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# 生物場對水耕栽培萵苣和小白菜的生長及生理影響

# Growth and Physiological Effects of Biofield on Hydroponically-Grown *Lactuca sativa* and *Brassica chinensis* Plants

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# 南 華 大 學

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# Abstract

The aim of this study was to investigate the effect of One-stroke Energy Art pieces on the growth and physiology of lettuce and bok choy plants. A total of four treatments was tested: 1) control (no energy art); 2) energy art; 3) energized water; 4) energy art + energized water. Five energy art pieces were placed directly under the planting container of the hydroponics system throughout the entire growing period. For the energized water treatment, water was put in a container and placed on the floor about 50 cm in front of an energy art piece for 7 days. This 'energized water' was then used in the hydroponic system.

Overall, both the lettuce and bok choy plants cultivated in the energy art + energized water treatment were significantly larger in terms of leaf and root growth than those in the other treatments. Clear differences in the vegetative growth of these plants can be seen from the significantly higher number of leaves, leaf fresh dry mass, leaf dry mass, and leaf area than those grown in the other treatments.

Furthermore, the highest chlorophyll *a*, total chlorophyll content, and carotenoids were detected in lettuces cultivated in the energy art treatment, which were significantly higher than those grown in the control. The chlorophyll and carotenoid contents of bok choy plants grown in energized water were significantly higher than all the other treatments. Moreover, the photosynthetic efficiency of the lettuce and bok choy plants exposed to any of the three energy treatments were improved significantly.

Based on these results, hydroponically-grown lettuce and bok choy plants treated with both energy art and energized water can be used as an alternative approach to improve plant growth rate and yield.

**Keywords: Biofield, One-stroke Energy Art, energy field, hydroponics, lettuce**

# 摘要

本研究目的為研究一筆畫能量藝術作品對萵苣和小白菜的生長及生理影響。此研究總共使用四種處理方式：1）對照組（無任何能量相關處理）; 2）能量藝術; 3）能量水; 4）能量藝術+能量水。對於能量藝術的處理，是在整個成長過程中將五張能量藝術作品直接放置在水耕栽培的容器之下，直至採收。對於能量水的處理，將自來水放入容器中並放置在能量藝術作品前面約 50cm 處的地板上 7 天，然後將這種“能量水”用於水耕栽培系統之中。

以研究成果而言，能量藝術+能量水處理所栽培出的萵苣及小白菜，在葉子和根部生長部分都有著明顯大於其它處理的結果，相較於其它處理的葉數、葉鮮重、葉乾重與葉面積皆有顯著，表示在處理上植物與植物間生長的明顯差距。

此次研究，在能量藝術處理所栽培的萵苣，檢測到最高值的葉綠素 a、總葉綠素含量和類胡蘿蔔素，其顯著值高於對照組生長的萵苣；而能量水處理所生長的小白菜，也檢測到葉綠素和類胡蘿蔔素含量顯著高於其它所有處理。研究發現，暴露於三組能量處理中的任何一項

時，萵苣及小白菜的光合作用效率得到顯著改善。基於以上結果，用能量藝術和能量水所處理的水耕栽培萵苣和白菜，可以視為提高植物生長速率和產量的替代方法。

**關鍵字：生物場、一筆畫能量藝術、能量場、水耕栽培、萵苣**

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# Chapter 1

# Introduction

## 1.1. Research Background

Plants are one of the oldest major life forms on earth. They have the ability to sense and respond to environmental stimuli. In order to better understand stimuli such as biofields that include 'energy fields' and other electromagnetic forces, plants have been used as test subjects to measure their physical and physiological responses to these stimuli. These studies also allow us to understand its effects on their subsequent growth and development pathways under various growing conditions.

Furthermore, responses of plants to biofields can also provide valuable data on its application in humans. At present, medicine is an imperfect science. Medical processes and treatments are being continuously improved, however, for certain illnesses the chances of being cured is low. Most illnesses are treated through suppression by drugs, instead of finding the root cause. Biofield is categorized under complementary and alternative medicine (CAM). Further studies will provide a better understanding of their effects and allow us to advance their use in both plants and humans.

## 1.2. One-Stroke Energy Art

The biofield used in this study was in the form of a type of art called One-Stroke Energy Art (一筆畫能量藝術) (Fig. 1.1), drawn by the energy artist Teng-Yuan Lee (李登元), in one continuous stroke. The art pieces are created using soft lines that are an abstract of what the artist "sees" during a heightened state of awareness. The ink is made from a special concoction of different materials, in which cinnabar is used to produce its red color. A specially-made brush is used primarily for large art pieces, while other types of tools are used for smaller pieces. The One-stroke Energy Art pieces have been exhibited at the Louvre in France as well as other art galleries around the world. It is also sought after by art collectors, who treasure its uniqueness in its possession of vital energy and/or energy-like properties.

Mr. Lee, who has studied Taoism for many years, calls the painting "the passage of energy". Mr. Lee is able to exchange the energy of his own with cosmic energy of the art piece. He describes the process before and during drawing the art as follows: He first meditates to relax his body and cleanse his mind. When he has reached a higher state of awareness, he is able to “sense” and “see” movements of a white light spot. In sync with the movements of the light, the artist draws the movements and trajectory of the light onto the art pieces. The red ink used by the artist represents blood, which also symbolizes the vitality of life, and as such, Mr. Lee considers his art as the creation of vital energy.

## 1.3. Aim of this research study

The objectives of this study were:

1. To investigate the effects of the energy field from the One-Stroke Energy Art pieces on the vegetative and root growth of lettuce and bok choy plants.

2. To analyze the effects of the energy field from the One-Stroke Energy Art pieces on total phenol content and DPPH radical scavenging activity of lettuce and bok choy plants.

3. To analyze the effects of the energy field from the One-Stroke Energy Art pieces on chlorophyll fluorescence (Fv/Fm), chlorophyll content and carotenoids of lettuce and bok choy plants.

**Fig. 1.1** One-stroke Energy Art by Teng-Yuan Lee

(Photograph by Chia-Tung Lee)

# Chapter 2

# Literature Review

## 2.1. Modern Medicine

In the era of modern medicine, traditional medicine is fast becoming an integral part of health care and medical treatment. The emergence of comprehensive medical treatment models has placed the emphasis on preventative medicine, which has provided patients with more choices in health care.

This model includes areas such as energy medicine, biophysics, biology, psychology, and body and mind research (such as psychosocial genetics). Biofields descriptions in the classics of Buddhism and Taoism have given biologists and physicists a more comprehensive understanding of the new concept (Rubik, Muehsam, Hammerschlag, & Jain, 2015).

## 2.2. Complementary and Alternative Medicine (CAM)

A wide range of complementary and alternative therapies (CAM) are described in literature. However, the CAM therapies that seem to challenge the current biomedical paradigm are related to field interactions (Rubik, 2002). These include among others, biofield therapies, homeotherapy, acupuncture, magnet therapy, bioelectromagnetic therapy, electrodermal therapy, and phototherapy.

### 2.2.1. Definition and Application of Biofield

The term biofield was proposed in 1992 by CAM practitioners and researchers at the US National Institutes of Health (NIH) (Rubik et al., 2015). Biofield can be used to describe a wide-ranging variety of biological concepts, which includes the phenomena that have been previously described as "energy medicine". It does not necessarily refer to electromagnetic energy, but rather "a massless field that surrounds and permeates living bodies” (Rubik et al., 2015). Biofield as a field of study aims to establish scientific basis for its regulation of life systems and dynamics in organisms, and provides scientific foundation for energy medicine.

According to Rein (2004), biofield is an endogenous energy field of the human body, including non-classical and quantum energy fields. In energy medicine, the healing method comes from the resonance of external energy forms. Biofield has a functional role in the self-healing mechanism in the human body. This mechanism is hypothesized based on the concept of biological information and consciousness. (Rein, 2004). In general, biofield is a term used to describe energy fields called *qi (chi)* in traditional Chinese medicine, *ki* in Japanese medicine, and *prana* in Ayurveda (Rubik et al., 2015). This subtle energy observation can be regarded as a high-level wave of electromagnetic energy, but is finer and more dispersed. Some of the source of the biological field is transmitted by the human body (Movaffaghi & Farsi, 2009).

The emergence of biofield as an important topic in energy-related studies has led to a better understanding of its efficacy on organisms. Scientific research on biofield has indicated that the existence of fundamental laws, which were previously thought to only hold in material events, to be also applicable in biofield energies (Nayak & Altekar 2015). Material energies and vital energies in biofield seem to be interconvertible, are of complementary forces of the same phenomenon, and are able to be manipulated from either side. An identification and confirmation of the laws that holds true in both the material and vital energies will allow researchers to make greater strides in understanding its characteristics and application. Closer coordination between these field of studies is crucial for the subsequent development of technologies that can be used to harness the vital energy to improve human health in medicine and plant growth in the agriculture sector.

### 2.2.2. Effect of Biofield on Cells

In general, a wide variety of biofields including bioelectromagnetic activities have been identified. Significant effects have been shown on cell growth, wound repair, regeneration, and reduction of inflammation (Funk, Monsees, & Ozkucur, 2009). Biofield treatments have been tested on cancer cells to study its effect on cell growth. Results showed the treatment that had the closest distance between the biofield and the cancer cell groups had a significant effect on inhibiting cancer cell growth (Young et al., 2013).

In another study, human liver carcinoma cells were treated with life energy for 5 and 10 min by a Ki-energy practitioner (Ohnishi, Ohnishi, Nishino, Tsurusaki, & Yamaguchi, 2005). The number of cells in the Ki-exposed groups were reduced by 30.3% and 40.6% for the 5 min and 10 min exposure times, respectively. In addition, the protein content in these cells was found to increase by 38.8% and 62.9%, respectively. These findings shows that the energy fields are able to suppress cancer cell growth, and therefore may be beneficial for treating cancer patients.

### 2.2.3. Effect of Biofield on Plants

Plants are known to be respond physically and physiologically to environmental stimuli, including energy fields (Creath & Schwartz, 2004). Although there are no energy field treatments in literature that are similar to the One-stroke Energy Art used in this study, there are studies using healing energy or energy fields that may somewhat be comparable. For example, studies have used healing energy on the germination of okra and zucchini seeds. The seeds were treated every 12 hours for 15- 20 min. After 72 hours, results showed that the healing energy had a significant effect on seed germination (Creath & Schwartz, 2004).

In a report that studied the effect of biofield on the growth of tomato and lettuce plants, results showed that when lettuces were exposed to biofields, the yield increased by 43% (Shinde, Sances, Patil, & Spence, 2012). In tomatoes, fertilized and unfertilized plants treated with biofield resulted in yield increases of 25% and 31%, respectively. Furthermore, the leaf number and chlorophyll content of the biofield-treated tomatoes and lettuces were higher than the untreated plants. In addition, these findings demonstrated that combining the use of biofields and chemical additives resulted in significantly higher crop yield and insect resistance.

## 2.3. Chlorophyll Fluorescence

When light strikes a leaf, it enters the Photosystem I (PSI) and Photosystem II (PSII) reaction centers in the chloroplast (Ritchie, 2006). As a photon of energy is absorbed by PSII, its chlorophyll *a* electron is raised to a higher energy state. It is captured in this state by an electron acceptor and transferred to PSI. Energy is generated through a photochemical process and used to convert carbon dioxide into sugar. However, chlorophyll *a* electrons fall back to their ground state if they are not captured by the electron acceptors. As a result, energy is lost and fluorescent light is released. This fluorescent light is measured as chlorophyll fluorescence.

The chlorophyll fluorescent is measured by first placing plant leaves in the dark to remove all excited electrons (dark-adaptation). A chlorophyll fluorometer is then used to illuminate plant cells with a saturating light pulse, after which the maximum and minimum fluorescent light released by the cell is measured.

After the period of complete darkness, the fluorescence yield of the leaf is minimal, denoted $F_0$. When the saturating light pulse is applied, the fluorescence level is maximal, denoted Fm (Schoefs, 2005). The increase from $F_0$ to Fm is known as variable fluorescence (Fv) (Govindje, 1995). The Fv/Fm ratio measures the optimal quantum efficiency of a plant, which is an estimation of the state of its photosynthetic apparatus (Genty, Briantais, & Baker, 1989). In general, the Fv/Fm ratio of a healthy plant falls between 0.70 – 0.83, which indicates a relatively efficient photosynthetic system (Ritchie, 2006).

# Chapter 3

# Materials and Methods

## 3.1. Plant Material and Growth Conditions

The lettuce (*Lactuca sativa* cv. Hong-Cui) (Chinese: 紅翠) and Bok Choy (*Brassica chinensis* cv. San-Feng No. 2) (Chinese: 三鳳二號) seeds used in this study were purchased from Known-You Seed Co. Ltd.

Using forceps, a single seed was placed about 0.5 cm deep into the cut opening of a hydroponic germination sponge cube (2 x 2 x 2 cm). The sponge cubes were then placed in a germination dish and soaked thoroughly with water (Fig. 3.1). Excess water (±0.5 cm deep) was left at the bottom of the dish to ensure the sponge cubes remain sufficiently hydrated. The germination dish was covered for the seeds to germinate in the dark. After 3 days, germinated seedlings were placed under lights to continue to grow. After 7 days, healthy seedlings were transplanted to a hydroponic system. The system consisted of a 5.4 L planting container (34 x 27 x 11 cm) covered by a Styrofoam board with 6 holes to insert the sponge cubes (Fig. 3.2). Two air stones connected to an air pump was placed in the planting container to continuously oxygenate the nutrient solution throughout the growing period.

Hyponica® nutrient solution (Kyowa Inc., Japan) was used in all treatments (1:500 dilution). After the preparation of the nutrient solution, 3.1 L of the solution were poured into each planting container. The pH and EC (electrical conductivity) of the nutrient solution from all treatments were measured at the beginning of the study (pH: 7.23; EC: 1.6 mS/cm), and were not adjusted throughout the duration of the experiment.

All plants were cultured under white light-emitting diodes (LEDs). The photosynthetically active radiation (PAR) was adjusted to 200 μmol.m$^-$

$^{2}$.sec$^{-1}$ at 25 cm above plant height with the photoperiod maintained at 16 h. The temperature and relative humidity of the plant factory where seed germination and hydroponics cultivation were conducted was maintained at 25±2ºC/20±2ºC (day/night) and 80%/60% (day/night), respectively.

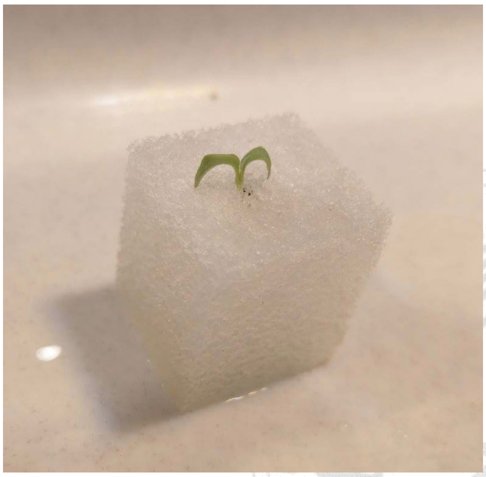

**Fig. 3.1** Germination sponge cube with germinated seedling.

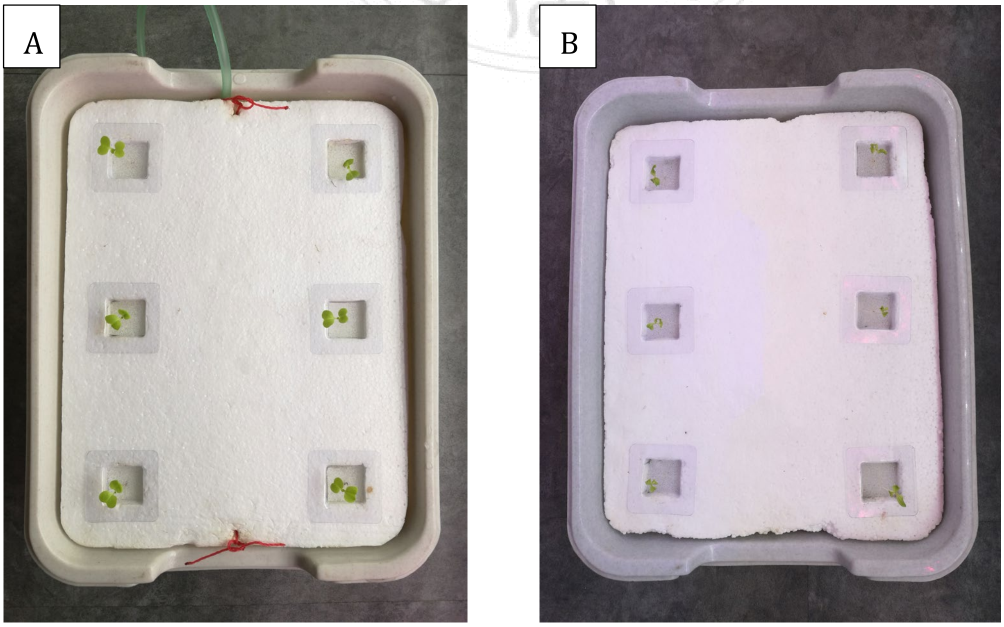


**Fig. 3.2** Hydroponic system with **(A)** lettuce and **(B)** bok choy seedlings.

## 3.2. One-Stroke Energy Art Treatments (Biofield)

The One-stroke Energy Art pieces (8.8 cm x 5.5 cm) used in this study is shown in Fig. 3.3A. A total of four treatments was tested: 1) control (no energy art); 2) energy art; 3) energized water; 4) energy art + energized water.

For the control treatment, all materials used from the seed germination stage to the hydroponics cultivation stage did not come in contact with any energy art or related materials. For the energy art treatment, five energy art pieces were placed directly under the germination container during the seed germination stage, and also placed under the planting container of the hydroponics system throughout the entire growing period (Fig. 3.3B).

For the energized water treatment, the water that was used for seed germination and the hydroponic system was first treated in a room with 15 One-Stroke Energy Art pieces hung on the walls. The water was put in a container and placed on the floor of the room about 50 cm in front of one of the 15 energy art pieces for 7 days. This ‘energized water’ was then used to soak the germination sponge cubes during the seed germination stage, and used for the initial dilution of the nutrient solution and subsequent weekly refills of water in the hydroponic system during the growing period.

For the energy art + energized water treatment, both energy art pieces and energized water as described above were used together throughout the germination stage and the hydroponics cultivation stage.

For each treatment, five planting containers each containing six seedlings were used. To ensure sufficient water was available to the plants, each planting container was refilled every 7 days with their respective treatment water.

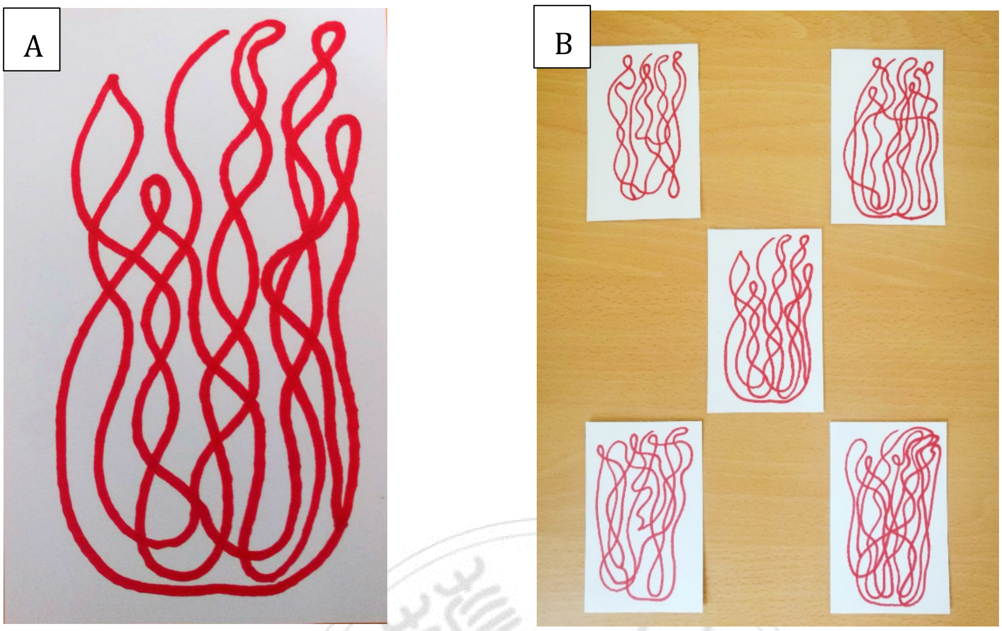


**Fig. 3.3 (A)** One-stroke energy art piece; **(B)** Arrangement of 5 art pieces under planting container of hydroponic system.

## 3.3. Plant sample preparation for extraction

Plant samples were dried in a freeze-dryer (Vacuum Freeze-Dryer, Tai Yiaeh Enterprise Co., Ltd, Taiwan) at -30°C for 1 h. Dried samples from each treatment were randomly grouped into five groups and ground into fine powder. Three groups of samples from each treatment were randomly selected for analysis.

### 3.3.1. Determination of chlorophyll content and carotenoids

The method described by Maadane, Merghoub, Ainane, El Arroussi, Benhima, Amzazi, Bakri, & Wahby (2015), with minor modifications, was followed to determine chlorophyll *a*, chlorophyll *b*, and carotenoid content. Briefly, bok choy (0.5 g) and lettuce (0.05 g) samples from each treatment were weighed. Each sample was homogenized with 10 mL of 95% ethanol. The sample mixture was then thoroughly mixed with a vortex shaker for 1 min, and stood in the dark for 30 min at 4°C.

Thereafter, the sample mixture was filtered, and the supernatant was centrifuged at 4°C for 10 min at 1000 rpm. A 200 μL aliquot of the supernatant was then pipetted to a 96-well plate. The absorbance was measured with a spectrophotometer (Microplate Spectrophotometer, Biotek Instruments, Inc., U.S.A) at 664 nm, 648 nm, and 470 nm for chlorophyll *a,* chlorophyll *b*, and carotenoids, respectively. Calculations were made according to the following formula:

- Chlorophyll *a* (μg/mL) = 13.36 x $A_{664}$ – 5.19 x $A_{648}$

- Chlorophyll *b* (μg/mL) = 27.43 x $A_{648}$ – 8.12 x $A_{664}$

- Carotenoids (μg/mL) = (1000 x $A_{470}$ – 2.13 x $C_a$ – 97.64 x $C_b$)/209

- Chlorophyll *a*+*b* = $C_a + C_b$

- Chlorophyll *a*/*b* = $C_a / C_b$

### 3.3.2. Determination of total phenol content

The total phenol content was determined with Folin-Ciocalteu reagent according to the method described by Chen et. al (2012) with modifications. Briefly, plant samples (1 g) were homogenized in 95% ethanol, vortexed for 30 s, stood for 30 min in the dark, and filtered. A standard curve for gallic acid was prepared (10 - 50 ppm).

The sample solution was further diluted with 95% ethanol (30:70), from which an aliquot of 150 μL was taken and mixed with 150 μL Folin-

Ciocalteu reagent (1: 2 v/v diluted with DDW). After 5 min, 150 μL sodium carbonate (20% w/v) was added to the sample solution. The mixture, which was shaken intermittently, was allowed to stand for 10 min. The sample was then centrifuged at 30,000 rpm for 1 min. A 200 μL aliquot of the supernatant was used for analysis. The absorbance was measured with a spectrophotometer (Microplate Spectrophotometer, Biotek Instruments, Inc., U.S.A) at 730 nm. The phenolic content was expressed as gallic acid equivalent (mg/g).

### 3.3.3. Determination of DPPH radical scavenging activity

The method used to prepare the plant samples for DPPH (2,2-Diphenyl-1-picrylhydrazyl) radical scavenging activity was the same as described for the total phenol content. A slightly modified procedure to the method described by Chiu (2009) to determine DPPH activity was followed. For each treatment, an aliquot of 20 μL, 230 μL and 750 μL of the sample solution, ethanol (95%), and DPPH (0.1 mM) solution, respectively, was vortexed and allowed to stand for 30 min in the dark at room temperature. A 200 μL aliquot of the mixture was pipetted into a 96-well plate. Absorbance was measured at 517 nm using a spectrophotometer (Microplate Spectrophotometer, Biotek Instruments, Inc., U.S.A).

### 3.3.4. Determination of chlorophyll fluorescence

The procedure for the determination of chlorophyll fluorescence (Fv/Fm value) of leaf samples was carried out according to the method described by Molero & Lopes (2012). Briefly, leaves were first dark-adapted for 3 h, after which measurements were taken in complete darkness. The third leaf from the top was placed into the sensor head (FluorPen FP100, PSI, Czech Republic) to take chlorophyll fluorescence readings. The dark-adapted Fv/Fm values obtained was used to interpret the photosynthetic efficiency and stress levels of the plants.

## 3.4. Statistical Analysis

In total, two types of plants were cultivated under four different biofield treatments (Fig. 3.4). For each plant type, thirty replicates per treatment were used. After 35 days, data for the following growth parameters were collected: number of leaves, leaf fresh mass, leaf dry mass, root fresh mass, root dry mass, and leaf area. For chemical analyses, all procedures were conducted in triplicate. The following analyses were carried out: chlorophyll content, carotenoid content, total phenol content, DPPH radical scavenging activity, and chlorophyll fluorescence (Fv/Fm value). Data were analyzed using Duncan's Multiple Range Test to compare treatment means, using SPSS v. 17 software.

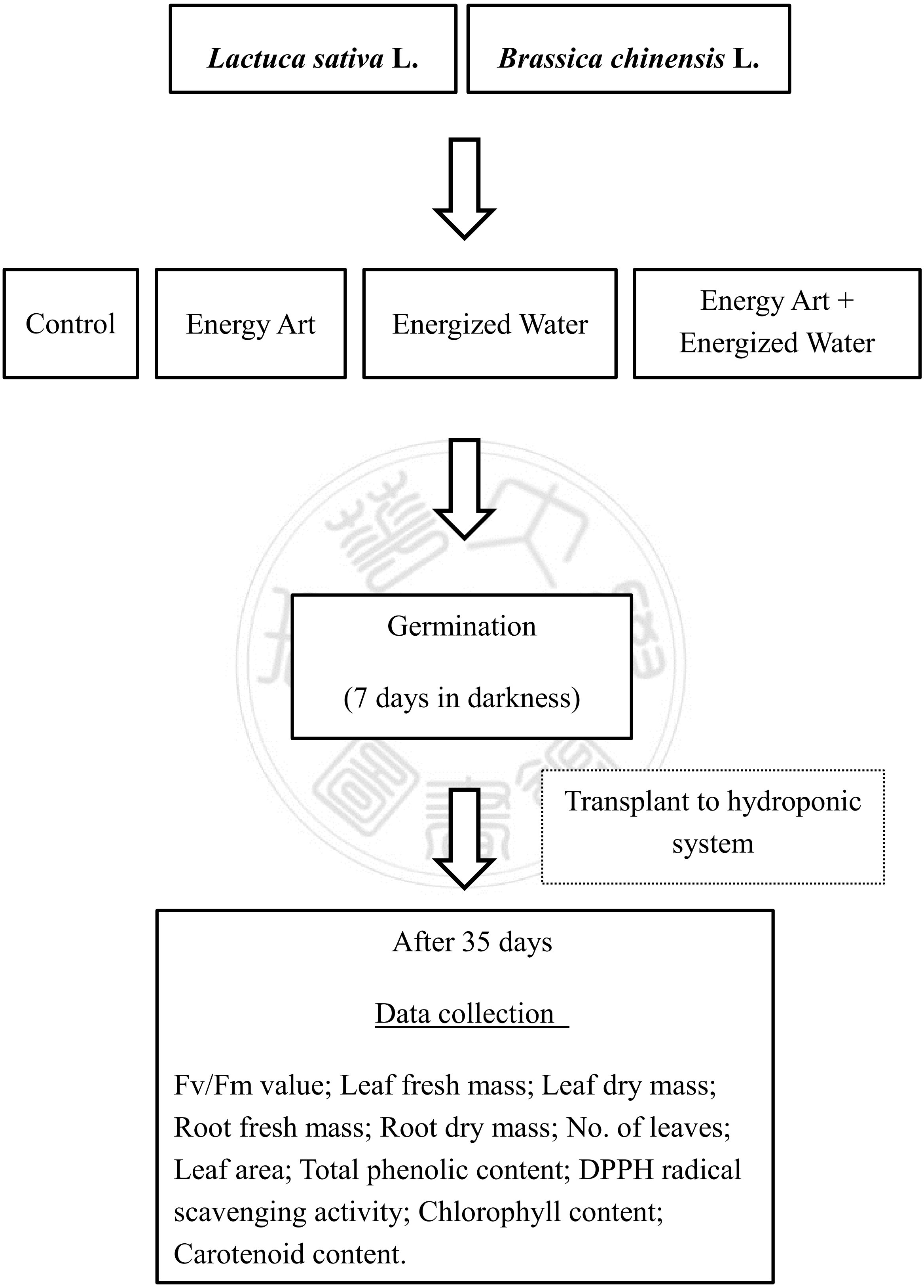


**Fig. 3.4** Experimental flow chart

# Chapter 4

# Results

## 4.1. Effect of One-stroke Energy Art on leaf and root growth

Overall, the lettuce plants cultivated in the energy art + energized water treatment were larger than those in the other treatments (Fig. 4.1). Striking differences in the vegetative growth of these plants can be seen from the significantly higher number of leaves (12.27), leaf fresh dry mass (22.12 g), leaf dry mass (1.86 g), and leaf area (606.62 $cm^2$) than those of the other treatments (Table 4.1).

It is also worth noting that lettuce plants cultivated in treatments with only energy art or only energized water produced the least number of leaves with the lowest leaf mass, which were significantly lower than the control treatment. However, of these three treatments, significant differences in leaf area were present only between the control (346.16 $cm^2$) and the energized water (242.85 $cm^2$) treatments. With regard to root growth, both fresh and dry mass of roots were significantly higher in lettuce plants grown in energy art + energized water than those in the other treatments (Table 4.1).

The effect of the energy art + energized water treatment on the vegetative growth of bok choy was similar to that of the lettuce, as seen in their much larger overall size (Fig. 4.2). Analysis of the data showed significantly higher number of leaves, fresh and dry mass of leaves, and leaf area of plants in this treatment than those grown in all the other treatments (Table 4.2). In fact, the leaf area of bok choy cultivated in the energy art + energized water treatment (699.33 $cm^2$) was over 1.5 times the size of the other treatments, namely, control (365.79 $cm^2$), energy art (448.20 $cm^2$) and energized water (364.81 $cm^2$).

Interestingly, when bok choy plants were exposed to a single type of biofield only, leaf growth was similar to that of the control, as indicated by their non-significant differences in leaf area. (Table 4.2).

In terms of root growth, significantly higher root fresh mass and dry mass were found between roots that formed in the energy art + energized water treatment than those produced in the other treatments. No significant differences in root growth were observed between bok choy plants grown in the control and those exposed to energy art only or energized water only (Table 4.2).

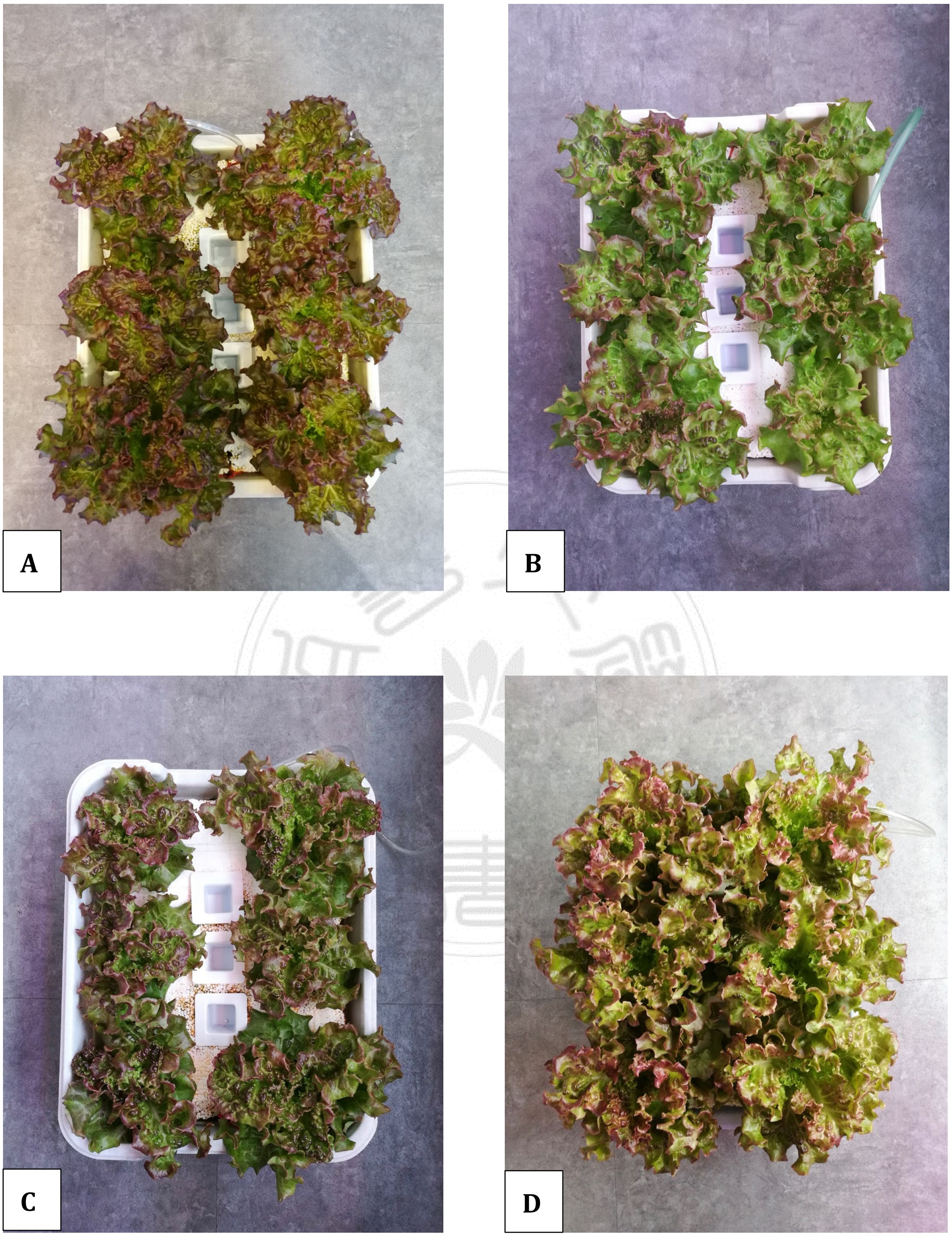


**Fig. 4.1** Growth of lettuce after 35 days in hydroponics. **(A)** Control; **(B)** Energy Art; **(C)** Energized Water; **(D)** Energy Art + Energized Water


**Fig. 4.2** Growth of bok choy after 35 days in hydroponics. **(A)** Control; **(B)** Energy Art; **(C)** Energized Water; **(D)** Energy Art + Energized Water

**Table 4.1** Effect of energy art treatments on leaf and root growth of lettuce plants.

| | No. of Leaves | Leaf Fresh Mass (g) | Leaf Dry Mass (g) | Leaf Area ($cm^2$) | Root Fresh Mass (g) | Root Dry Mass (g) |
|---|---|---|---|---|---|---|
| Control | 9.28 ± 1.53[b] | 17.65 ± 6.62[b] | 1.52 ± 0.49[b] | 346.16 ± 129.2[b] | 5.03 ± 1.59[b] | 0.29 ± 0.10[b] |
| Energy Art | 6.47 ± 1.04[a] | 10.27 ± 4.13[a] | 0.75 ± 0.28[a] | 290.64 ± 103.2[ab] | 3.91 ± 1.60[a] | 0.21 ± 0.09[a] |
| Energized Water | 6.33 ± 0.76[a] | 9.32 ± 3.25[a] | 0.74 ± 0.23[a] | 242.85 ± 73.0[a] | 3.60 ± 1.28[a] | 0.25 ± 0.08[ab] |
| EA + EW* | 12.27 ± 2.00[c] | 22.12 ± 9.58[c] | 1.86 ± 1.16[c] | 606.62 ± 260.3[c] | 7.10 ± 2.97[c] | 0.39 ± 0.19[c] |

Different letters within the same column indicate mean values differ significantly according to Duncan's Multiple Range test ($P \leq 0.05$).

* EA + EW = energy art + energized water

**Table 4.2** Effect of energy art treatments on leaf and root growth of bok choy plants.

| | **No. of Leaves** | **Leaf Fresh Mass (g)** | **Leaf Dry Mass (g)** | **Leaf Area ($cm^2$)** | **Root Fresh Mass (g)** | **Root Dry Mass (g)** |
|---|---|---|---|---|---|---|
| Control | 7.37 ± 1.07$^{a}$ | 20.60 ± 8.76$^{a}$ | 1.94 ± 0.95$^{b}$ | 365.79 ± 150.2$^{a}$ | 5.83 ± 2.18$^{a}$ | 0.35 ± 0.14$^{a}$ |
| Energy Art | 8.33 ± 1.27$^{b}$ | 21.35 ± 9.62$^{a}$ | 1.70 ± 1.43$^{b}$ | 448.20 ± 202.1$^{a}$ | 5.77 ± 2.51$^{a}$ | 0.35 ± 0.13$^{ab}$ |
| Energized Water | 7.83 ± 1.23$^{ab}$ | 17.14 ± 9.76$^{a}$ | 1.08 ± 0.84$^{a}$ | 364.81 ± 217.9$^{a}$ | 4.29 ± 2.19$^{a}$ | 0.29 ± 0.14$^{a}$ |
| EA + EW* | 9.59 ± 1.50$^{c}$ | 26.72 ± 10.75$^{b}$ | 2.52 ± 1.11$^{c}$ | 699.33 ± 245.1$^{b}$ | 9.11 ± 4.83$^{b}$ | 0.53 ± 0.25$^{b}$ |

Different letters within the same column indicate values differ significantly according to Duncan's Multiple Range test ($P \leq 0.05$).

* EA + EW = energy art + energized water

## 4.2. Effect of One-stroke Energy Art on chlorophyll content and carotenoids

In the lettuce plants that were grown in the energy art treatment, results of the chemical analyses showed that it contained the highest amount of chlorophyll *a*, which were significantly higher than those cultivated in the control treatment and energized water treatment (Table 4.3). In contrast, the lowest amount of chlorophyll *a* was detected in lettuce exposed to energized water. With regard to chlorophyll *b*, the amount detected in lettuce plants cultivated in the presence of a biofield did not differ significantly to those in the control treatment, regardless of the type of biofield used (Table 4.3).

With regard to the carotenoid content of lettuces, results were similar to those of the total chlorophyll content, where the highest carotenoid content was found in lettuce exposed to energy art only, which was significantly higher than plants in the control and energized water treatments (Table 4.3).

On the other hand, lettuces grown in energized water produced the lowest amounts of carotenoids, which was significantly lower than plants cultivated in the control treatment.

In contrast to lettuce plants, all bok choy plants exposed to biofield treatments contained significantly higher chlorophyll *a* and chlorophyll *b* contents than the control treatment, irrespective of the type of biofield used (Table 4.4). In fact, the chlorophyll content of bok choy grown without any biofield treatments (control) was several times lower than those cultivated in the presence of biofields. Furthermore, in a stark contrast to lettuce plants, bok choy cultivated in energized water produced the highest amount of chlorophyll, which were significantly higher even than the bok choy plants grown in the energy art + energized water treatment (Table 4.4).

The results of the analysis of carotenoid content in bok choy plants were similar to their chlorophyll content, i.e., significantly higher carotenoid content in biofield treatments compared to the control, with those grown in energized water containing the highest amount. The carotenoid contents of energy art (4.87 $mg.g^{-1}$), energized water (7.10 $mg.g^{-1}$), and energy art + energized water (6.64 $mg.g^{-1}$) were at least twice as high as those detected in plants of the control treatment (Table 4.4).

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**Table 4.3** Effect of energy art treatments on chlorophyll and carotenoid contents of lettuce plants.

| | **Carotenoids ($mg.g^{-1}$)** | **Chlorophyll ($mg.g^{-1}$)** | | | |
|---|---|---|---|---|---|
| | | ***a*** | ***b*** | ***a+b*** | ***a/b*** |
| Control | $2.05 \pm 0.65^{b}$ | $7.81 \pm 2.1^{b}$ | $3.08 \pm 0.7^{ab}$ | $10.89 \pm 2.8^{b}$ | $2.51 \pm 0.2^{b}$ |
| Energy Art | $2.49 \pm 0.29^{c}$ | $9.38 \pm 1.1^{c}$ | $3.47 \pm 0.4^{b}$ | $12.85 \pm 1.4^{c}$ | $2.70 \pm 0.7^{c}$ |
| Energized Water | $1.57 \pm 0.34^{a}$ | $5.74 \pm 1.2^{a}$ | $2.50 \pm 0.4^{a}$ | $8.24 \pm 1.5^{a}$ | $2.29 \pm 0.2^{a}$ |
| EA + EW* | $2.23 \pm 0.19^{bc}$ | $8.14 \pm 0.7^{bc}$ | $3.29 \pm 0.2^{ab}$ | $11.43 \pm 0.9^{bc}$ | $2.47 \pm 0.1^{b}$ |

Different letters within the same column indicate values differ significantly according to Duncan's Multiple Range test ($P \leq 0.05$).

* EA + EW = energy art + energized water

**Table 4.4** Effect of energy art treatments on chlorophyll and carotenoid contents of bok choy plants.

| | Carotenoids ($mg.g^{-1}$) | Chlorophyll ($mg.g^{-1}$) | | | |
|---|---|---|---|---|---|
| | | ***a*** | ***b*** | ***a+b*** | ***a/b*** |
| Control | $1.52 \pm 0.48^{a}$ | $6.24 \pm 1.5^{a}$ | $2.71 \pm 0.4^{a}$ | $8.94 \pm 1.8^{a}$ | $2.28 \pm 0.3^{a}$ |
| Energy Art | $4.87 \pm 1.12^{b}$ | $19.39 \pm 3.7^{b}$ | $6.16 \pm 1.0^{b}$ | $25.55 \pm 4.7^{b}$ | $3.13 \pm 0.1^{b}$ |
| Energized Water | $7.10 \pm 0.23^{c}$ | $26.77 \pm 1.8^{d}$ | $11.86 \pm 3.7^{c}$ | $38.62 \pm 5.3^{d}$ | $2.40 \pm 0.6^{a}$ |
| EA + EW* | $6.64 \pm 0.46^{c}$ | $23.64 \pm 2.0^{c}$ | $7.48 \pm 1.3^{b}$ | $31.12 \pm 3.3^{c}$ | $3.20 \pm 0.3^{b}$ |

Different letters within the same column indicate values differ significantly according to Duncan's Multiple Range test ($P \leq 0.05$).

* EA + EW = energy art + energized water

## 4.3. Effect of One-stroke Energy Art on chlorophyll fluorescence (Fv/Fm), total phenol content, and DPPH radical scavenging activity

As shown in Fig. 4.3, the Fv/Fm value of lettuce cultivated without any type of energy treatment (control) was significantly lower than those grown in the energy treatments, regardless of whether it was the energy art, energized water, or energy art + energized water treatments used. No significant differences in the Fv/Fm values of lettuces were detected between the three energy treatments.

In contrast, significantly lower total phenol content was observed in the energy art only and energized water only treatments of lettuce compared to the control and the energy art + energized water treatments (Fig. 4.4). Similar levels of total phenol were found between lettuce plants grown in the control and the energy art + energized water treatments. Results also showed that the DPPH free radical scavenging activity (% inhibition) of lettuce plants grown in energy art only and energized water only treatments were significantly higher than the other biofield treatments (Fig, 4.5). Significantly lower DPPH % inhibition was observed in lettuce grown in the energy art + energized water treatment, compared to all the other biofield treatments. Furthermore, there appears to be an inverse relationship between the total phenol concentration and the DPPH % inhibition (Fig, 4.4; Fig. 4.5).

In bok choy plants, the Fv/Fm values of all plants in the energy treatments were found to be significantly higher than the control treatment, with plants in the energized water treatment being the highest (Fig. 4.6). No significant differences in total phenol content were detected between bok choy cultivated in the control treatment and those exposed to any type of energy treatments (Fig. 4.7). The highest DPPH activity (% inhibition) was found in bok choy cultivated in the energized water treatment, while significantly lower activity was detected those grown in the control and the energy art + energized water treatments (Fig. 4.8).

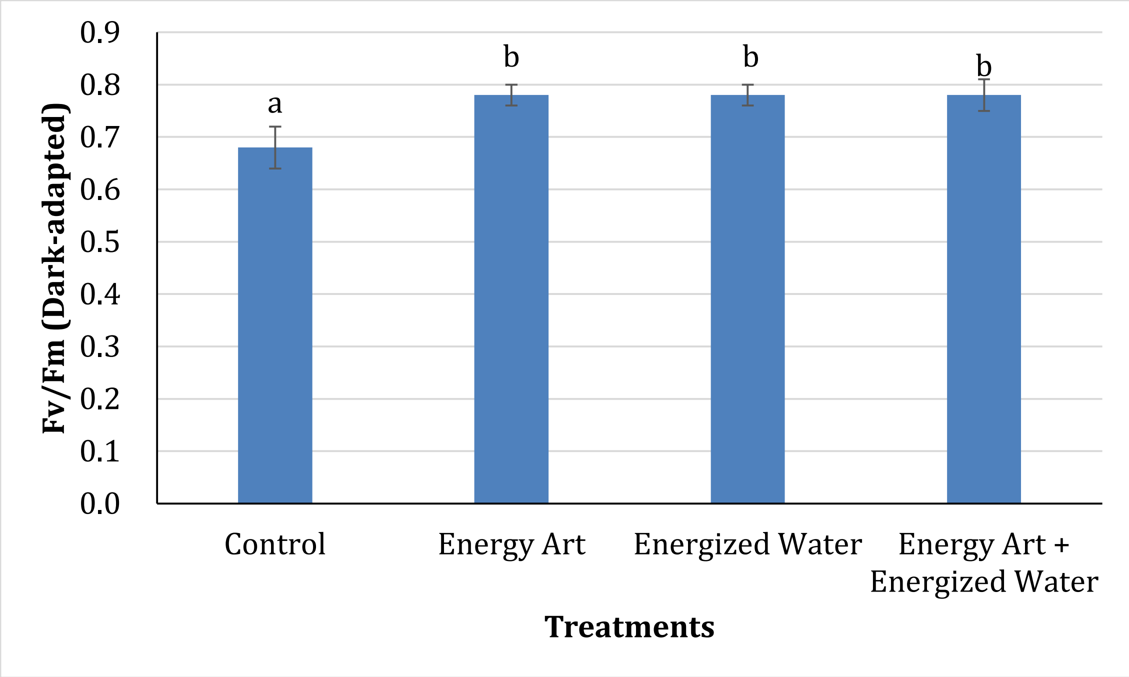


**Fig. 4.3** The effects of different energy treatments on the Fv/Fm (dark-adapted) of lettuce.

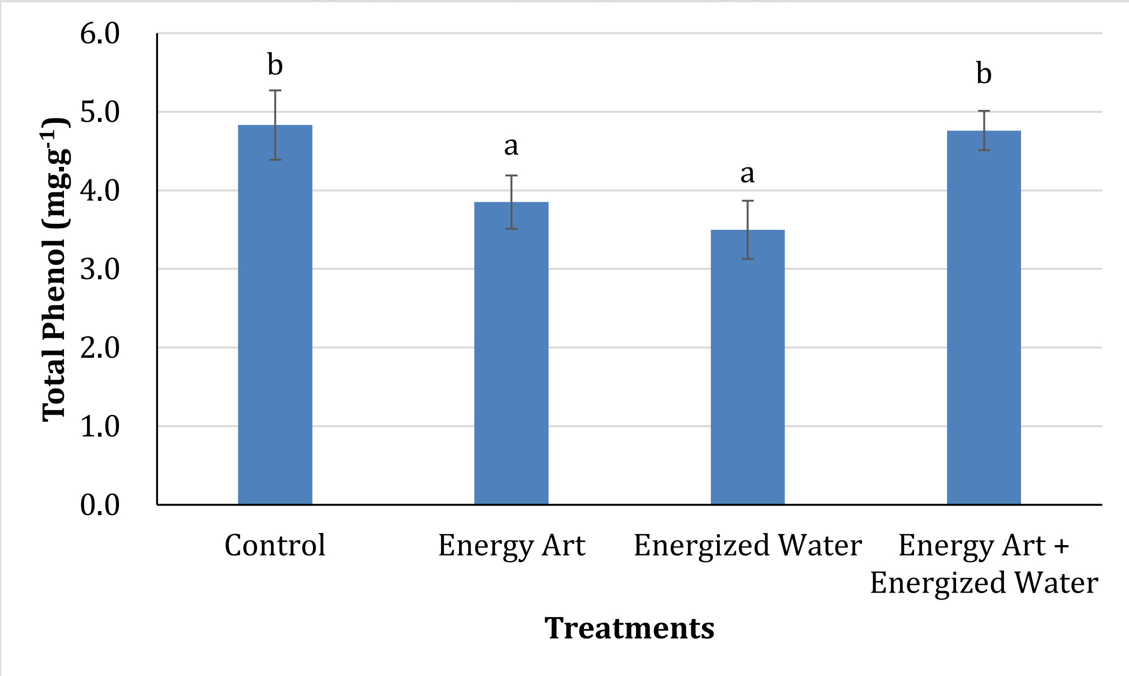


**Fig. 4.4** The effects of different energy treatments on the total phenol content of lettuce.

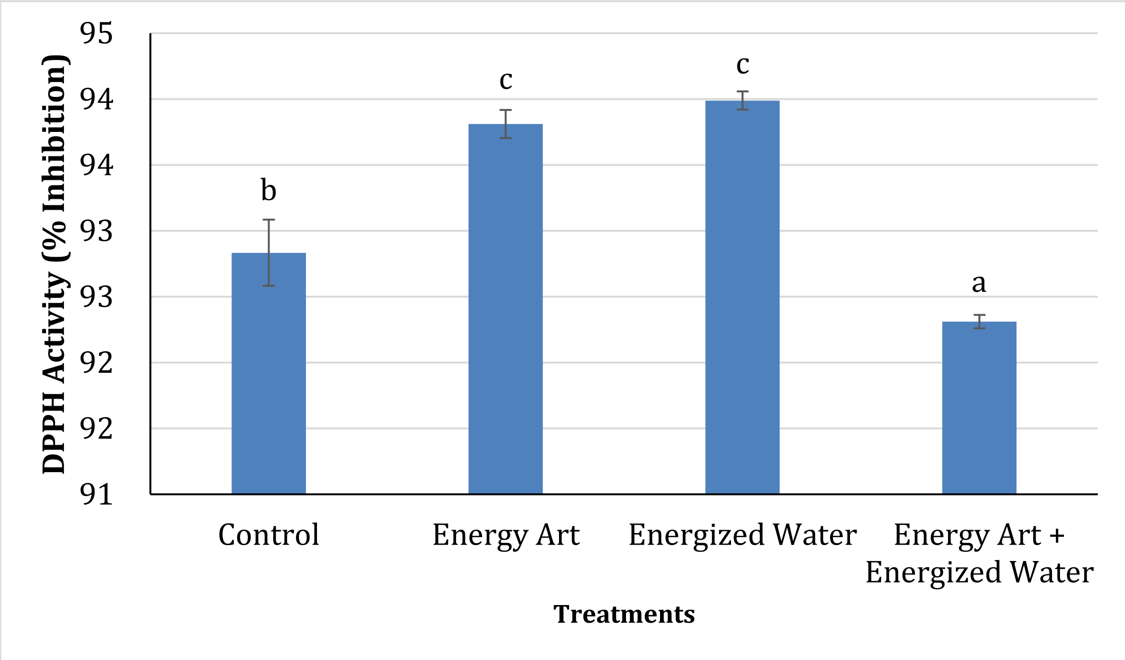


**Fig. 4.5** The effects of different energy treatments on the DPPH radical scavenging activity (% inhibition) of lettuce.

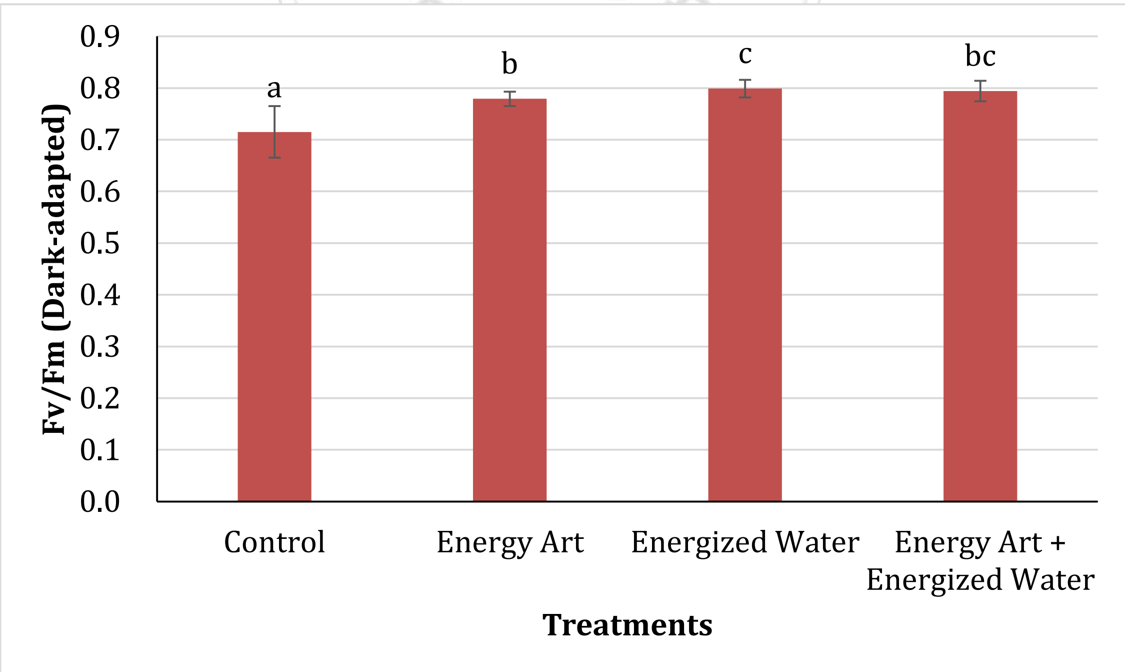


**Fig. 4.6** The effects of different energy treatments on the Fv/Fm (dark-adapted) of bok choy.

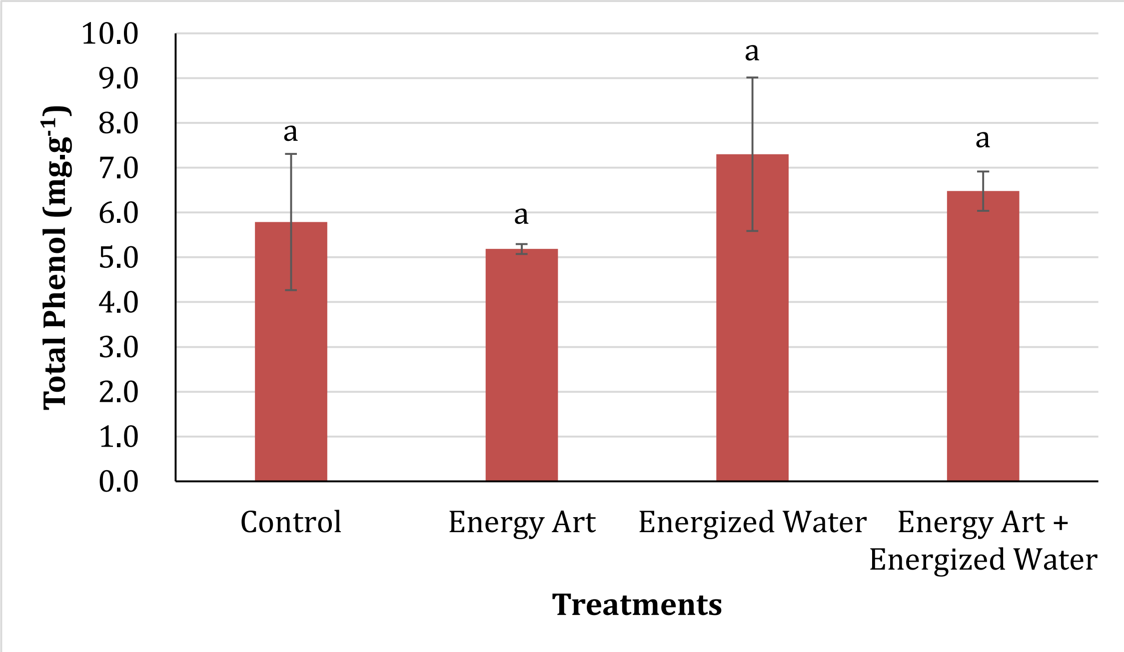


**Fig. 4.7** The effects of different energy treatments on the total phenol content of bok choy.

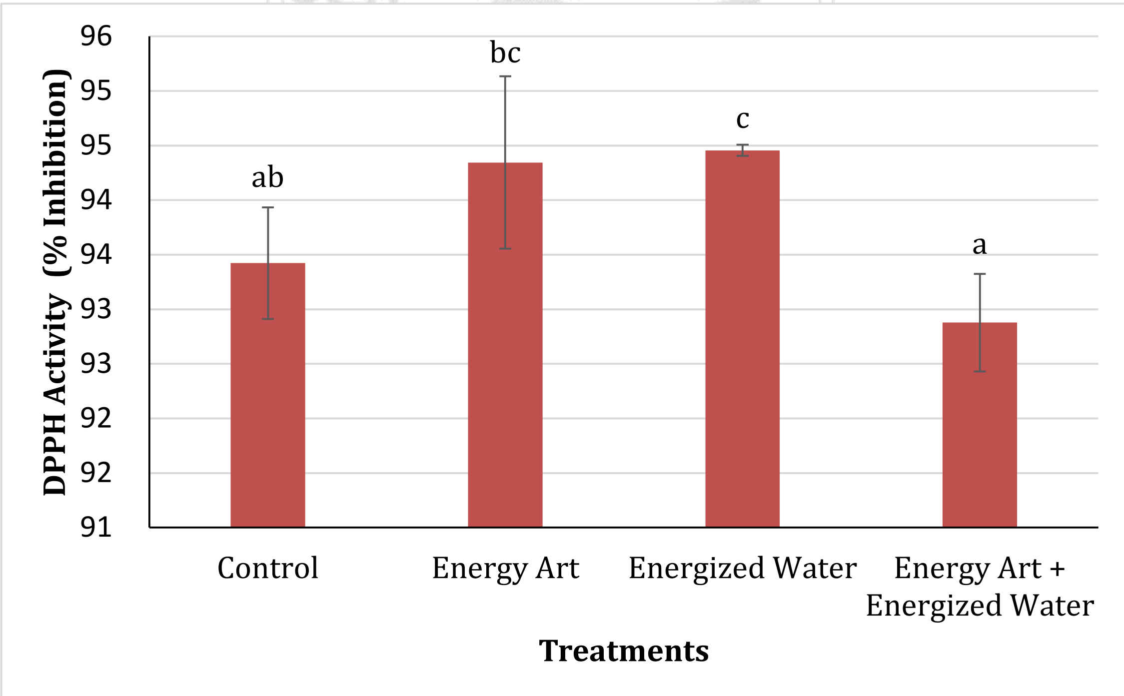


**Fig. 4.8** The effects of different energy treatments on the DPPH radical scavenging activity (% inhibition) of bok choy.

# Chapter 5

# Discussion

In literature, there are few studies reporting on the effects of energy fields or other similar forces on the growth of plants. In the studies that have been reported, there are very little information available that provides an in-depth analysis on the mechanisms of their effects. Moreover, of the research available, even fewer utilized a methodology or design that is equivalent or similar to the ones used in the present study. Nevertheless, despite limited scientific literature, comparisons can be made with the present study in areas such as bioelectromagnetism, magnetic fields, healing energy, or other related fields.

In lettuce plants, significant differences were observed between those cultivated in energy art + energized water and the other treatments (Table 4.1). The combined use of energy art and energized water clearly had a profound effect on the lettuce plants. According to Creath & Schwartz (2004), who used healing energy on the germination of okra and zucchini seeds, energy effects on plants could be attributed to the bioelectromagnetism as well as specific healing intentions originating from the hands of the healer. In the present study, we hypothesize that an exchange of vital energy between the artist and the art pieces during its creation occurred, which in turn was transferred to the water when it was placed in the immediate vicinity of the art pieces for seven days, and subsequently used as energized water in this research. This vital energy from the energy art and the energized water combined was then able to significantly influence the growth and development of the lettuce plants.

This hypothesis is in agreement with the views of Nayak & Altekar (2015) who proposed that biofield energies may interact with materials and structures to make absolute control of events that are not possible through material means alone. It was further stated that it provides some evidence of a potential for significant reciprocal influence of biofield energies on materials and its surroundings.

However, it seems that the potency level of the energy transmitted by the energy art or energized water is crucial to its level of influence on the lettuce plants. This is particularly clear in the significantly lower number of leaves, leaf fresh mass, leaf dry mass, root fresh mass, and root dry mass of lettuce plants grown in treatments with energy art only or energized water only. Regardless of the source, whether it is an energy field, magnetic field or other related forces, the intensity or dose of the energy/force used has been found to have clear differences in their effects on plant growth. In a soybean research, dose-response studies of magnetic fields showed that at its optimal intensity, significant enhancements of plant growth were evident. On the other hand, lower strength and exposure time of the same treatment did not alter seedling growth parameters profoundly, while at higher strengths, detrimental effects on growth were observed (Shine, Guruprasad, & Anand, 2011). In our study, results strongly suggest that the vital energy emitted by the energy art + energized water was at an optimal level, which promoted significant vegetative and root growth in the hydroponically-grown lettuces (Table 4.1).

With regard to the individual energy art and energized water treatments, there are two issues to consider. First, the similarity of the strengths of the vital energy in the energy art and the energized water was clearly demonstrated by their similar effects on lettuce leaf and root growth, which did not differ significantly in all parameters measured (Table 4.1). Second, it is noteworthy that, with the exception of the leaf area (290.62 $cm^2$) in the energy art treatment and the root dry mass (0.25 g) of the energized water treatment, the values of all the remaining parameter of lettuces cultivated in these two energy treatments were significantly lower than those grown without any energy influences (control). It is probable that the energy levels of these two treatments were not optimal to effect a positive response from the lettuce plants, but rather caused a delay in the overall development of these plants, resulting in a lower growth rate.

In fact, this phenomenon was observed during the seed germination period. The seedlings that were germinated with the energy art pieces placed under the germination containers or germinated with energized water were found to grow slower. This minor delay in seedling development was carried over to the hydroponic cultivation system, from which the resulting plants with significantly smaller vegetative and root growth can be seen (Table 4.1).

Overall, a near identical response of bok choy plants to the energy treatments as lettuces was observed. The number of leaves, leaf fresh mass, leaf dry mass, and leaf area of bok choy plants grown under the influence of energy art + energized water were significantly higher than all the other treatments (Table 4.2). However, a key difference between the response of the lettuce and bok choy plants to the treatments with energy art only and energized water only is that, except for the number of leaves (energy art) and leaf dry mass (energized water), the values of the remaining leaf parameters of these bok choy plants were not significantly different to that of the control treatment (Table 4.2). This difference in the response between the lettuces and bok choys provides a clearer insight into the variations of the effects of the vital energy to these two types of plants grown under identical energy treatments and hydroponic systems.

In contrast to the vegetative and root growth of lettuce plants, results showed that the chlorophyll and carotenoid contents of plants grown in energy art + energized water did not differ significantly with those of the control (Table 4.3). Instead, the highest chlorophyll *a,* total chlorophyll content (chlorophyll *a*+*b*), and carotenoids were detected in lettuces cultivated in the energy art treatment, which were significantly higher than those grown in the control. Similar results were reported in electromagnetically-treated corn plants (Anand, Nagarajan, Verma, Joshi, Pathak, & Bhardwaj, 2012). The chlorophyll contents of the corn plants were found to have increased after being pretreated with magnetic treatments. Shinde, et al. (2012) also found tomato and lettuce plants that were treated with biofield contained higher total chlorophyll content.

Similarly, mustard and chickpea plants treated with biofield energy consistently contained higher concentrations of chlorophyll *a*, chlorophyll *b*, and total chlorophyll content (Trivedi, Branton, Trivedi, Nayak, Mondal, & Jana, 2015). In addition, the chlorophyll *a,* chlorophyll *b*, and total chlorophyll content of cashew plants that were grown on a plot of land that had been treated with biofield were found to have increased by 30%, 93%, and 45%, respectively (Trivedi, Branton, Trivedi, Nayak, Gangwar, & Jana, 2015).

In contrast to the energy art treatment, lettuces that were grown with energized water produced the least amounts of chlorophyll *a*, chlorophyll *b,* total chlorophyll content, as well as carotenoids. These findings clearly demonstrate the differences between the vital energy possessed by the energy art pieces and the energized water in influencing chlorophyll and carotenoid content.

In bok choy plants, the opposite was true, where the chlorophyll *a*, chlorophyll *b,* total chlorophyll content, and carotenoids detected in plants grown in energized water were significantly higher than all the other treatments (Table 4.4). The stark differences in the influence of energy art pieces alone and energized water alone on bok choy compared to lettuces clearly illustrate that responses to the vital energy from the One-stroke Energy Art is also dependent on plant type. In line with this observation, the effect of the energy art + energized water treatment, which had a profound effect on lettuce, was not as pronounced on bok choy plants (Table 4.4).

The Fv/Fm value of lettuce plants in the control treatment was found to be less than 0.7 (Fig. 4.3). This suggests that these plants were under stress and were not photosynthetically efficient. This may have been due to the hydroponic conditions not being entirely optimal for the cultivation of lettuce plants. In contrast, the Fv/Fm values of the lettuce plants grown in the energy art, energized water, and energy art + energized water treatments were all significantly higher. Crucially, their Fv/Fm values were all close to 0.8 (Fig. 4.3).

This is a clear indication that their photosynthetic apparatus were efficient and productive. According to Ritchie (2006), plants with Fv/Fm values of between 0.7 and 0.83 are healthy and unstressed. These findings showed that exposure to any of the three energy treatments improves the photosynthetic efficiency of the lettuce plants, which were cultivated under the same hydroponic conditions as the plants not exposed to any energy treatment (control).

Similar results were found in the Fv/Fm values of the bok choy plants (Fig. 4.6). Although the bok choy plants in the control treatment had an Fv/Fm value above 0.7, the Fv/Fm values of bok choy plants grown in the three energy treatments were significantly higher. These results showed that the bok choy plants exposed to any of the three energy treatments were healthier and more photosynthetically efficient than those in the control. These results once again demonstrate the positive effects of the three energy treatments in improving the state of the photosynthetic apparatus of plants. Shine et al. (2011) reported that the photosynthetic efficiency of soybeans that were treated with magnetic fields were enhanced, which resulted in higher vegetative growth. The photosynthetic apparatus of corn seeds was also improved by pretreatment with magnetic fields, which alleviated drought-induced adverse effects on their growth (Javed, Ashraf, Akram, & Al-Qurainy, 2011).

Little information is available on the effects of biofield on the total phenol contents of plants. Nevertheless, the amount of phenolic content detected in plants has been reported to be related to osmotic stress of plants under certain conditions (Cui, Murthy, & Paek, 2014). However, the factors causing the stress may vary widely depending on the type of plant and growing conditions. In the present study, the environmental factors affecting the total phenol content in the lettuce and bok choy are not clear (Fig. 4.4; Fig. 4.7). It is possible that the energy art and energized water treatments played a role in the production of phenolic compounds in both these plants. Further studies to determine how biofield affects phenolic compounds in plants are needed.

With regard to DPPH activity, findings from this study showed that the % inhibition of lettuce and bok choy plants grown in the energy art only and energized water only treatments were the highest (Fig. 4.5; Fig. 4.8). It is unclear from these results how the different energy treatments affected DPPH free radical scavenging activity in relation to the total phenol content. It is possible that the energy treatments had a profound physiological effect on these plants, particularly in lettuce. Nevertheless, it is important to note that the lettuce and bok choy plants grown in the energy art + energized water treatment, which had the highest overall leaf and root growths, had the lowest DPPH % inhibition. Further studies are needed to better understand biofield effects on DPPH activity.

# Chapter 6

# Conclusion

Results of this study showed that the combined use of energy art and energized water clearly had a profound effect on the growth and development of lettuce and bok choy plants. Overall, both the lettuce and bok choy plants cultivated in the energy art + energized water treatment were significantly larger in leaf and root growth than those in the other treatments.

The highest chlorophyll *a,* total chlorophyll content, and carotenoids were detected in lettuces cultivated in the energy art treatment, which were significantly higher than those grown in the control. On the contrary, the total chlorophyll content and carotenoids detected in bok choys grown in energized water were significantly higher than all the other treatments.

These differences in the influence of the different energy treatments on lettuces and bok choys show that responses to the vital energy is dependent on plant type and on how the energy is applied and in what form/state it is used to treat the plants. This seems to be applicable to vegetative growth as well as their physiological development. Furthermore, analysis of the chlorophyll fluorescence (Fv/Fm) of the lettuce and bok choy plants gave a clear indication that exposure to the three energy treatments improves their photosynthetic efficiency. Based on these results, hydroponically-grown lettuce and bok choy plants treated with both energy art and energized water can be used as an alternative approach to improve plant growth rate and yield.

# Research Limitations

Findings from this study have provided a better insight into how the vital energy from the One-Stroke Energy Art affect plant growth and physiology. In future studies, its effects on other type of plants other than leafy vegetables need to be studied. Furthermore, the pH of the hydroponic solution was not adjusted to optimum levels. Adjustment of the pH and nutrient solution composition may lead to a further increase in vegetable production. In addition, the setup of the hydroponic system can be expanded in future research to allow bigger spacing between plants as well as incorporate an automated ebb-and-flow system. Larger art pieces and the length of the exposure time to the art pieces can also be tested to study their influence on plant growth.

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