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Utilizing Cocoa Rind as Organic Fertilizer to Support Sustainable Agriculture

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ABSTRACT

The main key in choosing manure is the level of ripeness, the ratio of Carbon and Nitrogen (C/N) and the Nitrogen, Phosphorus, Potassium (NPPt) contents. So far, the farmers have not effectively utilized organic materials as fertilizers in agricultural lands. Organic materials which can be used include agricultural waste and animal waste. The existence of alternative fertilizers and in order to support the development of sustainable agriculture, utilizing agricultural waste as the materials to make organic fertilizers is encouraged. Organic fertilizers can be in the forms of manure, compost, and the combination of both. The research was aimed to study the NPPt content in compost from cocoa rind and cow waste. This research was done in May – September 2015 in Sub-district Luwuk, District Banggai and in the Laboratory of Chemistry and Soil Fertility, Department of Soil Science Faculty of Agriculture, Hasanuddin University, Makassar. The experiment was conducted in a Completely Randomized Design (CRD). The experiment contained one factor with three treatments, which were repeated 3 times; thus, there were 9 treatments units. The treatments were comparison dosages of cocoa rind and cow waste, i.e. P1 = 50 kg of cocoa rind : 10 kg of cow waste; P2 = 50 kg of cocoa rind : 20 kg cow of waste; P3 = 50 kg of cocoa rind : 30 kg of cow waste. Data were analysed by comparing the average of NPPt element in cocoa rind compost and cow waste. Data was then analyzed statistically by One Way Anova (One Way Variant Analysis) by using SPSS 19.0 for Windows and further analyzed by Least Significant Difference (LSD) 1% by using Microsoft Excel Windows 7. The results showed that the highest macro nutrients content was in P2 with N = 0.25%; P = 3.91%; K = 5.23% and the lowest was in P3 with N = 0.19% and P = 3.33% as well as in P1 with K = 4.16%.

Keywords: Agricultural waste, cow waste, compost

ABSTRAK

Selama ini para petani belum banyak memanfaatkan bahan organik sebagai pupuk dilahan pertanian. Salah satu contoh bahan organik yang digunakan antara lain limbah pertanian dan kotoran hewan. Dengan munculnya berbagai pupuk alternatif dan untuk menunjang pembangunan pertanian yang berkelanjutan, maka digalakan pemanfaatan limbah pertanian sebagai bahan pembuatan pupuk organik. Pupuk organik dapat berupa pupuk kandang, kompos dan campuran keduanya. Kunci pokok dalam pemilihan pupuk kandang adalah tingkat kematangan, perbandingan Carbon dan Nitrogen (C/N) dan kandungan NPK. Tujuan dari penelitian untuk mengetahui kandungan NPK pada kompos dari limbah kulit buah kakao dengan kotoran sapi. Penelitian ini dilaksanakan pada bulan Mei-September 2015 dengan lokasi penelitian di Kecamatan Luwuk Kabupaten Banggai dan Laboratorium Kimia dan Kesuburan Tanah Jurusan Ilmu Tanah Fakultas Pertanian Universitas Hasanuddin Makassar. Rancangan percobaan yang digunakan adalah Rancangan Acak Lengkap (RAL). Percobaan terdiri dari satu faktor dengan 3 perlakuan, masing-masing diulang sebanyak 3 kali, maka ada 9 unit perlakuan. Dalam penelitian ini menggunakan perbandingan, yaitu P1 = 50 kg limbah kulit buah kakao : 10 kg kotoran sapi; P2 = 50 kg limbah kulit buah kakao : 20 kg kotoran sapi; P3 = 50 kg limbah kulit buah kakao : 30 kg kotoran sapi. Analisis data dalam penelitian ini dilakukan dengan cara membandingkan rata-rata unsur NPK pada kompos limbah kulit buah kakao dengan kotoran sapi. Pada masing-masing perlakuan yang diperoleh dari laboratorium kemudian data tersebut dianalisis secara statistik dengan *One Way Anova* (Analisis Varian Satu Arah) dengan SPSS 19.0 *for Windows* dan Uji lanjut BNT 1 % dengan menggunakan *Microsoft Ecxel Windows 7.* Berdasarkan hasil uji laboratorium menunjukkan bahwa kandungan unsur hara makro pada penelitian ini adalah dari ketiga perlakuan menghasilkan jumlah rata-rata unsur NPK yang tertinggi yaitu pada

perlakuan P2 yaitu N = 0,25%; P = 3,91%; K = 5,23% dan yang terendah yaitu pada perlakuan P3 untuk unsur N dan P yaitu 0,19% dan 3,33% serta perlakuan untuk unsur K yaitu 4,16%.

Kata Kunci : Kotoran sapi, kompos, limbah pertanian

INTRODUCTION

So far the farmers have not effectively utilized organic materials as fertilizers in agricultural lands. Most of organic materials used are animal waste (cow, goats, chickens, and many more) and agricultural waste. In order to create alternative fertilizers and to support the development of eco-friendly agriculture, utilizing agricultural waste as the source of organic fertilizers is encouraged. Nowadays, there are many brands of organic fertilizer in the market. Organic fertilizer can be in the form of manure, compost, and the combination of both. The main keys in choosing the manures are the level of ripeness, the ratio of Carbon and Nitrogen (C/N), and the content of nutrients.

Waste is a part of either agricultural or industry product in which its management is necessary. If it is not managed wisely, the agricultural waste often becomes the media of pest and disease proliferation and the cause of air pollution in the form of methane (CH_4), Carbon dioxide, and Nitro oxide. Waste is the remaining material which is thrown away from humans' activities or natural processes. It either has or does not have economical value; however it can develop negative effects. The intended negative effects are the disposal process and the cleaning which need expense and can cause environmental pollution. Generally, waste is in the form of solid, liquid, and gas. Solid waste can be a big problem if it is left unhandled (Djaja 2008).

There are many kinds of waste such as urban waste, household waste, and agricultural waste. Agricultural waste itself includes all the unused products of agricultural processes which have no economical value. Types of plants which contributes the biggest biomass are: Sugar cane (40 tons, 92% waste), Rice (10 tons, 80% waste), Corn (15 tons = 70% waste), Cocoa (92% = 6 tons of rind waste/ ha), Palm oil (96.5%) and vegetables (60%). One of the ways to utilize agricultural waste is by making them as manure, as well as cocoa rind. The cocoa rind is one of plantation waste. If it is not utilized, it can cause great problem in surrounding environment of the plantation. One of the ways to utilize cocoa rind is by making it as compost which can be used as organic fertilizer (Goenadi 1997).

Organic fertilizer which is used comes from the utilization of cocoa rind and cow waste which were firstly composted by using activator Em-4. According to Spillane (1995) cocoa rind can be used as the source of nutrients for plants in the form of compost, cattle fodder, producing biogas, and source of pectin. As organic material, cocoa rind has the composition of nutrients and compound which are very potential to be used as the plants' growing media. The water content of Lindak cacao is around 86% and the level of its organic material is around 55.7%. According to Darmono and Tri Panji (1999), large amount of cocoa rind waste can be a problem if it is not handled wisely. The production of this solid waste can reach up to 60% from the total of fruit production.

According to the former study done by Rosniawaty (2005), compost from cocoa rind possesses pH 5.4 from total N of 1.30%, C organic 33.71%, P_2O_5 0.186$, K_2O 5.5%, CaO 0.23%, and MgO 0.59%. Up to now, there are not many individuals or industries which utilize cocoa rind as the organic materials for fertilizer. Generally, the most used organic materials are animal wastes such as cow waste and goat waste. A good fertilizer is the one who can improve the growth and the development of plants that the high productivity can be obtained without neglecting the awareness towards the environment (Widyotomo *et al*. 2004). Furthermore, in accordance with Nurhayati and Salim (2002), it is explained that giving fermented fertilizer made of cocoa rind with the dosage of 25 tons ha^{-1} can increase the growth of sweet corns. The development can be seen from the height of the plants, the corn cob wrap, and the number of rows per corn cob.

From the explanation above and based on the literatures about the chemical substance in cocoa rind and cow waste, we are, therefore, interested in conducting a research with the title "Utilizing Cocoa Rind as Organic Fertilizer to Support Sustainable Agriculture".

The purpose of this research is to figure out the NPPK content in compost which is made of the mixture of cocoa rind and cow waste.

MATERIALS AND METHODS

Time and Venue

This research was conducted from May until September 2015. The location is in Sub-district Luwuk, District Banggai and Laboratory of

Chemistry and Soil Fertility, Departement o Soil Science Faculty of Agriculture, Hasanuddin University, Makassar.

Tools and Materials

The tools which are used include: bags, cutter, scale, bucket, thermometer, and tarpaulins for composting. The materials which are used include cocoa rind, cow waste, sugar, water, and EM4.

Composting Processes

Organic compost was made by cocoa sheet and cow waste. The compost materials were mixed with EM4 and sugar water and piled sheet by sheet. The compost materials were then closed by using tarpaulins for approximately 1 month and then the NPPKcontents were analyzed.

Data Collecting Methodology

The type of this research was experimental one, which means that this research was systematic, logic, and thorough in doing the control towards the existing conditions. Experimental research is the type of research which is used in order to find the influence of certain treatments towards others in controlled conditions (Sugiyono 2008). Independent variables in this research were the treatments of comparison between the composition of cocoa rind and cow waste. Meanwhile, the dependent variable were the NPPK contents.

Data Analysis

The experiment was designed in a Completely Randomized Design (CRD). The experiment contained of one factor with three treatments, with each of the treatments was repeated 3 times; thus, there were 9 treatment units. The treatments were:
P1 = 50 kg of cocoa rind : 10 kg of cow waste;
P2 = 50 kg of cocoa rind : 20 kg cow of waste;
P3 = 50 kg of cocoa rind : 30 kg of cow waste.

Data analysis in this research is done by comparing the average of NPPK element in cocoa rind compost and cow waste. Each data of actions obtained from the laboratory is then analyzed statistically by One Way Anova (One Way Variant Analysis) by using SPSS 19.0 for Windows.

RESULTS AND DISCUSSION

Physical Characteristics of Compost

During composting, observation towards compost was done weekly. The temperature of the compost increased in the first week and decreased approaching the room temperature in the next weeks. The change of temperature during the process of composting is presented in figure 1.

Based on Figure 2, it is explained that after inversion in the first week up to the inversion in the next week, the temperature of the compost decreased slowly from 30^{0}C to 24^{0}C. The phenomenon might caused by the process of decomposing which had not been prevalent to the whole parts of the compost and because the process of composting was done during the rainy season.

The temperature influences the types of microorganism living in one media. The temperature of composting reached around 24-30^{0}C and it continued optimally up to the 30th day. According to Ruskandi (2006), there are two phases in the process of aerobic composting; mesophilic phase 23-45^{0}C and thermophilic phase 45-65^{0}C. The range of ideal temperature of compost is 55-65^{0}C. Between those temperatures, the proliferation of microorganism reaches its best stage which also produces best population as well. Moreover, the produced enzyme which is used to decompose organic materials reaches its most effective ability.

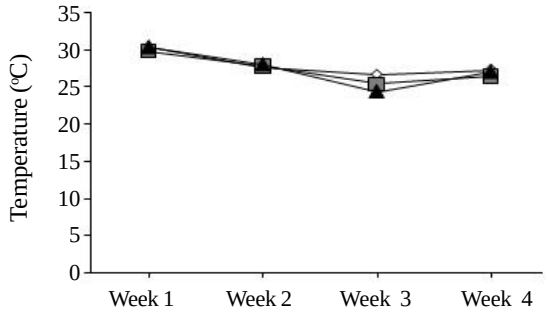

Figure 1. Change of temperature during the composting process.

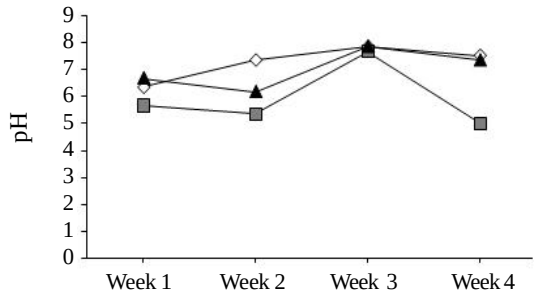

Figure 2. Change of pH during the composting process.

Change of pH

During the process of composting, inversion of the compost was done weekly. pH of the compost increased in the first week and reached the neutral pH. The data of pH measurement during the process of composting is presented in Figure 2.

Based on Figure 2, it is explained that the inversion in the first week up to the next weeks made the pH of the compost slowly increased until it reached the neutral pH. This phenomenon might caused by giving a good aeration during the process of composting. Stirring the materials can also keep the pH value in neutral condition. The process of composting itself causes the change in organic materials and its pH itself. As an example, the releasing process of acid, temporarily or locally, will cause the decreasing of pH (acidification). Meanwhile, the production of ammonia from the nitrogen-containing compounds will increase pH in the early phases of composting process. The ripe compost usually has pH value which approaches neutral (Cahyani and Pramudya 2013). The degree of acid or pH in the early decomposition falls down because some certain microbes of the organic waste turn into organic acid. However, in the next process, other types of microbes use organic acid that can cause the increasing of pH.

The average of pH changes shows the increasing of pH in each treatment. In accordance with Ruskandi (2006), pH which contains more alkali will produce malodorous ammonia. pH which contains either more alkali or more acid will produce smell, and the smell will draw flies. In this process, it is predicted that the biological activities will be decreased, nitrogen will be worn out, and some of the microorganisms will die. The average of last pH in the process of decomposing waste in all actions was around pH 5.00 – 7.83. According to Hadisumarno (1992), the ideal pH of aerobic decomposing is between 6.0 – 8.0, because in that particular degree, microbes can grow and do their activities in decomposing organic materials.

Nutrient Contents in Compost

The NPPK nutrient contents in organic compost made from different formulation of cocoa rind and cow waste, can be seen on Table 1. It can be seen that the NPPK nutrient contents in the compost made of cocoa rind and cow waste have exceeded the minimum value of Compost Quality Standard (SNI 19-7030-2004). P content reached 3.91%, while according to SNI, the minimum value is 0.10%; and K content reached 5.23%, while according to SNI, the minimum value is 0.20%. However, N content has not fulfilled the standard, which merely reached 0.25%, while according to SNI, the minimum value is 0.40%. According to Soedarsono *et al* (1997) and Didiek and Away 2004, the water level and organic materials in cacao rind is around 86%, with pH of 5.4, total N 1.30%, C organic 33.71%, P_{205} 0.186%, K_20 5.5%, CaO 0.23%, and MgO 0.59%.

Nitrogen Content (N)

Nitrogen (N) is functioned to stimulate the overall growth of plants, also for amino acid synthesis and the proteins in plants. It is also useful for stimulating the vegetative growth (leaf pigments and size) and the vegetative growth of stem (height and size of stem) (Kloepper 1993).

The result of the research showed that N content in all treatments has not reached SNI. However, it can still be used as fertilizer for plants, because the value is still closed to the SNI value. It is supposed that lacking of N content in this research is caused by the leaching process. In other words, the N content is carried away by the water.

Nitrogen is one of the nutrients which has negative charge in the form of NO_3^- and positive charge in the form of NH_4^+. Besides being absolutely necessary, nitrogen can be easily disappear or become unavailable for plants. The unavailability of nitrogen in soil can be caused by leaching process NO_3^-, denitrification of NO_3^- into N_2, volatilization NH_4^+ into NH_3 (Mukhlis and Fauzi 2003). According

Table 1. NPPK nutrient contents in compost made of cocoa rind and cow waste.

No	Description	N (%)	P (%)	K (%)
1	P1 (50 : 10)	0.24	3.40	4.16
2	P2 (50 : 20)	0.25	3.91	5.23
3	P3 (50 : 30)	0.19	3.33	5.16
4	Standard Quality Compost	0.40	0.10	0.20

Source: Laboratory of Chemistry and Soil Fertility Soil Science Department, Faculty of Agriculture, Hasanuddin University; SNI 19-7030-2004 (National Standardization Agency 2004). After being processed, 2015.

to Suriadikarta and Adimihardja (2001), the loss of nitrogen in the form of ammonium (NH_4^+) can be happened because of being carried away by water or due to the evaporation which turns it into ammonia gas (NH_3) (Anonim 2007).

Lacking of N content can cause stunted growth, leaf yellowing, and limited root system. If the stock of N content from the root is not enough, N in leaves will age and be mobilized in order to fulfill the need of young plant's organs. Lacking of N content in cereals plants such as corn is characterized by bad rooting and the decreasing of the number of corn cob per unit area and the number of seed per corn cob (Munawar 2011).

Phosphore Content (P)

Phosphate (P) is functioned as the energy carrier from metabolism process in plants, stimulator of flowering and fruiting, stimulator of root growth, stimulator of seed formation, and stimulator of cell division and tissue enlargement (Kloepper 1993).

The result of the research shows that the P content in compost made from cocoa rind with cow waste from all treatments has been able to be used as fertilizer for plants. It is due to the fact that the P content has been able to fulfill the need of the plants. This is based on the standardized by BSNI, which states that P content in organic compost needs to be above the standard minimum total. The P content in this compost can be used in plants because by the fulfillment of P content in plants, the root growth will be accelerated. By accelerating and strengthening the growth of mature plants generally, the body of the plants will not easily fall. P content in plants was around 0.15% - 1.00% of most plants' dry weight, with the adequante value of 0.20% - 0.40% in the tissue of newly ripe leaves (Jones 1998).

The stock of adequate P content causes the increasing of root growth that the nutrients and water can be absorbed well. Therefore, the function of P content is very important for the growth and metabolism of plants. Lacking of P contents will slow the cell division and development, respiration, and photosynthesis (Marschner 1986 and Havlin *et al.* 2005).

Table 2. Effect of compost treatment on Pt content.

Treatment	K content	Notation
P1	4.16	a
P2	5.23	b
P3	5.16	b
BNT 1 %	0.93	

Source: Primary Data After Being Processed, 2015.

Potassium Content (K)

Potassium (K) is functioned in the process of photosynthesis, carrying assimilation results, enzyme and minerals including water; increasing the immune of plants against diseases; increasing the cation exchange capacity (CEC) of the soil; and forming complex compounds with metal ion that can poisons the plants such as aluminum, iron, and manganese (Kloepper 1993). The result of BNT test 1% by using Microsoft Excel Windows 2 is presented in Table 2.

It can be seen from Table 2 that P1 is different from P2 and P3. The result of the research shows that the K content in compost made of cocoa rind and cow waste in all treatments were able to be used as fertilizers for plants. It is because the K content has fulfilled the need of the plants. This is based on the BSNI standard, which means that the K content in organic compost needs to be above the standard minimum total. K content in the result of this research can be used for plants because the adequate K content can prevent the shrinkage and folding of the leaves in potato plants. It can also keep the pigments of the leaves in dark green and prevent the yellowing and the

Table 3. One way anova using SPSS 19.0 for windows.

		Sum of Squares	df	Mean Square	F	Sig
Phosphore	Between Groups	.610	2	.305	1.754	.251
	Within Groups	1.044	6	.174		
	Total	1.654	8			
Potassium	Between Groups	2.142	2	1.071	11.179	.009
	Within Groups	.575	6	.096		
	Total	2.717	8			
Nitrogen	Between Groups	.006	2	.003	1.644	.270
	Within Groups	.011	6	.002		
	Total	.017	8			

appearance of brown spots. It can also be used in orange plants in order to prevent the unripe fruits from falling and make sure that the K content need is fulfilled.

For optimal growth of plants, the K content in plants is around 2-3% dry weight (Havlin *et al.* 2005). K content plays the role in biochemical process and physiology which is very vital for the growth and production of plants, also in their resistance against stress (Marschner 1986).

Statistical Test

After obtaining the analytical result of NPPK content in compost made of cocoa rind and cow waste in the laboratory, the further data is statistically analyzed with One Way Anova by using SPSS 19.0 as presented in Table 3. The statistical analysis shows that the significant result is taken by observing the probability columns from table One Way Anova. The significance of P = 0.251; K = 0.009; N = 0.270 and according to provision a = 0.05 and the analytical result is P= 0.251> 0.05; K= 0.009< 0.05; and N= 0.270> 0.05.

From the analytical result using One Way Anova, it is shown that the significance level of NPPK is bigger than 0.005 with the significance total (N = 0.270; P = 0.251; K = 0.009). If the probability is > 0.05, then Ho is accepted; and if the probability is < 0.05, then Ho is rejected.

The comparison of F arithmetic and F Table is explained below: (1) P = The probability is > 0.05, then Ho is accepted = 0.251 > 0.05, then Ho is accepted. It means that the three treatments of cocoa rind with cow waste gives imaginary influence towards Phosphor content. (2) K = The probability is > 0.05, then Ho is accepted = 0.009 < 0.05, then Ha is not accepted. It means that the three treatments of cocoa rind with cow waste gives real influence towards Potassium content. (3) N = The probability is > 0.05, then Ho is accepted = 0.270 > 0.05, then Ho is accepted. It means that the three treatments of cocoa rind with cow waste gives imaginary influence towards Nitrogen content.

CONCLUSIONS

Based on the result of laboratory testing, it is shown that the macro nutrient content in this research is from the three treatments which results in the highest average of NPPK content in P2 treatment in which the N = 0.25 %;P = 3.91 %; K = 5.23 %. Furthermore, the lowest average is in P3 treatment for N and P contents, which is 0.19% and 3.33% and P1 treatment with K content of 4.16%.

After reviewing the conclusion above, this research suggests that: (a) The use of waste around, either household or agricultural waste, is needed to be managed. (b) Making organic compost from cocoa rind and cow waste is better to be done by using the comparison 50 : 20. (c) The further research is needed to be done in order to study the application of flowering (*Saccarum edule* Hasskarl).

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