



Production Time and Nutritional Assessment of Garden Cress (*Lepidium sativum* L.) Leaves for Ethno-botanical Uses in Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: Futility of current health care systems for nourishment is a challenge to health professionals and researchers. Moreover, the high economic load and side effects necessitates the identification of natural and cheap products for nourishment. Reflecting those points, this research was aimed to evaluate the nutritional properties of garden cress leaves along with suitable production time in Bangladesh.

Introduction: Garden cress has been used in different countries for nourishment and treatment of different types of diseases but is new to Bangladesh. Successful production practices are indispensable for meeting the economic demand. The present research work was designed to establish a suitable production time for high biomass yield and evaluation of nutritional properties of garden cress leaves for ethno-botanical uses.

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Methodology: Factorial experiment with Completely Randomized Design (CRD) with three replications was used to accomplish the experiment replications in different months (July to October from 2017 to 2019). Seeds were shown in pots on 1st July, 1st August, 1st September and 1st October. Relevant data were taken at 40 days from sowing.

Results: Analysis of variance (ANOVA) showed the production parameters such as shoot height (31.43 cm), root length (6.67 cm), leaf area plant⁻¹ (35.38), shoot fresh and dry weight (1.57 and 0.33 g) was the highest in October planting. In case of nutritional assessment, an attempt was made to establish the variation of chlorophyll, vitamin C and nitrate concentration over planting time and minerals and proximate composition over garden cress seeds. The chlorophyll (1.0 mg 100 g⁻¹ fresh weight), vitamin C (0.93 mg 100 g⁻¹ fresh weight) and nitrate (391.00 mg 100 g⁻¹ fresh weight) concentration was the highest in the October planting. Mineral content, i.e. sodium (73.67 mg 100 g⁻¹ dry weight), potassium (1821.00 mg 100 g⁻¹ dry weight) and calcium (578.67 mg 100 g⁻¹ dry weight) was higher in leaves than seeds, except iron concentration, though proximate composition was higher in seeds than leaves, except moisture.

Conclusions: Winter planting (October) may attain higher biomass (leaf) production and its leaves could be a fresh source of bioactive compounds, minerals and vitamins.

Keywords: Chlorophyll; garden cress; mineral; nitrate; planting time.

1. INTRODUCTION

From time immemorial people have been using medicinal plants for nourishment and treatment of different types of diseases [1]. Currently, about 80% of people in developing countries are dependent on traditional medicines available in vegetation for nutrition and treating ailment [2,3] due to inanity of modern health care system.

Being a developing country, Bangladesh's ethno-botanical wealth is satisfactory, for instance leaves of *Adhatoda vasica* L. (Malabar nut) is used to cure asthma and dental ailments [4], leaves of *Ocimum tenuiflorum* L. (Holy basil) is used to treat cold, cough, and flu [5], but there is still a lack of traditional medicinal plants that can be used for both nourishment and treatment purposes. Keeping this in mind, garden cress (*Lepidium sativum* L.), which has been used as a traditional medicinal plant in Egypt and west Asia for over 5000 years [6] due to its nutrients and minerals content [7,8] has recently been introduced to Bangladesh.

Although it is a newly introduced crop in Bangladesh, its economic value could be high due to its ethno-botanical uses in the Bangladesh food market. Therefore, successful production practices are indispensable for meeting the economic demand. Several researchers have published results on the nutritional values and ethno-botanical uses the seeds of garden cress (*Lepidium sativum* L.) but there are few research results published on the nutritional value and ethno-botanical uses of the leaves. Treadwell et al. [9] and Xiao et al. [10] demonstrated that

emerging tender leaves contain higher concentrations of bioactive compounds such as antioxidants, phenolics, vitamins and minerals than mature plants or seeds. This research work was designed to establish the appropriate sowing date for high biomass yield and evaluation of the nutritional properties of garden cress leaves for ethno-botanical uses.

2. MATERIALS AND METHODS

2.1 Materials

Garden cress seeds were collected from China and pots from local market in Bangladesh. The growing media was prepared by mixing soil and cow-dung in 3:1 ratio.

2.2 Study Area

The experiment was conducted at the Department of Crop Botany experimental greenhouse, Bangladesh Agricultural University, Mymen Singh from July to October in 2017-2019. Geographically, the experimental area was located at 24°75' N latitude and 90°50' E longitudes under the Agro-ecological Zone-9 (AEZ-9) named old Brahmaputra Flood Plain at the elevation of 18 m above the sea level, which was under subtropical climate. The annual average humidity of the area was 70-75%; annual average precipitation was 2249 mm and annual average temperature was 25.3°C.

2.3 Design and Layout

Factorial experiment with Completely Randomized Design (CRD) with three replications was used to accomplish the

experiment. T. Seeds were shown in pots on the 1st July, 1st August, 1st September and 1st October. Relevant data were taken at 40 days after sowing (DAS).

2.4 Data Collection and Analysis

Shoot height (SH): Randomly selected and tagged plants were assessed by measuring SH from shoot base to the leaf tip at 40 DAS by a meter scale.

Root length (RL): Randomly selected and tagged plants were assessed by measuring RL from shoot base to the root tip at 40 DAS by a metre scale.

Leaf area per plant (LA plant⁻¹): Randomly selected and tagged plants were used for measuring LA by LI-3100 Area Meter at 40 DAS.

Shoot Fresh Weight (SFW) and Shoot Dry Weight (SDW): SFW was recorded at 40 DAS. Randomly selected and tagged plants were uprooted and cut at shoot base position and then SFW was measured using an electric weighing machine. The shoots were dried in an oven at 70±2°C for 72 hours. After drying, the leaves were weighed with an electric weighing machine.

Measurement of chlorophyll content: The fresh leaves (1 g) of plants were extracted in 10 ml of chilled acetone solution in a dark room. After centrifugation at 4000 rpm for 10 minutes the absorbance of supernatants was taken at 453, 505, 645 and 663 nm wave length. Chlorophyll was then calculated according to the equation depicted in Nagata and Yamashita, [11]. The results were expressed as mg 100 g⁻¹ of fresh weight.

Vitamin C concentration in leaves: Ascorbic acid was determined with 2,6-dichloroindophenol following a procedure described by Xaio et al. [10]. The results were expressed as mg 100 g⁻¹ of fresh weight.

Nitrate (NO₃⁻) concentration in leaves: Nitrate concentration was measured by an improved Diphenylamine-based Spectrophotometric Method described by Aoun et al. [12]. A nitrate calibration curve was prepared by using potassium nitrate (KNO₃). The results were expressed as mg 100 g⁻¹ of fresh weight (Fig. 1).

Mineral composition: Mineral composition was determined by the procedure of Ranganna [13]. The dried samples were wet digested in 25 ml of a di-acid mixture. The digested samples were analyzed for sodium, potassium and calcium by using a flame photometer and iron by atomic absorption spectrophotometer.

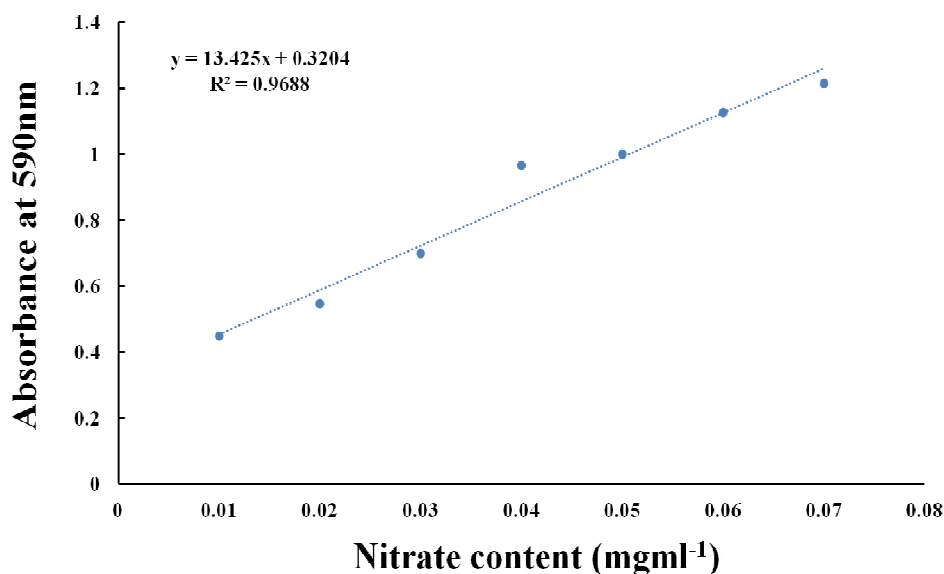


Fig. 1. Nitrate calibration curve

Proximate composition: Proximate principles were determined according to AOAC [14] protocol. The moisture content of the samples was determined by drying the samples at $70\pm 2^\circ\text{C}$ until a constant weight was obtained. Dried samples were analyzed to determine the total nitrogen concentration by micro Kjeldahl method. A conversion factor of 6.25 was used to calculate protein concentration. The ash concentration was determined by burning 2.5 g of oven-dried sample in a crucible in a muffle furnace at 550°C for 8 hours. Crude fibre was measured by digestion with 1.25% sulphuric acid, followed 1.25% of sodium hydroxide [15]. Carbohydrate content was also determined by the AOAC [14] protocol.

2.5 Statistical Analysis

The collected data were statistically analyzed using Minitab 17. Tukey's LSD test to compare the treatments means at 0.05 level of confidence. Significant differences among treatments means were determined using the Duncan Multiple Range Test (DMRT).

3. RESULTS AND DISCUSSION

3.1 Productional Parameters

The effects of sowing date on morphological parameters, except root length, were statistically significant. Shoot height increased to 22.71, 33.50 and 57.68% in August, September and October, respectively, compared to July plantation, though root length did not show statistically similarities. Leaf area per plant was

18.19, 21.67, 27.11 and 35.38 at July, August, September and October, respectively. Shoot fresh weight and shoot dry weight increased to 6.4, 10.68, 25.48 and 18.18, 30.77, 45.45% in August, September and October, respectively (Table 1).

All the production characteristics viz. shoot height, root length, leaf area per plant, fresh and dry weight of shoot were significantly affected by planting time, where all the characteristics were significantly higher in October date and lower in July date (Table 1). Kruk and Benech [16] and Anonymous [17] reported similar results. The possible reason for this could be the growth of garden cress is inhibited by long day time light because it is known that the vegetative and reproductive growth require short day time light. So, longer day time light in July, August and September could hamper their growth. Sharma and Agarwal [18] reported the negative effect of summer heat on garden cress which was consistent with our findings.

3.2 Nutritional Parameters

Chlorophyll content: Chlorophyll a was 0.58, 0.67, 0.77 and 1.00 $\text{mg } 100 \text{ g}^{-1}$ fresh weight in July, August, September and October, respectively, while chlorophyll b was 0.31, 0.27, 0.28 and 0.30 $\text{mg } 100 \text{ g}^{-1}$ fresh weight in July, August, September and October, respectively. Total chlorophyll increased to 4.35, 16.19 and 29.6% in August, September and October planting, respectively (Fig. 2).

Table 1. Time dependant variation on production parameters of garden cress at 40 DAS

Planting time	Shoot height (cm)	Root length (cm)	Leaf area per plant	Shoot fresh weight (g)	Shoot dry weight (g)
July	16.30d	5.44b	18.19c	1.17c	0.18c
August	21.09c	5.86ab	21.67c	1.25bc	0.22bc
September	24.50b	6.60a	27.11b	1.31b	0.26b
October	31.43a	6.76a	35.38a	1.57a	0.33a

Values marked with the same letter within the columns do not differ significantly at 5% level of probability.
DAS = days after sowing

Table 2. Mineral composition ($\text{mg } 100 \text{ g}^{-1}$ dry weight basis) of garden cress leaves, compared to seeds

Parameters	Garden cress leaves	Garden cress seeds (Chaudhary and Gupta 2017)	% variation in response to seed
Sodium	73.67 \pm 3.283	24.63 \pm 0.26	+ 66.57
Potassium	1821 \pm 17.349	1449.20 \pm 0.01	+ 20.43
Calcium	587.67 \pm 13.618	391.27 \pm 0.00	+ 33.42
Iron	63.67 \pm 3.283	109.10 \pm 0.06	- 41.64

Values represent the mean \pm SE

Table 3. Proximate composition (g 100 g⁻¹ dry weight basis) of garden cress leaves, compared to seeds

Parameters	Garden cress leaves	Garden cress seeds (Chaudhary and Gupta, 2017)	% variation in response to seed
Moisture	87.13±0.088	4.82±0.09	+ 94.47
Ash	1.80±0.015	4.95±0.00	- 63.63
Fibre	2.38±0.015	9.72±0.32	- 70.88
Fat	0.70±0.029	24.96±0.02	- 97.2
Protein	2.53±0.041	26.31±0.03	- 90.38
Carbohydrates	5.47±0.025	29.25±0.27	- 81.30

Values represent the mean±SE.

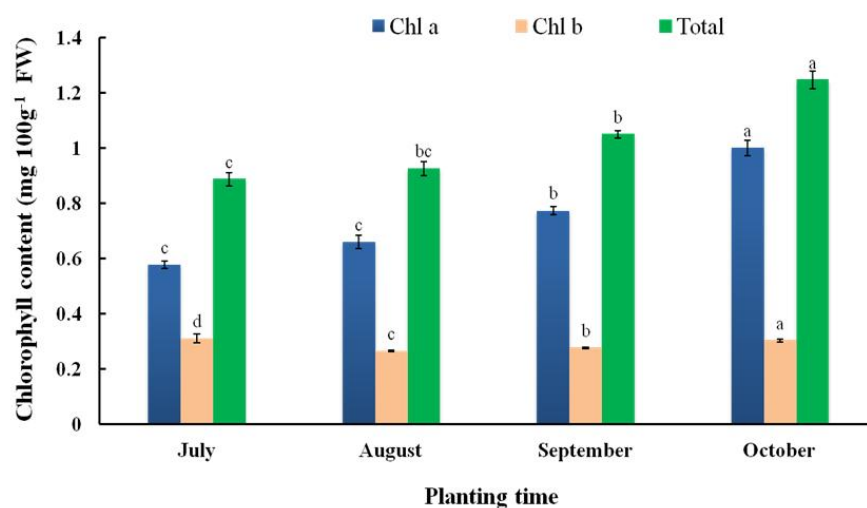


Fig. 2. Effect of production time on chlorophyll content of garden cress. The vertical bars represent the mean±SE. Values marked with the same letter within the columns do not differ significantly at 5% level of probability. FW= fresh weight, SE= standard error

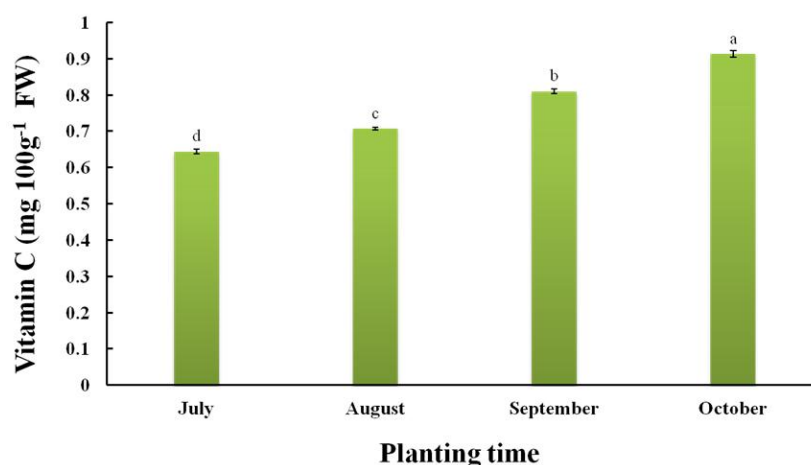


Fig. 3. Effect of production time on vitamin C content in garden cress. The vertical bars represent the mean±SE. Values marked with the same letter within the columns do not differ significantly at 5% level of probability. FW= fresh weight, SE= standard error

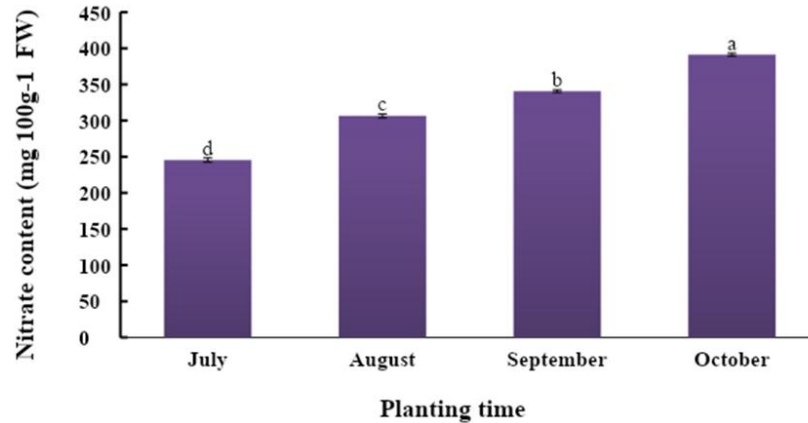


Fig. 4. Effect of Nitrate content on planting time in garden cress. Values marked with the same letter within the columns do not differ significantly at 5% level of probability

Vitamin C concentration: The effect of production time on vitamin C concentration at harvest was statistically significant. Vitamin C concentration was 0.65, 0.71, 0.81 and 0.93 mg 100g⁻¹ fresh weight in July, August, September and October planting, respectively (Fig. 3).

Nitrate concentration: Nitrate concentration was 245.45, 306.65, 340.85 and 391.32 mg 100g⁻¹ fresh weight in July, August, September and October planting, respectively which was statistically significant among the production time (Fig. 4).

Mineral composition: Garden cress leaves contained 73.67, 1821, 587.67 and 63.67 mg Na, K, Ca and Fe, respectively in 100 g dry weight. Haudhary and Gupta (2017) demonstrated that Na, K, Ca and Fe in garden cress seed were 24.63, 1449.20, 391.27 and 109.10 mg 100 g⁻¹ dry weight. The data revealed an increase in Na, K and Ca level at 66.57, 20.43 and 33.42% in leaves to seed. Leaves showed 41.64% decrease in Fe to seed (Table 2).

Proximate composition: The moisture concentration of garden cress leaves was 87.13 g 100g⁻¹ which was 94.47% more than that of seed. Ash, fibre, fat, protein and carbohydrate content in garden cress leaves were 1.80, 2.38, 0.70, 2.53 and 5.47 g 100 g⁻¹ dry weight, respectively, which showed a deviation at 63.63, 70.88, 97.2, 90.38 and 81.30% respectively in contrast to seed (Table 3).

Chlorophyll, vitamin C and nitrate concentration also increased in October plantings (Figs. 2, 3 & 4). It could be due to low temperature that

favours chlorophyll synthesis, vitamin C production and nitrate accumulation. Minerals concentration e.g. Na, K, and Ca were higher in leaves, compared to seeds (Table 2). Treadwell et al. [9] and Xiao et al. [10] reported that tender leaves contained higher minerals than mature plants and seeds. Proximate composition, except water, was higher in seeds than in leaves (Table 3). The possible reason could be that young, tender leaves contain more water so its ash percentage remains low and *vice versa*. As fat, protein and carbohydrates were determined from ash, higher ash percentage resulted in higher fat, protein and carbohydrates content.

3.3 Ethno-botanical Benefits of Garden Cress Leaves

Chlorophyll is sources of antioxidants [19] that may protect the DNA from binding with carcinogens in the liver and other organs [20]. Chlorophyll is believed to reduce heavy metal toxicity by chelating [21] and is an efficient deliverer of magnesium thus helping the blood carry oxygen to the cells and tissue. Generally, fresh edible leaves are a source of vitamin C that helps to defend the human body from the detrimental effects of free radicals [22]. Another benefit of vitamin C is preventing the formation of peroxynitrite (ONOO) by scavenging the superoxide (O₂⁻). Common colds and skin infection are cured by vitamin C [23].

Physicians imply that trinitroglycerin (NO₃ containing drugs) can cure cardiovascular diseases [24]. However, dietary nitrate from garden cress has also the potential for cardio-protection [25] with no side effect. Nitrate assists

in lowering blood pressure, development of endothelial function, protection against ischaemia reperfusion injury and reduction in platelet aggregation [26,27].

In humans, potassium helps to sustain normal water balance and pH of the body, thus maintaining normal physiological functions of the body [28]. Sodium helps in regulating blood pressure and maintaining function of muscle and nerves [29]. Deficiencies of calcium lead to osteoporosis. It assists in bone formation and prevents heart diseases [30]. Iron is not only essential in the formation of haemoglobin and oxidation of carbohydrates, protein and fats [31] but also helps in preventing of anemia [32].

4. CONCLUSION

Results of the current experiment concluded that Bangladeshi environment is suitable for production of garden cress vegetables and October is the best planting time to get commercial yield. In nutritional aspects garden cress leaves are the natural and cheapest source of nourishment and can also be used in treating ailments.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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