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Utilization of Artichoke Leaves to Prepare Functional pan bread

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ABSTRACT

The objective of this study is to utilize dried artichoke leaves (DAL) as a by-product as a source of antioxidant compounds in producing functional of pan bread. Additionally, the aim was to enhance the nutritional value of pan bread by incorporating fiber, minerals, and polyphenolic compounds from artichoke leaves. Another goal was to maximize the economic utilization of DAL, as it is a byproduct readily available from canning factories. Moreover, by creating a healthy product with high nutritional value, the study sought to capitalize on the health benefits offered by DAL and prepare a new item with significant nutritional, harnessing various antioxidants from their natural sources without compromising sensory qualities, particularly color and texture. This study revealed that the protein, fat, fiber, and ash contents gradually increased with higher levels of DAL incorporation. The substitution led to detect pan bread with high mineral levels, particularly calcium, compared to the control pan bread. Furthermore, pan bread containing DAL had a greater weight and volume than the control bread. Although substituting wheat flour with DAL resulted in increasing hardness and chewiness, and a slight decreasing in cohesiveness compared to the control. The acceptance of the supplemented pan bread was comparable to that of the control bread, up to a 15% addition of DAL. Furthermore, this addition did not lead to undesirable variations in color and was highly acceptable to the panelists. The results demonstrated that DAL can be successfully incorporated into bread, effectively increasing the mineral content while reducing the calorie content. Additionally, during storage, the alkaline water retention capacity (AWRC) increased, and the loss of freshness decreased in the resulted pan bread compared to the control samples.

Keywords: Wheat flour; dried artichoke leaves; sensory characteristics; total Polyphenols; antioxidants and pan bread.

1. Introduction

In recent times, there has been a global increase in health consciousness, leading to a growing interest in functional foods. Functional foods have been shown to provide various health benefits, such as reducing the risk of high cholesterol, preventing cancer, and promoting gastrointestinal health (Hayta *et al*., 2014).

Artichoke, a herbaceous perennial crop belonging to the Asteraceae family, contains leaves that are rich in phenolic compounds and have been traditionally used for healing properties (Fratianni *et al*., 2007; Salem, 2015). The cultivation of artichoke is widespread, with a prominent presence in Mediterranean countries (LaGow, 2004).

Historically, artichoke leaves have been utilized for the treatment and prevention of gastrointestinal and hepato-biliary diseases (Salmond, 2013). Artichoke leaves are commonly used alone or in combination with other herbs to add flavor to alcoholic and non-alcoholic beverages, herbal teas, and other herbal products (Mulinacci *et al*., 2004). Studies have demonstrated that artichoke leaves can effectively lower plasma lipid levels, including total cholesterol (Ann *et al*., 2008).

Artichokes are considered a healthful food due to their chemical and nutrient composition. They contain various nutrients, including phenolic compounds, dietary fiber, fat and proteins, as well as

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minerals (El-Sohaimy, 2013). Polyphenols, including flavonoids, isoflavones, anthocyanins, and catechins, are believed to have strong antioxidant activity and play a crucial role in countering oxidative stress caused by free radicals, which is associated with chronic non-communicable diseases (Biel *et al*., 2020). Artichoke, particularly its leaves, is recognized as one of the major natural sources of antioxidants and bioactive substances (Behara, 2011).

This study aims to enhance the economic value of artichoke waste, specifically the leaves, which are well natural sources of antioxidants components and crude fiber. The objective is, also, to incorporate these waste materials in pan bread preparation and evaluate the quality and sensory characteristics, of the final product.

2. Materials and Methods

2.1. Materials

Wheat flour (72%) was obtained from South Giza Flour Mills Company, Egypt. Artichoke leaves, were collected from artichoke canning factories (El Hadi Company - Sidi Ghazi – Beheira, Egypt).

2.2. Methods

The artichoke leaves were washed, dried at 60°C, then ground well in a laboratory mill (Athelzion, HZ: 50, H: I, V: 220, Italy)., and sieved through a 0.5 mm sieve. The rheological properties of the dough were tested using the Farinograph and Extensograph instruments, following the procedure outlined by AACC (2016).

2.2.1. Pan Bread manufacturing

The basic formula for the bread, is based on 100 g of flour, 1 g of salt, 5 g of sugar, 1.5 g of active dry yeast, 3 g of corn oil, and a appropriate amount of water to achieve a consistency of 500 BU (brabeder units). Different formulations were prepared by incorporating artichoke powder with the wheat flour at levels of 5, 10, 15 and 20% (based on the weight of the flour) as recorded Table (1). The wheat flour, yeast, and water were mixed for 5 minutes. Then, all the ingredients were mixed for an additional 10 minutes until the desired consistency was achieved. The dough was divided into 100 g pieces and hand-rounded. After resting for 5 minutes, the dough was panned and left to ferment for 1 hour at a temperature of 30°C and a relative humidity of 85%. The fermented dough was then baked at 180°C for 20 minutes, following the modified procedure by Frutos *et al.* (2008).

Table 1: The ingredients of produced pan bread.

Ingredients (g)	Control	T1	T2	T3	T4
Wheat flour ext. (72 %)	100	95	90	85	80
Dried artichoke leaves (DAL)	-	5	10	15	20
Salt	1.0	1.0	1.0	1.0	1.0
Sugar	5.0	5.0	5.0	5.0	5.0
Corn oil	3.0	3.0	3.0	3.0	3.0
Dry yeast	1.5	1.5	1.5	1.5	1.5
Water %	65.30	67.0	70.0	73.0	76.50

Control = 100% Wheat flour ext.72 % (WF)
T1= 95% wheat flour ext.72 % (WF) + 5 % Dried artichoke leaves (DAL)
T2= 90 % wheat flour ext.72 % (WF) + 10 % Dried artichoke leaves (DAL)
T3= 85 % wheat flour ext.72 % (WF) + 15 % Dried artichoke leaves (DAL)
T4 = 80% wheat flour ext.72 % (WF) + 20 Dried artichoke leaves (DAL)

2.3. Chemical Composition

The chemical composition of both raw materials and pan bread samples was determined following the official methods outlined by AOAC (2016).The total carbohydrate content was calculated by difference (Fraser and Holmes 1959), where carbohydrate % (on a dry basis) was calculated as 100 – (protein %+ fat %+ ash% + fiber%).The total calories of the pan bread were determined using the following equation: Total calories (kcal/100g) = 4 (protein %+ carbohydrate %) + 9 (fat %) according to FAO/WHO (1991) guidelines.

2.4. Mineral profile

Minerals content was analyzed. Microwave digestor (Multiwave GO Plus 50 HZ) was used prior to spectrophotometric analysis of the samples by MPAES4210 (Microwave Plasma -Atomic Emission Spectroscopy) (Agilent, Mulgrave, Victoria, Australia) according to Agilent Technologies, Inc. (2021).

2.5. Physical Properties

The physical properties of the pan bread were determined following the method described in AACC (2016). Measurements included height, weight (w), volume (v), and specific volume v/w (cm^3/g) of the produced bread.

2.6. The texture profile analysis (TPA)

A Texture analyzer (Brookfield CT3 Texture Analyser operating instructions. Manual No.M08-372-C0113, Stable Micro Systems, USA) was used to measure the Texture profile of pan bread in terms of Cohesiveness, Hardness (N), and resilience of the samples. The sample (2.5 cm height and 4 cm diameter) were compressed twice to 40% of the original height using settings as text-TPA, probe-36 mm cylindrical, Pre-text speed -2 mm/s, post- text speed -2mm. The experiments were conducted under ambient conditions.

2.7. Sensory Evaluation

The sensory evaluation of the pan bread attributes, including appearance (15), crust color (15), crumb color (15), texture (20), odor (20) and taste (20), was evaluated for sensory characteristics by well-trained ten panelists from the staff of the Bread and Pasta Research Department, Food Technology Research Institute, ARC, was conducted according to the method described by Dhingra and Jood (2001).

2.8. Pan Bread Staling

The staling of the pan bread was determined using the Alkaline Water Retention Capacity (AWRC) method as described by Kitterman and Rubenthaler (1971). The percentage of the absorbed alkaline solution to 5 g of baked product was calculated using the formula: (W2 - W1) / WS, where W1 is the weight of the empty tube, W2 is the weight of the tube with the sample after centrifuge, and WS is the weight of the sample.

2.9. Total Polyphenols

The total poly phenols content of the pan bread samples was determined using the method of Gao *et al.* (2000). The absorbance of the resulting blue color was measured at 765 nm using a spectrophotometer. The results were expressed as gallic acid equivalents (GAE) in milligrams per 100 grams of dry weight basis.

2.10. Antioxidant Activity

The antioxidant activity of the pan bread samples was determined by measuring the quenching of the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical using methanol extracts. The method reported by Siddhuraju *et al.,* (2000) was followed, where a volume of DPPH methanolic solution was mixed with pan bread samples methanol extracts, and the absorbance was measured after 30 minutes. The percentage of DPPH radical-scavenging ability was calculated using the formula: % scavenging = (A0 - A30) / A0 * 100, where A0 is the absorbance at 0 minutes, and A30 is the absorbance at 30 minutes.

2.11. Statistical Analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY). Mean comparisons were made by analysis of variance (ANOVA) and comparisons of the means of two groups. Statistical significance was accepted at $P < 0.05$. Data are presented as mean ± standard deviation (SD) (n = 3). By Snedecor *et al.,* (1980).

3. Results and Discussion

3.1. Farinograph test

The measured rheological attributes of wheat flour substituted samples with dried artichoke leaves powder (DAL) are presented in Table (2). The water absorption was gradually increased with the addition of DAL, rising from 65.3% in the control wheat flour sample to 76.5% in the wheat flour substituted with 20% DAL. This increase in water absorption is commonly observed when fiber content in the dough is increased, as reported by Sudha *et al.* (2007). The presence of hydroxyl groups in the fiber structure, also, enhances the interaction between water and hydrogen bonds, resulting in a greater water-holding capacity of the flour (Rosell *et al.,* 2001).

Moreover, the dough development time increased, reaching 6.9 minutes, in the dough containing 20% DAL, compared to the corresponding control with a development time of 1.5 minutes. Conversely, the dough stability time was reduced by increase DAL substituted in dough, due to the fiber particles disrupted the starch gluten network, leading to a decrease in dough stability time. However, the dough stability time increased and reached its maximum in the dough substituted with 20% DAL compared to the control sample. A longer dough stability time is considered favorable (Mehfooz *et al.,* 2018), although previous research by Urooj *et al.* (1998) and Hussein *et al*. (2006) reported similar findings. Furthermore, the degree of weakening (B.U) increased with increasing amount of DAL and reached its maximum in the dough blended with 20% DAL. These results are consistent with El-Taib *et al.* (2018), who found that a progressive increase in the degree of weakening (BU) with higher fiber ratios. This effect can be attributed to a decrease in network gluten content in the dough (Mekhael, 2005).

Table 2: Farinograph parameters of the wheat dough substituted with dried artichoke leaves (DAL).

Sample	Water absorption (%)	Mixing time (min)	Dough development (min).	Stability (min)	Degree of weakening (BU)
Control	65.3	1.0	1.5	9	100
T1	67.0	1.7	1.8	8	110
T2	70.0	2.0	2.9	6	120
T3	73.0	2.5	4.5	5	140
T4	76.5	3.9	6.9	3	160

Control = 100% Wheat flour ext.72 % (WF)
T1= 95% wheat flour ext.72 % (WF) + 5 % Dried artichoke leaves (DAL)
T2= 90 % wheat flour ext.72 % (WF) + 10 % Dried artichoke leaves (DAL)
T3= 85 % wheat flour ext.72 % (WF) + 15 % Dried artichoke leaves (DAL)
T4 = 80% wheat flour ext.72 % (WF) + 20 Dried artichoke leaves (DAL)

3.2. Extensograph test

Table (3) noted a decrease in the dough's resistance to extension and extensibility as the amount of DAL increased. This finding aligns with the observations of El-Taib *et al.* (2018), who reported that a reduction in dough extensibility is conjugated with the percentage of fiber increased. Dough mixing that exhibit a longer distance before rupture (higher extensibility) and require more force to rupture (higher maximal resistance to elasticity), are generally considered to have favorable characteristics for bread-making. Sullivan *et al.* (2010), also, conducted a study demonstrating that the addition of more fiber resulted in reduced dough extension. Notably, the proportional number (P.N.) increased from 3.8 in control to 4.78 in DAL samples of 5 to 20%. This increase in the proportional number with higher fiber amounts is consistent with the findings of Naeem *et al.* (2002) who indicated that the dough energy (cm^2) decreased with increasing amounts of whole flour which contains high fiber (Shaban, 2006).

3.3. Effect of artichoke leaves on chemical composition of pan bread

Table (4) presents the chemical analysis of pan bread prepared by partially substituted wheat flour with DAL. The use of DAL as a substitute of wheat flour led to an increase in protein, ether extract, ash, and fiber content in the pan bread. As DAL levels increased, there was a gradual decrease in the percentage of carbohydrates in the pan bread, resulting in a lower carbohydrate content compared to control. The decrease in carbohydrate percentage can be attributed to the high fiber content of artichoke leaves, which contributed to increase fiber content in pan bread. Notably, there was a decrease in energy content, primarily due to the reduction in carbohydrates present in the pan bread. These results are consistent with Ropciuc *et al.* (2017).

Table 3: Extensograph parameters of wheat flour substituted with dried artichoke leaves (DAL).

Sample	Resistance to extension (BU)	Extensibility	Proportional no. (R/E)	Energy (cm^3)
Control	570	150	3.8	120
T1	530	130	4.08	110
T2	510	110	4.64	115
T3	450	95	4.74	98
T4	430	90	4.78	77

Control = 100% Wheat flour ext.72 % (WF)
T1= 95% wheat flour ext.72 % (WF) + 5 % Dried artichoke leaves (DAL)
T2= 90 % wheat flour ext.72 % (WF) + 10 % Dried artichoke leaves (DAL)
T3= 85 % wheat flour ext.72 % (WF) + 15 % Dried artichoke leaves (DAL)
T4 = 80% wheat flour ext.72 % (WF) + 20 Dried artichoke leaves (DAL)

Table 4: Chemical composition (on dry basis) of pan bread substituted with dried artichoke leaves.

Treatments	Protein %	Fat %	Ash %
Control	8.90 ^{c} ±0.03	1.10 ^{a} ±0.02	1.30 ^{b} ±0.03
T1	9.62 ^{bc} ±0.25	1.25 ^{a} ±0.12	1.77 ^{ab} ±0.053
T2	10.03 ^{ab} ±0.50	1.28 ^{a} ±0.05	2.09 ^{ab} ±0.62
T3	10.45 ^{ab} ±0.01	1.31 ^{a} ±0.23	2.45 ^{a} ±0.16
T4	10.86 ^{a} ±0.72	1.34 ^{a} ±0.11	2.74 ^{a} ±0.29
Treatments	**Crude fiber %**	**Total carbohydrates %**	**Calories kcal/100g**
Control	2.09 ^{e} ±0.35	86.61 ^{a} ±0.55	391.94 ^{a} ±0.50
T1	4.00 ^{d} ±0.01	83.36 ^{b} ±0.90	383.17 ^{b} ±0.10
T2	5.50 ^{c} ±0.30	81.10 ^{c} ±0.30	376.04 ^{c} ±0.80
T3	7.50 ^{b} ±0.15	78.29 ^{d} ±0.33	366.75 ^{d} ±0.91
T4	8.50 ^{a} ±0.25	76.56 ^{e} ±0.18	361.74 ^{e} ±0.23

Control = 100% Wheat flour ext.72 % (WF)
T1= 95% wheat flour ext.72 % (WF) + 5 % Dried artichoke leaves (DAL)
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T3= 85 % wheat flour ext.72 % (WF) + 15 % Dried artichoke leaves (DAL)
T4 = 80% wheat flour ext.72 % (WF) + 20 Dried artichoke leaves (DAL)
Each value is followed by ±SD
Each value, within the same column, followed by the same letter is not significantly different at 0.05 level

3.4. Minerals content of produced pan bread by artichoke leaves

The high mineral content calcium (Ca), iron (Fe) and zinc (Zn) of DAL, is evident in the results presented in Table (5). When wheat flour was substituted with DAL at any percentage, rate of increase in minerals content was observed in the resulting pan bread. These results are consistent with EL-Sohaimy (2013) and Biel (2020) *et al.* Who said that adding artichoke leaves to bakery products increases the percentage of minerals.

3.5. Effect of artichoke leaves on weight, volume and specific volume of pan bread

The findings presented in Table (6) demonstrated that the incorporation of artichoke leaves powder led to an increase in weight, primarily due to the high fiber content present in DAL. The weight values were significantly higher than the control sample, particularly for the formulation containing 20% DAL. However, there was non-significant between treatment and control a slight decrease in specific volume as the level of DAL increased. These results align with the findings of Frutos *et al.* (2008) who reported the addition of artichoke fibers of bread decreased in the specific volume slightly, showing minor significant differences compared to the control formulation.

Table 5: Mineral content (mg/100g on dry basis) of pan bread substituted with dried artichoke leaves.

Sample	Ca	Fe	Zn
Control	30.11^{e} ±0.86	1.90^{c} ±0.200	0.71^{d} ±0.60
T1	45.31^{d}±0.89	2.10^{bc} ±0.16	0.86^{c} ±0.50
T2	63.11^{c} ±1.57	2.31^{ab} ±0.11	0.97^{b} ±0.03
T3	82.31^{b} ±2.31	2.50^{a} ±0.200	1.02^{b} ±0.07
T4	101.21^{a} ±.0.5	2.59^{a}±0.100	1.17^{a} ±0.02

Control = 100% Wheat flour ext.72 % (WF)
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T4 = 80% wheat flour ext.72 % (WF) + 20 Dried artichoke leaves (DAL)
Each value is followed by ±SD
Each value, within the same column, followed by the same letter is not significantly different at 0.05 level

Table 6: Physical characteristics of pan bread substituted with dried artichoke leaves.

Sample	Weight (g)	Volume (cm^{3})	Specific volume (cm^{3}/g)
Control	110.21^{e}±1.00	399.31^{a}±1.00	3.62^{a}±0.10
T1	115.50^{d}±0.50	390.50^{b}±1.00	3.38^{a}±1.00
T2	125.50^{c}±0.20	385.71^{c}±0.30	3.07^{a}±1.00
T3	135.70^{b}±0.30	380.31^{d}±1.00	2.80^{a}±0.50
T4	140.31^{a}±0.10	274.63^{e}±1.10	2.67^{a}±0.40

Control = 100% Wheat flour ext.72 % (WF)
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Each value is followed by ±SD
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Table (7) revealed that as the amount of DAL added increased in the tested different bread formulas, the texture gradually became harder. The addition of 20% DAL resulted in the most significant increase in hardness compared to the control. According to Salas-Mellado and Chang (2003), who existed a correlation between hardness and gluten concentration. Gluten contributes to the ability of the dough to retain gas during fermentation. Therefore, crumb hardness is inversely related to gluten concentration.

In the case of substituting different proportions of wheat flour with artichoke leaves, the presence of artichoke fiber had a dilution effect, reducing gluten content and altering the viscoelastic properties of gluten. This led to a decrease in loaf volume, as reported by Mohamed *et al.* (2006). As the amount of artichoke fiber (AF) increased from 3% to 12%, the loaf volume decreased, the crumb structure became more compact, and cohesiveness decreased. Cohesiveness refers to the ability of a material to be deformed without breaking. The substantial reduction in hardness and cohesiveness observed in this bread, resulting in a decrease in textural quality, was attributed to the addition of 20% artichoke fiber. Furthermore, there was a notable difference in texture between the bread infused with DAL and the control bread. Regardless of the amount of fiber added, the textural response was significantly reduced in the presence of DAL compared to the control loaves. Similar findings were observed in breads enriched with various fiber sources (Wang *et al.,* 2002), but the reduction in textural quality was in the loaves made with artichoke leaves especially in T3 and T4 (15 and 20 % addition)

3.6. Staling evaluation of pan bread

The results presented in Table (8) indicated that the score of AWRC in zero time for all samples was the highest value in relation to the stored samples for (24, 48 and 72 hr.). It began to decrease in both the control and the substituted pan bread samples. AWRC values of supplemented bread were increased as the dry artichoke leaves amounts increased. This is due to the presence of fibres in the artichoke leaves which lead to a rapid increase of AWRC values. However, by statistical analysis, it was found that there were significant differences among the control and each of the substituted samples in AWRC. The value of (AWRC %) were gradually increased in all substituted samples compared with the control. This may be due to the increase in water absorption impact of fiber content. From these data, it could be noticed that, there was agradual decrease in the rate of staling loss due to increase the substitut in all different samples during storage time. These may be due to the increase in fibre and fat content in substituted bread (Abo-Elnaga 2002).

Table 7: Textural profile analysis of pan bread during storage.

Storage time	Characteristics	Control	T1	T2	T3	T4
Zero time	**Hardness**	2.3^{d}±0.30	2.48^{cd}±0.10	2.9^{c}±0.40	3.89^{b}±0.06	6.39^{a}±0.2
24 hr		3.5^{c}±0.50	3.8^{c}±0.20	4.0^{c}±0.50	5.9^{b}±0.40	7.95^{a} ±0.4
48hr		4.2^{c}±0.20	4.6^{c}±0.20	5.8^{b}±0.40	6.3^{b}±0.30	8.0^{a} ±0.40
72hr		5.0^{a} ±0.30	5.3^{c}±0.30	6.96^{b}±0.25	7.56^{b}±0.67	9.2^{a} ±0.40
Zero time	**Coheseviness**	0.8^{a}±0.10	0.71^{ab}±0.02	0.67^{b}±0.02	0.62^{b}±0.02	0.6^{b}±0.10
24 hr		0.67^{a}±0.05	0.6^{ab}±0.10	0.57^{ab}±0.1	0.54^{ab}±0.02	0.50^{b}±0.4
48hr		0.6^{a}±0.10	0.54^{ab}±.02	0.50^{ab}±0.1	0.47^{b}±.02	0.44^{b}±0.02
72hr		0.49^{a}±0.02	0.43^{b}±0.02	0.40^{c}±0.00	0.37^{d}±0.02	0.30^{e}±0.00
Zero time	**Resilience**	0.25^{a}±0.05	0.2^{ab}±0.02	0.19^{b}±0.03	0.17^{b}±0.02	0.15^{b}±0.03
24 hr		0.22^{a}±0.03	0.19^{ab}±0.03	0.18^{abc}±0.02	0.16^{bc}±0.03	0.14^{c}±0.02
48 hr		0.20^{a}±0.02	0.17^{ab}±0.01	0.15^{bc}±0.01	0.13^{c}±0.03	0.12^{c}±0.02
72 hr		0.18^{a}±0.02	0.15^{b}±0.02	0.13^{bc}±0.01	0.11^{cd}±0.01	0.10^{d}±0.00

Control = 100% Wheat flour ext.72 % (WF)
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T3= 85 % wheat flour ext.72 % (WF) + 15 % Dried artichoke leaves (DAL)
T4 = 80% wheat flour ext.72 % (WF) + 20 Dried artichoke leaves (DAL)
Each value is followed by ±SD
Each value, within the same row, followed by the same letter is not significantly different at 0.05 level

Table 8: Alkaline water retention capacity (AWRC) of pan bread during storage.

Sample	(AWRC)% values for the storied samples						
	(AWRC)%Zero time	**(AWRC)% 24 hr**	**Rate of decrease %**	**(AWRC) %48 hr**	**Rate of decrease %**	**(AWRC)% 72 hr**	**Rate of decrease %**
Control	285.21^{e}±2.10	210.3^{e}±3.010	26.26^{a}±2.08	200.41^{e}±2.44	29.73^{a}±2.02	121.21^{e}±2.40	57.85^{a}±2.08
T1	310.31^{d}±3.20	260.41^{d}±5.20	19.30^{b}±1.11	230.11^{d}±2.52	25.85^{b}±1.01	200.32^{d}±3.00	35.44^{b}±1.04
T2	370.02^{c}±5.01	310.51^{c}±4.00	16.08^{c}±2.01	280.51^{c}±5.5	24.19^{bc}±2.00	240.17^{c}±3.80	35.09^{b}±2.09
T3	410.52^{b}±5.40	350.32^{b}±5.33	14.66^{c}±0.01	320.71^{b}±2.50	21.87^{cd}±1.03	270.32^{b}±4.00	34.15^{b}±.017
T4	430.72^{a}±5.10	390.12^{a}±5.50	9.42^{d}±1.09	340.3^{a}±3.50	21.05^{d}±1.04	301.41 a±6.50	30.22^{c}±2.04

Control = 100% Wheat flour ext.72 % (WF)
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Each value is followed by ±SD
Each value, within the same column, followed by the same letter is not significantly different at 0.05 level

3.7. Total phenolic content and antioxidant activity in pan bread samples

Total phenolic contents of control pan bread and pan bread containing DAL were determined by Folin-Ciocalteu reagent method and the results is expressed as gallic acid equivalents as shown in Table (9). Antioxidants play an important role to inhibit the dangerous effects of the free radicals. In general, antioxidants are the compounds which lead to inhibit or delay of the oxidation of other molecules such as the inhibition of the initiation or propagation of oxidizing chain reaction (Hollman and Katan 1999). The present study revealed that, the substitution of artichoke in pan bread caused an increasing in antioxidant capacity as shown in Table (9). Many of researches revealed that, a strong linear relationship between total phenolics and antiradical capacity. Based on these findings, the increasing of phenolic content in artichoke caused an increasing of antioxidant capacity. These findings agreed with (Lutz *et al.*, 2011) who proved that the antioxidant activity of mature artichoke was improved by thermal treatments.

It could be noticed that bread containing DAL at 5, 10, 15 and 20 % were high in polyphenol content (131.141, 250.51, 270.20 and 490.81 mg gallic acid /100gm respectively, compared with control 11.5 mg gallic acid /100g, Negro *et al.* (2012) reported that total polyphenols in DAL were more than in heads. This indicated that DAL represent an important source for phyto pharmaceutical applications. These results encourage utilization of leaves and should be strongly encouraged for the pharmaceutical industry and not solely for the fresh market, as they are now. Concerning the result of antioxidant activity, it could be clearly observed that bread which containing 20 % DAL had the highest level of antioxidant activity comparing with other samples due to the high content of total phenolic. These results agreed with Suja *et al.* (2005). This can be attributed to the difference in polyphenol content and to the nature of extracted compounds. Results show that DAL extracts possess the ability to act as hydrogen donors and they are the primary antioxidants that react with free radicals. This result was agreed with Wang *et al*. (2003); Lutz *et al.* (2011) and Yu *et al.* (2013) who revealed that, the total phenolic compounds were the highest in artichoke after thermal treatment.

Table 9: Total phenols compounds (mg gallic acid /100g and) antioxidants activities DPPH (%) of raw materials.

Sample	Total phenols (mg/100g)	antioxidant DPPH %
Control	11.50^{e} ±0.50	5.11^{e} ±0.12
T 1	131.41^{d}±1.41	9.53^{d} ±0.49
T2	250.51^{c} ±2.00	13.11^{c} ±0.64
T 3	270.20^{b}±6.04	20.12^{b} ±0.70
T 4	490.81^{a}±2.80	23.91^{a} ±0.91

Control = 100% Wheat flour ext.72 % (WF)
T1= 95% wheat flour ext.72 % (WF) + 5 % Dried artichoke leaves (DAL)
T2= 90 % wheat flour ext.72 % (WF) + 10 % Dried artichoke leaves (DAL)
T3= 85 % wheat flour ext.72 % (WF) + 15 % Dried artichoke leaves (DAL)
T4 = 80% wheat flour ext.72 % (WF) + 20 Dried artichoke leaves (DAL)
Each value is followed by ±SD
Each value, within the same column, followed by the same letter is not significantly different at 0.05 level.

Sensory evaluation of produced pan bread

Table (10) provides a summary of sensory evaluation results. The overall statistics indicated that the replacement of wheat flour in the pan bread recipe with artichoke leaves up to 10% is acceptable. Compared with the other samples (control and T3, T4) samples.

Table 10: Sensory evaluation of produced pan bread.

Sample	Taste (20)	Odor (20)	Crust color (15)	Crumb color (15)	Texture 15	Appearance 15
Control	19.00^{a}±1.00	18.50^{a}±0.5	14.50^{a}±0.5	14.77^{a}±0.7	14.50^{a}±0.5	14.55^{a}±0.4
T1	18.00^{a}±0.50	18.50^{a}±0.5	14.00^{b}±1.0	14.77^{a}±0.7	14.00^{a}±0.4	14.00^{a}±0.8
T2	17.00^{ab}±0.30	18.00^{a}±1.0	13.50^{c}±0.5	14.00a±0.4	14.00^{a}±1.0	13.00^{ab}±0.5
T3	16.00^{ab}±0.10	17.00^{ab}±0.5	13.00^{c}±1.0	12.00^{b}±0.4	12.00^{b}±0.5	12.00^{ab}±0.6
T4	13.00^{c}±0.40	14.00^{c}±1.0	12.00^{cd}±1.0	10.00^{c}±1.0	10.00^{c}±0.8	10.00^{c}±1.0

Control = 100% Wheat flour ext.72 % (WF)
T1= 95% wheat flour ext.72 % (WF) + 5 % Dried artichoke leaves (DAL)
T2= 90 % wheat flour ext.72 % (WF) + 10 % Dried artichoke leaves (DAL)
T3= 85 % wheat flour ext.72 % (WF) + 15 % Dried artichoke leaves (DAL)
T4 = 80% wheat flour ext.72 % (WF) + 20 Dried artichoke leaves (DAL)
Each value is followed by ±SD
Each value, within the same column, followed by the same letter is not significantly different at 0.05 level

The increment mount of wheat flour substitution with dried artichoke leaves in the pan bread samples, led to a decrease in preference for the categories of color, texture, appearance, taste. The compact texture of the crumb and the deeper color of the product were the main reasons for the loss in acceptability qualities at the high levels of DAL addition. Comparing the bread with the control, the addition of 5 and 10% DAL had no appreciable impact on the bread's acceptability. Similar to those reported by Wang *et al.* (2002).

4. Conclusion

This work is an attempt to raise the economic value of artichoke leaves (inner and outer leaves DAL). Using DAL is to reduce wheat flour in pan bread production to reduce calorie and increase nutritional value of pan bread, as it is a by-product and available product in the Egyptian canning factories. Maximizing the health benefits of DAL by producing a product with high nutritional value take the advantage of dietary fiber and antioxidants, with decreasing the price of the product by saving the amount of wheat flour. By studying all the technological, sensory and chemical properties, it was found that wheat flour can be replaced (5 % to 15%) with dry artichoke leaves as these samples gave a result nearly similar to the control in all the properties of the tests .on the other hand, the increase in the percentage of replacing wheat flour to 20 % led to a decrease in the technological and sensory properties, therefore, it was accepted according to the view point of the producer by a percentage up to 15 with respect to the various nutritional value (protein, fiber and minerals). therefore, it is acceptable. Concerning the poly phenol compounds and DPPH results. DAL with their antioxidant characteristic as quality criteria could be used in wheat-based food products.

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