Potential Protective Activity of Artichoke Leaves Powder *(Cynara scolymus L)* on Gastric Ulcer Induced by Ethyl Alcohol in Rats

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النشاط الوقائي المحتمل لمسحوق أوراق الخرشوف على قرحة المعدة المستحثة باستخدام الكحول الأيثيلي في الفئران

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الملخص

هدفت هذه الدراسة الى تقييم التأثير الوقائي لمسحوق اوراق الخرشوف بتركيزات مختلفة (2,5، 5، 10 %)على ذكور الفئران المصابة بقرحة المعدة باستحدام الكحول الأيثيلي وامكانية تطبيقها في تدعيم المخبوزات (الكيك) . حيث أجريت هذه الدراسة باستخدم ثلاثون فأر من الذكور البالغة تم تقسيمها إلى مجموعتين رئيسيتين: المجموعة الأولى الرئيسية (ن = 6): تم تغذيتها على الغذاء الأساسي كمجموعة ضابطة سالبة أما بالنسبة للمجموعة الثانية الرئيسية تم تقسيم الفئران التي ستصاب بالقرحة المعدية بشكل عشوائي إلى اربع مجموعات فرعية (ن = 6) وفقاً لما يلي: المجموعة الأولى: الفئران التي تغذت على الغذاء الأساسي كمجموعة ضابطة إيجابية، المجموعات (الثانية، الثالثة والرابعة) تم تغذيتها على الغذاء الأساسي مع إضافة تركيزات (2,5، 5، 10 %) من مسحوق اوراق الخرشوف بالترتيب . و في اليوم الاخير من التجربة (بعد 28 يوم) تم تصويم الفئران لمدة 24 ساعة ثم اعطاء المجموعات من المجموعة الضابطة الموجبة الى المجموعة الرابعة جرعة (10 مل /كجم من وزن الجسم) من الكحول الأيثيلي لاحداث قرحة المعدة خلال ساعتين من استهلاك الكحول . تم تجميع العصير المعوي لدراسة مؤشرات افراز العصير المعوي . كذلك تم تقدير حالة مضادات الاكسدة في الفئران ، وأظهرت النتائج ان لمسحوق اوراق الخرشوف تأثير وقائي مضاد لقرحة المعدة المستحثة بواسطة الكحول الأيثيلي مع أمكانية استخدامه في الصناعات الغذائية .

الكلمات الافتتاحية: العصير المعوي؛ الكيك؛ التقييم الحسي؛ معامل القرحة.

Potential Protective Activity of Artichoke Leaves Powder *(Cynara scolymus L)* on Gastric Ulcer Induced by Ethyl Alcohol in Rats.

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ABSTRACT:

This study aimed to evaluate the protective effect of dried artichoke leaves powder in different concentration (2.5, 5 and 10 %) against peptic ulcer induced by ethyl alcohol in adult male albino rats and its application in bakery products. Thirty rats were divided into two main groups: The first main group (n=6): rats, were fed on the basal diet only as control negative (Normal animals). The second main group (n=24): gastric ulcer rats were divided randomly into 4 subgroups(n=6) according to the following: Group 1: rats fed basal diet as the positive control, from second to forth groups rats were fed on basal diet supplemented with different concentration of dried artichoke leaves powder (2.5,5 and 10%) respectively. At the last day of experimental period (28th day), after fasting for 24 h ,all groups of rats except the negative control group were received a single orally dose of ethyl alcohol at 10 ml/kg of body weight to induce gastric ulceration for 2h. Gastric juice was collected for studying gastric secretion parameters. Also, antioxidants statue was determined. The results showed that dried artichoke leaves powder possesses a protective activity against peptic ulcer in adult rats which induced by ethyl alcohol and can be recommended for food technologies.

Key words: gastric juice; cake; sensory evaluation; ulcer score.

INTRODUCTION:

Gastric ulcer is the erosion in lining of stomach or duodenum **(Parasa *et al.*, 2013).** It is still a common disease in elderly patients and patients with multiple comorbid conditions. Some authors have referred to gastric ulcers as the new ‘‘plague of the 21st century’’ **(Malley, 2003).** The development of gastric ulcers is a complex and multi factorial process, occurring from an imbalance between aggressive and protective factors present in the gastric mucosa **(Choiet *et al.*, 2009 and Shaker *et al.*, 2010).** Some etiologies of gastric ulcers include increased acid secretion and pepsin activity, reduced mucus and bicarbonate secretion, imbalanced bile salt secretion, the presence of *Helicobacter pylori*, increased gastric contractions and decreased blood flow **(Galuska *et al.*, 2002 and Hoogerwerf & Pasricha, 2001a)**. The increased incidence of gastric ulcers is associated with aggressive factors against the gastric mucosa such as ethanol exposure, stress, smoking, nutritional deficiencies and frequent ingestion of non-steroidal anti-inflammatory drugs (NSAIDs) **(Correa and Houghton, 2007;Choiet *et al.*, 2009 and Shaker *et al.*, 2010).** The key defense factors of the gastric mucosa include: The secretion of bicarbonate and prostaglandin, increased levels of antioxidants and maintaining adequate levels of nitric oxide (NO) **(Hoogerwerf and Pasricha, 2001b and Malfertheiner *et al.*, 2009).**There are many different experimental models of gastric ulcer induction, including ethanol and acetic acid **(Shaker *et al.*, 2010).**Using such animal models, researchers simulate conditions to which humans may be exposed and, as a result, develop gastric ulcers.

Artichoke (*Cynara scolymus L*) is a perennial and cross-pollinated plant of the *Asteraceae* family **(García-Martínez *et al.*, 2017)**. Artichoke leaves have been used traditionally in Europe, Germany and Switzreland to improve digestive and urinary tract health **(Orlovskaya *et al.*, 2007).** It is a good source of natural antioxidants such as vitamin C, carotenoids, polyphenols, and flavones **(Pandino, *et al.*,2011 and Dabbou *et al.*, 2016).** The anti-ulcer activity might be due to flavonoids and their antioxidant properties **(Mota *et al.*, 2009).** Additionally, artichoke may be suitable for use in a wide range of food applications such as cake and bread **(Franck, 2002and Lo´pez-Molina *et al.*, 2005).**

Therefore, this study was conducted to clarify the potential protective activity of dried artichoke leaves powder in different concentrations (2.5,5 and 10 %) on gastric ulcer induced by ethyl alcohol in rats.

MATERIALS AND METHODS:

Materials: The fresh artichoke, wheat flour, egg, sugar, baking powder, milk powder and oil Were purchased from local market of Shiben El-Kom, Menoufia Governorate, Egypt. Casein, all vitamins, all minerals, and cellulose were obtained from Morgan Co. Cairo, Egypt.

Rats: Thirty adult white male albino rats weighing (150 ± 10 g per each), were purchased from research Institute of Ophthalmology, Medical Analysis Department Giza, Egypt, the were approximately of the same age, they were housed in galvanized iron cages measuring 40×2× ،20.

Chemical: All analysis kits were purchased from Bio Diagnostic Co., Giza, Egypt. Other chemicals used throughout the experiments which are ethanol, EDTA and formalin were purchased from El-Nasr Pharmaceutical Chemicals, El-Ameriea, Cairo, Egypt.

Methods:

Artichoke dried leaves preparation: Artichoke was washed and peeled. The leaves of artichoke were cut into small pieces, then dried at 45°C drying oven (Plue Pard ng oven T. S100, Taiwan) for 20 hours milled to a fine powder and kept for further analysis**.**

Chemical analysis:

Determination of total phenols, total flavonoids, and antioxidant activity: The method used for the determination of total phenols using Folin-Ciocalteau reagent was adapted from (**Mcdonald *et al.*, 2001)**.

The aluminum chloride colorimetric method was used for the determination of the total flavonoids content of the sample according to the method described by **(Miliauskas *et al.*, 2004)**.

Antioxidant activity of dried artichoke extracts was determined by 2.2 dipheneyl-1-picry hydrazyl (DPPH) according to **(Yen and Chen ,1995)**.

Identification and quantification of phenolics compounds by HPLC: Phenolic compounds were identified and quantified by modified version of the method described by **(Radovanović *et al*., 2010)**.

Experimental animals: The work was carried out at the biology laboratory, Faculty of Home Economic, Menoufia University, Egypt. Thirty male albino rats, Sprague Dawley Strain, weighting (150g±5) were fed a standard diet for 7 days as an adaptation period. The rats were kept in cylindrical wire cages with wire bottoms. The diet was introduced in special food cups to avoid scattering of food. Also, water was provided to the rats by glass tube projection through the wire cage.

Experimental design: Rats were divided into two main group: the first main group (n=6): rats were fed on the basal diet only as control negative (Normal animals). The second main group (n=24): gastric ulcer rats were divided randomly into 4 subgroups(n=6) according to the following: Group1: rats fed basal diet as the positive control, from second to forth groups rats were fed on basal diet supplemented with different concentration of dried artichoke leaves powder (2.5,5 and 10%) respectively. The experiment lasted for 28 days.

Induction of gastric ulcer: At the last day of experimental period (28^{th} day), the rats were fasted for 24 h with free access to water. The rats of positive control to forth groups were received a single orally dose of ethyl alcohol at 10 ml/kg of body weight to induce gastric ulceration for 2 h **(Huang *et al*., 2014)**. While The first group (a negative control group) received a single orally dose of saline (0.9%, w/v).

Biological Evaluation:

Collection of gastric juice and determine ulcer index: At the end of experiment, rats were fasted overnight (12 hour) and after administration of ethyl alcohol two hour later, all rats were anesthetized with diethyl ether then gastric juice was collected and centrifuged for studying of gastric secretion parameters. Stomach examined for ulceration., evaluation of ulceration degree was expressed in terms of ulcer score which is calculated by dividing the total number of ulcers in each group by number of rats in that group **(Robert *et al.*, 1968).** Ulcer index (UI) was calculated by multiplying ulcer score x 100 **(Radwan *et al.*, 2003)**, the ulceration (%) was calculated by dividing the number of animals with ulcer by the total number of animals and multiplying by hundred **(Ohara *et al.*, 1992)** and the preventive index was calculated according to the method of **(Hano *et al.* 1976).**

Determination of titratable acidity and pH value of gastric juice: About 0.2 ml of centrifuged gastric juice was titrated using phenol red as an indicator with end point at 7.0 pH against 0.01 NaOH. Titratable acidity was calculated in Meq/L. Total titratable acid output Meq/L amount of NaOH that neutralize 100mg of gastric juice **(Deverport, 1972),** pH value was determined according to **(Debnath *et al.*, 1974).**

Blood sampling: Blood sample were collected in EDTA as anticoagulant for determination SOD, MDA and CAT.

Biochemical analysis

Determination of antioxidant status: Super Oxide Dismutase (SOD), Malondialdehyde (MDA) and Catalase (CAT) were estimated in erythrocyte RBCs, using spectrophotometer technique according to **(Stroev and Makarova ,1989).**

Technological methods

Preparation of cake: Cakes were prepared according to the following formula **(Bennion and Bamford, 1983)** and **(Berger, 1986).**

Cake batter specific gravity: Specific gravity of batter was determined as the ratio of the weight of standard container filled with batter to that of the same container filled with water **(Hussein *et al.*, 2011)**.

Cake height, volume, and specific volume: The standing height (in centimeters) was measured in the center of the cake. Cake volume was measured by rapeseed displacement after cooling the cake for 1 hour at room temperature (~25°c). The cake was weighed after removal from the pan and specific volume was also calculated (cake volume / cake weight) **(Hussein *et al.*, 2011)**.

Viscosity and Shear stress: The Brookfield Digital Rotational Viscometer (Model DV - I, Brookfield Engineering Laboratories, Inc. MA, USA) was used to measure viscosity and shear stress at room temperature (25°C) and at speed 0.3 (rpm) according to (**Bartosz *et al.*, 2014)**

Sensory evaluation: Samples of cake were subjected to organoleptic tests (by fifteen judges) according to (**watts *et al.*, 1989)**. Judging scale for appearance, crust color, crump color, texture and flavor were as follow, excellent (9:8), very good (7:6), good (5:4), fair (3:2) and poor (2:1).

Statistical Analysis: The results recorded as the mean ± SD. The experimental data were subjected to an analysis of variance (ANOVA) for a completely randomized design using a statistical analysis system **(Artimage and Berry, 1987)**. Duncan's multiple range tests were used to determine the differences among means at the level of 5%.

RESULTS AND DISCUSSION:

Chemical composition, total phenols, total flavonoids, antioxidant activity content of dried artichoke leaves: Chemical composition of artichoke leaves (On dry weight basis), total phenols, total flavonoids, and antioxidant activity content were presented in Table (1). the obtained results revealed that Carbohydrates were the highest compound of artichoke leaves powder followed by fiber with values (46.31 and 30.6 g/100g) respectively. While protein, ash and fat were (8.32 ,8.13 and 2.18

g/100g) respectively. Additionally, artichoke leaves contain high proportion of total phenol (8.80 mg GAE/g) and flavonoids (9.85mg QE. /g). These findings agreed with **(Pandino *et al*., 2011)** who reported that artichoke contains proteins, minerals, and low amount of lipids. Also, these results were supported by (**Lattanzio *et al*., 2009)** who indicated that artichoke leaves have been found to be a rich source of fiber, inulin, minerals, and a variety of phenolic compounds.

Identification of phenolics compounds of dried artichoke leaves powder by HPLC: The phenolic compounds in dried artichoke leaves are presented in Table (2). Based on the obtained data, cynarin was higher than other component found in leaves of artichoke, followed by chlorogenic acid, salicylic acid, coumarin, apigenin, caffeic acid, gallic acid, ferulic acid, luteolin and narirutin with values (1.28, 0.72, 0.12, 0.12, 0.12, 0.10, 0.10, 0.10, 0.05, 0.025, and 0.022 Mg/100g) respectively. This finding agreed with **(Kawala and Zaba, 2001 and Wang *et al*., 2003)**. They elicited that artichoke contains cynarin and other flavonoids.

Effect of dried artichoke leaves powder on ulcer score, ulcer index, ulceration (%) and preventive index of gastric ulcer rats: The effect of dried artichoke leaves powder on ulcer score, ulcer index, ulceration % and preventive index of gastric ulcer rats were illustrated in Table (3). Positive control group had the highest value in ulcer score and ulcer index compared with other treated groups. Severe gastric damage was also observed in control positive group when compared to other treated groups. These results agreed with **(Warren and Marshall, 1993).** They reported that excessive alcohol consumption irritates the stomach lining and might increase the areas of bleeding that contribute to increase the risk of peptic ulcer. In the same context (**Gonzalez *et al*., 2001)** reported that ethanol can induce gastric damage because of the direct action of gastric epithelium causing lipid peroxidation.

On the other hand, rats that received ethyl alcohol alone recorded a reduction in preventive index when compared to treated groups. The highest value of preventive index (83.33%) was observed in rats which treated with 10% of dried artichoke

leaves powder. In ulceration percent, the concentration of 10% dried artichoke leaves powder had the lowest value which was (16.67) when compared to other treated groups. Our findings are supported by (**Pandino *et al*., 2011 and Metwally *et al*., 2011)**. Their results referred to the antiulcer activity of artichoke might be attributed to high proportion of phenolic compounds and flavonoids that act like a scavenger remove the reactive oxygen species from the surface of gastric mucosa and protect cells from gastric injury.

Effect of artichoke leaves on volume, pH, tetrable acidity and total tetrable acid output of gastric juice in gastric ulcer rats: Data reported in Table (4) illustrated the effect of artichoke leaves on volume, pH, tetrable acidity and total tetrable acid output of gastric juice in rats. More significantly reduction ($p \leq 0.05$) in volume of gastric juice was observed in 2.5 and 5 % treated groups when compared to positive control group. Followed by 10% dried artichoke leaves powder group. This finding came in accordance with (**Richardson, 1992)** who reported that artichoke can decrease acid content of gastric fluid with the progress of ulceration (ulcer index) and that might be due to the high content of phenolic compounds.

The highest pH value (8.83) was found in rats of the negative control group and the lowest pH value (1.71) was found in rats of the positive control group. There were non-significant different between treated dried artichoke leaves groups in their effect on PH value which were (3.57, 3.74 and 3.75) respectively. These results were similar to the obtained results by **(ENO *et al*., 2004)** who reported that high gastric acidity is known to be a factor in the etiology of peptic ulcer.

In the same table, Rats in positive control group were significantly higher ($p \leq 0.05$) in titratable acidity and total titratable acidity level than rats of normal control group and treated groups. Furthermore, rats which treated with 10% leaves of artichoke was more effective in reducing titratable acidity and total titratable acidity level. These results agreed with (**Ceccarelli *et al*., 2010).** They referred to the anti-inflammatory

action of chlorogenic acid (CGA) found in artichoke that could participate in improving induced gastric lesions.

Effect of leaves of artichoke on antioxidant status of gastric ulcer rats: Data presents in Table (5) elucidated the effect of leaves of artichoke on antioxidant stats of gastric ulcer rats.

Rats which received saline solution alone (normal rats) recorded the best antioxidants statue (CAT and SOD) when compared to gastric ulcer groups. Followed by 10% group which were (362 and 3.99) respectively in CAT and SOD. While, 5% group which recorded (350.33 and 3.84) respectively in CAT and SOD, These results were supported by (**Hirokawa *et al.*, 1998; Küçükgergin *et al*., 2010 and Magielse *et al*., 2014))**who showed that intracellular antioxidants may have a significant protective action against ethanol in gastric mucosal cells thus, artichoke has antiulcer action.

On the other side, the lowest value of MDA was showed in negative control group when compared to all gastric ulcer groups which was 3.45 followed of 10% treated group, then 5% and finally 2.5% with values of 4.74, 5.35 and 5.48 respectively. The obtained results were in the same context of **(Liorach *et al.*, 2002 and Pandino *et al*., 2011)** they concluded that the improvement in indicators may be due to antioxidant activity of flavonoids of artichoke.

Sensory evaluation of cake prepared with different levels of dried artichoke leaves powder: Data presented in Table (6) illustrated the sensory evaluation of cake prepared with different levels of dried leaves of artichoke. No significant differences were observed in control cake and cake prepared with 2.5% of leaves of artichoke powder in appearance**,** taste and texture which have the highest indicators compared to the other types of cakes, followed by cake prepared with 5% of dried artichoke leaves powder which was (6.6, 5.67 and 5.8) respectively. Cake prepared with 10% of dried artichoke leaves powder which was (4.87, 3.13 and 4.07 respectively) had lower significantly ($P \leq 0.05$) in appearance**,** taste and texture than control cake and other cakes prepared with different levels of dried artichoke leaves powder.

These results agreed with (**Berger, 1986)** who indicated that bakery products e.g. bread, cake, cookies, and biscuits prepared by using dried artichoke powder were acceptable.

Control cake had higher significantly ($p \leq 0.05$) in color and general admission than other treated cakes, followed by cake prepared with 2.5% then 5% and finally 10% leaves of artichoke powder. Cake prepared with 10% of leaves of artichoke powder had lower significantly ($P \leq 0.05$) in color and general admission than control cake and other treated cakes.

As for the odor, control cake had higher significantly ($p \leq 0.05$) which was (8.6) than other cakes prepared with different levels of dried leaves of artichoke, followed by cakes prepared with 2.5% and 5% dried artichoke leaves powder. Which were similar, with values of (7.53 and 6.87) respectively. Cake prepared with 10% of dried artichoke leaves powder which was (4.73) had lower significantly ($P \leq 0.05$) than control cake and other cakes prepared with different levels of dried leaves of artichoke. These findings supported by **(Lo´pez-Molina *et al.*, 2005)** who indicated that artichoke inulin is likely to be suitable for use in a wide range of food applications.

Effect of adding dried leaves of artichoke portions on batter and cake properties: Data in Table (7) summarized the effect of adding of dried leaves of artichoke. portions on batter and cake properties. There is no significant difference between the control cake and all treated cake by leaves of artichoke in hight, volume and specific volume.

As for the viscosity, there were non-significant differences observed in cake viscosity between all treated cake with different concentrations (2.5, 5 and 10%) of dried artichoke leaves powder. These results agreed with **(Stanley and Linda, 2001)**.

For specific gravity, cake prepared with 5% of dried artichoke leaves powder had higher significantly ($p \leq 0.05$) which was (0.835) than other cakes, followed by 2.5% then 10% and finally the control cake with values of (0.809, 0.804 and 0.759) respectively.

As for the cake weigh, control cake had higher significantly ($p \leq 0.05$) than other treated cakes which was 116.57. No significant differences were observed in treated cakes with values of 112.5, 113.47 and 113.98, respectively. These results emphasized that artichoke is useful in the baking industry because of its nutritional substance.

In conclusion, Artichoke leaves powder has been shown to possess a protective activity against peptic ulcer. This activity may be due to the high content of phenols and flavonoids that could protect cells from gastric injury in adult rats induced by ethyl alcohol. Furthermore, based on the obtained results, artichoke leaves powder can be used in preparing supplemented cakes with high acceptability so it is useful and recommended for food technology.

Table (1): Chemical composition (On dry weight basis), total phenols, total flavonoids, and antioxidant activity content of dried artichoke leaves powder

Parameters	Leaves of artichoke
Moisture (g/100g)	4.19±0.14
Protein (g/100g)	8.32±0.32
Fat (g/100g)	2.18±0.21
Ash (g/100g)	8.13±0.64
Fiber (g/100g)	30.6±0.77
Carbohydrates (g/100g)	46.31±0.96
Total phenol (mg GAE/g DW)	8.80±0.01
Total Flavonoids (mg QE. /g DW)	9.85±0.01
Antioxidant activity	61.25±0.01

GAE= Gallic acid equivalent QE= Quercetin.

Table (2): Identification of phenolic compounds in leaves of artichoke by HPLC.

phenolic compounds	Concentration mg/100g
Gallic acid	0.10
Caffeic acid	0.10
Cynarin	1.28
Ferulic acid	0.05
Coumarin	0.12
Apigenin	0.10
Luteolin	0.025
Salicylic acid	0.12
Chlorogenic acid	0.72
Narirutin	0.022

Table (3): Effect of leaves of artichoke on ulcer score, ulcer index, ulceration % and preventive index of gastric ulcer rats.

Parameters	Negative	Gastric Ulcer groups			
		Positive	G (1) 2.5%	G (2) 5%	G (3) 10%
Ulcer score	--	9.833	5.5	2.833	0.667
Ulcer index	--	983.3	550	283.3	66.67
Ulceration%	--	83.3	66.67	33.33	16.67
Preventive index	--	16.7	33.33	66.67	83.33

Table (4): Effect of artichoke leaves on volume, pH, tetrable acidity and total tetrable acid output of gastric juice in gastric ulcer rats.

Parameters	Negative	Gastric Ulcer groups			
		Positive	G (1) 2.5%	G (2) 5%	G (3) 10%
Volume(ml)	1.55^{c} ±.31	4.23^{a} ±.48	2.51^{bc} ±.51	2.15^{bc} ±.54	2.38^{b} ±.63
PH	8.83^{a} ±1.86	1.71^{c} ±.51	3.57^{b} ±1.29	3.74^{b} ±1.29	3.75^{b} ±.72
Titratable acidity (Meq/L)	1.93^{d} ±.47	8.1^{a} ±.77	3.15^{c} ±.12	4.51^{b} ±.25	2.36^{d} ±.17
Total Titratable acidity (Meq/L)	113.8^{d} ±17.94	421.3^{a} ±43.2	160.08^{c} ±1.84	230.21^{b} ±1.3	124.76^{d} ±.8

Data are expressed as mean ± SD. Values within the same row having different superscripts are significantly different ($p \leq 0.05$

Table (5): Effect of leaves of artichoke on antioxidant status of gastric ulcer rats.

Parameters	Negative	Gastric Ulcer groups			
		Positive	G (1) 2.5%	G (2) 5%	G (3) 10%
CAT (U/g)	397.83^{a} ±2.32	334^{e} ±3.58	342.5^{d} ±3.08	350.33^{c} ±2.16	362^{b} ±3.41
SOD (U/g)	4.65^{a} ±.09	3.8^{c} ±.09	3.79^{c} ±.03	3.84^{c} ±.03	3.99^{b} ±.03
MDA(µmol/l)	3.45^{e} ±.02	5.58^{a} ±.03	5.48^{b} ±.02	5.35^{c} ±.04	4.74^{d} ±.02

Data are expressed as mean ± SD. Values within the same row having different superscripts are significantly different ($p \leq 0.05$).

Table (6): Sensory evaluation of cake prepared with different levels of dried leaves of artichoke.

Parameters	Appearance	Textures	Color	Taste	Odor	General admission
Control	8.47^{a} ±.92	8.6^{a} ±.83	8.07^{a} ±1.03	8.73^{a} ±.70	8.6^{a} ±1.12	8.87^{a} ±.52
G (1) 2.5%	7.8^{a} ±1.01	7.93^{a} ±1.67	6.87^{b} ±1.41	8.07^{a} ±1.28	7.53^{b} ±1.77	7.13^{b} ±1.4
G (2) 5%	6.6^{b} ±1.55	5.67^{b} ±1.45	4.47^{c} ±1.41	5.8^{b} ±1.82	6.87^{b} ±1.18	5.93^{c} ±1.27
G (3) 10%	4.87^{c} ±1.41	4.07^{c} ±1.83	2.47^{d} ±1.41	3.13^{c} ±1.41	4.73^{c} ±1.48	3.8^{d} ±1.82

Data are expressed as mean ± SD. Values within the same column having different superscripts are significantly different ($p \leq 0.05$).

Table (7): Effect of adding dried leaves of artichoke portions on batter and cake properties.

Parameters	Batter		Cake			
	Viscosity	Specific Gravity	High	Volume	Cake Weigh	Specific Volume
Control	175511.3^{b} ±3941.1	0.759^{c} ±0.007	5.17^{a} ±0.76	134^{a} ±2.65	116.57^{a} ±2.44	1.149^{a} ±0.006
G (1) 2.5%	267733.3^{a} ±33282.5	0.809^{ab} ±0.03	5.566^{a} ±0.51	122.7^{a} ±4.04	112.5^{b} ±1.35	1.09^{a} ±0.04
G (2) 5%	255098.3^{a} ±28900.8	0.835^{a} ±0.01	5.93^{a} ±0.61	126.3^{a} ±3.06	113.47^{b} ±3.2	1.114^{a} ±0.05
G (3) 10%	295946^{a} ±23349.7	0.804^{b} ±0.007	5.66^{a} ±0.76	123.7^{a} ±5.03	113.98^{b} ±2.3	1.084^{a} ±0.02

Data are expressed as mean ± SD. Values within the same column having different superscripts are significantly different ($p \leq 0.05$).

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