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EFFECT OF XANTHAN GUM ADDITION ON THE CHEMICAL, AND RHEOLOGICAL PROPERTIES OF TOAST BREAD

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ABSTRACT: The aim of the study was to produce high quality, nutritional value, sensory and rheological properties of toast bread from xanthan gum and wheat flour (WF). Four toast were prepared; by substituting wheat flour with 0, 0.5, 1.0 and 2.0% by xanthan gum (XG). The chemical, caloric value, Physical and sensory properties of toast bread were studied. The results showed that addition of xanthan gum to WF at different proportion due to an increase in water absorption (%), dough softening (B.U), dough development (min) and water holding capacity. Meanwhile, extensibility (mm) decreased in all doughs of XG (0.5, 1.0 and 2.0%). Energy was decreased by addition of XG at levels of 1.0 and 2.0% of XG were (15 and 20 cm^2), respectively. The sensory evaluation results showed a significantly increase in the taste, odor, crumb grain and crumb texture by increasing the XG substitution comparing with control. Meanwhile, crust color, appearance and overall acceptability decreased than.

Key words: Pan bread, xanthan gum, Dough properties, Bread quality.

INTRODUCTION

In developing functional bakery products (such as bread), it is essential to change a products physiological effectiveness and consumer's acceptance in terms of texture, appearance and taste (**Siró *et al.*, 2008**).

Bread is an important staple food made of wheat flour, yeast and salt and consumed around the world (**Fan *et al.*, 2006**). Nowadays people prefer to eat healthier food in order to prevent noncommunicable diseases. For this purpose, industry and researchers are involved in optimizing bread making technology to improve the quality, taste, variety and availability of food products such as bread (**Hathorn *et al.*, 2008**). Among the ingredients that could be included in bread formulation there are spices and herbs, which are important part of the human food. They have been used for thousands of years to enhance the odor, aroma and color of food and also for their antimicrobial, anti-oxidative, preservative and other medicinal values.

For example, (**El-Dreny and El-Hadidy, 2020**) preparing luten free biscuits and flat bread with high quality for celiac patients. Wheat (*Triticum aestivum*) is main of the essential edible grains around the world (**Alu'datt *et al.*, 2012**). It is used in many forms consist of flat or pan style leavened bread. Wheat is depression in indispensable amino acids, for example, lysine and methionine, which reduces its nutritious value when utilization in foods products (**Newman and Newman, 2006**).

The general mechanism suggests that hydrocolloids causing a better water distribution and retention, and also a decrease in the crumb resistance as a result of its weakening influence on the starch structure (**Kohajdová and Karovičová, 2009**). Additionally, gluten network or the created bonds in wheat flour dough was influenced when hydrocolloids were added and consequently change its viscoelastic properties to produce breads with higher volumes, better porosity, and desired crumb texture (**Pečivová *et al.*, 2011**). In fact xanthan, guar, and arabic gums have been used n previous studies to improve bread quality (**Guarda *et al.*, 2004**). Different molecular structure, particle size and amount of hydrocolloids, bread recipe, dough

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and bread preparation methods as well as bread types are considered the important factors which the hydrocolloids effects on dough and bread properties depended on it (**Majzoobi *et al.*, 2007**). Hydrocolloids themselves have a low calorific value and are generally effective in a little quantity (**Mikuš *et al.*, 2011**). Gums regulated, and classified as either food additives or generally recognized as safe (GRAS) substances by The Food and Drug Administration (**Rodge *et al*., 2012**)

Xanthan gum is a heteropoly saccharides microbially produced by *Xanthomonas campestris*. The gum is a white to cream colored free flowing powder soluble in hot and cold water, but insoluble in most organic solvents (**Khan *et al.*, 2007**). The most important properties of xanthan gum are its high low-shear viscosity and strong shear-thinning character. The relatively low viscosity at high shear rates makes it easy to mix, pour, and swallow. Its high viscosity at low shear rates gives it good suspension properties and stability to colloidal suspensions (**Sun *et al*., 2007**). Xanthan gum can also induce dough strengthening; it increases water absorption and the ability of the dough to retain gas. It also increases the specific volume of the final bread and the water activity of the crumb **(Rosell *et al.*, 2001**). Xanthan gum is used to improve the texture and moisture retention in cake batters and bread dough's, to increase the volume and shelf life of cereal foods by limiting starch retrogradation, improve their eating quality and appearance, and to enhance the effectiveness of other hydrocolloids (**Gimeno *et al*., 2004**).

Recently, researchers focused on studying dietary fiber because of its nutritional and health importance on the human body, as the fiber works to reduce the symptoms of some diseases such as hypercholestero, cardiovascular disease, hypoglycemic, some forms of cancer and also health promotion of consumers through a reduction in fat and cholesterol, As a result of the high hydroclloids content of fiber to add to the industry of many bakery goods, such as bread, cakes, cookies and biscuits to producing products rich in fiber acceptable to the sensory attributes properties of the consumer (**Brownlee, 2011**).

This study was conducted to use XG as a functional food and as a high source of fiber in toast bread preparing and to estimate the impact of fortified of wheat flour (82% extraction) with the XG on chemical, sensory properties of toast bread and rheological properties of dough.

MATERIALS AND METHODS

Materials

Xanthan gum was purchased from El Gamhouria Trading Chemicals, Zagazig City Egypt. WF (82% extraction), sugar (sucrose), vegetable shortening, instant active dry yeast and salt (sodium chloride) were collected from the market in Zagazig City, Egypt. All chemicals purchased from El Gamhouria Trading Chemicals and Drugs Company, Egypt.

Chemical Analysis

The chemical analysis, i.e. crude protein, ash, ether extract and crude fiber of raw materials and toast bread blends were estimated according to **AOAC (2010)**. Total carbohydrate content was calculated by difference as reported by **Tadrus (1989)**. The energy value (on a dry weight basis) was calculate using the Atwater formula as follows:

Caloric value = (ether extract × 9) + (protein × 4) + (carbohydrates ×4).

The energy value was estimated according to **James (1995)**.

Wet gluten, dry gluten, and gluten index:

Wet and dry gluten as well as gluten index of wheat flour were determined using Glutomatic perten instruments (AB type 2200 No. 005092, Huddling, Sweden) as described by **Perten (1990).**

Toast bread processing

Toast bread is prepared according to the method **Boudonas *et al.* (1976**) with some modifications such as added 24 g of fresh egg and sugar (sucrose) to all blends. The baking formula was 100 g of flour, 1.5 g of yeast, 2 g of salt, 3 g of vegetable shortening, 5 g of sugar, and water as needed. XG as partially substitute for wheat flour at different levels (0.5, 1.0 and 2%) in Table 1. The flour mixture is kneaded in the perineum until the homogeneity is complete. Then leave the dough for fermentation for 90 min, then put it in a toast mold, then leave it for another 90 min to ferment, finally it baked in the oven at 250°C, for 30 min. (Table 1).

Table 1. Toast formula prepared with XG at different ratios of substitutions

Ingredients	C	B 1	B 2	B 3
WF (82% ext.)	100	99.5	99	98
XG (%)	0	0.5	1.0	2.0
Yeast (g)	1.5	1.5	1.5	1.5
Salt (g)	2	2.0	2	2
Butter (g)	3	3	3	3
Sugar (g)	5	5	5	5
Fresh egg (g)	24	24	24	24

WF; white flour, XG; xanthan gum, C; control "wheat flour without xanthan gum, wheat flour supplemented with B1 0.5, B2 1.0 and B3 2% of xanthan gum

Rheological Properties of WF and WFXG Dough

Farinograph properties of WF and WF-XG dough

The farinograph test was performed to estimate water absorption, arrival time, stability time, dough development time, degree of softening (B.U) of WF and WF- XG blends according to the method described by AACC (**1983**).

Extensograph properties of WF and WF-XG dough

AACC (1983) Method was used to estimate the extensor test on WF-XG for studying flour blends extensibility, proportional number, elasticity and energy.

Sensory Evaluation of Toast Bread

Twenty panelists from the staff of Sakha food Technology Research Laboratory., Agric. Res. Center, Egypt were asked for sensory evaluation of toast bread taste, crust color, odor, crumb grain, crumb texture, appearance and overall acceptability according to the method described by **Kramer and Twigg** (**1974**). Panelists evaluated pan bread blends on a 9 point hedonic scale quality analysis with 9 = liked extremely, 8 = liked very much, 7 = liked, 6 = liked mildly, 5 = neither liked nor disliked, 4 =disliked mildly, 3 = disliked, 2 = disliked very much and 1 = disliked extremely according to the method described by **Larmond (1997)**.

Statistical Analysis

Statistical analysis was done using SPSS software (version 15) and Duncan's multiple range tests was used for mean comparison.

RESULTS AND DISCUSSION

Chemical Composition of WF 82% Extraction (g/100g on dry Weight Basis)

The chemical composition of wheat flour is presented in Table 2. The obtained results revealed that wheat flour (82% extration) recorded the percentages of crude protein, lipids, ash, crude fiber and total carbohydrate content being 12.60, 1.80, 1.47, 1.50, and 82.63%, respectively.

Table 2 shows the average value of crude protein, crude ether extract, ash, fiber, total carbohydrates, available carbohydrates and calorie values (kcal/100g). The results indicate that crude protein, available carbohydrates and total carbohydrate contents in wheat flour correspond to **Abd El-Hafez (2015)** XG is reported to contain 5.68% protein, 6.80% fat, 24.30% crude fiber and 46.20% carbohydrates available respectively, while wheat flour is a good source of crude protein and carbohydrates. These results roughly correspond to those found by **Fadavi *et al*. (2006) and Kingsly *et al*. (2006**).

Table 2. Chemical composition of wheat flour (82% extraction)

Components	% on dry weight basis
Crude protein	12.60
Ether extract	1.80
Ash	1.47
Total carbohydrates	84.13
Crude fiber	1.50
Available carbohydrates	82.63
Caloric value (kcal/100 g)	397.12

Carbohydrate contents were determined by difference.

These results are nearest to the results obtained by **Jia *et al.* (2014)**, who reported that moisture, crude protein, crude fat, and ash content were 13.4%, 9.0%, 1.5%, and 0.8%.

Wet gluten, dry gluten, and gluten index

Wet gluten, dry gluten, and gluten index of wheat flour used in the current study were 28.64, 9.92 and 91.30%, respectively (Table, 3). These results are in the same line with that obtained by **Dagdelen and Gocmen (2007)**. They found that, wheat flour contained 27.2% wet gluten and 91.0% gluten index. Also, **Ribotta *et al.* (2010)** mentioned that, wheat flour (82% ext.) had 27.4% wet gluten. Since, **Chung *et al*. (2002)** stated that the flour (82% ext.) with gluten index value more than 90% could be considered as good bread flour. According to this status, the current wheat flour type is strong with a high gluten index that is good enough for bread manufacturing.

Farinograph parameters of prepared WF and WF- XG toast bread dough

Rheological properties of dough formula made from different levels of XG were determined by farinograph tests and the results were presented in Table 4 and Fig. 1. Increased absorption of dough with water due to the high percentage of fibers in the XG. As the fibers have the ability water holding capacity as reported by **Hussein *et al.* (2010) and Seleem (2015)**. With regarded to the arrival time, dough development time and dough stability values were directly affected by the addition of XG ratios. Dough with 2% XG was the highest arrival time and development time values as (4.00 and 5.00 min), respectively.

Similar findings were mentioned by **Hussein *et al.* (2010)**. They mentioned that arrival time and water absorption increment as XG level increased in dough. Dough stability values were found to be higher in toast dough prepared by 2% XG than the control dough, while dough softening value increased for all doughs of fortified with XG samples as comparing to the control. This may also be due to the fibers that interacts with the gluten, which affects the dough mixing properties (**Shouk and Ramadan, 2007**).

Concerning to degree of softening, it could be observed that the treatments which given high stability time value had lower degree of softening. Usually, flour with good bread making properties has high stability time and is more tolerant to mixing. Weaker flours tend to have higher values of degree of softening and it generally gives the rate of dough breakdown and the strength of flour **Bonet *et al.* (2006)**.

Extensograph parameters of WF and WF- XG dough

Data presented in Table 5 and Fig. 2 show that the effect of adding XG at three ratios on the rheological properties of dough as evaluated by extensograph. Elasticity (B.U) and Proportional increased as XG ratios increased of dough toast

Table 3. Wet gluten, dry gluten, and gluten index

Parameter	Percentage (%)
Wet gluten	28.6 ± 0.18
Dry gluten	9.9 ± 0.08
Gluten index	91.3 ± 0.12

The values are present the means of triplicate ± SD

Table 4. Farinograph parameters for WF and WF-XG dough

Samples	Water adsorption (%)	Arrival time (min)	Development dough(min)	Stability (min)	Degree of softening (B.U)
Control	60.0	1.0	1.5	12.0	10.0
XG 0.5%	63.0	1.0	1.5	10.0	60.0
XG 1.0%	66.0	2.0	2.5	12.0	40.0
XG 2.0%	68.8	4.0	5.0	13.0	30.0

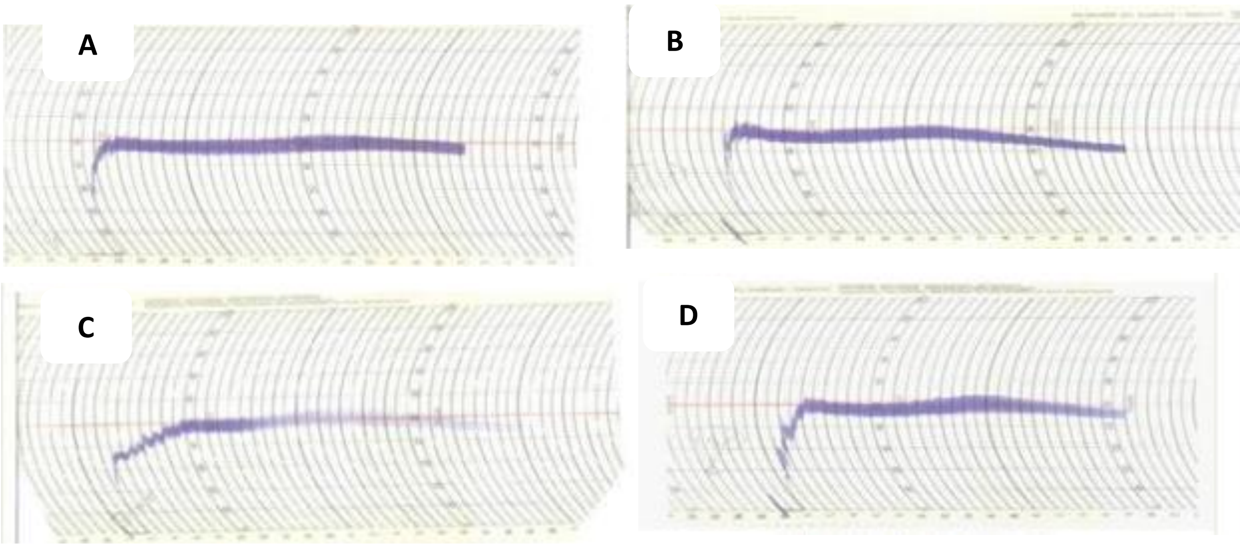

Fig. 1. Rheological properties WF and WF-XG dough by farinograph

Farinogram parameters of dough behavior of wheat flour supplemented (A), without or with (B) 0.5, (C) 1.0 and (D) 2% of xanthan gum

processed XG. Meanwhile, extensibility (mm) was 140 mm in control dough and decreased in all doughs of XG (0.5, 1.0 and 2.0%). Also, the proportion 0.5% substitution of wheat flour by XG induced an increase in energy to (38 cm^2) comparing with control dough (35 cm^2). Energy was decreased by addition of XG at levels of 1.0 and 2.0% of XG were (15 and 20 cm^2), respectively.

It could notice that the extensograph parameters are correlated to both the gum types and the addition levels. In general, maximum resistance to extension, extensibility, and energy were increased when the level of addition was increased. Regard to the xanthan gum concentration, the ordered was 0.5> 1.0> 2.0.

Sensory evaluation of WF and WFXG toast bread

Table 6 and Fig. 3 illustrates that the sensory properties of toast bread processed WF (82% extraction) only as a control and the toast bread prepared WF-XG. The results indicate that the taste, odor, crumb grain and crumb texture value were increases with the increase in the percentage of XG in toast bread. Meanwhile, other value decreases in crust color samples compared with control. Also, the appearance increased at the level of the addition of 0.5% XG and then decreases at the level of 1.0% or 2.0% XG-toast bread compared to the control. Data showed an increasing the acceptability in control of toast bread than blends 0.5, 1 or 2% of XG substituted toast were decrease. These results are in agreement with **Hussein *et al.* (2010) and Seleem (2015)**.

The overall acceptability values, which is a reflection of all the tested quality attributes and acceptability of the studied pan bread, were calculated as a sum of received sensory score. The results demonstrated that, the good quality of the prepared pan bread could be obtained by adding xanthan gum with a concentration of 1.0 and 2.0% give almost the same properties as control. These results are in agreement with **Shittu *et al.* (2009) and Polaki *et al.* (2010)**.

Table 5. Extensograph properties of WF and WF-XG dough

Dough properties	Elasticity (B.U)	Extensibility (min)	Proportional number	Energy (cm^2)
Control	230	140	1.64	35
XG 0.5%	320	130	2.53	38
XG 1.0%	320	90	3.55	15
XG 2.0%	380	75	5.06	20

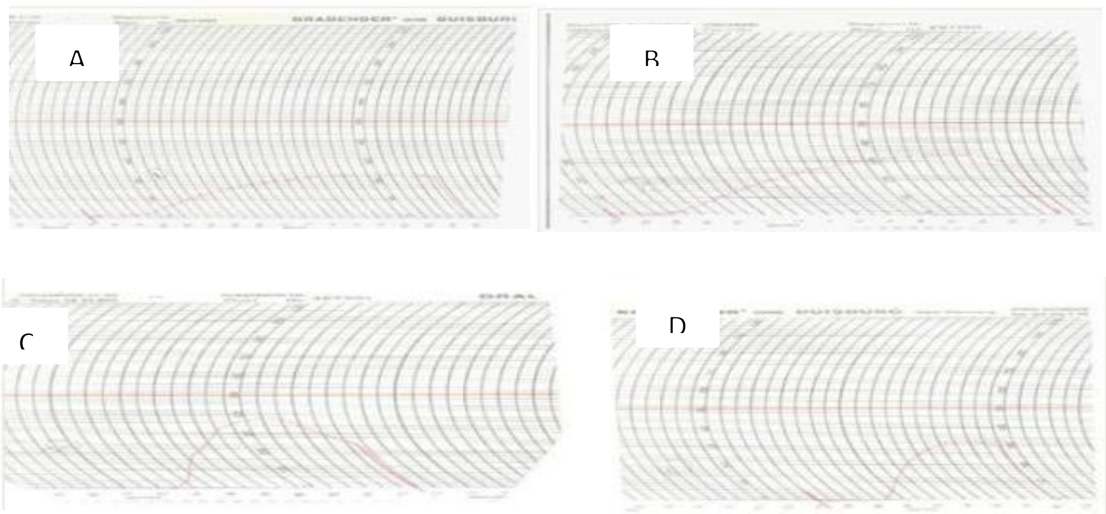

Fig. 2. Rheological properties of WF and WF-XG dough by extensogragh

Extensogram parameters of dough behavior of wheat flour supplemented (A), without or with (B) 0.5,(C) 1.0 and (D) 2% of xanthan gum

Table 5. Organoleptic properties of WF and WFXG toast bread

Samples	Taste	Crust color	Odor	Crumb grain	Crumb texture	Appearance	Overall acceptability
Control	8.00	8.50	7.33	8.00	8.00	7.70	8.00
XG 0.5%	8.30	8.17	7.7	8.50	8.33	8.33	7.33
XG 1.0%	8.23	7.66	8.7	8.80	8.90	7.33	7.00
XG 2.0%	9.00	7.33	9.00	9.00	9.00	7.16	6.50

-The sensory scores (9-point hedonic scale) of toast bread

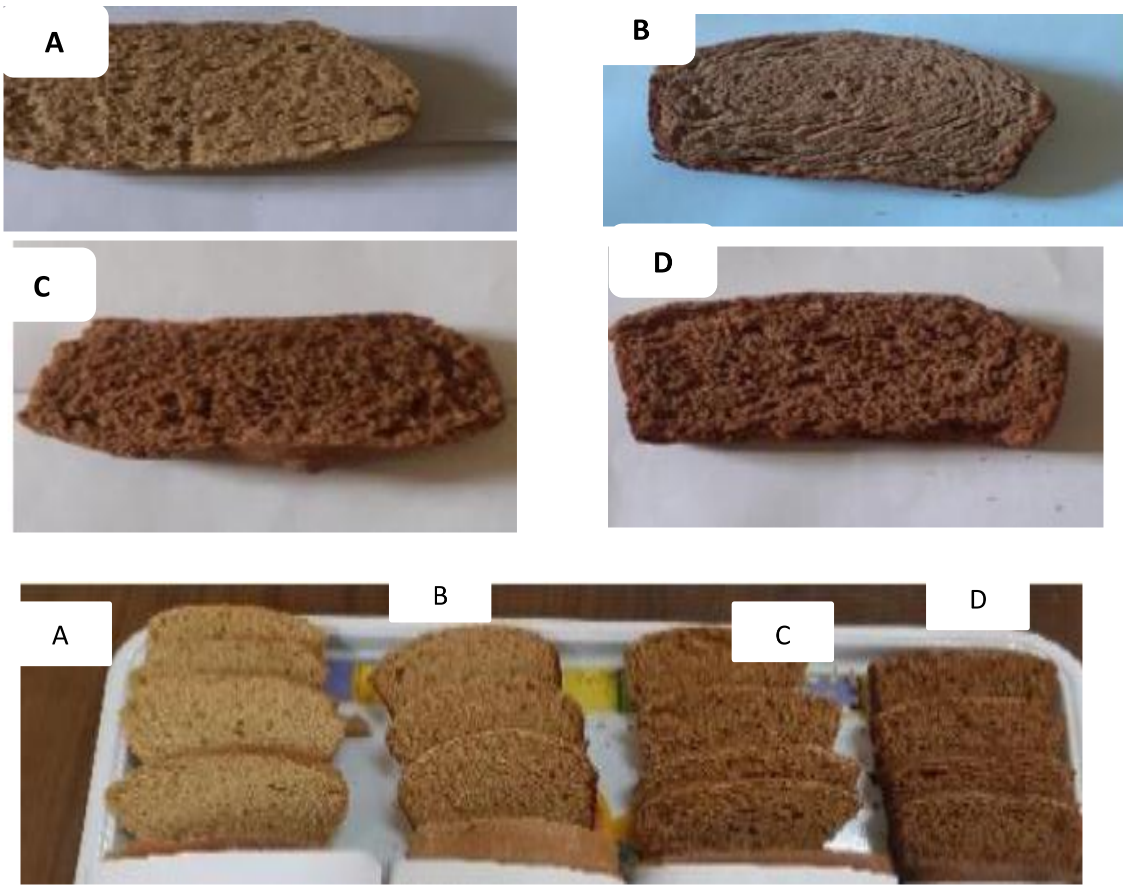

Fig. 3. Control and WF-XG toast bread

Conclusion

The results obtained in this study revealed that toast bread were prepared using wheat flour enriched with Xanthan gum at different levels. The final products were rich of crude fiber, ash and minerals with low caloric value. These products were a rich source of minerals. Supplemented toast bread had a lower energy value with decrease energy portions coming from fiber. The applied technological procedure using well blended combination of supplements resulted in the production of toast bread its excellent rheological and sensory properties of taste, odor, crumb grain and crumb texture. Meanwhile, crust color, appearance and overall acceptability decreased compared to the control. Finally, it could prepare some bakery products using materials such as xanthan gum of high quality that are suitable for consumers.

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تأثير إضافة صمغ الزانثان على الخواص الكيميائية والريولوجية لخبز التوست

منال علي الشحات هجرس - حفناوي طه حفناوي - هند احمد ممدوح العقاد

قسم الكيمياء الحيوية – كلية الزراعة – جامعة الزقازيق – مصر

الهدف من الدراسة هو إنتاج خبز توست ذو جودة عالية وخصائص حسية وريولوجية من دقيق القمح باضافة صمغ الزانثان ودقيق القمح. تم إعداد أربعة عينات. عن طريق استبدال دقيق القمح ب 0 و 0.5 و 1.0 و 2.0% بواسطة صمغ الزانثان . تمت دراسة القيمة الكيميائية والسعرات الحرارية والخصائص الفيزيائية والحسية لخبز التوست. أظهرت النتائج أن إضافة صمغ الزانثان إلى دقيق القمح بنسب مختلفة بسبب زيادة امتصاص الماء (%) ، تليين العجين (B.U) ، تطور العجين (دقيقة) والقدرة على الاحتفاظ بالماء. وفي الوقت نفسه، انخفضت قابلية التمدد (مم) في جميع عجائن صمغ الزانثان (0.5 و 1.0 و 2.0%). انخفضت الطاقة بإضافة صمغ الزانثان عند مستويات 1.0 و 2.0% من صمغ الزانثان كانت (15 و 20 سم^2) ، على التوالي. أظهرت نتائج التقييم الحسي زيادة معنوية في الطعم والرائحة وحبيبات الفتات وملمس الفتات من خلال زيادة استبدال صمغ الزانثان مقارنة بالكنترول. وفي الوقت نفسه، انخفض لون القشرة ومظهرها وقبولها بشكل عام عن الكنترول.

المحكمـــــون:

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