



---

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

Hayat M. N. Afify <sup>a\*</sup>

<sup>a</sup> Department of Bread and Pastry Research, Food Technology Research Institute, Agricultural Research Center, Cairo, Egypt.

## Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

## Article Information

DOI: 10.9734/AFSJ/2022/v21i11592

## Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/91918>

Original Research Article

Received 24 July 2022  
Accepted 27 September 2022  
Published 07 October 2022

---

## 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 p-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” [1]. Sarkar et al. [2] reported that garden cress seeds is categorized under both nuts and oil seeds. Gaafar et al. [3] reported that “*L. sativum* seeds with high nutritional value can be exploited as a functional food ingredient”. Also, Painuli et al. [4] 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 [5].

“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” [6].

“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” [7]. The scavenging ability of phenolic compounds is attributed to the hydroxyl groups [8].

“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 anticarcinogenic, antioxidants and antiasthmatic, respectively” [9].

“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” [10]. “Few more studies from different regions confirm that the seed extract of *L. sativum* possesses significant amount of antioxidants and antioxidant activity” [11,12].

Sethiya et al. [13] 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” [14]. However, the methanolic extract of seeds showed the presence of 0.5% and 0.375% of phenolic and flavonoid contents, respectively [11].

“Quercetin, a flavonoid found in fruits and vegetables, has unique biological properties that may improve mental/physical performance and reduce infection risk” [15]. “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” [16]. Other benefits of quercetin include the anti-dyslipidemic, hypotensive, and anti-diabetic effects in the obese rat model of metabolic syndrome [17].

“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” [18]. 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. MATERIALS AND METHODS

### 2.1 Materials

Garden cress seeds were obtained from Pharmaceutical Plant farm, Cairo University. Wheat flour (72% extr.) and other 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, [19] with some modification; the formulas are shown in Table 1.

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 [20].

Minerals content (i.e. Ca, Fe and Zn) were determined using the atomic absorption spectrophotometer (3300 Perkin-Elmer) as described in by AOAC [21].

### 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. [22]. 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 [23].

### 2.2.5 Physical characteristics of biscuits

Biscuits were evaluated for weight (g), thickness (mm), diameter (mm), density (g/cm<sup>3</sup>) and spread ratio as described by Gaines [24]. Spread ratio was calculated from the ratio of diameter to thickness and calculated using the following equation:

$$\text{Spread ratio} = \text{Diameter} / \text{Thickness}.$$

### 2.2.6 Sensory evaluation of biscuits

Biscuit samples were organoleptically evaluated for their sensory characteristics according to the method of Larmond [25]. Samples were scored for colour, flavour, crispiness, texture and overall acceptability by ten panelists.

**Table 1. Formula of biscuits**

Ingredient (g)	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 for dough development			

### 2.2.7 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  $P \leq 0.05$ .

## 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 agree with work by Alshehry, [26] Shehata, [27].

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/100g to 1.30 g/100g control and salted biscuits enriched with 10% garden cress seeds. Fiber content was the highest (5.17 g/100g) in salted biscuits enriched with 10% garden cress seeds and the lowest in control salted biscuits (0.38 g/100g). This could be explained by the high level of fiber in garden cress seeds (8.21 g/100g) as shown in Table 2. Our results agreed with work by Gaikwad et al. [28] and Kharkwal et al. [29].

DeVries [30] mentioned 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. [31].

WHO, [32] stated that the total dietary fiber intake should be more than 25g daily. For biscuits, the total dietary fiber increased from (2.16%) for control to (5.17%) for produced salted biscuits with 10% garden cress seeds, the soluble fiber also increased from (0.76%) for control to (1.81%) for biscuits with 10% garden cress seeds. While the insoluble part, significantly increased from (1.40%) for control to (3.36%) for biscuits with 10% garden cress seeds. Our results agreed with work by Alshehry, [26] and Shehata, [27].

Mineral composition of wheat flour, garden cress and biscuits are shown also, in Table 2. Iron content is considerably high in garden cress seeds compared with wheat flour (6.45 and 1.5 mg/100 g). The same is true for calcium and zinc which reached (568.75 and 3.06 mg/100 g) compared with (97.04 and 0.45mg/100 g) for wheat flour. Our results agreed with work by Gaikwad et al. [28]. The variation in chemical composition of seeds from other researcher's 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 [33]. For produced salted biscuits, the calcium content increased from 153.92 mg/100 g for control to 198.17 mg/100 g for biscuits with 10% garden cress. As for iron, it increased from 1.21 mg/100 g for control to 1.63 mg/100 g for biscuits with 10% garden cress. The same is true for zinc content which increased from 0.57 mg/100 g for control to 0.67 mg/100 g for biscuits with 10% garden cress. Our results are lower than work by Alshehry, [26] and Shehata, [27].

### 3.2 Phytochemicals

Results displayed in Table 3 indicate that 21 phenolic compounds have been identified in garden cress seed extract. Pyrogallol (12545.34  $\mu\text{g}/100\text{g}$ ) was the main phenolic compound followed by *p*-hydroxy-benzoic (3838.14  $\mu\text{g}/100\text{g}$ ). In addition,  $\alpha$ - Coumaric was found at the lowest level of 47.02 $\mu\text{g}/100\text{g}$  as given in same table. The obtained results are in accordance with the same trend reported by Al-Sayed et al. [34] and El-Salam et al. [35]. Goli et al. [36] 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 [37]. Youssif et al. [38] 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.

Also, Table 4 showed flavonoids compounds profile of garden cress seed was determined 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 Naringin (25319.04 µg/100g). Quercetin is another flavonoid that has been identified at reasonable

**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
<b>Mineral</b>						
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.

**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
Caffeine	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
α-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

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 [39]. Our results are in line with El-Salam et al. [35].

### 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. [40], 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 0.47 g/100g for wheat flour 72% ext. Our results agree with work by Alshehry, [26]. 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<sup>3</sup> while control biscuits were 0.80 g/cm<sup>3</sup>. Johry et al. [41] explained the increase by the high water holding capacity of the additive.

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, [42] 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 [43]. 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 [44]. Our results agree with work by Thanaa et al. [45].

### 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).

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. [28] 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.

**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

**Table 5. Physical characteristics of biscuits**

Treatment	Weight (g)	Diameter (mm)	Volume (cm <sup>3</sup> )	Thickness (mm)	Density (g/cm <sup>3</sup> )	Specific volume (cm <sup>3</sup> /g)	Spread ratio (D/T)	Water activity
<b>Control</b>	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
<b>Biscuits with 5% Garden Cress</b>	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
<b>Biscuits with 7.5% Garden Cress</b>	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
<b>Biscuits with 10% Garden Cress</b>	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,*

**Table 6. Sensory evaluation of biscuits**

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

*\*Values are means of ten replicates ±SD*

#### 4. CONCLUSION

The results 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.

#### COMPETING INTERESTS

Author has declared that no competing interests exist.

#### REFERENCES

- Balasubramanian M. Nutritive value of Indian food. Nat. Inst. Nutr, ICMR, Hyderabad; 2009.
- Sarkar S, Datta S, Ghosh I. Experimental studies on nutritional medicinal role of garden cress seed on animal and human. Int. J. Med. Chem. and Anal. 2014;4:41-45.
- Gaafar AM, Morsi AA, Elghamry HE. Chemical, nutritional and biochemical studies of garden cress protein isolate. Nat. and Sci. 2013;11(2):8-13.
- Painuli S, Quispe C, Herrera-Bravo J, Semwal P, Martorell M, Almarhoon ZM, Seilkhan A, Ydyrys A, Rad JS, Alshehri MM, Daştan SD. Nutraceutical profiling, bioactive composition, and biological applications of *Lepidium sativum* L. Oxidative Medicine and Cellular Longevity; 2022. DOI:https://doi.org/10.1155/2022/2910411.
- Diwakar BT, Dutta PK, Lokesh BR, Naidu KA. Physicochemical properties of garden cress (*Lepidium sativum* L.) Seed Oil. J. Ame. Oil Chem. Soc. 2010;87:539-548.
- Velioglu YS, Mazza L, Gao L, Oomah BD. Antioxidant activity and total phenolics in selected fruits, vegetables and grain products. Journal of Agricultural and Food Chemistry. 1998;46: 4113-4117.
- Prakasha GK, Singh RP, Sakariah KK. Antioxidant activity of grape seeds extracts on peroxidation models in vitro. Food Chem. 2001;73:285-290.
- Oktay M, Ihami G, Kufrevioglu O. Determination of in vitro antioxidant activity of fennel (*Foeniculum vulgare*) seed extracts. Lebens. Wissen. Tech. 2003; 36(2):263-271.
- Jain T, Grover K, Grewal I. Development and sensory evaluation of ready to eat supplementary food using garden cress (*Lepidium sativum*) seeds. Journal of Applied and Natural Science. 2016;8:1501 – 1506.
- Abdulmalek SA, Fessal M, El-Sayed M. Effective amelioration of hepatic inflammation and insulin response in high fat diet-fed rats via regulating AKT/mTOR signaling: Role of *Lepidium sativum* seed extracts. Journal of Ethnopharmacology. 2021;266:113439.
- Kumar V, Tomar V, Ranade SA, Yadav HK, Srivastava M. Phytochemical, antioxidant investigations and fatty acid composition of *Lepidium sativum* seeds. Journal of Environmental Biology. 2020; 41(1):59-65.
- Golkar P, Bakhtiari MA, Bazarganipour M. The effects of nanographene oxide on the morpho-biochemical traits and antioxidant activity of *Lepidium sativum* L. under in vitro salinity stress. Scientia Horticulturae. 2021;288:110301.
- Sethiya N, Trivedi A, Mishra S. The total antioxidant content and radical scavenging investigation on 17 phytochemical from dietary plant sources used globally as functional food. Biomedicine and Preventive Nut. 2014;4(3):439-444.
- Sat IG, Yildirim E, Turan M, Demirbas M. Antioxidant and nutritional characteristics of garden cress (*Lepidium sativum*). Acta Sci. Polonorum-Hort. Cultus. 2013;12:173-179.
- Davis JM, Murphy EA, Carmichael MD. Effects of the dietary flavonoid quercetin upon performance and health. Curr. Sports Med. Rep. 2009;8:206–213. [CrossRef] [PubMed]
- Aguirre L, Arias N, Macarulla MT, Gracia A, Portillo MP. Beneficial effects of quercetin on obesity and diabetes. Open Nutraceuticals J. 2011;4:189–198.
- Xu D, Hu MJ, Wang YQ, Cui YL. Antioxidant activities of quercetin and its complexes for medicinal application. Molecules. 2019;24(6):1123-1138.
- Brouns F, Kettlitz B, Arrigoni E. Resistant starch and the butyrate revolution. Trends Food Sci. Tech. 2002;13:251–261.
- Wade P. Biscuits, cookies and crackers. The principle of craft. Elsevier Applied Science, London. 1988;1.

20. AOAC. Official Methods of Analysis of the Association of Official Analytical Chemists, 18th Edition, Washington DC; 2005.
21. AOAC. Official Method of Analysis. The Association of Official Analytical Chemists, Washington, DC, USA; 2012.
22. Jakopic J, Veberic R, Stampar F. Extraction of phenolic compounds from green walnuts fruits in different solvents. *Acta Agriculturae Slovenica*. 2009; 93(1):11-15.
23. Zuo Y, Chen H, Deng Y. Simultaneous determination of catechins, caffeine and gallic acids in green, oolong and black tea using hplc with a photodiode array detector. *Talanta*. 2002;57:307-316.
24. Gaines CS. Instrumental measurement of the hardness of cookies and crackers. *Cereal Foods World*. 1991;36:989-996.
25. Larmond E. Laboratory methods of sensory evaluation of food. Research branch. Canada Department of Agriculture Publications; 1982.
26. Alshehry, G.A. Technological and sensory characteristics of biscuits fortified with garden cress (*Lepidium sativum*) seeds. *Life Sci. J*. 2019;16(8):28-35.
27. Shehata MM. Quality evaluation of cookies prepared from garden cress seeds and golden berry fruits and its effect on iron deficiency anemia in rats. *Journal of Research in the Field of Specific Education*. 2012;7(34):951-984.
28. Gaikwad VG, Chavan UD, Godase SN, Kotecha PM. Studies on nutritional quality of garden cress seed cookies. *IJCS*. 2021;9(1):1603-1609.
29. Kharkwal N, Prasad R, Kumar S. Physico-chemical characterisation of *Lepidium sativum* (garden cress) GA-1 seed. *Journal of Pharmacognosy and Phytochemistry*. 2021;10(2):1373-1377.
30. DeVries JW. AACC Report: The definition of dietary fiber. *Cereal Foods World*. 2001;46:112-126.
31. Gokavi SS, Malleshi NG, Guo M. Chemical composition of garden cress (*Lepidium sativum*) seeds and its fractions and use of bran as a functional ingredient. *Plant Foods for Human Nutrition*. 2004; 59(3):105-111.
32. WHO (World Health Organization) Diet, nutrition and the prevention of chronic diseases. Report of a joint WHO/FAO expert consultation. WHO Technical Report Series 916; 2003.
33. Taher-Maddah M, Maheri-Sis N, Salamatdoustnobar R, Ahmadzadeh A. Comparing nutritive value of ensiled and dried pomegranate peels for ruminants using in vitro gas production technique. *Annals of Biological Research*, 2012; 3(4):1942-1946.
34. Al-Sayed, Hanan MA, Zidan, Nahla, MA. Abdelaleem utilization of garden cress seeds (*Lepidium sativum* L.) as natural source of protein and dietary fiber in noodles. *International Journal of Pharmaceutical Research & Allied Sciences*. 2019;8(3).
35. El-Salam, A, Kholoud, H, Toliba, A.O, El-Shourbagy, G.A. and El-Nemr, S.E. Chemical and functional properties of garden cress (*Lepidium sativum* L.) seeds powder. *Zagazig Journal of Agricultural Research*. 2019;46(5):1517-1528.
36. Goli AH, Barzegar M, Sahari MA. Antioxidant activity and total phenolic compounds of pistachio (*Pistachia vera*) hull extracts. *Food Chem*. 2005;92:521-525.
37. Elfalleh W, Nasri N, Marzougui N, Thabti I, M'rabet A, Yahya Y, Lachiheb B, Guasmi F, Ferchichi A. Physico-chemical properties and DPPH-ABTS scavenging activity of some local pomegranate (*Punica granatum*) ecotypes. *Int. J. Food Sci. Nutr*. 2009;60(2):197-210.
38. Youssif MR, Hassen SK, Fahim JS. Using of natural antioxidant for preparing pizza. *Current Science International*. 2019;8(4): 852-873.
39. Moskaug J, Carlsen H, Myhrstad M, Blomhoff R. Molecular imaging of the biological effects of quercetin and quercetinrich foods. *Mechanisms of Ageing and Dev*. 2004;125(4):315-324.
40. Ajila CM, Leelavathi K, Prasada Rao, UJS. Improvement of dietary fiber content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. *J Cereal Sci*. 2008;48:319-326.
41. Johry P, Samsher GR, Singh BR, Singh V, Chandra S. Development of cookies from potato flour and their quality evaluation. *South Asian J. Food Technol. Environ*. 2016;2(1):309-312.
42. Hooda S, Jood S. Organoleptic and nutritional evaluation of wheat biscuits supplemented with untreated and treated

- fenugreek flour. Food Chemistry. 2005; 90:427-435.
43. Fontana AJ. Water activity: why it is important for food safety. Paper presented at the proceedings of the First NSF International Conference on Food Safety; 1998.
44. Jay JM. Microbiologia de alimentos (6 ed.): Porto Alegre: Artmed; 2005.
45. Thanaa M. Amer Shams SR. Omima, Hanan A. Hussien. Production and evaluation of gluten free biscuits supplemented with chickpeas and carob. J. Biol. Chem. Environ Sci. 2019;14(3):57-71.

---

© 2022 Afify; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

*The peer review history for this paper can be accessed here:  
<https://www.sdiarticle5.com/review-history/91918>*