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PRODUCTION OF HEALTHFUL BREAD GLUTEN-FREE FOR CELIAC PATIENTS FORTIFIED BY GARLIC AND PSYLLIUM AS ALTERNATIVE GLUTEN

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ABSTRACT

Celiac disease is considered a worldwide health problem in all the areas of the world where there is a great consumption of wheat. The gluten-free products will represents a real challenge both for patients and for physicians, mainly because gluten-free products are not commercially available, it considered of low quality and poor nutrition value. The present work was conducted to evaluate new formulas gluten-free bread that was obtained using maize, rice and garlic as potential healthy ingredients. The garlic was added to formulas at different concentrations levels 10, 15 and 20% to improve the nutrition value of gluten-free breads and the pysllium was added separately at level 3 and 6 % to the formulas as alternative gluten. Also, in the present work Kaiser bread formulas were evaluated chemically, nutritionally and organoleptically properties, compared with two control samples made from pysllium at two various ratios without any supplementation.

The results showed that the garlic had contained the highest total fat, ash, crude fiber, vitamins and minerals content compared with maize and rice flour. Also, maize contained the highest protein and rice contained the highest in total carbohydrate. Moreover, the results indicated that the chemical composition of Kaiser bread made from 20% garlic had contained the highest constitutions followed by formula 15% garlic which using 3 and 6% psyllium.

The sensory evaluation of Kaiser bread showed that the highest score in formula made from 10% garlic with 6% psyllium followed by 10% garlic with 3% psyllium. The formulas prepared 15% garlic with

3 and 6% psyllium were very closely similar to the Kaiser bread made from 10% garlic in all sensory evaluation. It may be concluded and recommended that the Kaiser bread prepared from 10 and 15% garlic with psyllium at 3 and 6% levels led to an acceptable quality and high nutrition value for manufacturing of bakery products for celiac patients.

Key words: Celiac disease - Gluten-free bread – Garlic - Nnutritive values - Organoleptically evaluation.

INTRODUCTION

Celiac disease (CD) prevalence is of one in 100 individuals to one in 300, it affects children of both sexes and women are twice as affected among adults (Zandonadi et al. 2009). It's also known as celiac nontropical sprue, gluten-sensitive enteropathy, immunologic, genetic, and environmental factors. Sometimes the disease becomes active after surgery, pregnancy, childbirth, viral infection, or severe emotional stress Sozer (2008). According to Saturni et al. (2010) indicated that a large proportion of celiac people remain undiagnosed; this is due to many clinicians being unfamiliar with the condition.

Wheat is the only cereal that contains the quality and amount of necessary gliadins, and glutenins which are the main proteins to form gluten in dough production. Gluten leads to extensibility, gas clamp, formation of soft crumb and crispy crust in bread products. Absence of gluten in these foods produces less viscous dough, with granular texture and low quality of final products Zandonadi et al. (2009).

Currently, the gluten-free diet can be monotonous, expensive and for compensate technologically to remove gluten, great quantities of fat are added to preparations Kennedy and Feighery (2000). According to Butterworth et al. (2004) published that the celiac patients are not able to develop appropriate recipes in accordance with their diets, in addition, modified foods often have undesirable sensory characteristics. Furthermore, the Brazilian Celiac Association's data published that the bread is the most demanded product by celiac disease patients, and the annual consumption of bread in the world, 79.0 kg Zandonadi et al., (2009).

Previous studies have been demonstrated that the nutritional composition of processed gluten free products have high levels of lipids, sugars and salt. Therefore, celiac patients may show an excessive consumption of total fats and saturated fats. According to

Lissner and Heitmann (1995) found that a high intake of dietary lipids is a major factor influencing the development of diseases such as coronary heart disease and obesity. Also, Mariani et al. (1998) reported that diet of CD adolescent patients was hyperproteic and hyperlipidic and contained low amounts of carbohydrates, iron, calcium, and fiber. Confirmed by Caponio et al., (2008) they published that all these components have a negative effect on health and this should be seriously taken into account.

Garlic is one of the most popular herbs in the world. More recent literature suggests possible beneficial effects of garlic and its extract in preventing cardiovascular diseases such as hyperlipidemia, hypertension, platelet aggregation and blood fibrinolytic activity also garlic protect against infections, rheumatism, dermatitis, abdominal pain, cough, headache, bites, worms, tumors, loss of appetite and loss of weight (Halaby 2001 and Thomson et al., 2007). Moreover, Singh and Singh (2008) published that eating of 10 g fresh garlic per day for 2 months significantly decreases (15% - 28.5%) serum cholesterol levels among hypercholesterolemia patient. Garlic is recommended for gastro-intestinal disorders as well as dog and snake bites.

Garlic is a common food for flavor and spice and strong odor is largely due to sulphur-containing compounds (e.g. S-allylcysteine sulphoxide), which are believed to account for most of its medicinal properties Husek (1991); hypocholesterolemia, hypoglycemic as well as hypotensive activities Rivlin (2001). Actually, garlic contains a variety of effective compounds that exhibit anticoagulant (antithrombotic) Amagase et al. (2001) antioxidant, Husek et al. (2003) antibiotic. Desired medicinal results of garlic are obtained when bulbs are chewed and swallowed or mixed with food and eaten Lee and Harnly (2005). Garlic is also an excellent source of selenium, which has potential therapeutic value in cancer treatment, all of these add up to a powerful herbal antioxidant to help maintain the body's health Thomson et al., (2007) and Singh and Singh (2008).

Moreover, Stevens and Rashid (2008) published that the cereals are important sources of proteins and carbohydrates for celiac individuals. In the literature, rice has also been reported that substances that swell in water could replace gluten in the dough, and the rice is as a safe food for celiac patients since it possesses no gluten and can be used in the production of pasta. Gelatinization of rice could be useful in improving the dough handling and rheological properties

of pasta made from it According to Lazaridou et al. (2007) found that the dairy proteins can be used to mimic the viscoelastic properties of gluten and result in improved structure mouth feel, acceptability and shelf life

Little research has also been published regarding incorporation of garlic with corn and rice flour to prepare free gluten bread with higher degree of acceptability. Therefore, it is important to studying the effects of replacing garlic at various levels with free gluten dough for celiac patients.

The objectives of the present study have been carried out to investigate the psyllium as alternative gluten at levels 3% and 6% without and with garlic at various concentrations 10, 15 & 20% on chemical and nutritional value of gluten-free dough. Assess the correlation exists between physical properties and consumer acceptance of sensory properties of various formulations.

MATERIALS AND METHODS

Raw materials:

Maize (Zea mays L.), rice (Oryza Sativa L.) and garlic (Allium sativum) were obtained from Field Crops Research Institute, Agric. Res. Centre, Cairo - Egypt. Psyllium and skim milk were purchased from local market.

Methods:

Chemical constituents of raw materials and Kaiser bread:

Protein, total fat, ash, crude fiber and total carbohydrates were determined according to AOAC (1995). The most satisfactory chemical methods for estimating ascorbic acid (vitamin C) based on the reduction of 2,6-dichlorophenol-indophenols by ascorbic acid (AOAC 1995). Meanwhile, the tocopherol (Vitamin E) was determined in the oil of raw materials according to Kirk and Sawyer (1991).

Minerals contents: including Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Iron (Fe) and Zinc (Zn) were determined in the diluted solution of ash samples using the atomic absorption spectrophotometer (3300 Perkin-Elme) as described in by AOAC (1995) method.

Preparation of Kaiser bread:

The ingredients (raw material) used in Kaiser bread formulas are given in Table (1) according to Khorshid et al. (1989). The Kaiser breads were baked at 450 – 500° C for a relatively short time (2–3 minutes) in an electric oven. Kaiser breads were allowed to cool on racks for about one hour before evaluation.

Table (1): Ingredients formula using kaiser bread on 100 gram flour.

Formulas	Maize	Rice	Skim milk	Psyllium	Salt	Garlic	Yeast
Control A	50	50	20	3	1.0	-	2.0
Control B	50	50	20	6	1.0	-	2.0
1	45	45	20	3	1.0	10	2.0
2	42.5	42.5	20	3	1.0	15	2.0
3	40	40	20	3	1.0	20	2.0
4	45	45	20	6	1.0	10	2.0
5	42.5	42.5	20	6	1.0	15	2.0
6	40	40	20	6	1.0	20	2.0

Sensory evaluation:

The scoring scheme was established according to the method described by (Abd El-Latif, 1990), by the panelists from the stuffs in the Food Technology Research Institute, Giza - Egypt, for taste, odor, volume, texture, inside color, color top layer, appearance and overall acceptability of Kaiser bread.

Statistical analysis:

The data obtained were analyzed by using SPSS statistical software (version 13 SPSS Inc., Chicago. USA). The results were expressed as mean ± SD. Tested for significance using one-way analysis of variance "ANOVA" according to (Armitage and Berry, 1987).

RESULTS AND DISCUSSION

Chemical analysis of raw materials:

The gluten-free diet for Celiac Disease at first sight seems very restrictive and difficult, although no one would argue that it is more challenging. Many people rave about the taste and quality of the foods on a gluten-free diet.

The demand for many nutrients is increased with celiac patients. Gluten free bread (without supplements) was insufficient in energy and all nutrients. Moreover, deficiencies can exist because of losses or mal-absorption associated with disease or inadequate intakes and lack of knowledge about adequate supplementation nutrients

Chemical compositions of raw materials (yellow maize, rice, garlic and psyllium) were investigated on dry weight basis. Results in Table (2) pointed out that maize had the highest content of protein (8.49%) followed by rice and garlic (7.22 and 6.36%). Total fat in garlic, maize and psyllium had contained the ratios 5.51%, 4.14% and 3.66% respectively, and the rice flour had the lowest content of fat (0.68% DW). Whereas, the highest total carbohydrate was in rice the ratio reached to 90.74% followed maize 85.01% then garlic 48.59% and the lowest ratio was in psyllium reached to 7.34% confirmed by Stevens and Rashid (2008).

Maize is a good source of vitamins C and E, meanwhile, psyllium was not detected in vitamins. According to Losonczy et al. (1996) published that the risk of undiagnosed coronary heart diseases was significantly lower in the highest quintile of dietary vitamin E intake in men and women aged 40 – 59 year, furthermore, high intake of vitamin C from food raises beneficial HDL cholesterol, lower serum triglyceride and inhibited high blood sugar.

Moreover, Rice flour is naturally gluten-free (Campbell 1982) and relatively non allergenic (James McCaskill 1983). Rice, maize, sorghum, vegetable, fruits and beans were free from gluten and could be used for development of gluten free bakery products such as fresh bread and puff pastry products (Acs and Kovacs, 2004).

Psyllium had the highest content of ash, crude fiber, Na, K, Ca, Mg and Fe (27.34, 60.33, 54.62, 811.37, 334.54, 51, 82 and 20.91mg/ 100g) followed by garlic which had contained (12.73, 26.81, 17.31, 401.57, 181.25 and 25.18 mg/100g) respectively, Moreover, garlic had the highest content of zinc 3.5091mg/ 100g compared with other raw materials.

Table (2): The chemical analysis of raw materials on dry weight basis

Chemical analysis	Maize	Rice	Garlic	Psyllium
Protein (g/100gm)	8.49	7.22	6.36	1.33
Total fat	4.14	0.68	5.51	3.66
Ash	1.16	0.38	12.73	27.34
Crude fiber	1.20	0.48	26.81	60.33
Total carbohydrates	85.01	90.74	48.59	7.34
Vit. C (mg/100gm)	40.25	13.91	31.20	0.0
Vit. E	15.72	2.62	0.08	0.0
Na	15.97	12.30	99.31	54.62
K	192.35	185.64	401.57	811.37
Ca	20.85	32.39	81.25	334.54
Mg	3.59	1.20	25.18	51.82
Fe	4.60	4.51	1.72	20.91
Zn	2.72	2.30	3.50	2.73

Chemical composition of Kaiser bread:

Chemical composition of Kaiser bread made from maize and rice flour using psyllium at 3% and 6% (control A & B) as alternative gluten to give the dough thickeners and gelling agents, compared with the other formulas of bread after addition of garlic which replaced at various levels 10%, 15% and 20% and the results are reported in Tables (3 and 4).

Data presented in Table (3) noticed that the Kaiser bread supplemented with 3% psyllium and 20% garlic had higher protein, total fat, ash and crude fiber (10.35, 3.82, 3.62 and 8.55 /100 gm DW), followed by formulas supplemented with 15% then 10% garlic, while the lowest content was found with control A. On the other hand, the control Kaiser bread (psyllium 3% and free garlic) had the highest contents of the carbohydrate (84.11). Confirmed by (Dube et al. 2005 and Zandonadi et al. 2009) published that Psyllium was chosen because it is stable at various pH levels and temperatures, being similar to gluten in food. These properties allow its application in the food industry; pysllium can be a substitute for fat or act as an

emulsifier or thickening agent. The results were in agreement with those obtained by Thompson et al. (2005) who reported that gluten-free diet is associated with a lower intake of dietary fibre. In fact, several studies have demonstrated that high-fibre diets prevent many human diseases, colon cancer, coronary heart disease and diabetes Anderson (2009). According to Saturni et al. (2010) published that an adequate intake (20-35g/d) of fibre has to be recommended in celiac disease subjects. As summarized in Tables 3 and 4, the fibre content in cereals range from 5 to 10 g /100 g. These levels are higher with respect to other plant foods fruits, nuts and cereals such as corn and rice. Therefore, their use in gluten-free diet can help to increase fibre intake in CD patients.

Vitamins C and E were increased by increasing of garlic to Kaiser bread. At the same time, it could be noticed that addition of 20% garlic improved the content of (Na, K, Ca, Mg, Fe and Zn) in Kaiser bead.

Table (4) showed that the Kaiser bread made from maize and rice supplemented garlic at different levels 10, 15 and 20% and psyllium at 6% level. The results were parallel to the results in Table (3). In general most gluten free Kaiser bread samples had superior nutritional value compared with control one. This due to the presence of raw materials characterized with high content of protein, vitamins and minerals.

Diets that contain moderate quantities of cereal grains, fruits and vegetables are likely to provide sufficient fiber. Due to the fact that gluten free products generally are not enriched fortified and are frequently made from refined flour or starch, they may not contain the same levels of nutrients as the gluten containing counter parts they are intended to replace. Therefore, uncertainty still exists as to whether celiac patients living on gluten free diet are ensured a nutritionally balanced diet (Gallagher et al. 2004). From the above results, it could may be notice that the free gluten Kaiser bread made with psyllium and garlic help to improve nutrients content and prevent nutritional deficiencies of celiac disease.

Table (3): Chemical composition of the Kaiser bread supplemented with various levels of garlic and 3% psyllium (dry weight basis).

Chemical analysis	Control A	Kaiser bread		
		10% garlic	15% garlic	20% garlic
Protein (g/100gm)	8.89	9.72	10.04	10.35
Total fat	2.52	3.17	3.49	3.82
Ash	1.75	2.22	3.11	3.62
Crude fiber	2.73	5.85	7.20	8.55
Total carbohydrates	84.11	79.04	76.16	73.66
Vit. C (mg/100gm)	19.25	22.35	24.15	25.65
Vit. E	8.00	8.01	8.11	8.12
Na	10.92	12.65	13.62	14.56
K	139.82	175.05	200.13	220.23
Ca	103.35	134.21	148.01	152.59
Mg	4.03	5.66	7.46	8.76
Fe	3.52	3.94	4.17	4.34
Zn	1.85	2.01	2.25	2.37

Table (4): Chemical composition of the Kaiser bread supplemented with various levels of garlic and 6% psyllium (dry weight basis).

Chemical analysis	Control B	Kaiser bread		
		10% garlic	15% garlic	20% garlic
Protein (g/100gm)	9.41	10.21	10.45	10.87
Total fat	2.64	3.35	3.62	3.99
Ash	2.92	3.78	4.02	4.67
Crude fiber	4.83	6.39	7.75	8.42
Total carbohydrates	80.20	76.27	74.16	72.05
Vit. C (mg/100gm)	19.60	22.42	24.15	25.65
Vit. E	8.00	8.01	8.11	8.12
Na	10.91	14.35	15.62	16.36
K	192.71	205.31	225.17	246.32
Ca	221.47	135.72	244.42	254.67
Mg	5.81	7.85	9.26	10.46
Fe	4.57	4.72	4.87	4.96
Zn	1.95	2.22	2.35	2.48

Sensory evaluation of the Kaiser bread:

From the results in Table (5), it may be seen that Control bread baked with 3% psyllium without any supplementation was a significant decrease, showed more reduction in general appearance when compared to control bread and changes in dough properties were greater which caused significant differences for overall acceptability, compared to the control bread with 6% Psyllium without any supplementation was acceptable to most members regarding epically to taste, texture, volume, general appearance and overall acceptability.

Control Kaiser bread at 3% and 6% psyllium without garlic supplementation received the lowest overall acceptability score. While, the lowest scores were seen for Kaiser bread at 3% and 6% psyllium supplemented with 20% garlic.

According to the results in table (5) revealed that supplemented with garlic at concentration 10 and 15% are significantly have attractive taste for baking bread. It is an excellent natural preservative. These formulas have distinctive flavor, which leads some people to prefer them than other supplementation with high concentration of garlic (20%).

Concerning the effects of garlic at different levels and psyllium at 6% level on Kaiser bread properties, the results are recorded in Table (5). The results showed that the Kaiser bread made from 10% garlic is significantly exhibiting the highest values of these properties compared to the other supplementations.

Kaiser bread prepared with 10% or 15% garlic with 3% psyllium were closely similar to the Kaiser bread made from 10% and 15% garlic and 6% psyllium in all sensory evaluation, total score and acceptable.

Acs et al. (1996a and 19996b) investigated the use of different binding agents (xanthan, guar gum, locust bean gum and tangent).as a substitute for gluten in gluten free formulations based on corn starch. They found that the binding agents resulted in a highly significant increase in loaf volume and lessening of the crumb structure. The highest quality gluten free bread contained xanthan gum at levels 1 – 3%.

Response surface methodology was performed by Huang et al. (2001) to produce non-gluten pasta. They based their optimization procedure on sensory properties and pasta thickness and found that gluten free pasta with characteristics most similar to a wheat-based

pasta was obtained when higher levels of modified starch, xanthan gum and locust bean gum were used. This give samples with a good hardness of first bite and cohesiveness. From the a formation results it could may concluded that the Kaiser bread prepared from 10% and 15% garlic with psyllium at levels 3% and 6% gave highly acceptability and nutrition value. Kaiser bread contained a major cereals and psyllium as alternative to gluten in the manufacture of gluten free bakery products. The uses of Kaiser bread gluten free cereals were to prevent nutritional deficiencies of celiac disease.

Moreover, the results of volume and color (inside & top layer) showed that there were non-significant differences in bread prepared with 3% and 6% psyllium. On the opposite direction, bread supplemented with 20% garlic, there was a significant decrease, showed more reduction in texture and general appearance when compared to other Kaiser bread at 10 and 15% garlic and changes in dough properties were greater which caused significant differences for overall acceptability.

Table (5): Organoleptically evaluation of control Kaiser bread with psyllium only at 3% and 6% compared with fortified of garlic at various levels

Bread Characteristics (control psyllium at 3% fomulas)								
Types of bread	**Taste (20)**	**Odor (20)**	**Texture (15)**	**Volume (10)**	**Inside Color (10)**	**Color (top layer) (10)**	**General appearance (15)**	**Overall acceptability (100)**
Control 3%	17.10^{b} ± 0.761	17.00^{b} ±0.799	12.35^{c} ± 0.938	7.300^{b} ± 0.637	8.100^{ab} ±0.645	8.180^{a} ±0.930	11.200^{bc} ± 0.633	82.23
Garlic 10%	18.55^{ab} ± 0.761	19.00 ± 0.329	14.35^{a} ± 0.989	9.300^{a} ± 0.629	9.000^{a} ±0.748	9.680^{a} ±0.071	14.000^{a} ± 0.465	93.88
Garlic 15%	19.30^{a} ± 0.433	18.76^{a} ± 0.995	13.10^{bc} ± 0.438	9.580^{a} ± 0.657	8.170^{ab} ±0.188	7.670^{cd} ±0.601	13.200^{c} ± 0.696	89.78
Garlic 20%	17.00^{b} ± 0.261	16.05^{c} ± 0.973	11.35^{cd} ± 0.998	8.330^{ab} ± 0.628	8.040^{b} ±0.758	7.640^{cd} ±0.042	13.000^{cd} ± 0.696	81.42
Bread Characteristics (control psyllium at 6% and formulas)								
Control 6%	18.15^{ab} ± 0.211	17.62^{bc} ± 0.359	14.850^{a} ± 0.755	8.980^{a} ± 0.113	8.310^{a} ±0.345	8.074^{a} ±0.876	13.860^{ab} ± 0.438	85.23
Garlic 10%	19.61^{a} ± 0.991	19.77^{a} ± 0.059	14.87^{a} ± 0.239	9.990^{a} ± 0.687	9.240^{a} ±0.228	9.779^{a} ±0.911	14.990^{a} ± 0.005	98.25
Garlic 15%	19.39^{a} ± 0.903	18.00^{a} ± 0.775	14.99^{a} ± 0.422	9.680^{a} ± 0.887	9.040^{a} ±0.098	7.203^{c} ±0.438	13.990^{c} ± 0.880	92.30
Garlic 20%	18.07^{b} ± 0.007	15.77^{c} ± 0.977	12.69^{cd} ± 0.656	8.190^{b} ± 0.071	8.770^{ab} ±0.900	7.220^{c} ±0.941	12.077^{cd} ± 0.653	82.80

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إنتاج خبز صحي خالي الجلوتين لمرضى السيالياك مدعم بالثوم والسيليوم كبديل للجلوتين

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يعتبر مرض السيا ليك (حساسية حلوتين القمح) مشكلة صحية منتشرة في كل أنحاء العالم وهى ناتجة من استخدام القمح . لذلك ففد وجد أن المنتجات الخالية من الحلوتين والتي تصلح لتغذيه مرضى السيالياك غير متوفرة في الأسواق كما أن المتاح منها فقير في القيمة الغذائية.

تم في هذه الدراسة تقييم خلطات جديدة من الخبز الكيزر الخالي الحلوتين باستخدام الذرة الصفراء والأرز الأبيض ودعم بواسطة الثوم على نسب 10،15،20% وذلك لرفع القيمة الغذائية للخبز الخالي الجلوتين كما تم أضافه السيليوم على نسب 6,3 % إلى خلطات كبديل للجلوتين . تم تقدير التركيب الكيماوي للمواد الخام وأيضا خبز الكيزر بعد إنتاجه من الخلطات المختلفة كما تم تقييم خبز الكيزر حسيا ومقارنته بالعينة القياسية الخالية من الثوم ولكن تحتوى على 6,3 % من السيليوم على التوالي .

أوضحت النتائج أن الثوم يحتوى على نسبه مرتفعه من الدهون الكلية والرماد والألياف الخام والفيتامينات والمعادن مقارنتا بالذرة والأرز كما وجد أن الذرة الصفراء مرتفعه في نسبه البروتين أما الأرز فهو يحتوى على نسبه عاليه من الكربوهيدرات الكلية . وأوضح التركيب الكيماوي لخبز الكيزر أن الخبز المحتوى على 20 % ثوم يكون مرتفع فى التركيب الكيماوي ويليه في الارتفاع خبز الكيزر المحتوى على 15 % ثوم وذلك على نسب 6,3 % من السيليوم

أوضح التقييم الحسي لخبز الكيزر ارتفاع نسبه القبول للخبز المحتوى على 10 % ثوم مع 6 % سيليوم ويليه 3 % سيليوم كما وجد أن خبز الكيزر المحتوى على 15 % ثوم على نسب 3 ، 6 % سيليوم اقرب في النتائج إلى خبز الكيزر المدعم 10 % ثوم .

لذلك يمكن أن توصى بإنتاج خبز الكيزر المدعم 10 ، 15 % ثوم على نسب 3 ، 6 % سيليوم كبديل للجلوتين لان هذه النسب وجد أنها تحتوى على قيمه غذائية عاليه ومقبولة الطعم . لذلك يمكن إنتاجه لمرضى السيالياك