Effects of different extractions on growth and nutritional quality of hydroponic endivia

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Abstract: In this study, Hydroponic endivia with completely decomposed distiller's grains, tea residue and extraction of commercial organic manure were applied to study its effects on growth and nutritional quality of endivia, as compared with modified Hoagland nutrient. The results showed that the root-shoot ratio of endivia under all treatment conditions was higher than that in CK group. Among them, treatment IV exhibited best improve efficiency; the treatment of I、 II、V、VI were beneficial to reduce the nitrate content. The treatment I significantly increased the content of VC and soluble sugar. The soluble protein content of treatment V was the highest. Above all, the application of tea residue and commercial organic fertilizer extracts in the actual production of hydroponic lettuce needs further and deeper research.

1 Introduction

Cichorium endivia L., also known as oleraceus, chinensis, arvensis. Its botanical classification is Compositae, Cichorium, Biennial vegetables. The main food organs of the endivia are its young leaves which were rich in various alkaloids, amino acids, vitamins and some trace elements [1-2]. With the development of science and the in-depth study of human nutrition, People are becoming more and more interested in eating wild vegetables. Therefore, there is still a large prospect to improve the application and development of endivia [3].

In recent years, Potato distiller's grains are the main byproducts in the production of non-grain fuel ethanol and it causes great pollution to the environment. Therefore, reuse potato distiller's grains is very important to control environmental pollution. Studies have shown that potato lees are rich in organic matter, the unit contents of dry matter, cellulose and total sugar were all higher than those of grain distillers' grains [4]. In addition, some predecessors have used cow dung and starch-based distiller's grains as organic fertilizer for soil fertilization [5]. Commercial organic fertilizer is made from all kinds of waste organic matter such as straw, pig manure and chicken manure by fermentation. Commercial organic fertilizers contain large amounts of humus that can be efficiently used for horticultural crops. At present, it is mainly used as a slow-effect soil fertilizer in the production of soil gardening crops which can significant increase yield. China is a big producer of tea. More and more waste tea leaves are produced by tea beverage processing in China every year. This not only caused enormous pressure on the environment, but also resulted in a serious waste of resources. Tea residue is rich in cellulose, crude protein, vitamins and so on. It is an excellent raw material for the production of organic fertilizers. The contents of organic matter (28.8%), crude fiber (21.30%), tea polyphenols (4.5%), water extract (22.12%), amino acid (1.85%), total nitrogen (4.95%) and total potassium (0.14%) were measured in the fermented tea lees. In addition, previous study have done the experiment of using tea residue as organic fertilizer. The results showed that the plant grew well when the tea residue was applied as the organic fertilizer. A number of biological indicators of the plant including the number of roots, growth, stem thickness and catalase activity were significantly increased. It shows that using tea residue as organic fertilizer can promote plant growth [5] [6].

At present, The hydroponic nutrient solution of horticultural crops is mostly inorganic nutrient solution. Inorganic nutrient solutions, however, make heavy use of nitrates. This often results in high nitrate levels in hydroponic gardening productions. Using organic nutrient solution can greatly reduce the amount of nitrate application, So as to reduce the residual nitrate in agricultural products [7-10]. The organic nutrient solution under the complete decomposition system can also provide the unique organic matter which the inorganic nutrient solution were absent [11]. Explore organic nutrient solution influence on crop growth can reduces the production inputs of horticultural products, develop green and pollution-free agriculture to ensure food security, improve the quality of horticultural products and enhance their market competitiveness.

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2 Materials and methods

Endivia, tea lees, distillers' grains, commercial organic fertilizers, decaying agents, standard Hoagland concentrate.

The treatment of germination and breeding of endivia [12], Sow the seeds of the accelerated endivia in a 64-well seedling dish.1 grain/hole. plants which grow six to seven true leaves were washed with clean water to remove the soil from the roots. Then planted on a foam box. Each foam box was planted with six young plants of endivia. After 7 days of colonization, Fill the box with fresh water to the designated load line every week.

The control group was treated with Hoagland nutrient solution. There are seven treatments as shown in Table 1. Generally, the pH value of the substrate is between 5.6 and 7.0. The pH index of nutrient solution was adjusted by phosphoric acid buffer as shown in the table below. Depending on the size of the growing container, Add the nutrient solution and the volume is about 4L.

Table1. Proportion and physico chemical properties of nutrient solution

treatment	ratio	EC(mS·cm^{-1})	pH
CK	Hoagland Nutrient Solution	2.05	7.10
I	tea residue: water = 1:4	0.85	7.02
II	Treatment I : Hoagland nutrient solution =1:1	0.95	7.13
III	commodity organic fertilizer: water = 1:4	0.88	7.05
IV	Treatment III: Hoagland nutrient solution=1:1	1.17	7.12
V	distiller's grains : water = 1:4	0.70	7.11
IV	Treatment V: Hoagland Nutritional Solution =1:1	0.83	7.21

At the end of the experiment, different treatments were randomly sampled. Morphological and physiological indexes of different treatments were determined. Morphological indexes included leaf number, plant height, above ground fresh weight, above ground dry weight, root length, above ground fresh weight and above ground dry weight. The content of nitrate in lettuce was determined by phenol disulfonic acid method [15].Protein content was determined by Coomassie bright blue G-250 staining [9].Vitamin C content was determined by 2.6-dichloroindigophenol method [16].The content of soluble sugar was determined by anthrone colorimetric method [10].

Excel 2010 was used for plotting the measured data, and SPSS17.0 software was used for data analysis.

3 Results &Discussion

3.1 Morphological Indexes of Different Treated endivia

Leaves are the main organs of photosynthesis in plants, The fresh weight of shoot is one of the important indexes to measure the yield of leaf vegetables. The size of root - shoot ratio indicates the correlation between above ground and underground parts of the plant. It can be seen from Table 2, the treatment VI with 46 leaves were significantly higher than other treatments.The treatment IVthe fresh weight of under ground was the highest than any treatment group .The fresh weight of the above ground was the highest in CK group (25.97 g), root-shoot ratio instead of plants' underground and aboveground relations, also the treatment IV root-shoot ratio was the highest in other treatments， it shows the treatment plant was grow well .

Table2. Morphological indexes of different treatments

Treat--ment	Leaves (Piece)	Underground fresh weight (g)	Underground dry weight (g)	Aboveground fresh weight (g)	Aboveground dry weight (g)	root-shoot ratio
CK	37±1.3d	4.51±0.03e	0.36±0.03e	25.97±0.10a	1.16±0.02a	0.17±0.03e
I	34±1.2e	5.05±0.05d	0.58±0.07d	22.08±0.12e	0.90±0.03e	0.23±0.04c
II	37±0.5d	5.82±0.06c	0.63±0.06c	23.87±0.04d	0.98±0.06d	0.24±0.07c
III	40±0.9c	6.39±0.09b	0.66±0.03b	24.51±0.09c	1.07±0.01c	0.26±0.02b
IV	41±1.5c	7.70±0.03a	0.79±0.05a	25.85±0.07b	1.14±0.06b	0.30±0.01a
V	44±0.7b	3.80±0.07g	0.29±0.02g	18.85±0.04g	0.72±0.07g	0.20±0.05d
VI	46±1.9a	4.06±0.06f	0.33±0.04f	19.09±0.11f	0.78±0.04f	0.21±0.03d

Note: Different lowercase letters in the table indicate significant differences (p<0.05).

3.2 Comparison of Physiological Indices of Different Treated endivia

Chlorophyll is related with photosynthesis, nitrate contents if excessive will be bad to our health .So The quality of vegetable nutrition is very important to human health.It can be seen from Table 3, CK has the highest chlorophyll content, is 32.4. The treatment III has the highest nitrate content (0.105mg/g). Among them, the nitrate contents of I, II, V and VI were significantly lower than those of CK and the nitrate content of treatment III and IV was significantly higher than that of CK. The treatment I has the highest vitamin C content. The content of vitamin C in the treatment of III, IV, V and VI was significantly lower than that in CK. The treatment V had the highest soluble protein content and the treatment I had the lowest soluble protein content; The content of soluble sugar in the treatment of I, ll, III and IV was significantly higher than that of CK.

Table3. Physiological indexes of different treatments

Treatmennt	SPAD	Nitrate (mg/g)	VC (mg/100g)	Protein (mg/g)	Soluble sugar (mg/g)
CK	32.4±0.1a	0.070±0.004c	3.40±0.07b	10.00±0.13cd	42.03±1.03d
I	31.0±0.2ab	0.059±0.005f	4.25±0.11a	7.14±0.09e	64.12±1.23a
II	30.6±0.6ab	0.066±0.008d	3.45±0.05b	9.43±0.03d	47.93±1.11c
III	30.1±0.1b	0.105±0.007a	2.55±0.08d	11.43±0.12bc	54.61±1.23b
IV	31.8±0.7ab	0.090±0.009b	2.98±0.09c	12.14±0.10b	47.45±1.43c
V	26.6±0.9c	0.063±0.002e	2.13±0.03e	14.29±0.12a	40.63±0.89d
VI	27.6±0.3c	0.064±0.010e	1.70±0.02f	12.86±0.13ab	41.22±0.78d

Note: Different lowercase letters in the table indicate significant differences($p<0.05$)

4 Conclusions

The results show that the extractions of tea lees, commercial organic fertilizer and distiller's grains had different effects on the growth of endivia. Tea residue and commercial organic fertilizer extracts can achieve the growth requirements of endivia. The root differentiation ability and soluble sugar content were improved in all cultivars compared with the control. To a certain extent, tea residue extract could effectively reduce the nitrate content of endivia. However, the commercial organic fertilizer extract significantly increased the nitrate content of endivia. It may be that this commercial organic fertilizer added a certain amount of inorganic nitrogen fertilizer in the production process to enhance the fertility. According the measurement results of various indicators, the distiller's grains extract is not conducive to the growth of bitter endivia. Three kinds of organic nutrient solutions were beneficial to increase the root-shoot ratio of endivia. Among them, the commercial organic fertilizer extraction were more beneficial to root-shoot ratio. In addition, the mixed treatment of different organic nutrient solution and Hoagland nutrient solution was basically a combination of their advantages and disadvantages. Under the premise of not reducing the yield of endivia, the extractions of tea residue and commercial organic fertilizer can be used in the commercial production of endivia. This is basis consistent with the research conclusions made by Zhou et al in 2011 and Zhou et al in 2010 [7] [9]. This study found that organic-matter must be completely fermented and decomposed before extraction. Otherwise, it may cause too many microorganisms in the extraction and consume oxygen in the water which would cause root rotted and affected the experimental results.

Because each organic matter contains different nutrient composition concentration difference is larger.So if you use a single organic extract.The nutrient concentration is generally much lower than that of the usual Hoagland solution.The use of a single organic nutrient solution will result in the imbalance of nutrient elements and deficiency of nutrients.In actual production and application, whether appropriate combination can be made according to the unique effect of different organic extracts and the different proportion of nutrient elements.The advantage that the mixed organic nutrient solution can integrate each single nutrient solution needs to be further explored.

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