Comparative study of active components in *Spinacia oleracea* grown Hydroponic (without soil) and indigenous (soil) cultivation system

Mirza Azim Beg, Ragib Ali and Rahisuddin

Himalaya Wellness Company, Faridabad Unit

DOI 10.51129/ujpah-2024-37-2(9)

Received – November 20, 2024
Revised – November 23, 2024
Accepted – November 26, 2024
Published – December 07, 2024

Abstract- Green leafy vegetables (GLV) play a substantial role in human nutrition and are essential for a healthy life. This study was undertaken to determine the active component of *Spinacia oleracea* grown in Hydroponic system and in soil system. As *Spinacia oleracea* consumed in India and all over the world especially for its iron source. The spectrophotometric as well as gravimetric methods were used to determine the concentration of iron, tannin, flavonoids, and total alkaloids. The result shown that iron and other active component were higher in hydroponic growing system as compare to soil system. This possibility is due to iron content present in micro nutrients. As in hydroponic system the micronutrients always in contact with the plants, hence the possibility of iron absorption is more here as compare to soil system. The reason of higher concentration of other component may be due to the compatible growing conditions available in hydroponic system like light source for photosynthesis, temperature and pressure those were controlled automatically. Surprisingly we have seen that the growing of *Spinacia oleracea* is fast in hydroponic system as compare to soil system. In hydroponic system the spinach mature in about 20 days as compare to 30 days in soil system.

Key words: *Spinacia oleracea*, Hydroponic system, soil system iron, tannin, flavonoids, total bitter, and total alkaloids.

Introduction

Green leafy vegetables play a significant role in human nutrition and are essential for a healthy life[1, 2]. These vegetables provide an adequate amount of dietary fibers, minerals, vitamins, and other nutrients require by human body to prevent several diseases[3, 4]. Spinach contains various minerals that play a significant role in growth and metabolism. Elements such as

sodium, potassium, iron, and calcium provide an alkalizing effect to the acidity produced by other foods[5]. Iron is one of essential transition metal in the living system which carries oxygen to the tissues and is responsible for the appropriate protection against microbes. The total iron present in an average adult is about forty grams which is mostly stored in the body organs like spleen, liver, and bone marrow[6,7,8]. The deficiency of iron is the most common and widespread nutritional deficiency globally, and it has been estimated that 30 to 40 percent of the world's population is iron deficient specially children and womens[9]. Iron is a component of hemoglobin, present in the ubiquitous RBC in the body that conveys oxygen throughout it[10]. Hydroponics can be briefly defined as cultivation of plants without soil[11]. Actually hydroponics is a Greek word where "hydro" means water and "ponos" means "labour". It is a technique of growing plants in soil-less condition in which their roots immersed in nutrient solution[12]. Professor William Gericke coined the word hydroponics in the early 1930s describe the growing of plants where their roots suspended in water having mineral nutrients. Mostly Europe is the biggest market for hydroponics vegetables in which France, the Netherlands, Spain and United States of America. Recent report shows that it is expected to reach a world growth of 18.8% from 2017 to 2023, corresponding to a global hydroponic market USD 490.50 Million by 2023[13]. Continuous production of vegetables is possible only through hydroponic systems so that vegetable of any season will be available for round the year. This technique require less space, and plants can be growing anywhere with a controlled conditions like temperature, pH, Light for photosynthesis, flow rate of water, concentration of nutrients[14]. Hydroponics system mostly allows them to have higher productivities and yields without any constrains of climate and weather conditions[15]. The quality of hydroponic crop is superior because it uses a highly controlled environment and enables a more homogeneous production without any loss of water and nutrients. Moreover, it is not dependent on seasonality[16].

Material and Methods[17-20]

Plant sample Collection

Spinacia oleracea leaves was collected from the hydroponic and field of Himalaya Wellness Company Faridabad, Haryana. These are thoroughly washed in running tap water and air dried at room temperature in the shade for 7 days, then powdered using a mixer grinder and stored in an air tight container at 4°C for further use.

Iron concentration

5 g of samples powders were place in silica

crucible and place in a muffle furnace at 500 ºC for one hour. The obtained powders were moistened with 5 drops of sulphuric acid and taken with distilled water in small portions, filtered and passed into 50 ml graduated flasks and brought to the mark with distilled water (Stock Solution) 10 ml of Stock sample solution were taken into a 25 ml volumetric The following reagents (same reagents as for the standard scale) are added to the samples:

- 5 ml 25% sodium acetate
- 1 ml 10% hydroxylamine chlorhydrat,
- 1 ml 0.5 % ethanol alcoholic solution of oo'-phenanthroline.

The added solutions were stirred well, distilled water was added to the mark and then the obtained mixture was leave to stand for 1 hour.

The blank solution was prepared from:

- 5 ml 25% sodium acetate
- 1 ml 10% hydroxylamine chlorhydrat,
- 1 ml 0.5 % ethanol alcoholic solution of oo'-phenanthroline.

The added solutions were stirred well, distilled water was added to the mark and then the obtained mixture was leave to stand for 1 hour.

The standard solutions (standard scale), consisting in 10 Fe (II) solutions with concentrations between 1-5 mg/L are prepared as follows:

In 25 ml graduated flasks were added:

- 5 ml 25% sodium acetate
- 1 ml 10% hydroxylamine chlorhydrat,
- 0.5 % ethanol alcoholic solution of o-o'-phenanthroline.
- 1,2,3,4 and respectively 5 ml Fe (II) etalon solution (25 mg/L)

The added solutions were stirred well, distilled water was added to the mark and then the obtained mixture was leave to stand for 1 hour. All the spectrophotometric determination was performed at 510 nm.

Determination of total tannins

Total tannins content was determined by Folin-Ciocalteu Phenol reagent with some modification. Five microliter of the sample extract was added into 2.5 ml of Folin-Ciocalteu reagent and 2 ml of 7.5% sodium carbonate solution. The mixture was shaken well, kept at 40 °C temperature for 30 min and absorbance was measured at 700 nm with the UV/Visible spectrophotometer. Blank was prepared with reagent instead of the sample. Total tannin content was determined from calibration curve made with standard tannic acid.

Determination of Flavonoids

The flavonoid content was determined by aluminum chloride method using Quercetin

as standard. Extracts and Quercetin were prepared in (10 mg/ mL). 0.1 mL of extract was mixed with 0.9 mL of distilled water in test tubes, followed by addition of 75 µL of 5% sodium nitrite solution. After 6 minutes, 150 µL of 10%aluminium chloride solution was added and the mixture was allowed to stand for further 5minutes after which 0.5 mL of 1M Sodium hydroxide was added to the reaction mixture. Then add 2.5 ml of distilled water and mixed well. The absorbance was measured immediately at 510 nm using a spectrophotometer. A calibration curve was generate during various concentrations of Quercetin (20-100µg). Blank consist of all the reagents, exceptfor the extract or Quercitin is substituted with 0.1ml of Results were expressed as the Quercetin equivalence (QE) of the sample was expressed in mg/g of the extract.

Determination of Alkaloids

To 5 g of plant powder in a 250 ml beaker, 200 ml of 20% acetic acid in ethanol was added. This was covered and allowed to stand for 4 h. The solution was then filtered, and the extract was allowed to become concentrated in a water bath until it reached a 1/4th volume of the original volume. To this concentrate, ammonium hydroxide was added until the precipitation was completed. The whole solution was left to settle down, and the precipitate was collected and washed with dilute ammonium hydroxide and then filtered. The precipitated residue was dried and weighed.

Result and Discussion

Table-1 The result obtained from the quantitative estimation of *Spinacia oleracea* leaves.

Active component	In hydroponic system Mg/100gm	In indigenous (soil) system Mg/100gm
Iron	10.35 ± 0.82	08.74 ± 0.77
Tannins	92.15 ± 12.38	82.54 ± 14.14
Flavonoids	11.05 ± 0.21	9.82 ± 0.72
Alkaloids	4820 ± 22	4572 ± 18

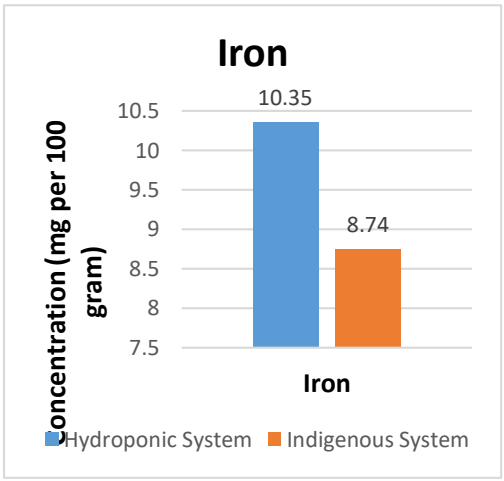

Figure-1 Concentration of Iron

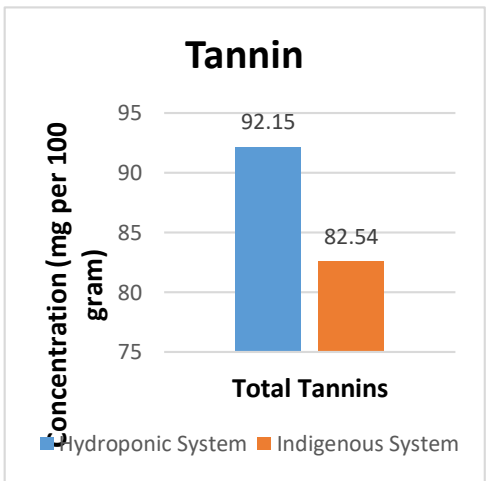

Figure-2 Concentration of Tannin

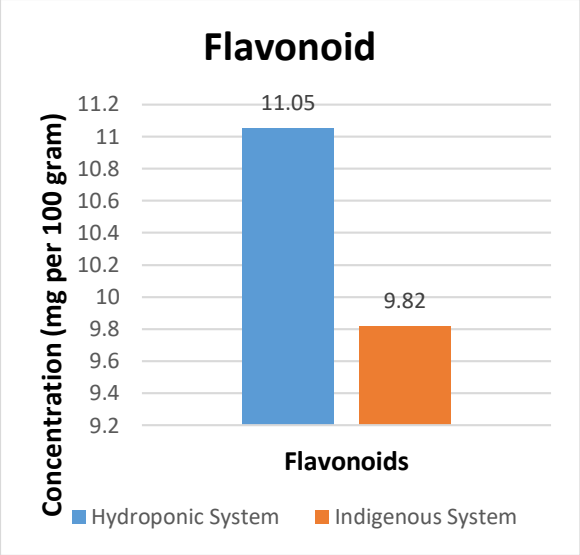

Figure-3 Concentration of Flavonoid

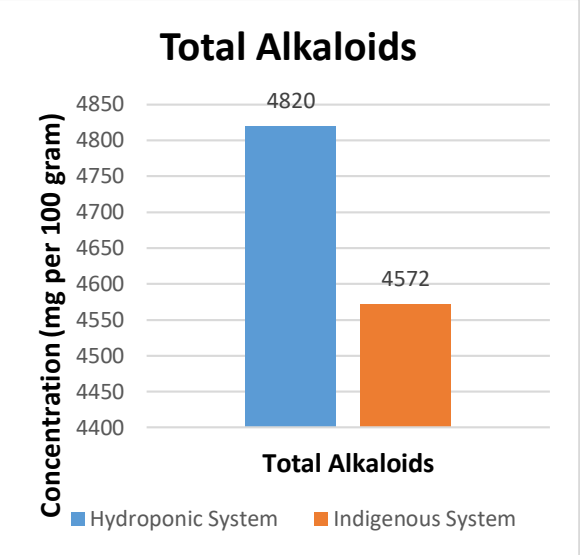

Figure-4 Concentration of Total Alkaloids

From the above table we find that the spinach leaves grow in hydroponic system (Hydroponic Leaves) has more iron content and other phyto-constituents are also high in the same leaves. Iron is determined by using colorimetric method of spectroscopy. The result shows the iron content in hydroponic leaves is 10.35 ± 0.82 mg as compared to 8.74 ± 0.77 mg in leaves that grown in soil (soil leaves). Tannins are determines by taking the absorbance of sample against the tannic acid as standard. The tannin content is 92.15 ± 12.38 mg in hydroponic leaves whereas soil leaves contains 82.54 ± 14.14 mg. The flavonoid is determined by UV-Spectrophotometer by using Quercetin as standard and found that hydroponic leaves contain 11.05 ± 0.21 mg as compare to 9.82 ± 0.72 mg in soil leaves. The total alkaloid was determined by gravimetric analysis and the result are higher in hydroponic leaves with 4820 ± 22 mg while soil leaves contains 4572 ± 18 mg.

Conclusion

The above study reveals that Spinach *(S. oleracea)* contains phytochemicals such as Iron, Tannins, Flavonoids and Total alkaloids. From the result we can say that adaptation of hydroponic system for growing of spinach as well as other leafy vegetables is good choice because the leaves grown in this system have more quantity of phytochemicals as compared to the indigenous growing system that is soil.

Disclaimer Statement

Authors declare that no competing interest exists. The products used for this research are commonly used products in research. There is no conflict of interest between authors and producers of the product.

References

1. Arasaretnam, S.; Kiruthika, A. and Mahendran, T. *Ceylon Journal of Science*, 2018, 47(1):35, http://doi.org/10.4038/cjs.v47i1.7484.
2. Swamy Thangiah, Anthoney; Titus Anthoney, Aldrich and Laolee, Wilai. Spectrophotometric determination of iron content in six indigenous green leafy vegetables consumed in muak lek, Thailand. January – March, 2022, Vol. 15, No. 1, 197-203.
3. Asaolu, S. S.; Adefemi, O. S.; Oyakilome, I. G.; Ajibulu, K. E. and Asaolu, M.F. *Journal of Food Research, 2012,* 1(3):214, http://doi.org/10.5539/jfr.v1n3p21 4
4. Mohammed, M. I. and Sharif, N. *Journal of Basic and Applied Science, Nigerian*, 2011, 19(2):208.
5. Angela, C.; Rodica, C.; Andrea, M. Z.; Elena, T. and Camelia, G. *Series of Life Sciences*, 2010, 20(2):45.
6. Leon, T. Health-promoting Properties of Fruits and Vegetables, CABI, 2011, pp. 18-21
7. Suvardhan, K.; Giridhar, C.; Deepali, S.; Phumlane, M.S.; Krishna, B.; Venkatasubba Naidu, N. and Myalowenkosi, S.I. *International Journal of Electrochemical Science*, 2016, 11:8027http://dx.doi.org/10.20964/2016. 09.53.
8. Akl, M. A.; Mori, Y. and Sawada, K. Analytical Sciences, 2006, 22(9): 1169. http://dx.doi.org/10.2116/analsci.22.1169.
9. World Health Organization, Iron Deficiency Anaemia: Assessment, Prevention, and Control: A Guide for Programme Managers, Report of a Joint WHO/UNICEF/UNU Consultation, Geneva, Switzerland. 2001.
10. Radhika, N. and Vijaya, I. *International Journal of Science, Environment*, 2015, 4(3):543.
11. Savvas, D. Hydroponics: A modern technology supporting the application of integrated crop management in greenhouse. *Food, Agriculture and Environment*, 2003, 1:80-86.
12. Maharana, L. and Koul, D.N. The emergence of Hydroponics. 2011, 55: 39-40.
13. Jensen, M. H. and Collins, W. L. Hydroponic vegetable production. *Horticultural Reviews*, 1985, 7: 483-558.
14. Hughes, A.J. Hydroponic Growing Offers Advantages, but won't replace the soil. 2017.
15. Sarah, W. S. Hydroponics-vs-soil reasons why hydroponics is better than soil. 2017.

16. Okemwa, E. Effectiveness of aquaponic and hydroponic gardening to traditional gardening. *International Journal of Scientific Research and Innovative Technology*, 2015, 2:2313-3759.
17. Alexandrina, F.; Anda Ioana Graţiela, P.; Claudia, M. and Teodora, S. Iron (Ii) Spectrofotometric Determination In Spinach (*Spinacia Oleracea*) Fresh Leaves And Spirulina (*Arthrospira Platensis*) Powder Analele. *Universităţii din Oradea-Fascicula Chimie*., 2019, Vol. XXVI.
18. Tuli1, et al. Phytochemicals - Tannins in some Leafy Vegetables of Bangladesh. *Indian Journal of Nutrition*, 2017, Volume 3, Issue 2.
19. Kaliyaperumal, Sowparthani and Radhika, M. Study of phytochemical analysis and antioxidant activity of *Spinach oleracea* L plant leaves. *The Pharma Innovation Journal*, 2020, 9(7): 01-04.
20. *Shivaranjani, et al.* Preliminary Phytochemical Screening and Quantification of Bioactive Compounds in the Leaves of Spinach (*Spinaceae Oleraceae* L.). *I. J. P.*, 2014, Vol. 1(7): 465-471.