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Phytochemical screening and return on investment of pechay (*Brassica napus* L. subsp. *chinensis* var. *Black Behi*) as influenced by inorganic fertilizers (ground and foliar application) and organic fertilizer

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Abstract
The study was conducted to evaluate the phytochemical properties of *Pechay* applied with different types and levels of organic and inorganic fertilizers under different methods of application. In particular, the study aimed to determine the phytochemical components of *Pechay* using different nutrient sources and application methods and compute its Return on Investment (ROI). Randomized complete block design (RCBD) was used with three replications conducted at Mindanao State University-Main Campus, Marawi City. Results of the study revealed that all three replications of T_2 plants showed double positive (++) in tannins while T_5 plants revealed double positive (++) in flavonoids indicating that both T_2 and T_5 plants are having harmful levels of the phytochemicals. The results showed that all other treatments are safe from harmful phytochemical components. Based on the results of the study, considering that T_2 (Rec. Rate (RR) Inorganic Fertilizer) and T_5 (50% RR Inorganic Fertilizer + 50% RR Organic Fertilizer) treated plants are high in tannins and flavonoids respectively, it is therefore safe to recommend the use of T_6 (50% RR Inorganic Fertilizer + 50% RR Foliar Fertilizer), T_3 (RR Organic Fertilizer) and T_4 (RR Foliar Fertilizer) whatever is affordable and locally available to the farmers. In areas where land area is a problem, this study showed that the use of pots can be a viable alternative to increase production and provide food in urban settings.

Keywords: *Pechay*, alkaloids, flavonoids, phytosterols, tannins, phenolics, r. sugar, organic fertilizers, inorganic fertilizers, phytochemical properties, return on investment (ROI), randomized complete block design

Introduction

Phytochemical component is emerging as a major concern in agriculture food production in the Philippines. It has been a challenge to produce foods free from toxic substances which is deemed detrimental to human health. Types and levels of fertilizer applied to crops therefore are very important in crop production and play an important role in the cropping systems. In addition, relying on inorganic or chemical fertilizers is a major constraint due to its prohibitive cost though identified an important factor in meeting the food requirements of a growing population.

Eleazu *et al*. (2012) [8] defined phytochemicals as chemical compounds formed during the plants normal metabolic processes. These chemicals are referred to as secondary metabolites which comprises of several classes and these includes; alkaloids, flavonoids, phenols, tannins, (Ndukwe *et al*., 2013; Nduche *et al*., 2015) [20, 19], coumarins, glycosides, gums, polysaccharides, terpenes, terpenoids, (Oludare and Bamidele, 2015; Singh, 2012) [22, 25]. Plants may contain other substances apart from the said chemicals.

Evidence from epidemiological, in vivo, in vitro, and clinical trial data suggests that the plant-based diet can reduce the risk of chronic due to the presence of biologically active plant compounds or phytochemicals. Key *et al*. (2009) [13] pointed out that phytochemicals include those plant-derived compounds that have specific biological activity in human. They can be defined also as bioactive natural molecules that can be of benefits for human health (Richardson *et al*., 2000) [23].

Cragg and Newman (2009) [5] identified that in terms of prevention, their beneficial effects have been described in different epidemiological investigations, which underlined, despite the limitations of these kind of studies, a reliable relationship between diets rich in phytochemical and reduction in the risk of developing several diseases, including cancer. Specifically, high intake of fruits and vegetables, the richest dietary components in phytochemicals, has been correlated to a decrease in the risk of several cancers (Danaei *et al*., 2005) [6]. However, one-third of all cancer deaths is estimated to be preventable by "healthy" lifestyles, including appropriate nutrition (Danaei *et al*., 2005) [6]. A plethora of phytochemicals, such as carotenoids, antioxidative vitamins, phenolic compounds, terpenoids, steroids, indoles, and fibers, has been considered responsible for the risk reduction (Alberts and Hess, 2008) [2].

On the other hand, phytochemicals can be assimilated to chemotherapeutics, which are frequently derived from natural substances, directly extracted from plants, or other natural sources, or chemically derived from naturally occurring compounds (Richardson *et al*., 2000) [23]. Behind traditional medicine, many cancer patients are currently using plant-derived compounds in the context of complementary therapies (Richardson *et al*., 2000) [23]. Moreover, phytochemicals can contribute to cancer prevention by influencing different stages of the tumor development, from tumor initiation through all the phases of cancer (Hanahan and Weinberg, 2011) [10], such as cell

proliferation, apoptosis, invasion and metastasis, angiogenesis, and immortality (Kroemer and Pouyssegur, 2008) [14].

However, phytochemical properties can also be harmful to human body. Limited studies had been made to evaluate the phytochemical components which are deemed toxic and harmful to human health if the amount exceeds safe levels. Hence, this study focused on the effects of phytochemical constituents of pechay (*Brassica napus* L. var. *Black Behi*).

Literature Review

Antinutritional and Toxic Effects of Tannins

Tannins are plant secondary metabolites usually considered as natural non-nutrients. Moreover, some of the phytochemicals normally found associated to tannins, including alkaloids and phenolic compounds occur as toxins. Among the antinutritional and toxic effects described for tannins, decreases in food intake, growth rate, feed efficiency, net metabolizable energy, and protein digestibility are the ones mainly investigated. Other deleterious effects of tannins include damages to mucosal lining of gastrointestinal tract, alteration of excretion of certain cations, and increased excretion of proteins and essential amino acids (Chung *et al*., 1998) [4]. Negative effects of foods rich in plant secondary metabolites can be also by reducing food intake, associated to decreases in food organoleptic quality. Many low-molecular weight plant secondary compounds are bitter and high-molecular weight ones, such as tannins, are usually involved in the interaction with macromolecules, particularly with salivary proteins, resulting as astringent (Hagerman, 1992) [9].

Tannin-containing Diet on Fatty Acid

In Mueller-Harvey's (2006) review, results showed that the harmful effects of tannins in ruminant and monogastric animals can range from producing chronic or systemic disorder. Many monogastric animal species appear to be more sensitive to tannins than ruminants. Furthermore, the effects of tannins could have been confused with the effects of other compounds; high-tannin sorghums contain many co-occurring phenolics, such as the relatively rare 3-deoxyanthocyanidins and flavan-4-ols, and faba beans (*Vicia faba* L.) contain lectins and trypsin inhibitors. This explains why lactating pigs fed sorghum/soybean meal had a poor N balance, whereas Iberian pigs thrive on acorns.

Variability in Tannin Contents

Alkurd *et al*. (2008) [3] in their study showed that tannin contents of the analyzed species were highly variable, ranging from 25 mg/kg in plums and verbena to 42961 mg/kg in rosemary (on dry matter basis). It is therefore expected that due to variability in tannin content, different nutrition-health effects may result, a matter which requires other studies to clarify these effects.

Health Benefits of Flavonoids

Tiwari and Husain (2017) [28] found that flavonoids are such phytochemicals that play significant role in enhancing the human health benefits. They are good sources of natural antioxidants in human diets. Flavonoids neutralize the harmful effects of free radicals in best of ways, and thus help in prevention of diseases. Flavonoids, occurring virtually, in all plant parts, particularly photo-synthesizing plants cells are a major coloring component of flowering plants. Flavonoids have extensive biological properties that promote human health and reduce the risk of diseases.

Alkaloids

Alkaloids are group of naturally occurring chemical compounds which mostly contain basic nitrogen atoms (Tadeusz, 2007) [26]. In other word, alkaloids are nitrogenous secondary metabolites heterocyclic derivatives of amino acids or by the transamination process which confers basic characters (Diaz *et al*., 2015) [7]. The group includes some related compounds with neutral and even weakly acidic properties. In addition to carbon, hydrogen and nitrogen, the group may contain some other elements such as oxygen, sulphur and more rarely other elements like chlorine, bromine and phosphorus (Tadeusz, 2007) [26]. Alkaloids are classified based on biosynthetic pathways (Lu *et al*., 2012) [17]. Lu *et al*. (2012) [17] observed that, alkaloids have a wide distribution in the plant kingdom and mainly exist in higher plants, such as those belonging to the family Ranunculaceae, Leguminosae, Papaveraceae, Menispermaceae and Loganiacea. Approximately 60% of the drugs from plants are alkaloids (Sibi *et al*., 2014) [24]. Lu *et al*. (2012) [17] asserted that, alkaloids exhibit significance biological activities, examples are the relieving action of ephedrine for asthma, the analgesic action of morphine, the anticancer effects of vinblastine (Lu *et al*., 2012; Vaghora and Shukla, 2016) [17, 30]. Quinine has been used in the treatment of malaria atropine serves as a vasodilator, berberine is used in the treatment of diarrhea, diabetes and others (Lu *et al*., 2012) [17]. Other important alkaloids include evodiamine, piperine, sanguinarine, matrine, tetrandrine, caffeine, codeine, tubocurarine, sanguinafine, cocaine, ajmaline, scopolamine, atropine, hyoscamine (Welegergs *et al*., 2015) [31], nicotine, ergotamine.

Flavonoids

Flavonoids belong to a group of natural substances with variable phenolic structures and are found in fruits, vegetables, grains, bark, roots, stems, flowers, tea and wine (Nijveldt *et al*., 2001; Lakhanpal and Kumar, 2007) [21, 16]. Several studies shown that more than 4000 varieties of flavonoids were identified, many of which are responsible for their attractive colours of flowers, fruits and leaves (Nijveldt *et al*., 2001; Lakhanpal and Kumar, 2007) [16] [21]. According to Marais *et al*. (2006) [18] the study of flavonoid chemistry has emerged like that of natural products from the search of new compounds with useful physiological properties. This group of natural products are categorized into classes depending on the position of the linkage of the aromatic ring to the benzopyrano (chromano) moiety as mentioned by Marais *et al*. (2006) [18] and these includes; flavones, flavonones, flavanols (Kumar and Pandey, 2013) [15] isoflavonones isoflavones, and anthocyanidins, (Lakhanpal and Kumar, 2007) [16]. A large number of studies showed that, flavonoids have a wide range of biological activities such as free radical scavenging, antioxidant, anti -inflammation, anti-cancer, bactericidal, regulating immunity, antivirus, (Huiduan and Jianzhong, 2016, 2017) [12], antimutation, antitumor, Protecting liver, and anti-allergic and antidiabetes (Agrawal, 2011) [1]. A number of reports have been published which demonstrate that flavonoids can modulate arachidonic acid metabolism via the inhibition of cyclo-oxygenase and lipooxygenase activity (Tapas *et al*., 2008) [27].

Materials and Methods

Research Design

The experiment was laid out using Randomized Complete Block Design (RCBD) with seven treatments replicated three times. A total area of 10 m x 12 m (120 m^2) was divided into three blocks each representing one replication. Distance between blocks is one (1) meter. Shown below are the treatments and their respective amount and types of fertilizers used.

Treatments

There were seven (7) treatment combinations used in the study. Each treatment was replicated three (3) times and consists of fifteen (15) pots per replicate. The total number of treatment replications, each considered an experimental unit was twenty-one (21) as shown in Appendix Figure 2.

Randomization was done through drawing of lots. The lay-out as shown in Appendix Figure 2 was done following the step–by–step procedure in RCBD experiment since it was conducted in an uncontrolled environment. The treatment combinations are the following:

Table 1

T_1	= Control
T_2	= Recommended Rate (RR) Inorganic Fertilizer (60-40-60 kg N, P_2O_5, K_2O/ha)
T_3	= RR Organic Fertilizer (30t/ha; 30g/pot)
T_4	= RR Foliar Fertilizer (60ml/ 16 li H_2O)
T_5	= 50% RR Inorganic Fertilizer (30-20-30 kg N, P_2O_5, K_2O/ha) + 50% RR Organic Fertilizer (15t/ha; 15g/pot)
T_6	= 50% RR Inorganic Fertilizer (30-20-30 kg N, P_2O_5, K_2O/ha) + 50% RR Foliar Fertilizer (30ml/ 16 li H_2O)
T_7	= 50% RR Organic Fertilizer (15t/ha; 15g/pot) + 50% RR Foliar Fertilizer (30ml/ 16 li H_2O)

*Treatment (T)

Materials

The following materials were used in this study: plastic pots, fertilizer materials (complete fertilizer, muriate of potash, ammonium sulfate, foliar fertilizer (crop giant) and vermicompost), garden soil, spade, standard ruler, weighing scale, and *Pechay* seeds (*Brassica napus* L. var. *Black Behi*). Black Behi is an all-season variety adapted to both lowland and highland. It can be harvested in 25 to 39 days after sowing.

Cultural Management

The variety used in this study was Black Behi from East-West Company. A total of three hundred fifteen (315) pots were used corresponding to the number of treatments and the number of replications per treatment. Each pot was 8" in diameter and 10" in depth. Soils used in this study was taken from the Dairy Farm, Mindanao State University – Main Campus, Marawi City. The soil was homogenized or mixed thoroughly to ensure that each pot for each treatment and replicate is filled with the same soil quality.

Three seeds were sown per pot. Thinning was done to keep one plant per pot as the seedlings have developed their first true leaves. Watering was done uniformly and as necessary for all treatments throughout the study period. The amount of water applied per pot was 200ml per watering. Insect pests were controlled by a combination of handpicking and spraying with crushed /pounded chili solution. The pots were kept weed-free by manual hand pulling where needed and prior to treatment application. Plants were harvested by hand-pulling 45 days after sowing.

Fertilizer Application/Application of Treatments

Table 2: Treatment, rate, method, and time of application of fertilizer

Treatment	Description	Rate of Application per Plant	Method of Application	Time of Application
T1	Control	-	-	-
T2	Rec. Rate (RR) Inorganic Fertilizer (60-40-60 kg N, P_2O_5, K_2O/ha)	-2.86 g Complete (C) -3.33 g Muriate of Potash (MOP) - 9.52 g Ammonium Sulfate (AS)	Side dress	-7 days after planting (DAP) for C and MOP -14 days DAP for AS
T3	RR Organic Fertilizer (30t/ha; 30g/pot)	-30 g	Basal	-Before planting
T4	RR Foliar Fertilizer (60ml/ 16 li H_2O)	33.33 ml at a rate (3.75 ml per liter of water)	-Foliar spray	-7 DAP -14 DAP -21 DAP
T5	50% RR Inorganic Fertilizer (30-20-30 kg N, P_2O_5, K_2O/ha) + 50% RR Organic Fertilizer (15t/ha; 15g/pot)	-1.43 g Complete (C) -1.67 g Muriate of Potash (MOP) - 4.76 g Ammonium Sulfate (AS) -15g/pot	-Side dress -basal application	-7 days after planting (DAP) for C and MOP -14 days DAP for AS -before planting
T6	50% RR Inorganic Fertilizer (30-20-30 kg N, P_2O_5, K_2O/ha) + 50% RR Foliar Fertilizer (30ml/ 16 li H_2O)	-1.43 g Complete (C) -1.67 g Muriate of Potash (MOP) - 4.76 g Ammonium Sulfate (AS) -33.33 ml at a rate (1.88 ml per liter of water)	-Side dress -Foliar spray	-7 days after planting (DAP) for C and MOP -14 days DAP for AS -7 DAP -14 DAP -21 DAP

T7	50% RR Organic Fertilizer (15t/ha; 15g/pot) + 50% RR Foliar Fertilizer (30ml/ 16 li H_2O)	-15g/pot -33.33 ml at a rate (1.88 ml per liter of water)	-basal application -foliar spray	-before planting 7 DAP -14 DAP -21 DAP

*The weight of soil in 1 ha is 2,000,000kg
* The weight of soil per pot is 2kg

Phytochemical Properties

Sample Collection

Pechay (*Brassica napus* L. var. *Black Behi*) was collected from a study site at Mindanao State University-Marawi City, Philippines. The plant was analyzed in the Department of Chemistry, Mindanao State University, Marawi, Philippines. The residual moisture was evaporated at room temperature thereafter the fresh leaves samples were allowed to dry completely for two weeks at a room temperature before using them for this study.

Phytochemical Screening

Screening of phytochemical constituents were carried out following the standard methods described in the laboratory manual for the UNESCO (1990). The various phytochemical constituents tested were the following: alkaloids, flavonoids, phytosterols, tannins phenolics and reducing sugar.

Test for tannins

An aliquot of 0.5 mL extract of the sample plants as added to 10 mL of distilled water in a test tube and was filtered. Two mL of 5% Ferric Chloride (FeCl) was added to the filtered sample. Brownish green or black coloration observed indicates the presence of tannins.

Test for alkaloids

Five ml of the extract was prepared in a beaker and 200 mL of 10% CH_3COOH in ethanol (C_2H_5OH) was added. The mixture was filtered and the extract was allowed to become concentrated in a water bath until it reached one fourth of the original volume. Concentrated NH_4OH was added. Formation of the white precipitate or turbidity indicated the presence of alkaloids (Trease and Evans, 1983) [29]

Test for flavonoids

Few drops of 1% Ammonia (NH_3) solution was added to 5 mL extract of plant sample in a test tube. Yellow coloration indicated the presence of flavonoids.

Test for phytosterols

About 0.05g of the crude ethanolic extract was treated with 2mL chloroform and filtered. The filtrates were treated with few drops of concentrated sulphuric acid, shaken and allowed to stand. Appearance of golden yellow colour indicates the presence of triterpenes.

Test for phenolics

About 0.03g of crude ethanolic extract was weighed and 1mL of 1% ferric chloride solution was added. Appearance of blue or green colour indicates the presence of phenols.

Test for reducing sugar

About 0.03 g of crude etahnolic extract was treated with 1mL of Fehling's A and B solutions. The resulting solution was heated. Formation of red precipitate indicates the presence of reducing sugars.

Data Gathering Procedures

Return on Investment (ROI). This was taken using the formula below.

$$\text{Return on Investment (ROI)} = \frac{\text{Net Income}}{\text{Cost of Production}} \times 100$$

Data Analysis

Profitability Using Return of Investment (ROI)

This included all the inputs used for the study which begin from the seedling stage up to the harvesting using the formula:

$$\text{Return on Investment (ROI)} = \frac{\text{Net Income}}{\text{Cost of Production}} \times 100$$

Results and Discussion

Phytochemical Analysis of *Pechay*

Based on the result, Table 13 shows a positive result of alkaloids, flavonoids, phytosterols, tannins and phenolics. However, T_2 (Rec. Rate (RR) Inorganic Fertilizer) shows a double positive (++) in tannins while T_5 (50% RR Inorganic Fertilizer + 50% RR Organic Fertilizer) shows a double positive (++) in flavonoids. All treatments of the study show negative (-) in R. Sugar.

The result of the study conforms with Mueller-Harvey (2006) study on "The Conundrum of Tannins in Animal Nutrition and Health". Results showed that the harmful effects of tannins in ruminant and monogastric animals can range from producing chronic or systemic disorder. Many monogastric animal species appear to be more sensitive to tannins than ruminants.

However, T_5 (50% RR Inorganic Fertilizer + 50% RR Organic Fertilizer) which turned out double positive (++) in flavonoids is something good as shown in a study by Tiwari and Husain (2017) [28] which found that flavonoids are such phytochemicals that are good sources of natural antioxidants in human diets.

Table 13: Summary of Results on Phytochemical Analysis of *Pechay* leaves with three Replications in RCBD

	Treatments	Phytochemical Components					
		Alkaloids	Flavonoids	Phytosterols	Tannins	Phenolics	R. Sugar
T_1	Control (garden soil)	+	+	+	+	+	-
T_2	Rec. Rate (RR) Inorganic Fertilizer	+	+	+	++	+	-
T_3	RR Organic Fertilizer	+	+	+	+	+	-
T_4	RR Foliar Fertilizer	+	+	+	+	+	-

T_5	50% RR Inorganic Fertilizer + 50% RR Organic Fertilizer	+	++	+	+	+	-
T_6	50% RR Inorganic Fertilizer + 50% RR Foliar Fertilizer	+	+	+	+	+	-
T_7	50% RR Organic Fertilizer + 50% RR Foliar Fertilizer	+	+	+	+	+	-

Legends: Absent (-) Present (+) Concentrated (**++**)

Return on Investment (ROI)

The cost of inputs used for this study which began from the procurement of materials up to the harvesting and the output was computed to determine the profitability of the production. Return on investment measures the overall effectiveness of management generating profits with its available assets.

Table 14: Price per Crop Based on Treatment

	Treatments	Unit Price per kg (in Peso)
T_1	Control (garden soil)	-
T_2	Rec. Rate (RR) Inorganic Fertilizer (60-40-60 kg N, P2O5, K2O/ha)	20.00
T_3	RR Organic Fertilizer (30t/ha; 30g/pot)	35.00
T_4	RR Foliar Fertilizer (60ml/ 16 li H2O)	25.00
T_5	50% RR Inorganic Fertilizer (30-20-30 kg N, P2O5, K2O/ha) + 50% RR Organic Fertilizer (15t/ha; 15g/pot)	25.00
T_6	50% RR Inorganic Fertilizer (30-20-30 kg N, P2O5, K2O/ha) + 50% RR Foliar Fertilizer (30ml/ 16 li H2O)	25.00
T_7	50% RR Organic Fertilizer (15t/ha; 15g/pot) + 50% RR Foliar Fertilizer (30ml/ 16 li H2O)	30.00

Table 15: Sales per Treatment

Treatment		Replication			
		R_1	R_2	R_3	Treatment Total
T_1	Control (garden soil)	-	-	-	
T_2	Rec. Rate (RR) Inorganic Fertilizer (60-40-60 kg N, P2O5, K2O/ha)	67.62	67.93	67.73	203.28
T_3	RR Organic Fertilizer (30t/ha; 30g/pot)	98.24	98.39	98.35	294.98
T_4	RR Foliar Fertilizer (60ml/ 16 li H2O)	69.55	69.60	69.66	208.81
T_5	50% RR Inorganic Fertilizer (30-20-30 kg N, P2O5, K2O/ha) + 50% RR Organic Fertilizer (15t/ha; 15g/pot)	57.98	57.90	58.00	173.88
T_6	50% RR Inorganic Fertilizer (30-20-30 kg N, P2O5, K2O/ha) + 50% RR Foliar Fertilizer (30ml/ 16 li H2O)	75.63	75.54	75.55	226.72
T_7	50% RR Organic Fertilizer (15t/ha; 15g/pot) + 50% RR Foliar Fertilizer (30ml/ 16 li H2O)	73.91	73.96	73.80	221.67
Final Total					1,329.34

Computation of the Return on Investment (ROI) showed an ROI of 61.13% which shows that the production is profitable. Looking at Table 15, T_3 (RR Organic Fertilizer (30t/ha; 30g/pot)) turned out the highest sales followed by T_6 (50% RR Inorganic Fertilizer (30-20-30 kg N, P_2O_5, K_2O/ha) + 50% RR Foliar Fertilizer (30ml/ 16 li H_2O)), T_7 (50% RR Organic Fertilizer (15t/ha; 15g/pot) + 50% RR Foliar Fertilizer (30ml/ 16 li H_2O)), T_4 (RR Foliar Fertilizer (60ml/ 16 li H_2O)), T_2 (RR Inorganic Fertilizer (60-40-60 kg N, P_2O_5, K_2O/ha)), and T_5 (50% RR Inorganic Fertilizer (30-20-30 kg N, P_2O_5, K_2O/ha) + 50% RR Organic Fertilizer (15t/ha; 15g/pot)). This means that even if T_2 showed to have to have the highest marketable yield (Table 12), T_3 which used vermicompost (organic fertilizer) has the greatest potential for more profit due to low fertilizer cost. On top of it being environmentally-friendly.

Table 16: Production Expenses

Material Cost	*PECHAY*
Seeds	75.00
Organic Compost (Vermi) and	100.00
Pots	150.00
Inorganic Fertilizer 1. Complete Fertilizer 2. Ammonium Sulfate 3. Muriate of Potash 4. Crop Giant	500
Subtotal	825.00
LABOR COST	
Land Preparation	
Weeding	00.00
Subtotal	00.00
IMPLICIT COST	
Pot Preparation	00.00
Organic Fertilizer Application	00.00
Thinning	00.00

Weeding	00.00
Inorganic Fertilizer Application	00.00
Watering	00.00
Harvesting	00.00
Subtotal	00.00
TOTAL COST	825.00
NET INCOME	(504.34)

$$ROI = \frac{\text{Net Income}}{\text{Cost of Production}} \times 100$$

$$= \frac{504.34}{825.00} \times 100$$

ROI = 61.13%

Conclusion

T_2 (RR Inorganic Fertilizer) revealed a double positive (++) in tannins which means that *Pechay* contained chemical components that is deemed harmful to human health and T_3 topped the sales due to much lower production cost, the use of all organic fertilizer (in this case, vermicompost) is a very viable alternative to higher and more profitable *Pechay* production which is safe for human consumption.

Recommendations

Based on the results and conclusions of this study, the use of organic fertilizers is therefore highly recommended. This will foster the conversion of biodegradable farm wastes to inexpensive organic fertilizers and produce vegetables that are safe for human consumption.

In areas where land area is a problem, this study showed that the use of pots can be a viable alternative to increase vegetable production and provide food in urban settings. Moreover, the result of the study is recommended for dissemination to the Department of Agriculture (DA) to guide the farmers to use safe fertilizer options and the Department of Trade and Industry (DTI) for the consumers to identify foods free from toxic substances.

Further studies on *Pechay* production is recommended especially on the use of different organic fertilizer sources and the foliar method of fertilizer application as the latter did not show a double positive (++) in tannins on the phytochemical analyses.

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