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Abstract:

There is a compelling epidemiological evidence that fruit and vegetable consumption plays an important role in inhibiting development of chronic disorders. Pomegranate (*Punica granatum* L.) peels have achieved a great attention for its health benefits in the last years. Therefore, pomegranate peels were chemically estimated and introduced (by 1.0, 2.0 or 5.0%) in the tested pan bread formulas. It was found that the pomegranate peels contained detectable amount of fiber and ash (12.52 and 6.02%, respectively) and lower amounts of protein and carbohydrates (3.77 and 76.61%, respectively) in relative to that found in wheat flour (0.92, 0.50, 12.25 and 85.55%, respectively). Consequently, as the pomegranate peels level increased, the fiber and ash were increased while the protein and carbohydrates were decreased in the resulted pan bread. Loaf and specific volume showed no specified model with the pomegranate peels level increased. On contrary, each of pomegranate peels level addition was increased as the fermentation time increased. The pan bread staling (measured as % Alkaline water retention, AWRC) was enhanced as the increased of pomegranate peels level addition. Sensory evaluation of the tested samples showed that 1% pomegranate peels pan bread seemed to be more closed to the control sample than the other pan bread (2.0 or 5.0% pomegranate peels) samples.

Key words: Pomegranate peel, pan bread, chemical, nutritional value, physical and sensory properties.

Introduction:

Recently, a considerable importance is given to functional foods, which, in principle, apart from their basic nutritional functions, provide physiological benefits and play an important role in disease prevention or slow the progress of chronic diseases. There has been a virtual explosion of interest in the pomegranate as a medicinal and nutritional product because of its multifunctionality and its great benefit in the human diet as it

contains several groups of substances that are useful in disease risk reduction. As a result, the field of pomegranate research has experienced tremendous growth (**Jaiswal *et al.*, 2010**). Infectious diseases are still one of the leading causes of death in the world. Although conventional drugs provide effective treatment for some infections, antibiotic resistance continues to grow among key microbial pathogens such as Staphylococcus aureus (*S. aureus*), Pseudomonas aeruginosa, (*P. aeruginosa*), Streptococcus spp, and Enterobacteriaceae (**Bax *et al.*, 2000; Bhavnani and Ballow, 2000**). Therefore, the search for new antimicrobial agents is imperative. Medicinal plants have always been a good source to find new remedies for human health problems. Recently, a wide range of these plants has been screened for antimicrobial property (**Upadhyay *et al.*, 2010**). Punica granatum, commonly known as pomegranate, has been highlighted in some studies as having this property (**Al-Zoreky, 2009**). For example, methanolic extract of pomegranate fruit has been shown to induce antibacterial activity against Listeria monocytogenes, *S. aureus*, Escherichia coli and Yersinia enterocolitica (**Al-Zoreky, 2009**). The same activity has been demonstrated for pomegranate against Klebsiella pneumoniae, Proteus vulgaris and Bacillus subtilis (**Prashanth *et al.*, 2001**). Although these pieces of evidence implicate pomegranate as antimicrobial therapeutic, some questions still remained to be answered. For example, the antifungal activity of pomegranate and its antibacterial effects on other strains are open questions. More studies are needed to investigate the antimicrobial effects of other types of pomegranate extracts and other parts of this plant.

Nowadays researchers are increasingly turning their attention to folk medicine, looking for new discovery to develop better drugs against microbial infections caused by various pathogens. The clinical efficacy of many existing antibiotics is being threatened by the emergence of multidrug-resistant pathogenic strains (**Bandow *et al.*, 2003**). It is important to discover new antimicrobial compounds with diverse chemical structures and with novel mechanisms of action for new and re-emerging infectious diseases. The antibiotic resistance and failure of chemotherapeutics exhibited by pathogenic microbial infectious agents has led to the screening of several medicinal plants for their potential

antimicrobial activity. According to the medicinal point of view and global environmental perspective, herb is an immeasurable wealth of nature. It plays a significant role ameliorating the disease resistant ability and combating various unfavorable metabolic activities within the living system. Plant- based antimicrobials have enormous therapeutic potential as they can serve the purpose with lesser side effects that are often associated with synthetic antimicrobials (**Sangeetha and Vijayalakshmi, 2011**).

Pomegranate (*Punica granatum* L.) fruits are widely consumed, fresh and in commercial products, such as juices, jams and wines. Pomegranate rind is a rich source of hydrolysable tannins of the ellagitannin group. Pomegranate rind extracts have recently attracted interest because of their potential use as natural food preservatives and nutraceuticals (**Negi *et al*., 2003**).

Antimicrobial drug resistance in human bacterial pathogens is a continuing worldwide issue and as a consequence, effective treatment and control of such organisms remains an important challenge. Bacterial resistance has appeared for every major class of antibiotic (**Lambert, 2005**). Since their introduction the emergence of resistance to antibiotics has become increasingly evident, particularly for important pathogens such as *Escherichia coli* (*E. coli*), *Salmonella* spp., *Campylobacter* spp., *Enterococcus* spp. and *Staphylococcus* spp. (**Adesiyun *et al*., 2007 and Rodrigo *et al*., 2007**).

Pomegranate fruits peel is an inedible part obtained during processing of pomegranate juice. Pomegranate peel is a rich source of tannins, flavonoids and other phenolic compounds (**Li *et al*., 2006**).

It could be illustrated that pomegranate fruits peel powder (PPP) protein contained a much higher content from lysine, leucine, aromatic fatty acids (phenylalanine and tyrosine), threonine and valine than the reference protein pattern and therefore the amino acid score of these IAAs was higher than 100. On the other hand, the PPP had slight lower contents of amino acids containing sulphur (methionine and cysteine) and isoleucine which having amino acid score of 95.7 and 93.2, respectively. Therefore, the incorporation of available inexpensive pomegranate by-products; peel, powder in Egypt into the foodstuff; especially which deficient in amino acids containing sulfur, aromatic amino acids, leucine and

isoleucine has a great economic value and a good standpoint in food technology and human nutrition (**Rowayshed *et al*., 2013**).

Therefore, due to the large amount of pomegranate peel and because of the valuable pharmaceutical and nutritional compounds of such peel (by product), the current research is carried out to throw the light on its nutritional value indices and its proximate chemical composition. The utilization of such byproduct in enhancing the nutritional value, physical and sensory properties of specific bakery product (pan bread) was estimated and verify if it possible to be implicated in such product. The examination to define the most favorite amount of the pomegranate peel addition was, also, extended in the present study.

Materials and Methods:

Collection of plant material:

The pomegranate specimen for the proposed study was procured from local fruit market at Mecca, Kingdom of Saudi Arabia. Care was taken to select healthy fruits. It was identified as reddish or yellowish red color rind belonging to Punicaceae family. The pomegranate fruits were handy peeled and the required fruit rind were cut and removed from the fruits. The fruit rind (pomegranate peel) was dried in an oven at 40°C for 24 h, then mechanically powdered and the fine powder was sieved through 24-mesh (**Dahham *et al*., 2010**), then it was stored at -18°C until use.

Preparation of pan bread:

A straight dough bread making process was performed according to **Wang *et al*. (2002)**. Basic dough formula was consisted of flour (500 g), salt (5 g), compressed yeast (25 g), sugar (7.5 g), bread improver (5 g) and the required amount of water to reach 500 BU of consistency. The dough was put into greased fermentation bowel and placed in a fermentation cabinet at 37°C and a relative humidity 80-85% for 20 min, and then dough piece was divided, hand-moulded then put in metal pans. The dough was proofed for 30 min in a fermentation cabinet under controlled temperature and a relative humidity and then baked for 25 min at 190°C in a baking oven. The pan bread was separated from the metal pans and the attributes were evaluated after cooling for 1hr at room temperature.

Analytical Methods:

Moisture, crude protein, Ether extract, ash and crude fiber contents of pomegranate peels and the tested pan bread samples were determined according to the procedures of the AOAC (2000). Total carbohydrates were calculated by difference as follows: %Carbohydrates = 100 - the sum of (% moisture + % crude protein + % fat + % ash + % crude fiber) according to the equation of **Chatffeld and Admas (1940)**.

Pan bread volume was measured by the rapeseed displacement method (**Xie *et al.*, 2004**). Pan bread weights were recorded by using a 2-decimal digital weighing scale and the specific volume was calculated by divided the pan bread volume by its weigh.

Pan bread freshness was rheological tested by AWRC determination according to the method described by **Adebowale *et al.* (2002)** as follows: Each sample (1.0g) was quantitatively placed in a test-tube (test tube weighed with dry sample W1). 5.0 ml of 0.1 M NaHCO3 (8.4 g sodium bicarbonate dissolved in one liter of distilled water) was added and mixed for 30 second in a Variwherl mixer. The samples were then allowed to stand at 30±2°C for 20 min, centrifuged (417 xg for 15 min). The supernatant was descanted and the precipitate was left for 10 min at 45° angel (to get rid of free water). Test tubes with their content were then weighed (W2) and the alkaline water retention calculated as follows:

$$\text{Alkaline water retention of sample} = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100$$

Sensory evaluation:

The tested pan bread samples were sensorial attributes (overall acceptability, taste, odor, crust color, crumb color, roundness and texture, represented by hardness) evaluated. The sensorial evaluation was done by a group consisted of well trained twenty members at Umm Al-Qura University, Ministry of Education, Kingdom of Saudi Arabia. Each of the samples was numbered using the random three-digit numbering system. Panellists were asked to indicate their preference on a Hedonic scale with a maximum degree for the extremely like and a minimum degree for the extremely dislike as recommended by **Jayasena *et al.* (2008) and Pacheco de Delahaye *et al.* (2005)**.

Statistical analysis:

All data are presented as mean values (±SD). Analysis of variance (ANOVA) were performed using SAS (1987) software, where there was statistical significance ($P < 0.05$), the means were further separated using Duncan's Multiple Range Test.

Results and Discussion:

Table (1): Chemical composition of wheat flour and pomegranate peels

Components*	Wheat flour (70% ext)	Pomegranate peels
Protein	12.25^{a}	3.77^{b}
	±0.62	±0.04
Fat	0.78^{b}	1.08^{a}
	±0.01	±0.03
Ash	0.50^{b}	6.02^{a}
	±0.8	±0.08
Carbohydrates	85.55^{a}	76.61^{b}
	±1.12	±1.22
Fibers	0.92^{b}	12.52^{a}
	±0.11	±0.43

* As % on dry weight basis.
Carbohydrate contents were determined by difference.
Each mean value is followed by ± standard deviation.
Each mean value, within the same row, followed by the same letter is not significant at 0.05 level.

As shown in Table (1), the crude protein, crude fat, ash, crude fibers and carbohydrates contents for pomegranate fruits peel powder were 3.77, 1.08, 6.02, 12.52 and 76.61%, versus, 12.25, 0.78, 0.50, 0.92 and 85.55% for wheat flour, on dry weight basis; respectively. Thereupon, the pomegranate fruits peel powder is considered a good source of crude fibers and ash, while wheat flour considered a good source of crude protein and carbohydrates. Such results are nearly in according with those found by **Fadavi *et al.* (2006) and Kingsly *et al.* (2006)**. Consequently, the resulted pan bread was possessed more amounts of both fiber and ash

as the pomegranate peels level increased (Table 2). On contrary, the corresponding samples contained lower amounts of protein and carbohydrates. Such data confirmed that pomegranate fruit peels powders should be utilized in fiber and ash fortification of the foodstuffs as reported by **Rowayshed *et al.* (2013)**.

Table (2): Chemical composition of pan bread produced by wheat flower and pomegranate peels.

Components*	Control	Pan bread with 1% pomegranate peels	Pan bread with 2% pomegranate peels	Pan bread with 5% pomegranate peels
Protein	12.78^{a}	12.72^{a}	12.52^{ab}	12.46^{b}
	±0.11	±0.2	±0.06	±0.11
Fat	3.55^{a}	3.21^{a}	2.88^{a}	2.53^{b}
	±0.42	±0.08	±0.04	±0.05
Ash	0.92^{d}	1.22^{c}	1.64^{b}	2.92^{a}
	±0.02	±0.01	±0.01	±0.02
Carbohydrates	81.43^{a}	81.23^{ab}	80.36^{b}	77.27^{c}
	±1.42	±0.24	±0.44	±0.46
Fibers	1.32^{d}	1.62^{c}	2.60^{b}	4.82^{a}
	±0.04	±0.11	±0.01	±0.06

* As % on dry weight basis.

Carbohydrate contents were determined by difference.

Each mean value is followed by ± standard deviation.

Each mean value, within the same row, followed by the same letter is not significant at 0.05 level.

In this concern, pomegranate fruits peel can be used as functional ingredient as a good source of crude fibers which provide numerous health benefits such as their ability to decrease serum LDL-Cholesterol level, improve glucose tolerance and the insulin response, reduce hyperlipidemia and hypertension, contribute to gastrointestinal health and the prevention of certain cancers such as colon cancer (**Lansky and Newman, 2007 and Viuda-Martos *et al.*, 2010a and b**). On the other

hand, fruits‟ fibers can be considered as potential ingredients of foods because of their ability to reduce the residual nitrite level, thus avoiding the possible formation of nitrosamines and nitrosamides (**Viuda-Martos *et al*., 2010b**) and they have been used in meat products processing as fat replacer, reducing agent of fat absorption during frying, volume enhancer, binder, bulking agent and stabilizer (**Alesón-Carboned *et al*., 2005**).

It was stated, also, that pomegranate has gained popularity in recent years due to its multifunctionality and nutritional benefit in the human diet. Pomegranate fruit peel constitutes about 50% of the total fruit weight, and it is often discarded as waste. However, the fruit peel contains higher amounts of polyphenol compounds than the juice, and it possesses stronger biological activities. Besides high antioxidant capacity, pomegranate peel extracts have been reported to possess a wide range of biological actions including anti-cancer activity, antimicrobial activity, antidiarrheal activity, apoptotic and anti-genotoxic properties, anti-tyrosinase activity, anti-inflammatory and anti-diabetic activities (**Fawole *et al*., 2012**).

Many researchers reported that pomegranate peels could be used in therapeutic applications. In addition to its ancient historical uses, it is used in several systems of medicine for a variety of ailments. It is considered “a pharmacy unto itself” and is used as an antiparasitic agent,a “blood tonic,”and to heal aphthae, diarrhea, and ulcers. Pomegranate also serves as an anti-inflammatory, remedy for diabetes and Hypertension, Prostate Cancer, significantly reduced total and LDL cholesterol, and improved total/HDL and LDL/HDL cholesterol ratios, Atherosclerosis, Hyperlipidemia, The potential therapeutic properties of pomegranate are wide-ranging and include treatment and prevention of cancer, cardiovascular disease, diabetes, dental conditions, erectile dysfunction, and protection from ultraviolet (UV) radiation. Other potential applications include infant brain ischemia, Alzheimer’s disease, male infertility, arthritis, and obesity (**Jurenka, 2008**).

If fruit peels of pomegranate cultivars show potential to improve human health, their utilization should be encouraged during fruit processing. In the quest to promote the development of functional foods with health-benefiting properties. Furthermore, the investigation of the physical and sensory characteristics must be carried out to explain to

what extended such implementation is a successful process to gain the beneficial of pomegranate peels utilization. Data presented in Table (3) showed that there was insignificant difference loaf volume of pan bread manufactured by all the pomegranate peel level addition (1.0, 2.0 or 5.0%) in relative to the control one.

It could be, also, noticed that the same result was found after all the tested fermentation time (60, 90 and 120 min). It simply meaning that addition of pomegranate peel amount by the tested levels showed no effect on the loaf volume of pan bread at all the tested fermentation time. On the other hand, the specific volume of pan bread was not significantly affected by differentiate the fermentation time for each pomegranate peel addition level. While specific volume of pan bread containing 1.0 or 2.0% pomegranate peel was significantly, lower than control or 5.0% pomegranate peel pan bread.

Table (3): Loaf volume and specific volume of pan bread produced by wheat flour and pomegranate peels.

Pan bread samples of	Loaf volume (cm^3) after fermentation time (in min) of			Specific volume (cm^3/gm) after fermentation time (in min) of		
	60	90	120	60	90	120
Control	1030^{ab}	1320^{ab}	1500^{a}	4.06^{a}	5.60^{a}	6.80^{a}
1% pomegranate peels	1040^{a}	1400^{a}	1600^{a}	3.40^{b}	4.20^{b}	5.60^{b}
2% pomegranate peels	1010^{b}	1200^{b}	1500^{a}	3.50^{b}	4.00^{b}	4.71^{b}
5% pomegranate peels	910^{b}	990^{b}	1400^{a}	4.30^{a}	5.90^{a}	6.15^{a}

Each mean value, within the same column, followed by the same letter is not significant at 0.05 level.

Bread staling is a complex process that occurs during bread storage. It is delayed the deterioration progress of qualities such as taste, firmness, etc. The mechanism of bread staling is still not clear yet even though it has been studied for 150 years (**Xie *et al.*, 2004**). Alkaline water retention capacity (AWRC) of the pan bread loaves could be considered as an indication for staling and freshness. Therefore, it was estimated for each pomegranate peel addition level at zero time and after storage periods (12, 24, 48 and 72 h.) as shown in Table (4). The presented data showed

that in spite of that AWRC was increased as the pomegranate peel addition level increased, it was decreased as the storage time increased in all the tested pan bread. Such phenomena could be illustrated by the findings of **Xie *et al.* (2004)** who cleared that protein inhibited starch retrogradation by forming a complex with starch. Protein interacts with a glucose unit by a hydrogen bond in either the amylose or the amylopectin chain.

Table (4): Staling of pan bread produced by wheat flour (70% ext) and pomegranate peels

Samples	Value at Zero time	After 12 hr		After 24 hr		After 48 hr		After 72 hr	
		Value	% Decrement	Value	% Decrement	Value	% Decrement	Value	% Decrement
Control	382^{a}	359^{b}	6.0^{a}	330^{c}	13.6^{a}	288^{c}	24.6^{a}	236^{c}	38.2^{a}
Pan bread with 1% pomegranate peels	380^{a}	362^{b}	4.7^{bc}	341^{bc}	10.3^{a}	293^{bc}	22.9^{a}	255^{b}	32.9^{a}
Pan bread with 2% pomegranate peels	382^{a}	368^{b}	3.7^{c}	350^{ab}	8.4^{b}	310^{b}	18.8^{b}	291^{a}	23.8^{b}
Pan bread with 5% pomegranate peels	384^{a}	378^{a}	1.6^{d}	361^{a}	6.0^{b}	330^{a}	14.1^{c}	303^{a}	21.1^{b}

Each mean value, within the same column, followed by the same letter is not significant at 0.05 level.

One of the limiting factor for consumer acceptability is the organoleptic properties. Therefore, general appearance (GA), taste, odor, crust color, crumb color, roundness and texture of consumer preference were found in Table (5).

Table (5): Sensory evaluation of pan bread produced from wheat flour (70% ext) and pomegranate peels.

Samples	General appearance	Taste (10)	Order (10)	Crust color	Crumb color	Roundness (10)	Texture (20)
Control	9.8^{a}	9.5^{a}	10^{a}	9.5^{a}	9.8^{a}	9.9^{a}	9.7^{ab}
	±0.02	±0.03	±0.06	±0.01	±0.05	±0.04	±0.01
Pan bread with 1% pomegranate peels	9.6^{a}	9.4^{a}	9.7^{b}	9.00^{bc}	9.00^{b}	9.5^{b}	9.8^{a}
	±0.01	±0.02	±0.04	±0.02	±0.02	0.01±	±0.06
Pan bread with 2% pomegranate peels	9.5 ab	9.2 b	9.5c	8.8 c	8.7 c	9.5 b	9.6 b
	0.05±	±0.05	0.02±	±0.04	±0.04	±0.06	±0.04
Pan bread with 5% pomegranate peels	9 c	8.5 c	9.0 d	7.5 d	7.0 d	9.0c	8.5 c
	±0.01	±0.04	0.06±	±0.03	±0.04	0.01±	±0.06

Each mean value is followed by ± standard deviation.

Each mean value, within the same row, followed by the same letter is not significant at 0.05 level.

It revealed that GA and texture of 1.0 and 2.0% pomegranate peel pan bread were closed to the consumer preference of control. Whereas, all the other attributes and all 5.0% pomegranate peel pan bread attributes were significantly difference than the control sample attributes in a narrow extend variation.

In general, it could be concluded that pomegranate peel could be utilized in improving the nutritional, physical and sensory characteristics of pan bread.

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تقييم جودة الخواص الطبيعية والفيزيائية والحسية فى الخبز المضاف له قشر الرمان

العنود عمر علي

الملخص :

في السنوات الأخيرة أثبت علميا أن لقشور الرمان (*Punica granatum* L.) فوائد صحية كثيرة. ولذلك، تم تقييم الخواص الكيميائية لعجينة خبز مضاف إليها قشور الرمان (بنسبة ١.٠، ٢.٠ أو ٥.٠%). وقد وجد أن قشور الرمان تحتوي على كمية من الألياف والرماد (١٢.٥٢ و ٦.٠٢% على التوالي) وكميات أقل من البروتين والكربوهيدرات (٣.٧٧ و ٧٦.٦١%، على التوالي) بالنسبة لتلك الموجودة في دقيق القمح (٠.٩٢، ٠.٥٠، ١٢.٢٥ و٨٥.٥٥%، على التوالي). وبالتالي، كلما ارتفع مستوى قشور الرمان، زادت نسبة الألياف والرماد بينما تنخفض نسبة البروتين والكربوهيدرات في الخبز. عوضا عن ذلك، كانت هناك زيادة ملحوظة في حجم الخبز المضاف له قشور الرمان. وعند زيادة جميع نسب قشور الرمان المضافة زاد وقت التخمير.

تم تحسين (measured as % Alkaline water retention, AWRC) بزيادة مستوى قشور الرمان المضافة. وأظهر التقييم الحسي للعينات أن الخبز المضاف له قشور الرمان بنسبة ١% أقرب في الصفات الحسية لعينات الخبز الأساسية من عينات الخبز الأخرى (٢.٠ أو ٥.٠% قشور الرمان).