Refilda 11

by Refilda Refilda

Submission date: 14-Jun-2019 01:17PM (UTC+0800)
Submission ID: 1143535853
File name: of_fermented_ngapi_nut_peel_Pithecellobium_jiringa_Prain_as.pdf (698.79K)
Word count: 4418
Character count: 22898

Journal of Physics: Conference Series

Utilization of fermented ngapi nut peel (*Pithecellobium jiringa* Prain) as natural fertilizer and pesticide on tomatoes (*Solanum lycopersicum* Mill) plant

Utilization of fermented ngapi nut peel (*Pithecellobium jiringa* Prain) as natural fertilizer and pesticide on tomatoes (*Solanum lycopersicum* Mill) plant

Refilda[1]*, T O Pranesa[2], S Emil[3], Indrawati[2]

[1]Applied Chemistry Laboratory, Department of Chemistry, Faculty of Mathematics and Natural Sciences, Andalas University, Padang, 25161, Indonesia
[2]Environmental Analytical Chemistry Laboratory, Department of Chemistry, Faculty of Mathematics and Natural Sciences, Andalas University, Padang, 25161, Indonesia
[3]Organic Chemistry Laboratory, Department of Chemistry, Faculty of Mathematics and Natural Sciences, Andalas University, Padang, 25161, Indonesia

*E-mail: refilda@sci.unand.ac.id

Abstract. Fermented Plant Extract (FPE) from the ngapi nut peel (*Pithecellobium jiringa* Prain) was produced as organic liquid fertilizer and pesticide to replace consumption of inorganic fertilizers and plant resistance for pests. FPE was fermented from the composition 250 g ngapi nut : 40 mL Effective Microorganism-4 (EM-4) : 40 mL brown sugar 1kg/L : 920 mL distilled water for 15 days, it contained Nitrogen 0.98%, Phosphor 0.05%, Potassium 0.62%, C.org 12.90%, phenolic content 414.1 mg/L and pH 3. The FPE was applied to planted tomato (*Solanum lycopersicum* Mill) and showed the best growth and plant resistance for pests. Macronutrient N, P, K, organic carbon in soil that treated and non-treated by FPE after 30 days were analyzed by Kjehdahl, Spectrophotometry and Atomic Absorption Spectrophotometry (AAS) method. FPE treatment could increase the amount of macronutrient in soil compared to the non-treated soil (control). Similarly, the nutrient (N, P, K) uptake by tomato with FPE treatment was higher than that with non-treated FPE. The nutrient uptake by tomato were nitrogen 2.62%; phosphorus 74.71%; potassium 42.44%; and non-treated with nitrogen 0.60%; phosphorus 27.07%; potassium 11.72%.

1. Introduction

Inorganic fertilizers consumption increase throughout the world. Indonesia is one of developing countries that consume high fertilizer. The use of inorganic fertilizers continuously causes adverse effects, such as resulting in a number of environment problems because some fertilizers contain heavy metals like Cd and Cr, high concentrations of radionuclide and it can cause water, air, and soil pollution [1]. Chemical fertilizers produce waste that contaminates soil, organic fertilizers are environmentally friendly, because it is made from organic source. It also provides macronutrients; suppress plant from pest and also increasing yield crops. Organic fertilizers improve soil physical, chemical, and biological role is well known, which it helps better nutrients absorption by plants [2].

Pithecellobium jiringa Prain is one of the Leguminosae families, this plant is native of Southeast Asia. In Indonesia it is called djengkol, jering in Malaysia, krakos in Cambodia, and niang-yai in Thailand. In these countries, the seeds of *Pithecellobium jiringa* Prain are consumed with rice while

the peel is removed and throughout [3]. This waste can be converted into a productive product like liquid organic fertilizer. Ngapi nut peel extract contains alkaloids, flavonoids, tannins, saponins, glycosides and triterpenoids which act as antibacterial, antibiotic, anti-inflammatory and antioxidant [4].

The fermentation process can increase the biological activity of the active compounds nutrional component in the food ingredients. The fermentation process increases total phenolic, total flavonoids and antibacterial activity. Degradation of chemical components during the fermentation process thought to be related to the bioactivity of these compounds. The bioactivity of compounds such as tannins, hydrolysable tannins and flavonoids are generally increased of these compounds into smaller components and release its aglicon. Degradation of complexes into simpler components will enhance the biological and pharmacological activity of these compounds [5]. Plant that was fermented beans which Okra extracted with water enhance a total content of phenolic, vitamin C, flavonoids, non-flavonoids and also showed antioxidant activity of the most high from the seeds of okra unfermented [6].

Effective microorganism-4(EM-4) is a mixture of microbial inoculums that was developed by Teruo Higa of Ryukyus University in japan. This microorganism contain population of actinomycetes, bacteria, yeast, and smaller number of photosynthetic bacteria. EM-4 has many advantages like it suppresses of soil pathogen, increasing decomposition of organic waste, enhancing availability of mineralized nutrients to plant and improving soil quality, soil health, the growth, yield and quality of crops [7-8]. Application of EM in compost increases the macro and micronutrient content of soil [9]. Some studies showed that using of organic compost with EM addition can significantly increase the grain and biomass yield [10]. EM significantly enhanced the NPK nutrition of mung bean plants following farmyard manure amendment, both at the flowering stage and at maturity. The application of EM enhanced NPK nutrition markedly only at a later growth stage [11].

Fermented Plant Extract (FPE) is the result of plant fermentation using organic waste, sugar solution and Effective Microorganism-4 (EM) solution. Fermentation is an anaerobic process by facultative microorganisms (e.g.yeasts) which transform complex organic molecules (e.g., carbohydrates) into simple organic compounds that it is absorbed directly by plants and organic substances contained in fermented plant extracts can control plant-disease. Fermentation yields a relatively small amount of energy compared with aerobic decomposition of the same substrate by the same group of microorganisms [12]. The manufacture of Liquid Organic Fertilizer through fermentation (decomposition) are by decomposing the physical form of solids and releasing some nutrients in the form of complex compounds and simple compounds from raw materials [13]. This fermented plant extract is easy to be made, low cost because it only uses plants that are widely available and safe for the environment.

The used of ngapi nut peel to produce fermented plants extract (FPE) by using the effective microorganism-4 (EM-4) and brown sugar was done. The FPE was applied as liquid fertilizer and biopesticide on tomato plant (*Solanum lycopersicum* Mill). The pH and nutrient N,P,K, organic carbon content in FPE and soil before and after treated by various concentration of FPE which showed the best growth in tomato plants and pest resistant after 30 days growth are reported.

2. Research Methodology

2.1. Materials

Waste of ngapi nut peel were collected in Pasar Raya, Padang, West Sumatera, brown sugar; *effective microorganism*-4, soil, sulfuric acid (H_2SO_4) pa, *selenium mixture*, destilated water, hydrogen peroxide (H_2O_2), nitric acid (HNO_3) pa, sodium hydroxide (NaOH), boric acid (H_3BO_3) 3%,; conway indicator, potassium chloride (KCl), chloric acid (HCl) pa, potassium dihydrogen phosphate (KH_2PO_4), $K_2Cr_2O_7$ 2N, ascorbic acid ($C_6H_8O_6$), $(NH_4)_6Mo_7O_{24}.4H_2O$, methyl red, BCG (*Bromcresol Green*). ethanol 96%, potassium antimonyltartrate ($K(SBO)C_4H_4O6.½H_2O$), gallic acid, Na_2CO_3 20%, folin-ciocalteu reagent and filter paper.

2.2. Equipment

Equipments were used 1.5 L plastic bottle, scales, desiccators, Kjehdahl flask, distillation device, measuring cup, UV-Vis Spectrophotometer (T70 UV/VIS Spectrophotometer), Atomic Absorption Spectrophotometer (AAS Variant AA240) other glass tools in the laboratory.

2.3. Preparation of Fermented Plant Extract (FPE)

The ngapi nut peel was cut and put into a 1500 mL plastic bottle, added EM-4, brown sugar 1 kg/L and distillated water with the composition shown in Table 1. The plastic bottle was closed tightly, mixed, stirred and kept from light. The gas was emitted during fermentation and gas was released every day by opening the bottle cap in order to avoid explosion due to high gas pressure. The fermentation was stopped when the gas was not emit

Table 1. Composition of Preparation Fermented Plant Extract from Ngapi Nut Peel

Code	Ngapi Nut Peel (g)	Water (mL)	EM-4 (mL)	Brown sugar 1 kg/L (mL)
FPE. I	250	900	50	50
FPE. II	250	920	40	40
FPE. III	250	940	30	30
FPE. IV	250	960	20	20
FPE. V	250	980	10	10

2.4 Determination of pH and Macronutrient N, P, K, Organic Carbon and Total Phenolic in FPE

Some parameters in FPE that produced from the composition in Table 1. were analyzed by standard methods. The pH was determined by potentiometry, N by Kjehldah,, P by UV-VIS Spectrometry, K by Flame Atomic Absorbtion Spectrometry, C.org by *Walkley and Black* and total phenolic content determined by *Folin-Ciocalteu* method [14].

2.5 Application FPE to Tomatoes Plant

2.5.1. Treatments of FPE

FPE is watered 100 mL/tomato by concentration 2 mL/L by using *hand sprayer*. The design of tomato plant polybags is shown in Figure 1.

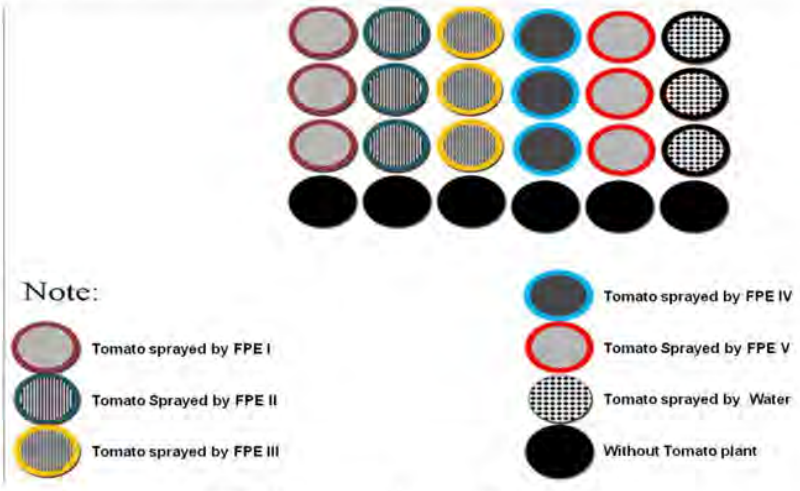

Figure 1. Design of Tomato Plant Polybags

2.5.2. Observation of Tomatoes plant

Observations were done for height growth of tomato, the number of leaves, and the percentage of disease plants at 5, 10, 15, 20, 25 and 30 days after planting (DAP).

Percentage of plants disease was calculated by the following formula:

$$P = \frac{n}{N} \times 100\% \quad (1)$$

Note:

P= intensity of disease

n= number of leaves are attacked disease

N= number of leave are observed

2.6. Analysis of Soil

Macronutrient N, P, K, C organic and pH in Soil after tomato plant growth 30 days were analyzed by the same method for FPE analyzed [14]

3. Result

3.1. Fermented Plant Extract (FPE)

The amount of addition of EM-4 affects the amount of organic material degradation. During the fermentation process creates a gas characterized by fermentator. Gas condensation was removed from the fermentator. Gas is released every day by opening the bottle cap in order to avoid explosions due to high gas pressure. The time is required 15 days until the gas is gone. The color of FPE solution is yellow-brown and smelled. The color is influenced by microorganism; the more microorganisms make thicker color because it produced more organic matter decomposed by the microorganism, the process of making fermented plant extract (FPE) affected by bio-activators. The effective microorganism-4 (EM-4) was used as bio-activator because it contains many active microorganisms [8]. The bio-activator of EM-4 culture had higher nutrient content of C/N ratio, organic C, total-N, Co, B, Mn, Fe Cu and Zn than others, although it has lower pH and nutrient content of, P_2O_5, K_2O but it was not significantly different from bio-activator of boisca and shrimp paste[15]. Some fermentation processes with microorganisms create gases, such as carbon dioxide and methane gas. Brown Sugar (BS) is as a food source for microorganisms and as a carbon source. It was used because it contains 20-30 times more glucose than normal sugar. BS is also rich in Potassium, Magnesium, and Iron. BS contains 88.2% total sugar and 5.8% reducing sugars [16]. Addition of 5% brown sugar plus 6% calsium superphosphate produced the highest quality compost with respect to C/N rasio, organic matter content, and electrical conductivity [16].

3.2. pH and Macronutrient N, P, K, Organic Carbon and Total Phenolic in FPE

The pH values of FPE I, II, III, IV, V are 4.00, 4.30; 4.50; 4.80; and 5.20 and FPE contains macro-nutrient composition which is useful for plant growth. Based on the standard quality of minimum technical requirements liquid organic fertilizer, the resulting pH to quality standards required was 4.00-9.00[17]. The more microorganisms added the more acidic pH FPE because the more organic acids are produced and the microbes can increase the nutrients in the soil. The results of macronutrient N, P, K, organic Carbon and Total Phenolic in FPE are shown in Table 2.

Table 2. Macronutrient N, P, K, organic Carbon content in FPE of Ngapi nut peel

No.	Code	N-Total (%)	P-Total (%)	K-Total (%)	Org-C (%)
1.	FPE. I	1.19	0.04	0.81	12.30
2.	FPE. II	0.98	0.05	0.62	12.90
3.	FPE. III	1.26	0.05	0.84	12.30
4.	FPE. IV	1.05	0.04	0.86	12.00
5.	FPE. V	1.54	0.06	0.86	12.00

3.3 Total Phenolic Content in FPE

Total phenolic content of fermented plant extract was determined by using folin-Ciocalteu. Phenolic determination was obtained from the gallic acid equation. The regression equation Y= 0.0039x + 0.0007 and R^2= 0.9999. The curve shows the relationship between the concentration and absorbance of gallic acid is used comparable. If the concentration is high, so absorbance value is high too because there are many phenolic compounds that reacting with folin ciocalteu and forming thick blue. The amount of phenolic compounds in fermented ngapi nut peel is 414.1 mg/L. Phenolic compounds have been reported as antibacterial, antioxidant or antimicrobial compounds.

The fermentation process can increase the biological activity of the active compounds. The fermentation process increases total phenolic, total flavonoids and antibacterial activity. Degradation of chemical components during the fermentation process thught to be related to the bioactivity of these compounds. The bioactivity of compounds such as tannins, hydrolysable tannins and flavonoids are generally increased of these compounds into smaller components and release its aglicon. Degradation of complexes into simpler components will enhance the biological and pharmacological activity of these compounds [5]. Fermented Extract Plant from seeds of Okra has a total content of phenolic, vitamin C, flavonoids, non-flavonoids and antioxidant activity higher than the unfermented seeds of okra [6].

3.4 Effect of FPE on Tomato Plant

3.4.1 Effect of FPE on Plant Height

Based on the results of the analysis, giving FPE of ngapi nut peel increased the growth of tomato plants than without non treatment. Giving FPE has been able to supply nutrient uptake by plants. The results of each treatment are shown in Figure 2. The treatment of FPE II produced the average of tallest plants of (43.1 cm) height 30 days after planting (30 DAP). The lowest average of plant height (31.4 cm) was recorded in control (non-treated plant).

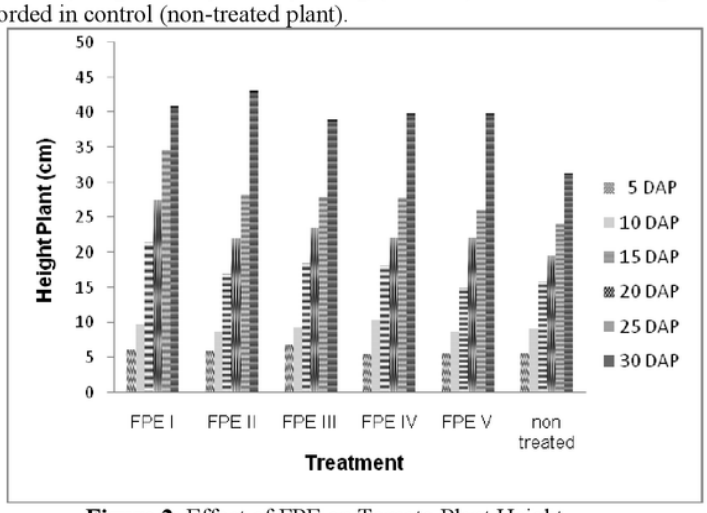

Figure 2: Effect of FPE on Tomato Plant Height, at 5, 10, 15, 20, 25 and 30 days after planting (DAP).

3.4.2 Effect of FPE on Number of Tomato Leaves

Based on the results of analysis of variance on the average number of leaves on tomato showed that the application of liquid organic fertilizer from fermented plant extracts increased number of leaves of tomato plants compared without non treatment. The average of higher number of tomato leaves is FPE II (103,3 leaves) and the lowest number of tomato plants is control (non-treated plant) (42,3 leaves) after 30 days. The results of each treatment are shown in Figure 3.

The results of this FPE can also fortify the plant from disease attack. Therefore the leaves that are formed appear healthy and not attacked by disease. While the treatment of water is attacked by the disease on the leaves such as rolled up, yellow leaves, eaten caterpillars and disease. This result was supported by the highest increment in wheat grains yield was obtained for treatment with use of compost with EM in comparison to control [8]. Application of EM with mineral fertilizer significantly increased leaf N content to control and was the only treatment that resulted in leaf N content greater than critical level. Application of compost + recommended fertilizer + EM improved leaf N content and N uptake and application of sole EM increased leaf N content but not its uptake[10].

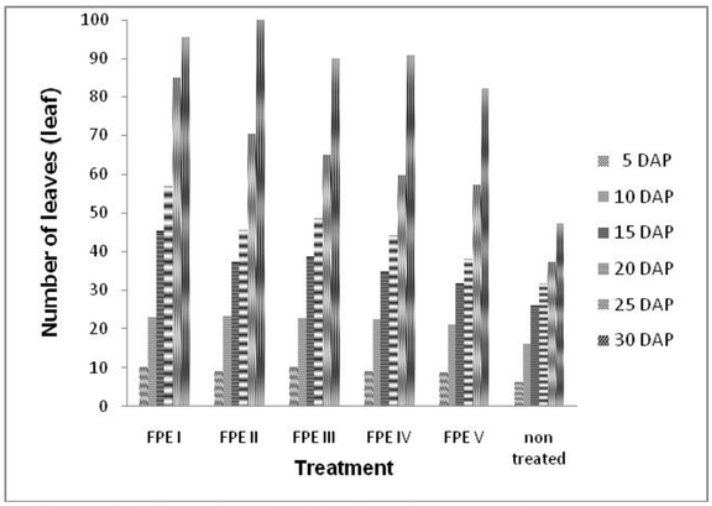

Figure 3: Effect of FPE on Number of Tomatoes Leaves at 5, 10, 15, 20, 25 and 30 days after planting (DAP).

3.4.3 Effect of FPE on Plant Disease

Several tomato diseases and disorders cause leaf spots and fruit rots, yellowing, rolled up, contracted etc. Typically, these diseases do not kill the plants, but they can lead to significant yield and quality losses [9-10]. Based on observations for 30 days the incidence of disease is most prevalent in the plant treated by water with percentage of 42.17%. Whereas with FPE, there was no disease attack except on FPE I which started on 30 days after growing with percentage of 17.04%. Giving FPE can increase resistance to pest attack because FPE contains phenolic compounds and organic acids.

3.5 Effect of FPE on Soil pH and Content of Macronutrient in Soil after Giving FPE

3.5.1 Effect of FPE on Soil pH

Tomato plants require soil with acidity (pH) 5.50-6.50. Based on the results soil pH value decreased compared with initial analysis results before treatment. Soil without FPE has a pH of 6.00, by giving fermented plant extract, pH of tomato plants decreased to 5.76. The decrease in pH is assumed to be due to the influence of organic acids produced by the decomposition process of organic. These organic acids will function to release nutrients the soil becomes more available. The decrease in pH in soil is attributed to the nutrication and acidification processes stimulated by continuous application of fertilizers as well as by H^+ by roots [18]. Soil pH can have positive impacts on availability of nutrients such as phosphorus, zinc, iron and manganese. The availability of phosphorus is more in the pH range from 6.5 to 7.5.

3.5.2 Effect of FPE on Macronutrient N, P, K and C-org in Soil

Macronutrient content (%) N, P, K and C in soil after treated by FPE and without FPE are shown in Table 3. Generally, amount of macronutrient in soil after treated with FPE is higher than without FPE.

Table 3. Macronutrient N, P, K and C (%) in soil after treated with FPE and without FPE

No.	Treatment	Treated by FPE				Without FPE			
	On	%N	%P	%K	%C	%N	%P	%K	%C
1	Soil (wtp)	0.85	2.08	0.07	22.87	0.82	0.54	0.04	26.13
2	Soil (tp)	0.82	0.65	0.04	29.14	0.81	0.47	0.04	30.57

Note: soil (wtp): soil without tomato planted; soil (tp): soil with tomato planted

Based on the results shown in **Table 3**, the treatment of FPE II, %N without tomato grown is higher 0.85% than %N with tomato plant 0.82%. It proves that plants absorb Nitrogen elements. Percentage of N with tomato plant treated with water is lower than without tomato plant 0.82% tomato and with tomato plant is 0.81%. These results prove that giving FPE from ngapi nut peel can increase the element of nitrogen in the soil.

As shown in **Table 3**, the percentage of phosphorus in soil without tomato plant (2.08%) is higher than with tomato plant (0.65%). Levels of phosphorus available on tomato-planted soils were reduced due to absorption by plants, whereas soil without treated by FPE, without tomato plant contained P 0.54% and 0.47%. for soil with tomato plant. This FPE gives the highest contribution of phosphorus than water because the bioactivator EM-4 has a bacterial solvent culture of phosphate and mycorrhiza. The function of this bacterial culture dissolve phosphate in the raw material so that leachate will be produced with high levels of phosphorus. Phosphorus is important for young plants and seedling growth, intense coloring, browning or purpling of foliage in some plants, thin stems, and reducing flowering. Phosphorus is absorbed as orthophosphate ions H_2PO^{2-} or HPO_4^-. This complex don't leach readily from the soil and is mobile once in the plant. Plant uptake of HPO_4^- is more rapid than HPO_4^{2-}. Potassium is absorbed as K^+ ion and it is responsible for regulating the opening and closing of stomata by guard cells in the leaf [19]. In Table 3, the percent of potassium content in soil treated by FPE without tomato plant and without FPE treatment are 0.07% and 0.04%. FPE was successful in raising potassium nutrients because the percentage of water treatment was smaller without tomato plant 0.04% and with tomato plant 0.04%. Potassium levels available on tomato-growing soils are reduced due to absorption by plants.

Potassium is mobile in plants, which meaning that the symptoms of deficiency will appear in older growth. Potassium helps the growth and stimulating tomatoes in the early flowering and fruiting arrangements, thereby increasing the amount and production of tomatoes per plant. Potassium nutrition can affect the quality of tomatoes. Excess potassium may cause N deficiency in plants and may affect the uptake of other positive ions. Potassium deficiency results will reduce growth and tendency to wither easily [20].

Carbon as an organic compound reduces $K_2Cr_2O_7$ to $Cr_2(SO)_4$. In acid condition, the intensity of the green color reveals the carbon content and is measured by UV-Vis Spectrophotometer at λ=582 nm.Based on Organic carbon analysis with Walkley and Black method. Table 3 shown that percentage of organic carbon without tomato plant is 22.87% while with tomato plant is 29.14%. Percentage of organic carbon of control without tomato plant and with tomato plant are 26.13% and 30.57% respectively.

Carbon nutrient decline is caused by the process of weathering organic matter by microorganisms because FPE contains microorganisms, so CO_2 is released into the air, along with energy production. CO_2 is produced from the oxidation process, and it will be released into the air, then reused by plants in the process of photosynthesis, producing energy and oxygen liberated into the air. In the soil organic carbon and organic matter have been decomposed by microorganisms into simpler compounds.

3.6 Effect of FPE on Percentage of Nutrient uptake

The nutrient uptake is a function of yield and nutrient concentration in plant. This FPE was attributed to better availability of nutrients in the soil under this treatment [10]. Absorption of nutrients by plant greatly affects the growth of plants. However, not all are absorbed by plants because some nutrients were fixed, lost, leaching, hydrolysis, and evaporation (volatilization). Based on Figure 4 the percentage of nutrient uptake by tomato plant on soil treated by FPE is higher than non treatment, hence the growth of tomato has good growth because it is able to absorb nutrients well. The presence of FPE increases the absorption of nutrient elements because the pH is slightly acidic some organic materials are easily soluble and have good cation exchange capacity. The pH of FPE was 5.7 6. EM decomposes organic material and dissolving substances such as amino acids, sugars, alcohols and organic compounds that can be readily absorbed by plants [8].

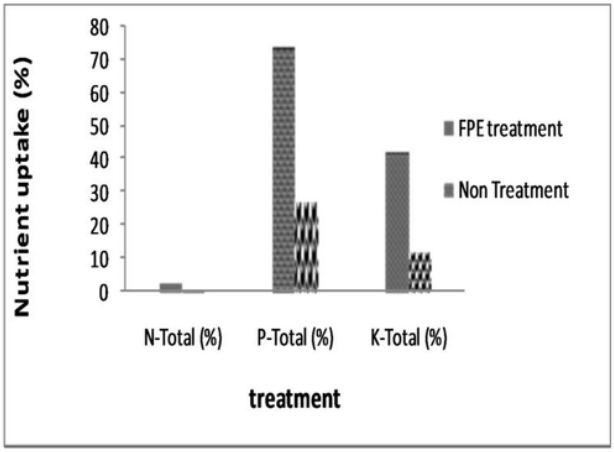

Figure 4 Percentage of nutrient uptake by tomato plants

4. Conclusion

Based on the research result, it can be concluded that fermented plant extract (FPE) from Ngapi nut peel contained N, P, K, organic Carbon and total phenolic compound. Giving FPE to tomato plants can increase nutrient content in soil compared to non treatment. The best growth of tomato plants is obtained in FPE with the composition of EM-4: palm sugar: water is 40 mL: 40 mL: 920 mL. As well as total phenolic compound 414.1 mg/L contained in FPE. It can be concluded that FPE from Ngapi nut peel has potential as organic liquid fertilizer and biopesticide in tomato plant.

Acknowledgment

The authors would like to thank to Directorate General of Higher Education, Ministry of Research, Technology and Higher Education, which has funded this study in accordance with the Agreement on Implementation of Leading "Higher Education Grant Number: BOPTN Andalas University number 32/UN.16.17/RD/LPPM/2017.

References

[1] Savci S 2012 *Journal Elsevier* 287-292
[2] Nogueira A J *et al* 2015 *R Braz Ci Solo* **39** 151
[3] Bakar R A *et al* 2012 *Bangladesh J Pharmacol* **7** 131
[4] Yanti F I *et al* 2015 *Scholars Academic Journal of Biosciences (SAJB)* **9** 790
[5] Nazarni R *et al* 2016 *International Food Research Journal* **23** 309-315

[6] Adetuyi F O and Ibrahim T A 2014 *Nigerian Food Journal* **32** 128
[7] Ong K K *et al* 2001 *J. Trop. Agric. and Fd. Sc.* **29** 189
[8] Aredehey G and Daniel B 2016 *Pearl Research Journal* **8** 133
[9] Dehghani I *et al* 2013 *Annals Biol. Res* **4** 126
[10] Lindani N and Brutsch M 2012 *J. Plant Sci* **6** 120
[11] Javaid A and Bajwa R 2011 *Turkish Journal of Agriculture and Forestry* **39** 443
[12] Higa T 2002 *EM World journal* **1** 1
[13] Wood M T at al 1997 EM fermented plant extract and EM 5 for controlling pickleworm (*Diaphinia nitidalis*) in organic cucumber. (*In*: Proceedings of 5th Intl. Conf. on Kyusei Nature Farming: Bangkok Thailand) pp 207-208.
[14] Jackson M L 1958 *Soil chemical analysis* (New Jersey: Prentice Hall) pp 42-47
[15] Raden L S *et al* 2012 *Nusantara Bioscience* **9** 209
[16] Zhang l *et al* 2013 *Bioresource Technology* **131** 68
[17] Minister of Agriculture, Decree of the Minister of Agriculture No.70/Permentan /SR.140/10/2011 about Organic Fertilizer, Compost, and Land Purification (Republic of Indonesia: Jakarta)
[18] Czarnecki S and During RA 2015, *Journal Hesse*, **1** 23
[19] Mevada K D *et al* 2017 *Journal of Pure And Applied Microbiology* **11** 1559
[20] Brar B S *et al* 2015 *Agronomy* **5** 220

Refilda 11

ORIGINALITY REPORT

0%	0%	0%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

Exclude quotes	Off	Exclude matches	< 3%
Exclude bibliography	On		