Quality of organic fertilizer made from water hyacinth with the addition of corncobs waste and soybean dregs

H Fitrihidajati*, F Rachmadiarti, Winarsih, T Purnomo and S Kuntjoro

*herlinafitrihidajati@unesa.ac.id
Biology, FMIPA Universitas Negeri Surabaya, Ketintang Street, Gedung C3 Lt.2 Surabaya, Indonesia

Abstract. The purpose of this research was 1) described the nutrient quality of organic fertilizer made from water hyacinth with the addition of corncobs waste and soybean dregs, 2) described the difference in quality of the organic fertilizer made from water hyacinth with the addition of corncobs waste and soybean dregs, 3) described the best quality from organic fertilizer made from water hyacinth with the addition of corncobs waste and soybean dregs. The method of this research was experimental with completely randomized design. The experiment consisted of one treatment factor namely the type of raw material water hyacinth which included three types, namely P1: with the addition of corncobs waste; P2: with the addition of soybean dregs; P3: with the addition of corncobs waste and soybean dregs (50%:50% ratio). Each type of treatment was carried out three times so that the sample amounted 9. The measured parameters were nutrient content included C, N, C/N, P, K, and pH. The research was conducted at the Ecology Laboratory, FMIPA, Unesa. Data was analysed by descriptively quantitative and statistically used 1-way Anava. The results showed that 1) Based on the criteria of soil chemical properties, organic fertilizer content has the same quality in elements C, N, K, C/N (very high), pH neutral, and P was very low, 2) There was a difference in the effect of the type of material on the amount of nutrient content of organic fertilizer, 3) Water hyacinth that addition with corncobs waste had a higher amount nutrient in several elements namely C, N, K, C/N. Whereas organic fertilizer with addition soybean dregs had a higher amount of content in the element P.

Keywords: quality of organic fertilizer, water hyacinth, corncobs waste, soybean dregs

1. Introductions
Water hyacinth is one of the weeds that live in the waters and can grow rapidly so that it dominates the surface of the water. This condition will be very detrimental to the biota that is in the waters because these plants can inhibit the intensity of light and reduce the dissolved oxygen in the water needed by the biota. For this reason, management efforts need to be made by making water hyacinth a useful product. Basically, water hyacinth was an organic material that has a nutrient content of nitrogen (N) 0.28%, phosphate (P) 0.0011%, and potassium (K) 0.016% [1]. Based on these contents, the effort that can be done is to process them into organic fertilizer.

In addition to weeds, there is a lot of waste in our environment that is residual or a by-product of human activities. An example of such waste is corncobs and soybean dregs whose numbers are increasing with population growth. If the waste is not managed properly, it will cause environmental pollution.

Basically, the waste still has the potential to be utilized. Corncobs still has carbohydrate content that can be utilized as well as soybean dregs still has protein and fat content [2][3].
Made organic fertilizer with fermented water hyacinth with the addition of bran from corn cobs produced good quality with very high content of C, N, P, and K [4]. According to [5] nutrient content in organic fertilizer has a great influence on soil properties namely as a granulator, macro and micro nutrient sources, increased the soil cation dosing capacity, and an energy source for microorganisms.

Considered the waste from soybean dregs was mainly as result of sampling from the home industry of the large number of processed soy milk and the demands from Law No. 23 Article 70 of 2009 concerning Environmental Protection and Management that the community was required to managed waste, the researchers sought to process water hyacinth with the addition of corn cobs waste and soybean dregs. Weed and waste treatment efforts are one of the activities aimed at reducing pollution in the environment.

The purpose of this research was to (1) described the nutrient quality of organic fertilizer made from water hyacinth with the addition of corn cobs waste and soybean dregs, (2) described the difference in the effect of the type material on the total nutrient content of organic fertilizer made from water hyacinth with the addition of corn cobs waste and soybean dregs, and (3) described the best quality of organic fertilizer made from water hyacinth with the addition of corn cobs waste and soybean dregs.

2. Method

This research was experimental with one treatment factor, namely the type of waste addition which included: P1: water hyacinth + corn cobs waste, P2: water hyacinth + soybean dregs, and P3: water hyacinth + corn cobs waste + soybean dregs (50%:50%). Each treatment was repeated three times so that the number of samples = 3 x 3 = 9 samples. The parameters measured were macro and micro nutrient content. Macro nutrient content consisted of C, N, P, K, C/N, and pH.

Made organic fertilizer was done by composted or fermented according to the journal [6] as well as the composition ingredients. Basically, the materials used were as followed: chopped water hyacinth that has been dried by wind for 7 days, corn cobs milled to formed powder or bran, and fresh soybean dregs that were wind-dried for 1 day. The ingredients were as followed:
P1: 1kg water hyacinth + 250gr bran of corn cobs + 10 cc molasses + 14gr tempe yeast
P2: 1kg water hyacinth + 250gr soybean dregs + 10 cc molasses + 14gr tempe yeast
P3: 1kg water hyacinth + 125gr bran of corn cobs + 125gr soybean dregs + 10 cc molasses + 14gr tempe yeast

The design of this research was Completely Randomized Design (RAL). Data was analyzed by descriptive quantitative to determine the nutrient quality of each type of fertilizer treatment by compared with nutrient standards according to the criteria for evaluated the chemical properties of the Departemen Pertanian, 1983 [7]. To find out the best results were used statistically with one-way Anava followed by Duncan’s difference test.

3. Results and discussions

3.1 Results

Research data in the form of macro nutrient content which included C, N, P, K, C/N, and pH have been tested at the Balai Perindustrian (Baristan) Surabaya.

Data analyzed included nutrient quality based on criteria for evaluated soil chemical properties and effect of different types of materials an organic fertilizer nutrient content. Then to determined the differences in the effect of the type of material on nutrient content, statistical analysis was performed with Anava.

Criteria for assessed soil chemical properties were listed in Table 1 below.

| Nature of the Soil | Very Low | Low | Average | High | Very High |
|--------------------|----------|-----|---------|------|-----------|

Table 1. Criteria for Assessment of Soil Chemical Properties.
Table 2. Nutrient Quality of Organic Fertilizer in Various Types of Materials Based on Assessment Criteria of Soil Chemical Properties.

| Parameter       | P1               | P2               | P3               |
|-----------------|------------------|------------------|------------------|
| C-organic (%)   | 52.7 ± 0.05a     | 49.9 ± 0.15b     | 49.5 ± 0.05a     |
| Criteria        | Very high        | Very high        | Very high        |
| Nitrogen (%)    | 2.49 ± 0.02c     | 1.96 ± 0.03b     | 1.89 ± 0.01a     |
| Criteria        | Very high        | Very high        | Very high        |
| Phosphor (%)    | 0.6              | 1.01             | 0.82             |
| Criteria        | Very low         | Very low         | Very low         |
| Potassium (%)   | 1.63             | 0.91             | 1.42             |
| Criteria        | Very high        | High             | Very high        |
| C/N (%)         | 21.2             | 25.7             | 26.2             |
| Criteria        | High             | Very high        | Very high        |
| pH (%)          | 7.26             | 7.22             | 7.27             |
| Criteria        | Neutral          | Neutral          | Neutral          |

Based on the results in Table 2 it showed that the quality of the three organic fertilizer materials used, namely P1, P2, and P3 showed criteria for nutrient content which were almost the same based on the criteria for assessed the chemical properties of the soil. The quality criteria were almost the same for all 3 treatments with gradations ranged from very low to very high. Quality with very high criteria for content of C, N, K, and C/N for all three treatments except for K on P2 with high criteria. Likewise, C/N in P1 with high criteria. Very low criteria for P content in all 3 treatments.

The results of the statistical analysis were carried out to determine the difference in the effect of the treatment (ingredients) on the nutrient content of organic fertilizer. The analysis results were presented in Table 3 below.

Table 3. Nutrients for Organic Fertilizers in Various Treatments (Ingredients).

| Parameter       | Nutrient Levels in A Variety of Organic Fertilizer |
|-----------------|--------------------------------------------------|
|                 | P1                       | P2                       | P3                       |
| C Organic       | 52.7 ± 0.05c             | 49.9 ± 0.15b             | 49.5 ± 0.05a             |
| Nitrogen        | 2.49 ± 0.02c             | 1.96 ± 0.03b             | 1.89 ± 0.01a             |

Based on data from the analysis of nutrient content of the 3 treatment materials and their comparison with the criteria for assessed the chemical properties of the soil, the quality of nutrient content was presented in Table 2 below.
Based on Table 3 showed that there was a very significant difference in effect on nutrient content of the three treatments, namely P1, P2, and P3. Significant differences can be seen in the elements C, N, K, C/N, and pH.

Based on these data showed that P1 has the highest content of organic elements C, N, K, and C/N then P2 was best in the content of nutrients P and pH.

3.2 Discussions

Based on the results of processed water hyacinth weeds and solid waste from corncobs and tofu dregs have produced organic fertilizer. Organic fertilizers produced with very high quality for the contents of the nutrients were C, N, K, and C/N, but very low for the P content. Based on the criteria of soil chemical properties, the fertilizer can already be used but for nutrients with very low criteria need to be added from other ingredients so that its function was maximized for fertilization.

The existing nutrient content showed that microbes have been able to decomposed compounds such as carbohydrates, proteins, and fibers and fats that exist in water hyacinth, corncobs bran, and tofu dregs into its elements. The types of microflora founded in tempe yeast were Rhizopus oligosporus, Rhizopus oryzae, Rhizopus stolonifer, and Rhizopus arhizus [8]. These microorganisms were from the cellolytic, amylolytic, proteolytic, and lipolytic groups. Cellolytic groups will degraded cellulose into its constituent components namely glucose, amylolytic groups will break down the starch components found in raw materials into glucose, protein components will be broken down into simpler peptides by proteolytic organisms [8]. The fat component will be simplified by lipolytic organisms.

Water hyacinth has an organic material content of 78.47%, organic C 21.23%, a total N of 0.28%, a total P of 0.0011%, and a total K of 0.016% [9]. Corncobs had 90% dried matter (BK) nutritional composition, crude protein (PK) 2.8%, crude fat (LK) 0.7%, ash 1.5%, crude fiber (SK) 32.7%, walls 80% cells, 25% cellulose, 6% lignin and 32% ADF [10]. [11] explained that soybean dregs contained isoflavones (genistein and daidzein), lignans, phytosterols, coumestants, saponins, and phytates.

Nitrogen content as shown in Table 2 shows the highest nitrogen found in P1 fertilizer with a value of 2.49% and the lowest content in P3 fertilizer with a value of 1.89%. Based on the criteria [5] the N content of the three organic fertilizer treatments had very high levels. High nitrogen occurs through the processed of decomposition of fertilizers, starting with mineralization, namely the aminase stage in the form of a hydraulic breakdown of amines from amino acids carried out by microorganisms. Then the ammonification stage by the release of ammonia by microorganisms used amines or amino acids, then the ammonia released undergoes a nitrification process of NH$_3$ changed that would be converted into nitrates and nitrates which mix with water into ammonium and then absorbed by plants [12]. [13] stated that the important role of cellulotic microorganisms such as the T. harzianum had the ability to remodel nitrogen in the media which causes increased nitrogen mineralization so that nitrogen in a stable form is nitrate (NO$_3^-$/)

Phosphor play an important role in soil fertility, plant physiological processed, and photosynthesis. Phosphor content in Table 3 showed that P2 fertilizer had the highest content of 1.01% while the lowest content of P1 fertilizer was 0.60%. Phosphor content in P1, P2, and P3 fertilizers had very high levels in accordance with the criteria [5]. [14] stated that the content of

| Nutrient | P1          | P2          | P3          |
|----------|-------------|-------------|-------------|
| Phosphor | 0.60 ± 0.03$^a$ | 1.01 ± 0.02$^c$ | 0.82 ± 0.00$^b$ |
| Potassium| 1.63 ± 0.00$^c$ | 0.91 ± 0.00$^a$ | 1.42 ± 0.00$^b$ |
| C/N     | 21.2 ± 0.19$^a$ | 25.7 ± 0.46$^b$ | 26.2 ± 0.18$^c$ |
| pH (5%) | 7.26 ± 0.00$^b$ | 7.22 ± 0.01$^a$ | 7.27 ± 0.00$^b$ |

$^a, ^b, ^c$ Notation in the numbers showed a significant difference of nutrient levels in organic fertilizer based on the Duncan test (p=0.05), a<b<c.
P₂O₅ in composted was dependent and in line with the nitrogen content. The greater the Nitrogen content, the multiplication of microorganisms that overhaul Phosphor will increased which caused the Phosphor content in compost material to increased [15]. Renovation and assimilation of Phosphor in organic matter occurs because there was a phosphotase enzyme produced by microorganisms, then Phosphor will be decomposed by microorganisms that were converted into orthophosphate form or also called P-available which can be utilized directly by plants [16].

Potassium was a macro nutrient that functions in plant metabolism to activated the work of enzymes, plant resistance to disease, and transportation of photosynthesis [17]. The results of Potassium content in Table 3 showed that P1 fertilizer had the highest content of 1.63% and the smallest content of P2 fertilizer is 0.91%. Based on criteria [5] P1 and P3 fertilizers have very high potassium levels, but in P2 fertilizers have low levels. This was caused by the activity of decomposition by microorganisms changed complex organic materials into simple organics that produce potassium which can be more easily absorbed by plants [18].

According to [19] water hyacinth contains cellulose at 25%, lignin at 10%, and hemicellulose at 35%. So that when the water hyacinth was added with soybean pulp the fiber content will increased, because in soybean dregs according to [20] contains 11.7% lignin, cellulose at 5.6%, and hemicellulose at 12.1%. [21] stated that one of the obstacles in the process of decomposition of lignocellulose in organic matter was the lignin content which was difficult to be degraded by microorganisms during the composting process. Lignocellulose was composed of the main components of lignin, cellulose, and hemicellulose [22]. This caused the nutrient content in P2 fertilizer was low.

The C/N ratio was a comparison of the amount of Carbon content to the amount of Nitrogen content in organic matter. The C/N value in Table 3 showed that P3 fertilizer has the highest ratio value of 26.2 and P1 fertilizer has the lowest ratio value of 21.1. C/N values for all organic fertilizer treatments were included in the very high criteria because according to [5] the range of values ranges from 11-15. The higher value of the C/N ratio means that the compost has not completely decomposed or in other words was not yet ripe, due to the high amount of ammonia and nitrogen trapped in the pores of the compost pile [23]. [24] stated that if C/N was high, nutrient content for plants was only small, whereas if it was low, nutrient availability was high. In addition, the high C/N value in all treatments can be caused by the high content of C-organic in organic fertilizer and the lack of composting time. According to [25] the longer the composting process was carried out, the smaller the C/N will be. This can occur because the C-organic content in fertilizer material has been greatly reduced because it was used by microorganisms as an energy source, while the nitrogen content has increased due to the decomposition of fertilizer by microorganisms that produced ammonia and nitrogen so that C/N decreases [26].

The pH value in all 3 treatments has a neutral pH range. [25] stated that the pH of compost material was acidic at the beginning of composting due to the formation of simple organic acids, then acid-forming bacteria will decrease the pH so that compost was more acidic. Furthermore, microorganisms will convert inorganic nitrogen into ammonium so that the pH rises rapidly to become alkaline, some ammonia was released or converted to nitrate and nitrate was denitrified by bacteria so that the compost pH becomes neutral [27]. The higher the pH value in the composting process, the faster the decomposition process of compost, the pH of the compost will approach normal when the decomposition process was completed [28]. pH values that were in the neutral range will be easily absorbed by plants and were useful for reducing soil acidity because the original nature of the soil was acidic [29].
4. Conclusion

Based on the results of the study showed that:

1. Based on the criteria for soil chemical properties, organic fertilizer content has the same quality in elements C, N, K, C/N (very high), pH neutral, and P was very low.

2. There was a difference in the effect of the type of material on the amount of organic fertilizer nutrient content.

3. The mixture of water hyacinth and corncob has a higher amount of nutrient content in several elements, namely C, N, K, C/N. Whereas organic fertilizer with a mixture of water hyacinth and soybean dregs has a higher amount of content in the element P.

5. Suggestions

1. More composting time is needed so that the C/N fertilizer approaches the C/N soil so that it can be used for fertilization.

2. Need to increase the concentrations of microbes so that the process of degradation of organic matter is faster.

3. Need additional concentration for the mixture of corncobs and tofu dregs (1:1).

4. Need the addition of other wastes that can enrich the potassium content.

6. References

[1] Penzi et al. 2015 Aplikasi Beberapa Dosis Tricho-Eceng Terhadap Pertumbuhan dan Produksi Tanaman Cabai (Capsicum annum L.) pada Medium Gambut. JOM Faperta vol. 2 pp 1-12

[2] Anggraini & Firiani 2018 Limbah Ampas Tahu sebagai Bahan Baku untuk Produksi Biodiesel. Jurnal Integrasi Proses vol. 7 pp 13-19

[3] Mawardi et al. 2019 Pelatihan Pemanfaatan Limbah Ampas Tahu sebagai Produk Pangan Layak Konsumsi di Desa Meurandeh Dayah, Jurnal Ilmiah Pengabdian Kepada Masyarakat vol. 1 pp 40-44

[4] Fitrihidajati et al. 2015 Kualitas Hasil Fermentasi pada Pembuatan Pakan Ternak Ruminansia Berbahan Baku Eceng Gondok (Eichornia crassipes). Biosaintifika: Journal of Biology & Biology Education vol. 7 pp 62-67

[5] Hardjowigeno 2003 Ilmu Tanah Jakarta: Pustaka Utama

[6] Wardhani & Rachmadiarti 2016 Pengaruh Pemberian Pupuk Organik Berbahan Eceng Gondok Terfermentasi dengan Berbagai Konsentrasi terhadap Pertumbuhan Tanaman Cabai Merah Varietas Gada MK Fl. LenteraBio vol. 7 pp 148-152

[7] Suhariyono & Menry 2005 Analisis Karakteristik Unsur-unsur dalam Tanah di Berbagai Lokasi dengan Menggunakan XRF Prosiding PPI – PDIPTN pp. 197–206

[8] Fitrihidajati H, Isnawati, Gatot S, and Evie R 2013 Pemanfaatan Eceng Gondok (Eichornia crassipes) untuk Pakan Ternak Ruminansia sebagai Salah Satu Cara Mengatasi Gulma Perairan Laporan Penelitian Hibah Bersaing:Kementerian Pendidikan dan Kebudayaan Unesa

[9] Moi et al. 2015 Pengujian Pupuk Organik Cair dari Eceng Gondok (Eichhornia crassipes) Terhadap Pertumbuhan Tanaman Sawi (Brassica juncea) J. MIPA UNSRAT Online vol. 4 pp 15-19

[10] Wahyono D E and Hardianto R 2004 Pemanfaatan Sumber Daya Pakan Lokal untuk Pengembangan Usaha Sapi Potong Lokakarya Nasional Sapi Potong pp 66–76

[11] Li B, Qiao M, Lu F 2012 Composition, Nutrition, and Utilization of Okara (Soybean Residue) Food Review International vol 28 pp 231–252

[12] Wasilah, Winarsih, Bashri A 2019 Pengaruh Pemberian Pupuk Organik Cair Berbahan Baku Limbah Sisa Makanan dengan Penambahan Berbagai Bahan Organik terhadap Pertumbuhan Tanaman Sawi (Brassica juncea L). LenteraBio vol. 8 pp 136-142

[13] Pulungan et al. 2014 Uji Efektivitas Trichoderma harzianum dengan Formula Granular Ragi Untuk Mengendalikan Penyakit Jamur Akar Putih (Rigidoporus microporus (Swartz:fr.) van Ov) pada Tanaman Karet di Pembibitan Jurnal Online Agroteknologi vol. 2 pp 497-512
[14] Wulandari et al. 2016 Kualitas Kompos dari Kombinasi Eceng Gondok (Echornia crassipes Mart. Solm) dan Pupuk Kandang Sapi dengan Inokulan Trichoerma harzianum L. J. Protobiont vol. 5 pp 34-44
[15] Yani et al. 2018 Kualitas Fisika dan Kimia Kompos Eceng Gondok (Euchornia crasipess) Menggunakan Aktivator EM-4 Jurnal Konversi vol. 7 pp 1-8
[16] Purnomo et al. 2017 Pengaruh Variasi C/N Rasio Terhadap Produksi Kompos Dan Kandungan Kalium (K), Pospit (P), Dari Batang Pisang Dengan Kombinasi Kotoran Sapi Dalam Sistem Vermicomposting Jurnal Teknik Lingkungan vol. 6 pp 1-15
[17] Indrawan et al. 2019 Efesiensi Penggunaan Pupuk Padat Limbah Rumput Laut Pada Tanaman Bekul Jurnal Emasains vol. 8 pp 170-185
[18] Widarti et al. 2015 Pengaruh Rasio C/N Bahan Baku pada Pembuatan Kompos Dari Kubis dengan Kulit Pisang Jurnal Integrasi Proses vol. 5 pp 75-80
[19] Lutfi & Hendrawan 2014 Analisis Pengaruh Waktu Pretreatment dan Konsentrasi NaOH terhadap Kandungan Selulosa, Lignin dan Hemiselulosa Eceng Gondok Pada Proses Pretreatment Pembuatan Bioetanol Jurnal Keteknikan Pertanian Tropis dan Biosistem vol 2 pp 110–116
[20] Quitain A T, Ora K, Katoh S, Moriyoshi T 2004 Environmentally Benign Pressurized Fluid Technologies for Recovery of Useful Compounds from Okara Research Institute for Solvothermal Technology vol 247 pp 1–8
[21] Bugg T D, Ahmad M, Hardiman E M, Singh R 2011 The Emerging Role for Bacteria in Lignin Degradation and Bio-product Formation Current Opinion in Biotechnology vol 22 pp 394–400
[22] Prabawa & Numilatani 2017 Analisis Kualitas Formula Pupuk Organik Pelet dari Eceng Gondok dan Tandan Kosong Kelapa Sawit Jurnal Riset Industri Hasil Hutan vol. 9 pp 17-28
[23] Surtinah 2013 Pengujian Kandungan Unsur Hara dalam Kompos yang Berasal dari Serasah tanaman Jagung Manis (Zea mays sassharta) Jurnal Ilmiah Pertanian vol. 11 pp 11-17
[24] Surya & Suyono 2013 Pengaruh Pengomposan Terhadap Rasio C/N Kotoran Ayam dan Kadar Hara NPK Tersedia serta Kapasitas Tukar Kation Tanah UNESA Journal of Chemistry vol. 2 pp 137-144
[25] Supadma A A N and Arthagama D M 2008 Uji Formulasi Kualitas Pupuk Kompos yang Bersumber dari Sampah Organik dengan Penambahan Limbah Ternak Ayam, Sapi, Bab, dan Tanaman Pahitan Jurnal Bumi Lestari vol 8 pp 113–121
[26] Trivana & Pradhana 2017 Optimalisasi Waktu Pengomposan dan Kualitas Pupuk Kandang dari Kotoran Kambing dan Debu Sabut Kelapa dengan Bioaktivator PROMI dan Orgadec Jurnal Sain Veteriner vol. 35 pp 136-144
[27] Suwatanti & Widiyaningrum 2017 Pemanfaatan MOL Limbah Sayur pada Proses Pembuatan Kompos Jurnal MIPA vol. 40 pp 1-6
[28] Sc et al. 2013 Efektivitas Jamur Trichoderma Harzianum dalam Pengomposan Limbah Sludge Fabrik Kertas Indonesian Journal of Chemical Science vol. 2
[29] Anif et al. 2007 Pemanfaatan Limbah Tomat sebagai Pengganti EM-4 pada Proses Pengomposan Sampah Organik Jurnal Penelitian Sains & Teknologi vol. 8 pp 119-143

Acknowledgement
The authors thank those who have helped in this research process so that this research can be completed and will be presented. The authors thank the Dean of FMIPA Unesa, Chair of the Department of Biology FMIPA Unesa, fellow lecturers, and the laboratory.