PRODUCTION OF COMPOST FROM RICE STRAW UNDER PROTOTYPE CONDITION

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ABSTRACT

Composting of rice straw with fresh farmyard manure without inoculated with any microorganism could produce. The quantity and particle size of rice straw and quantity of fresh farmyard manure were controlled in the retention time. While used 35% of value of pile rice straw with large pieces size ranged from 25 – 30cm and 65% of value of pile manure, and turned the pile once a week, with kept the moisture content in range 45 – 50%, have got a good compost characteristic in 60 days of composting. The compost had 13:1 C:N ratio from 30:1 in initial. When used 50% of value of pile rice straw and 50% of value of pile was manure and the same condition, have got compost with a good quality but after 75 days of composting. The compost had 16:1 C:N ratio from 40:1 in initial.
Keywords: - Compost – Rice Straw – Manure – C:N ratio – Retention Time

INTRODUCTION

Rice (*Oryza sativa L.*) is an important crop in many areas of the world, and yields a large amount of rice straw residue. A major portion of this agricultural waste is disposed by burning or is mulched in rice fields. However, an attractive alternative usage of rice straw is composting (***Abdelhamid et al., 2004***).Composting is the biological decomposition and stabilization of organic substrates, under conditions that allow development of thermophilic temperatures as a result of biologically produced heat, to produce a final product that is stable, free of pathogens and plant seeds, and can be beneficially applied to land (***Haug, 1993***).

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CSCWM & GCU (2000) and ***Haug (1993)*** reported that the aerobic composting is the decomposition of organic substrates in the presence of oxygen (Air).

During the composting process, microorganisms break down the organic matter and produce humus, carbon dioxide, water, ammonia, new cells, and heat, as shown in Eq. 1 and figure 1

$$\underset{Organic\ Material}{\begin{Bmatrix} Proteins \\ Amino\ Acids \\ Lipids \\ Carbohydrates \\ Cellulose \\ Lignin \end{Bmatrix}} + O_2 \xrightarrow{Microorganism} \underset{Compost}{\begin{Bmatrix} Cellulose \\ Lignin \\ Minerals \end{Bmatrix}} + CO_2 + H_2O + NH_3 + New\ Cells + Heat \longrightarrow \quad (1)$$

The end product is safer to use than the raw organic material and one that improves soil fertility, tilth, and water holding capacity. In addition, composting reduces the bulk of organic material to be spread, improves its handling properties, reduces odor, flies, and other vector problems, and can destroy weed seeds and pathogens ***(Ghaly et al., 2006)***.

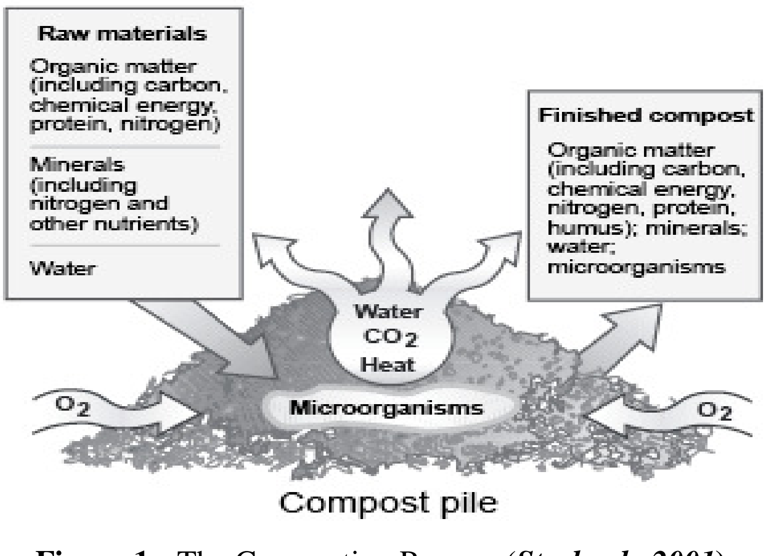

Figure 1:- The Composting Process (***Starbuck, 2001***)

Generally the mix gets turned every three or four days, but sometimes every day or sometimes only weekly or monthly. In some systems air is forced through the compost to control temperature and keep the pile supplied with oxygen. When little or no further heat output is observed, the material is removed, remixed and put in a curing pile for several months ***(Keener and Elwell, 2006)***.

Factors Affecting the Composting Process

Natural decomposition rates can be accelerated by providing favorable conditions for bacterial growth and reproduction ***(Thomsen, 2002)***. Factors affecting the composting process include nutrient ratio, moisture content, oxygen concentration, pH, surface area, temperature, and retention time. **Table 1** displays the desirable conditions for the composting process ***(Sherman, 1999)***.

Table 1:- Desired Characteristics for the Composting Process ***(Sherman, 1999)***.

Characteristic	Reasonable range	Preferred range
(C:N) ratio	20:1 – 40:1	25:1 – 30:1
Moisture content	40 – 65 %	50 – 60%
Oxygen content	> 6%	~ 16 – 18.5%
pH	5.5 – 9.0	6.5 – 8.5
Bulk density	< 40 lbs per cubic foot	----
Temperature	110 – 140°F	130 – 140°F
Particle size	1/8 – 2 inches diameter	Varies*

* Depends on raw materials, pile size, and/ or weather conditions.

A) Nutrient Balance

Cooperband (2002) reported that the supply of carbon (C) relative to nitrogen (N) is an important quality of compost feedstocks. Microorganisms use carbon for both energy and growth, while nitrogen is essential for protein production and reproduction. Raw materials blended to provide a C:N ratio of 25:1 to 30:1 are ideal for active composting, although initial C: N ratios from 20:1 up to 40:1 consistently give good composting results ***(Pace et al., 1995)***.

B) Temperatures

Microorganisms release heat while they work, so temperature is a good indicator of the composting process ***(Sherman, 1999). Hansen et al.***

(1995) reported that the temperature increase that occurs during composting results from the breakdown of organic material by bacteria, actinomycetes, fungi and protozoa. In composting, as in the decomposition of any complex substance, the breakdown is a dynamic process accomplished by a succession of microorganisms with each group reaching its peak population when conditions have become optimum for its activity. The maximum rate occurs when compost temperatures range from 110-150°F (43-65°C), and weed seeds and most microbes of pathogenic significance cannot survive as shown in figure 2.

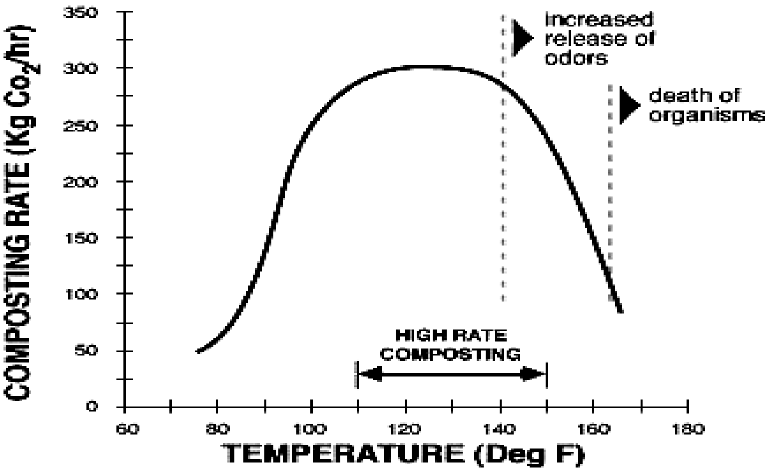

Figure 2: Effect of temperature on the composting rate.

(Hansen et al. 1995)

C) <u>Moisture Content</u>

Like all living things, microorganisms need water. Microorganisms need water to support their metabolic processes and to help them move about ***(Keener et al., 1999)***. ***Pace et al. (1995)*** and ***Sherman (1999)*** reported that if the moisture content is below 40%, microbial activity slows. It ceases below 15%. When moisture levels exceed 65%, air in the pore spaces of the raw materials is displaced by water, which leads to anaerobic conditions, odors, and slower decomposition.

E) <u>pH</u>

One of the most important indicators of overall health in your compost pile is pH. ***Thomsen (2002)*** reported that generally, the pH of the yard wastes will drop to between 5.5 – 6.0 (or lower) during Phase II of composting. The microorganisms that produce the acids can also utilize these organic acids as food once the most readily biodegradable materials have been consumed, typically within a few days. The rise in pH typically continues until a level of 7.5 to 9.0 is reached, and the mass becomes alkaline. It is more important to manage aeration so that anaerobic conditions are controlled.

F) Retention Time

The length of time required to convert raw materials to compost depends on the factors described above. The shortest composting period results from proper moisture content and C/N ratio, plus frequent aeration ***(Sherman, 1999)***.

So that, the recent research work is performed to identify rice straw pieces size and the quantity and quality of the addition manure as an organic matter (carbon and biological). And how to get compost with a good quality in suitable time?

MATERIAL AND METHODS

Materials

Rice Straw (RS):

Rice straw collected from El- Quren, El- Shraquia Governorate. It was air dried and chopped to 25 – 30cm before compost heap preparation. The properties of rice straw which used, it had 15% moisture content, 0.85g/cm^3 density and 77.8: 1 C:N ratio. This analysis was done by Microbial. Dept., Soil, Water and Environmental. Res. Inst., A.R.C. Giza.

Farmyard Manure (FM):

Fresh farmyard manure from El- Quren, El- Shraquia Governorate. The Properties of manure which used, it had 60% moisture content 0.7g/cm^3 density and 8.66:1 C:N ratio. This analysis was done by Microbial. Dept., Soil, Water and Environmental. Res. Inst., A.R.C. Giza.

Experimental procedures

Compost production

This study was done in El-Arabia Compost Factory. Two compost piles were prepared from rice straw and cattle manure. The materials of each pile were in several layers at site area of about 4.5m (W) x 1.5m (H) x

100m (L).The amount of each of the previous materials were added ignored the density and moisture content.

1) Pile 1:- was contained 35% rice straw and 65% fresh farmyard manure (210m^3 rice straw and 390m^3 farmyard manure).
2) Pile 2:- was contained 50% rice straw and 50% fresh farmyard manure (300m^3 rice straw and 300m^3 farmyard manure).

The piles were turned by turned machine (Figure 3) for aeration once a week. The turned machine was used to turning and moistening the mixed. The wide of machine is 5m, the high is 2.4m, the rate of turning 3000m^3/h and it has a motor 209k.Watt. Moisture was ranged from 45 - 50%.

Figure 3: Turned Machine with rate of turning 3000m^3/h

<u>METHODS OF ANALYSES:</u>

<u>Physical and chemical characteristics</u>

1) <u>Temperature Measurement:</u>

Temperature in piles was measured at different places and depths {(front – middle - end) & (above – center)} through the composting period by a thermo-couple thermometer (HI 9395005) the range of measurement from -50ºC to 199.5ºC and -58ºF to 399.5ºF.

2) <u>Moisture content</u>

The samples of compost were weighed and placed in drying oven. The samples were allowed to dry for 24h at 105°C, and then were left to cool down in oven. The moisture content was calculated as a percentage according to the following equation:

$$\text{Moisture Content } \% = \frac{\text{Initial sample weight - Final sample ewight}}{\text{Initial sample weight}}$$

3) Determination of pH

The pH values of compost were determined in 1:10 compost-water suspension using a digital pH meter (WTW, pH 320, model 82362).

4) Organic Carbon (OC):

Organic carbon in both raw organic materials and compost samples was determined by Walkley and Black method according to ***Page et al. (1982)***. This analysis was done by Microbial. Dept., Soil, Water and Environmental. Res. Inst., A.R.C. Giza.

5) Total Nitrogen (TN):

Total nitrogen was determined in both raw organic materials and compost samples using Kjeldahl digestion method reported by ***Jackson (1973).*** Three grams of each compost sample were digested using concentrated sulphuric acid and a digestion mixture, consisted of potassium and, copper sulfates as well as selenium a ratio of 100:10:1. The distillation was carried out with 40% NaOH solution, and ammonia resulted was absorbed in aliquots of 10ml boric acid with few drops of the mixed indicator containing bromo-cresol green and methyl red indicator. Titration was carried by a standard solution of H_2SO_4. This analysis was done by Microbial. Dept., Soil, Water and Environmental. Res. Inst., A.R.C. Giza.

RESULTS AND DISCUSSION

Physical and chemical changes during composting process.

1) Temperature evolution and variations

Temperature is a good indicator of the composting process. Temperature increases are noticeable within a few hours of forming a pile or a windrow ***(Allam, 2005)***. Changes in temperature during the composting period for the two piles at different places are shown in figure 4. The composting process for the tested piles exhibited a classical temperature pattern, where it was possible to distinguish three different phases:

mesophilic, thermophilic and cooling down phase, which continues later as compost maturation stage.

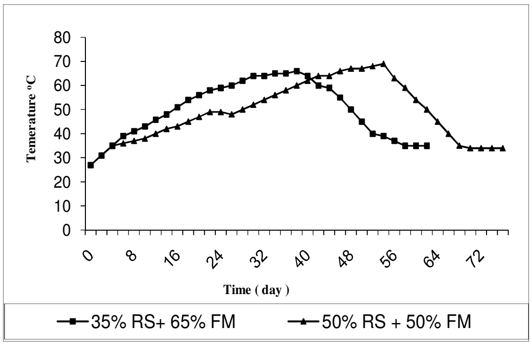

Fig. 4:- Temperature during different composting time

The initial mesophilic stage (up to 45°C) showed a short duration of 7 days. A progressive increase in piles temperatures has been measured after 10 days in pile 1, but has been measured after 18 days in pile 2. The temperature of the composting materials follows a pattern of rapid increase from 48 - 66°C where it is maintained from 14 - 38 days in pile 1, and it increase from 47 - 69°C where it is maintained from 20 - 54 days in pile 2. The thermophilic phases are optimum for thermophilic microbial activities in the degradation of cellulose and lignocelluloses materials. After that, the temperature get decline. The continuous decline of temperature during the last cooling and maturing phase could be attributed to the exhaustion of available substrate and the replacement of thermophilic microorganisms by the mesophilic one, which continues the partial degradation of bio-resistant compounds, fundamentally cellulose and lignin.

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2) <u>C:N ratio of compost</u>

Taking C:N ratio as an indicator for rice straw decomposition. the results showed in figure 5 that decomposition of rice straw with farmyard manure was completed in different period depending the quantity of rice straw and farmyard manure.

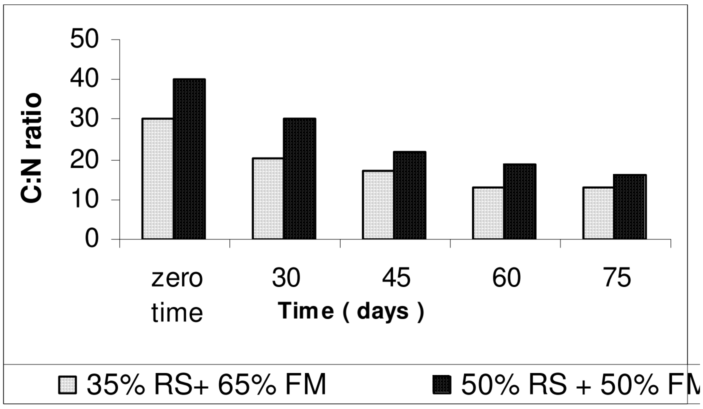

Fig. 5:- C:N ratio during different composting time

The C:N ratio decreased from an initial 30:1 to 13:1 in pile 1 after 60 days of composting, and decreased from an initial 40:1 to 16:1 in pile 2 after 75 days of composting.

3) <u>pH of compost</u>

Like temperature, pH may be a good parameter of the bio- oxidative phase evolution and microbial development ***(Allam, 2005)***. the results showed in **figure 6** that by the time of composting, a general decreased on the pH values from an initial values of 8.5 in pile 1 and 8.8 in pile 2 in first 30 days of composting was observed. And it get increased again after 45 days of composting in pile 1 and after 60 days of composting in pile 2.

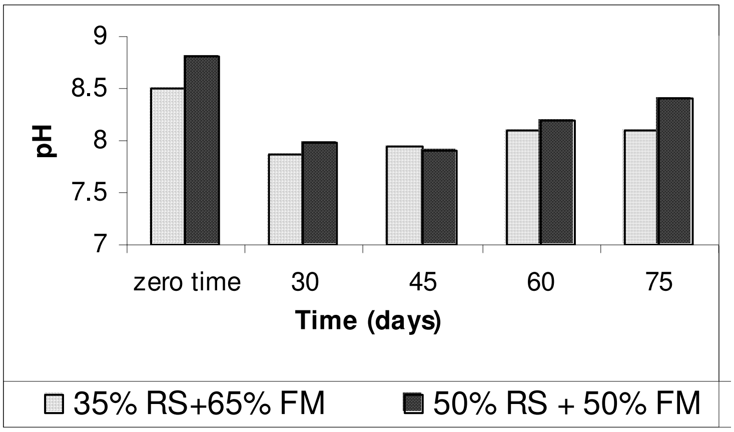

Fig 6:- pH during different composting time

The length of convert rice straw with large particle size to compost depends on the quantity of rice straw, fresh farmyard manure and factors affecting the composting process. So we fine an ejective relation between quantity of rice straw which added and retention time.

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الملخص العربي

إنتاج سماد حيوي (كومبوست) من قش الأرز تحت النطاق التجريبي

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نظراً لاستخدام مصر الأسمدة المعدنية تحت نظام الزراعة المكثفة، فهذا أدى إلى حدوث تلوث بيئي. ولذلك اتجهت مصر في الآونة الأخيرة إلى إتباع الزراعة العضوية، وهى تعنى استخدام أسمدة عضوية. والأسمدة العضوية هي الأسمدة المصنعة من مصادر طبيعية. وبما أن الأرز من أهم المحاصيل الزراعية في مصر، وحرق المخلفات الناتجة من زراعته (قش الأرز) تسبب مشاكل بيئية خطيرة. لذلك أجرى هذا البحث بهدف الاستفادة من قش الأرز والمخلفات الحيوانية المزرعية وتحويلهم إلى سماد عضوي (كومبوست). وقد أجريت هذه التجربة على النحو التالي:-

1- الكومة الأولى :- تم استخدام 35% من حجم الكومة قش أرز يتراوح طوله من 25 – 30سم و 65% من حجم الكومة مخلفات حيوانية. مع مراعاة التقليب مرة أسبوعياً، ومع المحافظة على رطوبة نسبية تتراوح من 45 – 50 %. وقد تم الحصول على كومبوست ذو صفات جيدة، فنسبة الكربون : النيتروجين فيه 13 : 1 حيث كانت 30 : 1 عند بداية التخمير، وذلك بعد 60 يوماً.

2- الكومة الثانية:- تم استخدام 50% من حجم الكومة قش أرز و 50% من حجم الكومة مخلفات حيوانية. وتحت نفس الظروف السابقة. فتم الحصول على كومبوست تكون نسبة الكربون إلى النيتروجين 16 : 1 حيث كانت 40 : 1 عند بداية التخمير، وذلك خلال 75 يوم.

ومن نتائج البحث وجد انه يمكن الحصول على كومبوست من قش الأرز ذو موصفات جيدة وذلك خلال فترة زمنية قصيرة. كما وجد أن كمية قش الأرز وطوله وكمية المخلفات الحيوانية تتحكم في زمن التخمير، ومن هنا نجد انه توجد علاقة طردية بين كمية قش الأرز وزمن التخمير.

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