ISSN (p) : 2302-559X
ISSN (e) : 2549-0818

JURNAL Teknik Pertanian Lampung

Vol. 8, No. 2, Juni 2019

TERAKREDITASI
SINTA 3

SK Dirjen DIKTI No : 21/E/KPT/2018

Jurnal Teknik Pertanian Lampung	Volume 8	No. 2	Hal 65-152	Lampung Juni 2019	(p) 2302-559X (e) 2549-0818

Published by: Jurusan Teknik Pertanian, Fakultas Pertanian Universitas Lampung

Jurnal **TEKNIK PERTANIAN LAMPUNG**

ISSN (p): 2302-559X ISSN (e): 2549-0818 **Vol. 8 No. 2, Juni 2019**

Jurnal Teknik Pertanian (J-TEP) merupakan publikasi ilmiah yang memuat hasil-hasil penelitian, pengembangan, kajian atau gagasan dalam bidang keteknikan pertanian. Lingkup penulisan karya ilmiah dalam jurnal ini antara lain: rekayasa sumber daya air dan lahan, bangunan dan lingkungan pertanian, rekayasa bioproses dan penanganan pasca panen, daya dan alat mesin pertanian, energi terbarukan, dan system kendali dan kecerdasan buatan dalam bidang pertanian. Mulai tahun 2019, J-TEP terbit sebanyak 4 (empat) kali dalam setahun pada bulan Maret, Juni, September, dan Desember. Sejak tahun 2018, J-TEP mendapatkan terakreditasi SINTA 3 berdasarkan SK Dirjen Dikti No.21/E/KPT/2018. J-TEP terbuka untuk umum, peneliti, mahasiswa, praktisi, dan pemerhati dalam dunia keteknikan pertanian.

Chief Editor

Dr. Ir. Agus Haryanto, M.P

Reviewer

Prof. Dr. Ir, R.A. Bustomi Rosadi, M.S. (Universitas Lampung)
Prof. Dr. Ir. Udin Hasanudin, M.T (Universitas Lampung)
Prof. Dr. Indarto, DAE (Universitas Negeri Jember)
Dr. Ir. Sugeng Triyono, M.Sc. (Universitas Lampung)
Dr. Nur Aini Iswati Hasanah,S.T., M.Si (Universitas Islam Indonesia)
Dr. Diding Suhandy, S.TP., M.Agr (Universitas Lampung)
Dr. Sri Waluyo, S.TP, M.Si (Universitas Lampung)
Dr. Ir. Sigit Prabawa, M.Si (Universitas Negeri Sebelas Maret)
Dr. Eng. Dewi Agustina Iriani, S.T., M.T (Universitas Lampung)
Dr. Slamet Widodo, S.TP.,M.Sc (Institut Pertanian Bogor)
Dr. Ir. Agung Prabowo, M.P (Balai Besar Mekanisasi Pertanian)
Dr. Kiman Siregar, S. TP., M.Si (Universitas Syah Kuala)
Dr. Ansar, S.TP., M.Si (Universitas Mataram)
Dr. Mareli Telaumbanua, S.TP., M.Sc. (Universitas Lampung)

Editorial Boards

Dr. Warji, S.TP, M.Si
Cicih Sugianti, S.TP, M.Si
Elhamida Rezkia Amien S.TP, M.Si
Winda Rahmawati S.TP, M.Si
Febryan Kusuma Wisnu, S. TP, M.Sc
Enky Alvenher, S.TP

Jurnal Teknik Pertanian diterbitkan oleh Jurusan Teknik Pertanian, Universitas Lampung.

Alamat Redaksi J-TEP:

Jurusan Teknik Pertanian, Fakultas Pertanian Universitas Lampung
Jl. Soemantri Brodjonegoro No.1, Telp. 0721-701609 ext. 846
Website :http://jurnal.fp.unila.ac.id/index.php/JTP
Email :jurnal_tep@fp.unila.ac.id dan ae.journal@yahoo.com

PENGANTAR REDAKSI

Dengan mengucapkan puji syukur kepada Allah yang Maha Kuasa, Jurnal Teknik Pertanian (J-TEP) Volume 8 No 2, bulan Juni 2019 dapat diterbitkan. Pada edisi kali ini dimuat 8 (delapan) artikel dimana salah satu artikel pada volume ini berbahasa Inggris yang merupakan karya tulis ilmiah dari berbagai bidang kajian dalam dunia Keteknikan Pertanian yang meliputi perlakuan uap panas dan pengaruhnya terhadap mutu buah melon, aplikasi USLE dan GIS untuk perdiksi laju erosi, studi kuantifikasi pencampuran kopi dekaf-non dekaf menggunakan UV-Vis, manajemen irigasi pembibitan sawit dengan CROPWAT, uji kinerja dan analisis ekonomi mesin penepung biji jagung, *the effects of empty fruit bunch treatments for straw mushroom*, sistem otomasi photovoltaic pada PLTS berbasisi mikrokontroler, dan penerapan rancang bangun sistem hidroponik otomatis untuk budidaya bawang merah.

Pada kesempatan kali ini kami menyampaikan ucapan terima kasih yang sebesar-besarnya kepada para penulis atas kontribusinya dalam Jurnal TEP dan kepada para reviewer/penelaah jurnal ini atas peran sertanya dalam meningkatkan mutu karya tulis ilmiah yang diterbitkan dalam edisi ini.

Akhir kata, semoga Jurnal TEP ini dapat bermanfaat bagi masyarakat dan memberikan konstribusi yang berarti bagi pengembangan ilmu pengetahuan dan teknologi, khususnya di bidang keteknikan pertanian.

Editorial J TEP-Lampung

Jurnal **TEKNIK PERTANIAN LAMPUNG**

ISSN (p): 2302-559X ISSN (e): 2549-0818 **Vol. 8 No. 2, Juni 2019**

Halaman

PEDOMAN PENULISAN ARTIKEL BAGI PENULIS

1) **Naskah:** Redaksi menerima sumbangan naskah/tulisan ilmiah dalam bahasa Indonesia atau bahasa Inggris, dengan batasan sebagai berikut :

   a. Naskah diketik pada kertas ukuran A4 (210mm x 297mm) dengan 2 spasi dan ukuran huruf Times New Roman 12pt. Jarak tepi kiri, kanan, atas, dan bawah masing-masing 3 cm. Panjang naskah tidak melebihi 20 halaman termasuk abstrak, daftar pustaka, tabel dan gambar. **Semua tabel dan gambar ditempatkan terpisah pada bagian akhir naskah (tidak disisipkan dalam naskah)** dengan penomoran sesuai dengan yang tertera dalam naskah. Naskah disusun dengan urutan sebagai berikut: Judul; Nama Penulis disertai dengan catatan kaki tentang instansi tempat bekerja; Pendahuluan; Bahan dan Metode; Hasil dan Pembahasan; Kesimpulan dan Saran; Daftar Pustaka; serta Lampiran jika diperlukan. Template penulisan dapat didownload di ***http://jurnal.fp.unila.ac.id/index.php/JTP***

   b. **Abstrak (Abstract)** dalam bahasa Indonesia dan bahasa Inggris, tidak lebih dari 200 kata. Mengandung informasi yang tertuang dalam penulisan dan mudah untuk dipahami. Ringkasan (abstract) harus memuat secara singkat latar belakang, tujuan, metode, serta kesimpulan dan yang merupakan *high light* hasil penelitian.

   c. **Pendahuluan:** memuat latar belakang masalah yang mendorong dilaksanakannya perekayasaan dan penelitian, sitasi dari temuan-temuan terdahulu yang berkaitan dan relevan, serta tujuan perekayasaan atau penelitian.

   d. **Bahan dan Metoda:** secara jelas menerangkan bahan dan metodologi yang digunakan dalam perekayasaan atau penelitian berikut dengan lokasi dan waktu pelaksanaan, serta analisis statistik yang digunakan. Rujukan diberikan kepada metoda yang spesifik.

   e. **Hasil dan Pembahasan:** Memuat hasil-hasil perekayasaan atau penelitian yang diperoleh dan kaitannya dengan bagaimana hasil tersebut dapat memecahkan masalah serta implikasinya. Persamaan dan perbedaannya dengan hasil perekayasaan atau penelitian terdahulu serta prospek pengembangannya. Hasil dapat disajikan dengan menampilkan gambar, grafik, ataupun tabel.

   f. **Kesimpulan dan Saran:** memuat hal-hal penting dari hasil penelitian dan kontribusinya untuk mengatasi masalah serta saran yang diperlukan untuk arah perekayasaan dan penelitian lebih lanjut.

   g. **Daftar Pustaka:** disusun secara alfabetis menurut penulis, dengan susunan dan format sebagai berikut: Nama penulis didahului nama family/nama terakhir diikuti huruf pertama nama kecil atau nama pertama. Untuk penulis kedua dan seterusnya ditulis kebalikannya. Contoh:

      - Kepustakaan dari Jurnal:
        Tusi, Ahmad, dan R.A. Bustomi Rosadi. 2009. *Aplikasi Irigasi Defisit pada Tanaman Jagung*. Jurnal Irigasi. 4(2): 120-130.
      - Kepustakaan dari Buku:
        Keller, J., and R.D. Bleisner. 1990. *Sprinkle and Trickle Irrigation*. AVI Publishing Company Inc. New York, USA.

h. **Satuan:** Satuan harus menggunakan system internasional (SI), contoh : m (meter), N (newton), °C (temperature), kW dan W (daya), dll.

2) **PenyampaianNaskah:**Naskah/karya ilmiah dapat dikirimkan ke alamatdalambentuk*soft copy*ke :
   Redaksi J-TEP*(JurnalTeknikPertanianUnila)*
   Jurusan Teknik Pertanian, Fakultas Pertanian
   Universitas Lampung
   Jl. Sumantri Brodjonegoro No. 1
   Telp. 0721-701609 ext. 846
   Website : http://jurnal.fp.unila.ac.id/index.php/JTP
   Email : ae.journal@yahoo.com

3) Selama proses penerimaan karya ilmiah, penelaahan oleh Reviewer, sampai diterimanya makalah untuk diterbitkan dalam jurnal akan dikonfirmasi kepada penulis melalui email.

4) Reviewer berhak melakukan penilaian, koreksi, menambah atau mengurangi isi naskah/tulisan bila dianggap perlu, tanpa mengurangi maksud dan tujuan penulisan.

THE EFFECTS OF EMPTY FRUIT BUNCH TREATMENTS FOR STRAW MUSHROOM SUBSTRATE ON PHYSICOCHEMICAL PROPERTIES OF A BIOFERTILIZER

Sugeng Triyono[1, *], Rio Pujiono[1], Iskandar Zulkarnain[1], Ridwan[1], Agus Haryanto[1], Dermiyati[2] and Jamalam Lumbanraja[2]
[1] Lampung University, Agriculture Faculty, Agricultural Engineering Department
[2] Lampung University, Agriculture Faculty, Soil Science Department
[*]Komunikasi Penulis, e-mail: striyono2001@yahoo.com
DOI:http://dx.doi.org/10.23960/jtep-l.v8i2.120-129

Naskah ini diterima pada 27 Mei 2019; revisi pada 29 Juni 2019;
disetujui untuk dipublikasikan pada 29 Juni 2019

ABSTRACT

This research aims to elaborate characteristics of an organic fertilizer, named as "Organonitrofos", produced from agricultural wastes supplemented with spent mushroom substrate (SMS) from oil palm empty fruit bunch (EFB). After the experiment of the straw mushroom cultivation was over, the spent EFB was used as one of raw materials for the experiment of Organonitrofos bifertilizer production. Completely Randomized Design was implemented in the experiment of mushroom cultivation. Tereatments consisting of inorganic fertilizer and organic fertilizer factors were applied on the EFB substrate preparation. The inorganic fertilizer and the organic fertilizer each included 3 levels of doses, with 3 replications. After the experiment of the straw mushroom cultivation was over, the spent EFB was used in the experiment of the organic fertilizer production. The spent EFB was mixed with other materials using ratio of 1:1 by volume. The other materials constisted of cattle manure, chicken litter, cocodust, rice husk ash, and MSG industry waste sludge with ratio of 6:1:1:1:1 by volume. After all the materials of every experiemental unis were mixed, fermentation of organic biofertilizer was started with the treatment and the experimental design held the same as those used in the experiment of the mushroom production. The results showed that there was no significantly different among the parameters observed at $p<0.05$. Winthin 3 month priod of fermentation; however, the screened portion of the compost produced increased to 88.54±1.69% of total weight. C-N ratio (12.80±0.55), organic C (16.11±0.59), total N (1.26±0.59), total P (3.04±0.19), and total K (0.42±0.04) of finished compost met the SNI 19-7030-2004 requirement. Dry weight lost of 2.58±0.59 and ash of 53.96±1.42 content were noted from the finished compost. The organic C content and some other chemical proserties were relatively better than those in previous variants of Organonitrofos.

Keywords: Compost, Empty fruit bunch, Organic fertilizer

I. INTRODUCTION

Organonitrofos is the name of organic fertilizer made from the mixtures of organic wastes such as cattle manure, chicken litter, coco dust, charcoal, and sludge of MSG industry waste locally available. The production of Organonitrofos is intended to help farmers to find fertilizers especially when government-subsidized fertilizers are scare, commonly in the planting seasons. Quantity of available subsidized fertilizers did not suffice the farmers demand. In that situation, farmers have to apply fertilizers to their lands with suboptimal doses because they do not have enough money to pay for regularly priced fertilizers, in order to meet their demand of fertilizer. Finally their crop production is not optimal.

Granular Organonitrofos was introduced in 2011 (Nugroho et al. 2012). This granulated organic fertilizer was made from the mixture of fresh cow dung (70-80%) and phosphate rock (20-30%), with the addition of phosphorus solubilizers and nitrogen fixers (Nugroho et al. 2013). This production involved a lot of manufacturing processing machinery such as hammer mill, screener, mixer, granulator, dryer, inoculators, which caused a high production cost. As a consequence, the price of the granular Organonitrofos was not competitive. Powder or Crumb Organonitrofos was then produced, as the efforts to suppress the production cost. In addition, farmers who work with horticultural crops actually preferred to use powder organic fertilizers than to use granular fertilizers. Based on previous research, Organonitrofos could substitute the use of chemical fertilizers by half doses usually farmers used.

In 2013, the powder Organonitrofos was then developed by using little broader variety of agricultural wastes such as cow dung, chicken litter, coco dust, rice husk ash, and Monosodium Glutamate (MSG) industry waste sludge which are locally available. Cow dung was used as the source of organic carbon, chicken litter as the source of nitrogen, coco dust and rice husk ash as the sources of potassium, and MSG industry waste sludge was used as the source of phosphorus. The sludge of MSG industry wastes was used to substitute the use of phosphate rock. Sludge of MSG industry wastes was actually the residue of phosphoric acid which is one of the raw materials of MSG industry. The performance of this variant of Organonitrofos was better; in that soluble phosphorus and nitrogen contents were improved, but potassium content remained low.

In 2015, the performance of Organonitrofos was upgraded by implementing a supplement of biochar as soil amendment (Dermiyati et al. 2017). Biochar is a carbonaceous material derived from biomass such as wood which is heated in a container with little or no air (Thomas et al. 2018; Jain et al. 2018. Hagemann et al. (2018) mentioned that biochar applications much more effectively improved the retention of nutrients to plants than any other organic materials, such as compost or manure. Research done by Kaudal and Weatherley (2018) showed that biochar could promote plant growth, lower emissions of N_2O and improve nitrogen use efficiency. In mine soil, application of biochar amended compost increased pH, nutrient, carbon, total nitrogen and CEC (Forján et al. 2017). Dermiyati et al. (2017) found that treatment of 5000 kg biochar ha^{-1} indicated that soil respiration rate and soil microbial biomass were higher as compared to treatment without biochar.

In other side, utilization of oil palm empty fruit bunch (EFB) to improve its added value has gained increasing attention from researchers recently. Palm oil mills by-product, i.e. shell, fiber, EFB are produced in large quantities (Hayawin et al. 2017), and EFB constitutes 23% of total fresh fruit bunch (FFB) processed (Omar et al. 2011). Research on the utilization of EFB for bioenergy generation was carried out by some researchers including Abdullah et al. (2011), Lim Meng Hon (2011), Shafie et al. (2012), Sudiyani et al. (2013), Fauzianto (2014), and Pogaku (2016). Some works on EFB for a biofertilizer such as those done by Hayawin et al. (2012), Kananam et al. (2011), Hoe et al. (2016), Wan Razali et al. (2012), and Kavitha et al. (2013) have been published. The utilization of EFB for oyster mushroom cultivation has been investigated by Tabi et al. (2008), Rizki and Tamai (2011), Kavitha et al. (2013), Marlina et al. (2015). Other works on the use of spent oyster mushroom substrates as compost material have also been performed by Meng et al. (2017), Owaid et al. (2017), Castro et al. (2008), and Siddhant and Singh (2009).

Research on the utilization of spent EFB from straw mushroom cultivation for compost has not been reported yet. In this research, the spent EFB was supplemented to the formulation of Organonitrofos. The spent EFB was previously used as the growth medium for rice straw mushroom (*Volvarealla volvacea*) cultivation. The spent EFB was then used as one of the ingredients of Organonitrofos materials. Currently, straw mushroom grown on the EFB was increasing in Lampung, Indonesia, because the EFB was abundant as one of solid wastes generated by palm oil industry. The EFB was known as organic waste with high content of potassium. Some supplemental materials such as rice bran, dolomite, organic or inorganic fertilizers were also added to the mushroom growth medium when it was prepared. Therefore, these supplements may improve nutritive value of the spent EFB.

The earlier variants of Organonitrofos have been already produced and tested on farm with some food crops such as rice, corn, and cassava, and many horticultural corps such chili, tomato, egg plant, melon. The result showed that Organonitrofos application by 5000 kg/ha still needed to be combined with inorganic fertilizers, in order to maintain the optimum production especially for fruiting crops. Dermiyati (2017) found that application Organonitrofos with supplement of biochar by 5000 kg/ha improved the growth of sweet corn. This study aims to investigate the effects of EFB treatments for straw mushroom production on physicochemical characteristics of Organonitrofos biofertilizer, and to compare the physicochemical properties of the biofertilizer produced to the physicochemical properties of earlier variants of Organonitrofos.

II. MATERIALS AND METHOD

The spent EFB used in this research was taken from an experiment of straw mushroom cultivation where EFB was used as the growth media of straw mushroom. When the mushroom cultivation experiment was over, the spent EFB was used for the experiment of Organonitrofos production.

2.1. The Stage of Straw Mushroom Experiment

The experiment of straw mushroom cultivation was conducted by using EFB as the growth medium. Completely Radomized Design (CRD), with factorial arrangement and 3 replications, was used for this research. Two factors implemented were inorganic fertilizer (NPK:15-15-15) and liquid organic fertilizers. Concentrations of the fertilizers per 100 kg of EFB medium (per bed) were as follows: inorganic fertilizer factor (N) had 3 dose levels: 25 gram (N_1), 50 gram (N_2), 75 gram (N_3), and the commercial liquid organic fertilizer factor (O) had also 3 dose levels: 5 cc (O_1), 10 cc (O_2), and 15 cc (O_3). Doses of N_2 and O_2 followed what are normally used by local farmers. Other supplemental materials needed to be added to the EFB medium included chicken manure, rice bran, and dolomite with doses of 80 kg, 70 kg, and 60 kg per 1000 kg of EFB respectively.

Firstly the EFB was weight for 100 kg (per experimental unit), put in a sack, tied up, and soaked in water for over night. On the following day, each of the 27 soaked sacks of EFB was pored one by one on a sheet of terpalin, mixed with the fertilizers and the supplemental materials. The mixture was then put in every sack back and composted for 8-day fermentation. After 8-day fermentation, every sach of EFB substrates was transferred to the growing bed in a random manner, in a mushroom house. After that, mushroom cultivation and investigation were carried out until harvest time. More detailed steps of the mushroom cultivation experiment were described in Triyono et al. (2019).

2.2. The Stage of Organnitrofos Fertilizer Production

When the experiment of the mushroom cultivation has been over (about 1 month production), the spent EFB from the straw mushroom growth medium was taken for one of raw materials of Organonitrofos biofertilizer production. For each of the experimental unit, the spent EFB was taken and mixed with other materials (cattle manure, chicken litter, coco dust, rice husk ash, and MSG waste sludge), with the following composition (by volume) as on Table 1.

Table 1. Composition of Organonitrofos Biofertilizer Materials

Materials	Volume (Liter)	Bulk density (g/lt)	Fresh weight		Water Content (%)	Dry Weight	
			(kg)	(%)		(kg)	(%)
Spent EFB	50	300.22	15.01	38.38	41.63	5.24	30.27
Cattle manure	30	536.00	16.08	41.11	54.70	7.28	42.06
Chicken litter	5	493.00	2.48	6.34	14.45	2.12	12.25
Cocodust	5	256.00	1.28	3.22	80.63	0.24	6.99
Rice husk ash	5	252.00	1.26	7.67	3.26	1.21	7.05
MSG waste sludge	5	600.00	3.00	3.27	59.03	1.22	1.39
Total	100	391.10	39.11	100.00	21.80	17.31	100.00

The treatments and the experimental design on the mushroom production were maintained (except for the additional materials) and used in this Organonitrofos biofertilizer production. The spent EFB was taken out from each of the mushroom bed, pored on a sheet of terpalin and mixed thoroughly. Every mixture of about 100 Liter volume or 17.31 kg dry weight (Table 1) was then put in a sack. Total of 27 sacks (experiemntal units) was layed randomly on wooden logs and feremented for three months. The pile of the compos materials was covered by using a sheet of terpalin. By doing such the steps, the treatment and experimental design of Organonitrofos biofertilizer production were infact not different from those of the straw mushroom cultivation reseach.

All the sacks of the compost materials were maintained weekly. The sacks of compost material were opened, the materials were pored and turned. The compost materials were also sprayed with water when needed to maintain moisture. Parameters observed included water content (gravimetric), organic-C (Walkley and Black), Total-N (Kjeldahl), total-P (HCl 25%), total-K (OA method) for the raw materials and Organonitrofos biofertilizer produced. Organic-C and Total-N were measured every month. The compost materials in every experimental unit were screened, and weighed with a 0.5 cm sieve every month, then mixed again and returned back in each composting sack. The screened compost percentage was recorded to monitore the composting rates. The characteristics of Organonitrofos biofertilizer produced were compared to the characteristics of earlier variants of Organonitrofos.

III. RESULTS AND DISCUSSION

3.1. Raw Materials

At the first time, granular organonitrofos was made from blend of Cow dung and phosphate rock with ratio of 80%-20% (Nugroho et al. 2012). Later generations of Organonitrofos used mixed materials such as cattle manure, cocodust, chicken litter, rice husk ash, MSG industry waste sludge, and the last was added with the spent EFB taken from the mushroom cultivation. The fresh cattle manure was intended for organic C and decomposer sources (Gupta et al. 201). On Table 2, organic C content in the cattle manure for granular Organonitrofos was 22.85% (Nugroho et al. 2012) which was not much different from the measured organic C (22.71%) used for powder Organonitrofos. The two materials were taken from the same cattle fattening industry but in different year. The organic C contents of the cattle manure were much higher than that (9.30%) measured by Achmad et al. (2016). Organic C content of the spent EFB(46.67%) was higher, but slightly lower than C content of fresh EFB (49.65%) measured by Siddiqui et al. (2009). The spent EFB from the straw mushroom cultivation has been composted only 2-8 days, so it was not much degraded. Overall, the highest contribution of organic C was apparently from rice husk ash (51.30%).

Table 2. Characteristics of Raw Materials of Organonitrofos Fertilizer

No	Raw Materials	WC (%)	Org C (%)	Total N (%)	C-N Ratio	Total P (%)	Total K (%)
	Garnular Organonitrofos:						
1	Cattle Manure	61.32	22.71	1.08	21.03	0.26	
2	phosphate rock	20.00				10.27	
	Crumb Organonitrofos:						
1	Spent EFB	41.60	46.67	1.29	36.18	0.14	2.50
2	Cattle Manure	70.00	22.71	1.47	15.45	1.93	1.16
3	Cocodust	19.54	44.67	0.56	79.77	0.27	0.77
4	Chicken Litter	55.00	22.34	2.26	9.88	0.54	0.46
5	Rice husk ash	9.02	51.30				
6	MSG Waste Sludge	20.00				21.74	

Chicken litter was used to enhance N content in compost. Total N Contents of chicken litter was measured to be 2.26% which was considerably the highest among those contained in the other materials. But, the measured total N content was about half of what (4.18%) Doydora et al. (2011) reported. It may be understood because nitrogen is very unstable and subject to volatilization, so it tends to vary with sources, location, and time.

Phosphate rock was initially to improve P content of compost, but later was changed to MSG industry waste sludge. Content of total P in the phosphate rock was 10.27%, much lower than total P content in the MSG waste sludge which was 21.74%. The total P in the MSG waste sludge was in fact residue of phosphoric acid used as one of raw materials in the MSG industry. Therefore, solubility of P in the MSG waste sludge was supposed to be much higher than that in the natural phosphate rock. The difference of the P solubility was expected to be able to improve the performances of Organonitrofos. Cocodust was expected to contribute P content, but its contribution was quite low (0.27%) although still in the ranges (0.28-2.81%) of what was reported by Abad et al. (2002).

The spent EFB was primarily intended to enhance K content. With 2.50%, the spent EFB contributed the highest total K content among the raw materials. This K content was also higher than that (1.4%) measured by Wan Razali et al. (2012). The spent EFB was also relatively high in total N content (1.29%).

3.2. Decomposition Rate of Organonitrofos Biofertilizer

Composting rate was normally determined by compost maturity using parameter of C-N ratio, but physical disintegration of raw materials could also be used as an indicator. Levels of disintegration could be determined by screening the compost biomass, and a 0.5 cm sieve screen was used in this research. As mentioned previously, Organonitrofos biofertilizer was made from the mixture of spent EFB (50%) and other raw materials (50%) by by volume. When taken from the mushroom beds to be mixed with other materials, the spent EFB has not been practically decomposted yet, while the other materials were in the forms of powder or crumble already. Every month after the fermentation was started, the compost materials were uncovered, screened, and weighted. The monthly percentage of the screened compost was presented on Figure 1. After a month of the fermentation, the percentage of the screened compost was 56.7±3.32% on the average, meaning that biomass materials have not much degraded yet. After the second month of the fermentation; however, the percentage of the screened compost was increasing to 70.29±2.56% on the average, and finally 88.54±1.69% after three month fermentation. Based on ANOVA and LSD analysis the treatments

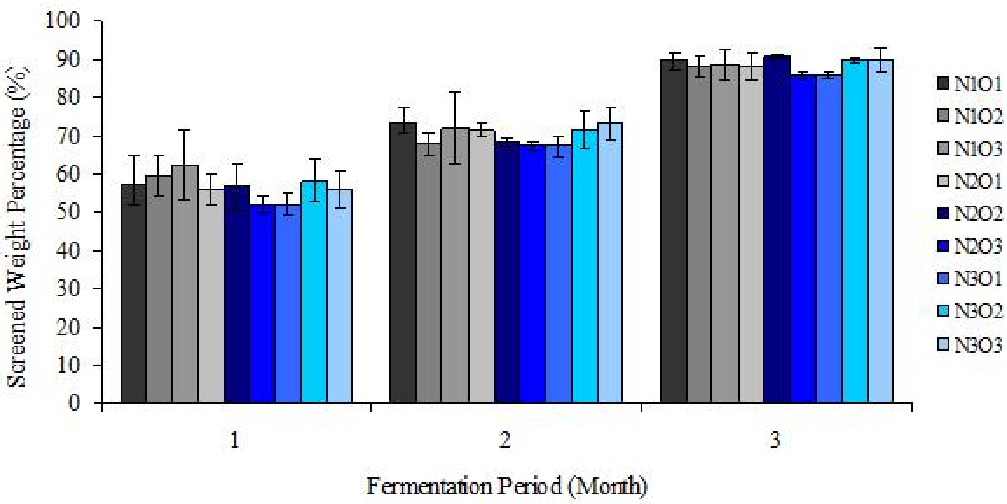

Figure 1. Effect Of EFB Treatments for Straw Mushroom Substrate on The Screened Weight Percentage of Organonitrofos Fertilizer

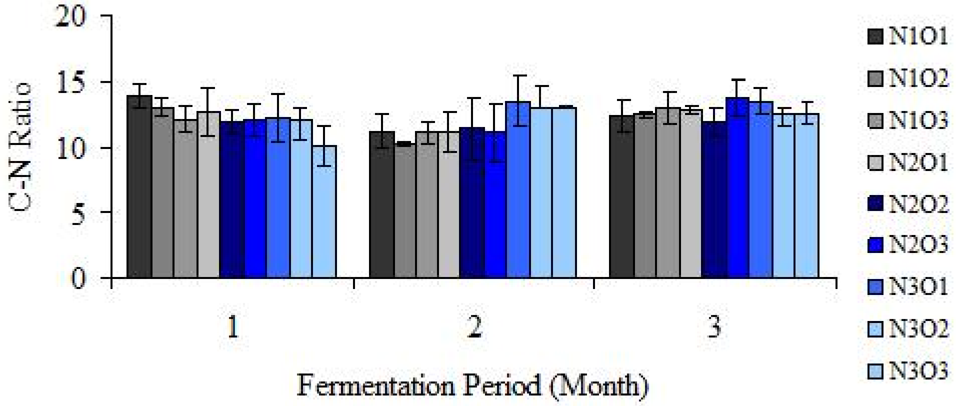

Figure 2. Effect of EFB Treatments for Straw Mushroom Substrate on The C-N ratio of Organonitrofos Fertilizer

of EFB medium on the degradation rates at every month were not significantly different at p<0.05. Even the effects of the EFB treatments were not significantly different, percentages of the screened compost increased remarkably within three month of the fermentation.

With respect to C-N ratio, the decomposition rate of the compost has been leveling off (Figure 2). On the averages, the C-N ratios were 12.28±1.03, 11.81±1.11, 12.80±0.55 for the first, second, and third months of the fermentation respectively. These ranges of the C-N ratios have been in maturity stage for the compost. But some materials having high C-N ratios have not been totally decomposted yet. The coodust with C-N ratio of 79.77 was the hardest material to be decomposted, then followed by the spent EFB with C-N ratio of 36.18 9 (Table 1). In the third month of the fermentation, the major unscreened portion was more likely to be the spent EFB, because it was initially in the form of whole EFB and has high C-N ratio. Additional time of the fermentation might be required for the material to be tollay degraded.

3.3. Physical Properties of Organonitrofos Produced

Physical properties of finished Organonitrofos fertilizer were shown on Table 3. statistical analyses showed that none of the parameters was significantly different at p<0.05. Dry weight of Organonitrofos produced was 14,38±0.18 kg on the average. As shown on Table 1, total dry weight of raw materials was 17.31 kg, so there was 2.58±0.59 kg dry weight lost on the average. This lost of the dry weight was due to mineralization. Abad et al. (2002) states that the supplemental materials tends to loss weight because of some mineralization. The weight loss, due to respiration and mineralization of nitrogen during decomposition of organic matter, may have resulted in increased nitrogen content in finished compost. Shown on Table 3, ash content of the finished Organonitrofos fertilizer was 53.96±1.42 %.

3.4. Chemical Properties of Organonitrofos Produced

Table 4 presents the effect of EFB treatments for straw mushroom substrate on chemical properties of Organonitrofos fertilizer produced. None of the chemical contents was significantly different at p<0.05. Supplements of inorganic and organic fertilizers to the EFB for the straw mushroom substrate did not affect the chemical contents of Organonitrofos fertilizer produced using the spent EFB as one of the raw materials. Many possible factors could play the role in this case. The inorganic and organic fertilizers added to the EFB medium was intended to enrich the nushroom growth medium, thus promote the mushroom growth and increase the yield. It was very possible that the nutritions of the substare was already absorbed by the mushroom, then the rest in the spent EFB was really low. As shown Table 2, the content of organic C of the Organonitrofos fertilizer was 16.11±0.59 on the average, already in the ranges of SNI 19-7030-2004, where organic C for organic fertilizers

Table 3. Ash Content of The Finished Organonitrofos Fertilizer

No	Sample Code	Dry Weight (kg)	Weight Lost (%)	Ash Content (%)
1	N1O1	14,44±0.24	2.68±0.24	54.92±0.76
2	N1O2	14,58±0.27	2.56±0.27	53.12±4.00
3	N1O3	14,52±0.27	3.01±0.27	56.54±6.20
4	N2O1	14,57±0.74	3.04±0.74	55.21±1.01
5	N2O2	14,23±0.72	2.55±0.72	52.81±0.93
6	N2O3	14,11±0.45	2.87±0.45	54.50±2.65
7	N3O1	14,12±1.11	2.96±1.11	52.14±4.95
8	N3O2	14,38±1.37	2.64±1.37	52.90±4.20
9	N3O3	14,47±0.06	2.88±0.69	53.46±2.43
	Average	14,38±0.18	2.58±0.59	53.96±1.42

Table 4. Effect of EFB Treatments for Straw Mushroom Substrate on Chemical Properties of Organonitrofos Biofertilizer

No	Kode sampel	Organic C (%)	Total N (%)	Total P (%)	Total K (%)
1	N1O1	16,52±0.43	1.33±0.10	2.78±0.08	0.40±0.07
2	N1O2	15.38±1.20	1.23±0.11	3.39±0.48	0.47±0.11
3	N1O3	15.16±1.33	1.17±0.04	3.10±0.36	0.40±0.08
4	N2O1	15.73±0.90	1.23±0.06	2.91±0.21	0.43±0.10
5	N2O2	15.92±1.06	1.33±0.12	2.89±0.09	0.49±0.02
6	N2O3	16.89±0.72	1.24±0.12	3.20±0.25	0.39±0.06
7	N3O1	16.47±0.60	1.22±0.08	3.09±0.12	0.37±0.06
8	N3O2	16.44±1.03	1.31±0.12	2.89±0.29	0.41±0.11
9	N3O3	16.47±0.10	1.31±0.08	3.07±0.25	0.42±0.04
	Average	16.11±0.59	1.26±0.59	3.04±0.19	0.42±0.04

should be 9.8-32 %. If compared to the previous variants of granular Organonitrofos fertilizers, the organic C content in this variant was the highest. The organic C contents were 12.81-14.93%, 8.91%, and 9.52% respectively for granular organonitrofos (Nugroho et al. 2012), powder organonitrofos (Lumbanraja et al. 2014), and organonitrofos plus (Dermiyati et al. 2017). However, the organic C content in this research was about the same as the organic C content (16.71%) reported by Awaluddin et al. (2017).

For total N, the Organonitrofos fertilizer contained 1.26±0.59 on the average. Based on SNI 19-7030-2004 for organic fertilizers, the total N contents in this research met the national standard, where total N content should be higher than 0,40 %. If compared to the total N content of granular Organonitrofos in which total N was 1.80-3.10% (Nugroho et al. 2012), the total N content found in this research was still comparable. The total N content in this research; however, was higher than those in powder Organonitrofos (0.67% (Lumbanraja et al. 2014), and in Organonitrofos plus (1.13%) (Dermiyati et al. 2017).

For total P, the Organonitrofos fertilizer in this research contained 3.04±0.19% on the average. This total P met SNI 19-7030-2004 for organic fertilizers, which is required to contain total P more than 0.10 %. The total P in this research was comparable to total P (2.28-5.76%) in granular Organonitrofos (Nugroho et al. 2012), higher than total P (0.32%) in powder Organonitrofos (Lumbanraja et al. 2014), but lower than total P (5.58) in Organonitrofos plus (Dermiyati et al. 2017). Organonitrofos plus has benn using MSG industry waste sludge as P sources, the same as in this research.

For total K, the Organonitrofos fertilizer in this research contained 0.42±0.04% on the average. The total K content was quite low but still met the SNI 19-7030-2004 where total K is required to be higher than 0.20%. The total K in this research was not much different from those in powder Organonitrofos (0.53%) (Lumbanraja et al. 2014), and in Organonitrofos plus (0.68) (Dermiyati et al. 2017). The low total K contents of the Organonitrofos fertilizers were considerably low in general. The total K content of the spent EFB (2.50%) as the one of raw materials has not been successful to enhance the total K content of Organonitrofos biofertilizer.

IV. CONCLUSIONS

Based on the parameters observed, the effects of of EFB treatmnents for straw mushroom substrate on physicochemical properties of Organonitrofos biofertilizer were not significantly different at p<0.05 among. However, within a 3-month period of fermentation, the screened compost reached 88.54±1.69% of total weight. C-N ratio (12.80±0.55), organic C (16.11±0.59), total N (1.26±0.59), total P (3.04±0.19), and total K (0.42±0.04) of finished compost also met the SNI 19-7030-2004 requirement. Dry weight lost of 2.58±0.59 and ash of 53.96±1.42 content were noted from the finished compost. The averaged organic C in the Organonitrofos biofertilizer was relatively the highest as compared to the granular, powder, and Organonitrofo splus bioferetilizers. Total N was also practically higher than those in powder Organonitrofos (0.67%) and in Organonitrofos plus biofertilizers. Total P was comparable to that in powder Organonitrofos but slightly lower than that in Organonitrofos plus. For total K, Organonitrofos biofertilizer in this research is also relatively the same content as powder Organonitrofos and Organonitrofos plus.

REFERENCES

Abad M, Noguera P, Puchades R, Maquieira A and Noguera V 2002 Physico-chemical and chemical properties of some coconut coir dusts for as a peat substitute for containerised ornamental plants. Bioresource Technology 82 pp 241-5

Abdullah N, Sulaiman F and Gerhauser H 2011 Characterisation of oil palm empty fruit bunches for fuel application. *J. Physical Science*, 22(1), 1–24

Achmad KTB, Hidayati YA, Badruzaman DZ, Hamidah I, Yudhantoro and Abidin J 2016 The effect of water content and c/n ratio of a mixture of cow dung and albizzia falcata sawdust on the change of ph and temperature of composting process and the nutrient content of resulted liquid organic fertilizer. Lucrãri ªtiinþifice, 54, Seria Zootehnie

Awaluddin A, Prayitno A, Suherman I, Itnawita and Saryono 2017 Compost characteristic made from mixture of palm empty fruit bunch and chicken manure with liquid waste of palm oil processing and EM-4 as bioactivators. https://www.researchgate.net/publication/288874013

Castro RIL, Delmastro S, Curvetto NR. 2008. Spent oyster mushroom substrate in a mix with organic soil for plant pot cultivation. *Msubstrate Icologia Afromplicada Oyster International Mushroom*, 20(1) pp 17-26

Dermiyati, Karyanto A, Niswati A, Lumbanraja J, Triyono S and Harini NVA 2017 Activity of soil microorganisms during the growth of sweet corn (ZeaMays Saccharata Sturt) in the second planting time with the application of organonitrofos and biochar. J Trop Soils, 22(1) pp 35-41

Doydora SA, Cabrera M.L., Das KC, Gaskin JW, Sonon LS and Miller WP 2011 Release of nitrogen and phosphorus from poultry litter amended with acidified biochar. *Int. J. Environ. Res. Public Health*, 8 pp 1491-502

Fauzianto R 2014 Implementation of Bioenergy from Palm Oil Waste in Indonesia. Journal of Sustainable Development Studies, 5(1) pp 100-15

Forján R, Rodríguez-Vila A, Cerqueira B and Covelo EF 2017 Comparison of the effects of compost versus compost and biochar on the recovery of a mine soil by improving the nutrient content. *J Geochemical Exploration* 183 pp 46–57

Gupta KK, Aneja KR and Rana D 2016 Current status of cow dung as a bioresource for sustainable development. Bioresources and Bioprocessing 28 (3)

Hagemann N, Subdiaga E, Silvia Orsetti S, de la Rosa JR, Knicker H, Schmidt HP, Kappler A and Behrens S 2018 Effect of biochar amendment on compost organic matter composition following aerobic compositing of manure. *Sci. of the Total Environment,* 613–614 pp 20-29

Hayawin ZN, Astimar AA, Anis M, Ibrahim MH, Khalil HPSA and Ibrahim Z 2012 Vermicomposting of empty fruit bunch with addition of palm oil mill effluent solid. *J. Oil Palm Res.,* 24 pp 1542-49

Hoe TK, Sarmidi MR, Alwee SSRS, Zakaria ZA. 2016. Recycling of oil palm empty fruit bunch as potential carrier for biofertilizer formulation. *J. Teknologi (Sciences & Engineering,)* 78(2) pp 165–170

Jain MS, Jambhulkar R and Kalamdhad AS. 2018 Biochar amendment for batch composting of nitrogen rich organic waste: Effect on degradation kinetics, composting physics and nutritional properties. Bioresource Technology, DOI: https://doi.org/10.1016/j.biortech.2018.01.038

Lumbanraja J, Dermiyati, Triyono S, Ismonno H. 2014. Pemasyarakatan aplikasi pupuk organik rakitan baru organonitrofos di kelompok tani dan pemberdayaan kewirausahaan kelompok tani di kabupaten lampung selatan. Nomor Kontrak: 18/SP2H/KMP/DIT.LITABMAS/V/2014 Tanggal 5 Mei 2014

Kananam W, Suksaroj TT and Suksaroj C.2011 Biochemical changes during oil palm (*Elaeis guineensis*) empty fruit bunches composting with decanter sludge and chicken manure. *Sci. Asia* 37 pp17-23

Kavitha B, Jothimani P and Rajannan G .2013 Empty fruit bunch- a potential organic manure for agriculture. *Int. J. Science, Environment and Technology*, 2(5) pp 930-37

Kavitha B, Rajannan G, Jothimani P. 2013. Utilization of empty fruit bunch of oil palm as alternate substrate for the cultivation of mushroom. *Inter J Sci, Environ and Tech* 2(5): 839-846.

Kaudal BB and Weatherley AJ. 2018 . Agronomic effectiveness of urban biochar aged through co-composting with food waste. *Waste Management,* 77 pp 87–97

Lim Meng Hon, J. 2010 .A case study on palm empty fruit bunch as energy feedstock. *SEGi Review* 3(2) pp 3-15

Marlina L, Sukotjo S, Marsudi S .2015. Potential of oil palm empty fruit bunch (EFB) as media for Oyster mushroom, Pleurotus ostreatus cultivation. *Procedia Chem* 16: 427-431.

Meng X, Dai J, Zhang Y, Wang X, Zhu W, Yuan X, Yuan H, Cui Z. 2017. Composted biogas residue and spent mushroom substrate as a growth medium for tomato and pepper seedlings. *J. Environmental Management* pp 1-8

Nugroho SG, Lumbanraja J, Dermiyati, Triyono S and Ismono H 2012 Optimum ratio of fresh manure and grain size of phosphate rock mixture in a formulated compost for organomineral np fertilizer. *J. Trop. Soils,* 17(2) pp 121-128

Nugroho SC, Dermiyati, Lumbanraja J, Triyono S, Ismono H, Ningsih MK and Saputri FY .2013. Inoculation effect of N2-fixer and P-solubilizer into a mixture of fresh manure and phosphate rock formulated as Organonitrofos fertilizer on bacterial and fungal populations. J Trop Soils, 18(1) pp 75-80

Omar R, Idris A, Yunus R, Khalid K and Aida Isma MI. 2011. Characterization of empty fruit bunch for microwave-assisted pyrolysis. Fuel 90 pp 1535-44

Owaid MN, Abed IA, Al-Saeedi SSS. 2017. Applicable properties of the bio-fertilizer spent mushroom substrate in organic systems as a byproduct from the cultivation of Pleurotus spp. *Information Processing in Agriculture* 4 pp 78-82

Pogaku R, Hardinge BS, Vuthaluru H and Amira HA. 2016. Production of bio-oil from oil palm empty fruit bunch by catalytic fast pyrolysis: a review. BIOFUELS

Rizki M and Tamai Y. 2011. Effects of different nitrogen rich substrates and their combination to the yield performance of oyster mushroom (*Pleurotus ostreatus*). *World J Microbiol Biotechnol* 27:1695–1702.

Shafie SM, Mahlia TMI, Masjuki HH, Ahmad-Yazid A .2012. A review on electricity generation based on biomass residue in Malaysia. *Renewable and Sustainable Energy Reviews* 16, 5879–89

Siddhant and Singh CS .2009. Recycling of spent oyster mushroom substrate to recover additional value. *Kathmandu University Journal of Science, Engineering and Technology,* 5 (2) pp 66-71

Siddiqui Y, Meon S, Mohd RI, Rahmani M and Ali A. 2009. Efficient conversion of empty fruit bunch of oil palm into fertilzer enriched compost. *Asian Jr. of Microbiol. Biotech. Env. Sc.* 11 (2) pp 1-6

Sudiyani Y, Styarini D, Triwahyuni E, Sudiyarmanto, Sembiring KC, Aristiawan Y, Abimanyu H and Han MH. 2013. Utilization of biomass waste empty fruit bunch fiber of palm oil for bioethanol production using pilot – scale unit. Energy Procedia 32 pp 31 – 38

Tabi ANM, Zakil FA, Fauzai WNFM, Ali N, and Hassan O. 2008. The usage of empty fruit bunch (EFB) and palm pressed fibre (PPF) as substrates for the cultivation of *Pleurotus ostreatus*. *J Teknologi* 49(F): 189–196

Thomas LO, Sikirica N, Mondini C, Loopez G, Peter J. Kuikman PJ and Holden NM. 2018. Biochar, compost and biochar-compost blend as options to recover nutrients and sequester carbon. *J. Environmental Management* 218 pp 465-476

Triyono S, Haryanto A, Telaumbanua M, Dermiyati, Lumbanraja J, Filip To. 2019. Cultivation of straw mushroom (volvariella volvacea) on oil palm empty fruit bunch growth medium. Int J of Organic Waste in Agriculture. Online first. DOI 10.1007/s40093-019-0259-5.

Wan Razali WA, Baharudin AS, Talib AT, Sulaiman A, Naim MN, Hassan MA and Shirai Y. 2012. Degradation of oil palm empty fruit bunches (OPEFB) fibre during composting process using in-vessel composter. *BioResources* 7(4) pp 4786-05

Department of Agricultural Engineering The University of Lampung