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Utilization of Garden Cress Seeds (Lepidium sativum L.) as Natural Source of Protein and Dietary Fiber in Noodles

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ABSTRACT

The objective of this study was to investigate the effect of garden cress (Lepidium sativum L.) seeds on chemical composition, cooking properties of noodle and antioxidant properties. Garden cress (GC) was added to semolina flour at different levels 5, 10, 15 % (w/w), respectively. The chemical composition, cooking properties and sensory values of these samples were studied. The results showed an increasing level of protein, fat, ash, and fiber of garden cress noodles (GCN) by increasing the level of addition of garden cress (GC); while, a decrease of moisture content was noticed. The cooking quality properties of GCN were improved also by an increased level of garden cress (GC). Garden cress is a good source of phenolic acids, flavonoids compound, and unsaturated fatty acids and for these reasons, garden cress is considered as a functional food for due to health and nutritional values and its high content of protein and dietary fiber.

Key words: *Noodles, Lepidium Sativum, Flavonoids, Total Antioxidant.*

INTRODUCTION

The plant seeds are well known for their nutritional and medicinal value. The therapeutic features of plants have attracted world-wide interest about medicinal plants which resulted in novel sources of drugs for wide modern applications [1]. They are also widely used to control various insects [2]. 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 [3]. Grass cress seeds are one of the important medicinal plants which have considerable quantities of fat, minerals, protein, fibers, and phytochemicals playing an important role in many functional beverages and foods.

Lepidium sativum (garden cress) seeds are largely used in Arabic countries for many purposes. Fortification of various food items is one of its different utilizations, due to its different nutritional and medicinal properties. Anti-diarrheal [4], antimicrobial, hypoglycemic, hypotensive, bronchodilator and cardiotonic [5] properties may be due to bioactive compounds in the studying plants like flavonoids. Flavones, flavanones, isoflavones, flavanols, chalcones and anthocyanins are mainly sub-classes in flavonoids compounds, all these compounds are combined to sugars in forms of C-gylcosides and O-glycosides [6].

Lepidium sativum (Garden cress) is an annual herb that is rich in phytochemicals. Total phenolic compounds, one of the phytochemicals, tends to be a natural antioxidant that is responsible for the antioxidant activity of the Garden cress. Furthermore, seeds have additional medicinal properties like aperient, alterative, diuretic, tonic, aphrodisiac, emmenagogue, aperient and carminative properties. Moreover, seeds are used in treating hypertension and renal diseases [7].

The seeds comprise a good amount of protein (23 - 25%) and an almost equal amount of fat. The calcium content of seeds is 317 mg/100g. It also contains an admirable amount of iron (17 - 33 mg/100g) and zinc (4 - 5 mg/100g) and other minerals and vitamins [3, 8]. Since the seeds are rich in macro and micro-nutrients, they have been supplemented in food products to combat malnutrition, anemia and other diseases.

Many supplementation and compensation studies have been conducted on garden cress seeds (protein and fats rich) and its products which really had good results, where garden cress extract or powder can be added in fruits and vegetable juices which are rich in vitamins and minerals but are poor in proteins and fats [9-13].

For many years ago, irradiation processing was well considered as a physical and non-thermal or cold method to preserve foods and food products by exposure of foods to ionizing radiation [14].

FAO (2005) and Hou (2001) reported that about 12% of wheat production in Asia is noodle products due to the lowest cost, easy cooking, and long shelf life [13, 15]. Recently, market statistics indicated that noodles consumption expand rapidly in Europe, South America, and the Middle East in addition to Asia. Instant noodles are the fastest spread product among different types of noodles [16], and Kubomura (1998) expressed the texture of the noodles to be firm, rubbery and smooth [17].

Asian people consider noodles as a staple food. Noodles produced from wheat are divided into two categories based on the contained ingredient [18]. Many studies referred to noodles lack essential nutritional components *i.e.*; vitamins, minerals, and dietary fibers, due to a refinement of wheat flour. So, noodles must be enhanced and compensated with other essential nutrients [19].

The development of new products is a strategic area of the food industry. Consumers have to cope up with food demanding with two main characteristics; dealing with traditional nutritional properties of foods and extra health benefits are expected from its systematic ingestion. These characterized foods are called nutraceutical foods. Regarding the changes in food consuming habits and stressful lifestyles, a healthy digestive system is an important issue which also increaes the overall quality of life [20].

In this study, the utilization of Garden Cress seeds (*Lepidium sativum* L.) as natural sources of protein and dietary fiber in noodles were investigated.

MATERIALS AND METHODS

Materials

Plant material

Lepidium sativum seeds (Fig.1) were obtained from the local Market. Seeds were dried with an oven at (40 ºC) and ground in a mixer to be powder. *Lepidium sativum* seeds powder was used in the preparation of noodles with substitution in 5, 10 and 15% levels. Commercial semolina flour was obtained from Regena Company Al. Sadat, Cairo, Egypt, and salt was purchased from the local market, Cairo, Egypt.

Figure 1. Seeds of garden cress *Lepidium sativum* L.

Methods

Preparation of the Fresh Noodles

Methods of Oh *et al*. (1983) and Collins and Pangloli (1985) were used with some modifications for noodle preparation [21, 22]. Semolina flour 100 g and 2 g salt were mixed with (45 g) water to obtain uniform dough for all samples (control 100% semolina flour) and semolina flour used in noodles preparation was replaced at levels of 5, 10 and 15% all ingredient mixed (in a laboratory dough mixer) with water. After mixing, the dough was kneaded by hand for 1 min and divided to 50 g portions and rested at room temperature (30ºC) in plastic bags. The rested dough was sheeted by wood rolling pin and pressed by passage by the rolls machine. Finally, the dough sheet was cut into 5 mm wide noodles strips. Fresh noodles were dried in a laboratory air oven at 40ºC for 18 h. Then, the samples were cooled enough to reach room temperature, and packed in polyethylene bags for further analysis.

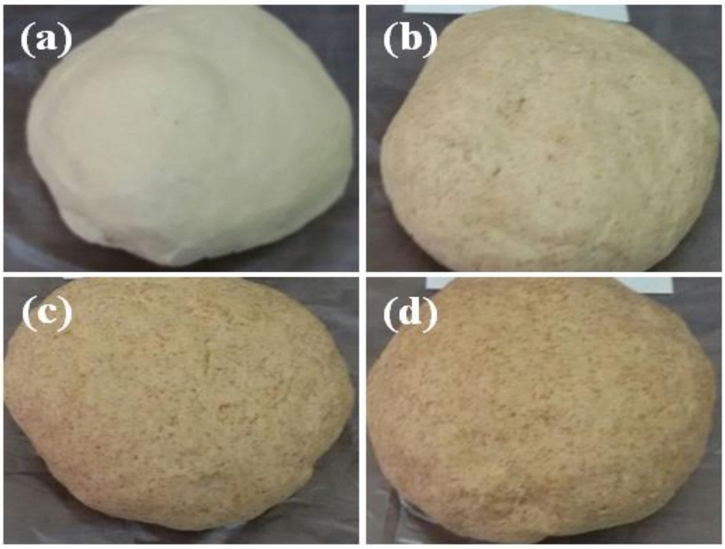

Figure 2. Semolina noodles dough with different addition levels of garden cress; (a) control, (b) 5%, (c) 10% and (d) 15%.

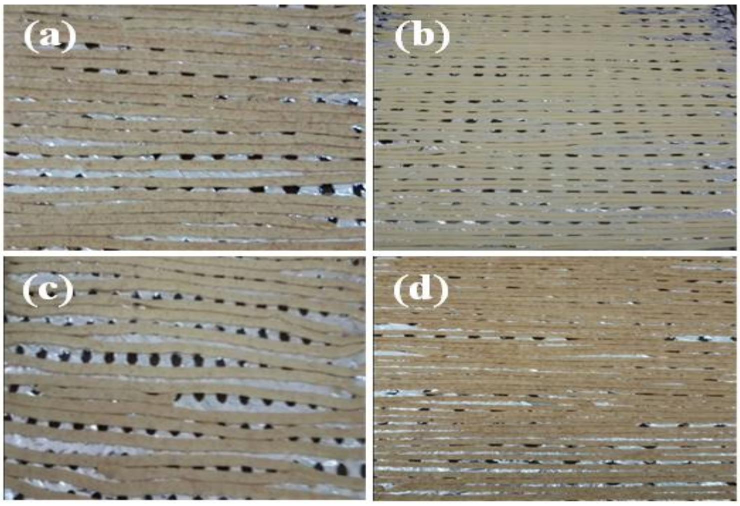

Figure 3. Semolina noodles with different addition levels of garden cress after baking; (a) control, (b) 5%, (c) 10% and (d) 15%

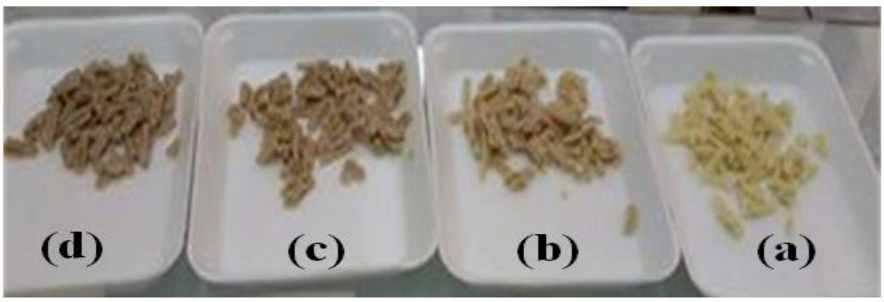

Figure 4. Semolina noodles with different addition levels of garden cress after cooking; (a) control, (b) 5%, (c) 10% and (d) 15%

Analytical methods

Irradiation treatment

Lepidium sativum seeds were irradiated with gamma irradiation at doses of 1.5, 3 and 4.5 kGy using an experimental ^{60}Co Gamma chamber (dose rate 665.6 Gy/h), Cyclotron Project, Nuclear Research Center, Atomic Energy Authority, Egypt.

Microbiological examination method (total bacterial count)

Total bacterial count per 10 gm of garden cress (*Lepidium sativum* L.) either irradiated or un-irradiated was enumerated on a plate count agar as recommended by APHA (1971) [23].

Chemical Composition

Chemical composition of Garden Cress seeds and noodles samples including the content of moisture, protein, fat, fibers and ash contents were determined according to the method described in the AOAC (2000) [24]. Total carbohydrates were calculated by difference according to Pellet and Sossy (1970) [25].

Water and oil absorption capacity

Water absorption capacity (WAC) and oil absorption (OAC) of ground garden cress seeds were determined according to Zhang *et al*. (2005) and Abdul-Hamid and Luan, (2000) respectively [26, 27].

Determination of total phenolic

Total phenolic content of Garden Cress seeds was determined by the Folin- Ciocalteu micro method and total flavonoid contents were expressed using aluminum chloride ($AlCl_3$) colorimetric assay by the method of [28].

Determination of Mineral Contents

Minerals content of seeds of garden cress *Lepidium sativum* including K, P, Ca and Fe (mg/100g) were determined according to the methods described in AOAC (2000) [24].

Cooking and textural quality of noodles

Dried noodles (25.0 g) were cut into small pieces (5.0 cm in length) and boiled in 250 mL of water for 5 min with occasional stirring. The cooking time of noodles was determined by pressing the noodle between two glass plates and the disappearance of the white core was examined with naked eyes. Cooking time is the time taken for the white core to disappear when the noodle strand is boiled in water [29]. The cooked samples were drained for 5 min and immediately weighed. The drained water was collected and the volume was noted. Twenty milliliters of the drained water was transferred to an evaporating dish and dried at 105 °C until a constant weight was attained. Cooking loss (%) was calculated based on the dry weight of noodles [30]. Rehydration or swelling ratio was estimated as the percentage increase in the weight of cooked noodles compared to the weight of dried noodles [31].

Sensory Evaluation

All noodle samples were boiled using tap water for the optimum cooking time. The cooked noodles were subjected to evaluate their appearance, color, flavor, stickiness (texture) and tenderness (mouthfeel) by 10 members' semi-trained preference test panel from the staff of Food Science Department, Faculty of Agriculture, Ain Shams University as described by Matz (1959) [32].

Statistical analysis

Data were expressed as the mean of three replicates. The experimental data were analyzed using Analysis of Variance followed by Duncan, Multiple ranges at ($p \leq 0.05$) using SAS (version 9.1.3). The data were analyzed according to the User Guide of Statistical Analysis System [33].

RESULTS AND DISCUSSION

Most of the herbs, spices and dried vegetables contain numerous microorganisms, these microorganisms cause harmful contamination to introduced foods. Nowadays, irradiation treatments are used to sterilize this kind of food. Consequently, an experiment was conducted to elucidate the effect of gamma irradiation on the total microbial load of the garden cress (*Lepidium sativum* L.). As shown in Figure (5), the total microbial count of un-irradiated garden cress was 2.4 x 10^2 Colony forming unit, cfu/gm. The decrease in the total microbial count was linear as a function of the radiation dose. Thus, the obtained results illustrated that the higher irradiation dose (4.5 kGy) eliminates all microbial contamination of garden cress. 3 kGy was sufficient dose to lower the microbial count up to 0.1 x 10^2 cfu/gm.

Depending on the irradiation dose, the foods may be pasteurized to eliminate or reduce pathogens [34]. Phianphak *et al*. (2007) reported that about 5 to 10 kGy reduced the bacterial vegetative cell to 6 – 7 log-cycle and bacterial spores to 2 – 3 log-cycle [35].

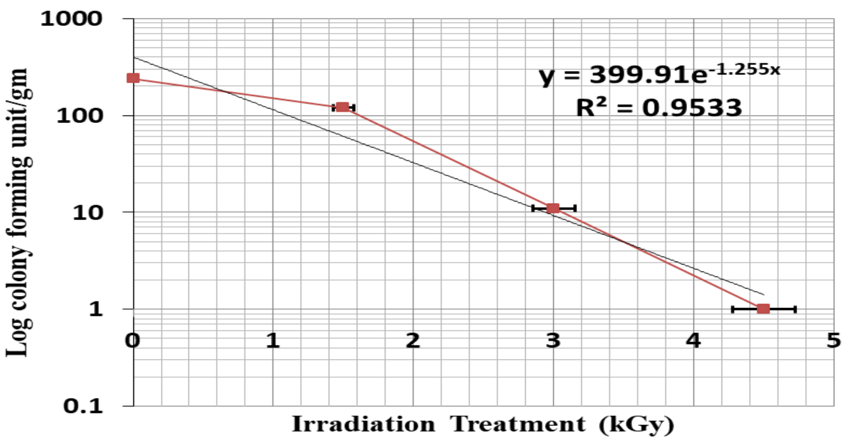

Figure 5. The effect of gamma irradiation doses on the total microbial count (cfu/g) in garden cress (*Lipedium sativum* L.) seeds

The gross chemical composition of the whole meal of garden grass seeds (GC) is presented in Table (1). Moisture, protein, fat, ash, crude fiber and carbohydrates as well as, water absorption capacity oil, and absorption capacity are included. They were 7.61, 22.401, 24.188, 2.985, 14.282, 36.143, 11.207, and 0.726, respectively. Dietary fiber Insoluble was 35.494 (%) but soluble was 6.966 (%). These results agree with Zia-Ul-Haq *et al.* (2012) who found the proximate composition of *L. sativum* seeds indicating the presence of appreciable amounts of protein (24.18 ± 1.54 %), fiber (6.75 ± 1.02 %), lipids (28.03 ± 1.05 %), ash (3.92 ± 1.06 %), moisture (3.92 ± 1.06 %) and carbohydrates (32.87 ± 0.29 %) [36]. The results showed that garden cress leaves contained 7.23 ± 0.09 percent moisture, 14.24 ± 0.38g/100g ash, 23.40 ± 0.36g/100g protein, 6.04 ± 0.18g/100g fiber, 3.09 ± 0.14g/100g fat and energy as 334.33 Kcal per 100g. Hassan *et al*. (2011) studied the nutritional and antinutritional composition of dehydrated garden cress leaves and reported the proximate composition as protein (18.25 %), ash (15.38 %), fiber (9.31%) and energy 312.20 Kcal per 100g [37]. The total and soluble iron content of dehydrated leaves was found to be 75.46 ± 0.13 and 29.38 ± 0.36 mg/100g.

CAC (1998) noted that dietary fibers, 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 [38]. The total dietary fiber intake should be more than 25g daily [39]. Dietary fibers mainly consist of non-starch polysaccharide *i.e.*; cellulose, some hemicellulose, pectins and gums, as well as resistant starch [40].

An additional daily intake of 10 g fiber appeared to lower the risk of coronary death by17% [41, 42].

Table 1. Chemical composition, WAC, OAC and Dietary fiber of garden cress seeds

Constituents	**(%)**
Moisture (%)	7.161
Crude Protein (%)	22.402
Crude Fat (%)	24.188
Ash (%)	2.985
Crude fiber (%)	14.282
Carbohydrates (%)*	36.143
WAC (g H_2O/g) **	11.207
OAC (g oil/g) ***	0.726
Dietary fiber	
Insoluble (%)	35.494
Soluble (%)	6.966
Total (%)	40.375

* Carbohydrates were calculated by difference, ** Water Absorption Capacity, *** Oil Absorption Capacity

Minerals are inorganic materials that are presented in ash after burning foods and living organisms. Minerals content of seeds of garden cress *Lepidium sativum* include K, P, Ca and Fe (mg/100g) included in Table (2). Potassium (K) participates in certain enzyme systems in the body and controls acid balance along with sodium to maintain fluid balance, it was 1215.476 (mg/100g). Phosphorous (P) content was 780.494 mg/100g. Calcium (Ca) is essential for tooth formation and also helps in muscle contraction, maintenance of cell membranes, clotting of blood and normal functioning of nerves, muscles, and heart. There was a declining heart. It participates in the activation of many enzymes, it was 398.549 mg/100g and Iron was 5.091 mg/100g [37].

Table 2. Mineral content (mg/100g) of whole meal of garden cress seeds

Minerals (mg/100 g)	
Potassium (K)	1215.476
Phosphorous (P)	780.494
Calcium (Ca)	398.549
Iron (Fe)	5.091

Table (3) showed total phenolic, flavonoids contents and antioxidant activity of whole meal of garden cress seeds from results, and it could be noticed that total phenolic was 92.670 (mg GAE/g), total flavonoids 11.733 (mg CE/g), antioxidant activity recorded with DPPH 165.963 (mg TE/g), ABTS 179.933 (mg TE/g), and FRAP 159.347 (mg TE/g). Total phenolic compounds are one of the most important materials which have natural antioxidant activity, these materials are responsible for antioxidant properties of vegetable tissues. Garden cress seeds have medicinal properties such as; aperient, tonic, demulcent, carminative, carminative, aperient and diuretic as well as, lowering hypertension and renal disease therapy. All previous properties promoted the garden cress to be used as functional food.

Garden cress seeds, one of the brassicaceous plants, contain both glycosides (sulfur-containing) and glucosinolates. These compounds could be hydrolyzed enzymatically and non-enzymatically, where non-enzymatic hydrolysis form primarily isothiocyanates and/or simple nitriles. Regarding human health, isothiocyanates (mainly, benzyl isothiocyanate BITC) are the most important components due to inducing ability of carcinogen-detoxifying enzymes. Kasabe *et al*. (2012) found that the concentration of total phenolic compounds was 0.021± 0.002 (mg/mg GAE) and DPPH radical scavenging activity of the methanolic extract was 176.18 (μg/ml) [43]. The antioxidant activity of an extract symbolizes its reduced potential and its tendency to neutralize reactive oxygen species (ROS) available in the environment. The *in vitro* study, Yadav *et al*. (2011) found that the antioxidant activity of ethanolic extract of garden cress evaluated as TFC and TPC, were 3.57 mg QE/g and 4.46 mg GAE/g, respectively [44]. While, Indumathy and Aruna (2013) illustrated that the methanolic extract of garden cress measured as radical scavenging activity of both TFC and TPC which contain a noticeable amount of total polyphenols, were 4.023 mg CAE/g and 8.651mg GAE/g, respectively [45].

Ramarathnam *et al.* (1989 a, b) reported that antioxidants are defined as organic molecules that maintained our health by protecting the body's cell from damage by reactive oxygen species and free radicals [46, 47]. Phenolic acids possess to have antioxidant activity due to the carboxylic acid function involved in phenolic rings [48]. In a recent study, the antioxidant activity of *Lepidium sativum* seeds was attributed to the presence of kaempferol and Quercetin, which made the garden cress utilized in folk medicine [49].

Table 3. Total phenolic, flavonoids contents and antioxidant activity of whole meal of garden cress seeds.

Phytochemical analysis	
Total phenolic (mg GAE/g)*	92.670
Total flavonoids (mg CE/g)**	11.733
Antioxidant activity	
DPPH (mg TE/g)***	165.963
ABTS (mg TE/g)	179.933
FRAP (mg TE/g) Total (%)	159.347

* GAE = gallic acid equivalent, ** CE = quercetin equivalent, *** TE = Torolox equivalent

Table (4) shows carotenoids extracted from whole meal of garden cress seeds by HPLC. Lutin content was 4.04 μg/g and β-carotene was recorded as 49.227 μg/g.

Table 4. Carotenoids extracted from whole meal of garden cress seeds by HPLC

Carotenoids	µg/g
Lutin	4.047
Lycopene	ND
B-carotene	49.227

ND = Not Detected

As shown in Table (5) tocopherols extracted and identified from whole meal of garden cress seeds by HP LC. α-tocopherol content was 4.65 µg/g and delta-tocopherol 7.79 µg/g.

Table 5. Identified Tocopherol extracted from whole meal of garden cress seeds by HPLC

Tocopherols	µg/g
γ-tocopherol	105.54
α-tocopherol	4.65
Δ-tocopherol	7.79

In addition, Radwan *et al*. (2007) studied the phytochemical properties of *L. sativum* and they found that these characteristics were attributed to coumarins, glycosides, sulfur, sterols, triterpenes, various imidazole alkaloids, and flavonoids [50]. Isothocyanates, found in plants belonging to the *Brassicaceae* family, have been identified as anticancer as well as, as a potent detoxifying agent in environmental pollution and neutralizing reactive oxygen species. An ethanolic extract of *L. sativum* has a nephron-curative and nephron-protective activity [51] where, it contains essential oils, flavonoids, and isothiocyanate glycosides.

Table (6) showed the phenolic acids profile of the whole meal of garden cress seeds by HPLC they were pyrogallol, gallic, protochatchuic, p-hydroxybenzoic catachine, caffeic, syrngic, ferulic, sinapic, Rrutin and cinnamic. 146.36, 40.30, 60.91, 40.73, 221.27, 6.11, 13.91, 142.20, 4367.15, 18.64 and 10.16 µg/g, respectively. Also, Table (7) showed flavonoids compounds profile of whole meal of garden cress seeds by HPLC. naringeen, rosmarinic , qurcetin, apegnin and kaempferol they were 39.33, 15.96, 7.79, 42.85 and 2.43 µg/g, respectively.

Table 6. Phenolic acids profile of whole meal of garden cress seeds by HPLC

Phenolic acids	(µg/g)
Pyrogallol	146.36
Gallic	40.30
Protochatchuic	60.91
ρ-hydroxybenzoic	40.73
Catachine	221.27
Caffeic	6.11
Syrngic	13.91
Ferulic	142.20
Sinapic	4367.15
Rutin	18.64
Cinnamic	10.16

Table 7. Flavonoid compounds of whole meal of garden cress seeds by HPLC

Flavonoid compounds	(µg/g)
Naringeen	39.33
Rosmarinic	15.96
Qurcetin	7.79
Apegnin	42.85
Kaempferol	2.43

Fatty acids composition of oil extracted from garden cress seeds

Data in Table (8) showed fatty acids composition of oil extracted from ground garden cress seeds. The results reflected 20.12% saturated acids and 79.88% unsaturated acids. The sum of monounsaturated fatty acids was 37.37% and the sum of polyunsaturated fatty acids was 42.51%.

Egypt is the origin of many wild herbs and weeds, garden cress or garden cress pepper weed which is commonly known as a fast-growing annual herb belonging to *Brassicaceae* family. In a nutritional study on garden cress seeds, the proximate analyses of these seeds showed that the fat, protein and dietary fiber content were 27.5%, 22.5% and, 30%, respectively. Moreover, Gopalan *et al*. (2004) mentioned that 18 – 24% fat in garden cress is about 34% of fatty acids linolenic acid [52].

Furthermore, Gokavi *et al*. (2004) and Moser *et al*. (2009) revealed that the fat content of dried garden cress was 22.7%, where the highest fatty acids content were; oleic acid (30.6%) and linolenic acid (29.3%), while the minor fatty acids were palmitic (9.4%), linoleic (7.6%), erucic (3.0%), stearic (2.8%), and arachidic (2.3%) [53, 54]. The ratio of Linoleic acid was approximately 1: 4 – 2: 3, these percentage is good for garden cress which could be used as a functional food [55, 56].

Regarding the highest functional and nutritional value of *L. sativum* (garden cress), garden cress meal and protein isolate can be used as a source of minerals and protein rich in essential amino acids. Bioavailability of both protein isolate and meal as well as its contained dietary fiber has totally been recommended to utilize garden cress as functional foods [57].

Table 8. Fatty acids profile of ground garden cress seeds oil by HPLC

Fatty acids	**(%)**
Palmitic acid (C16:0)	11.48
Stearic acid (C18:0)	3.91
Arachidic acid (C20:0)	4.08
Behenic (C22:0)	0.65
Oleic (C18:1, n-9)	22.62
Eicosanoic (C20:1, n-9)	12.83
Erucic (C22:1, n-9)	1.92
Linoleic (C18:2, n-6)	11.58
Linolenic (C18:3, , n-3)	30.93
Total saturated fatty acids	**20.12**
Total unsaturated fatty acids	**79.88**
Total monounsaturated fatty acids	**37.37**
Total polyunsaturated fatty acids	**42.51**

The Chemical composition of noodles prepared by substitution of semolina with different levels of the whole meal of GCS was shown in Table (9). Moisture content was the highest in control noodles 9.016 and lowest in noodles enriched with 15% GCS was 8.621. Protein content ranged from 11.50 to 13.06 in control and noodles enriched with 15% GCS. It could be noticed that the protein level was increased by increasing the additive with garden cress seeds GCS. Fat content also was increased by increasing the additive with garden cress seeds and it ranged from 1.857 to 5.212 in the control and noodles enriched with 15% GCS. Ash content ranged from 2.303 to 3.292 control and noodles enriched with 15% GCS. Fiber content was the highest in 1.636 noodles enriched with 15% GCS and the lowest in control noodles 0.648. Carbohydrates content was the highest in control noodles and the lowest in noodles enriched with 15% GCS.

Table 9. Chemical composition of noodles prepared by substitution of semolina with different levels of whole meal of garden cress seeds

		Moisture (%)	**Protein (%)**	**Fat (%)**	**Ash (%)**	**Fiber (%)**	**Carbohydrates (%)**
Garden cress substitution	**0%**	9.016^{A}	11.50^{D}	1.857^{D}	2.303^{B}	0.648^{C}	83.69^{A}
	5%	8.894^{A}	12.09^{C}	2.558^{C}	2.707^{AB}	81.33^{B}	1.313^{B}
	10%	8.642^{B}	12.74^{B}	3.626^{B}	3.017^{A}	79.17^{C}	1.432^{AB}
	15%	8.621^{B}	13.06^{A}	5.212^{A}	3.292^{A}	76.80^{D}	1.636^{A}

Means in a column showing the same letter are not significantly different ($P \leq 0.05$).

Regarding cooking loss, which is the main factor in determining cooking quality, the results in Table (10) indicate that optimum cooking time (min) was increased as the levels of noodles fortification, it ranged from 12.83 to 13.83 in control and noodles enriched with 15% GCS, respectively. Weight was increased with an increase of additives of garden cress seeds, it ranged from 148.7 and 170.0 in control and noodles enriched with 15% GCS, respectively. Cooking loss ranged from 5.51 to 7.76 in control noodles and enriched with 15% GCS noodles. Volume increased from 259 to 288.4 in control noodles and enriched with 15% GCS noodles.

Table 10. Cooking quality of noodles prepared by substitution of semolina with different levels of whole meal of garden cress seeds

Garden cress substitution	Optimum cooking time (min)	Weight increase (%)	Cooking loss (%)	Volume increase (%)
0%	12.83^{B}	148.7^{D}	5.513^{C}	259.0^{D}
5 %	13.17^{B}	151.4^{C}	5.520^{C}	266.2^{C}
10%	13.83^{A}	157.8^{B}	6.293^{B}	272.2^{B}
15%	13.83^{A}	170.0^{A}	7.763^{A}	288.4^{A}

Means in a column showing the same letter are not significantly different ($P \leq 0.05$)

Table 11. Means scores of sensory properties of noodles prepared by substitution of semolina with different levels of whole meal of garden cress seeds

Garden cress substitution	Appearance	Color	Flavor	Tenderness	Stickiness	Overall acceptability
0 %	3.8^{A}	3.8^{A}	3.6^{A}	4.6^{A}	2.90^{A}	18.40^{A}
5 %	3.8^{A}	3.6^{AB}	3.3^{A}	4.4^{A}	2.85^{A}	17.95^{A}
10 %	3.6^{A}	3.3^{B}	2.4^{B}	4.2^{AB}	2.95^{A}	16.50^{B}
15 %	2.5^{B}	2.1^{C}	1.9^{C}	3.7^{B}	3.00^{A}	13.20^{C}

Means in a column showing the same letter are not significantly different ($P \leq 0.05$)

Sensory evaluation is the last evaluation of the end product which is done by judges towards the product by rating the liking on a scale. From the results indicated in Table (11), it was observed that appearance ranged from 3.8 to 2.5 in control and 15% GCS noodles. Manley (2002) mentioned that color changing might be due to Maillard reaction (the interaction between reducing sugar and proteins), dextrinization and carmelization [58]. These all natural colors totally affect the appearance.

The color was ranged from 3.8 to 2.1 in control and 15% GCS noodles flavor values ranged from 3.6 to 1.9 in control and 15% GCS noodles. Tenderness values ranged from 4.6 to 3.7 in control and 15% GCS noodles. Stickiness was the highest in 15% GCS noodles and the lowest in control noodles. The taste is a sensation perceived by the tongue and characteristics. In was influenced by the texture, flavor and composition of foods, overall acceptability was determined on the basis of quality scores obtained from the evaluation of color, taste, flavor, texture and crispness of the cookies overall acceptability was the highest in control noodles and lowest in 15% GCS noodles.

CONCLUSION

Based on our findings, a dose of 3 kGy was not only a typical dose for decontaminating garden cress seeds but also keeping the quality and sensory characteristics. Garden cress is a good source of protein, fiber, phenolic acids, and so many nutritional compounds. Noodles supplemented with 15% garden cress raised the protein and fiber concentrations up to 13.06% and 76.80% and the sensory evaluation of noodles fortified with garden cress is generally acceptable.

REFERENCES

1. Ramakrishna, N., Saidulu, Ch. Medicinal Plants Used By Ethnic People of Adilabad District, Andhra Pradesh, India. Int. J. of Pharm. Res. & All. Sci., 2014, 3(2), 51-59.
2. Ojewumi, M.E., Adedokun, S.O., Omodara, O.J., Oyeniyi, E.A., Taiwo, O.S., Ojewumi, E.O. Phytochemical and Antimicrobial Activities of the Leaf Oil Extract of Mentha Spicata and its Efficacy in

Repelling Mosquito. International Journal of Pharmaceutical Research & Allied Sciences, 2017, 6(4), 17-2.

3. 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, 2016a, 8, 1501 – 1506.
4. Merzouki, A., Ed-derfoufi, F., Moleromesa, J., Contribution to the knowledge of Rifian traditional medicine, II: Flok Medicine in ksra lakbir district (INW Moroco). Fitoterapia, 2000, 71, 278 – 307.
5. Edwards, S., Asfaw, Z., Plants used in African traditional medicine as practised in Ethiopia and Uganda. Botany 2000: East and Central Africa Monograph Series Number 5. Published by NAPRECA, Addis Ababa University, Addis Ababa, 1992.
6. Xiao, J. B., Muzashvili, T. S. and Georgiev, M. I., Advance on biotechnology for glycosylation of high-value flavonoids. Biotechnol. Adv., 2014, 32, 1145 – 1156.
7. Patel, U., Kulkarni. M., Undale, V., Bhosale, A., Evaluation of diuretic activity of aqueous and methanol extracts of Lepidium sativum garden cress (Cruciferae) in Rats. Tropical Journal of Pharmaceutical Research, 2009, 8(3), 215 – 219.
8. Jain, T., Grover, K., Kaur, G., Effect of Processing on Nutrients and Fatty Acid Composition of Garden Cress (Lepidium sativum) Seeds. Food Chemistry, 2016b, 213, 806 – 812.
9. Longvah, T., Ananthan, R., Bhaskarachary, K. and Venkaiah, K., "Indian Food Composition Tables National Institute of Nutrition, Indian Council of Medical Research, Ministry of Health and Family Welfare, Government of India, Hyderabad, India, 2017.
10. Angel, M., Devi, K. P. V., Therapeutic impact of garden cress seeds incorporated ladoo among the selected anaemic adolescent girls (12-15 years). Journal of Drug Delivery and Therapeutics, 2015, 3(25), 18 – 22.
11. Lohekar, A. S., Arya, A. B., Development of value added instant 'dhokla' mix. International Journal of Food and Nutritional Sciences, 2014, 3(4), 78 – 83.
12. Bhuiyan, M. H. R., Shams-Ud-Din, M., Islam, M. N., Development of functional beverage based on taste preference. Journal of Environmental Science and Natural Resources., 2012, 5(1), 83 – 87.
13. FAO, Food and Agriculture Organization, Agricultural statistics databases: Crop production, 2005.
14. Antonio, A.L., Carocho, M., Bento, A., Quintana, B., Luisa Botelho, M. and Ferreira, I.C., Effects of gamma radiation on the biological, physico-chemical, nutritional and antioxidant parameters of chestnuts – A review. Food and Chemical Toxicology, 2012, 50, 3234 – 3242.
15. Hou, G., Oriental noodles. Advances in Food and Nutrition Research, 2001, 43, 143 – 193.
16. Rho, K. L., Seib, P. A., Chung, O. K., Chung, D. S., Retardation of rancidity in deep-fried instant noodles (Ramyon). J. American Oil Chem. Soci., 1986, 63, 251 – 256.
17. Kubomura, K., Instant noodles in Japan. Cereal Foods World, 1998, 43, 194 – 197.
18. Martin, J. M., Beecher, B., Giroux, M. J., White salted noodle characteristics from transgenic isolines of wheat over expressing puroindolines. J. Cereal Sci., 2008, 48, 800 – 807.
19. Choo, C. L., Aziz, N. A. A., Effects of banana flour and β-glucan on the nutritional and sensory evaluation of noodles. Food Chemistry, 2010, 119(1), 34 – 40.
20. Brouns, F., Kettlitz, B., Arrigoni, E., Resistant starch and the butyrate revolution. Trends Food Sci. Tech., 2002, 13, 251 – 261.
21. Oh, N. H., Seib, P. A., Deyoe, C. W., Ward, A. B., Noodles. I. Measuring the textural characteristics of cooked noodles. Cereal Chem., 1983, 60, 433 – 438.
22. Collins, J. L., Pangloli, P., Chemical, physical and sensory attributes of noodles with added sweetpotato and soy flour. Journal of Food Science, 1985, 62(3), 662 – 625.
23. APHA, American Public Health Association. Recommended methods for the microbiological examination of foods." Amer. Public Health Association, Inc., New York, 1971.
24. AOAC, Official methods of analysis of AOAC. International 17th edition; Gaithersburg, MD, USA Association of Analytical Communities, 2000.
25. Pellet, P. I. and Sossy, S., Food Composition Tables for Use in the Middle East. American University of Beirut. Beirut – Lebanon. 1970.
26. Zhang, P., Whistler, R. L., BeMiller, J. N., Hamaker, B. R., Banana starch: production, physicochemical properties, and digestibility - A review. Carbohydrate Polymers, 2005, 59(4), 443 – 458.

27. Abdul-Hamid, A., Luan, Y. S., Functional properties of dietary fiber from defatted rice bran. Food Chem., 2000, 68, 15 – 19.
28. Žilić, S., Serpen, A., Akillioğlu, G., Janković, M., Gökmen, V., Distributions of phenolic compounds, yellow pigments and oxidative enzymes in wheat grains and their relation to antioxidant capacity of bran and debranned flour. J. Cereal Sci., 2012, 56, 652 – 658.
29. Chen, H., Lin, Y., Hsieh, C., Evaluation of antioxidant activity of aqueous extract of some selected nutraceutical herbs. Food Chemistry, 1998, 104, 1418 – 1424.
30. SLS, Sri Lankan Standards (SLS) 858. Specifications for Rice Noodles (Rice Vermicelli). Sri Lanka Standards Institution, Colombo 08. 1989.
31. Suhendro, E. L., Kunetz, C. F., McDonough, C. M., Rooney, L. W., and Waniska, R. D., Cooking characteristics and quality of noodles from sorghum. Cereal Chemistry, 2000, 77(2), 96 – 100.
32. Matz, S. A., The Chemistry and Technology of Cereal as Food and Feed. pp. 23-28. AVICO., Inc., Westport, Conn. USA. men and women: a 12-year prospective study. Am. J. Epidemiol., 1959, 126, 1093 – 1102.
33. SAS, Statistical Analysis System. SAS User's Guide Release 6.04, Edition Statistics SAS Institute. Inc. Editors, Cary, NC, USA. 2004.
34. Olson, D. G., Irradiation of food. Food Technology, 1998, 52 (1), 56 – 62.
35. Phianphak, W., Rengpipat, S., Cherdshewasart, W., Gamma irradiation versus microbial contamination of Thai medicinal herbs. Songklanakarin Journal of Science and Technology, 2007, 29, 157 – 166.
36. Zia-Ul-Haq, M., Ahmad, S., Calani, L., Mazzeo, T., Del Rio, D., Pellegrini, N., Feo, V. D., Compositional study and antioxidant potential of Ipomoea hederacea Jacq. and Lepidium sativum L. seeds. Molecules, 2012, 17, 10306 – 10321.
37. Hassan, L. G., Hassan, S. W., Hashim, T., Umar, K.J., Sani, N.A., Determination of nutritive values of garden cress (Lepidium Sativum L.) leaves. Bayero J. Appl Sci., 2011, 4, 18 – 23.
38. CAC, (Codex Alimentarius Commission), Codex Alimentarius: Food Labeling Complete Texts. FAO/WHO, Rome, 1998.
39. 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.
40. DeVries, J. W., AACC Report: The definition of dietary fiber. Cereal Foods World, 2001, 46, 112 – 126.
41. Morris, J. N., Marr, J. W., Clayton, D. G., Diet and heart: a postscript. Br. Med. J., 1997, 2, 1307 – 1314.
42. Khaw, K. T., Barrett, C. E., Dietary fiber and reduced ischemic heart disease mortality rates in men and women: a 12 year prospective study. Am. J. Epidemiol., 1987, 126(6), 1093 – 1102.
43. Kasabe, P. J., Patil, P. N., Kamble, D. D., Dandge, P. B., Nutritional, elemental analysis and antioxidant activity of garden cress (Lepidium sativum L.) seeds. International Journal of Pharmacy and Pharmaceutical Sciences, 2012, 4(3), 392 – 395.
44. Yadav, Y. C., Srivastava, D. N., Saini, V., Seth, A. K., Ghelani, T. K., Malik, A. and Kumar, S., An International Journal of Pharmaceutical Sciences, 2011, 2(3), 244 - 253.
45. Indumathy, R., Aruna. A., Free radical scavenging activities, total phenolic and flavonoid content of Lepidium sativum (Linn.). International Journal of Pharmacy and Pharmaceutical Sciences, 2013, 5(4), 634 – 637.
46. Ramarathnam, N., Osawa, T., Namiki, M., Kawakishi, S., Chemical studies on novel rice hull antioxidants. 2. Identification of isovitexin, a C-glycosyl flavonoid. J. Agric. Food Chem., 1989a, 37, 316 – 319.
47. Ramarathnam, N., Osawa, T., Namiki, M., Kawakishi, S., Studies on changes in fatty acid composition and content of endogenous antioxidants during γ-irradiation of rice seeds. J. Am. Oil Chem. Soc., 1989b, 66, 105 – 108.
48. Goufo, P., Falco, V., Brites, C., Wessel, D. F., Kratz, S., Rosa, E. A. S., Carranca, C., Trindade, H., Effect of elevated carbon dioxide concentration on rice quality: nutritive value, color, milling, cooking, and eating qualities. Cereal Chemistry, 2014b, 91(5), 513 – 521.
49. Ait-yahia, O., Perreau, F., Bouzroura, S. A., Benmalek, Y., Dob, T., Belkebir, A., Chemical composition and biological activities of n-butanol extract of Lepidium sativum L. (Brassicaceae) seed. Tropical Journal of Pharmaceutical Research, 2018, 17(5), 891 – 896.

50. Radwan, H. M., El-Missiry, M.M., Al-Said, W.M., Ismail, A.S., Abdel Shafeek, Seif-El-Nasr, M. M., Investigation of the glucosinolates of Lepidium sativum growing in Egypt and their biologicalactivity. Res. J. Medicine Med. Sci., 2007, 2, 127 – 132.
51. Yadav, Y. C., Srivastav, D. N., Seth, A. K. and Saini, V., Nephroprotective and curative activity of Lepidium sativum L. seeds in albino rats using cisplatin induced acute renal failure. Der Pharma Chemica, 2010, 2(4), 57 – 64.
52. Gopalan, C., Rama S. B. V., Balasubramanian, S. C., Nutritive value of Indian foods", Printed by National Institute of Nutrition, Indian Council of Medical Research, Hyderabad-500 007, India, 2004, 2 - 58.
53. Gokavi, S. S., Malleshi, N. G., Guo, M., Chemical composition of garden cress (Lepidium sativumL.) seeds and its fractions and use of bran as a functional ingredient. Plant. Food, Hum. Nutr., 2004, 59, 105 – 111.
54. Moser, B. R., Shah, S. N., Winkler-Moser, J. K., Vaughn, S. F., Evangelista, R. L., Composition and physical properties of cress (Lepidium sativum L.) and field pennycress (Thlaspi arvense L.) oils," Industrial Crops and Products, 2009, 30(2), 199 – 205.
55. Mathews, S., Singhal, R. S., Kulkarni, P. R., Some physicochemical characteristics of Lepidium sativum (haliv) seeds. Journal of Biological Chemistry, 1993, 202, 675 – 682.
56. Sumangala, S.G., Nagappa, G. M. and Mingruo, G., Chemical composition of Garden cress (Lepidium Sativum) seeds and its reactions and use of bran as a functional ingredient. Plant Foods for Human Nutrition, 2004, 59(3), 105 – 111.
57. Gaafar, M.A., Morsi, A. A., Elghamry, E. Heba., Chemical, nutritional and biochemical studies of garden cress protein isolate. Nature and Science, 2013, 11, 8 – 13.
58. Manley, D., Technology of Biscuits, Crackers and Cookies, 3rd ed. Woodhead Pub. Ltd., Cambridge, 2002.