SPRING PRODUCTION ON AMOUNT OF ASCORBIC ACID IN CORIANDER

Fatemehsadat Mirmohammadmakki[1*], Ramona Massoud[2], Seyed Fathollah Mir Mohammadmakki[3], Nargessadat Mirmohammadmakki[3], Armita Massoud[4]

[1]Department of Food Science and Technology, Science and Research Branch, Islamic Azad University & amp; Researcher of Medical Ethics and Law Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

[2]Department of Food Science & Technology, Science and Research Branch, Islamic Azad University, Tehran, Iran.

[3]Department of Industrial Engineering & Management Systems, Amirkabir University of Technology, Tehran, Iran.

[4]Department of Medicine, University of Tehran, Tehran, Iran.

*Corresponding author

DOI: https://doi.org/10.51193/IJAER.2024.10601

Received: 28 Oct. 2024 / Accepted: 08 Nov. 2024 / Published: 16 Nov. 2024

ABSTRACT

Studies have consistently shown a lack of vitamin C in low- and middle-income countries, posing a significant health challenge. However, vegetables, particularly coriander, have emerged as a potential solution due to their high ascorbic acid content. In our study, we measured the ascorbic acid content in coriander (*Coriandrum sativum L.*) over three consecutive months in spring 2021. The ascorbic acid content of the harvested coriander was determined using a titration method with dichlorophenol-indophenol as an oxidizing agent. At the endpoint of the process, the solution was treated with a di-chlorophenol indophenol. The results were promising, with the ascorbic acid in coriander reaching 0.29 ±0.0033 $mg.kg^{-1}$, indicating a hopeful increasing trend from the beginning to the end of the studies. This study highlights the rise in ascorbic acid content in coriander throughout the spring season, underscoring its potential as a significant dietary source to address vitamin C deficiency.

ISSN: 2455-6939

Volume: 10, Issue: 06 "November-December 2024"

Keywords: *Coriandrum sativum*; dichlorophenol-indophenol; food chemistry; plant science

INTRODUCTION

The most important vitamin in fruits and vegetables is vitamin C (also known as ascorbic acid) (Mirmohammadmakki, 2023; Fatima, 2021; Rossetti, 2020; Odeyemi, 2019; Amanda et al., 2011). Fruits and vegetables make up more than 90% of the vitamin C in diets (Sahbaz & Somer, 2019; Vasanth Kumar, 2013). The amount of ascorbic acid in vegetables, can vary depending on the season (Mieszczakowska-Frąc, 2021; Said-Al Ahl H.A.H. & Omer, 2014). Generally, vegetables grown in the warmer months, like spring and summer, tend to have higher vitamin C levels than those grown in colder seasons, like fall and winter (Medda, 2022; Phillips, 2018). It happens for sunlight exposure, which is more abundant in warmer months and helps stimulate plant vitamin C production. However, it is not just the weather that affects vitamin C levels (Feszterová ,2023; Fenech, 2018; Amanda, 2011). Factors like soil quality and, importantly, cultivation practices also play important roles in selecting the vitamin C content of vegetables (Rahman, 2024). By understanding these factors, vitamin C-rich vegetables can be grown and controlled in terms of nutrition. The amount of ascorbic acid in vegetables during different spring months can vary depending on temperature, sunlight exposure, and plant growth stage (Mieszczakowska-Frąc, 2021). Generally, early spring vegetables like spinach, kale, and early varieties of lettuce tend to have higher levels of vitamin C as they benefit from cooler temperatures and ample sunlight (Medda, 2022). The plant growth stage also plays a role, as younger plants have higher vitamin C content. As spring progresses into later months, vegetables like peas, broccoli, and radishes also contain significant amounts of vitamin C. However, the levels might vary depending on the specific growing conditions and the maturity of the plants. Spring vegetables, with their freshness and nutritional value, including their ascorbic acid content, are a delightful addition to any diet (Feszterová, 2023; Paciolla, 2019; Fenech et al, 2018,).

It is said it can act as an antioxidant and lower the risk of arteriosclerosis, cardiovascular conditions, and some types of cancer (Vasanth Kumar, 2013). Titrimetric and spectrometric techniques have often been employed to measure ascorbic acid. Ascorbic acid measurements can also be made using polarographic techniques (Shahbaz &somer, 1992). The living, edible parts of herbaceous, are essential foods that are very advantageous for preserving health and contain wholesome food ingredients (Odeyemi, 2019; Hanif, 2006). Leafy greens are excellent suppliers of antioxidants, minerals, vitamins, and other nutrients (Mirmohammadmakki, 2023; Mirmohammadmakki, 2022; Kumari, 2021). Globally, people consume different amounts of fruit and vegetables (Kaur & Tamber Aeri, 2019). Insufficient consumption of fruits and vegetables has been linked to diseases like obesity (WHO, 2018; Balarajan, 2009; HE, 2004; Sartorelli, 2008), hypertension (Alonso, 2004; Miura, 2004; Wang e, 2012); dyslipidemia/raised cholesterol

ISSN: 2455-6939

Volume: 10, Issue: 06 "November-December 2024"

(Muraki, 2013; Fornés, 2004; Wild, 2004; Obarzanek, 2001; Sargeant, 2001). Coriander (Coriandrum sativum L.) is an annual herb that's commonly used to add flavor to dishes. Its seeds, leaves, and roots are all edible, each bringing a distinct taste and purpose in cooking. The herb itself has a light, fresh flavor that can brighten up a variety of meals (Bhat et al. 2014). Coriander (belonging to the Apiaceae family) as one of the oldest crope that originally belongs to southwestern Asia, North Africa, and southern Europe, is an annual herbaceous plant, and can be used in different forms and, employed in various medicine (Gahory, 2022; Afshari, 2022; Hassanein, 2022; Gahory, 2022; Asfaw, 2021; Said-Al Ahl, 2014; Sangwan, 2011). Coriander is an annual plant, and it is herbaceous that came from the Mediterranean and Middle Eastern countries. it is famous as medicinal plants and encloud essential oil (Bhat et al. 2014). The medical benefits of coriander include the treatment of digestive, pulmonary, and urogenital problems as well as skin inflammatory disorders (Afshari, 2022; Dhakshayani & Priya, 2022; Gahory, 2022; Said-Al Ahl, 2014). Coriander is well known for its antibacterial, anxiolytic, analgesic, neuroprotective, anticonvulsant, migraine- relieving, low lipidemic, low glycemic, low blood pressure, and anti-inflammatory properties (Mirmohammadmakki & Hosseini, 2023; Dhakshayani & Priya, 2022). 100 g of fresh coriander leaves contain 250 mg vitamin C. (Singh, 2020) For the improvement of these nutritive properties, many cultural practices—such as controlled temperature, light, and mineral nutrient levels—have become standard practice in vegetable production systems (Kumari, 2021). May through July and October through January are sowing seasons for coriander (*Coriandrum sativum* L.). Coriander is picked when seed reach maturity and turn from dark green to brown (Devi, 2020). The findings of the present paper suggest that the combination of temperature-dependent activity during warm seasons can be harnessed to increase the levels of ascorbic acid in leafy vegetables, thereby improving their nutritional value.

METHODS AND MATERIALS

Coriander seeds *(Coriandrum sativum L.)* were taken from the Ministry of Agriculture, Tehran (Bean, vegetable, and seed manufacturing section) and planted in pots with suitable soil (pH 6.5) for the cultivation of this plant. Both flora for appropriate developing situations, from the beginning of planting to the quilt of harvest, have been monitored carefully. It should be noted that no fertilizer was used. In April, May, and June, when the vegetation reached harvesting, the samples were collected and assessed for ascorbic acid had been achieved. Because veggies are flora touchy to water pressure, watering was executed regularly (about two times a week during plant growth). The Number of treatments turned into nine treatments. The collected samples were transferred to the laboratory and kept at an ambient temperature. The coriander samples were dried and grinded at ambient temperature and finally kept in a suitable condition for further experiments.

These measurements were made on the samples: According to AOAC 967.21, ascorbic acid concentrations in the plant's aerial parts were measured. This method is based on titrating with 2,6-dichlorophenol indophenol after extracting ascorbic acid from the sample using metaphosphoric acid and acetic acid. Until a light pink was achieved, the dye 2, 6-dichlorophenol indophenol was titrated. A 50-ml volumetric flask was filled with 50 milligrams of ascorbic acid. The sample was carefully weighed in a particular amount. Five milliliters of the ascorbic acid answer were diluted with 5 milliliters of the extraction answer. It was titrated immediately until a shiny purple appeared. The last calculation to determine the quantity of ascorbic acid changed primarily based on the preliminary weight of the sample. All experiments were done with three repetitions.

Statistical Analysis

Every measurement was made in triplicate. Data were presented as the mean ±SE (standard error). The information was statistically investigated using SPSS 24. Significant differences between the means were determined using the Duncan multiple range test. A P-value of 0.05 or less was regarded as statistically significant.

RESULTS

Titration was used to measure the concentration of ascorbic acid in the aerial parts of the coriander (*Coriandrum sativum L*.) plant for three months starting in spring. The results are shown in Figure 1.

Figure 2 shows the standard titration curve of ascorbic acid at different concentrations. The titration method was used to calculate the ascorbic acid content. The coefficient of determination was calculated after drawing the standard curve and doing the line equation calculation.

The results from the test confirmed that the accuracy of coriander (*Coriandrum sativum L*.) measurements was excessive. The following outcomes can be a remarkable document to understand the extent of ascorbic acid changes for researchers and people searching out a source of ascorbic acid through herbal materials. Choosing a suitable dietary sample is sensible and helpful (Figure 1).

ISSN: 2455-6939

Volume: 10, Issue: 06 "November-December 2024"

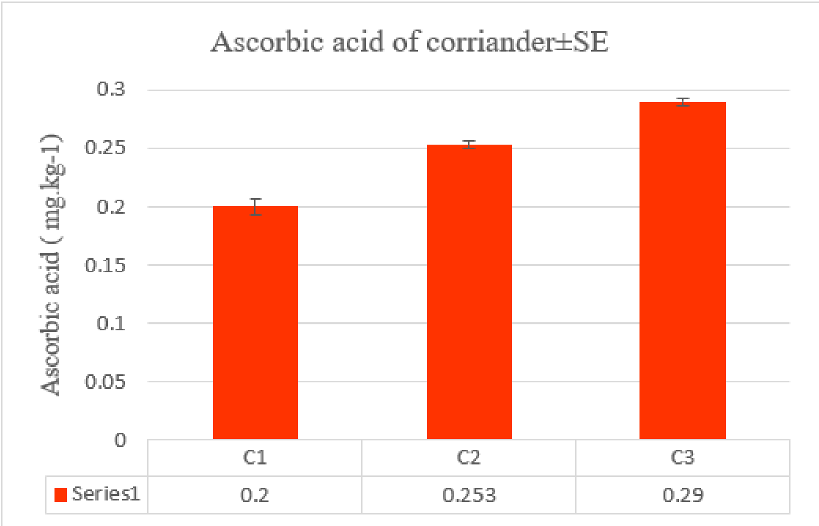

Figure 1: Mean concentration of ascorbic acid measured in different treatments in Coriander (C1: Ascorbic acid of coriander in May, C2: Ascorbic acid of coriander in Jun, C3: Ascorbic acid of coriander in July)

The relationship between actual concentrations of ascorbic acid and measured concentration using the titration method in Coriander was shown in the Figure 2.

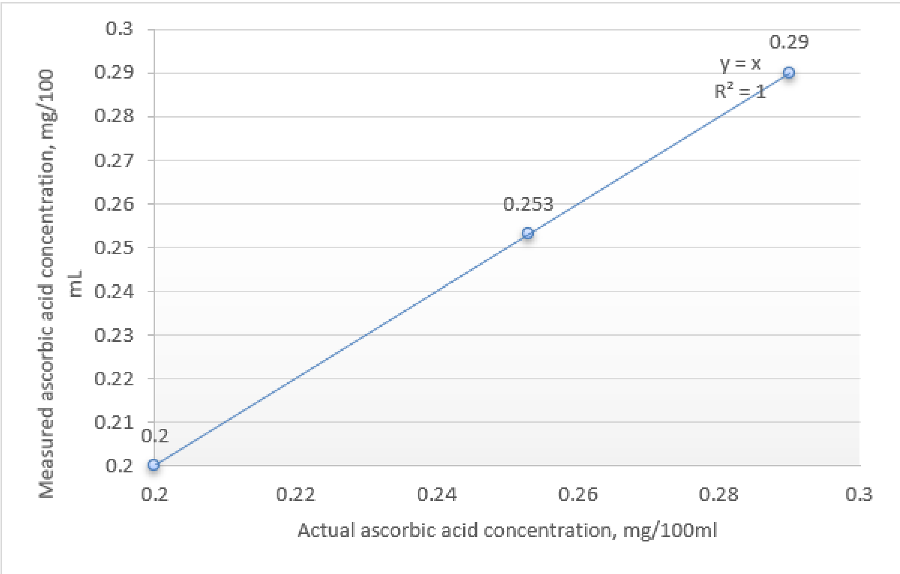

Figure 2: Relationship between actual concentrations of ascorbic acid (x) vs measured concentration (y) using the titration method in Coriander.

ISSN: 2455-6939

Volume: 10, Issue: 06 "November-December 2024"

This research showed that coriander (*Coriandrum sativum L.*) had the highest ascorbic acid in June. The amount of ascorbic acid in this plant was satisfactory in May, and this amount was the lowest in April.

The concentrations of ascorbic acid in coriander (*Coriandrum sativum L.*) increased considerably in May (0.253 ±0.0033 $mg.kg^{-1}$) as well as June (0.29 ±0.0033 $mg.kg^{-1}$). The measured mean amount of ascorbic acid in coriander (*Coriandrum sativum L.*) samples harvested in April was 0.2 ±0.06028 $mg.kg^{-1}$.

The recorded data on may indicating a significant increase from earlier months. This relatively low concentration underscores the early stage of the plant's growth or less favorable environmental conditions for ascorbic acid synthesis.

The collected data on Jun reveals that this month provides the most favorable conditions for the synthesis or accumulation of ascorbic acid in coriander. This could be attributed to various environmental factors such as temperature, sunlight, and soil conditions, which are optimal during this period.

This upward trend from April to May suggests that the plant's growth cycle and possibly the increasing temperatures and daylight hours contribute to the enhanced production of ascorbic acid. These findings are essential for agricultural practices and nutritional planning, as they identify the optimal harvesting time to maximize the health benefits of coriander.

In 2016, a study investigated the flavor characteristics and free radical scavenging activity of coriander (*Coriandrum sativum L.*) foliage. One of the subjects of this research was the examination of vitamin C. Ascorbic acid was determined using the 2,6-dichlorophenol-indophenol visual titration method, as in the current study. Their results showed that coriander contains 1.16 ± 0.35 ($mg.kg^{-1}$) of ascorbic acid, which was more than the amount in the present study (Priyadarshi, 2016).

DISCUSSION

The method is accepted in the American Pharmacopoeia (USP), and in Europe, it is the same method (Brater, 2002; Calam, 2002). On this basis, the titration method was also used in this research.

It should be noted that ascorbic acid is determined by different methods, some of which are described below. In different investigations, different methods are used to measure ascorbic acid.

ISSN: 2455-6939

Volume: 10, Issue: 06 "November-December 2024"

For example, in a comprehensive study by Guanghan et al., the amount of ascorbic acid in fruits and vegetables was determined by stripping voltammetry on a glassy carbon electrode.

Of course, this research believes in the limitations of the titration method compared to more precise methods like HPLC or voltammetry. Still, it's necessary to mention that the advantages of this method, like being applicable with fewer facilities in the most experimental situations, must be considered.

This method was successfully used to determine ascorbic acid in fruit and vegetable juices (Guanghan, 1994). Also, another study that was done by Wen-zhu Zhao et al., in 2020 used a new method to determine vitamin C content in fruits and vegetables. In the proposed research method mentioned above, computers' image and data processing capabilities are exploited by pairing a digital camera and a color reaction. An image acquisition device was also developed to collect solution image information for measurement after the dye reaction. Also, in the mentioned research, standard vitamin C concentration and color component curves were created by fitting non-linear, linear, and multivariate data. After announcing the range of detection by this new method, the researchers admitted that the accuracy of the proposed method is higher than the spectrophotometric method. However, more information was needed regarding comparing this method with titration. According to the researchers, the proposed new method has a simple design and facilitates easy operation (Mirmohammadmakki & Ziarati, 20115). It can be a suitable method to replace the spectrophotometric method for determining vitamin C in fruits and vegetables. However, the titration method is possible, according to the researchers present in this research. It should be more as well the mentioned research there was another research that focused on using new methods to determination of ascorbic acid. New methods of measuring vitamin C were conducted in 2023 to investigate the total content of vitamin C, ascorbic acid, and dehydroascorbic acid in food products with a voltammetry technique using tris (2-carboxyethyl) phosphine. It was treated as a reducing agent. In this research by Mazurek et al., the reduction of dehydroascorbic acid was done using tris(2-carboxyethyl) phosphine. The interference caused by the presence of tris(2-carboxyethyl) phosphine during the voltametric determination of ascorbic acid was effectively eliminated by reaction with N-ethylmaleimide. This method was much more accurate than the one used in the present study. According to the results announced by the researchers of this research, the analysis of dehydroascorbic acid content could have been more precise due to the use of the differential method. The results of the analysis and validation parameters of the developed method were determined with a high degree of compliance with the results obtained with the chromatographic reference method, which indicated the equivalence of the two methods, and this comparison made this research a fascinating and extensive research compared to the current research (Mazurek , 2023). straightforward and more economical. Moreover, the extent of using the new method compared to the titration method in food, chemical, and medical fields should be considered because, according to its researchers, this method is widely used in pharmaceutical sciences and food industries (Zhao, 2020; Harmeet Kaur, 2019).

Also, in research by Sehbaz and Somer in 1991, ascorbic acid in fruits and vegetables was measured using conventional polarography. The amount of ascorbic acid in fruits and vegetables was determined as normal polarography revealed that oxalic acid and EDTA protected the vitamin during sample preparation, and oxalic acid was preferred for polarographic analysis (Sehbaz & Somer, 1991). The quality of coriander leaves as impacted by growth circumstances was examined in the Surya et al., 2018 study. The outcomes in their observations showed that the mean value (100g mg. $^{-1}$) for vitamin C in Coriander leaves changed into observed to be extensively better in open fields (189.72) as compared to the rain shelter (124.55) (Surya, 2018). In research conducted by Nigeria in 2020, researchers studied sixteen different vegetables widely consumed in Nigeria as food and medicine and conducted a quantitative analysis of ascorbic acid based on their availability and agronomic desirability in six different geopolitical zones in Nigeria. Ascorbic acid content was determined using iodometric titration. The data obtained from this research showed that all sixteen vegetables contain significant amounts of ascorbic acid. Like the current research, the results showed that these vegetables should be added to the diet in a suitable amount that can provide the daily amount of ascorbic acid needed by the body for normal and healthy growth and to protect against diseases (Olotu, 2020). In research by Khanum et al., the impact of drying Coriander on antioxidant activity and mineral content was studied. In their research, like the present research, the amount of the ascorbic acid was determined by the 2, 6-dichlorophenolindophenol visual titration method. Their research examined the effects of four drying procedures on the coriander herbs' quality, mineral content, and antioxidant activity. The coriander herb was dried using several techniques, including low temperature, low humidity, infrared, sun, and hot air oven drying, and was then examined. Dried coriander that was kept at low temperatures and low humidity retained more ascorbic acid (Khanum, 2013). In order to focus on the health aspect and the nutritional importance of vitamin C, which is very important in this research, similar research conducted by Svetlana Trifunschi et al. in 2022 focused on determining the ascorbic acid content and antioxidant activity of different types of vegetables consumed in Romania from farmers and supermarkets. In the research of Svetlana Trifunschi and colleagues, vitamin C content in different types of bell peppers and tomatoes consumed in Romania was identified. Vitamin C content was determined using titration and iodometry methods, similar to the method of determining ascorbic acid in the present study. The research results showed that the vitamin C content in the analyzed bell peppers is between 4.693 and 11.264 mg/100 grams, and in the analyzed tomatoes, between 0.939 and 4.639 mg/100 grams. The mentioned study has shown that vegetables purchased from farmers have a higher vitamin C content than those purchased from supermarkets. Of course, in the current research, the advantage that existed was that the studied vegetable was monitored entirely from the beginning and controlled from the beginning of planting until it reached the amount the researchers could harvest them while in the mentioned study the researchers were collected the samples. This process was entirely under control. it should be noted that both studies demonstrated that local vegetables are a rich source of natural antioxidants and can be used to prevent various health conditions caused by oxidative stress (Trifunschi , 2022).

CONCLUSION

The results obtained from the present study were compared with those of other studies on estimating ascorbic acid from some local fruits and vegetables. The results of the present study were discussed with the results of the studies in the conclusion section. This study investigated changes in ascorbic acid in three consecutive months of spring. The method used in this study is the titration method for determining ascorbic acid in coriander with 2,4-DNPH, which is a simple and reliable method. It can be implemented in all laboratories with low facilities. Ascorbic acid plays an essential role in the human diet. Studies on ascorbic acid might help you choose vegetables that are nutrient-dense by nature. The ascorbic acid content of different consumable plant species varies. Hence, it is crucial to determine the concentrations in vegetables during the growing season. This study determined ascorbic acid changes in three consecutive months of spring. The results showed that the coriander's amount of ascorbic acid slightly changed from the beginning to the end of spring. A significant amount of ascorbic was observed in coriander. There was a significant statistical difference between the amount of ascorbic acid in the vegetables investigated in this study in different months. In order to get more amount of cilantro through the daily diet, it is suggested to consume compounds containing more ascorbic acid. This study indicated that the coriander's amount of ascorbic acid had no notable changes during harvesting. There are no statistically significant differences in coriander in all treatments ($P > 0.05$). An additional study on other minerals and vitamins in all vegetables in all situations and conditions is recommended.

Comparing titration results with alternative methods for validation in future studies is recommended for further studies.

REFERENCES

[1]. Afshari, m., Pazoki, A., Sadeghipour, O. (2022). Biochemical Changes of Coriander (Coriandrum sativum L.) Plants under Drought Stress and Foliar Application of Salicylic Acid and Silicon Nanoparticles, *J. medicinal plants by- products*.

[2]. Alonso, A., De la Fuente, C., Martin-Arnau, A., M., De Irala J., Martinez, J., A., Martinez, G. Fruit and vegetable consumption is inversely associated with blood pressure in a Mediterranean population with a high vegetable-fat intake: the Seguimiento Universidad de Navarra (SUN) Study. Br J Nutr. 2004; 92:311- 19.

[3]. Amanda, K., Schlueter, M., S., Johnston, C., S. (2011). Vitamin C: Overview and Update, *J Evid Based Complementary Altern Med*, 16(1), 49–57. DOI: 10.1177/1533210110392951.

[4]. AOAC Official Method 967.21 Ascorbic Acid in Vitamin Preparations and Juices 2,6-Dichloroindophenol Titrimetric Method First Action 1967 Final Action 1968.

[5]. Asfaw, M, D. (2021). A Review on the Chemical Constituent, Pharmacological and Medicinal Properties of Coriandrum sativum, Natural Products Chemistry & Research, Nat Prod Chem, 9 (8) -1000,419, 1–11.

[6]. Balarajan, Y., Villamor, E. Nationally representative surveys show recent increases in the prevalence of overweight and obesity among women of reproductive age in Bangladesh, Nepal, and India. J Nutr. 2009;139(11):2139-44.

[7]. Brater ,M.,D. The United States Pharmacopoeia (USP) 25 and National Formulary (NF) 20, Webcom Limited. Toronto. 2002; 163. 12.

[8]. Bhat S , Kaushal P ,Kaur M, and Sharma H. K., 2014, Coriander (Coriandrum sativum L.): Processing, nutritional and functional aspects, Africa Journal of Plant Science, 8(1). 25-33.

[9]. Calam D. European Pharmacopoeia, 4th ed, Council of Europe, Strasbourg. 2002; 675.

[10]. Devi, S., Kanpur, Sahu, M., Mishra, P. 2020, Proven Health Benefits and Uses of Coriander (Coriandrum sativum L.), Chapter 15, DOI: 10.4018/978-1-7998-2524-1.ch015.

[11]. Dhakshayani, G., M., Alias Priya S., J. 2022. A comparative study of phytochemical, antioxidant, anticarcinogenic, and antidiabetic potential of Coriander (Coriandrum sativum L.): Microgreen and mature plant, Foods and Raw Materials. 2022, 10(2).

[12]. Fatima, A., Usman Ali Khan,M., Najeeb,M., Yasoob Ali Khan,M., Ul Haq, F. 2021. Role of high dose IV vitamin C and zinc in coronavirus, Geriatric Care 2021; 7:9338, doi:10.4081/gc.2021.9338.

[13]. Fenech M, Amaya I., Valpuesta V., Botella M, A. Vitamin C Content in Fruits: Biosynthesis and Regulation. Front Plant Sci. 2019 Jan 24; 9:2006. doi: 10.3389/fpls.2018.02006. PMID: 30733729; PMCID: PMC6353827.

[14]. Feszterová , M., Kowalska, M., Mišiaková , M. Stability of Vitamin C Content in Plant and Vegetable Juices under Different Storing Conditions. *Applied Sci*. 2023; 13(19):10640. https://doi.org/10.3390/app131910640

[15]. Fornés, N., S., Martins, I., S., Hernan, M., Velásquez-Meléndezd, G., Ascherioc, A. Food frequency consumption and lipoproteins serum levels in the population of an urban area, Brazil. Rev Saude Publica. 2000;34(4):380-87.

[16]. Gahory, A., M., O., Ayyat, A., M., Soliman, T., M., A. (2022). Growth, Yield and Its Component of Coriander (Coriandrum sativum L.) in Response to The Addition of Compost, Ascorbic Acid and Salicylic Acid under Aswan Governorate Conditions, Egypt, J. of Plant Production, Mansoura Univ., 13 (12), 899 -905

[17]. Guanghan, L., Yu, W., Leiming, Y., Shuanglong, H. (1994). Determination of ascorbic acid in fruits and vegetables by stripping voltammetry on a glassy carbon electrode, Food Chem., 51 (1994) 237–239.

[18]. Guanghan, L., Yu, W., Leiming, Y., Shuanglong, H. (1994). Determination of ascorbic acid in fruits and vegetables by stripping voltammetry on a glassy carbon electrode. Food Chem.,51 (1994) 237–239.

[19]. Hanif, R., Iqbal,Z. , Iqbal, M., Hanif, S., Rasheed, M. 2006, USE OF VEGETABLES AS NUTRITIONAL FOOD: ROLE IN HUMAN HEALTH, *Am. j. agric. biol. sci*., 1(1), 18-22.

[20]. Harmeet Kaur, H., Tamber Aeri, B. (2019). Protective Impact of Fruits and Vegetable Intake on Cardiovascular Risk Factors-A Review, J Clin Diagn Res. 2019 May, Vol-13(5), OE06-OE09.

[21]. Hassanein, R., A, Hussein, O., S., Farag, I., A., Hassan, Y., E., Abdelkader, A., F., Ibrahim, M., Salt-Stressed Coriander (Coriandrum sativum L.) Responses to Potassium Silicate, Humic Acid, and Gamma Irradiation Pretreatments. AgroN., 2022, 12, 2268. https://doi.org/ 10.3390/agronomy12102268

[22]. He, K., Hu F., B., Coldit, G., A., Manson, J., E., Willett, W., C., Liu ,S. Changes in intake of fruits and vegetables in relation to risk of obesity and weight gain among middleaged women. Int J Obes Relat Metab Disord. 2004;28(12):1569-74.

[23]. Khanum, H., Sulochanamma, G., Borse,B., B. 2013, IMPACT OF DRYING CORIANDER HERB ON ANTIOXIDANT ACTIVITY AND MINERAL CONTENT, Int. J. Biol. Sci. · 1 (2). 50-55.

[24]. Kumar Singh ,S., Samsher, B.,R Singh, S., Sengar, R.,S ., Kumar, P. 2020. Study on biochemical properties of dehydrated Coriander leaves at different drying conditions, Int. J. Chem. Stud. 2020; 8(4), 2348–2352.

[25]. Kumari, R., Bedi, R., Dhatt, A. S., Sethi, V., P. 2021, effect of Proportion of NO 3 - and - NH 4 + in Nutrient Solution and Growing Seasons on Yield and Quality in Coriander, J. Agr. Sci. Tech. 23(4): 891 -902

[26]. Mazurek A, Włodarczyk-Stasiak M., A New Method for the Determination of Total Content of Vitamin C, Ascorbic and Dehydroascorbic Acid, in Food Products with the Voltammetric Technique with the Use of Tris(2-carboxyethyl) phosphine as a Reducing Reagent. *Molecules*. 2023; 28(2):812. https://doi.org/10.3390/molecules28020812

[27]. Mieszczakowska-Frąc., M, Celejewska K., Płocharski, W. Impact of Innovative Technologies on the Content of Vitamin C and Its Bioavailability from Processed Fruit and Vegetable Products. Antioxid (Basel). 2021 Jan 5;10(1):54. doi: 10.3390/antiox10010054. PMID: 33466266; PMCID: PMC7824742.Medda S, Fadda A, Mulas M. Influence of Climate Change on Metabolism and Biological Characteristics in Perennial Woody Fruit

Crops in the Mediterranean Environment. *Horticulturae*. 2022; 8(4):273. https://doi.org/10.3390/horticulturae8040273

[28]. Mirmohammadmakki, F., Gharachorloo, M., Ghavami, M., Abdossi, V., Azizinezhad., R. (2022). The efficiency of almond shell (Amygdalus communis L.) bio-sorption in reduction of heavymetals (lead, cadmium, arsenic, and nickel) from parsley (Petroselinum crispum). *BIOMASS CONVERS BIOR*. https://doi.org/10.1007/s13399-022-02635-6.

[29]. Mirmohammadmakki, F., Gharachorloo, M., Ghavami, M., Abdossi, V., Azizinezhad., R. (2023) Quantitative Changes in Ascorbic Acid and Chlorophyll Contents of Parsley (Petroselinum crispum) and Dill (Anethum graveolens) Harvested in Three Consecutive Months of Spring. J. Food Biosci Tech. 17(2) 1-12. DOI:10.30495/jfbt.2022.66836.10287, a.

[30]. Mirmohammadmakki, F., Gharachorloo, M., Ghavami, M., Abdossi, V., Azizinezhad.,R. *(2023)* Quantitative Changes in Essential Oils Contents of Parsley (Petroselinum crispum) Harvested in Three Consecutive Months of Spring, *J Food Bioprocess Eng*, 6(2): 48-5, https://doi.org/10.22059/JFABE.2023.365275.1154, b.

[31]. Mirmohammadmakki, F., Hosseini, E. (2023) CORIANDER (Coriandrum Sativum L.) ESSENTIAL OIL CHANGES LEVELS DURING THE SPRING SEASON, *Int. j. agric. environ. res*., 9(5) 876 – 885. Doi:10.22004/ag.econ.339068

[32]. Mirmohammadmakki, F., Ziarati, P. (2015). Nitrate and Nitrite in Fresh Tomato and Tomato derived Products, *Biomed. pharmacol. J.* 8(1), (2015).

[33]. Miura, K., Greenland,P., Stamler, .J, Liu ,K., Daviglus ,M.,L., Nakagawa, H. Relation of vegetable, fruit, and meat intake to a 7-year blood pressure change in middle-aged men: the Chicago Western Electric Study. Am J Epidemiol. 2004; 159:572–80.

[34]. Muraki, .I, Imamura ,F., Manson ,J.,E., Hu, F.,B., Willett, W.,C., et al. Fruit consumption and risk of type 2 diabetes: results from three prospective longitudinal cohort studies. BMJ. 2013;347: f5001.

[35]. Obarzanek, E., Sacks, F.,M., Vollmer ,W.,M., Bray, G.,A., Miller, E.,R., Lin, P.,H., et al. Effects on blood lipids of a blood pressure-lowering diet: The Dietary Approaches to Stop Hypertension (DASH) Trial. Am J Clin Nutr. 2001;74(1):80-89.

[36]. Odeyemi, O., T., Amira, E., O., and Hassan, I., R. (2019). Determination and Comparison of Ascorbic Acid Contents in Selected Fruits and Vegetables obtained from Ilorin Metropolis, ChemSearch Journal 10(2), 100 – 103.

[37]. Olotu, P., Olotu,I., Onche, E.,U., Ajima, U., Yakubu, N.,S and Ochigbo, P. Determination of the ascorbic acid content of selected Nigerian local vegetables used as food and medicine. J Pharmacogn Phytochem 2020;9(5):11-15.

[38]. Phillips, K., M., Tarrago-Trani, M., T., McGinty, R.,C., Rasor, A.,S., Haytowitz, D.,B., Pehrsson, P.,R,. Seasonal variability of the vitamin C content of fresh fruits and vegetables

in a local retail market. J Sci Food Agric. 2018 Aug;98(11):4191-4204. doi: 10.1002/jsfa.8941. Epub 2018 Apr 2. PMID: 29406576.

[39]. Priyadarshi, S., Khanum, H., Ravi, R., Borse, B. B., & Naidu, M. M. (2016). Flavour characterisation and free radical scavenging activity of Coriander (Coriandrum sativum L.) foliage. J. Food Sci. Technol., 53(3), 1670–1678. https://doi.org/10.1007/s13197-015-2071-1.

[40]. Rahman, A., Baharlouei P., Koh, E.,H.,Y., Pirvu, D.,G., Rehmani ,R., Arcos ,M., Puri ,S., A. Comprehensive Analysis of Organic Food: Evaluating Nutritional Value and Impact on Human Health. *Foods*. 2024; 13(2):208. https://doi.org/10.3390/foods13020208

[41]. Rossetti, C, A., , Juan Pablo Real, J,P., Palma, S.D. 2020. High Dose Of Ascorbic Acid Used In Sars Covid-19 Treatment: Scientific And Clinical Support For Its Therapeutic Implementation, Ars Pharm. 61(2),145-148.

[42]. Sahbaz, F., Somer, G. (1992). Determination of ascorbic acid in fruit and vegetables using normal polarography, Food Chem, 44 (1992) 141–146.

[43]. Said-Al Ahl H.A.H., El Gendy A.,G., and Omer E.,A, (2014). Effect of Ascorbic Acid, Salicylic Acid on Coriander Productivity and Essential Oil Cultivated in two Different Locations, *J ENVIRON BIOL Journal*, 8(7), 2236–2250.

[44]. Sangwan, A., Kawatra, A., Sehgal, S. (2011). BIO-CHEMICAL ANALYSIS OF CORIANDER LEAVES POWDER PREPARED USING VARIOUS DRYING METHODS, J. Dairying, Foods & H.S., 30 (3),202 – 205.

[45]. Sargeant, L., A., Khaw, K.,T., Bingham. S., Day, N., E., Luben, R.,N., Oakes ,S., et al. Fruit and vegetable intake and population glycosylated haemoglobin levels: the EPICNorfolk study. Eur J Clin Nutr. 2001;55(5):342-48.

[46]. Sartorelli, D., S., Franco, L.,J., Cardoso, M.,A. High intake of fruits and vegetables predicts weight loss in Brazilian overweight adults. Nutr Res. 2008; 28:233-38.

[47]. Sehbaz, F and Somer, G., 1991. Determination of ascorbic acid in fruit and vegetables using normal polarography, Food Chem. 44 (1992) 141-146.

[48]. Surya, R., Geethumol, T., Anitha, P., (2018). Quality in Coriander leaves as influenced by growing conditions, J. Hortl. Sci. 13(2) , 188-191.

[49]. Trifunschi ,S., Zugravu, C.,A., Munteanu, M.,F., Borcan ,F., Pogurschi ,E.,N. Determination of the Ascorbic Acid Content and the Antioxidant Activity of Different Varieties of Vegetables Consumed in Romania, from Farmers and Supermarkets. *SustaiN*. 2022; 14(21):13749. https://doi.org/10.3390/su142113749

[50]. Vasanth Kumar, G., Ajay Kumar K., G., Raghu Patel ,G.,R., Manjappa ,S. (2013). Determination of vitamin C in some fruits and vegetables in Davanagere city, (Karanataka) – India, Int. J. of Pharm. & Life Sci. (IJPLS), 4(3), 2489-2491.

[51]. Wang, L, Manson J., E, Gaziano, J., M., Buring, J., E., Sesso, H., D. Fruit and vegetable intake and the risk of hypertension in middle-aged and older women. Am J Hypertens. 2012;25(2):180-89.

[52]. Wild, S., Roglic, G., Green, A, Sicree, R., King, H. Estimates for the year 2000 and projections for 2030. Diabetes Care.2004;27(5):1047–53.

[53]. World Health Organization. World Health Statistics 2012[pdf]. Available from: http://www.who.int/gho/publications/world_health_statistics/EN_WHS2012_ Full.pdf. [Accessed on 14 July 2018].

[54]. Zhao, Wen-zhu , Cao, Ping-ping, Zhu, Yuan-yang, Liu, Sheng, Gao, Hong-Wen, Huang, Chao-qun, 2020/12/01 , RAPID DETECTION OF VITAMIN C CONTENT IN FRUITS AND VEGETABLES USING A DIGITAL CAMERA AND COLOR REACTION, 43, 10.21577/0100-4042.20170642, Química Nova, http://dx.doi.org/10.21577/0100-4042.20170642

