INFLUENCE OF COMPOSTED FOOD WASTE AND SEWAGE SLUDGE ON PLANT GROWTH ENHANCED WITH MAGNETIC FIELDS

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This thesis is dedicated,

To my respected and beloved mak & ayah,
Habsah binti Ahmad & Ahmad bin Md Hassan
Thanks for your support, love, valuable sacrifice, and patience,
To my family, especially my lovely sister and nephew, Noraliza and AmirZikri
My precious friends Nor faizah, Maria, Hudai, Nurul & Lavania
Thank you for the support, unconditional giving and always there for me,
May Allah grant us happiness and success in this life, as well as happiness in the hereafter . Aaminn.ya Robbal alamin.
Love u all...

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"In the name of Allah, the Most Gracious, the Most Merciful"

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ABSTRACT

Sewage sludge and composting food waste have the potential to be used as fertilizer due to nutrient availability. Thus, application of sewage sludge and composted food waste as nutrient sources for plants enhanced with the magnetic field to water the plants was studied. The study focused on nutrient content in sewage sludge powder (SSLG) and liquid from composted food waste (LCFW) from a primary oxidation pond at Taman Sri Pulai, Johor and food waste from wet market Kipmart Tampoi, Johor. *Capsicum annum* (red chili) was selected as the plant to receive different concentrations of nutrients. In order to increase the efficiency of sewage sludge and composted food waste, magnetized water was applied to irrigate the plants along with SSLG and LCFW. Five different amounts and concentration of SSLG and LCFW were prepared. SSLG was applied to the plant only once at the beginning, while LCFW was applied on a weekly basis. All the plants were watered by the same amount of magnetized and tap water on a daily basis. Plant growth was recorded on weekly basis. The study revealed that there is a significant difference between the application of SSLG and LCFW to the plants and control plants with no SSLG and LCFW in the tap and magnetized water. SSLG and LCFW increased the plant growth up to 83.33% in root, 85.71% in stem and 86.66% in leaves Nitrogen Nitrate (NO_3^--N) content, while for Phosphorus (P) content the SSLG and LCFW enhanced 78.57% in root, 73.33% in stem and 75.59% in leaves, for Total Kjedhal Nitrogen (TKN) content organic waste boosted the growth of 59.38% in root, 58.02% in stem and 69.88% in leaves in tap water condition which was higher than control plants. In the meantime for magnetized water, SSLG and LCFW increased up to 84.91% in root, 87.18% in stem and 87.23% in leaves for NO_3^--N content, while for P content SSLG and LCFW enhanced growth of 79.31% in root, 75.51% in stem and 80.77% in leaves, for TKN content those organic waste boost 65.02% in root, 85.87% in stem and 71.64%. Magnetic field enhanced nutrient absorption up to 4.76% in root, 11.89% in stem and 16.67% in leaves for NO_3^--N content, while for the P content the magnetized water enhanced 17.31% in root, 8.78% in stem and 14.42% in leaves, for TKN content that magnetic treatment boost 29.34% in root, 58.18% in stem and 17.90% in leaves higher than untreated tap water. In conclusion, the application of sewage sludge and composted food waste, enhanced by magnetic water is a viable option for plant growth where the quality of the crops was increased. However, in terms of consumption and safety, other alternatives should also be considered in order to further validate the safety of crops grown with sewage sludge.

ABSTRAK

Enapcemar kumbahan dan komposan sisa makananmempunyai potensi untuk digunakan sebagai baja kerana ia mengandungi nutrien. Justeru itu, penggunaan enapcemar kumbahan dan kompos sisa makanan sebagai sumber nutrien untuk tumbuhan boleh ditingkatkan menerusi penyiraman air bermedan magnet. Kajian ini tertumpu kepada kandungan nutrien yang ada dalam serbuk enapcemar kumbahan (SSLG) dari kolam pengoksidaan utama Taman Sri Pulai, Johor dan pengkomposan sisa makanan (LCFW) daripada pasar basah Kipmart Tampoi, Johor. *Capsicum annum* (cili merah)adalah tumbuhan yang dipilih untuk menerima jumlah nutrient yang berbeza. Bagi meningkatkan keberkesanan SSLG dan LCFW, air termagnet digunakan untuk penyiraman tumbuhan bersama SSLG dan LCKW. Lima jumlah dan kepekatan yang berbeza bagi SSLG dan LCFW telah disediakan. SSLG diletakkan ke atas tumbuhan hanya sekali sahaja diawal pertumbuhan, manakala LCFW diletakkan setiap minggu. Tumbuhan akan disiram setiap hari oleh air magnet dan air paip dalam jumlah yang sama. Kajian menunjukkan bahawa terdapat perbezaan besar antara penggunaan SSLG dan LCFW terhadap pertumbuhan pokok dengan tumbuhan kawalan iaitu tanpa aplikasi SSLG dan LCFW, dengan siraman air paip dan magnet. SSLG and LCFW meningkatkan nilai penyerapan Nitrogen Nitrate (NO_3^--N) sehingga 83.33% dalam akar, 85.71% dalam batang dan 86.66% pada daun, manakala untuk nilai Phosphorus (P), SSLG and LCFW meningkatkan pertumbuhan pokok sebanyak 78.57% dalam akar, 73.33% dalam batang dan 75.59% dalam daun, untuk kandungan Total Kjedhal Nitrogen (TKN), sisa buangan organik tersebut meningkatkan sebanyak 59.38% dalam akar, 58.02% dalam batang dan 69.88% dalam daun yang lebih tinggi berbanding air paip. Pada masa yang sama air termagnet, SSLG and LCFW meningkatkan penyerapan sehingga 84.91% dalam akar, 87.18% dalam batang dan 87.23% pada daun bagi kandungan NO_3^--N, manakala untuk kandungan P, SSLG and LCFW meningkatkan 79.31% dalam akar, 75.51% dalam batang dan 80.77% dalam daun, dan untuk kandungan TKN penyerapan adalah sebanyak 65.02% dalam akar, 85.87% dalam batang dan 71.64%. Medan magnet mampu meningkatkan kadar penyerapan nutrient sehingga 4.76% dalam akar, 11.89% dalam batang dan 16.67% dalam daun kandungan NO_3^--N, manakala untuk kandungan P, air magnet meningkatkan kadar penyerapan sebanyak 17.31% dalam akar, 8.78% dalam batang dan 14.42% dalam daun, untuk TKN, kadar peningkatan dari rawatan yang air magnet adalah 29.34% dalam akar, 58.18% dalam batang dan 17.90% didalam daun, lebih baik daripada air paip biasa. Kesimpulannya, penggunaan enapcemar kumbahan dan kompos sisa makanan, ditingkatkan oleh air termagnet adalah satu pilihan berdaya maju untuk pertumbuhan pokok dengan kualiti tanaman. Namun, dalam soal pemakanan dan keselamatan peningkatan pokok yang ditanam dengan enapcemar kumbahan, alternatif lain patut dipertimbangkan bagi mengesahkan keselamatan.

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LIST OF ABBREVIATIONS

C:N	-	Carbon to nitrogen
EPA	-	Environmental Protection Act
FAO	-	Food and Agriculture Organization
HDPE	-	high density polyethylene
IWK	-	Indah Water Konsortium
LCFW	-	Liquid from Composted Food Waste
N	-	Nitrogen
NH_4^+	-	Ammonium
NO_2^-	-	Nitrite
NO_3^-	-	Nitrate
NO_3^-N	-	Nitrogen Nitrate
P	-	Phosphorous
SSLG	-	Sewage sludge powder
TKN	-	Total Kjeldahl Nitrogen
WWTP	-	Wastewater treatment plant

LIST OF SYMBOLS

t	-	Time (day)
R^2	-	Correlation coefficient (dimensionless)

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The management of sludge from wastewater treatment facilities is one of the most critical environmental issues in Malaysia, due to the very fast increase in sludge production as a result of sewerage extension, new installations and upgrading of existing facilities. Thus, it is necessary to develop a comprehensive plan for different kind of sludge deriving from wastewater treatments, which are produced under different technical, economic, social contexts and hence require different approaches.

Sewage sludge is the insoluble residue from wastewater treatment after either aerobic or anaerobic digestion processes (Hussein *et al.,* 2010). The production of sewage sludge has increased gradually in worldwide due to the demand for better water quality and the strict environmental laws (Walter *et al.,* 2006). The composition of the sludge is based on organic and inorganic solids, nutrients as well as the biomass produced during aerobic and anaerobic degradation processes. Sewage sludge has good fertilizer properties because of humification of nutrients and organic matter in soil. On the other hand, although sewage sludge contains heavy metals but there is no negative impact associated with its application in agriculture. Hence, the sewage sludge can effectively spread to reactivate degraded areas, replace humus material and plant grass.

At the same time, Jaya *et al.,* (2006) reported solid waste management is one of the major environmental challenges due to population growth and urbanization. The sustainable waste management approach is required to treat organic waste on-site and produce useful products. Hence, the composting process in organic composition are reduced rapidly from large to small volumes of decompose material and continue to slow decomposition (Raabe, 2009)

Composting is a biological decomposition with controlled stabilization of thermophilic organic substrates and aerobic conditions (Haug, 1993). The advantages of compost utilization in crop management are to reduce the use of chemically synthesized (i.e., nitrogen and phosphorus) fertilizers and to prevent land degradation (Albiach *et al.,* 2001). Thus, composting is seen as one of the potential economic and sustainable approach in organic waste management which is easy to conduct in the limited space provided to produce useful product.

Another aspect of research related to plant growth is the effect of the irrigated water. All plants vary in their water requirements according to their size and growth stage as well as the length of their maturity and time of year of maximum growth. Plants and trees need mineral from the soil for growth and food production. The proper balance of minerals and nutrients are needed and also, pH is useful in the soil. Previous studies have been conducted on the effect of magnetic fields on particles crystallization, coagulation, dissolved the scale (Jacob *et al.,* 1999) and increasing the settling of suspended particles (Johan, 2003) and have proven that the magnetic field could help to convert water into biologically active by applying magnetic energies which affect and regroup water molecules into a perfect structure and ensure its retaining its natural form.

Vermeiran (1958) and Klassen (1981) reported that the efficiency of coagulation and flocculation of total suspended solids and iron increased by magnetic water treatment (Duffy, 1977; Tombaez *et al.,* 1991). Duarte Diaz *et al.,* (1997) reported the magnetic field could increase the plant tolerance to fungus. Bogatin *et al.,* (1999) also reported the beneficial uses of magnetic water treatment for agricultural applications. Therefore, this study sought to determine the most efficient type, chemical composition and magnetic treatment method in natural water, including the effects of magnetic treatment of irrigated water.

1.2 Problem Statement

In Malaysia, sewage sludge was produced over 5 million m^3 each year (Rosenani *et al.,* 2008). This amount could mount up to 7 million m^3 by the year 2020 (Abdul Kadir & Velayutham, 1999). Likewise, organic waste management is one of the biggest environmental challenges facing the world today due to the increasing population and urbanization products. One of the main problems related to this entire is the disposal of the waste. Although numerous alternatives are available, most of them are either costly, difficult to be carried out or not environmental-friendly.

The utilization of sewage sludge onto croplands has been met with distress and rejection (Chale-Matsau, 2005). While composting food waste has the potential in economic and sustainability in organic waste management as it is easy to conduct in a limited space provided to produce useful product. Previous studies have been conducted in this area to ascertain the role of soil organic matter in sustaining crop production and improve soil quality (Bationo, 1997; Williams, *et al.,* 1993). Due to the lack of scientific knowledge, the public tends to reject anything that associates sewage sludge and crops..

Since twenty years back, the study was only focus on individual research consist only sewage sludge and food waste by direct application. Thus, there is a need to address and change the public perception of the land application of sewage sludge and composting food waste. Hence, in this study the waste from sewage sludge and food waste were emphasized to conduct as one combined alternative not only to reduce the waste production but to enhance the plant growth as well. Furthermore, the application of magnetized water to water the plants from application of the sewage sludge and food waste combination is the new alternative to increase the plant development better than untreated tap water. It is clear that if the members of the public are aware of the benefits of sewage sludge and composted food waste in agriculture, reception of the alternative will increase in the future.

1.3 Objective of the study

i. To evaluate the nutrient availability and trace elements in sewage sludge powder (SSLG) and liquid generated from composted food waste (LCFW);
ii. To determine the growth of agriculture, plant sections respectively upon SSLG, LCFW and both (SSLG and LCFW) with different rates and concentrations;
iii. To determine the positive effect of water exposed to the strength of magnetic fields on plant growth;
iv. To study the comparison of SSLG, LCFW, and magnetic fields on the growth of agriculture plant.

1.4 Scope of study

Sludge is collected from the oxidation pond of sewage treatment plant in Taman Sri Pulai, Skudai, Johor and the food waste was collected from the wet market in Kipmart Tampoi Market, Johor Bahru. Food waste was fermented and sewage sludge was air dried and subsequently ground to fine powder form and was analyzed in the Environmental Laboratory Universiti Teknologi Malaysia. Sewage sludge powders were then mixed with the ordinary loam soil with different concentrations. Composted food waste i.e. rice, green vegetable, fruits, leaves, grass trimmings, paper, were fermented and turned into a valuable organic fertilizer. The value of C/N ratio for material composted is 30 to 1 (Joan, *et al.,* 2010). The liquids from composted food waste were applied together with the dried sewage sludge powder to the crop two weeks once.

The parameters analyzed were consisted of Nitrogen Nitrate (NO_3^--N), Phosphorus (P) and Total Kjedhal Nitrogen (TKN) for nutrient analysis and Copper (Cu), Manganese (Mn), Iron (Fe), and Zinc (Zn). *Capsicum Annum L.* (red chili) with the surface edible part of the leaf was grown as part of the experiment in measuring the efficiency of sewage sludge and liquid from composting kitchen waste. Water magnetized with magnetic fields was watered daily to the plant. The strength of magnetic fields used was 0.55T.

Known the sewage sludge application will present the actual species and quantity of pathogens from a particular water treatment plant may differ depending on the health status of the local municipality and may vary substantially at different times (EPA, 1999). This study was only focus on nutrient and metal availability in sewage sludge and excluded the pathogen effect for further study.

1.5 Significant of study

The usage of SSLG and LCFW which contain high concentration of nutrients is the best alternative for increasing soil resilience which has commonly used in agriculture activities especially in poor countries. Utilizing sewage sludge could reduce the amount of sludge normally dump at the disposal site. Composting is another aspect of waste reduction technology, where waste is converted to a beneficial product or material. On the other hand, the use of compost products increased in crop production and reduces the negative effect of delayed sowing and lack of credit for investment in soil management. Water that admitted magnetically has the potential to increase the plant growth and improves the water productivity based on grain yield and total biomass production compared with non-magnetic treated water irrigation. The major beneficiaries of the project would be the bio-technology agriculture industries and sewage treatment plant operations..

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