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The Influence of Dry Roasting Process on Chemical and Nutritional Properties of Garden Cress Seeds Flour

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Abstract: The garden cress seeds were subjected to dry roasting process. Changes in chemical and nutritional quality properties after roasting process were investigated. The results showed that cress seeds are good source of nutrients, such as oil, protein, carbohydrates, in addition to β-carotene, lycopene, phenolic and flavonoids compounds. Chemical composition of the studied seeds flour was significantly ($P<0.05$) affected by the roasting process. The roasting process resulted in a decrease in moisture, protein, vitamin C contents; however, the content of ash, oil, lycopene and total flavonoids was increased. The abundant minerals in the unprocessed seed flour were phosphorus and calcium. Whereas the contents of magnesium increased after roasting, iron content was decreased. Moreover, the flour obtained from seeds after roasting process was used to manufacture water biscuits; and the overall acceptability of these biscuits did not show significant differences between these biscuits and control (100% wheat flour). Indeed, it could be suggested that dry roasting can be used as processing method for production of roasted cress seeds flour with good edible and nutritional quality to be used as dietary supplement.

Keywords: Roasting process, Garden cress seeds, Phenolic compounds, Flavonoids, Spread ratio, Sensory evaluation

I. INTRODUCTION

Garden cress (*Lepidium sativum L.*), is an edible herb, in Egypt it is called Hab El-Rchad. Actually, *Lepidium sativum L.* belongs to the *Brassicaceae* family, and it has been known centuries ago for their medicinal values **(Ait-Yahia et al., 2015).** Garden cress seed and its leaves are used in various food preparations. It is also used as house hold remedy to treat some health problems. Plant seed, leaves and roots, all these parts possess economic importance. Moreover, garden cress seeds are oval in shape and it has a dark brownish color **(Dannehl et al., 2012; Sumangala et al., 2004).** The garden cress seed comprising of 80–85% endosperm, 12–17% seed coat and 2–3% embryo. Seed contain 22-25% protein, 14-27% lipids, 33-54% carbohydrates, 8% crude fiber, 100mg/100g iron, 0.59mg/100g thiamine, 0.61mg/100g riboflavin, 14.3mg/100g niacin which can combat anemia, malnutrition and other micronutrient deficiencies **(Dannehl et al., 2012; Gopalan et al., 2011**). It is a good source of calcium (377 mg/100g) and magnesium (430mg/100g) which helps in normal contraction of muscle for healthy movements of limbs and heart. Actually, it seems like garden cress seeds are packed with power of nutrients (**Divanji *et al*., 2012; Doke and Guha, 2014; Kasabe *et al*., 2012; Mahassni and Al-Reemi 2013).**
Phytochemical studies of *Lepidium sativum* seeds have revealed the presence of phenolic compounds, alkaloids, flavonoids, glycosides, glucosinolates, sterols, tannins and triterpene as the most important phytochemical constituents **(Ghante et al., 2011).** It have been reported that phytochemicals which are considered as secondary metabolites components are directly responsible for activity such as antioxidant, antimicrobial, antifungal, anticancer, anti-inflammatory among others (**Bahrami et al., 2016; Raish et al., 2016)**. Moreover, **Diwakar et al. (2010)** showed that garden cress seeds contain tocopherols (alpha, gamma and Sigma) and carotenoids (β –Carotene, Zeaxanthin and Lutein). On the other hand, it was reported that mucilage of Garden cress seed exhibited better emulsifying property than gum acacia **(Dannehl et al., 2012; Raval et al., 2013);** While **Karazhiyan et al. (2009)** reported that the Garden cress seed gum consists of many different sugar residues like mannose (38.9 %), arabinose (19.4%) and galactouronic acid (8 %), with a total dietary fiber (TDF) content (up to 77 %).
The oven roasting and other roasting methods are used as a pretreatment for improve the yield of oil from oilseeds. The roasting of garden cress imparts a characteristic flavor, color, texture and overall acceptability of the product. The quality of roasted oilseeds depends on roasting conditions (temperature/time), which further influences the quality of the finished products **(Ramos et al., 2017: Mulla et al., 2018).**

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Actually, **Singh et al. (2015)** referred to the garden cress seeds as functional food due its nutritional and functional properties. While **Deshmukh et al. (2017)** fortified cookies with garden cress seed bran to improve nutritional and functional characteristics of cookies, **Doke et al. (2018)** made sensory acceptable, nutritious, and crunchy ready-to-eat sweet snack by using garden cress seeds. Moreover, when biscuits are used as long shelf-life substitutes, it can be called crackers. Indeed, water biscuits (as a very basic form of laminated cracker) had a lower water content during making the dough (the dough is harder also) than cream or soda crackers. Besides, the eating quality is much harder and crisper **(Manley 2001).**
The aim of our investigation was study the effect of roasting on the nutritional, technological quality of garden cress seeds and its crackers. Gross chemical composition, minerals, ascorbic acid, beta carotene, total phenolic, total flavonoids contents were analyzed in studied samples.

II. MATERIALS AND METHODS

Materials

The garden cress seeds used in this research were purchased from the local super market.

Methods

Preparation of Garden Cress seeds

- Roasting process: Seeds were roasted at 160 °C for 5, 10 and 15 minutes using a high-temperature oven, then milled in a laboratory mill to obtain the whole flour, and then stored at 4°C until analyzed.
- Extraction of seed mucilage:The mucilage of garden cress seeds were extracted according to **Karazhiyan et al. (2011)**. The names of samples were abbreviated as illustrated in Table (1).

Table (1): The samples code.

Code of sample	Samples
Raw	Garden cress whole flour without any treatment prior to milling
R5min	Garden cress whole flour after roasting seeds at 160 °C for 5 minutes prior to milling
R10min	Garden cress whole flour after roasting seeds at 160 °C for 10 minutes prior to milling
R15min	Garden cress whole flour after roasting seeds at 160 °C for 15 minutes prior to milling
RawM	Garden cress mucilage which extracted from seeds without any treatment
R5minM	Garden cress mucilage which extracted after roasting seeds at 160 °C for 5 minutes
R10minM	Garden cress mucilage which extracted after roasting seeds at 160 °C for 10 minutes
R15minM	Garden cress mucilage which extracted after roasting seeds at 160 °C for 15 minutes

Proximate composition analysis

Chemical composition: Moisture, crude protein, crude oil and ash were determined as described in the **AOAC (2000)** Methods. While total carbohydrates were calculated according to **Pellet** and **Sossy (1970**) by difference, the caloric value was calculated according to **Livesy, (1995)**. Triplicate determinations were carried out for each sample and the means were reported.
Determination of minerals content: Contents of Ca, Mg, Fe, Zn, Cu and Mn in the studied samples were determined by iCAP6200 (ICP-OES) Inductively Coupled Plasma Emission Spectrometry (**Isaac and Johnson 1985**). Na and K contents were determined by a flame photometer corning 400; while P content was determined by spectrophotometer (**Jackson, 1967**) after wet ashing by method described in **AOAC (2000).**
Determination of total polyphenols: The total polyphenols content of samples was determined using modified Folin-Ciocâlteu colorimetric method (**Singleton et al., 1999**), and the results were expressed as milligram of gallic acid equivalents/100 g sample (mg GAE/ 100 g sample).
Determination of total Flavonoids: The aluminium chloride colorimetric assay was used for flavonoids determination, as described by **Marinova et al., (2005)**. First, the extraction of flavonoids from the samples (n=3) was achieved by homogenizing 2.00 g of the sample in 50 mL distilled water. Then, the mixture was transferred into a rotary shaker for 12 h to ensure full extraction. Thereafter, the mixture was filtered and the filtrate (extract) made up to 50 mL. Precisely, 1 ml of extracts or standard solution of catechin (20, 40, 60, 80 and 100 mg/ L) was added to test tubes containing 4 ml of redistilled water. Then, 0.3 ml of 5% $NaNO_2$ was added to this mixture. After 5 min, 0.3 ml 10% $AlCl_3$ was added. Immediately, 2 ml NaOH (1M) was added and the total volume was made up to 10 ml with redistilled water. After that, the solution was mixed thoroughly and the absorbance of both blank and standard was read at 510 nm using UV–Visible spectrophotometer Model UV 1601 version 2.40 (Shimadzu). Total flavonoids content was expressed as mg catechin equivalents (mg catechin/100g sample D.w).

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Detrmination of lycopene and ascorbic acid: Lycopene content of samples extract was determined using a colorimetric method by **Rao *et al.*, (1998).** As Lycopene extracted from samples with solvents mixture hexane, methanol, and acetone (2:1:1) for 1h. Then the absorbance of the extracts was measured at 502 nm using spectrophotometer. Ascorbic acid was determined according to the method described by **Sahlin *et al.*, (2004).** The results were expressed as mg/100 g dry weight (D.W.).

Determination of β- carotene by HPLC: β-carotene was determined according to the method of **Tee and Lim (1991)**. As 5g sample was hydrolyzed with 20 ml of 95% (v/v) ethanol (HPLC grade) and 5 ml of 100% KOH, then the mixture was refluxed for 30 min. For drying purposes the extracted hydrolysate by n-hexane was passed through anhydrous sodium sulphate. The extraction was repeated three times. Extracted samples were then filtered through 0.45µm nylon membrane filter (Whatman, Maidstone, England) and analysed using a reversed phase HPLC using µ Banda Pak C18 (3.9 x 300 mm) column and the used mobile phase was acetonitrile-methanol-ethyl acetate (88:10:2). An UV-Visible detector attached to the 600 controller model HPLC (Waters, Milford, MA, USA) was used to detected and quantified β-carotene eluted. The retention time (rt) and peak areas of appropriate standard (β-carotene) was used to identify and quantify the isolated β-carotene.

Evaluation of Flow properties of extracted seed mucilage: Bulk and Tapped Densities were determined according to **Lachman and Liberman (1991); Aulton (2007); Thube et al. (2011)**; while Carr's Index and Hausner's Ratio were estimated according to **Efentakis et al. (2001).** On the other hand, Compressibility index, swelling ratio **(Bhatia et al., 2014);** and water retention capacity **(Kilor and Bramhe, 2014)** were determined in extracted seed mucilage.

Water biscuits preparation: The water biscuits were prepared according to procedure of **Manley (2001).**

Physical chracteristics of water biscuits: Thickness (cm), width (cm), spread factor and spread ratio were estimated in five biscuits and averages were reported. Spread ratio and spread factor were calculated according to ***Rao and Manohar (1997*)** as follow: Spread ratio $=\frac{\text{Width}}{\text{Hight}}$;

Spread factor $=\frac{\text{spread ratio of sample}}{\text{spread ratio of control}} \times 100$

Sensory evaluation: Sensory evaluation was conducted using 10 semi-trained panellists who were asked to score colour, flavour, texture, tast and overall acceptability on 9-point hedonic scales (1 = dislike extremely, 9 = like extremely) **(Amerine et al., 1965).**

Statistical analysis

The data of study were analyzed statistically with analysis of variance (ANOVA) Procedures, which SAS Statistical Software Package v.9.2 (**SAS, 2008**) was used. Differences between averages were compared by LSD (least significant difference) at 5% level of significant **(Gomez and Gomez, 1984).**

III. RESULTS AND DISCUSSION

Chemical composition of garden cress samples

Chemical composition of garden cress samples are shown in Table 2. The moisture content of raw garden cress whole flour was 8.47%, which dropped significantly (P<0.05) to 3.51%, 1.85%, 1.40% after roasting for 5, 10 and 15 min.; respectively. The ash, oil, protein and crude fiber contents of the control sample were 4.69%, 26.09%, 22.41% and 7.92%, respectively; roasting did not change significantly (P<0.05) these parameters, but the ash and oil contents was increased in roasted samples comparing with raw sample. The total carbohydrate was ranged from 37.44% to 39.81% for the studied samples. The caloric value was increased significantly (P<0.05) in roasted samples as a result of roasting, which ranged from 481.47 to 488.31 kcal/100g. Roasting of garden cress seeds caused evaporation of moisture which affected on the composition of parameters via increased or decreased. Our results for chemical composition were in agreement with **Gopalan et al., (2011) and Dannehl et al., (2012)**.

Table (2): Chemical composition of Garden cress samples

Samples	Moisture	Ash*	Oil*	Protein*	Crude fiber*	Total carbohydrates*	The caloric value (Kcal/100g)
Raw	8.47	4.69	26.09	22.41	7.92	38.89	480.01
R 5 min	3.51	5.12	26.75	20.37	7.95	39.81	481.47
R 10 min	1.85	5.25	27.39	21.84	6.91	38.61	488.31
R 15 min	1.40	5.29	27.08	22.00	8.19	37.44	481.48
LSD 0.05	0.32	3.72	4.92	4.96	2.98	5.43	0.11
**Results calculated on dry weight basis*							

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Mineral composition of garden cress samples

The contents of minerals in raw and roasted samples are presented in Table 3. There were significant (P<0.05) differences between samples for K, P, Ca, Na and Mg contents. K content was ranged from 1185.54 to 1685.67 mg/100g for garden cress samples. The P and Ca contents were decreased in roasted samples with values 520.83-605.65 and 188.54-215.83 mg/100g, respectively when compared with raw sample. The high K, P, Ca, Na and Mg content of the studied samples confirming that these samples may be used for helping human to obtain the daily requirements from some minerals. The results also revealed that mineral analysis shows high content of K and low content of Na in studied samples which make it beneficial against high blood pressure and also can be recommended to athletes **(Dannehl et al., (2012); Mahassni and Al-Reemi (2013)).** On the other hand, the Fe, Zn, Cu and Mn contents did not change significantly (P<0.05) in the roasted samples with reasonable quantities via increased or decreased comparing with control.

Table (3): Mineral composition (mg/100 dry weight) of garden cress samples.

Samples	K	P	Ca	Na	Mg	Fe	Zn	Cu	Mn
Raw	1486.86	721.14	265.21	135.29	125.19	9.76	4.19	1.35	1.03
R 5 min	1685.67	595.78	201.39	146.79	121.80	8.77	3.76	2.12	1.01
R 10 min	1667.68	520.83	188.54	157.14	126.32	8.97	4.46	3.61	1.09
R 15 min	1185.54	605.65	215.83	132.99	137.40	7.18	4.85	4.20	1.21
LSD 0.05	0.23	0.19	0.21	0.68	0.40	4.86	8.59	2.27	2.69

Phytochemical components of garden cress seeds

The vitamin C, β-carotene, lycopene, total phenolics and total flavonoids contents of garden cress samples are presented in Table 4. The results revealed that roasting of garden cress seeds caused significant (P<0.05) changes in all the parameters in Table 4 for roasted samples comparing with untreated sample. Vitamin C and total flavonoids were decreased significantly (P<0.05) in roasted samples. On the other hand, lycopene and total phenolics were increased significantly (P<0.05) in roasted samples when comparing with raw sample. For β-carotene the R5min sample was the highest (0.51) among the other samples, while the R15min was the lowest one (0.29) comparing with raw sample (0.42 mg β-carotene/100g). It is obviously that roasting causing a liberation, decomposition of some compounds as a result of heat or conversion between isomers which resulted increasing or decreasing in contents of phytochemical components. Several reports are available on flavonoid groups which exhibited high potential biological activities such as antioxidant, anti-inflammatory, antimicrobial, anti-angionic, anticancer and anti-allergic reactions **(Dannehl et al. 2012; Sat et al., 2013).**

Table (4): Phytochemical components* of garden cress samples**.**

Sample	Vitamin C (mg vit. C/100g)	B-carotene (mg Bcarotene/100g)	Lycopene (mg lycopene/100g)	Total phenolics (mg GAE/100g)	Total flavonoids (mg catechin/100g)
Raw	15.75	0.42	0.30	460.57	383.10
R 5 min	11.47	0.51	0.41	481.58	345.69
R 10 min	9.86	0.36	0.58	479.27	372.41
R 15 min	5.12	0.29	0.71	468.58	326.99
LSD 0.05	1.68	0.11	0.15	2.38	9.53
**Results calculated on dry weight basis*					

Garden cress seeds mucilage

Yield

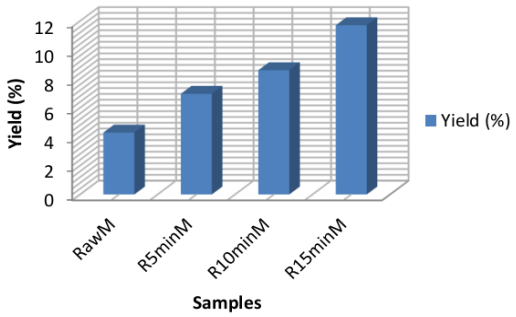

Fig.1: Mucilage yield (%) of garden cress seeds before and after roasting treatment.

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Fig.1 illustrated that the sample RawM (which obtained from raw garden cress seeds), recorded the lowest percentage (4.28%). Likewise **Patel et al. (2011)** referred to the hardness of mucilage separation from *Lepidium sativum* seeds. While **Kilor and Bramhe (2014)** used different solvents in precipitate *Lepidium sativum* seeds mucilage and found that mucilage yield recorded 12, 5 and 3%; respectively . On the other hand, Fig.1 showed that the sample R15min recorded the highest yield (11.7%). Indeed, it was observed that roasting processes increased the total content of mucilage yield; due to increase water solubility index of roasted seeds **(Khan and Saini, 2016).**

Physical properties of garden cress seeds mucilage

Fig. 2 showed bulk and tapped densities of dried *Lepidium sativum* mucilage powder before and after roasting process. Fig. 2 illustrated that mucilage extracted from raw sample recorded 0.1396 and 0.2178g/ ml for bulk and tapped densities respectively. Furthermore **Archana et al. (2012)** determined bulk and tapped densities of the mucilage extracted from the seeds of *Lepidium sativum*, which recorded 0.2857 and 0.3389 (g/cc); respectively. Meanwhile, **Bhatia et al. (2014)** found that bulk and tapped densities in *Lepidium sativum* mucilage were 0.673 and 0.7 g/ml; respectively. Moreover, Fig.2 showed that the increase in roasting time increase the bulk density; as R15minM recorded highest values of bulk and tapped densities (0.17013 and 0.3162 g/ml; respectively) when compared to the other extracted mucilage. Similar results were conducted by **Khan and Saini (2016)** when they roasted flaxseeds.

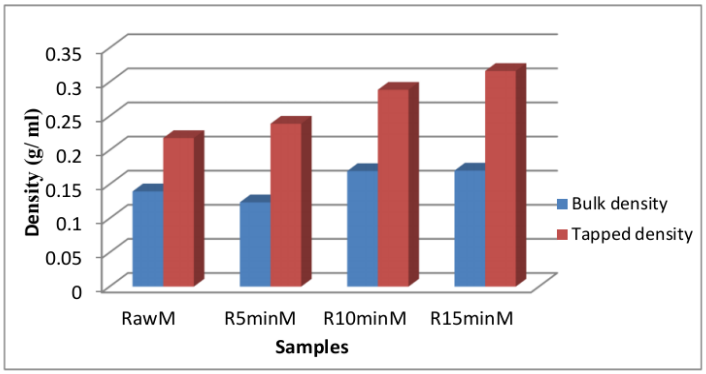

Fig. (2): Bulk and tapped densities of *Lepidium sativum* mucilage powder before and after roasting process.

On the other and, Carr's index and the Hausner's ratio (which selected as flow indicating parameters according to **Kilor and Bramhe (2014))** of *Lepidium sativum* mucilage powder before and after roasting process were showed in Fig. 3. Indeed, Fig. 3 revealed that the values of Hausner's ratio and Carr's index are highest for the sample R5minM (indicating that it is a highly compressible powder), whereas the same values recorded its lowest score for the RawM sample; which referred to its free flowing behavior **(Bodhmage, 2006).**

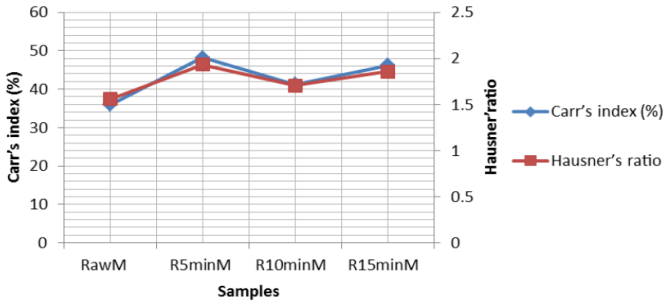

Fig. (3): Carr's index and the Hausner's ratio of Lepidium sativum mucilage powder before and after roasting process.

Swelling ratio and water retention capacity of *Lepidium sativum* mucilage

Fig.4 showed the changes in swelling ratio and water retention capacity of *Lepidium sativum* mucilage before and after roasting process. As seen in Fig.4 the swelling ratio and water retention capacity for Raw sample were 8.75 and 17.59ml/g; respectively. Likewise **Archana et al. (2012)** found that swelling ratio of extracted mucilage from *Lepidium sativum* seeds was 11ml. Moreover, water retention capacity in *Lepidium sativum* mucilage (with different methods during extraction), was

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determined by **Kilor and Bramhe (2014)** and recorded a range from 10.5 to 20.8ml/g. On the other hand, roasting process for 5 min. caused a decrease in swelling ratio and water retention capacity of *Lepidium sativum* mucilage, due to the decrease in bulk density during roasting the seeds **(Chung et al. 2011).** Furthermore, the increase in time roasting showed a positive effect on swelling ratio and water retention capacity (Fig. 4). Similar results were noticed by **Ranganathan et al. (2013)** as they found that roasting process increased the value of water absorption capacity for roasted sorghum grain samples when compared with raw sample, due to the enhancement of starch gelatinization with the increment in roasting time.

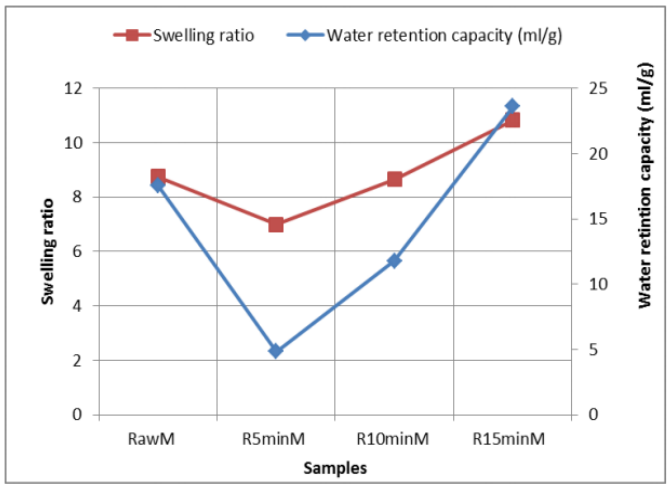

Fig. (4): Swelling ratio and water retention capacity of *Lepidium sativum* mucilage before and after roasting process.

Viscosity

Fig.5 showed that viscosity recorded its highest value in raw sample (RawM). Moreover, **Patel et al. (2011)** reported that the viscosity of 0.5% solution of *Lepidium sativum* mucilage was 8.05mPa.s**.** On the other hand, Fig. 5 showed that roasting process of seeds for 5 minutes (before extracting the mucilage) caused a decrease in viscosity; due to the less resistance to flow as a result of macromolecules mobility in the extract **(Karazhiyan et al., 2009).** Whereas, the increase in roasting time enhancement viscosity (Fig. 5); **Naji et al. (2013)** found similar results on *Lepidium sativum* gum solutions.

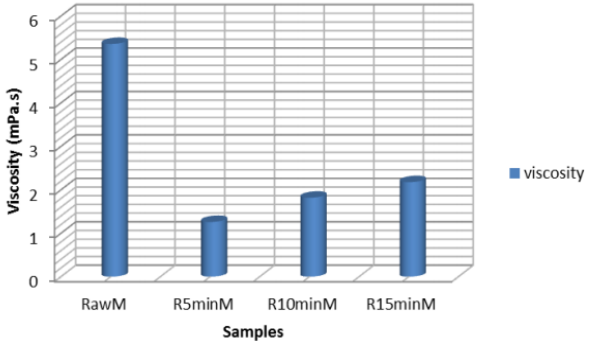

Fig. (5): Viscosity of *Lepidium sativum* mucilage before and after roasting process.

Water biscuits samples

Chemical composition of water biscuits

Chemical composition of garden cress water biscuits samples from wheat flour with 10% replacement ratio are shown in Table 5. The control sample (100% wheat flour) contained significantly ($p<0.05$) the highest moisture (12.74%) and total carbohydrate (83.47%) content when compared with other samples. Supplementation of biscuits with 10% of raw, roasted studied seeds caused a significant decrease in moisture and carbohydrates contents. On the other hand, ash, oil, protein and crude fiber contents of supplemented biscuits increased significantly and ranging 2.01-2.12%, 3.38-7.85%, 11.20-12.92% and 1.19-1.46%; respectively when comparing with control sample. The caloric value changed significantly ($P<0.05$) in supplemented biscuits via increase or decrease which ranging from 403.02 to 426.09Kcal/100g.

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Table (5): Chemical composition of water biscuits samples without and with garden cress flour supplementation.

Sample	Moisture	Ash*	Oil*	Protein*	Crude fiber*	Total carbohydrates*	The caloric value (Kcal/100g)*
Control (100% WF)	12.74	1.60	3.21	11.09	0.63	83.47	407.13
90% WF + 10% Raw	11.83	2.10	7.85	11.20	1.19	77.66	426.09
90% WF + 10% R5min	10.50	2.09	5.37	11.86	1.24	79.44	413.53
90%WF + 10% R10 min	11.17	2.12	6.44	12.92	1.37	77.15	418.24
90% WF + 10% R15min	10.56	2.01	3.38	12.86	1.46	80.29	403.02
LSD 0.05	0.32	1.14	6.87	0.45	0.28	0.21	0.23
*WF: Wheat flour; *Results calculated on dry weight basis*							

Mineral composition of garden cress water biscuits samples

Minerals content of control and supplemented biscuits samples are summarized in Table 6. Supplemented the biscuits with 10% Raw sample recorded significantly ($P<0.05$) higher contents of K, Na and Zn. While the addition of 10%R5min to wheat flour increased the contents of P and Ca; the Mg content recorded its higher value (132.70 mg/100g) when the sample R15min was added to wheat flour. On the other hand, the Fe content decreased significantly in supplemented biscuits ranging 13.45-22.49 mg/100g when compared with control. Moreover, no significant ($P<0.05$) difference was found in the contents of Mn between samples with values ranging from 2.06 to 2.73 mg/100g.

Table (6): Mineral composition (mg/100 dry weight) of water biscuits samples without and with garden cress flour supplementation.

Samples	K	P	Ca	Na	Mg	Fe	Zn	Cu	Mn
Control (100% WF)	118.55	222.70	91.20	14.68	87.93	27.37	7.55	1.63	2.20
90% WF + 10%Raw	357.92	267.02	117.40	18.01	110.46	22.49	8.10	2.39	2.73
90% WF + 10%R5min	197.51	290.21	123.26	15.14	122.83	19.15	7.58	1.56	2.06
90%WF + 10%R10 min	168.68	250.17	115.76	15.48	108.11	15.35	5.90	5.27	2.06
90% WF + 10%R15min	167.43	272.87	118.71	13.41	132.70	13.45	6.38	2.73	2.59
LSD 0.05	1.85	9.25	0.24	0.25	0.16	1.33	0.23	0.27	1.21
WF: Wheat flour									

Phytochemical components of garden cress water biscuits samples

The β-carotene, lycopene, total phenolics and flavonoids contents of the water biscuits samples are presented in Table 7. The β-carotene, lycopene of biscuits samples were ranging 0.25-0.35 mg β-carotene/100g and 0.09-0.19mg lycopene/ 100g. The addition of 10% garden cress whole flour after roasting seeds for 15 minutes increased significantly ($P<0.05$) the contents of total phenolics (318.97 mg GAE/100 g D.W.) and total flavonoids (142.65 mg catechin/100g D.W.).

Table (7): Phytochemical components* of water biscuits samples without and with garden cress flour supplementation.

Sample	β-carotene (mg β carorene/100g)	Lycopene (mg lycopene/100g)	Total phenolics (mg GAE/100g)	Total flavonoids (mg catechin/100g)
Control (100% WF)	0.26	0.14	105.26	99.92
90% WF + 10%Raw	0.35	0.19	209.45	139.99
90% WF + 10%R5min	0.27	0.10	278.91	67.86
90%WF + 10%R10 min	0.25	0.09	297.61	70.52
90% WF + 10%R15min	0.27	0.14	318.97	142.65
LSD 0.05	1.22	0.06	93.56	0.21
*WF: Wheat flour; *Results calculated on dry weight basis*				

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Physical properties of water biscuits

In general, thickness, width and spread ratio were affected by the addition of garden cress seed flour in the crackers (Fig. 6). Addition of garden cress seed flour to biscuits also resulted in reduced width of final products. The same effect was observed by **Kohajdová et al. (2011)** when the chickpea flours were added to cookies. Results of our study indicated that the addition of garden cress seed flour affected spread ratio of supplemented water biscuits; due to its effect on gluten network. Results of this study are in concordance with those reported earlier by **Deshmukh et al., (2017).**

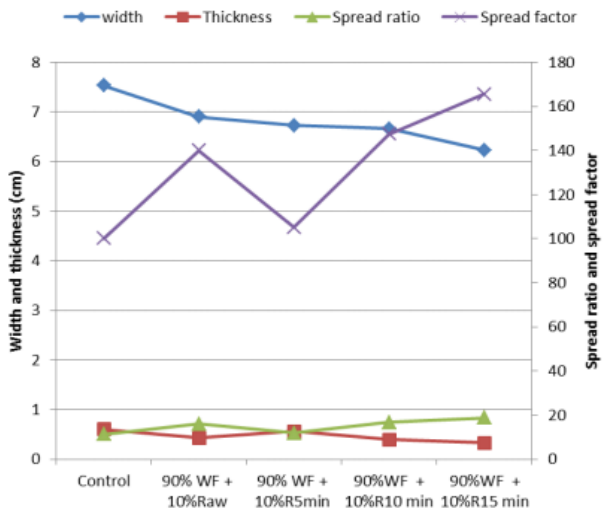

Fig. 6: Physical properties of water biscuits samples without and with garden cress flour supplementation.

Sensory evaluation of water biscuits:

Sensory evaluation of water biscuits which supplemented with garden cress seed flour is presented in Fig. 7. Indeed addition of garden cress seed flour to wheat flour caused a negative effect on color parameter (Fig. 8), due to brownish color of garden cress seed **(Deshmukh et al., 2017).** Meanwhile, roasting process for 15 minutes caused a decrease in color score as sample with 10%R15min had the lowest color value (5.8). Similar results were conducted by **(Deshmukh et al. 2017)** as they found that the color score of cookies obtained with use of garden cress seed bran was less acceptable as compared to control. On the other hand, the flavor and taste parameters recorded its lowest values with addition of 10% raw garden cress seed flour. While the roasting process improved the flavor, the addition of 10% R10min to wheat flour recorded the highest value (7.6) in taste parameter. Moreover, Fig. 7 showed that the addition of 10% of raw garden cress seed flour (Raw sample) to wheat flour improved texture score, while the addition of roasting samples (R5min, R10min and R15min) to wheat flour decreased texture scores. Also, it was observed that overall acceptability of water biscuits did not show significant differences between control sample and samples with R5min, R10min and R15min, in which 10 % of fine wheat flour was replaced by garden cress seed flour after roasting process of its seeds.

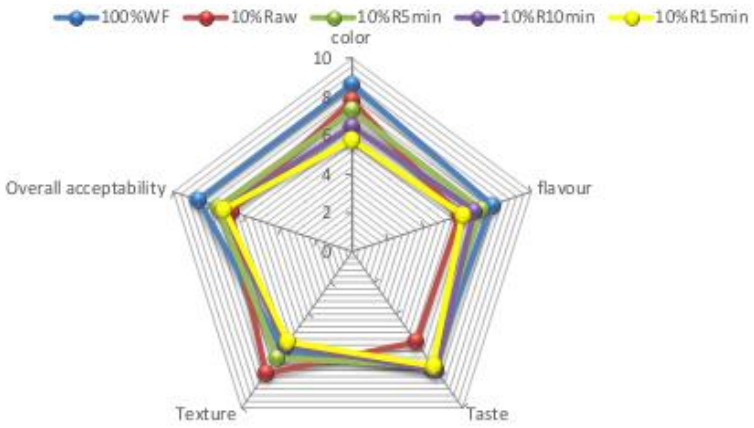

Fig. 7: Sensory evaluation of water biscuits which baked from wheat and wheat-garden cress composite flours.

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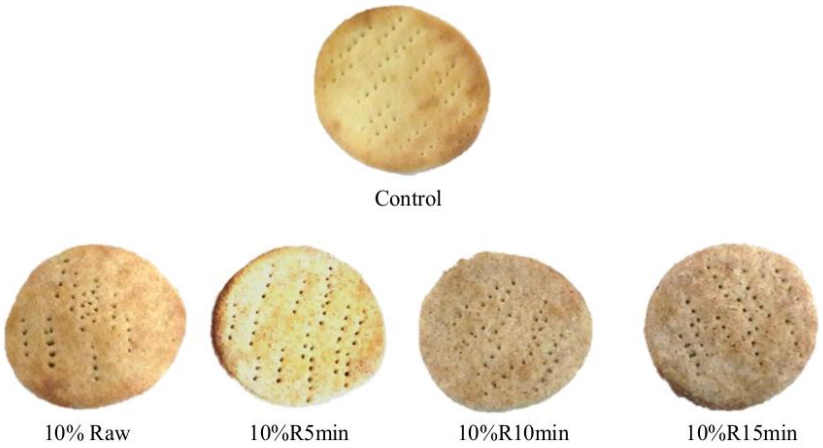

Fig. 8: Water biscuits which baked from wheat and wheat-garden cress composite flours.

IV. CONCLUSION

Results of the present study indicated that the raw and roasted garden cress seeds are rich in oil, protein and total carbohydrates. The garden cress seeds are good source of nutrients, such as minerals, β-carotene, lycopene, phenolic compounds and flavonoids which possess potential health benefits. In addition, roasted garden cress seeds can be used in various food applications, especially when roasted at 160°C for 15 minutes as nutritive supplements due to their good properties; while roasting garden cress seeds at 160°C for 5 minutes was much better for product appearance.

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