

Production and Characterization of Organic Fertilizer from Tubang-Bakod (*Jatropha curcas*) Seed Cake and Chicken Manure

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Abstract –The processing of *Jatropha curcas* (tubang-bakod) to produce biodiesel entails wastes in the form of seedcake which can be converted into valuable product that can help nurture and improve soil properties. The College of Industrial Technology and the Chemical Engineering Department of Batangas State University (BatstateU) conducted an experimental study which includes the composting of the combination of *Jatropha* Seed-Cake(JSC) and Chicken Manure(CM) , formulating ratios of JSC and CM and characterization of the organic fertilizer produced. Generally, this study aimed to promote proper waste disposal by producing an organic fertilizer from the waste of biodiesel production which uses *Jatropha* plant and proving the feasibility of making the fertilizer as the main source of nutrient for plants. Specifically, the nutrients that were considered were Nitrogen (N), Phosphorus (P), Potassium (K) and the Carbon: Nitrogen (C:N) ratio. Composting lasted for 6 weeks, three formulations were used, 30(CM):70(JSC), 50(CM):50(JSC) and 70(CM):30(JSC). The result implies that theorganic fertilizers produced can be a good substitute to the commercially available fertilizers.

Keywords –composting, C: N ratio, *Jatropha* seedcake, organic fertilizer, plant nutrients

INTRODUCTION

In agricultural productivity, fertile soil is the basis for crop production because it is where the nutrients vital for the growth of plants come from. Through the correct use of fertilizer, soil fertility and agricultural productivity can be improved, restored and maintained.

Several factors contribute to the continuous decline in agricultural production nowadays. In the Philippines for instance, 13.5 million hectares or 45% of the total arable lands is affected by soil erosion and about 12 million hectares or 40.8% of the total land area is affected by low fertility. The most common deficient nutrients are nitrogen, phosphorus, potassium, sulphur and zinc as indicated in the National Academy of Science and Technology-Philippine Council for Agriculture, Forestry and Natural Resources Research and Development NAST-PCARRD Industry Strategic Plan for Environment Services [1]. With these figures, there is an urgent need to find ways and means to abate such problems.

Among the common practice in improving soil fertility is the application of fertilizer of different levels of Nitrogen (N), Phosphorus (P) and Potassium (K), which improves vegetable production. Aside from chemical fertilizers, organic substrate such as animal manure and green manure are considered good potential source of macronutrients and micronutrients for the plants. Chatuverdi [2] reported the relatively high NPK content of *Jatropha curcas* seed cake besides sufficient organic matter content. Moreover, the addition of the composted organic wastes improves availability of calcium as well as key micronutrients such as iron, copper, and manganese in the soil.

Jatropha curcas is a drought-resistant perennial, growing well in marginal or poor soil. The *Jatropha curcas* seed cake which is the waste by-product of the biodiesel transesterification process can be used as a rich organic fertilizer as reported in the study of Srinophakun et al. [3]. Though *Jatropha curcas* is known to contain phorbol esters, a toxic chemical to human and animals, the study of Devappa, Makkarand Becker proved that no residue

of toxin is found on the soil as well as in the fruit of tomato, Chinese kale leaves and sweet potato tuber planted using organic fertilizer from *Jatropha* seedcake [4].

In the production of biodiesel from *Jatropha curcas*, about 3 kilograms of waste seed cake is produced [3]. Upon investigation by Kumar and Schuma, the *Jatropha* seed cake is reported to contain 3.2-4.55 Nitrogen, 1.4-2.1% Phosphorus and 1.2-1.7% Potassium [5]. These values are much higher than the NPK values of chicken or cow manure [6]. This led the researcher to investigate the characteristics of the organic fertilizer produced from composting *Jatropha curcas* seed cake and chicken manure.

The result of this study intends to benefit the agricultural sector of the country by providing other source of nutrients for the soil along with valuing the *Jatropha* seedcake waste material. Various sectors, such as the academe, government agencies and local farmers may utilize the results of this study in further studies or researches, in plan and policy formulations and actual farming practice as well.

Table 1. Comparison of N, P and K contents in *Jatropha curcas* seed- cake with other Organic Fertilizers

Fertilizer	Nitrogen (%)	Phosphorus (%)	Potassium (%)
<i>Jatropha curcas</i> seed-cake	4.44	2.09	1.68
Cow-manure	0.97	0.69	1.66
Chicken manure	3.04	6.27	2.08
Duck manure	2.37	2.10	1.09
Compost of raw straw	0.81	0.18	0.68
Compost of water hyacinth	1.48	0.46	0.48
Compost of municipal wastes	1.25	0.25	0.65
Karanj-oil cake	4.00	1.00	1.00
Neem-oil cake	5.00	1.00	1.50

Source: <http://agritech.tnau.ac.in>[7]

Table 1 shows the NPK contents of some known organic fertilizers as compared to the NPK contents of *Jatropha curcas* seedcake. The *Jatropha* seedcake and chicken manure have the highest NPK values among others.

OBJECTIVES OF THE STUDY

This study aimed to produce and characterize the organic fertilizer from the *Jatropha* seed cake composted with chicken manure. Specifically, it

sought to answer the following questions:(1). What are the characteristics of *Jatropha* seed cake in terms of Nitrogen(N), Phosphorus(P), Potassium(K)?(2) What are the NPK values and C:N ratios of the *Jatropha* Seed Cake(JSC) and chicken manure(CM) fertilizers having the following formulations: (70:30, 50:50, 30:70)?(3). How do the above formulations of the produced fertilizers compare in terms of NPK and C: N ratio?

MATERIALS AND METHODS

The project involved two phases described as follows:

Phase I. Production of the Organic Fertilizer Site Selection

The composting site used was shaded, well drained and near a source of water. The site was located in Tabangao Dao, Batangas City.

The *Jatropha* seed cake was composted in a space measuring 1.5 ft by 1.5 ft by 3 ft. A total of 5 compost pits were prepared for the treatments. The ratios of *Jatropha* seed cake to the chicken manure are as follows: (a).100:0, (b). 70:30, (c).50:50, (d).30:70, (e). 0:100

Material Gathering and Preparation

Jatropha curcas seed cake, as waste material from the research conducted by Agena, et. al.[8]were utilized in this study. The collected seed cake was packed for travelling and brought to Tabangao Dao, Batangas City.

The chicken manure which served as the stabilizer for the *Jatropha* seed cake was taken from a poultry farm in San Pascual, Batangas.

Piling of Materials

The materials were mixed in the compost site. The ratio of the percentage composition of *Jatropha* seed cake to chicken manure in the mixture were 100:0, 70-30, 50-50, 30-70, and 0:100.

The table 2 shows the weight of the *Jatropha* seed cake and chicken manure comprising the different fertilizer formulations.

The mixed materials were piled in the prepared compost site and were moistened to about 60% moisture. The composts were covered with laminated plastic sacksfor 4 weeks to increase the temperature, maintain moisture and minimize the escape of gases to the atmosphere.

Table 2. Weight Composition of the Fertilizer Formulations

Fertilizer Formulations	Jatropha Seed Cake (weight in kg)	Chicken Manure(weight in kg)
100 JSC – 0 CM	6.0	0.0
0 JSC - 100 CM	0.0	6.0
50 JSC - 50 CM	3.0	3.0
70 JSC - 30 CM	4.2	1.8
30 JSC - 70 CM	1.8	4.2

Since it is difficult to measure moisture, a general rule of thumb was to use the "squeeze test". Squeezing a handful of material should have the moisture content of a well wrung sponge. Material should feel damp to the touch, with just a drop or two of liquid expelled when squeezed in the hand.

Mixing and Turning Over

After four weeks, the compost was turned and mixed thoroughly and water was again added on each pit. Then, the cover was placed again and the compost was incubated for two more weeks. Ripe compost exhibited dark brown to black color, and with no offensive smell.

Harvesting, Sieving, and Further Processing

After six weeks, the compost was then spread in a drying area and was allowed to dry for one week. The fertilizer was screened through a manual sieve with 20 millimeter mesh. The fertilizer was then packed.

Phase II. Characterization and Analysis of the Organic Fertilizer

Determination of Macronutrients Content (%NPK), Micronutrients Content (%Ca, %Mg), and Carbon to Nitrogen (C:N) ratio. Samples of the five fertilizer formulations were brought to Lipa Quality Control Center for analysis. Tests were based on the AOAC Official Methods of Analysis, 17th edition, 2002.

One-way Analysis of Variance (ANOVA) was utilized in determining the validity of the differences in the chemical properties of the five fertilizer formulations produced.

RESULTS AND DISCUSSION

Table 3.NPK Content of Jatropha Seed Cake

Parameter	Results
% Nitrogen	3.61
% Phosphorus	0.72
% Potassium	1.89

The %Nitrogen, %Phosphorus, and %Potassium content of the jatropha seed cake were 3.61, 0.72 and 1.89 respectively as shown in table 3. The values obtained for Nitrogen and Potassium ascertained the findings of Kumar and Shuma [5], while for Phosphorus the findings was higher than those found in the literature. This must be due to the mixture formulation of Jatropha seedcake with chicken manure which has high amount of Phosphorus.

Table 4.Properties of the Produced Organic Fertilizer

Parameter	Fertilizer Formulations		
	50 JSC – 50 CM	70 JSC – 30 CM	30 JSC – 70 CM
% Phosphorus	0.05	0.05	0.03
% Potassium	0.48	0.47	0.51
C:N Ratio	48:1	50:1	39:1

Table 4 presents the results of the analyses made on the three formulations of fertilizers, as to varying the ratio of Jatropha seed cake (JSC) and chicken manure (CM). Understanding N-P-K ratings on plant fertilizers is an important part on deciding whether or not fertilizers are appropriate for the soil and necessary for the plants. Nitrogen promotes growth of stems and foliage. All-leaf produce such as cabbages and lettuce will benefit from fertilizers with high nitrogen content to have best-tasting leaves. Phosphorous aids healthy root systems. It is useful for plants from cucumber family, peppers and tomatoes. Potassium promotes fruit formation and flowering.[9]. It also gives the plant ability to resist diseases.

Application rates depend on the nutrient need of the soil and the percent of nutrients in the specific fertilizer. From the results of the soil tests, the N-P-K content/ratio of the soil is 3:1:2. The formulations however exhibited higher ratios. The 70 JSC – 30 CM NPK ratio is 7:1:9.4, the 50 JSC – 50 CM with 7:1:9.6 and the 30 JSC – 70 CM with the ratio of 8:1:17. The two preceding formulations exhibited good results but still, the three formulations were utilized in vegetable production for more comparison.

Fertilizers typically provide, in varying proportions six macronutrients- nitrogen (N), phosphorus(P), potassium(K), calcium(Ca), magnesium(Mg),and sulfur (S). Calcium enhances crop quality, enhances cell wall strength, improves water management. Fertilizers typically provide, in varying proportions six macronutrients- nitrogen(N), phosphorus (P), potassium(K), calcium(Ca),

magnesium(Mg), and sulfur(S). Calcium enhances crop quality, enhances cell wall strength, improves water management, improves post harvest storage ability of fruit and vegetables, and enhances tolerance to fungi infection and resistance to stress conditions [10]. From the produced fertilizers, the 50 JSC – 50 CM and 70 JSC – 30 CM formulations exhibited good results. Magnesium, on the other hand inhibits uptake of N-NH₄ (ammonium form), improves transfer of energy within the plant and controls protein synthesis and cell structure. From the analyses, the 50 JSC – 50 CM and 30 JSC – 70 CM formulations exhibited good results.

Meanwhile, the C:N ratio results did not fall within the ideal C:N ratio recommended for composts, which is 30:1. Results showed that all the formulations exhibits high C:N ratio. Higher ratios mean that there is not sufficient nitrogen for optimal growth of the microbial populations. For the pH results, all the formulations except the 100 JSC – 0 CM are within the pH range advisable for composts, which is 5.5 to 8.5.

Table 5. Difference on the Chemical Properties of the Fertilizers Produced

Chemical properties	p-values	Computed f-ratio	Decision on Ho	Verbal Interpretation
Nitrogen	.01	5.79	Reject	Significant
Phosphorus	.007	7.18	Reject	Significant
Potassium	.23	1.71	Failed to Reject	Not Significant
Carbon	.001	14.60	Reject	Significant

Using One-Way Analysis of Variance (ANOVA), the three formulations were compared for the difference in their individual chemical properties. In table 5, it was revealed that the three formulations of fertilizers have p-value of 0.01, f-ratio of 5.79 in terms of nitrogen. It implies that the amount of nitrogen in the three formulations is significantly different from each other. In terms of Phosphorus, a p-value of 0.007 and f-ratio of 7.18 was generated, which shows statistically significant difference. Meanwhile, in terms of Potassium, the p-value of 0.23, f-ratio of 1.71, were obtained indicated no significant difference among the formulations.

CONCLUSION AND RECOMMENDATIONS

The nutrient content of the Jatropha seedcake namely nitrogen, phosphorus and potassium are

among the most important factor for the growth and development of a plant. Upon analysis of the data for each formulation, it was observed that %Nitrogen and % Potassium of the organic fertilizer obtained from Jatropha seedcake and chicken manure are within the desired value. The phosphorus level on the other hand is above the literature value.

Among the five formulations, the 70JSC-30CM gave the ideal NPK values for the soil. Nevertheless, in fertilizer application, the properties of soil must be considered and should be well-matched with the fertilizer to be applied in order to achieve the best result on the plant. On the other hand, the ideal C: N ratio for fertilizers is 30:1, all the formulations gave high values of C: N ratio which reflect that there is insufficient amount of nitrogen that is necessary for optimal growth of the microbial populations.

It is recommended to evaluate the efficacy of the organic fertilizer produced by applying it to plants or crops. That related research be made utilizing other stabilizers for the Jatropha seed cake complementing the properties of the seed cake in order to produce an equally effective or even more effective organic fertilizer.

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