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Rapid composting of rice husks with chicken bones to produce compost rich with calcium and the effect of product compost in the increase of soil pH value

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ABSTRACT

Compost production is considered an economic and environmentally friendly means to reduce the waste going into landfill. It is a novel study of compost production from raw materials which are available in Malaysia, especially the northern region to get a high percentage of carbon and calcium to be used in the treatment of soils that suffering from leached very high amounts of calcium and magnesium because heavy precipitation particularly in the tropical soils. Compost application can improve soil quality and productivity as well as sustainability of agricultural production by replenishing soil organic matter and supplying nutrients. The results indicated an increase in ratio of calcium, also increase ratio of nitrogen and pH.

Keywords:

Compost production, rice husks, chicken bones, calcium, pH

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Introduction

Rice husk (RH) has a number of names, the most common being husk, hull, and chaff. RH is a by-product in rice milling process, global production of this RH is approximately 150 million tonnes per annum [1]. These amount being produced in more than 75 countries around the world [2]. The RH are usually dumped in the open thereby maybe impacting negatively of the environment without any economic benefits. While led application of RH to significantly increased soil organic carbon, that rate of RH application significantly increased soil organic carbon content for the first three months, also led to increased calcium concentration but was not statistically significant [3]. RH posses both organic and inorganic components. The organic components includes crude protein, carbohydrates, lipid, lignin, vitamins and organic acids [4]. The inorganic constituents having ash as the major component which is between 13.2 to 29.0% of the weight of rice husk [5].

Calcium is one of the essential nutrients for growth and development of plants. It is an important component of various structures in cell wall and membranes [6]. The loss of calcium lead further reduce the soil fertility and consequently decreased crop production. Soil texture, soil reaction (pH) and original nutrient status are important factors affecting the leaching behavior of nutrient cations (K^+ , Ca^{+2} and Mg^{+2}) in the tropical soils [7]. The presence of calcium in the agriculture soils is very important for the proper growth of the crop plants.

Compost application can help improve the soil nutrient levels and its health, also reduce pathogen attacks, as well as that the compost application is also an environmentally friendly alternative to chemical use, which is the most common approach in agriculture today [8]. Composts usually be rich in plant nutrients, is a readily available fertilizer with beneficial effects on physical, chemical, biochemical and biological properties of the soils. Moreover treatments of compost stimulate an enhanced plant physiological status with improvements in quantity and quality of crop productions [9]. The addition of compost can also increase the levels of organic matter and improve soil porosity, structural stability, and moisture, as well as biological activity [10].

Experimental Material

A circular bin be made using fencing from the wires woven contain holes (5×5 cm). The bin should be about (100 cm) in diameter and at least (150 cm) high. This bin gives the stent to the internal bin which is same diameter and high just the difference in the size of the holes (0.1×0.1 cm) to maintain the rice husk from the collapse outside the bin because it's size very small (figure. 1). With this design, to maintain the shape of the pile and facilitate adding water, also it is easy to turn the composting material by open the bin and moving it a few feet, and turning the compost back into it.

The study was conducted with three replications at the The study was conducted with three replications at the Agro technology Research Station, University Malaysia Perlis Padang Besar, Perlis, Malaysia. The used of certain raw materials available in Perlis such as rice husks that have been obtained from the rice mills. The purpose of the use is to get a high percentage of carbon (table 1), as well as to get the right amount of material to get to the appropriate height to the compost pile for such a method to production of compost. Bones of cooked chicken are obtained from KFC restaurants available all over Malaysia. The purpose is to get the calcium, where that chicken bones containing a high ratio of calcium (Table 2). As well as used of a small amount of rice straw as a source of carbon and the use of chicken manure and green waste as a source of nitrogen in the pile.

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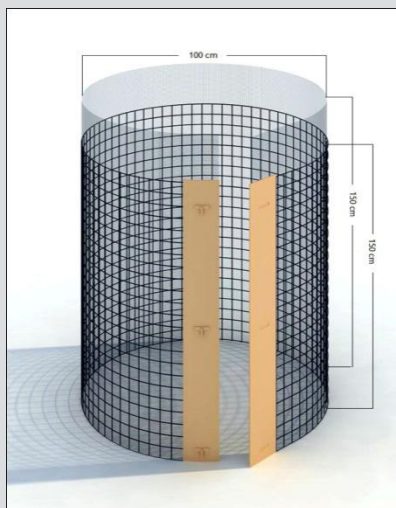


Figure 1. Cylindrical bin

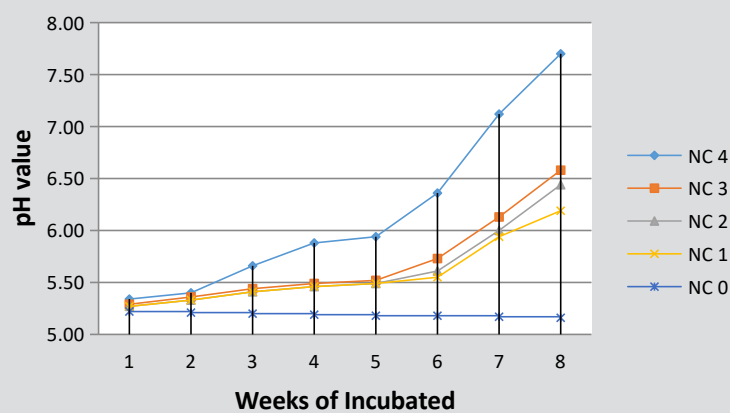


Figure 2. Soil pH value during period of incubation

Table 1. Chemical contents of rice husk

	C (%)	N (%)	Hydrogen (%)	Si (%)	Ca (%)	Mg (%)	Na (%)	K (%)	P (%)	Mi (%)	Moisture content %
Rice husks	33.67± 1.2	1.13± 0.07	6.01± 1.02	6.91± 0.93	0.14± 0.04	0.048± 0.002	0.012± 0.001	0.30± 0.07	0.030± 0.06	0.037± 0.07	9.61 ± 1.26

Preparation of compost

The stages of hot composting using the Berkley method [11]. Dried the rice husks and chicken bones aerobically. Cut the chicken bones and green waste into small pieces. The process of building the heap in the form of layers inside the bin. Put at the bottom of the pile layer of rice straw, then put a layer of chicken manure then a layer of chicken bones, then put a layer of rice husks and then put a layer of green waste and then another layer of rice husks. This was to continue making these layers until reaching the top of the heap. The process of turning the pile and checking the water content. The turning of the heap in the fourth day of the process of building the compost pile and then was turned every two days after opening the bin and moved it a few feet of their place and put the compost pile in the bin again. Each time turned the pile being checking water content and temperature in the pile until reaching the stage of completion of the compost production. The covering of compost heap with a plastic sheet, to prevent the rain cooling it down, since the water will penetrate into the core of the compost pile. Through the training process was taken some samples to measure some elements such as carbon and nitrogen while the all the elements within the study were measured at the end of the composting process.

Design of incubation experimrnt

The Complete Randomized Design (CRD) has been used in this study for incubated the soil to assess the impact of the compost product to increase in value soil pH. The study was conducted in the laboratory at the Agro technology Research Station, University Malaysia Perlis Padang Besar, Perlis, Malaysia. The study included five levels of compost (C0, C1, C2, C3 and C4) where the amounts of compost were (0, 50, 100, 150 and 200 g. Kg-1 soil) respectively, and with three replications. Soil incubation was conducted in 2000 ml plastic vessels on 1000 g soil. The soil pre-incubated for 8 weeks at 25 °C.

Sampling and Procedures of Analytical

During the composting process, temperatures within each pile were measured daily using a digital thermometer, while pH (1:10 w/v sample: water extract) using a pH meter with a glass electrode. pH and temperature measurements

were taken at two locations (25 cm from the top and 25 cm from the bottom) within the pile when the ambient temperature was fairly stable that between the hours of 06:00 am and 08:00 am. Sampling was done whenever turning of compost pile from the start to the end of the experiment. Three samples each were collected at three locations in a pile (25 cm from the top, the middle and 25 cm from the bottom) and composites. Samples were analyzed for the following parameters: moisture content (105 oC for 24 h); ash content (expressed as a percentage of residues after ignition at 600 °C for 5 h); Thermal Coefficient was estimated from the ash content according to the formula [12].

As for the total concentrations of Ca, Mg, K, and P are determined with an inductively coupled plasma (ICP) spectrophotometer, where took one gram of the soil samples was introduced into digesting tubes following the addition of 10 ml concentrated HNO₃. The samples were placed in the digester for 8 h at 96 °C with intermittent stirring. Upon complete digestion, the samples were filtered into 100 ml volumetric flasks using Whatman no. 42 filter paper, The samples were made up to the 100 ml mark in the volumetric flask using distilled-demonized water at last day for composting process [13]. Organic matter contents of compost and BGS were determined according to loss on ignition method. Manures samples containing crucibles were placed in oven at 105 °C for 24 h. Weighed 2 g of each manures (triplicate) in crucibles, weighed (sample + crucible) and placed in muffle furnace at temperature of 450 °C for 24 h. Removed all the crucibles and calculated organic matter contents of manures following this formula.

Results And Discussion

The composting process was proven to be completed by reaching the normal heat degree and also because of disability to differentiate between the materials used in the compost pile. The results in table (3) showed an increase in the calcium percentage in the composting process that reached 4.29% and that was due to adding the chicken bones to the compost pile, in the first place and it is considered an exchangeable element and has a special importance in the soil structure because it work on aggregation the soil colloids and thus it improves the soil structure

Table 2. Chemical contents of Chicken bone (KFC Restaurants) after cooking.

	Ash (g/kg)	Fat (g/kg)	Crude protein (g/kg)	Moisture content (%)	Ca (g/kg)	Mg (g/kg)	K (g/kg)	C (g/kg)	N (g/kg)	P (g/kg)	Organic matter (g/kg)
Chick- en bone	461.4 ± 12.41	9.75 ± 2.81	234.0 ± 10.14	97 ± 3.1	237.4 ± 11.02	4.1 ± 0.36	1.7 ± 0.11	62.0 ± 3.12	6.7 ± 1.04	79.4 ± 4.42	277.4 ± 11.66

Table 3. Product compost specifications and ratios of some important nutrients

	pH	CEC Coml. Kg-1	OM % dm	Ash (%)	C (%)	N (%)	Ca (%)	Mg (%)	K (%)	P (%)	C/N
New Com- post	8.03	29.91	38.7	22.168	43.24	1.64	4.29	0.60	1.02	1.26	26.37

and survival its molecules are constant. Also, table (3) explained an increase in the percentage of both Magnesium and Potassium 0.60% and 1.02% respectively compared with some of the composts that is already there in the local market and these main three Cations (Ca, Mg, and K) are necessary to enhance the qualities of the soil and to adjust the acid of the acid soil which suffers a shortage of these elements and especially the tropical arias' soil because of loss of these elements from it because of the heavy rains [7].

Also the results in the same table showed a presence of a high percentage of both Nitrogen and Phosphor so they become 1.64% and 1.26% respectively, compared with some of the composts that is already there in the local market and these elements are extremely important for the plants and it should be available in the soils to increase its fertility and this percentage of these elements in the compost as a storage to the plants in the soil during the adding to the soil and it works as a supplier to the plants when these element are in shortage in the soil [14]. The source of this increase in the nitrogen percentage was the rice husks and the green waste that were added to the compost pile, whereas the chicken bones were the main source of the phosphor which contains a high percentage of phosphor.

As far as the total carbon was concerned in the compost product, the percentage was 43.24% and that is compared with the total nitrogen in the compost, whereas the optimum percentage of the carbon to the nitrogen in the operation of the organic compost should be (C:N) 25-30:1, where the bacteria is able to dissolve the organic materials fast, and this indicates that the percentage of the carbon to the nitrogen was appropriate since the starting of the compost pile.

Table (3) also shows the pH and the Cation Exchange Capacity (CEC) it was 8.03 and 29.91 coml. Kg-1 respectively, and this increase definitely a consequence of the increase of the percentage of the base cations (Ca, Mg, and K) in the compost pile, also due to decomposition of organic matter. The same table showed a high value of organic matter was (38.7 % dm) and organic matter in the compost is considered very important where it play an important role in adjustment the organic matter to the soil when added and which, in turn improving the soil proper-

ties [15].

The results showed as shown in the (figure. 2) a significant increase in the value of the pH of the soil throughout the incubation period when adding all levels of compost to the soil compared with control treatment. Also the same figure showed the addition of 200 g. Kg⁻¹ led to significant increase in pH value compared with control treatment and often with the rest of other levels for addition compost during of incubation period for the soil. As well as that the addition of 200 g. Kg⁻¹ soil led to change the pH of the soil during the eighth week of the soil incubation process where reached a value to 7.70. Thus, the compost product has helped in transform the soil from acidic soil to alkaline soil. These results were mostly due to the presence of calcium in the high rate of compost and some other cations such as magnesium and potassium, this result corresponds with [16][17][18] where confirmed that the application of Ca to soil led to increased in soil pH.

Statistical Analysis:

The statistical results were made by using the ANOVA test. The differences were assessed by ANOVA test. The reason for doing an ANOVA is to see if there is any difference between levels of compost to change the soil pH. ANOVA is used to test for differences of among two or more levels. The significance at $P < 0.01$ levels has been considered for evaluation

Conclusion

The objective of the research is to production the type of compost contain high percentage of calcium and in the short time. Already, the production of this type of compost led to get a rich-calcium compost through which can be processed the low soil pH that suffer from calcium deficiency, Also the high value of pH In this compost helps to change the pH of the soil which are added the compost to it. This compost contain of a high percentage from N, P, K, Mg and organic matter, its important for any soil suffer from those elements. As well as this compost is low cost and production its fast during 18 days, also can benefit from the rice husks which usually are dumped in the open thereby cause damage for the environment. Also benefit from the chicken bones in the kitchen waste which thrown after

eating the meat of cooked chicken.

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