INTRODUCTION

In complementary and alternative medicine, biofield is described as an endogenous energy field of the human body that includes bio electromagnetics and biophysical fields (Movaffaghi & Farsi, 2009). It has been referred to as a massless field that surrounds and permeates living bodies (Rubik, Muehsam, Hammerschlag, & Jain, 2015). According to Rein (2004), 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. Biofield treatments or interventions often involve intentional mental engagement and/or interaction with energy fields, which are usually performed by trained energy healers or practitioners (Rubik, Brooks, & Schwartz, 2006).

Healing energy has been shown to improve the growth of skin cell cultures, such as cell proliferation and wound healing activity (Singh et al., 2017). Furthermore, anticancer drugs exposed to energy healing treatments were found to improve solubility, absorption, and bioavailability (Nayak, Trivedi, Branton, Trivedi, & Jana, 2019). In addition to its application in medicine, numerous studies have also documented positive effects of various types of biofield energy on microbes and plants. A study by Rubik, Brooks, & Schwartz (2006) reported improvements in the growth of bacterial cultures exposed to Reiki treatment, a form of biofield energy. Findings by Creath & Schwartz (2004) reported that healing energy had a significant effect on the germination of okra and zucchini seeds. Similarly, the growth rate of plant callus (Centella asiatica) was found to be significantly improved after being treated by an energy healer (Branton, Trivedi, Trivedi, Nayak, & Jana, 2018). In a study on the effects of biofield on the growth of tomato and lettuce plants, results showed that when lettuces were exposed to a combination of energy art and energy art-treated water treatments, respectively, which were significantly higher than those grown in the control. Moreover, the photosynthetic efficiency of the lettuce and bok choy plants exposed to the energy treatments were improved significantly. The results of this study demonstrated significant effects of biofield in the form of energy art and energy art-treated water on hydroponically-grown lettuce and bok choy plants. Biofield treatments such as energy art can be used as an alternative approach to improve plant growth and yield.

ABSTRACT

The aim of this study was to investigate the effects of biofield treatments on the growth and physiology of lettuce and bok choy plants. Energy art pieces and water treated by energy art were used as biofield treatments. Overall, both the lettuce and bok choy plants exposed to a combination of energy art and energy art-treated water were significantly larger in terms of leaf and root growth than those in the other treatments. Clear improvements in the vegetative growth of these plants were found, as seen in the significantly higher number of leaves, leaf dry mass, and leaf area. Furthermore, the highest chlorophyll and carotenoid contents were detected in lettuces and bok choy cultivated in the energy art and energy art-treated water treatments, respectively, which were significantly higher than those grown in the control. Moreover, the photosynthetic efficiency of the lettuce and bok choy plants exposed to the energy treatments were improved significantly. The results of this study demonstrated significant effects of biofield in the form of energy art and energy art-treated water on hydroponically-grown lettuce and bok choy plants. Biofield treatments such as energy art can be used as an alternative approach to improve plant growth and yield.
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. Moreover, a report by Sances, Flora, Patil, Spence, & Shinde (2013) demonstrated that ginseng and blueberry crops treated with biofield energy led to significant increases in yield quantity and quality. Similarly, significant increases in the growth of biofield-treated patchouli leaves, nodes, and petioles, as well as stomatal cells and epidermal hair, were reported by Patil, Nayak, Barve, Tembe, & Khan (2012). Further studies to better understand the influence of biofield from different materials and interventions are crucial for the subsequent development of technologies that can be used to harness the biofield energy to improve human health in medicine and plant growth in the agriculture sector.

The source of the biofield energy used in the present study was in the form of a type of energy art called One-Stroke Energy Art (Fig. 1). The energy art was created in one continuous stroke by a well-known energy artist and practitioner, whose name is not mentioned in this paper in accordance with best scientific practice. This research hypothesizes that the energy transmitted by the energy artist surrounds and permeates the energy art, which in turn is able to effect change or regulate living systems nearby. To the best of our knowledge, there are few studies, if any, reporting on the effects of energy art or other similar materials on plant growth and development. Nevertheless, comparisons can be made with the present study in areas such as healing energy, bioelectromagnetism, or other related sources. This study investigated the impact of One-Stroke Energy Art pieces on the growth and physiology of hydroponically-grown lettuce and bok choy plants.

**Fig. 1. One-stroke energy art**

**MATERIALS AND METHODS**

**Plant Material and Growth Conditions**

This research was conducted from September 2018 to March 2019 at the Department of Natural Biotechnology, Nanhua University, Taiwan. Lettuce (*Lactuca sativa*) and Bok Choy (*Brassica chinensis*) seeds were germinated for seven days and transplanted to a hydroponic system. A commercially available hydroponics nutrient solution, which was continuously oxygenated, was used in all treatments. The pH was 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/m²/s at 25 cm above plant height with the photoperiod maintained at 16 h. The temperature of the growth room was maintained at 25 ± 2°C/20 ± 2°C (day/night).
Biofield Treatment (One-Stroke Energy Art)

Small One-stroke Energy Art pieces (8.8 cm x 5.5 cm) drawn by an energy artist were used in this study (Fig. 1). A total of four treatments were tested: 1) control; 2) energy art; 3) energy art-treated water; 4) energy art + energy art-treated water. A completely randomized design was used. In the treatments where energy art pieces were used, five energy art pieces were placed directly under the germination container and the planting container of the hydroponics system throughout the entire growing period. For the energy art-treated water treatment, water was first put in a container and placed about 50 cm in front of an energy art piece hung on a wall for 7 days before being used for germination and the hydroponic system.

Determination of Chlorophyll Content and Carotenoids

The method described by Maadane et al. (2015), with minor modifications, was followed. Briefly, plant samples were freeze-dried, weighed, and homogenized with 10 ml of 95% ethanol. The sample mixture was then mixed with a vortex shaker for 1 minute, and stood in the dark for 30 minutes at 4°C. Thereafter, the sample mixture was filtered, and the supernatant was centrifuged at 4°C for 10 minutes at 1,000 rpm. A 200 μl aliquot of the supernatant was then pipetted into 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.

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). Plant samples were homogenized in 95% ethanol, vortexed for 30 seconds, stood for 30 minutes 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 dilution). After 5 minutes, 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 minutes. The sample was then centrifuged at 30,000 rpm for 1 minute. 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).

Determination of Chlorophyll Fluorescence

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.

Statistical Analysis

For each treatment, five planting containers, each containing six plants were used. Data were collected after 35 days of cultivation. All data were analyzed using Duncan's Multiple Range Test to compare treatment means.

RESULTS AND DISCUSSION

Effect of Biofield on Leaf and Root growth

Overall, the lettuce plants cultivated in the energy art + energy art-treated water treatment were larger than those in the other treatments (Fig. 2). Striking differences in the vegetative growth of these plants can be seen from the significantly higher number of leaves, leaf dry mass, and leaf area than those of the other treatments (Table 1). It is also worth noting that lettuce plants cultivated in treatments with energy art only or energy art-treated water only 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 only present between the control and the energy art-treated water treatments. With regard to root growth, the dry mass of roots was significantly higher in lettuce plants grown in energy art + energy art-treated water than those in the other treatments (Table 1).
Fig. 2. Growth of lettuce after 35 days in hydroponics. (A) Control; (B) Energy art; (C) Energy art-treated water; (D) Energy Art + Energy art-treated water

Table 1. The effects of biofield treatments on leaf and root growth of lettuce and bok choy plants

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No. of Leaves</th>
<th>Leaf Dry Mass (g)</th>
<th>Leaf Area (cm²)</th>
<th>Root Dry Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lettuce</td>
<td>Bok Choy</td>
<td>Lettuce</td>
<td>Bok Choy</td>
</tr>
<tr>
<td>Control</td>
<td>9.3±1.5b</td>
<td>7.4±1.1a</td>
<td>1.5±0.5a</td>
<td>1.9±0.9b</td>
</tr>
<tr>
<td>Energy Art</td>
<td>6.5±1.0b</td>
<td>8.3±1.3a</td>
<td>0.7±0.3a</td>
<td>1.7±1.4b</td>
</tr>
<tr>
<td>EAW¹</td>
<td>6.3±0.8a</td>
<td>7.8±1.2a</td>
<td>0.7±0.2a</td>
<td>1.1±0.9a</td>
</tr>
<tr>
<td>EA + EAW²</td>
<td>12.3±2.0c</td>
<td>9.6±1.5a</td>
<td>1.9±1.2a</td>
<td>2.5±1.1c</td>
</tr>
</tbody>
</table>

Remarks: Different letters within the same column indicate mean values differ significantly based on Duncan’s Multiple Range test (P ≤ 0.05); EAW¹ = energy art-treated water; EA + EAW² = energy art + energy art-treated water
Similar to the results of lettuce plants, bok choy plants grown in the energy art + energy art-treated water treatment were much larger in size (Fig. 3). Analysis of the data showed significantly higher number of leaves, leaf dry mass, and leaf area of plants in this treatment than those grown in all the other treatments (Table 1). In fact, the leaf area of bok choy cultivated in the energy art + energy art-treated water treatment was over 1.5 times the size of plants in the other treatments. When bok choy plants were exposed to a single type of biofield treatment only, leaf growth was similar to that of the control (Table 1). In terms of root growth, significantly higher root dry mass was found between roots that formed in the energy art + energy art-treated 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 energy art-treated water only (Table 1).

Fig. 3. Growth of bok choy after 35 days in hydroponics. (A) Control; (B) Energy art; (C) Energy art-treated water; (D) Energy art + Energy art-treated water
The combined use of energy art and energy art-treated water clearly had a profound effect on the growth and development of lettuce and bok choy plants. A study by Trivedi et al. (2016) showed that watermelons and eggplants treated with biofield energy had improved growth characteristics, growth rate, and crop yield. 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 bioelectromagnetism as well as specific healing intentions originating from the hands of the healer. In the present study, this research hypothesized that an exchange of energy between the artist and the art pieces occurred during its creation, 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 energy art-treated water in this research. The combined biofield energy from the energy art and the energy art-treated water 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 affect or control events that are not possible through material means alone. It was further stated that their findings provide some evidence of a potential for significant reciprocal influence of biofield energies on materials and its surroundings.

It seems that the energy transmitted by the energy art or energy art-treated water is crucial to its level of influence on the lettuce and bok choy plants. This is particularly clear in the significantly lower amount of vegetative and root growths of lettuce plants grown in treatments with energy art only or energy art-treated 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 (Shine, Guruprasad, & Anand, 2011). 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. In this study, results strongly suggested that the energy emitted by the energy art + energy art-treated water was probably at a near-optimal level, which promoted significant vegetative and root growth in the hydroponically-grown lettuce and bok choy vegetables.

**Effect of Biofield on Chlorophyll and Carotenoid Content**

In lettuce plants that were grown in the energy art treatment, results of the chemical analyses showed that it contained the highest concentration of carotenoids, chlorphyll a and b (Table 2). The total chlorophyll content (chlorophyll a+b) and carotenoids of lettuces cultivated in this treatment were significantly higher than those grown in the control. 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 2).

**Table 2.** The effects of biofield treatments on chlorophyll and carotenoid contents of lettuce and bok choy plants

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Carotenoids (mg/g)</th>
<th>Chl. a (mg/g)</th>
<th>Chl. b (mg/g)</th>
<th>Chl. a+b (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lettuce</td>
<td>Bok Choy</td>
<td>Lettuce</td>
<td>Bok Choy</td>
</tr>
<tr>
<td>Control</td>
<td>2.1±0.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.5±0.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.8±2.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.2±1.5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Energy Art</td>
<td>2.5±0.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.9±1.1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.4±1.1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>19.4±3.7&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>EAW&lt;sup&gt;i&lt;/sup&gt;</td>
<td>1.6±0.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.1±0.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.7±1.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>26.8±1.8&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>EA + EAW&lt;sup&gt;ii&lt;/sup&gt;</td>
<td>2.2±0.2&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>6.6±0.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.1±0.7&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>23.6±2.0&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Remarks: Different letters within the same column indicate mean values differ significantly based on Duncan’s Multiple Range test (P≤0.05); EAW<sup>i</sup> = energy art-treated water; EA + EAW<sup>ii</sup> = energy art + energy art-treated water

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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. 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, which were at least twice as high as those detected in plants of the control treatment.

These findings are similar to those reported in electromagnetically-treated corn plants (Anand et al., 2012). The chlorophyll contents of the corn plants were found to have increased after being pretreated with magnetic treatments. Shinde, Sanches, Patil, & Spence (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, et al., 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, et al., 2015).

The inverse effects between the energy art treatment and the energy art-treated water treatment on the carotenoid and chlorophyll a and b contents of bok choy and lettuces clearly illustrate that responses to the energy from these treatments are also dependent on plant type (Table 2). In line with this observation, the effect of the energy art + energy art-treated water treatment, which had a profound effect on bok choy, was not as pronounced on lettuce plants (Table 2).

**Effect of Biofield on Chlorophyll Fluorescence (Fv/Fm) and Total Phenol Content**

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 F₀. When the saturating light pulse is applied, the fluorescence level is maximal, denoted Fm (Schoefs, 2005). The increase from F₀ 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).

As shown in Table 3, the Fv/Fm values of both lettuce and bok choy plants cultivated without any type of biofield treatment (control) were significantly lower than those exposed to biofield treatments, regardless of the type of biofield used. In addition, the Fv/Fm value of lettuce plants in the control treatment was found to be less than 0.7. This suggests that these plants were under stress and were not photosynthetically efficient. This might be caused by 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 three energy treatments were all significantly higher. Crucially, their Fv/Fm values were all within the range of 0.70–0.83 (Table 3). This is a clear indication that their photosynthetic apparatus was 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 the exposure to any of the three energy treatments improved the photosynthetic efficiency of the lettuce plants, compared to those not exposed to any energy treatments (control).
In bok choy plants, although those cultivated in the control treatment have an Fv/Fm value above 0.7, those grown in the three energy treatments are significantly higher (Table 3). These results again 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. Similar to the results found in lettuces, these findings demonstrated the positive effects of the three energy treatments in improving the state of the photosynthetic apparatus of bok choy plants.

Shine, Guruprasad, & Anand (2011) reported that the photosynthetic efficiency of soybeans 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).

Significantly lower total phenol content was observed in the energy art only and energy art-treated water only treatments of lettuces compared to the control and the energy art + energy art-treated water treatments (Table 3). No significant differences in total phenol content were detected between bok choy cultivated in the control treatment and those exposed to energy treatments. 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 is known 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 effects of the energy treatments on total phenol content in the lettuce and bok choy are not clear. Further studies are required to determine how biofield affects phenolic compounds in plants.

**CONCLUSION AND SUGGESTION**

The combined use of energy art and energy art-treated water had a profound effect in improving the growth of lettuce and bok choy plants. The positive impact also extends to their physiological development, as demonstrated by the improvements in their photosynthetic efficiency. Based on these results, energy art and energy art-treated water combined can be used as an alternative approach to improve plant growth and yield. Future studies are warranted to determine the underlying mechanisms of these effects.

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