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The Effect of Roasting Process on Antioxidant Properties of Different Egyptian Grains and Utilization in Cereal Bars

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THE EFFICIENCY of the roasting process at various temperature, 160 and 200°C for 30 min. on theantioxidantactivity for some Egyptian grains(wheat, barley and triticale) was investigated. Total flavonoid contents (TFC) and total phenol contents (TPC) for the selected three samples were determined.Antioxidant activities were tested using DPPH radical scavenging activity (RSA). In addition, the tested roasted grains were used to produce cereal bars and the evaluation of their sensory properties was done. The roasting grains process resulted in significant increases in phenolic contents. The total flavonoid concentrations of the three roasted grain extracts at 160°C were higher than the raw grain.Data also indicated that the roasted grains resulted in a higher antioxidant activity than the untreated.Furthermore, the result of sensory evaluation of producing cereal bars revealed that barley and wheat bars were more acceptable than triticale bar.

Keywords: Roasting, Wheat, Barley; Triticale, Antioxidant activity,Total phenol content, Cereal bars.

Introduction

Wheat (*Triticum aestivum*), Barley (*Hordeum vulgare*) and Triticale (*Triticosecale wittmack*) are the most important cereal crops in Egypt and they play a prime role in human alimentation and also used in bakery products. The wheat grain contains different categories of phytochemical compounds, including carotenoids, flavonoid, phenolic acids, phytosterols, tocopherols and tocotrienols. (Tsao, 2008 and Hidalgo et al., 2009). The Barley grain is a rich source of *β*-glycan and it contains a high level of phenolic compounds (Madhujith and Shahidi, 2009). Triticale (*Triticosecalewittmack*) is a crossbred crop developed by crossbreeding wheat (*Triticum* spp.) and rye (*Secale cereale*) that integrate the attributes of both parental cereals (Salmon et al., 2001).

Processed foods by the minimal treatments are more healthy utility as compared with the other processed products food (Shahidi, 2009). The roasting process is considered a quick process utilizes dry heat at a short period. The roasting process of cereal leads to improveing puffing properties, crispiness and texture (Hoke, et al., 2007). Roasting as well improves the flavor, digestibility, shelf life, color and minimizes the antinutritional factor for grain (Gahalawat and Sehagal, 1992).

Radical scavenging characteristic for several roasted grains and nuts was intensively studied,then it was concluded that the roasted hazelnut,wheat germ, sweet almond (Krings & Berger, 2001), peanut (Hwang et al., 2001) and coffee brews (Borrelli, et al., 2002 and Charurin et al., 2002) have antiradical properties at certain levels.

Health benefits of the tested grains probably refer to the cell wall polymers and its chemical structure. Phenolic acids linking by covalent bonds with insoluble wheat bran matrix. Newly, phenolic acids gained repute due to their activity anti-carcinogenic, anti-inflammatory, anti-oxidativeand anti-mutagenic. In addition, the properties of phenolic acids can modify some functions of basic enzymes in several cells (Shahidi, 2008). This paper studied the effect of roasting process on the phenolic content for some Egyptian grains and their potential health benefits for using in cereal bars.

Materials and Methods

Materials

Egyptian grains Wheat (Bensufi 1), Barley (Giza 130) and Triticale (Breeding) were procured from the Agriculture Research Centre,Giza, Egypt.

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The grains were cleaned and stored until further treatment.

Methods

Roasting process

All grain samples were cleaned and then roasted at 160 and 200 °C for 30 min in an electric oven. After roasting, the grains were allowed to cool at room temperature.

Grain antioxidant extract

Grain samples were cleaned and milled. Two grams of grain were ground to 80 mesh and extracted for 15 hr with l litter of 50% acetone (v/v) using a Soxhlet extractor. The acetone extracts were concentrated under a reduced pressure, and the final volume was adjusted to 25 ml. The antioxidant extracts were kept in the dark at −20 °C until analysis. (Yu et al., 2003).

Radical scavenging activity

Radical scavenging capacities of sample extracts were estimated by the reduction of the reaction color between 1,1-diphenyl-2-picrylhydrazyl (DPPH) solution and sample extracts as described by Huang et al. (2005). A final concentration of DPPH solution used was 0.15 mM. DPPH solution (3.9 ml) was mixed with the sample solution (0.1 ml). The mixture was kept in the dark at ambient temperature. The absorbance of the mixtures was recorded at 515 nm for exactly 30 min. Blank was made from 3.9 ml of DPPH and 0.1 ml methanol and measured absorbance at t=0. The scavenging of DPPH was calculated according to the following equation by Liyana- Pathiran and Shahidi (2007)

$$\% \text{ DPPH scavenging} = (\text{Abs } t=0 - \text{Abs } t=30) / \text{Abs } t=0 \times 100$$

where Abs(t=0) = (absorbance of DPPH radical + methanol) at t = 0 min

Abs(t=30) = (absorbance of DPPH radical + phenolic extracts) at t = 30 min.

Total phenolic contents

The total phenolic contents in the different grain extracts were estimated using Folin–Ciocalteu reagent (Yu et al., 2003). In brief, the reaction mixture contained 50 µl of grain extracts, 250 µl of freshly prepared Folin–Ciocalteu reagent, 0.75 ml of 20% sodium carbonate, and 3ml of pure water. After 2 hr of reaction at ambient temperature, the absorbance at 765 nm was measured and used to calculate the phenolic contents using gallic acid as a standard and expressed as milligrams of gallic acid equivalent (GAE) per gram of sample.

Total flavonoid contents

Flavonoid contents of grain samples were assayed using the aluminum chloride colorimetric method of Chang et al. (2002). The appropriate dilution of extracts (0.5 ml) were mixed with 1.5 ml of 95% ethanol, followed by 0.1 ml of 10% aluminum chloride, 0.1 ml of 1 M potassium acetate and 2.8 ml of distilled water. After incubation at room temperature for 30 min, the absorbance of the reaction mixture was measured at 415 nm using a UNICO UV/VIS-2100A spectrophotometer (Dayton, USA). The flavonoid content was calculated using a standard calibration of rutin solution and expressed as micrograms of rutin equivalent (RE) per gram of sample.

Preparation of cereal bars

Wheat, Barley and Triticale roasted grains at 160 and 200°C were used in recipe of bar products. The process was carried out in three steps: weighing the dry ingredients; heating the glucose syrup to 95°C; and mixing the dry ingredients with the syrup. Then the bars were placed in a mold diameter 8 cm long, 3 cm wide and 1.5 cm thick and were left to cool for 1 hr (Garcia et al., 2012).

Sensory evaluation

Samples were coded with three digits. The sensory attributes evaluated are as follows (Taste, Color, Flavor, Crunchiness, and Overall acceptability). The three cereal bars (wheat, barley, triticale) were evaluated by means of acceptance using unstructured hedonic scale of nine points, 9-point hedonic scale with 1= disliked extremely, 2 = disliked very much, 3 = disliked moderately, 4 = disliked slightly, 5 = neither liked nor disliked, 6= liked slightly, 7= liked moderately, 8 = liked very much and 9 = liked extremely. Scores were collected and analyzed statistically (Dutcosky, 2007).

Statistical analysis

The data obtained in this study were expressed as the mean of triplicate determinations. Statistical comparisons were made with Duncan's test and were analyzed with SPSS (SPSS for Windows, Version Rel. 10.0.5., 1999, SPSS Inc.,). P values <0.05 were considered to be significant.

Results and Discussion

Radical scavenging activity (RSA%)

Reduction of DPPH radicals shows that tested samples have radical inhibitors and scavengers with the potential to act as primary antioxidant. The total antioxidant activities for all samples are shown in Fig. 1 For barley extracts, the RSA% mean values were in the range 29.03% to 53.38 %. Roasted grains at 200°C were considered the highest (significant) antioxidant activity when compared to roasted grins at 160°C

The total antioxidant activity of the wheat extracts prepared from roasted and untreated grain ranged from 23.17 to 39.65 %. The roasted wheat at 200°C had the highest (significant) antioxidant activity, followed by the grains roasted at 160°C. The same trend was also observed for the triticale grain and barley extracts were the highest of antioxidant activity in roasted samples.These results are agree with those of Dewanto et al. (2002) who found that, the thermal treatment showed an increase in the antioxidant activity in sweet corn. Several researchers claim that,the high antioxidant activity of thermally food products due to the formation of chemical products for the Maillard reaction, including hydroxy methyl furfural, hence causes high antioxidant activity (Duenas et al., 2006 and Siddhuraju, 2006).

In addition, Durmaz and Alpaslan (2007) studied the influence of different roasted periods on the antioxidant properties of apricot kernel, and compare roasted with unroasted kernel. The antioxidant activity of kernel flour extracts estimated by DPPH radical scavenging changed significantly with the roasting periods, on the other hand untreated extract samples showed the least activity. The results of the antioxidant activities of the Egyptian grain extracts indicate that a roasted sample had the highest antioxidant activity; in contrast, raw grain (untreated) had the lowest activity.These results are in harmony with those of Omwamba and Hu (2009) who invertigated the antioxidant capacity and antioxidative compounds in barley (*Hordeum vulgare* L.) grain optimized using response surface methodology in hot air roasting,they revealed that the antioxidant capacity in the grains was highest under optimum conditions of 250°C, 63.5 min and 42 g.

Total phenolic contents (TPC)

Total phenolic contents for barley, wheat and triticale extracts were illustrated in Fig 2. Total phenolic contents were expressed equivalence as mg Gallic acid/g dry weight sample. Among the three grain extracts, barley extract showed greatest contents (2.39 mg GAE/g dw), while the total phenolic contents of wheat and triticale were found to be 2.19 and 1.62 mg GAE/g, respectively.

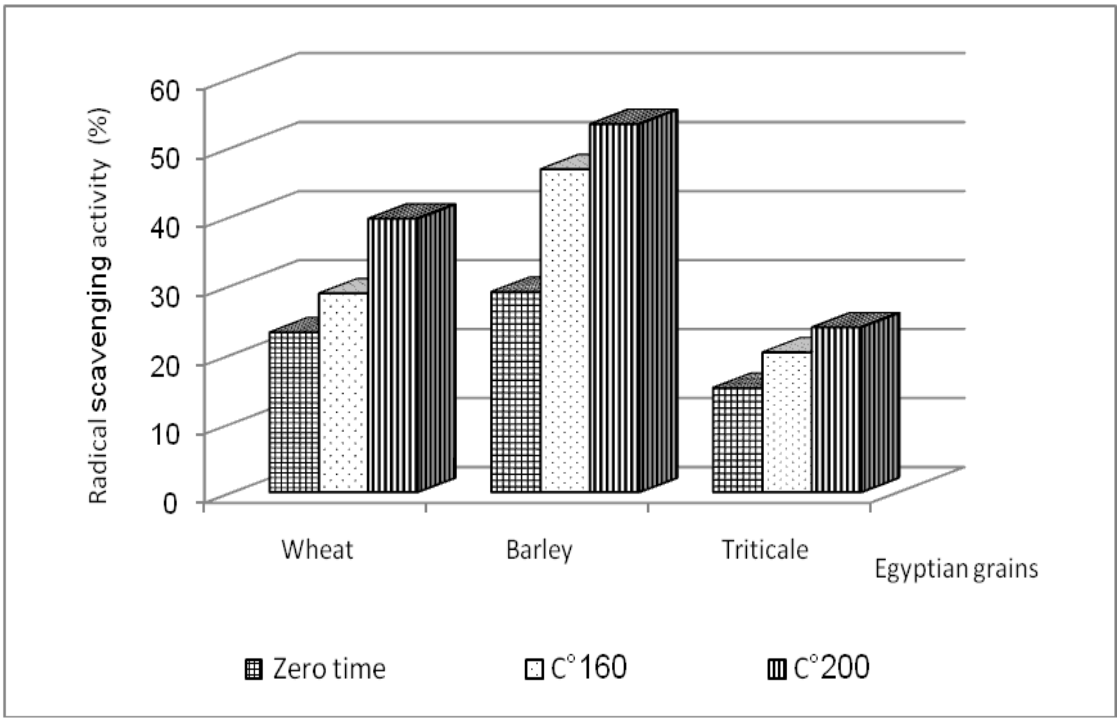

Fig.1 .The radical scavenging activity ofuntreated and roasted barley, wheat and triticale samples.

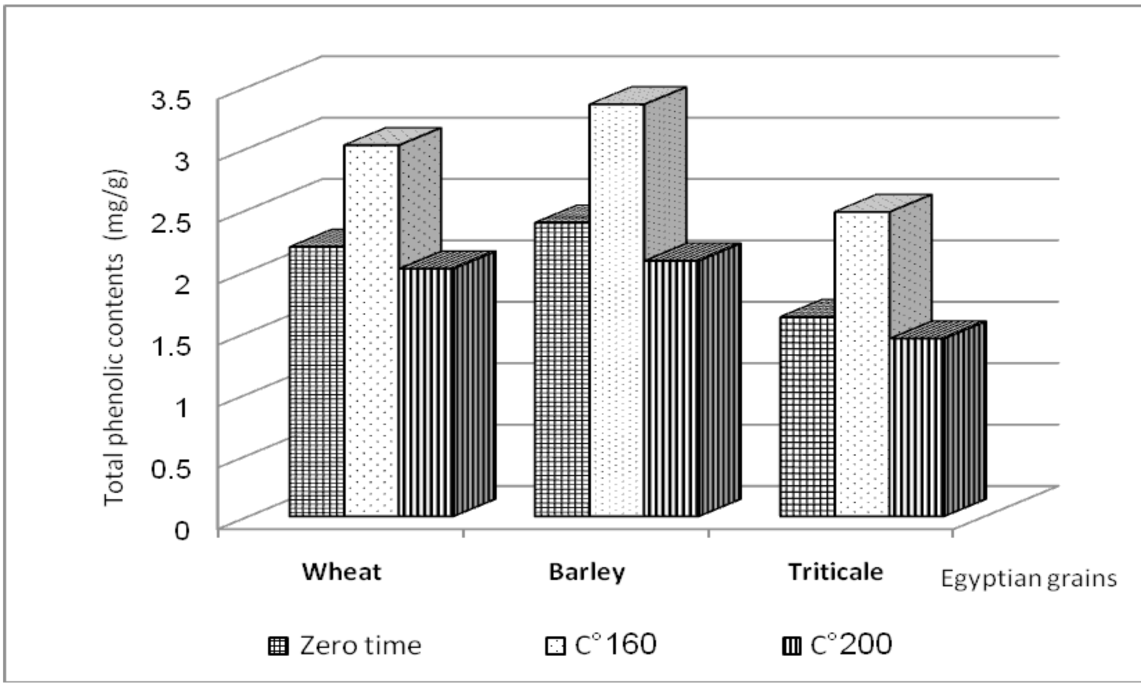

Fig. 2.The total phenolic contents ofuntreated and roasted barley, wheat and triticale samples.

The results of TPC indicated that the roasting process at 160°C increased the content of total phenolic acid in the three tested grains when compared with untreated samples. These results agree with those observed by Gallegos-Infante et al. (2010) who found an increase in total phenolic acids for roasted and cooked barley samples when compared with the control. Roasting process may cause a degradation in cell wall structure in some grains, which may cause release of the conjugated some phenolic compound principally bound phenolic acids (Ee et al., 2011). Similar results also revealed an increase in phenolic acids by heat treatments of plant products as reported for gallic acid (Rakic et al., 2007), p-coumaric and ferulic acids in common beans (Galvez-Ranilla et al., 2009).

From the same figure it is clear that roasted samples at 200°C had the lowest phenolic content when compared with other extracts in all tested grains. This decrease in phenolic contents may be caused by over roasting process. Yen & Chien-Ya, 2000 and Zadernowski et al., 1999) mentioned that the phenolic components, may be degraded by high temperatures and caused a decrease in total phenolic contents.

Total flavonoids content (TFC)

Flavonoids are the major common group of polyphenolic compounds that are found ubiquitously in plants. Figure 3 illustrated the flavonoid contents in the three Egyptian grain samples.Significant differences were found in the flavonoid contents for roasted and untreated extracts, barley extracts were the best among all the tested grain. The mean values of the flavonoid contents were 173.89, 166.51 and 149.20 µgRE/g roasted grain at 160°C in barley, wheat and triticale extracts, respectively. The total flavonoid contents of the three Egyptian grains showed superiority which was found in untreated barely extracts (144. µgRE/g) followed by untreated wheat and triticale extracts with mean values 123.99 and 113.69 µgRE/g, respectively.

The results revealed that the roasted grain extracts at 160°C showed higher content of total flavonoids than those untreated and roasted extracts at 200°C in all the tested grain. These results are consistent with those of Boateng et al. (2008) who stated that the thermal treatments was increased in total flavonoids levels for pinto beans, black-eyed peas and kidney. From the above result, we can conclude that technological treatments such as heating could increase the flavonoid contents due to the release of some bound compound formation by thermal treatment including bound flavonoid compounds.

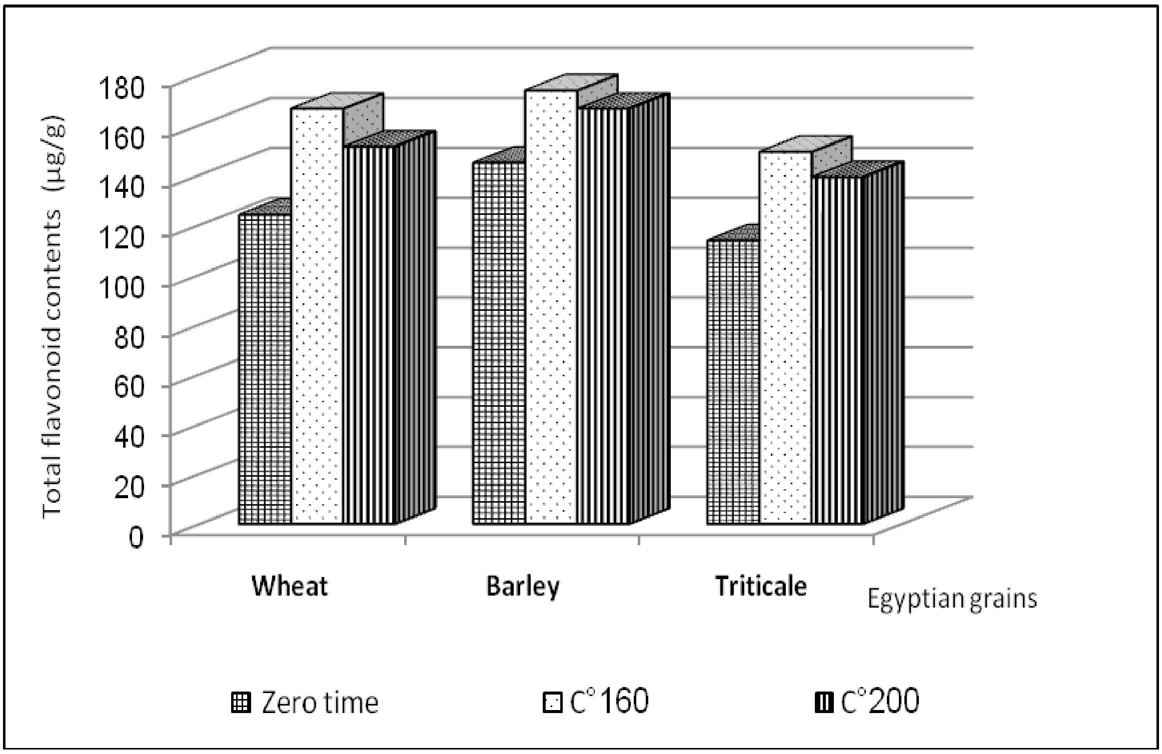

Fig. 3.The total flavonoid contents ofuntreated and roasted barley, wheat and triticale samples.

Sensory evaluation of cereal bar

The sensory evaluations for different cereal bars are presented in Table 1. The cereal bars prepared from roasted wheat at 200°C had the highest score for both taste and crunchiness. Statistical analysis showed that there was a relationship between roasting temperature and sensory parameters (taste and flavor) for all samples of cereal bars. It can be concluded that, increasing the roasting temperature gave rise positive effect on the acceptability of cereal bars. However, there were no significant differences in overall acceptability of different cereal bars prepared from roasted grain at 160°C and 200°C.

Furthermore, the results indicated that using roasted whole wheat and barley succeeded to develop new formulations of cereal bars. Based on all evaluated parameters, it was observed, that among the three cereal bars formulations barley and wheat were more accepted than a formulated triticale.

TABLE 1. Mean values of sensory evaluation for cereal bars.

Treatments		Taste	Colour	Flavour	Crunchiness	Overall acceptability
Wheat	160°C	8.0^{b}	9.5^{a}	8.1^{b}	8.3^{b}	8.3^{ab}
	200°C	9.8^{a}	9.7^{a}	9.7^{a}	9.1^{a}	9.6^{a}
Barley	160°C	7.6^{bc}	9.5^{a}	8.3^{b}	8.3^{b}	8.3^{ab}
	200°C	8.0^{b}	9.7^{a}	9.6^{a}	8.3^{b}	9.6^{a}
Triticale	160°C	6.9^{c}	9.5^{a}	7.95^{b}	6.9^{c}	8.3^{ab}
	200°C	5.4^{d}	9.5^{a}	7.95^{b}	6.9^{c}	8.3^{ab}

Means within a column showing the different small letter are significantly different ($P < 0.05$)

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تأثير عملية التحميص على الخصائص المضادة للأكسدة للحبوب المصرية المختلفة واستخدامها في حلوى أشرطة الحبوب

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تمت دراسة تأثير عملية التحميص على النشاط المضاد للأكسدة لبعض أصناف من الحبوب المصرية ومقارنتها مع مثيلتها التى لم يجرى عليها عملية التحميص وذلك بتقدير المحتوى من م الفينولات الكلية والفلافونات الكلية وكذلك اختبار النشاط المضاد للاكسدة لمستخلصات تللك الحبوب. الحبوب محل الدراسة هى القمح والشعير والتراتيكال حيث تم اجراء عملية التحميص على درجات حرارة مختلفة هى ١٦٠ و ٢٠٠ درجة مئوية لمدة ٣٠ دقيقة، تمت عملية استخلاص المركبات المضادة للاكسدة باستخدام مذيب الأسيتون بتركيز (٧٠٪). أوضحت النتائج أن عملية التحميص للحبوب أدت إلى زيادة كبيرة في محتويات الفينولات الكلية كما وجد أن تركيزات الفلافونات الكلية لمستخلصات الحبوب المحمصة عند ١٦٠ درجة مئوية أعلى من الحبوب التى لم يجرى عليها عملية التحميص. وأشارت النتائج أيضا إلى أن العينات المحمصة كانت ذات نشاط مضاد للاكسدة اعلى من العينات غير المحمصة. وعند أستخدام تللك الحبوب فى تصنيع حلوى أشرطة الحبوب (cereal bars) وجد أن إستخدام القمح والشعير كان أكثر قبولاً فى الطعم من إستخدام التراتيكال.