

Vitamin A and C Content of Peranggi Chili (*Capsicum annuum* L. var. *chinensis*) in Different Growing Media

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Abstract: Peranggi chili (*Capsicum annuum* L. var. *chinensis*) is a local chili variety that has not been extensively studied, particularly with regard to its vitamin content under different growing media and across different harvest periods. This study aimed to analyze the vitamin A and vitamin C contents of Peranggi chili (*Capsicum annuum* L. var. *chinensis*) grown in various growing media and to examine changes in vitamin content over the harvest period. The study employed a Randomized Complete Block Design (RCBD) consisting of four growing media treatments (P1, P2, P3, and P4), with three replications across three blocks. The vitamin A and vitamin C contents of the harvested Peranggi chili fruits were analyzed using a Rayleigh UV-1800 spectrophotometer. The data were analyzed using the nonparametric Kruskal–Wallis test because they did not meet the assumptions of normality and homogeneity. The results showed that the average vitamin A content ranged from 6.04 to 6.43 mg/100 g, while the vitamin C content ranged from 1,311.36 to 2,279.68 mg/100 g. Different growing media did not have a significant effect on vitamin A content ($p = 0.093$; $H = 4.761$), but they had a significant effect on vitamin C content ($p = 0.012$; $H = 8.804$). Based on the harvest period, both vitamin A and vitamin C contents showed significant changes, with the highest levels observed at the first harvest and a tendency to decrease in subsequent harvests.

Keywords: Growing Media; Harvest Period; Peranggi Chili; Vitamin A; Vitamin C.

Introduction

Chili (*Capsicum* sp.) are among the most widely cultivated crops in Indonesia due to its high market value, both in terms of consumption and economic value. These plants are frequently used in industry and exported to various countries. This plant can grow in paddy fields or dry fields at elevations ranging from 0 to 1,300 meters above sea level, from lowland to highland areas [1]. Chili is a cultivated crop whose fruits are used for food, industrial purposes, and as a medicinal plant. In addition to serving as a crop, chili are now also cultivated as ornamental plants due to the unique and diverse shapes of their fruits [2].

Chili contains many nutrients beneficial to health, including protein, carbohydrates, sugar, fiber, fat, vitamin A, vitamin B6, vitamin C, iron, magnesium, potassium, water, and capsaicin [3]. Based on research [4], red chili has the highest β -carotene content compared to other vegetables. The order of β -carotene content from highest to lowest after red chili is carrots, sweet corn, red spinach, yellow squash, tomatoes, green spinach, red beets, potatoes, and purple eggplant. Vitamin A is an essential nutrient that plays a crucial role in growth and development, particularly in children. In the body, vitamin A stimulates white blood cell production, supports bone formation, and maintains cell growth and maintenance, thereby enhancing the immune system [5]. Meanwhile, vitamin C, or ascorbic acid, plays a vital role in maintaining overall health as the primary antioxidant. This vitamin protects cells from damage caused by free radicals, which can trigger oxidative stress and various degenerative diseases, such as cancer, heart disease, and premature aging [6].

Peranggi chili (*Capsicum annuum* L. var. *chinensis*) is a local chili variety commonly found in Sambas Regency, West Kalimantan. Peranggi chili (*Capsicum annuum* L. var. *chinensis*) is a chili variety with a distinctive aroma and unique spicy flavor [7]. Although it is quite abundant in the region, scientific information regarding peranggi chili remains very limited. However, peranggi chili shares several similarities with katokkon chili. According to Rustam, Salengke, and Muhidong [8], katokkon chili has a short, plump fruit shape with a blunt tip, averaging 3–4 cm in length and 2–3.5 cm in width. Its shape resembles a bell pepper, but it is smaller.

The high levels of vitamin A and vitamin C in chili indicate that this crop has the potential to serve as an alternative source for meeting the public's daily vitamin needs and may even contribute to achieving certain nutritional adequacy levels. This is supported by the fact that chili contains higher levels of vitamin A and vitamin C than some types of fruit. β -carotene, a provitamin A, and ascorbic acid play crucial roles in maintaining eye health, boosting the immune system, and preventing various diseases caused by vitamin deficiency. However, the use of chili as a primary source of vitamins remains limited because they are generally consumed only in small amounts as a food accompaniment, unlike fruits such as oranges, which can be consumed in larger quantities. Consequently, the contribution of vitamin intake from chili to daily consumption is relatively small.

Chili plants generally grow best in tropical regions with specific soil conditions, although they can adapt to both lowland and highland areas up to a certain elevation above

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sea level, with better growth in lowland areas. Chili plants can also grow in various soil types as long as drainage, aeration, and water availability are adequate [9].

Chili are influenced by internal and external factors. Internal factors relate to the seeds, seedlings, or the plants themselves, while external factors stem from the external environment that affects growth, one of which is the growing media [10]. Environmental factors such as temperature, water availability, light, and humidity can influence the formation of carotenoids in plants [11]. Sari et al. [12] state that the vitamin C content in fruit is also influenced by environmental climatic factors, including the elevation of the planting site, soil pH, soil moisture, air humidity, number of rainy days, rainfall intensity, and light intensity.

Carotenoids are 40-carbon secondary metabolites composed of eight isoprene units (C₅). These compounds are synthesized via the methyl erythritol phosphate (MEP) pathway within plant cell plastids. In the early stages, etioplasts (plastids in cotyledons that have not yet been exposed to light) contain only small amounts of carotenoids. Upon exposure to light, etioplasts differentiate into chloroplasts, leading to increased synthesis and accumulation of chlorophyll and carotenoids to support photosynthesis. Additionally, carotenoids also accumulate in chromoplasts, particularly in floral and fruit tissues [13]. The extensive conjugated double bonds allow carotenoids to absorb visible light, producing yellow, orange, and red colors that make them the most striking pigments in plants [14]. Carotenoids contribute to red color development during chili pepper ripening. This process occurs as chloroplasts develop into chromoplasts, with chlorophyll gradually degrading while carotenoids are synthesized and accumulated in the chromoplasts [15].

Ascorbic acid, or vitamin C, is one of the natural antioxidant compounds found in plants. This compound is a major metabolite that plays a crucial role in protecting plant cells from oxidative damage caused by aerobic metabolism, photosynthesis, or exposure to pollutants [16]. Vitamin C (ascorbic acid) in plants is formed from sucrose, which is hydrolyzed into glucose and fructose, both monosaccharides [17]. The formation of vitamin C is influenced by nutrient availability. The elements that make up vitamin C are carbon (C), hydrogen (H), and oxygen (O), which are produced through photosynthesis [18]. Vitamin C levels are influenced by factors that affect photosynthesis. This is because ascorbic acid is synthesized from glucose. Any disruption to glucose photosynthesis will affect the plant's production of vitamin C [19]. Specifically in plants, various AsA biosynthetic pathways involving different precursor molecules have been described, namely the L-galactose pathway, the D-galacturonic acid pathway, the myo-inositol pathway, and the L-gulose pathway. Among these pathways, the L-galactose pathway is considered the dominant pathway in various types of fruit. The L-galactose pathway consists of eight sequential reactions that culminate in the intermediate compound L-galactone-1,4-lactone, which is then directly converted to AsA by the enzyme L-galactone-1,4-lactone dehydrogenase (GLDH). GLDH has been found in the inner mitochondrial membrane; other AsA biosynthetic enzymes are located in the cytosol, suggesting that most of the reactions in the AsA biosynthetic pathway occur in the cytoplasm of plant cells [20].

Growing media are among the most important environmental factors for providing nutrients and water in crop cultivation. The use of high-quality growing media, such as burnt husks, organic fertilizer, and others, plays a crucial role in supporting maximum plant growth and yield [21]. Growing media serve as the medium for plant growth, including root development. Although there are many types of growing media, not all are suitable for every plant. Chili cultivation is also highly dependent on the growing media. The right growing media will effectively support the growth and development of chili plants [22]. Nutrient content, particularly nitrogen (N) and potassium (K), influences vitamin C levels in plants. Excess nitrogen can lead to a decrease in vitamin C levels, whereas sufficiently high levels of potassium tend to increase vitamin C content in plants [23].

No research has been conducted on the vitamin A and C content in peranggi chili (*Capsicum annum* L. var. *chinensis*) using different growing media, particularly studies examining the direct relationship between growing media and the resulting vitamin A and C content. In fact, growing media play a crucial role in providing nutrients and supporting plant physiological processes that influence vitamin synthesis. Therefore, this study various the growing media to determine their effect on the vitamin A and C content of peranggi chili (*Capsicum annum* L. var. *chinensis*).

Research methods

Research Design

This research uses quantitative methods, an experimental type. This study uses a Randomized Completely Block Design (RCBD) with 4 treatment types, 3 repetitions, and 3 blocks, for a total of 36 experimental units. The growing media were arranged into four treatments: P1 (alluvial soil, sand, cow manure (1:1:1)), P2 (alluvial soil, sand, cow manure, perlite (1:1:1:0.25)), P3 (alluvial soil, sand, cow manure, burnt husk (1:1:1:0.5)), P4 (alluvial soil, sand, compost, burnt husk (1:1:1:0.5)). All ingredients are first mixed together in a dry, loose state according to the specified composition, using one pot volume for each mixture.

Equipment and Materials

The equipment used in this study included a trowel, a soil scoop, trays, 12.7 mm PVC pipes, plant tags, 15x15 cm seedling pots, 30x40 cm pots, scissors, soil fork, hanging scale, 70% shading net, wire, nails, saw, sacks, wooden planks, measuring tape, soil shovel, anemometer, lux meter, soil meter, writing utensils, cooler box, refrigerator, latex gloves, funnel, beaker, knife, blender, dropper pipette, drop pipette, watch glass, measuring flask, stirring rod, centrifuge, centrifuge tubes, spray bottles, analytical balance, glass bottles, spatulas, cuvettes, and Rayleigh UV-1800 spectrophotometer.

The materials used were peranggi chili seeds (*Capsicum annum* L. var. *chinensis*), sand, burnt husks, burnt soil, cow manure, alluvial soil, perlite, compost, NPK fertilizer solution, insecticide (Agus 500 SC), gravel, aluminum foil trays, PP (polypropylene) plastic bag, label

paper, Whatman No. 1 filter paper, aluminum foil, distilled water, acetone, petroleum ether, ascorbic acid, beta-carotene, and perangi chili from the plants of treatments using various growing media.

Seedling

Chili seeds are soaked for approximately 2 hours [24]; floating seeds are discarded because their viability has decreased. Seeds that have been soaked for 2 hours are first drained and then sown by scattering them on the soil surface in pots. The sowing media used is a mixture of baked soil and Malang sand in a 2:1 ratio. Watering is performed daily. The pots are placed in a greenhouse equipped with 70% shading net, and environmental factors are recorded daily. These environmental factors include light intensity, wind speed, air humidity, soil temperature, and soil pH.

Preparation of Growing Media & Soil Analysis

The growing media used in the treatments is a mixture of alluvial soil, cow manure, sand, perlite, burnt soil, burnt husks, and compost. The alluvial soil was first loosened with a sieve to reduce particle size and improve soil structure. Each treatment has a different ratio. This growing media is placed in 30 x 40 cm pots, which are then labelled and fitted with PVC pipes to prevent waterlogging during heavy rain. The growing media is left to settle for approximately one week before transplanting to ensure it mixes evenly and reaches a homogeneous state within the pot. Soil analysis was conducted at the Chemical and Soil Fertility Testing Laboratory, Faculty of Agriculture, Tanjungpura University, Pontianak. The chemical properties analyzed included nitrogen (N-Total).

Plant Transfer

Transplanting is performed when the seedlings have 3–5 leaves. Holes are made in the growing media to a depth of approximately ± 3 cm, and the seedlings are then placed one by one into these holes [25]. Watering is performed on the growing media one day before planting to ensure the medium is saturated with water [26].

Plant maintenance

Plant maintenance includes watering, weeding, fertilizing, and pest and disease control. Watering is performed at a rate of 200 mL per day. Watering is not performed on rainy days to avoid waterlogging of the growing media; watering is performed to prevent moisture buildup on the leaves at night. Proper watering aims to optimize water use and prevent fungal disease outbreaks, especially when environmental humidity is high [27]. Weeding is performed weekly by pulling out weeds to prevent competition with other plants growing in the pot. Fertilization is applied every two weeks using NPK fertilizer, with the dosage following the manufacturer's recommendations. The fertilizer used is Mutiara. Fertilization is performed every two weeks [28]. An insecticide (Agus 500 SC) is used to control whitefly infestations.

Environmental Factor Measurement

Environmental factor measurements included light intensity with a lux meter, air temperature and humidity with dry and wet thermometers and a hygrometer, and soil conditions, including moisture content and pH, with a soil meter. All measurements were taken daily throughout the study period for each treatment.

Preparation of Perangi Chili Samples

Samples of perangi chili were collected from the harvests of plants in each growing media treatment—P1, P2, and P3—from the 16th to the 23rd week. The fruits used were fully ripe, ranging in color from orange to red. Next, the samples were packaged in a PP plastic bag, placed in a cooler box, and stored in a refrigerator to maintain a stable temperature, preserve freshness, and prevent quality degradation prior to further analysis. Treatment P4 was not included in the testing because it produced few fruits. This limitation resulted in an insufficient sample of chili for simultaneous analysis of vitamin A and vitamin C. Treatment P4 produced a limited sample, making it impossible to conduct tests for vitamin A and vitamin C.

Extraction Preparation

The procedure for preparing chili extract for vitamin A testing involves several steps. First, the chilies are cut with a knife to separate the flesh from the seeds. Next, 20 g of the flesh (from 4–7 chilies) is weighed and then pureed using a blender. The pureed perangi chili are then mixed with 70 mL of acetone, 15 mL of water, and petroleum ether up to the 100 mL mark on a measuring flask. Next, the mixture is filtered using Whatman No. 1 filter paper. The filtrate is measured using a measuring cylinder [29]. After that, the mixture was centrifuged at 1300 rpm for 5 minutes to separate the organic phase. The organic phase is the red upper layer containing carotenoids, while the aqueous phase is the lower layer [30]. In the next step, the red upper layer is pipetted into a clear vial, which is then sealed with aluminum foil.

The preparation of chili extract for the vitamin C assay was performed by blending the chili in a blender, then weighing out 100 mg and dissolving it in 20 mL of distilled water in a beaker. It was then filtered using Whatman No. 1 filter paper. The filtrate was then diluted with distilled water to the mark in a 100 mL graduated cylinder [31].

Preparation of standard Vitamin A and C solutions

According to Indrawati et al. [32], ppm (parts per million) is the ratio of the concentration of a solute to that of its solvent. To calculate the concentration (ppm), follow these steps:

$$\text{Ppm} = (\text{mg solute})/(\text{solution volume (L)})$$

The preparation of a vitamin A standard solution consists of several steps. First, 10 mg of pure β -carotene is weighed. Next, it is dissolved in acetone, distilled water, and petroleum ether in a 100-mL volumetric flask. A solution with a concentration of 100 ppm is obtained. After that,

pipette 0.5 ml, 1 ml, 1.5 ml, 2 ml, and 2.5 ml of the 100 ppm solution into a 10-ml volumetric flask and dilute to the mark. This yielded β -carotene standard solutions at concentrations of 5, 10, 15, 20, and 25 ppm [33].

The preparation of a vitamin C standard solution consists of two steps. The first step is to add 10 mg of pure ascorbic acid to a 100-mL volumetric flask. Next, dilute with distilled water to the mark to obtain a solution at 100 ppm. The second step involves pipetting 0.2 mL, 0.4 mL, 0.6 mL, 0.8 mL, and 0.10 mL, respectively, into 10-mL volumetric flasks. This yields solutions with concentrations of 2 ppm; 4 ppm; 6 ppm; 8 ppm; and 10 ppm [31].

Determination of Vitamin A and Vitamin C Content

Vitamin A can be analyzed using a UV-1800 Rayleigh spectrophotometer to determine absorbance at wavelengths of 350–550 nm [34], and the results show that the wavelength with the highest absorbance is 431 nm; therefore, this wavelength was selected as the optimal wavelength for further analysis. Meanwhile, vitamin C content was determined using an ascorbic acid solution at wavelengths of 200–400 nm [31], and the results showed that the wavelength with the highest absorption was at 200 nm. The vitamin content of the sample solution was calculated using a regression equation [34]:

$$y = a + bx$$

Information:

a = Regression constant (intercept)

b = Regression coefficient (slope)

y = Area

x = Concentration

The calculation formula for vitamin content in a sample is [34]:

$$C = Cs \cdot Fp \cdot V$$

Information:

C = Sample concentration

Cs = Concentration obtained from the calibration curve regression equation (ppm)

Fp = Dilution factor

V = Total sample volume

Data analysis

Data analysis in this study did not use ANOVA because the data did not meet the assumptions of normality and homogeneity of variance, and thus did not meet the criteria for parametric analysis. The Kruskal–Wallis test was used to compare more than two groups (P1, P2, and P3). Therefore, the nonparametric Kruskal–Wallis test was used, in accordance with the data characteristics, to compare more than two independent groups (P1, P2, and P3) without assuming normality. The entire statistical analysis process was conducted using the Statistical Program for the Social Sciences (SPSS) version 26 and Microsoft Excel.

Results and Discussion

Since the data were not normally distributed and were not homogeneous, they were analyzed using the Kruskal–

Wallis test. If the test results indicated significant differences, the analysis was continued with the Mann–Whitney test.

Vitamin A Content of Peranggi Chili (*Capsicum annuum* L. var. *chinensis*) Planted in Different Growing Media.

Average vitamin A content of peranggi chili (Capsicum annuum L. var. *chinensis*).

The average vitamin A content were 6.04 mg/100 g, 6.28 mg/100 g, and 6.43 mg/100 g for P1, P2, and P3 subsequently (Figure 1). Descriptively, these data indicated differences in vitamin A content among the different growing media treatments. The average vitamin A content in treatments P1, P2, and P3 did not differ significantly ($p = 0.093$; $H = 4.761$) from the vitamin A content of peranggi chili (*Capsicum annuum* L. var. *chinensis*).

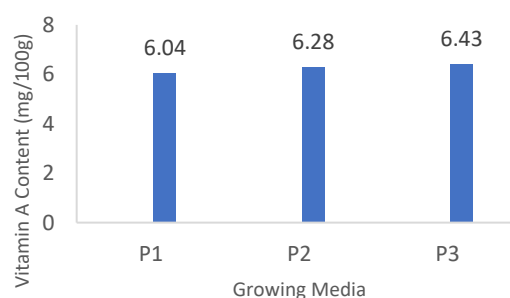


Figure 1. Average Vitamin A Content of Peranggi Chili (*Capsicum annuum* L. var. *chinensis*) in Different Growing Media during Harvest Period.

Average vitamin A content of peranggi chili (Capsicum annuum L. var. *chinensis*) per week during the harvest period.

Measurements were taken from the 16th week through the 23rd week. Weeks during the harvest period that yielded no results for any treatment were not measured due to limited fruit availability.

a. Vitamin A content of peranggi chili (*Capsicum annuum* L. var. *chinensis*) in treatment P1.

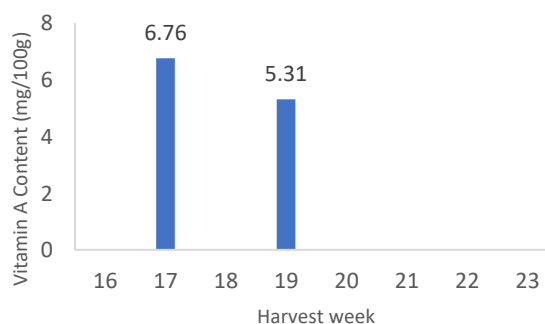


Figure 2. Vitamin A content of peranggi chili (*Capsicum annuum* L. var. *chinensis*) in treatment P1 during harvest period.

The results showed the vitamin A content of peranggi chili in the P1 treatment group from the 17th to the 19th week

showed a decrease during the harvest period. The vitamin A content were 6,76 mg/100g to 5,31 mg/100g for 17th week to 19th week (Figure 2). The vitamin A content of peranggih chili showed a significant difference ($p = 0.050$; $H = 3.857$) in treatment P1 between the 17th and 19th weeks.

- b. Vitamin A content of peranggih chili (*Capsicum annuum* L.var. chinensis) in treatment P2.

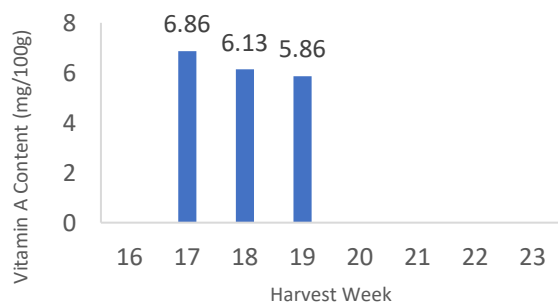


Figure 3. Vitamin A content of peranggih chili (*Capsicum annuum* L. var. chinensis) in treatment P2 during harvest week.

The result showed the vitamin A content of peranggih chili in treatment P2 a decrease during the harvest period. The vitamin A content of peranggih chili in treatment P2 decreased from week 17 to week 19. In treatment P2, the content measured at week 17 was 6.86 mg/100g, then decreased to 6.13 mg/100g in week 18 and to 5.86 mg/100g in week 19 (Figure 3). The vitamin A content of peranggih chili showed a significant difference ($p = 0.039$; $H = 6.489$) in treatment P2 between weeks 17, 18, and 19. In treatment P2, the vitamin A content between weeks 17 and 18 and between weeks 17 and 19 showed a significant difference ($p = 0.050$; $U = 0.000$), whereas there was no significant difference between weeks 18 and 19 ($p = 0.127$; $U = 1.000$).

- c. Vitamin A content of peranggih chili (*Capsicum annuum* L. var. chinensis) in treatment P3.

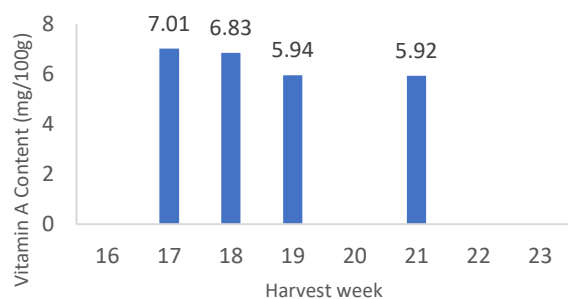


Figure 4. Vitamin A content of peranggih chili (*Capsicum annuum* L. var. chinensis) in treatment P3 during harvest week.

The results showed the vitamin A content of peranggih chili in the P3 treatment group decreased from week 17 to week 21. Vitamin A content in week 17 was 7.01 mg/100g, in week 18 it was 6.83 mg/100g, in week 19 it was 5.94 mg/100g, and it decreased again in week 21 to 5.92 mg/100g (Figure 4). The vitamin A content of peranggih chili showed a significant difference ($p = 0.010$; $H = 11.452$) in treatment P3 between weeks 17, 18, 19, and 21. In treatment P3, the vitamin A content showed no significant difference ($p =$

0.066; $U = 2.000$) between week 17 and week 18. However, between week 17 and week 19 as well as between week 17 and week 21, there was a significant difference ($p = 0.018$; $U = 0.000$). Furthermore, between weeks 18 and 19 and weeks 18 and 21, there was a significant difference ($p = 0.050$; $U = 0.000$), whereas between weeks 19 and 21, there was no significant difference ($p = 1.000$; $U = 4.500$).

One plant known to contain various chemical compounds, including natural pigments, is the chili. Chili is also rich in β -carotene (vitamin A), which helps prevent vision problems and supports throat health [35]. Chilies a horticultural commodity favored by the public because they contain nutrients beneficial to health. Chili can be consumed directly in their raw form or after processing, depending on the intended use [36]. The color of chili is closely related to their carotenoid content. According to Kim et al. [37], carotenoids are responsible for the yellow and red colors in chili varieties. The color change from green to yellow, orange, and finally red indicates the fruit's ripening process, which is accompanied by increased carotenoid synthesis, although degradation of these compounds may occur at certain stages.

Based on the results, the vitamin A content in peranggih chili (*Capsicum annuum* L. var. chinensis) ranges from ± 6 mg/100 g, as reflected by the average values for each treatment: 6.04 mg/100 g (P1), 6.28 mg/100 g (P2), and 6.43 mg/100 g (P3). These findings are consistent with those of Daningsih et al. [38], who reported that the vitamin A content of peranggih chili ranged from 6.91 to 8.68 mg/100 g in samples obtained from the market. When compared to other chili varieties, the vitamin A content of peranggih chili in this study was higher than that of curly red chili (5.57 ± 0.13 mg/100 g) but lower than that of large red chili (10.54 ± 0.07 mg/100 g) [39].

Vitamin A content is influenced by external factors, including the growing medium. The results of the measurements did not indicate that different growing media had an effect on the vitamin A content of peranggih chili (*Capsicum annuum* L. var. chinensis). Research conducted by Nurjismi and Wahyuningrum [40] showed that the growing media did not have a significant effect on the carotenoid content in broccoli microgreens. One factor influencing this condition is the availability of nutrients, particularly nitrogen, which is crucial for protein synthesis. Based on soil analysis results, the nitrogen content in each treatment (P1, P2, P3, and P4) was relatively uniform, at 0.12 mg/L, 0.11 mg/L, 0.09 mg/L, and 0.10 mg/L, respectively. The relatively similar nitrogen content across all treatments is suspected to have resulted in no significant differences in carotenoid content.

In all treatments, there was a decrease in the vitamin A content of peranggih chili (*Capsicum annuum* L. var. chinensis) from the beginning of the harvest week to the next harvest. Mousavi et al. [41] state that in the early stages of sweet corn harvest, higher concentrations of essential nutrients are found, particularly β -carotene and minerals. However, in subsequent harvests, dry matter and sucrose content increase due to ripening, while carotenoid concentrations decrease. the allocation of carbohydrate content in chili plants during subsequent harvests remains unknown because the research focused solely on vitamin analysis. In corn plants, the decrease in β -carotene is generally associated with ripening, which is accompanied by

increased carbohydrate accumulation. Changes in β -carotene in chili plants do not follow the same mechanism as in corn. An'nissa [42] states that during the ripening process of red chili, there is an increase in starch hydrolysis into glucose by the enzyme amylase. Febrianti, Aina, & Farpina [43] state that the ripeness level of chili affects β -carotene content, such that the riper the chili, the higher the β -carotene content produced. However, β -carotene degradation can occur naturally and due to its own composition; for example, unripe green chili or overly ripe chili can affect their β -carotene content. Sunlight and heat influence the oxidation of β -carotene, leading to carotenoid degradation and accelerating the development of a darker color.

Beta-carotene is a pigment that occurs naturally in many plants and photosynthetic organisms. This compound has a distinctive chemical structure and a crystalline form, with colors ranging from reddish-brown to purple. In terms of solubility, beta-carotene is slightly soluble in chloroform and benzene, highly soluble in ether and acetone, but insoluble in water. As part of the carotenoid family, beta-carotene is highly sensitive to the effects of acids, high temperatures, light, and oxygen [44]. According to Marita in Fendri et al. [45], several factors that can influence vitamin content in fruits include planting location, season, harvest time, variety, plant type or species, storage duration, and other factors. Environmental factors such as temperature, water availability, light, and humidity can influence carotenoid formation in plants. Carotenoids function to protect chlorophyll from high light intensity, so their content in plants tends to adjust to the chlorophyll content. On the other hand, genetic differences among plants also influence their ability to synthesize carotenoids. Carotenoids themselves are accessory pigments found within chloroplasts alongside chlorophyll [11].

Vitamin C Content of Peranggi Chili (*Capsicum annuum* L. var. *chinensis*) Planted in Different Growing Media.

Average vitamin C content of peranggi chili (Capsicum annuum L. var. *chinensis*).

The average vitamin C content in treatment P1 was 1,311.36 mg/100 g, in treatment P2 it was 1,827.24 mg/100 g, and in treatment P3 it was 2,279.68 mg/100 g (Figure 5).

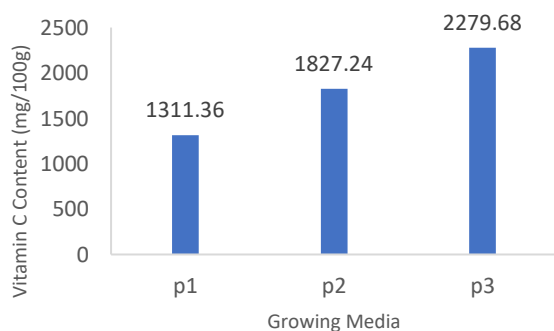


Figure 5. Average Vitamin C Content of Peranggi Chili (*Capsicum annuum* L. var. *chinensis*) in Different Planting Media until the End of Harvest.

Descriptively, these data indicated differences in vitamin C content among the different growing media treatments. Based on the results of the Kruskal-Wallis non-

parametric test, the growing media had a significant effect ($p = 0.012$; $H = 8.804$) on the vitamin C content of peranggi chili plants. Based on the results of the Mann-Whitney post-hoc test, there were significant differences between treatments P1 and P2 ($p = 0.001$; $U = 0.000$) and between P1 and P3 ($p = 0.029$; $U = 17.000$) regarding the vitamin C content of peranggi chili (*Capsicum annuum* L. var. *chinensis*). Meanwhile, the comparison between treatments P2 and P3 ($p = 0.161$; $U = 44.000$) showed no significant difference in the vitamin C content of peranggi chili (*Capsicum annuum* L. var. *chinensis*).

Average vitamin C content of peranggi chili (Capsicum annuum L. var. *chinensis*) per week during harvest period.

a. Vitamin C content of peranggi chili (*Capsicum annuum* L. var. *chinensis*) in treatment P1.

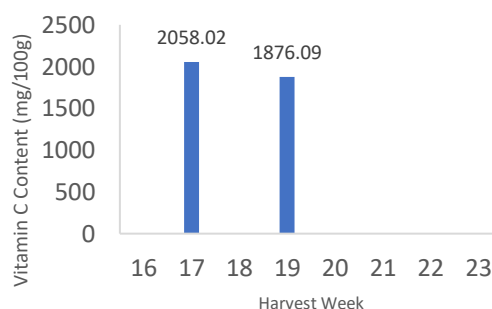


Figure 6. Vitamin C content of peranggi chili (*Capsicum annuum* L. var. *chinensis*) in treatment P1 during harvest week.

The results showed the vitamin C content measured in week 17 was 2,058.02 mg/100 g, and then decreased in week 19 to 1,876.09 mg/100 g (Figure 6). The vitamin C content of peranggi chili showed a significant difference ($p = 0.012$; $H = 8.804$) in treatment P1 between weeks 17 and 19.

b. Vitamin C content of peranggi chili (*Capsicum annuum* L. var. *chinensis*) in treatment P2.

The results showed the vitamin C content of peranggi chili in treatment P2 decreased during the harvest period. Vitamin C content in week 17 was 2,612.27 mg/100g, then decreased in week 18 to 2,392.24 mg/100g and decreased again in week 19 to 2,304.44 mg/100g (Figure 7).

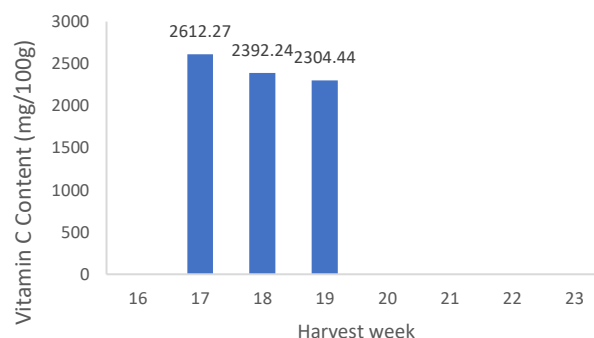


Figure 7. Vitamin C content of peranggi chili (*Capsicum annuum* L. var. *chinensis*) in treatment P2 during harvest week.

The vitamin C content of the peranggi chili showed a no significant difference ($p = 0.051$; $H = 5.956$) in treatment P2 between weeks 17, 18, and 19.

c. Vitamin C content of peranggi chili (*Capsicum annuum* L. var. chinensis) in treatment P3.

The results showed the vitamin C content of peranggi chili in treatment P3 showed a downward trend during the harvest period. The vitamin C content in week 17 was 2,776.64 mg/100g, then decreased in week 18 to 2,552.59 mg/100 g and decreased again in week 19 to 2,487.96 mg/100 g, and in week 21 to 1,801.54 mg/100 g (Figure 8).

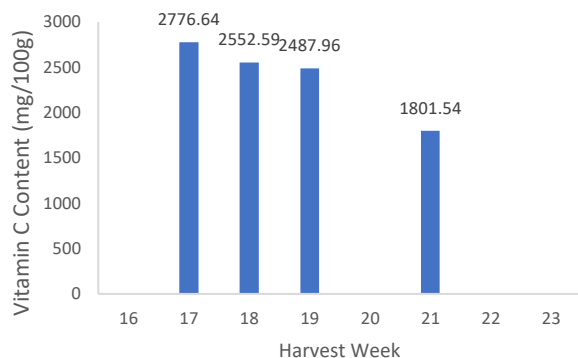


Figure 8. Vitamin C content of peranggi chili (*Capsicum annuum* L. var. chinensis) in treatment P3 during harvest week.

The vitamin C content of the peranggi chili showed a significant difference ($p = 0.007$; $H = 12.225$) in treatment P3 between weeks 17, 18, 19, and 21. In treatment P3, the vitamin C content between weeks 17 and 18, weeks 17 and 19, and weeks 17 and 21 showed a significant difference ($p = 0.020$; $U = 0.000$). However, no significant difference was observed between weeks 18 and 19 ($p = 0.513$; $U = 3.000$), whereas significant differences were observed between weeks 18 and 21 and between weeks 19 and 21 ($p = 0.050$; $U = 0.000$).

Fluctuation of vitamin A and C during harvest period.

Vitamin A and C content during the harvest period can be illustrated as highest at the beginning of harvest, then decline at the following harvest until steady content towards the end of harvest.

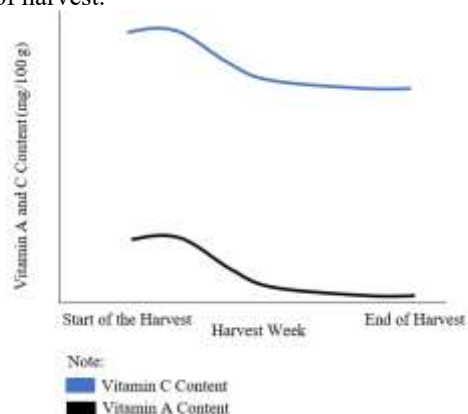


Figure 9. Illustration of vitamin A & C content of peranggi chili during the harvest period.

Vitamin C is found in fruits and vegetables, one of which is chili. The vitamin C in chili acts as an antioxidant that is beneficial for the body and helps improve the body's ability to absorb calcium [46].

Based on the results, the vitamin C content of peranggi chili (*Capsicum annuum* L. var. chinensis) under various growing media treatments showed differences among the treatments. Treatment P3 showed the highest vitamin C content, namely 2,439.06 mg/100g, followed by P2 at 1,827.24 mg/100g and P1 at 1,433.91 mg/100g. When compared to previous studies, the vitamin C content in the peranggi chili in this study was higher than that of large curly red chili reported by Hasana, Aina, and Suryani [47], which was 1,351.32 mg/100 g. Furthermore, in the highest treatment (P3), the vitamin C content of peranggi chili was also higher than that of large red chili reported by Husna and Kurniaty [31], which was 2,242 mg/100 g.

Based on the results of the Kruskal-Wallis test, differences in growing media had a significant effect ($p = 0.012$) on the vitamin C content of Peranggi chili (*Capsicum annuum* L. var. chinensis). Descriptively, there were differences in the mean vitamin C content among treatments P1 through P3, indicating that differences in growing media may influence vitamin C formation in the plants. Based on the results of the Mann-Whitney post-hoc test, there were significant differences between treatments P1 and P2 ($p = 0.001$) and P1 and P3 ($p = 0.029$) regarding the vitamin C content of Peranggi chili (*Capsicum annuum* L. var. chinensis). Meanwhile, a comparison between treatments P2 and P3 ($p = 0.161$) did not reveal a significant difference.

The difference between P1 and P2 was due to the addition of perlite in the P2 treatment. This is consistent with Lee et al [48], who stated that bioactive compounds and antioxidant activity (AA) increase with aeration. Proper aeration of the root zone is effective for higher fruit yield and fruit bioactivity in perlite culture; however, excessive aeration inhibits root respiration, nutrient uptake, bioactivity, and water absorption, thereby reducing plant growth and fruit yield.

The difference between P1 and P3 was due to the addition of charred rice husks in treatment P3. Charred rice husks are known to improve the physical and chemical properties of growing media, such as increasing porosity, aeration, and the media's water-holding capacity, thereby creating better root conditions [49]. These conditions support the uptake of water and nutrients, which are involved in vitamin C synthesis. The results of this study are consistent with those of Mulya, Nugraha, and Parlinah [50], who reported that the use of burnt rice husks as a growing media can increase the vitamin C content in green spinach.

P2 and P3 are not significantly different because P2 has a higher potassium content ($K\ P2 = 3.35$; $K\ P3 = 1.42$), while P3 has a higher phosphorus content ($P\ P2 = 21.83$; $P\ P3 = 37.69$). Potassium helps enhance photosynthesis and transport the products of photosynthesis to the fruit, while phosphorus aids in the formation of metabolites, including ascorbic acid. The differences between these two elements have not yet resulted in a significant difference in vitamin C content [51].

In all treatments, there was a decrease in the vitamin C content of peranggi chili (*Capsicum annuum* L. var. chinensis) from the beginning of the harvest week to the next harvest. Sari et al. [12] explain that the vitamin C content in

tomatoes increases from 45 to 63 days after sowing, then decreases at 72 days after sowing. This change indicates that vitamin C levels are closely related to the fruit's ripeness. Consistent with these findings, Rahman et al. [52] reported that tomatoes at optimal ripeness have higher vitamin C content compared to unripe fruits or those that have passed the ripening phase. The decrease in vitamin C content in overripe fruit is associated with increased sugar content, which contributes to vitamin C degradation. Dewi [53] also noted that as tomatoes ripen, vitamin C levels decrease. This is because vitamin C is the most easily oxidized vitamin, and this process is accelerated by light, heat, alkali, and the fruit's age. Overripe fruit is associated with the release of the hormone ethylene, which activates transcription of genes for enzyme synthesis that inactivate vitamin activity. Additionally, low vitamin C levels may result from the antioxidant response to repair tissue damage caused by increased free radicals within plant cells [12].

Differences in vitamin C content are influenced by the environmental conditions in which plants grow, primarily through metabolic processes such as biochemical reactions and the formation of secondary metabolites. Environmental factors such as temperature, humidity, and light intensity and duration vary with altitude, which can induce stress in plants [54]. During ripening, fruits undergo chemical changes, including shifts in sugar, acid, and vitamin C levels. Vitamin C content is influenced by fruit type, growing conditions, ripeness level at harvest, and postharvest handling. Another factor that can influence vitamin C content is genetic factors that determine crop yield, such as taste, aroma, chemical composition, nutritional value, and productivity [55].

Thus, the results of the analysis indicate that differences in growing media did not have a significant effect

on the vitamin A and vitamin C content of peringgi chili. Treatment P4 was not tested for vitamin A and C content because it did not yield sufficient production for analysis, due to low soil pH. According to Ramdhan [56], the addition of immature organic matter or material still undergoing decomposition will cause a decrease in soil pH, as organic acids are released during the decomposition process, lowering the soil pH. Although there were data limitations for several weeks due to insufficient sample numbers, in general, vitamin A and C content tended to be higher at the beginning of the harvest period and decreased over the following weeks (Figure 9). Therefore, the timing of harvest before full maturity is reached should be considered in future research.

Environmental Factor Measurement

Average measurement of environmental factors over the harvest period. Differences in growing media P1, P2, and P3 did not have a significant effect on the vitamin A and C content of peringgi chili (*Capsicum annuum* L. var. *chinensis*). Measurement results showed that the soil pH for treatment P1 was 6.2; for P2, 5.9; for P3, 5.8; and for P4, 4.7. Subhan et al. [57] state that the ideal soil pH range for chili growth is between 5.5–6.8, as plant production tends to be low at pH levels below 5.5 or above 6.8. Supit, Kamagi, & Karamoy [58] also state that acidic soil and low soil pH result in reduced nutrient availability for plants, increasing toxicity of soil elements, and decreasing crop productivity. To obtain samples from each treatment across different harvests. To obtain more fruit at harvest, a field-scale, field-level, or large-scale approach is needed to ensure consecutive harvests yield more fruit and provide adequate vitamin A and C analysis.

Table 1. Average of environmental factor measurements.

Week	Light Intensity (W/m ²)	Wind Speed (m/s)	Humidity (%)	P1		P2		P3		P4	
				Soil Temperature (°C)	pH	Soil Temperature (°C)	pH	Soil Temperature (°C)	pH	Soil Temperature (°C)	pH
16	174.3	0.1	71.1	30.7	6.1	31.1	5.8	31	5.7	30.8	4.5
17	172	0	75.7	32.2	6.4	32.4	6.1	32.4	6.1	31.9	5.3
18	142	0	67.4	29.1	6.2	29.4	5.8	29.4	5.9	29.7	4.6
19	206.8	0.2	71.8	29.9	6.2	30.2	5.6	30	5.4	30	4.5
20	176.6	0	69.4	31.5	6.2	31.8	5.9	31.8	5.9	31.9	4.5
21	170	0.1	73.7	28.7	6.2	29.4	6.1	29.7	5.8	29.6	4.7
22	155	0.1	74.4	29.6	6.1	29.9	5.4	29.9	5.7	29.6	4.9
23	146.6	0	72.9	29.1	6.1	28.8	6.1	29.3	5.9	28.9	4.7
Average	167.94	0.1	72.05	30.1	6.2	30.4	5.9	30.4	5.8	30.3	4.7

The average environmental conditions were: light intensity of 167.94 W/m², wind speed of 0.1 m/s, and humidity of 72.05%. Relatively, soil temperature and pH were measured for each treatment. The soil temperatures were 30.1°C, 30.4°C, 30.44°C, and 30.3°C for P1, P2, P3 and P4, respectively. Meanwhile, the soil pH value showed variations with an average of P1 (6.2), P2 (5.9), P3 (5.8), and P4 (4.7) (Table 1).

Conclusion

The vitamin A content of peringgi chili (*Capsicum annuum* L. var. *chinensis*) under various growing media treatments showed no significant differences. Vitamin A content ranged from 6.04 to 6.43 mg/100 g, while vitamin C content showed significant differences among growing

media treatments, ranging from 1,131.36 mg/100 g to 2,279.68 mg/100 g. During the harvest period, vitamin content in each treatment tended to decrease. Vitamin A and vitamin C content tended to be higher at the start of the harvest and decreased in subsequent harvests across all treatments. Treatment P4 resulted in low soil pH, is not recommended as a growing media for the cultivation of peringgi chili. Further testing on a larger field scale is required to ensure sufficient fruit yield per harvest for vitamin A and C analysis, thereby verifying fluctuations in vitamin A and C content across harvests. Additionally, further research is recommended to optimize the use of NPK fertilizer to increase nutrient availability for the plants, thereby improving the growth, yield, and quality of Peranggih chili.

Author's Contribution

E. Delima: Investigation, Data Collection, Data Curation, Data Analysis, and Writing Original Draft. E. Daningsih: Conceptualization, Methodology, Supervision, and Writing, Review, and Editing; Corresponding Author. A.N. Mardiyyaningsih: Data Analysis, Validation, and Writing, Review, and Editing. All authors reviewed and approved the final version of the manuscript.

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