11.76 a	69.28 a	0.04 a	-0.42	-1.11	2.52 bc	74.66 a	0.04	-0.79	-2.55	3.10 c
<b>Average</b>		<b>15.99 a</b>	<b>0.47 b</b>	<b>0.73 b</b>	<b>3.03</b>	<b>5.14 a</b>	<b>21.43 a</b>	<b>0.38 a</b>	<b>0.51 a</b>	<b>1.35 a</b>	<b>4.57 a</b>	<b>25.46 a</b>	<b>0.30 a</b>	<b>0.43 b</b>	<b>-0.29 b</b>	<b>5.87 a</b>
Average (amount of corn flour)		0.00	1.39 d	0.60 a	0.94 a	0.78 d	0.82 d	1.98 f	0.46 a	0.91 a	0.80 abc	0.88 d	2.85 f	0.39 ab	0.90 a	0.97 a
	10.0	2.07 d	0.56 ab	0.92 ab	1.07 cd	1.17 d	2.34 f	0.50 a	0.90 a	1.04 ab	1.16 cd	2.76 f	0.44 a	0.90 a	1.07 b	1.19 c
	20.0	2.98 d	0.47 cd	0.89 bc	1.32 cd	1.47 d	4.12 ef	0.45 a	0.83 ab	1.56 a	1.90 cd	5.85 e	0.25 bc	0.83 a	1.31 b	1.62 c
	30.0	3.53 d	0.53 abc	0.86 c	1.63 c	1.92 d	5.86 e	0.37 ab	0.77 ab	1.77 a	2.37 abc	6.36 e	0.36 ab	0.77 a	1.85 b	2.45 c
	40.0	7.60 c	0.47 bcd	0.77 d	2.69 b	3.58 c	9.47 d	0.34 abc	0.82 ab	2.37 a	3.42 bc	12.53 d	0.08 cd	0.82 a	1.04 b	1.34 c
	50.0	13.17 b	0.42 d	0.70 e	3.52 a	5.36 b	17.25 c	0.26 bcd	0.69 b	2.78 a	4.75 ab	21.16 c	0.23 bc	0.69 a	3.25 a	5.12 b
	75.0	26.32 a	0.21 f	0.58 f	3.06 ab	5.49 b	28.40 b	0.19 cd	0.18 d	-1.13 bc	6.91 a	34.40 b	0.24 bc	-0.17 b	-6.59 d	12.78 a
	100.0	27.98 a	0.30 e	0.41 g	3.16 ab	8.09 a	45.92 a	0.08 d	-0.51 c	-1.44 c	2.74 abc	49.94 a	0.04 d	-0.56 c	-1.65 c	2.05 c
<b>F value (additive type) A</b>	<b>363.00<sup>ns</sup></b>	<b>6.70<sup>*</sup></b>	<b>36.00<sup>**</sup></b>	<b>102.00<sup>**</sup></b>	<b>154.00<sup>**</sup></b>	<b>425.00<sup>**</sup></b>	<b>12.90<sup>**</sup></b>	<b>2.30<sup>ns</sup></b>	<b>2.1<sup>ns</sup></b>	<b>34.00<sup>**</sup></b>	<b>1031.00<sup>**</sup></b>	<b>6.00<sup>**</sup></b>	<b>540.00<sup>**</sup></b>	<b>9.68<sup>**</sup></b>	<b>171.00<sup>**</sup></b>	
<b>F value (Amount of corn flour) A</b>	<b>187.00<sup>**</sup></b>	<b>24.70<sup>**</sup></b>	<b>219.00<sup>**</sup></b>	<b>19.30<sup>**</sup></b>	<b>48.00<sup>**</sup></b>	<b>262.00<sup>**</sup></b>	<b>6.40<sup>**</sup></b>	<b>66.2<sup>**</sup></b>	<b>4.1<sup>**</sup></b>	<b>7.00<sup>**</sup></b>	<b>529.00<sup>**</sup></b>	<b>6.06<sup>**</sup></b>	<b>260.00<sup>**</sup></b>	<b>56.20<sup>**</sup></b>	<b>58.00<sup>**</sup></b>	
<b>F value (A × A)</b>	<b>62.00<sup>**</sup></b>	<b>2.70<sup>**</sup></b>	<b>7.00<sup>**</sup></b>	<b>5.80<sup>**</sup></b>	<b>14.00<sup>**</sup></b>	<b>79.00<sup>**</sup></b>	<b>0.47<sup>ns</sup></b>	<b>2.50<sup>ns</sup></b>	<b>1.73<sup>ns</sup></b>	<b>6.00<sup>**</sup></b>	<b>192.00<sup>**</sup></b>	<b>1.37<sup>ns</sup></b>	<b>1.65<sup>ns</sup></b>	<b>41.80<sup>ns</sup></b>	<b>59.00<sup>**</sup></b>	

<sup>1</sup> The averages shown by the same letter are statistically different from each other (P ≤ 0.05).

<sup>2</sup>\*\* : Significant at P ≤ 0.01, \* : Significant at P ≤ 0.05, ns: Non-significant at P ≥ 0.05.

Analysis of variance displayed that there were significantly two-way interactions between additive type  $\times$  amount of corn flour ( $P \leq 0.01$ ) (Table 2). The results of mean comparison of 0<sup>st</sup> TPA the highest mean of hardness in without additive + 100.0% with 42.18, in cohesively without additive + 0.0% with 0.66, in elasticity at without additive + 0.00 with 0.96, in chew ability at without additive 50.0% with 4.99 and in gumminess without additive + 100.0% with 11.76 were observed respectively, whereas the lowest were in without additive + 0.0% with 1.22, additive + 75% with 0.20, without additive + 100.0% with 0.35, additive + 30.0% with 0.72, without additive + 0.0% with 0.80 respectively all the maintained parameters. The results of mean comparison of 1<sup>st</sup> TPA, the highest mean of hardness in without additive + 100.0% with 69.28, in cohesively without additive + 0.0% with 0.60, in elasticity at without additive + 0.00 with 0.95, in chew ability at without additive 50.0% with 4.14 and in gumminess without additive + 75.0% with 12.47 were observed respectively, whereas the lowest were in without additive + 0.0% with 1.72, additive + 100% with 0.4 without additive + 100.0% with -0.42, without additive + 100.0% with -1.11, additive + 0.0% with 0.73 respectively all the maintained parameters. Also, the results of mean comparison of 1<sup>st</sup> TPA, the highest mean of hardness in without additive + 100.0% with 74.66, in cohesively without additive + 0.30% with 0.43, in elasticity at without additive + 0.00 with 0.93, in chew ability at without additive 50.0% with 4.57 and in gumminess without additive + 75.0% with 24.96 were observed respectively, whereas the lowest were in additive + 10.0% with 2.57, additive + 40.0% with 0.00, additive + 100.0% with -0.34, without additive + 75.0% with -13.28, additive + 40.0% with 0.001 respectively all the maintained parameters.

#### 4. Discussion

##### **Bread mass, volume and specific volume values of bread added to different levels of corn flour**

According to interaction effects of additive type and amount of corn flour, the highest mass, volume and specific volume values in additive + %40 amount of corn flour (137.48 g), additive + %0.0 amount of corn (612.50 ml) and additive + %0.0 amount of corn (4.55 ml) respectively was achieved (Table 2). The properties of the inner part of the bread being formed at the desired quality, the effects of improving the properties of the inner part of the oil, and during their doughing and processing; Depends on the fractions that can be found solid at the paste temperature [10]. The shortening,

especially the dough, must be sufficiently solid during the final fermentation that the inclusion of solid crystalline fractions is necessary to have a positive effect on bread characteristics [11]. The use of yogurt in bread making positively affects the rheological properties of the dough, the volume of bread, specific volume, crust color, bread texture and coloring [12]. Our result presented that the volume and specific volume values decreased as the corn flour contribution level increased. In bulk, an increase was observed up to the addition of 50% corn flour and then a decrease was observed. This decrease mass leads to a relative decrease in the gluten content of the flour formulation and consequently a reduction in the gas holding capacity. [19], added that the solid fat added to the plow increased the gas holding capacity, and increased the bread volume, in the early stages of cooking [20]. Since the lecithin in the yogurt is characterized by the emulsifier, it improves the structure of the pastry positively. [21], In their study, investigated the effect of lecithin and monoglycerides on the rheological quality and flatbread quality of the dough. It has been observed that these materials alone or in combination improve the rheological properties of the dough and the firing quality. The increase in viscoelastic properties of the wheat flour paste is attributed to the gluten content of the flour [7]. At the same time, the fermentation of the sugars keeps the gas cells in the resulting pasteurization of the dough. During cooking, gluten counteractively increases the stability of the dough and the internal structure and volume of the product [22]. With the addition of corn flour, the gluten net weakens, results in a decrease of gas retention, dough elasticity, pulp expansion and of the bread [23].

##### **Crust color and inner color in the cornbread to different levels of corn flour and addition type**

Variance analysis of this study was shown in 1<sup>st</sup> and 2<sup>nd</sup> repeat of L, a and b color values of crusts of corn flour added the bread at different levels were statistically highly significant ( $p \leq 0,01$ ). Duncan Multiple comparison test results of the mean values of L, a and b color values of the corn flour variant was demonstrated that the additive made to flour causes the intensity of red color in the shell color to increase, while the value of L in the shell decreases, while the color value of b does not cause any change. The increase in the color value of the crust + a (red) can be explained by the caramelization and Maillard reaction during the addition of the lactose in the added yogurt. [12], According to the studies they performed, the rheological properties of yoghurt

underwater at a rate of 1.0% over the dry matter were statistically increased ( $p \leq 0.05$ ) compared to other additive ratios and unadulterated walnut bread, palatability, specific, shell color, bread texture, and color. The addition of added corn flour causes both the crust L value of the crust and the + b color value (yellow) to increase and the + a color (red) value to decrease. Gluten-free bread doughs are in a fluid structure, and after firing, crumbly textured and poor color are formed [24, 25].

Also, the added flour increased the value of a while it did not cause any change in the L and b color values of the bread. [26], The effect of fat substitutes such as inulin husk, inulin gel, and simplest on rheological properties of the dough and quality of the wheat bran were investigated. Volume yield, in-bread texture, crust color and in-bread image characteristics measured for cooked nuts. In fat-containing doughs, the dough complex module is lower than the fat-substitute doughs. The addition of corn flour added increased the color value of L and b for bread, caused the green color to turn yellow first and then to increase this value. Other end-product qualities such as texture, volume, color, appearance, and taste are negatively affected in wheat flour gluten-free products and quality problems arise [27].

#### **Moisture values in the cornbread to different levels of corn flour and addition type**

cohesiveness values of the bread decreased. [The first and second recurrence results of moisture values of corn flour-added to bread at different levels were statistically highly significant ( $p \leq 0.01$ ). The addition of the additives to the flour caused a decrease in moisture values after 0, 1<sup>st</sup> and 2<sup>nd</sup> days of the bread. While the storage time increases, the stalks stiffness increase. [28], observed that as the storage period increases, the bread hardness increased and the elasticity and 29], found an increase in crumb moisture, crumbling, stiffness and opacity, and a decrease in bread moisture [30]. Corn flour content causes a decrease in the moisture content in both unpacked and first and second day bread. As the corn flour level increased, the moisture level in the bread decreased. While the added corn flour was 0%, the bread moisture content was the highest, and the lowest bread moisture level was for 100% corn flour addition.

#### **Sensory analyzes in the cornbread to different levels of corn flour and addition type**

The results of the first and second replicates of values of the appearance, pore, texture and volume from the sensory analysis of corn flour flour added bread at

different levels were statistically highly significant at ( $p \leq 0.01$ ) on appearance, pore, texture and volume values of the bread. The additives additions to the flour give an increase in the bread appearance, pore, texture and volume. [16], investigate the effect of yeast and herbal shorts on the textural and physical properties of partially cooked frozen bread. The results obtained after four weeks of storage showed that hardness and chewing values increased as there was no significant change in tack and resilience, as is true for all formulations. Shortening added bread showed lower hardness and chewing values due to the softening effects of it. Also, the addition of corn flour affects the appearance of the bread, pore, texture and volume negatively. The use of yogurt in making bread, positively affects the rheological properties of the dough, volume, specific volume, crust color, texture and color of the bread [12]. [13], While the dough softness decreased with the addition of eggs, the farinograph increased the dough development time and stability. The lecithin emulsifier characteristic of the yolk it improves the structure of the pastry positively.

The sensory analysis results of corn flour added breads of the first and second interaction of crust color, inner color, and chewing values at different was verified that the additives variables and corn flour addition were found to be statistically highly significant at ( $p \leq 0.01$ ) in shell color, inner color and chewing values of the bread. The main variance of additive variable sources showed the added corn flour reduces the appreciation of chew ability, bread crust and crumb color. The addition of corn flour increases bread crust hardness and of the bread to be harder and the pore structure of the bread crumb which the reason for bread volume deterioration, resulting in an increase of the yellow pigment due to beta-corn starch in corn.

Results of the first and second interaction of sensory analysis of flavor, taste and general acceptability values of corn flour-added bread at different levels were statistically highly significant at ( $p \leq 0.01$ ). The added corn flour made to the bread increased the flavor, taste and overall acceptability values. While Table 3.28, shows that the added corn flour made negative affects the flavor, taste and overall acceptability of the bread. Because white and baked bread have neutral taste and aroma, the people who are constantly consuming such bread are also used to those bread. However, panelists did not like the unique taste and flavor of cornbread because they did not consume cornbread before, and they evaluated the overall acceptability of it with low scores.

### **TPA properties of corn flour powdered bread of hardness, cohesively, elasticity, chewability and gumminess values in the cornbread to different levels of corn flour and the addition type**

The first and second recurrence results of day 0th of the hardness, cohesiveness, elasticity, chewability and gumminess values determined in TPA of corn flour-added breads at different levels the added flour made additive reduces the hardness values on days 0th, first and second for breadcrumb. The decrease in bread hardness may also be due to lactic acid bacteria which found in yogurt. [28], He observed that the bread softness values of in which the lactic acid bacteria were used were higher in the significant level than the unmixed bread. [31], Water storage capacity and softness values increased as storage period increased, and softness values of bread were observed to decrease.

As shown in Table 5, added corn flour increased the hardness value on days first and second. The hardest cornbreads were observed in the inner part of the bread with 100% corn flour added. As seen in Table 5, the added flour additive reduces the cohesive values on days first and second of the bread. Also result verified, added corn flour decreased the cohesive value on days first and second of the bread. The minimum cohesive corn bread was observed in corn bread with 100% corn flour added, while the highest values were observed in 0% corn flour added breads. Also, the added flour additive increases the elasticity values on days first and second for bread inner part. In this study with added corn flour decrease the elasticity value on days first and second of the bread. The lowest elasticity cornbreads were observed in cornbreads with 100% corn flour added, while the highest values were observed in 0% corn flour added breads. Our result showed that the added flour additive decrease the Chewiness values on days 0th and second for bread inner part. Also, addition of corn flour causes an increase in chew ability value on day 0 and a decrease chew ability of bread on days 1 and 2 with a decrease in moisture content. The highest values of chewiness were obtained on day 0 bread with 100% corn flour, while the lowest values were observed in 0% corn flour added bread. The lowest values in the chewiness values of the first and second day bread are in cornbreads with 100% corn flour added. The added flour has reduced the gumminess values of the bread inner on days 0th, 1 and 2. Gluten is the main protein responsible for the appearance and bread inner structure, responsible for the elasticity and extensibility properties of the dough. For this reason, it is primarily responsible for the bread quality [27]. As seen in Table 5, the addition of corn flour caused an increase

in the value of gumminess on days 0th, first and second. The highest gumminess values were obtained in cornbreads supplemented with 75% and 100% corn flour, while the lowest values were observed in 0% corn flour added bread.

### **Conclusion**

In this study, the additives added to corn flour; mass, volume, specific volume, the red colour intensity in the crust, the moisture content of the 0, 1<sup>st</sup> and 2<sup>nd</sup> days of bread was decreased, so the appearance of the additive added to the flour has reduced the pore, texture, and volume. The contribution made from flour bread crust has reduced colour, internal colour, and chewing values. The addition of flour resulted in a decrease in cohesive values on 0, 1<sup>st</sup> and 2<sup>nd</sup> days for bread. The addition of flour resulted in decreased elasticity values at 0, 1<sup>st</sup> and 2<sup>nd</sup> days for bread. The contribution made to flour decreased on the 1st and 2nd days of bread for chewiness values it has caused. The addition of flour resulted in a decrease in the gaminess values on the 0, 1<sup>st</sup> and 2<sup>nd</sup> days for bread. In contrast to, L colour value, b colour value in the crust, red (a) colour on the inner was increased. The addition of flour resulted in an increase in hardness values on 0, 1<sup>st</sup> and 2<sup>nd</sup> days for bread. In this research, with an increase of corn flour in bread, the values of mass, volume, and specific volume decreased. The appearance of corn flour for bread affects the pore, texture and volume values negatively. The corn has reduced the chewing ability of the flour, the bread crust and the likeness of the inner colour. Corn flour has affected the flavour, taste and overall acceptability of the bread in the negative direction. Corn flour caused the decline of cohesive value on the 1<sup>st</sup> and 2<sup>nd</sup> days and the 0th day of sowing. Corn flour caused a decrease in the elasticity value on 0, 1<sup>st</sup> and 2<sup>nd</sup> days of the bread. The addition of cornflour resulted in a decrease in the viability of the cultivars on 1<sup>st</sup> and 2<sup>nd</sup> days when the value of chewability increased on day 0, while the added corn flour caused an increase in the blue pigment for the bread. Flour added additives have increased the value of bread flavour, taste, and overall acceptability. Corn flour caused an increase in the value of hardness of 0, 1<sup>st</sup> and 2<sup>nd</sup> days of the bread. The addition of cornflour resulted in an increase in the gum value on the 1<sup>st</sup>, 2<sup>nd</sup> days and the 0. Day.

## References

- [1] Anonim (2012). Türk Gıda Kodeksi Ekmek ve Ekmek Çeşitleri Tebliği, Tebliğ NO: 2012/2. (In Turkish).
- [2] Elgün A, Ertugay Z, Certel M, Kotancılar HG. (2002). Tahıl ve Ürünlerinde Analitik Kalite Kontrolü ve Laboratuvar Uygulama Klavuzu. Atatürk Üniversitesi Yayın No: 867, Ziraat Fakültesi Yayın No: 335, Ders Kitapları Serisi No: 82. Erzurum. s: 245. (In Turkish).
- [3] Kanburoğlu S, Öğretir K (1980). Mısır, Toprakşu Genel Müdürlüğü, Eskişehir Bölge Toprakşu Araştırma Enstitüsü Müd. Yay. Genel Yay. No: 146, Çiftçi Bülteni Seri No: 26, Eskişehir. (In Turkish).
- [4] [4] Sosulski FW, Wu KK (1988). High-fiber breads containing field pea hulls, wheat, corn, and wild oat brans. *Cereal chemistry (USA)*.
- [5] Gül H (2007). Mısır ve Buğday Kepeğinin Hamur ve Ekmek Nitelikleri Üzerindeki Etkilerinin İncelenmesi. Doktora Tezi, Fen Bilimleri Enstitüsü, Çukurova Üniversitesi, Adana. (In Turkish).
- [6] Altın P (2007). Bazı Katkı Maddeleri Kullanımı ile Süneli Unların Teknolojik Özelliklerinin Düzeltilmesi Konusunda Bir Araştırma. Yüksek Lisans Tezi, Fen Bilimleri Enstitüsü, Çanakkale Onsekiz Mart Üniversitesi, Çanakkale. (In Turkish).
- [7] İşleröğlü H, Dirim SN, Ertekin FK (2009). Gluten İçermeyen, Hububat Esaslı Alternatif Ürün Formülasyonları ve Üretim Teknolojileri. *GIDA*, 34: 29-36. (In Turkish).
- [8] Karaoğlu MM (2006). *Cephalaria syriaca* addition to wheat flour dough and effect on rheological properties. *International journal of food science & technology*, 41(s2), 37-46.
- [9] Shukla R, Cheryan M (2001). Zein: The Industrial Protein from Corn. *Industrial and Crops Products*, 13, 171-192. (In Turkish).
- [10] Chamberlain N, Collins TH, Elton GAH (1965). Chorleywood Bread Process Recent Developments. *Cereal Science Today* LO (412).
- [11] Cooley JA (1965). Role of Shortening in Continuous Dough Processing *Bakers Digest* 39 (3) 31.
- [12] Demir MA, Elgün A, Argun MŞ (2008). Sütçülük Yan Ürünlerinden Peynir Altı, Yayık Altı ve Süzme Yoğurt Suları Katkılarının Bazı Ekmek Özelliklerine Etkileri Üzerine Bir Araştırma. Selçuk Üniversitesi, Ziraat Fakültesi, Konya. (In Turkish).
- [13] Zhao X, Shi-Jian D, Tao G, Xu R, Wang M, Reuhs B, Yang, Y (2010). Influence of phospholipase A2 (PLA2)-treated dried egg yolk on wheat dough rheological properties. *LWT-Food Science and Technology*, 43(1), 45-51.
- [14] Kotancılar HG (2015). Laboratuvar Teknikleri ve Enstrümental Analiz Uygulama Kılavuzu, Atatürk Üniversitesi, Ziraat Fakültesi Ders Yayınları NO: 245. (In Turkish).
- [15] Kramer A, Twigg BA (1980). *Quality Control for The Food Industry*. Vol 13rd Ed. Lhe AVI Publ. Co. Inc. Connecticut. USA.
- [16] Carr G, Tadini CC (2003). Influence of yeast and vegetable shortening on physical and textural parameters of frozen part baked French bread. *LWT-Food Science and Technology*, 36(6), 609-614.
- [17] Karim AA, Norziah MH, Seow CC (2000). Methods for the study of starch retrogradation. *Food chemistry*, 71(1), 9-36.
- [18] Yıldız N, Bircan H (2003). Araştırma ve Deneme Metotları. Atatürk Üniv. Ziraat Fak. Yayınları. Yayın No:305. Erzurum. S: 266. (In Turkish).
- [19] Ertugay Z, Elgün A, Koca F (1988). Bitkisel Kaynaklı Katı ve Sıvı Shorteningler ile Yüzey Aktif Madde Kombinasyonlarının Ekmek İçi Özellikleri ve Bayatlaması Üzerine Etkileri. Atatürk Üniversitesi, Ziraat Fakültesi, 13 (5): 323-330. (In Turkish).
- [20] Junge RC, Hosenev RC (1981). A mechanism by which shortening and certain surfactants improve loaf volume in bread. *Cereal Chem*, 58(5), 408-412.
- [21] Azizi MH, Rajabzadeh N, Riahi E (2003). Effect of mono-diglyceride and lecithin on dough rheological characteristics and quality of flat bread. *LWT-Food Science and Technology*, 36(2), 189-193.
- [22] O'Neill J (2010). Gluten-free foods: trends, challenges, and solutions. *Cereal foods world*, 55(5), 220-223.
- [23] Pomeranz Y, Shogren MD, Finney KF (1976). White wheat bran and brewer's spent grains in high-fiber bread. *Bakers Digest*.
- [24] Torbica A, Hadnadev M, Dapčević T. (2010). Rheological, textural and sensory properties of gluten-free bread formulations based on rice and buckwheat flour. *Food hydrocolloids*, 24(6-7), 626-632.
- [25] Turabi E, Sumnu G, Sahin S (2010). Quantitative analysis of macro and micro-structure of gluten-free rice cakes containing different types of gums baked in different ovens. *Food Hydrocolloids*, 24(8), 755-762.

- [26] O'brien CM, Mueller A, Scannell AGM, Arendt EK (2003). Evaluation of the effects of fat replacers on the quality of wheat bread. *Journal of Food Engineering*, 56(2-3), 265-267.
- [27] Özüğür G, Hayta M (2011). Tahıl Esaslı Glutensiz Ürünlerin Besinsel ve Teknolojik Özelliklerinin İyileştirilmesi. *GIDA*, 36 (5): 287-294. (In Turkish).
- [28] Gerçekaslan KE (2012). Vakfikebir Ekmek Hamurundan Laktik Asit Bakterilerinin İzolasyonu-İdentifikasyonu ve Ekmek Üretiminde Kullanılabilme İmkanları. Doktora Tezi, Fen Bilimleri Enstitüsü, Atatürk Üniversitesi, Erzurum. (In Turkish).
- [29] Herz KO (1965). Staling of bread-a review. *Food Technology*, 19(12), 1828.
- [30] Martin ML, Zeleznak KJ, Hosney RC (1991). A mechanism of bread firming. I. Role of starch swelling. *Cereal chemistry (USA)*.
- [31] Karaoğlu MM (2002). Farklı Sıcaklık ve Sürelerde Muhafaza Edilen Kısmi Pişmiş Ekmeklerin Teknolojik ve Mikrobiyolojik Özellikleri. Doktora Tezi, Fen Bilimleri Enstitüsü, Atatürk Üniversitesi, Erzurum. (In Turkish).