

THE COMPOSTER PROGRAM AND ITS POTENTIAL USE IN THE PREDICTION OF A CORRECT COMPOST MIXTURE

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Abstract

It is well known that organic waste can be processed by composting. One of the first tasks in developing a successful composting program is to get the right combination of ingredients. Two parameters are particularly important in this regard: moisture content and the carbon to nitrogen (C:N) ratio. The correct compost mixture can be determined with the use of the Composter program for optimizing the raw material composition for compost, as described in this paper. The basic evaluation criteria for compost software are the operational parameters, the C:N ratio and the moisture content. The database for this software contains cca 60 fundamental leads of organic materials. The software is created in Java programming language. One of the main aims of this project is to create software that will be easy-to-use and reliable, with a friendly graphical user interface. All of this can be achieved by Java.

Key words: composting, program, organic waste, C:N ratio, moisture content, Java

INTRODUCTION

Composting is the biological decomposition of organic matter under controlled aerobic conditions. Many factors affect the composting process. Some of these factors play a major role in the process while others can influence its direction or extent. Since 1969 new chemical and physical techniques have provided scientists with the tools to examine and manipulate these factors and to delve into the composting process in a rigorous manner (Epstein, 1997). Many composters combine raw materials by trial and error, based on the look and feel of the mix. More manure or water is added if the mix feels dry, or dry amendments are added until the mix stands in a pile without slumping. Usually this involves some judgment about the moisture content, structure and porosity of the mix. With experience, this approach to determining composting recipes can be successful, especially when the composting does not need to be rapid or closely controlled. When the raw material characteristics are not known, the "look and feel" approach may be the only alternative. However, when the composter is unfamiliar with the material or the process, or when it is important to establish near optimum composting conditions, it is better to develop composting recipes based on calculations. The calculations predict the moisture content and C:N ratio of a mix from the characteristics of the individual raw materials (Rynk, 1992). Ideally, the raw materials should be chosen and mixed in the right proportion to produce characteristics within the ranges, C:N ratio 30-35/1 (Rynk, 1992; Gotaas, 1956), moisture content 50-60 % (Schultz, 1962; Poincelot, 1975). Below 40%, microbial activity decreases and above 60% anaerobic conditions can exist because of blocked pore space (Epstein, 1997).

However, it is not always necessary or even possible to achieve these values. Composting is a flexible process. It occurs over a broad range of conditions, which might be quite different from the ideal. The allowable deviation from the ideal depends on the time available to complete composting, the potential for odors, and the final use of the compost. For rapid composting or for materials with high risk of odors, it is important to stay close to the ranges listed above.

MATERIAL AND METHODS

Database of raw materials for software

The ingredients for composting are organic by-products or waste materials. On farms such materials include animal manures, bedding, crop residues and some processing wastes. In most cases, there is a primary raw material to be composted, such as manure, and other materials are added. The full database includes over 60 fundamental leads of organic materials. Some typical raw materials for tropical and subtropical areas are also available. The database includes some elements for moisture and C:N ratio corrections such as water, ammonia sulphate and urea.

Equation for mixture calculation

In order to maintain rapid composting, feedstocks are blended to provide an initial C:N ratio of approximately 30 and a moisture content of 60%. It is assumed that the feedstock available for composting is free of contaminants and is reduced to a particle size of from 5 to 25 mm (Haug, 1993). The C:N ratio of the mixture is calculated using equation 1, where W_i is the mass of the i^{th} component and M_i , C_i , and N_i are its corresponding moisture, carbon, and nitrogen content,

respectively. The final moisture content (MC) is calculated using equation 2 (Das et al., 2001).

$$C : N \text{ Ratio} = \frac{\sum_{i=1}^n \%CiWi(1 - Mi)}{\sum_{i=1}^n \%NiWi(1 - Mi)} \quad (1)$$

$$\text{Moisture Content } MC = \frac{\sum_{i=1}^n WiMi}{\sum_{i=1}^n Wi} \quad (2)$$

The carbon content of many materials can be difficult to find in the literature. If the literature or test results report the percentage of ash, the carbon content can be roughly estimated by the following equation 3 (Rynk, 1992).

$$\% \text{ Carbon} = \frac{(100 - \% \text{ Ash})}{1.8} \quad (3)$$

SOFTWARE DEVELOPMENT SYSTEM

The software is in the Java programming language. Java is a high-level, object oriented, third generation programming language, like C, Fortran, Smalltalk, Perl, and many others. Java is more similar to C than to other programming languages. A special feature is that Java allows you to write special programs called applets, which can be downloaded from the Internet and played safely within a web browser (Harold, 1997). Java, designed to be type-safe and easy to use, is platform-independent, garbage collection, and range checking on strings and arrays. Java applets run on web pages and can be used for dynamic and interactive web sites (Ladd, 1998).

Two platforms were used for creating the compost software. The Java™ 2 Platform, Standard Edition (J2SE™) provides the essential compiler, tools, runtimes and APIs for writing, deploying and running applets and applications in the Java programming language (Sun Microsystems Inc, 2001a). The Java Foundation Classes group (JFC), which encompasses a set of features to help build graphical user interfaces (GUIs), enables developers to easily incorporate high-quality 2D graphics, text and images in applications and applets. The Swing components, which are the major features of the JFC, include everything from buttons to slider to split panes (Sun Microsystems Inc, 2001b).

The second platform is the Java™ 2 Platform, Micro Edition (J2ME™). This technology specifically addresses the vast consumer space, which covers the range of extremely tiny commodities such as smart cards or a pager all the way up to the set-top box, an appliance almost as powerful as a computer (Sun Microsystems Inc, 2001c). The Mobile Information Device Profile (MIDP), combined with the Connected Limited Device Configuration (CLDC), is the Java™ runtime environment for today's mobile information devices (MIDs) such as phones and entry level PDAs. What MIDP provides is the core application functionality required by mobile applications - including the user interface, network connectivity, local data storage, and application lifecycle management - packaged as a standardized Java runtime environment and set of Java APIs (Sun Microsystems Inc, 2001d).

Results and Discussion

The *Composter* program is applicable for determining the correct compost mixture. There are two basic forms in which the program can be used. The first edition is created by Java (J2SE™), which enables the program to be installed on a PC with any Operating System. The second edition is create by Java (J2ME™), which can be run on mobile phones.

Function procedure of the software:

When the program starts a window with suitable materials for composting is displayed on computer screen. The raw material for composting will be selected by the user. Click the left button on the mouse to select a material for composting. Click on *Results* (Fig. 1.) a new window opens. It has two parts. The top part shows selected materials for composting. At this stage the user can change the position of the scroll box *A* (Fig. 2.), which automatically sets the required volumes of the composted materials. According to the changes in quantity of each material we can monitor the value of the C:N ratio and the moisture content in the lower part of the same window. The optimal composition of materials for composting is achieved when the values of the C:N ratio and the moisture content are in the optimal zones *B* (Fig.2.). When this happens we can find the amounts of each component, which are displayed next to the selected materials, in order to obtain the optimal composition of immature compost. Under each selected material arrays are displayed, from which the nitrogen, carbon and moisture content values can be edited.

An analogical method of operating applies for the mobile phone edition. First, the materials for composting are selected from the list of components (Fig.3.). This selection is confirmed by the *Results* button. In contrast to the PC edition, due to the small size of the display unit, the selected ingredients for compost are displayed separately on the full screen of a

mobile phone (Fig. 4., Fig. 5.). The optimal compost mixture is achieved by the same rules as were described for the PC edition.

To demonstrate the function of the program, the following scenario was analyzed. Six components from the database were chosen for a composting process. Cattle manure (moisture 78%, 45% of C in db, 2.1 % of N in db); Poultry manure (moisture 90%, 38.9% of C in db, 6.55 % of N in db); Grain straw (moisture 17%, 52.2% of C in db, 0.5 % of N in db); Dry leaves (moisture 20%, 50.6% of C in db, 1.2% of N in db); Kitchen refuse (moisture 73%, 45% of C in db, 1.75% of N in db); and Night soil (moisture 94%, 21.7% of C in db, 3.1 % of N in db). These materials were processed with the use of equation (1) and (2), which are presented in the section on *Materials and methods*. The program found that the optimal composition of the compost is as follows: 19t of cattle manure, 20t of poultry manure, 5t of grain straw, 60t of dry leaves, 11t of kitchen refuse, 37t of night soil, with a total C:N ratio value of 33 and a moisture content of 58.2%. The conception of the program allows a broad spectrum of different compost mixtures to be set. For instance, if the user wants to hold the dry leaves value at 15t, the correct compost mixture can be estimated by modifying the other selected materials. Accordingly, the final compost mixture will be changed to: 18t of cattle manure, 20t of poultry manure, 14t of grain straw, 15t of dry leaves, 8t of kitchen refuse, 3t of night soil, with a total C:N ratio value of 34.2 and a moisture content of 59.1%.

CONCLUSIONS

The operational parameters such as C:N ratio and moisture content are usually required as inputs (Das et al., 2001 and Governo, 2001). The database of *Composter* program include the values of Carbon and Nitrogen content as well as the moisture content for each component. This may have advantage in case the values of operational parameters are unknown. If the user know exact composition of each material it is possible to insert these values to the arrays, which are signed as Moisture, C, N, (Fig. 2.).

One of the main aims of this project was to create a program that will be easy-to-use and reliable, with a friendly graphical user interface. Another important consideration was the easy availability of the program, which was achieved by distributing it on Web pages. The Java programming language was chosen to help in achieving these aims. The software for optimizing the raw material composition for compost is aimed at small

compost plants, farmers, gardeners and consultancy firms.

ACKNOWLEDGEMENT

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Fig. 1. Select materials for composting from the list of components. The optimizing of compost mixture begins after pressing the *Results* button.

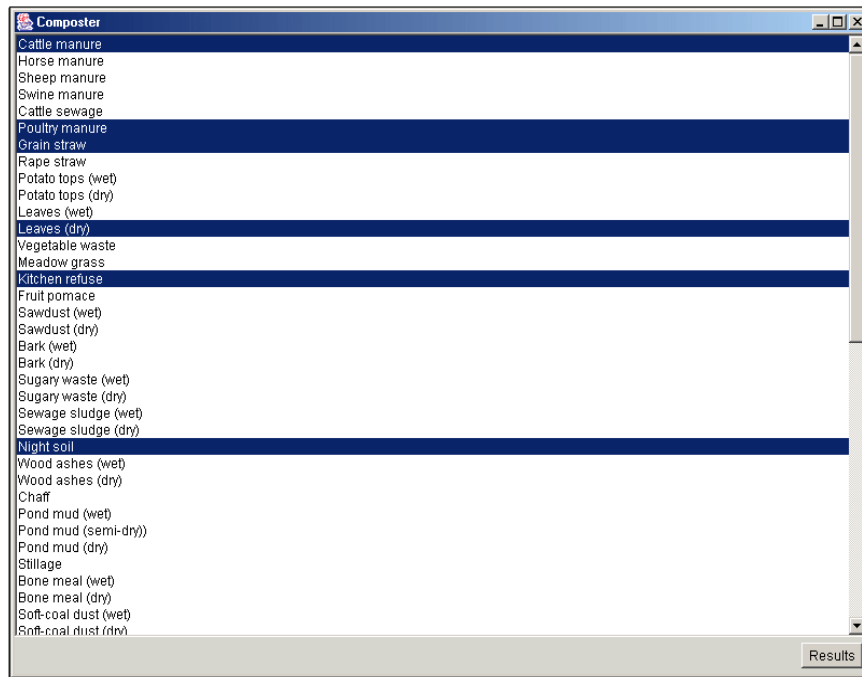


Fig. 2. Window with output results. A – Scroll box for input data changing. B – Optimal zones of C:N ratio and moisture content.

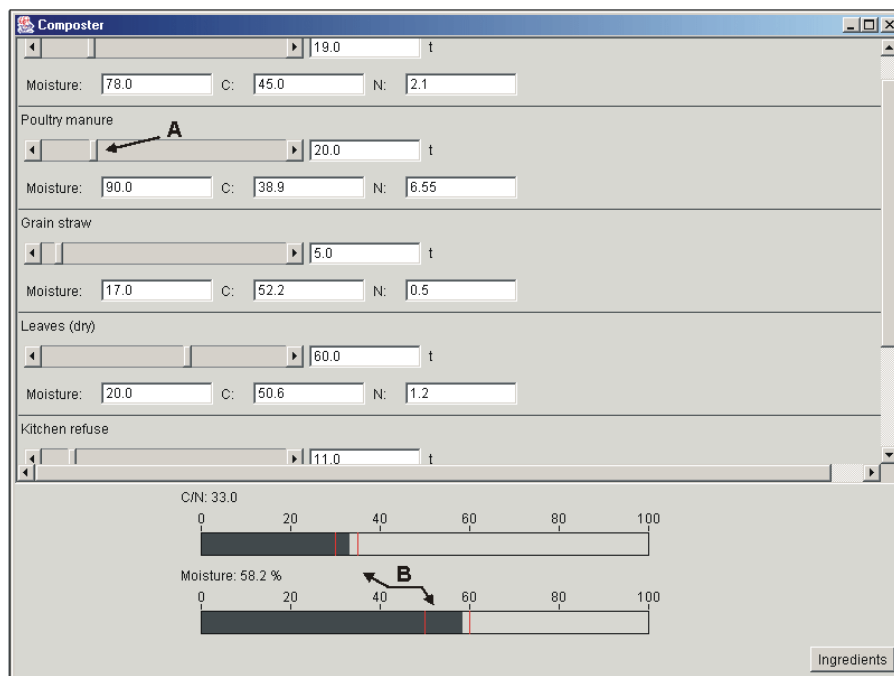


Fig. 3. Select materials for composting from the list of components for mobile for edition. The optimizing of compost mixture begins after pressing the *Results* button

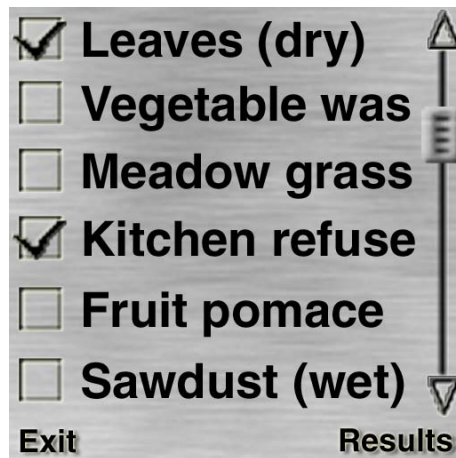


Fig. 4. Select material for composting and its operating parameters are displayed separately on full screen of mobile phone. The values of C:N ratio and moisture content are not in optimal zones.

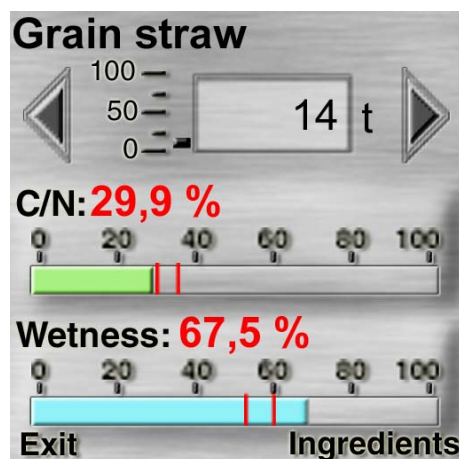


Fig. 5. Select material for composting and its operating parameters are displayed separately on full screen of mobile phone. The values of C:N ratio and moisture content are in optimal zones.

