

**Sudan University of Science and Technology
College of Graduate Studies and Scientific Research**

**Production of Gluten Free Bakery Products Based on Sorghum
(*Sorghum bicolor* L. Moench) and Maize (*Zea mays* L.) Flours)
Supplemented with Chickpea (*Cicer arietinum* L.) Flour and Some
Improvers**

إنتاج مخبوزات خالية من الجلوتين إعتقادا على طحين الذرة وطحين الذرة الشامية مضافا
إليهما طحين الحمص وبعض المحسنات

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Dedication

To

My family, my wife

And

Celiac disease patients

Mohammed

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Production of Gluten Free Bakery Products Based on Sorghum (*Sorghum bicolor L. Moench*) and Maize (*Zea mays L.*) Flours Supplemented with Chickpea (*Cicer arietinum L.*) Flour and Improvers

Ph.D.

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ABSTRACT

Gluten free products were formulated to utilize decorticated sorghum and maize (90% extraction) supplemented with chickpea flour at different ratio (0%, 10%, 20% and 30%) and improvers to produce biscuits, balady and tin breads. Raw material and final products were analyzed. Sensory evaluation by panelists, semi trained panelists and celiac disease patients. Physical properties of the raw material and final products were conducted. Statistical analysis was done. Results showed that protein of decorticated sorghum, maize and chickpea was 12.15%, 11.12% and 23.18%, respectively. Protein digestibility was 62.4%, 63.74% and 60.78%, respectively; starch digestibility was 62.07%, 63.76% and 60.82%, respectively. Tannin was 41.60, 80.00 and 305.00mg/100gm for decorticated sorghum, maize and chickpea, while, phytic acid was 75.03, 117.01 and 299.65mg/100gm, respectively. Bulk density of decorticated sorghum, maize flour supplemented with chickpea flour with (0, 10%, 20% and 30%) ranged from 0.45 to 0.50gm/ml for sorghum and from 0.51 to 0.57gm/ml for maize, respectively. Whereas, sorghum water retention capacity ranged between 210 and 230ml/100gm, therefore, from 210 and 270ml/100gm for maize, respectively. While, fat absorption capacity of sorghum ranged between 208.3 and 225ml/100gm, whereas, maize fat absorption capacity ranged between 205 and 240ml/100gm, respectively. The biscuits, balady and tin breads made from decorticated sorghum and maize (90% extraction) supplemented with chickpea flour at different ratio (0%, 10%, 20% and 30%) results showed that protein content increased significantly ($P \leq 0.05$) with increasing the level of chickpea from 12.84 to 15.89% for sorghum biscuits and from 11.14 to 15.50% for maize biscuits, then, sorghum balady breads protein increased from 11.26 to 15.90%, and from 10.57 to 15.54% for maize balady breads. Therefore, sorghum tin breads protein increased

from 11.26 to 16.89% and so maize tin breads protein increased from 11.15 to 16.96%. Sorghum biscuits Protein digestibility increased significantly ($P \leq 0.05$) with increasing the level of chickpea from 43.51 to 58.60%, and from 48.13 to 60.29% for maize biscuits. So, sorghum balady breads Protein digestibility increased from 39.41 to 46.20%, whereas, maize balady breads from 47.70 to 56.38%. Also, sorghum tin breads protein digestibility increased from 43.35 to 48.22, and maize tin breads from 50.78 to 58.54%. Starch digestibility increased significantly ($P \leq 0.05$) with increasing the level of chickpea from 46.81 to 60.36% and from 62.65 to 67.16% for sorghum and maize biscuits, respectively. Therefore, balady breads starch digestibility increased significantly ($P \leq 0.05$) with increasing the level of chickpea from 62.17 to 65.35% and from 65.57 to 67.22% for sorghum and maize, respectively. Likewise, sorghum tin breads starch digestibility increased 62.55 to 66.11% and so maize tin breads from 66.77 to 67.41%. Mineral elements analysis showed that Na, P and K elements were found to be the most dominant mineral in all the products studied. However, Na, P and K elements increased significantly in both sorghum and maize biscuits on increasing the level of chickpea. Spread ratio of biscuits was between 6.99 and 8.16 cm for sorghum, and 7.10 and 8.21 cm for maize. Balady bread specific volume ranged between 2.32 to 2.72 cc/gm for sorghum, and from 2.14 to 2.24 cc/gm for maize. Likewise, loaf specific volume of tin bread showed sorghum bread got the highest value 2.79 cc/gm. Generally increasing the inclusion of chickpea in bread making decreased the bread specific volume. General acceptability of products showed no significant differences between sorghum and maize products. The scores of general acceptability ranged from acceptable to highly acceptable and indicated that those gluten free products samples were generally appreciated by the panelist and celiac disease patients. Finally, sorghum and maize gluten free products supplemented with chickpea satisfied the need of such products for celiac disease patients and enhanced the nutritional value.

إنتاج مخبوزات خالية من الجلوتين إعتقاداً على طحين الذرة وطحين الذرة الشامية مضافاً إليهما طحين الحمص و المحسنات

الدكتورة

محمد عبدالرحمن حسين أحمد

الخلاصة

قد تم إعداد منتجات خالية من الجلوتين بإستخدام الذرة (طابت) والذرة الشامية (90% من الاستخلاص) و إضافة دقيق الحمص بنسبة مختلفة (0% و 10% و 20% و 30%) والمحسنات لإنتاج البسكويت والخبز البلدي وخبز القوالب. تم تحليل المواد الخام والمنتجات النهائية. التقييم الحسي من قبل المقيمين ، وشبه المقيمين ومرضى مرض السيلياك. وقد أجريت الخصائص الفيزيائية للمواد الخام و المنتجات النهائية. تم إجراء تحليل إحصائي. وأظهرت النتائج أن بروتين المواد الخام من الذرة والذرة الشامية والحمص كان 12.15% و 11.12% و 23.18% على التوالي. و هضم البروتين 62.4%، و 63.74% و 60.78%، على التوالي، وكان هضم النشا 62.07%، و 63.76% و 60.82% على التوالي. وكان التانين 41.60 و 80.00 و 305.00 ملجم / 100 جم للذرة والذرة الشامية والحمص بينما كان حمض فيتيك 75.03 و 117.01 و 299.65 ملجم / 100 جم على التوالي. وقد تراوحت الكثافة الظاهرية لطحين الذرة ، وطحين الذرة المضاف إليه طحين الحمص (0 و 10% و 20% و 30%) من 0.45 إلى 0.50 جم / مل للذرة ومن 0.51 إلى 0.57 جم / مل للذرة الشامية على التوالي. حيث تراوحت القدرة على احتباس الماء بين 210 و 230 مل / 100 جم، للذرة من 210 و 270 مل / 100 جم للذرة الشامية، على التوالي. في حين تراوحت القدرة على امتصاص الدهون للذرة بين 208.3 و 225 مل / 100 جم، في حين تراوحت قدرة امتصاص الدهون للذرة الشامية بين 205 و 240 مل / 100 جم على التوالي. البسكويت والخبز البلدي وخبز القوالب المصنوع من طحين مقشور الذرة والذرة الشامية (90% الاستخلاص) المضاف إليهما طحين الحمص بنسبة مختلفة (0% و 10% و 20% و 30%) أن محتوى البروتين زاد معنوياً ($P \leq 0.05$) مع زيادة مستوى الحمص من 12.84 إلى 15.89% لبسكويت الذرة ومن 11.14 إلى 15.50% لبسكويت الذرة الشامية، ثم زاد بروتين الخبز البلدي من الذرة من 11.26 إلى 15.90%، ومن 10.57 إلى 15.54% للخبز البلدي للذرة الشامية. كذلك، زاد بروتين خبز القوالب من الذرة من 11.26 إلى 16.89%، وأيضاً زاد بروتين خبز القوالب من الذرة الشامية من 11.15 إلى 16.96%. زادت نسبة هضم بروتين بسكوت الذرة معنوياً ($P \leq 0.05$) مع زيادة مستوى الحمص من 43.51 إلى 58.60%، ومن 48.13 إلى 60.29% لبسكويت الذرة الشامية . وكذلك زاد هضم بروتين الخبز البلدي من الذرة من 39.41 إلى 46.20%، بينما في الخبز البلدي من الذرة الشامية من 47.70 إلى 56.38%. أيضاً، زاد هضم البروتين في خبز القوالب من الذرة من 43.35 إلى 48.22، وخبز القوالب من الذرة الشامية من 50.78 إلى 58.54%. زادت قابلية هضم النشا بشكل ملحوظ ($P \leq 0.05$) مع زيادة مستوى الحمص من 46.81 إلى 60.36% ومن 62.65 إلى 67.16% لبسكويت الذرة و

بسكوييت الذرة الشامية على التوالي. وازدادت نسبة قابلية هضم النشا للخبز البلدى بشكل ملحوظ ($P \leq 0.05$) مع زيادة مستوى الحمص من 62.17 إلى 65.35% ومن 65.57 إلى 67.22% للذرة والذرة الشامية على التوالي. وكذلك ، زاد هضم النشا فى خبز القوالب من الذرة من 62.55 إلى 66.11%، وأيضا خبز القوالب من الذرة الشامية من 66.77 إلى 67.41%. وأظهر تحليل العناصر المعدنية أن عناصر Na ، P و K الأكثر هيمنة في جميع المنتجات المدروسة. ومع ذلك، زادت عناصر Na و P و K بشكل ملحوظ في كل من بسكوييت الذرة وبسكوييت الذرة الشامية بزيادة مستوى الحمص. وكانت نسبة إنتشار البسكوييت بين 6.99 و 8.16 سم للذرة ، و 7.10 و 8.21 سم للذرة الشامية. تراوح الحجم النوعى الخبز البلدى بين 2.32 إلى 2.72 سم³/جم للذرة ، ومن 2.14 إلى 2.24 سم³/جم وبالنسبة للذرة الشامية. وكذلك، أظهر الحجم النوعى لخبز القوالب من الذرة أعلى قيمة 2.79 سم³/جم. عموما زيادة إضافة الحمص في صناعة الخبز خفض الحجم النوعى للخبز. وأظهر القبول العام للمنتجات عدم وجود فروق ذات دلالة إحصائية بين منتجات الذرة و الذرة الشامية. وتراوحت درجات القبول العام بين المقبول والمقبول للغاية، وأشارت إلى أن عينات المنتجات الخالية من الجلوتين هذه كانت موضع تقدير عام من قبل المقيمين و مرضى مرض السيلياك. وأخيرا، منتجات الذرة والذرة الشامية الخالية من الجلوتين المضاف إليهما الحمص أُرضتُ حاجةً مثل هذه المنتجات مرضى السيلياك وعززت القيمة الغذائية.