<u>Original Research Article</u>

Use of Garden Cress (*Lepidium sativum L.*) Seeds to Produce some Healthy Bakery Products

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ABSTRACT

Aims: The aim of this study is the utilization of Garden Cress seeds (*Lepidium sativum L.*) as natural sources of phenols, flavonoids and dietary fiber in salted biscuits

Methodology: Salted biscuits prepared by substitution of wheat flour with 5, 7.5 and 10% of garden cress powder. The biscuits were evaluated for their quality based on proximate analysis, phytochemical content, physical properties and sensory evaluation.

Results: Chemical analysis of garden cress powder showed higher contents of protein, fat, crude fiber and ash (19.17, 21.11, 8.21 and 4.94 g/100 g, respectively) compared to those in wheat flour. It had an increasingly protein and fat contents by increasing the substitution level with garden cress powder. Twenty-one phenolic compounds were identified in garden cress seed extract. Pyrogallol (12545.34 µg/100g) was the main phenolic compound followed by □-hydroxy-benzoic (3838.14µg/100g). Also, nine flavonoid compounds were quantitatively identified in garden cress seeds with hisperidin as the major component (34488.97µg/100g). The overall acceptability and other sensory parameters of the biscuits were affected in different ways by the addition of garden cress powder. Biscuits with 7.5% garden cress powder had the highest scores in all sensory parameters.

Conclusion: Salted biscuits with potential health benefits, good quality and acceptable sensory characteristics can be produced by substituting 7.5% of wheat flour with garden cress powder in the biscuit formula.

Keywords: Garden cress, Salted biscuits, phytochemical, phenolic compounds, flavonoid

1. INTRODUCTION

Garden cress, *Lepidium sativum L.*, is an annual herb, belonging to family Brassicaceae. It is a fast-growing, edible plant which is botanically related to watercress and mustard and sharing their peppery, tangy flavour and aroma. The main advantage of garden cress is its ability to grow in any type of climate and soil condition with few requirements (**Balasubramanian, 2009**). **Sarkar *et al.* (2014)** reported that garden cress seeds is categorized under both nuts and oil seeds. **Gaafar *et al.* (2013)** reported that L. sativum seeds with high nutritional value can be exploited as a functional food ingredient. Also, **Painuli *et al.* (2022)** showed that it is an important edible herb that possesses wide range of therapeutic properties and high nutraceutical potential and can be used in case of malnutrition. Garden cress oil is considered to be fairly stable oil, due to its higher natural antioxidants content (tocopherol, phytosterol, and carotenoids) that protects the oil from rancidity (**Diwakar *et al.,* 2010**).

Antioxidants are important in disease prevention in both plants and animals, inhibiting or delaying the oxidation of biomolecules by preventing the initiation or propagation of oxidizing chain reactions (**Velioglu *et al*., 1998**).

Phytochemicals from plants are being used for the prevention from various diseases mainly caused by free radicals. The higher polyphenol content would then exhibit stronger inhibition of free radicals and also higher antioxidant activity (**Prakasha *et al*., 2001**). The scavenging ability of phenolic compounds is attributed to the hydroxyl groups (**Oktay *et al*., 2003**).

The seeds contain many phytochemical substances responsible for their medicinal properties. The seeds contain lepidine which acts as a diuretic. Imidazole compounds present in seeds are antihypertensive. Glucosinolates, flavonoid compounds and semilepidinoside (a and b) act as anticaricnogenic, antioxidants and antiasthmatic, respectively (**Jain *et al*., 2016**).

Nitric oxide assay, total antioxidant capacity assay, reducing power assay, and hydrogen peroxide scavenging assay of aqueous and ethanolic seed extract of *L. sativum* showed the presence of significant antioxidant activity (**Abdulmalek *et al*., 2021**). Few more studies from different regions confirm that the seed extract of *L. sativum* possesses significant amount of antioxidants and antioxidant activity (**Kumar *et al*., 2020**, **Golkar *et al.,* 2021)**.

Sethiya *et al.,* 2014 reported that gallic acid and protocatechuic acid are phytochemicals that are considered a potential source of functional food ingredients for their high antioxidant capacity.

Total phenolic and flavonoid contents of *L. sativum* leaves of two cultivars (Dadas and Izmir from Turkey) was measured to be 0.573 mg gallic acid equivalent (GAE)/g fresh weight (FW) and 6.332 mg GAE/g DW for Dadas cultivar and 0.774 mg GAE/g FW and 7.401 mg GAE/g DW for Izmir cultivar, respectively (**Sat *et al*., 2013)**. However, the methanolic extract of seeds showed the presence of 0.5% and 0.375% of phenolic and flavonoid contents, respectively [**Kumar *et al.,* 2020**].

Quercetin, a flavonoid found in fruits and vegetables, has unique biological properties that may improve mental/physical performance and reduce infection risk [**Davis *et al.,* 2009**]. These properties form the basis for potential benefits to overall health and disease resistance, including anti-carcinogenic, anti-inflammatory, antiviral, antioxidant, and psychostimulant activities, as well as the ability to inhibit lipid peroxidation, platelet aggregation and capillary permeability, and to stimulate mitochondrial biogenesis [**Aguirre *et al*., 2011**]. Other benefits of quercetin include the anti-dyslipidemic, hypotensive, and anti-diabetic effects in the obese rat model of metabolic syndrome (**Xu *et al*., 2019)**.

The development of new products is a strategic area of the food industry. Producers have to cope-up with nutritional demands and extra health benefits. Regarding the changes in food consuming habits and stressful lifestyles, a healthy digestive system is an important issue which also increase the overall quality of life (**Brouns *et al*., 2002)**. In this study, the utilization of Garden Cress seeds (*Lepidium sativum L.*) as natural sources of phenols, flavonoids and dietary fiber in salted biscuits were investigated.

2. MATERIAL AND METHODS

2.1. MATERIALS

Garden cress seeds were obtained from Cairo University, Pharmaceutical Plant farm. Wheat flour (72% extr.) was obtained from a local wheat mill in Cairo, Egypt. Baking ingredients were purchased from the local market in Cairo, Egypt. Chemicals were of analytical reagent grade.

2.2.1. Preparation of Garden Cress Powder

The seeds were cleaned and rendered free of dust, dirt, foreign materials and broken seeds. Garden cress seed powder was prepared by grinding the seeds (Moulinex A59, France), and then sieving process was conducted using a 60-mesh sieve. Powder obtained was kept in an airtight polyethylene bag.

2.2.2. Preparation of Biscuits

The blends and formula of control biscuit and other suggested formula were made according to the **Wade, 1988** with some modification; the formulas are shown in Table (1).

Table 1: Formula of Biscuits

Ingredient (gm)	Control	5% Garden Cress	7.5% Garden Cress	10% Garden Cress
Wheat flour (72% ext)	100	95	92.5	90
Garden Cress Powder	-	5	7.5	10
Sugar	3	3	3	3
Salt	3	3	3	3
Margarine	25	25	25	25
Baking powder	5	5	5	5
Water	as needed			

The dough was sheeted to a thickness of about 3 mm using Atlas Brand rolling machine. The sheeted dough was cut into round shape using a 45 mm diameter cutter and baked on an aluminum tray in an electric oven at 180°C for 6 minutes. The biscuit was cooled for 30 minutes, packed in polyethylene bags and stored at 4 ±2°C in refrigerator.

2.2.3 Chemical Analysis of Ingredients and Biscuits

Wheat flour, garden cress powder and biscuits were analyzed for protein, ash, fat, crude fiber, TDF according to the methods of **AOAC (2005)**.

Minerals content (i.e. Ca, Fe and Zn) were determined in the diluted solution of ash raw materials and their blends using the atomic absorption spectrophotometer (3300 Perkin-Elmer) as described in by **AOAC (2012)**.

2.2.4 Fractionation of Phenolic and Flavonoid Compounds

A high-performance liquid chromatography system equipped with a variable wave length detector (Agilant, Germany) 1100. Also, the HPLC was equipped with auto sampler, Quaternary pump degasser and column compartment. Analyses were performed on a C18 reverse phase (BDS 5 µm, Labio, Czech Republic) packed stainless-steel column (4×250 mm, i.d.).

To determine phenolic acids, 200 mg of each plant extract was measured into a test tube. Weights of samples were extracted with 10 ml methanol in ultrasonic bath for 45 minutes. Then the samples were centrifuged for 7 minutes at 4200 rpm. The supernatant was filtered through polyamide filter Chromafil AO-45/25, transferred into vial prior analyses prepared according to the method described by **Jakopič *et al.,* 2009**. HPLC method started with linear gradient at a flow rate of 1.0 ml / min with mobile phase of water / acetic acid (98: 2 v/v, solvent A) and methanol / acetonitril (50: 50, v/v, solvent B), starting with 5 % B and increasing B to levels of 30% at 25 min, 40% at 35 min, 52% at 40 min, 70% at 50 min, 100% at 55 min. The initial conditions were re-established by 5 min wash in both solvents. All chromatograms were plotted at 280 nm to estimated phenolic acids. All components were identified and quantified by comparison of peak areas with external standards (**Zuo *et al.,* 2002).**

2.2.4 Physical Characteristics of Biscuits

Biscuits were evaluated for weight (g), thickness (mm), diameter (mm), density (g/cm^3) and spread ratio as described by **Gaines (1991)**. Spread ratio was calculated from the ratio of diameter to thickness and calculated using the following equation: Spread ratio = Diameter / Thickness.

2.2.5 Sensory Evaluation of Biscuits

Biscuit samples were organoleptically evaluated for their sensory characteristics according to the method of **Larmond (1982)**. Samples were scored for colour, flavour, crispiness, texture and overall acceptability by ten panelists.

2.2.6 Statistical analysis

The analytical data were analyzed using SPSS 16.0 software. Means and standard deviations were determined using descriptive statistics. Comparisons between samples were determined using analysis of one-way variance (ANOVA) and multiple range tests. Statistical significance was defined at $P \le 0.05$.

3. RESULTS AND DISCUSSION

3.1. Chemical Composition

Chemical compositions as protein, fat, crude fiber and ash content and were determined in raw materials (wheat flour and garden cress powder) and its composites and the results are reported in Table (2). From the results it could be observed that the garden cress was higher in protein, fat, crude fiber and ash content (19.17, 21.11, 8.21 and 4.94 mg/100g, respectively). Our results agreed with work by **Alshehry, 2019; Shehata, 2021.**

The Chemical composition of salted biscuits prepared by substitution of wheat flour with different levels of garden cress powder was shown in Table (2). Protein content ranged from 8.26 to 8.96 g/100g in control and salted biscuits enriched with 10% garden cress powder. It could be noticed that the protein level slightly increased by increasing the additive with garden cress powder. This trend was observed for fat content, it ranged from 16.77 to 18.37 in the control and salted biscuits enriched with 10% garden cress powder. This could be explained by the high level of fat in garden cress seeds (21.11g/100g) as shown in table (2). Ash content ranged from 0.40 g/100 g to 1.30 g/100 g control and salted biscuits enriched with 10% garden cress seeds. Fiber content was the highest (5.17 g/100 g) in salted biscuits enriched with 10% garden cress seeds and the lowest in control salted biscuits (0.38 g/100 g). This could be explained by the high level of fiber in garden cress seeds (8.21g/100g) as shown in table (2). Our results agree with work by **Gaikwad *et al.,* 2021 and Kharkwal *et al.*, 2021**

DeVries (2001) explained that the dietary fibers in the edible parts of plants are not totally digested in the human digestive system because of its resistance to digestion and absorption in the small intestine and the retained parts fermented in the large intestine. The amount of total dietary fiber in garden cress was higher than that present in wheat flour (40.37 and 2.65%). The insoluble part in garden cress seeds was more than the soluble fiber (35.49 and 6.96 %). Our results agreed with **Gokavi *et al*., 2004.** They reported the total dietary fiber to be 30%, the soluble fiber (1.51%) is highly negligible compared to the insoluble part (28.49%).

WHO, 2003 stated that the total dietary fiber intake should be more than 25g daily. For samples the total dietary fiber increased from (2.16%) for control to (5.17%) for salted biscuits with 10% garden cress seeds, the soluble fiber also increased from (0.76%) for control to (1.81%) for salted biscuits with 10% garden cress seeds. While the insoluble part, significantly increased from (1.40%) for control to (3.36%) for salted biscuits with 10% garden cress seeds. Our results agreed with work by **Alshehry, 2019 and Shehata, 2021.**

Mineral compositions of wheat flour, garden cress and samples are shown also, in Table 2. Iron content is considerably high in garden cress seeds compared with wheat (6.45 and 1.5 mg/100 g). The same is true for calcium

(568.75 and 97.04mg/100 g) and zinc (3.06 and 0.45mg/100 g). Our results agreed with work by **Gaikwad *et al.,* 2021.** For samples, the calcium content increased from 153.92 mg/100 g for control samples to 198.17 mg/100 g for samples with 10% garden cress. As for iron, it increased from 1.21 mg/100 g for control samples to 1.63 mg/100 g for samples with 10% garden cress. The same is true for zinc content which increased from 0.57 mg/100 g for control samples to 0.67 mg/100 g for samples with 10% garden cress. Our results are lower than work by **Alshehry, 2019** and **Shehata, 2021.** The variation in chemical composition of seeds from other researchers work may be due to different growing conditions (such as geographic, seasonal variations, climatic conditions and soil characteristics), and extent of foreign materials, impurities, varieties, different processing and measuring methods (**Taher-Maddah *et al.,* 2012)**.

Table 2: Chemical Composition of Raw Materials and Produced Salted Biscuits

	Wheat	Garden Cress	Samples			
			Control	5%	7.5%	10%
Protein (g/100 g)	10.35	19.17	8.26	8.61	8.80	8.96
Fat (g/100 g)	1.05	21.11	16.77	17.57	17.85	18.37
Crude Fiber (g/100 g)	0.47	8.21	0.38	1.975	4.41	5.17
Ash (g/100 g)	0.49	4.94	0.40	0.83	1.08	1.30
TDF (%)	2.65	42.45	2.16	3.67	4.41	5.17
Soluble DF (%)	1.06	6.960	0.76	1.29	1.55	1.81
Insoluble (%)	1.59	35.49	1.40	2.38	2.86	3.36
Mineral						
Ca (mg/100 g)	97.04	568.75	153.92	176.04	185.82	198.17
Fe (mg/100 g)	1.50	6.45	1.21	1.42	1.53	1.63
Zn (mg/100 g)	0.45	3.06	0.57	0.66	0.71	0.76

Values are means of three replicates ±SD, on dry weight basis.

3.2. Phytochemicals

Results displayed in Table 3 indicate that 21 phenolic compounds have been identified in garden cress seed extract. Pyrogallol (12545.34 µg/100g) was the main phenolic compound followed by □-hydroxy-benzoic (3838.14µg/100g). In addition, **□- Coumaric** was found at the lowest level of 47.02µg/100g as given in same table. The obtained results are in accordance with the same trend reported by Al-**Sayed *et al*., 2019 and El-Salam *et al*. 2019**. **Goli *et al*., 2005** reported that the technique of phenolic isolation, including the methods and type of extracting solvent, depends mainly on the type of phenolic compound and the solvents used. The variation between results of phenolic acid content and antioxidant activity and those of other studies is likely due to the differences in local production area because the production of phenolic compounds is affected by sun light (**Elfalleh *et. al*., 2009**). **Youssif *et al*., 2019** reported that phenolic compounds are suitable for scavenging reactive oxygen species due to their electron giving properties. Their antioxidant effectiveness depends on the stability in different systems, as well as number and position of hydroxyl groups. In numerous in vitro studies, phenolic compounds demonstrated advanced antioxidant activity than antioxidant of vitamins and carotenoids.

Table 3: Phenolic acids profile of whole meal of garden cress seeds by HPLC

(µg/100g)	Garden Cress	Samples			
		Control	5%	7.5%	10%
Gallic	2420.53	360.66	750.00	1270.12	1350.37
Pyrogallol	12545.34	3366.36	4355.41	5063.12	6789.83
4-Aminobenzoic	443.67	78.16	110.07	185.10	220.13
Protocatechuic	2258.35	184.50	262.64	393.96	525.28
Catechein	3758.59	1187.25	1801.19	2101.79	2602.39
Chlorogenic	373.35	142.55	165.91	205.87	237.83
Catechol	922.63	252.49	374.88	462.32	549.76
Caffiene	686.241	24.52	38.24	46.43	69.65
P.oH. benzoic	3838.14	311.52	672.97	1109.45	1645.93
Caffeic	257.39	83.01	95.59	103.38	115.17
Vanillic	624.79	184.55	370.54	560.31	740.08
p-Coumaric	414.31	69.29	78.42	107.63	216.84
Ferulic	178.57	37.48	56.27	92.90	112.53
Iso- ferulic	1059.30	59.36	226.76	340.14	453.52
Ellagic	975.96	154.57	242.44	363.66	584.88
□- Coumaric	47.02	2.21	17.21	25.81	34.41
Benzoic	3572.66	378.79	529.13	793.69	1058.25
Salicylic	2369.11	637.78	970.13	1055.20	1740.27
3,4,5. Methoxy Cinnamic	392.98	58.72	152.24	208.36	244.48
Coumarin	140.47	27.20	45.45	68.18	90.91
Cinnamic	98.66	11.05	18.24	27.36	36.48

Also, Table (4) showed flavonoids compounds profile of garden cress seed was determine by using HPLC. The current research has found that nine flavonoid compounds were quantitatively identified in garden cress seeds extract as shown in Table 4. Hesperidin was the major component (34488.97µg/100g) followed by Narengin (25319.04 µg/100g). Quercetin is another flavonoid that has been identified at reasonable levels and attracted great interest because it is a potent antioxidant with proven anticancer effects. Its structure contains a double bond in the C ring and a 4-oxo group, which enhance its antioxidant activity (**Moskaug *et al*., 2004**). Our results are in line with **El-Salam *et al*., 2019.**

Table 4 Flavonoid compounds of whole meal of garden cress seeds by HPLC

(µg/100g)	Garden Cress	Samples			
		Control	5%	7.5%	10%

Narengin	25319.04	930.45	1109.52	1464.28	1919.04
Rutin	4695.27	322.76	986.33	1479.50	1972.67
Hesperidine	34488.97	1369.06	9321.48	13994.22	18650.96
Quercetrin	1621.38	110.03	577.29	859.94	1140.59
Quercetin	505.26	65.73	128.12	242.18	356.24
Naringenin	35.80	6.08	8.10	12.26	15.35
Hespirtin	280.04	85.08	108.56	137.84	177.12
Kampferol	108.56	29.52	32.13	52.70	71.27
Apigenin	65.99	18.36	21.24	36.86	42.48

3.3. Physical Properties

Physical properties of biscuits are an important feature for both manufacturers and consumers. Table 5 shows the results of the evaluation of biscuits prepared from mixture of wheat flour and garden cress powder, at different levels, for several physical characteristics. Results show a significant increase in the weight of biscuits after the supplementation garden cress powder. The weight of biscuits increased to 9.0, 9.25 and 9.40 g compared to control biscuits (8.85 g). Incorporation of garden cress powder slightly decreased the diameter of biscuits from 63.06 mm to 60.02 mm. The decreasing trend was directly proportional to the increasing level of garden cress powder substitution. The decrease in the diameter of biscuits was suggested, by **Ajila *et al.*, 2008,** to be due to the increase in fiber contents, which in our case is garden cress powder, which is a rich source of fiber (8.21 g/100g) compared with 0.47g/100g for wheat flour 72% ext. Our results agree with work by **Alshehry, 2019.** The thickness of control biscuits and its fortified biscuits was 8.10, 8.05, 8.00, and 7.93 cm, respectively. The same is true for volume of biscuit decreased linearly

The density of biscuits was significantly increased in different substituted biscuits 0.83, 0.88 and 0.94 g/cm^{3}while control biscuits were 0.80 g/cm^3. **Johry *et al.*, 2016** explained the increase by the high water holding capacity of the additive. While **Alshehry, 2019** reported that the increase may be due to the garden cress that gives the porous nature to the biscuits. ~~Whereas, density increased in the similar manner.~~

Table 5: Physical characteristics of biscuits

Treatment	Weight (g)	Diameter (mm)	Volume (cm^3)	Thickness (mm)	Density (g/cm^3)	Specific Volume (cm^3/g)	Spread Ratio (D/T)	Water Activity
Control	8.85±0.05d	63.06±0.01a	11.00±0.05a	8.05±0.04d	0.80±0.09 d	1.24±0.05 a	7.83±0.02 a	0.25±0.01c
Biscuits with 5% Garden Cress	9.00±0.03c	62.19±0.05b	10.82±0.09b	8.31±0.05c	0.83±0.02 c	1.20±0.02 b	7.48±0.03 b	0.37±0.05b
Biscuits with 7.5% Garden Cress	9.25±0.05b	61.02±0.07b	10.50±0.07c	8.80±0.09b	0.88±0.03 b	1.14±0.07 c	6.93±0.05 c	0.39±0.03b

Biscuits with 10% Garden Cress	9.40±0.03a	60.02±0.02d	10.00±0.03d	9.40±0.01a	0.94±0.07 a	1.06±0.05 d	6.39±0.03 d	0.41±0.01a

*Values are means of three replicates ±SD,

The changes in width and thickness are reflected in spread ratio which was calculated from dividing the width (W) by thickness (T) of the biscuit. A significant decrease in spread ratio of biscuits from 7.83 (control) to 6.39 among treatment with the 10% garden cress. Increase in the thickness of biscuits was noticed (Table 5). **Hooda and Jood, 2005** referred the reduction in spread ratio of the cookie to the fact that composite flours form aggregates with high numbers of hydrophilic sites available for competing for the limited free water in cookie dough.

The measurement of water activity has been shown useful for predicting the stability and safety of foods, with respect to microbial growth, deterioration reactions, and chemical and physical properties (**Fontana, 1998**). When compared with the control (0.25), the biscuits with garden cress substitution showed a significant difference in aw (0.37, 0.39 and 0.41). All formulations presented showed values of aw less than 0.50 (**Jay, 2005)**. Our results agree with work by **Thanaa *et al.*, 2019.**

3.4. Sensory Evaluation of Biscuits

The preference for the products, in terms of the sensory parameters was used in assessing the product. Biscuits produced from different percent of garden cress powder were sensory-evaluated and compared with control biscuits (100% wheat flour) (Table 6).

Table 6: Sensory Evaluation of Biscuits

Treatment	Appearance (20)	Taste (20)	Texture (20)	Color (20)	Flavor (20)	Overall (100)
Control	17.25±0.02^{c}	17.25±0.03^{c}	17.98±0.06^{c}	17.55±0.04^{c}	18.02±0.02^{c}	88.05±0.24^{d}
Biscuits with 5% Garden Cress	18.25±0.06^{b}	17.95±0.07^{b}	18.87±0.05^{b}	18.55±0.04^{b}	19.10±0.04^{b}	92.72±0.52^{c}
Biscuits with 7.5% Garden Cress	18.95±0.05^{a}	18.97±0.04^{a}	19.10±0.06^{a}	18.70±0.02^{a}	19.13±0.03^{a}	94.85±0.10^{a}
Biscuits with 10% Garden Cress	18.25±0.06^{b}	18.70±0.02^{a}	18.87±0.05^{b}	18.25±0.04^{a}	19.15±0.04^{a}	93.22±0.52^{b}

*Values are means of ten replicates ±SD.

As shown in Table 6, the overall acceptance and other parameters of the biscuits were affected by the additives. Biscuits with 7.5% garden cress powder had the highest score in all parameters. Such data are in line with **Gaikwad *et al.*, 2021** findings. Therefore, it could be recommended to ~~be~~ produce salted biscuits with good quality and acceptable sensory quality attributes with the addition of 7.5% garden cress powder.

4. CONCLUSION

~~The results were concluded that when increases addition gradually from garden cress powder to prepare biscuits, the acceptability biscuits at least up to 7.5% level to prepare different biscuits. On the basis of the results, it may be concluded that the biscuits can be successful in using garden cress seed powder had contained rich amounts from the nutritional value and vital compounds without found a negative effect on sensory characteristics.~~

The results were concluded that when addition of garden cress powder increases gradually from 5% to 10% to prepare biscuits, the acceptability of prepared biscuits was best up to 7.5% level. On the basis of the results, it may be concluded that nutritionally rich biscuits with vital compounds can be successfully prepared using garden cress seed powder without any negative effect on sensory characteristics.

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