Anadolu Tarım Bilimleri Dergisi,
Anadolu Journal of Agricultural Sciences

e-ISSN: 1308-8769, ANAJAS June 2022, 37 (2): 373-386

The Effect of Used Different Waste Growing Media on Soilless Lettuce Cultivation

Kullanılmış Farklı Yetiştirme Ortamlarının Topraksız Marul Yetiştiriciliğine Etkisi

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Makale Bilgisi / Article Information

Makale Türü / Article Types: Araştırma Makalesi / Research Article
Geliş Tarihi / Received: 23 Kasım / November 2021
Kabul Tarihi / Accepted: 18 Şubat / February 2022
Yıl / Year: 2022 | **Cilt – Volume:** 37 | **Sayı – Issue:** 2 |**Sayfa / Pages:** 373-386

Atıf/Cite as: Kilim, M., Yörük, E. Hazneci, E. Özer, H., ve Gürdil, G. A. K. "The Effect of Used Different Waste Growing Media on Soilless Lettuce Cultivation". *Anadolu Journal of Agricultural Sciences*, 37(2), June 2022: 373-386.

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https://doi.org/10.7161/omuanajas.1027549

THE EFFECT OF USED DIFFERENT WASTE GROWING MEDIA ON SOILLESS LETTUCE CULTIVATION

ABSTRACT:

This study investigated the effects of reusing the growing media (TSW; tomato stalk waste, PTSW; pretreated tomato stalk waste, Peat + Perlite, Cocopeat) used in soilless agriculture on soilless lettuce cultivation. Significant effects of growing media on stem diameter, root length, total dry weight, yield, titratable acidity, SSC and Vitamin C values of lettuce (Maritima) grown without soil were determined ($p<0.05$; $p<0.01$). As a result, the highest root length (33.63 cm), total dry weight (27.22 g) and yield (558 g plant^{-1}) were obtained from TSW medium. The highest titratable acidity values (1.05 g 100 mL^{-1}) and Vitamin C (391.6 mg 100 g^{-1}) were obtained from PTSW medium. It has been determined that TSW and PTSW media can compete with growing commercial media, especially in yield and quality. The second use of the growing medium created from tomato waste significantly reduced the production costs. As a result, it has been determined that tomato waste (TSW) is a good alternative for productivity and profitability instead of a commercial growing medium.

Keywords: *Cocopeat, Peat, Perlite, Tomato Waste, Cost, Gross Profits.*

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KULLANILMIŞ FARKLI YETİŞTİRME ORTAMLARININ TOPRAKSIZ MARUL YETİŞTİRİCİLİĞİNE ETKİSİ

ÖZ:

Bu çalışmada, topraksız tarımda kullanılan yetiştirme ortamlarının (DA; domates sap atığı, ÖDA; ön işlem görmüş domates sap atığı, Torf + Perlit, Hindiscan cevizi lifi) tekrar kullanımının topraksız marul yetiştiriciliği üzerindeki etkileri araştırılmıştır. Topraksız olarak yetiştirilen marulun (Maritima) gövde çapı, kök uzunluğu, toplam kuru ağırlık, verim, titre edilebilir asitlik, suda çözünebilir kuru madde ve C vitamini değerleri üzerine yetiştirme ortamının önemli etkileri belirlenmiştir ($p<0.05$; $p<0.01$). En yüksek kök uzunluğu (33.63 cm) toplam kuru ağırlık (27.22 g) ve verim (558 g bitki^{-1}) DA ortamından elde edilmiştir. En yüksek titre edilebilir asitlik değerleri (1.05 g 100 mL^{-1}) ve C vitami (391.6 mg 100 g^{-1}) ÖDA ortamından elde edilmiştir. DA ve ÖDA ortamları, özellikle verim ve kalite açısından ticari yetiştirme ortamları ile rekabet edebilir durumda olduğu belirlenmiştir. Domates atıklarından oluşturulan yetiştirme ortamının ikinci kez kullanılmasının üretim maliyetlerini önemli ölçüde azaltmıştır. Sonuç olarak, ticari yetiştirme ortamı yerine domates atığının (DA) verimlilik ve karlılık yönünden iyi bir alternatif olduğu belirlenmiştir.

Anahtar Kelimeler: *Hindistan Cevizi Lifi, Torf, Perlit, Domates Atığı, Maliyet, Brüt Kar.*

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1. INTRODUCTION

Lettuce, which is in the group of vegetables whose leaves are eaten, is one of the vegetables with the highest production (520,000 tons) and consumption (İşlek and Kuzucu; TUIK 2021). Salad and lettuce, which can be grown outdoors in all regions of our country (except for June and August), are grown throughout the year in greenhouses and low plastic tunnels to take advantage of the high prices, especially in winter. Since lettuce is a vegetable that can grow in a short time, continuity in the market can be ensured by periodically planting and harvesting it, especially under the greenhouse (Sönmez, 2010; İşlek and Kuzucu 2018).

In greenhouse vegetable cultivation, traditional techniques have caused an increase in environmental pollution and soil-based problems. This situation has led producers to soilless cultivation systems (Leonardi, 2004). Today, water scarcity is experienced globally and affects crop production significantly. The use of soilless cultivation systems in agriculture gains tremendous importance in preventing water scarcity that occurs on a global scale (Saraçoğlu et al., 2020). The soilless cultivation technique is much more controlled than the classical cultivation technique. Solid media culture is widely used in commercial plant cultivation. Many growing media are used in soilless farming. The cost of materials used in solid media culture is one of the most important reasons for preference. The material must be readily and continuously available and inexpensive. Coconut fiber and rock wool are the most commonly used materials in solid media culture in Turkey. The costs of these imported materials are pretty high (Dönmez et al., 2016). There is no commercially available, cheap and suitable environment for soilless agriculture in our country (Varış and Eminoğlu, 2003). With the increase in agricultural production globally and in our country, vegetable harvest waste and agricultural industry waste increase yearly. These plant-based wastes are a severe source of organic matter; they also have significant potential in the plant nutrients they contain. At the same time, these wastes can also be used as a plant growing medium with appropriate mixtures (Çıtak et al., 2007; Özer and Uzun, 2013).

Approximately 13 million tons of tomatoes are produced in our country (TUIK 2021). According to one study, tomato greenhouses in Antalya produce 112 tons of waste as dry matter each year (Kürklü et al., 2004). Considering that soilless agricultural areas in Turkey exceed 8000 decares and the most critical species produced in these areas is tomato, it will transform tomato waste into a growing medium with a simple system. This study aims to help primarily producers create a growing environment by using their waste.

2. MATERIALS AND METHODS

2.1. Experimental Site

The study was carried out at Ondokuz Mayıs University, Faculty of Agriculture, Horticulture. Lettuce seedlings (*Lactuca sativa* var. *crispa* 'Maritima') were planted in bags inside the growing trays (5 m long, 25 cm wide) in the glass greenhouse (4x8.8m) on October 15, 2019.

In the study, four different growing media were used. Tomatoes were grown in the same growing media before. Two different growing media (**TSW**; tomato stalk waste and **PTSW**; pretreated tomato stalk waste) obtained from tomato wastes were used. In addition, growing bags consisting of a mixture of **Cocopeat** and peat+perlite (**peat+perlite**; 65%+ 35%) were used as control commercial growing media. At the beginning of the study, all media were used precisely, except for the TSW environment. Tomato waste was added as a 10% volume reduction was detected in the previous growing period in the TSW medium. Tomato wastes were prepared from post-harvest fresh tomato waste grown in our greenhouses. First, tomato wastes were ground on an 8 mm sieve (Bilgin et al., 2016). Physical analyses such as organic matter, bulk weight, water holding capacity, and chemical analyses such as EC and pH (Table 1) were performed (Kacar and İnal 2008, Gülser and Pekşen 2003). Tomato stem waste to be used directly was disinfected with formaldehyde. It was carried out by spraying a mixture of formaldehyde (540 ml) and water (20 L) onto the waste. At the end of this process, repeated four days later, the tomato wastes (TSW; 21 L/bag) were bagged, waiting for three fertilizers. The dry weight of tomato waste was 91.3 g m-1 (leaf and stem), and the dry weight of 1 growing bag was determined as 25.2 kg.

Table 1. Physical properties of growing media

Growing media	pH	EC (ms cm^{-1})	Organic matter (%)	Water hold capacity (kg)	C/N (%)	Volume weight (g/cm^3)
TSW	6.6	0.9 a*	71.3 b	6.3 c	27.49 a	0.12 b
PTSW	5.7	0.6 b	63.6 b	4.6 c	16.95 b	0.27 a
Peat + Perlite	5.8	0.5 b	46.9 c	13.2 b	22.37 b	0.34 a
Cocopeat	6.2	0.5 b	99.0 a*	43 a*	32.19 a*	0.08 b

*: $p < 0.05$. TSW: Tomato stalk waste, PTSW: pretreated tomato stalk waste

Pretreated tomato stem waste; tomato waste was determined by considering the C:N ratio (Table 1). Accordingly, 210 liters of tomato waste were wetted with a solution (100 L) obtained from a mixture of urea (1 kg), barnyard manure (3 kg), granulated sugar (1 kg) and forest soil (5 kg). Then a pile was formed and covered with transparent nylon. The pile was regularly temperature-controlled to

https://doi.org/10.7161/omuanajas.1027549

complete the semi-composting process. While the heap temperature was 12.1 oC at the beginning, it reached its highest, 62.6 oC, at the end of the process. Then the cooling process started and the temperature dropped to 11.1 °C. Next, pretreated tomato waste (PTSW) was packed into grow bags (21 L/bag).

Table 2. Macro and micronutrient solutions and ratios to be applied in soilless culture (Hoagland ve Arnon, 1938; Day, 1991)

	Elements	mg/l	Chemicals used	
Stock (A)	N	150	Ammonium nitrate	NH_4NO_3 (%33)
	K	150	Potassium nitrate	KNO_3 (%13 N, %46 K)
	Ca	150	Calcium nitrate	$5Ca(NO_3)_2.NH_4NO_3.10H_2O$ (%15.5 N, %19 Ca)
	Fe	5	Iron chelate	Na_2.Fe-EDTA (%12.5 Fe)
Stock (B)	P	40	Phosphoric acid	H_3PO_4 (%85)
	Mg	50	Magnesium sulfate	$MgSO_4.7H_2O$ (%10Mg)
	Zn	0.50	Zinc sulfate	$ZnSO_4.7H_2O$
	Mn	0.75	Manganese sulfate	$MnSO_4.H_2O$
	B	0.4	Boric acid	H_3BO_3
	Cu	0.10	Copper sulfate	$CuSO_4.5H_2O$
	Mo	0.05	Ammonium molybdate	$(NH_4)6Mo_7O_{24}.4H_2O$

TSW, PTSW, Peat+Perlite and **Cocopeat** were prepared by opening drainage and ventilation holes in the growing bags. Growing media bags were placed in the greenhouse in 5.5 m long, 25 cm wide, and 1.5% inclined channels. Macro and micronutrients used in fertilization were prepared as stock solutions in 2 tanks with a volume of 300 liters (Table 2). Fertilization was done five times a day and at 20-minute intervals throughout the growing period. Fertilization application with a drip irrigation system was carried out at 2 hour intervals. E.C. and pH were measured continuously in the growing environment's drained water from the seedling planting to the harvest. When the salinity was high, the environments were only washed at 10-minute intervals. In this way, the salinity of the environment is reduced. In addition, water was passed through the environments once a week for 10 minutes with the irrigation tank.

In the study, greenhouse temperature (°C), relative humidity (%) and temperature values of growing media were measured from planting to the end of harvest with a data logger (KT100, Kimo, France) during the growing period. The measurement values are given in Table 1. as mean, highest and lowest values.

Table 3. Indoor air temperatures, relative humidity and light intensity value

	Temperature (°C)	Humidity (%)	Light (lux)
Average	16.53	69.38	2930
Highest	23.48	97.56	7383
Smallest	7.43	36.77	181

Seedlings of the Bandita F1 tomato variety (40 cm between rows and 30 cm in rows) were planted in their growing bags on October 15, 2019. On the day of planting, only vital water (200 ml/plant) was given to the plants and nutrient solution was started to be given the following day of planting. Pruning was carried out to remove the yellowed and diseased leaves with the shoots emerging from the leaf axils, which are widely used in tomato cultivation. The old leaves under the harvested clusters were wholly removed by paying attention to leaving five fruits per cluster. 2 leaves are left under the next green fruit cluster. It has been applied in any other maintenance, spraying and cultural processes necessary during the growing period. Seat purchase was made once or twice a week.

2.1. Determination of Plant Characteristics

Plant height, stem diameter and the number of leaves were measured at 15-day periods. The plant height was determined in cm with a ruler and the stem diameter in mm with a caliper. Root length values were measured in cm at the end of harvest in lettuce plants. Leaves and roots separated from the plant were placed in small paper bags separately and placed in an oven at 80 °C. The drying process was carried out for at least 48 hours. It was decided whether the drying process was completed by applying the weight change method on the samples that did not complete their drying in this period. When it was understood that the samples were dehydrated, the dry weights of the leaves, root and stem were weighed with a balance sensitive to 0.01 g.

Leaf chlorophyll content (CCI) and stomatal conductance (mmol m-2 s-1) were measured with a chlorophyll meter (CCM-200, Opti-Sciences, USA) and porometer (SC-1, Decagon Devices, The USA), respectively in young, middle-aged and old leaves. The fruits from the first harvest to the last harvest date were weighed using an electrical balance with 0.1 g accuracy. The yield per plant (g plant-1) was calculated by adding all weights. While calculating the yield values, the fresh weights of the harvested lettuce plants were calculated by weighing them in grams. To measure soluble dry matter, ten fruits from each replication were cut into slices, crushed with an electric mixer to prepare pulp and filtered through cheesecloth to get clean juice. Juice samples were read on a digital refractometer (PAL-1, McCormick Fruit Tech. Yakima, ABD), with soluble solid content expressed as a percentage (%). Titratable acidity was measured by taking 10 ml of juice, diluting with 10 ml of distilled water and titrating it with 0.1 N sodium hydroxide (NaOH) to an endpoint of 8.1 pH. Titratable acidity was expressed as citric acid (g citric acid 100 ml-1) based on the NaOH volume used in the titration. A 25 g tomato sample from each replication was taken to determine vitamin C. Samples were crushed with a Waring commercial blender (Blender 8011ES, ABD) by adding 25 ml oxalic acid (0.4%), and the filtrate was filtered with filter paper. The amount of vitamin C (L-ascorbic acid) was measured with a spectrophotometer at a wavelength of

518 nm (AOAC 1995) using the titrimetric method 2.6-dichloroindophenol. The results (wet weight of vitamin) were given in mg vitamin C 100 g-1 fresh weight. The lettuce skin color of the tomatoes was measured as Chroma and hue angle on equatorial sides of fruits using a colorimeter (Minolta, model CR–400, Tokyo, Japan) in 10 randomly selected fruits from each replicate plot (McGuire, 1992).

2.2. The Method Used to Calculate Production Costs and Profitability

The research was conducted at the Ondokuz Mayıs University Faculty of Agriculture trial area, using pre-existing equipment and environment. It is known that fixed costs will not be affected when the inputs used in production change. For this reason, depreciation, preservation costs, land rent, etc. Fixed costs are not considered, and only variable costs are taken into account. The differences in the variable costs of the change in the lettuce production environment were examined. For the same reason, the cost of the farmyard was calculated in the research, and the marketing and transportation costs were not included in the calculation. The study was carried out in a trial area of approximately 10 m^2.

Depending on the production, costs that increase or decrease are called variable costs (Cinemre, 2013). Variable costs in tomato production in soilless agriculture; production environment preparation, seedling cost, agricultural control (fertilization), maintenance expenses and labor costs (planting, maintenance, etc.), irrigation and labor cost, revolving fund interest. It was the revolving fund interest of T.C. It was calculated over half of the loan interest rate opened by Ziraat Bank for crop production (Kıral et al., 1999). In the lettuce production process, drugs that are expected to be included in variable costs were not required.

While comparing the profitability of lettuce production in soilless agriculture in different environments, the gross profit calculation was used (Eq.1). For this, first of all, the Gross Production Value (GPV), which is obtained by multiplying the product price with the yield values, was calculated, and then the variable costs were subtracted from the GPV and the gross profits was reached (Açıl and Demirci, 1984; Kral et al., 1999; Tanrıvermiş, 2000). Gross profits show the unit income provided to the business in the event of activity and reflect the relative advantages of the activities relative to each other (Cinemre, 2013). For this reason, the gross profit calculation method was used in the study to compare the profitability of different lettuce production environments in soilless agriculture and the profitability of production activities.

$$Gross\ profits = GPV - Variable\ Costs\ (VC) \quad \text{(Eq.1)}$$

The production environments used in the research can participate in the production activity during the two production cycles. For this reason, while calculating the production costs, the variable costs of these production environments were accepted as semi-variable costs. The calculated costs were divided into two and the study was carried out. Prepared production environments were used in the production of two different products.

For this reason, lettuce can be included in the production period 3 times in the same production environment in the relevant period. However, in this study, the growing process of lettuce was observed during only one production period in the soilless agriculture trial area. For this reason, while calculating the costs of lettuce production, the typical costs (tomato waste grinding process and production environment preparation) were calculated by dividing them into three. Other cost elements may differ according to the production period. In addition, approximately 15% loss occurred due to tomato production in the volume weight of tomato waste (TSW) prepared at the beginning. Therefore, the same amount of waste was added before the start of lettuce production and included in the costs.

2.3. Statistical Analysis

The experiment data were analyzed using a split-plot design with 9 plants in each replication with three replications. Experimental results were assessed through Microsoft Excel 2010 and SPSS 15.0 software. Means were compared with Duncan's multiple range tests at $p < 0.05$ and $p < 0.01$.

3. RESULTS AND DISCUSSION

Significant effects of different growing media (TSW, PTSW, Peat+Perlite and Cocopeat) on stem diameter, root length and total dry weight were determined. The highest stem diameter (19.12 mm) values were obtained in the coconut fiber medium, while the lowest stem diameter (13.59 mm) values were determined from the PTSW medium. The maximum root length and total dry weight values were measured from TSW medium. Other environments showed similarities between root length and total dry weight values (Table 4). In the study investigating the effects of different fertilizers in organic lettuce cultivation, it was determined that the plant height values in lettuce varied between 18 and 25.3 cm. In the same study, it was reported that the leaf number values ranged from 23.7 to 59.3 (Tüzel et al., 2012). Although similar values were obtained in our study, no statistical difference was determined between the applications. Can et al. (2019) investigated the effects of different bat fertilizers on lettuce cultivation, and stem diameter values varied between 21-29 mm. In the study in which the salt tolerance of different varieties in soilless lettuce cultivation was determined, it was determined that the dry weight value increased despite the decrease in root dry fresh weights with the increase in salt concentrations (Bartha et al., 2015; Saraçoğlu et al., 2020). In our study, the highest root length value was determined in the medium (TSW) with the highest

EC (0.9 ms cm-1) value (Table 1) among the growing media. TSW environment was determined in the total dry weight values for which we obtained similar values (Table 4).

Table 4. Effects of different growing media on stem diameter, plant height, number of leaves, root length and total dry weight of lettuce

When the effects of growing media on leaf chlorophyll content, leaf stomatal

Growing media	Stem diameter (mm)	Plant height (cm)	Number of leaves	Root length (cm)	Total dry weight (g)
TSW	16.43 ab	22.40	36.00	33.63 a	27.22 a*
PTSW	13.59 b	22.17	37.33	28.87 ab	19.57 b
Peat + Perlite	15.52 ab	22.70	35.67	18.93 b	19.82 b
Cocopeat	19.12 a	20.97	34.67	19.80 b	20.50 b
Significance	**	ns	ns	*	*

*: $p < 0.05$. **: $p < 0.01$. ns: non-significant

conductivity and yield values were examined, only the yield values were statistically significant (p<0.01). The highest leaf chlorophyll content (7.63 CCI), leaf stomatal conductivity (138 mmol m^{-2} s^{-1}) and yield value (558 g plant-1) were obtained from TSW application. The lowest yield value was determined from Peat+Perlite medium with 410 g (Table 5). One of the factors affecting stomatal conductivity is salt stress. Plants exposed to salt stress tend to reduce water loss through transpiration (Munns and Tester, 2008; Bartha et al., 2015). Another important factor is irrigation irregularity. Insufficient moisture on the soil surface increases the tendency of stomata to close. Plants with high stomatal conductivity reach the highest yield (Özer, 2017a). In our study, although the EC values of the TSW medium were high and the water holding capacity of the medium was low, the stomatal conductivity values were higher. Although the stomatal conductivity was not statistically significant, its highness significantly affected the yield. While the average yield values ranged between 288-345 g in lettuce grown in soil, it was determined that it varied between 332 and 584 g in soilless lettuce cultivation (Çakmak, 2011; Tüzel et al., 2012). Similar yield values in growing media were found and the amount of organic matter (Table 1) was high.

Table 5. Effects of different growing media on kroma, hueo. leaf chlorophyll content, stomatal conductance and yield of lettuce

Growing media	Leaf chlorophyll content (CCI)	Stomatal conductance (mmol m^{-2} s^{-1})	Yield (g $plant^{-1}$)
TSW	7.63	138	558 a
PTSW	6.80	127	535 ab
Peat + Perlite	7.45	120	410 b
Cocopeat	7.02	124	478 ab
Significance	ns	ns	**

*: $p < 0.05$. **: $p < 0.01$. ns: non-significant

The effect of different growing media on color values (Chroma and Hueo) in soilless lettuce cultivation was insignificant. However, the highest color (Chroma; 30.31 and Hueo; 134.9) values were determined from TSW (tomato stalk waste) media. The application of PTSW (pretreated tomato stalk waste) resulted in the highest statistically significant titratable acid (1.05 g 100 mL-1) and vitamin C (391.6 mg 100 g-1) contents. Peat + Perlite medium had the highest soluble solid content determined from Peat + Perlite medium with 4.17%. In addition, the lowest titratable acid (0.62 g 100 mL-1), water-soluble dry matter (3.53%) and vitamin C (281 mg 100 g-1) values were determined from the coconut fiber medium (Table 6). Tüzel et al. (2012) found similar Croma (28-35) and Hue (123-125) values to our results. A study investigating the effects of different salt concentrations on soilless lettuce cultivation stated that vitamin C values varied between 9.95-6.91 mg g-1. Although our results are similar to the findings of Saraçoğlu et al., (2020), it is thought that the increased vitamin C content is due to stress conditions. Because, while the water holding capacity, organic matter content and EC values (Table 1) of the cocopeat medium gave better results, vitamin c and titratable acidity values decreased. In his study, Özer (2017b) stated that vitamin C and titratable acid values increased in tomatoes, especially under stress conditions. Contrary to these results, soluble solid content was measured in Peat+Perlite medium, which has lower values in terms of organic matter (Table 1-6). It is stated that the titratable acidity values of organic and conventionally grown lettuce in soilless cultivation vary between 0.09 and 0.17 %. In the same study, it was determined that SSC values (2.90-3.50%) were similar to our study (Çakmak, 2011). A similar study determined that the application of waste mushroom compost to the soil decreased the vitamin C values and increased the SSC values. In the study where vitamin C values ranged from 9.10 to 12.10 mg 100 g-1, SSC values (4.40-4.60 %) were similar to our study (Polat et al., 2004).

Table 6. Effects of different growing media on pH, titratable acidity, soluble solids content (SSC), vitamin C of lettuce

Growing media	Chroma	Hue°	Titratable acidity (g 100 mL^{-1})	SSC (%)	Vitamin C (mg 100 g^{-1})
TSW	30.31	134.9	0.72 ab	3.78 ab	277.6 b
PTSW	26.76	135.4	1.05 a	3.93 ab	391.6 a
Peat + Perlite	25.15	137.1	0.44 b	4.17 a	328.3 ab
Cocopeat	26.01	136.8	0.62 b	3.53 b	281.0 b
Significance	ns	ns	**	*	*

*: $p < 0.05$. **: $p < 0.01$. ns: non-significant

Table 7 shows the variable costs and profitability analysis of lettuce produced in different growing environments. The mixture of Cocopeat and peat+perlite was taken ready-made. The tomato waste (TSW) and pretreated tomato waste (PTSW) were the subjects of the study and were prepared by the researchers. For this reason, while no grinding process was applied for Cocopeat and T+P, the cost of the grinding process was calculated as 3.35 TL for 1 production period of lettuce grown with TSW and 2.09 TL for PTSW. Agricultural control and maintenance expenses and labor costs accounted for the largest share of variable costs in all production environments. The production environment with the highest total variable cost was cocopeat (TSW) (184.05 TL), followed by pretreated tomato waste (PTSW), peat and perlite mixture and tomato waste (TSW) production environments, respectively. The environments with the highest average yield per plant in the production area were tomato waste (TSW) (558 g/plant) and pretreated tomato waste (PTSW) (535 g/plant) prepared by the researchers (Table 5). The yield values of lettuce produced in ready-made production environments (peat+perlite, cocopeat) were low (Table 4). Since lettuce is a product sold by the market, this situation is not expected to affect the gross production value. However, it is expected that the lettuce obtained from TSW and PTSW production environments with higher yield and leaf number will be larger, more attractive and therefore have a high market value and demand. During the production period, the selling price of lettuce per kg was determined as 3 TL. As a result, the highest profit (48.19 TL) was obtained from tomato waste (TSW) among lettuce production environments in soilless agriculture. The main reason for the higher profitability of this production environment is that the production environment preparation costs are lower than other methods (11.98 TL) (Table 7). It should be noted that the values calculated here are valid for a production period. The producers' incomes who can produce during the three production periods will also be higher, although they may vary depending on the applications and costs in the production period.

VARIABLE COSTS (VC) (TL)	TSW	PTSW	Peat + Perlite	Cocopeat
Lettuce waste grinding process	3.35	2.09	0.00	0.00
Production environment preparation	8.63	20.28	20.10	44.59
Seedling cost	13.20	13.20	13.20	13.20
Agricultural control	52.20	52.20	52.20	52.20
Maintenance expenses and labor cost	43.70	43.70	43.70	43.70
Irrigation and labor	21.60	21.60	21.60	21.60
Revolving fund interests	7.13	7.65	7.54	8.76
TOTAL VC	149.81	160.73	158.34	184.05
Yield (number)	66.00	66.00	66.00	66.00
Price	3.00	3.00	3.00	3.00
GROSS PRODUCTION VALUE (GPV)	198.00	198.00	198.00	198.00
Variable costs	149.81	160.73	158.34	184.05
GROSS PROFITS	48.19	37.27	39.66	13.95

Table 7. Effects of different growing media (TSW, PTSW, Peat + Perlite, Cocopeat) on cost and profitability analysis.

4. RESULTS

According to the results, although the volume weight of the growing media obtained from tomato waste decreased compared to Cocopeat, it came to the fore, especially in yield and quality criteria. It was determined that the TSW medium, in particular, stood out in terms of total dry weight, root length and yield values. It was determined that vitamin C and titratable acidity values were higher in pretreated tomato wastes (PTSW). It has been found that tomato waste contributes to waste management and profitability as a growing medium. In addition, it offers significant advantages that the wastes can be competitive with commercial growing media when they are used repeatedly.

As a result, considering the profitability of different production environments in lettuce production, the number of plant leaves and plant yields, both tomato waste and pretreated tomato waste production environments can be recommended to producers as an income-generating alternative to the imported cocopeat production media our country. In lettuce production, plant yield and the number of leaves may decrease in the next production period, but this situation is not expected to affect the market value of lettuce. In addition, while the planting frequency is higher in soilless agriculture under normal conditions (30 cm between rows and 40 cm between rows), this area (30 cm between rows and 50 cm between rows) was kept less frequently in the experimental area. In real life, producers are expected to plan their production areas most rationally and thus in a way that will maximize efficiency. This situation is expected to be effective in increasing profitability.

Author Contribution Rates

Design of Study (Çalışmanın Tasarlanması): HÖ (%30), MK (%35), EY (%10), EH (%15), GG (10)

Data Acquisition (Veri Toplanması): HÖ (%30), MK (%35), EY (%10), EH (%15), GG (%10)

Data Analysis (Veri Analizi): HÖ (%30), MK (%35), EY (%10), EH (%15), GG (%10)

Writing up (Makalenin Yazımı): HÖ (%40), MK (%35), EY (%5), EH (%15), GG (%5)

Submission and Revision (Makalenin Gönderimi ve Revizyonu): HÖ (%50), MK (%20), EY (%10), EH (%10), GG (%10)

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