Nig J. Biotech. Vol. 23 (2011) 1- 4
ISSN: 0189 17131
Available online at www.biotechsocietynigeria.org.

NIGERIAN JOURNAL OF BIOTECHNOLOGY

Potential of Rice Husk and Cassava Peel as Carriers for Bio-fertilizer Production

Ogbo, F.C. [1] **and Odo, M.O.**[2]
[1]Department of Applied Microbiology & Brewing, Nnamdi Azikiwe University, PMB 5025, Awka, Anambra State, Nigeria. [2]Department of Food Science and Technology, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria

(Received 04.08.11, Accepted 05.12.11)

ABSTRACT

The quality of carrier is a vital factor in determining microbial load and shelf life of biofertilizers. Rice husk and cassava peels are abundant and practically of no economic value in many developing countries and thus satisfy two important requirements of biofertilizer-carrier materials. This study evaluated other properties necessary to confirm their suitability for this purpose. Low moisture content and bulk density, high porosity and good water absorption capacity of both materials suggest adequate environmental conditions within them for the growth and survival of inoculant organisms. Both carrier materials supported the growth of the test organism, thus suggesting the presence of nutrients and absence of toxicity. Rice husk showed potential for good shelf life. Promotion of plant growth ($p \leq 0.5$) by test organism was not diminished after six weeks of immobilization in this carrier.

Keywords: Biofertilizer carriers; cassava peel; rice husk

Correspondence: frankogbo@yahoo.com

Introduction

Biofertilizers are living or latent cells of efficient strains of microorganisms, usually immobilized on a carrier, which by their interactions in the rhizosphere, help crops take up nutrients resulting in improvements in their yield. Biofertilizers have numerous advantages over chemical fertilizers. These include their eco-friendliness and for developing countries, amenability to small and medium scale production using materials available within different localities. Biofertilizers are accepted as inputs for organic agriculture by the International Federation of Organic Agriculture Movements (IFOAM, 2005). The quality of carrier is a vital factor in determining microbial load and shelf life of biofertilizers. Somasegaran and Hoben (1994) described the properties desirable of a good carrier material to include availability in adequate amounts and being inexpensive, non-toxicity to inoculant bacterial strains and plants, good moisture absorption capacity and amenability to processing and sterilization. Peat, a dark fibrous material created by the partial decomposition of plant matter, is the most frequently used carrier. This material, however, is not readily available in many developing countries and thus, availability of carriers may hinder the development of biofertilizer technology in these countries.

Various other types of materials including agricultural wastes have been investigated as carrier materials for biofertilizers (Kannaiyan, 2002). Wastes such as cassava peel and rice husk are abundant in many developing countries. Cassava peel comprises about 10% of the wet weight of the cassava, while rice husk constitutes around 20% of the paddy grain. According to Food and Agriculture Organization of the United Nations (FAO) data, the majority of current world production rates of 230 million and 410 million tons of cassava (*Manihot esculenta* Crantz) and rice (*Oryza sativa* L.) respectively, is geographically located in developing countries. Even though numerous research findings about the utilization of these wastes as animal feed (cassava peel) and fuel (rice husk) have been published, these wastes can be seen in heaps of various sizes around processing facilities, where they not only constitute a nuisance and health risks, but may also occupy and put large areas of land out of use (Plate 1).

Plate 1: Heaps of rice husk behind mill at Abakaliki, Nigeria

Being very abundant and practically of no economic value in many developing countries, rice husk and cassava peels already meet two important requirements of carrier materials. This study was carried out to evaluate other properties necessary to confirm their suitability for this purpose. Successful utilization of these materials for biofertilizer production will introduce a viable method of safely disposing of these wastes.

Materials and Methods

Carrier materials: Fresh rice husk was obtained from the Abakaliki Multipurpose Cooperative Society, Rice Mill, Ogoja Road, while cassava peel was collected from a cassava processing facility at Azugwu community, both in Abakiliki, Ebonyi State, Nigeria. The cassava peel was dried in the oven at 50 °C and then ground coarsely in a domestic mill to obtain particles ranging in size between 0.1–1.5 mm. Both materials were sterilized by autoclaving.

Physical analyses of carrier materials: Physical parameters of carriers are important for providing suitable environmental conditions required for the growth and survival of the inoculant organism during the curing and storage of biofertilizers. They are also important considerations for their handling and transport. Moisture, bulk density, porosity and water absorption capacity of the carrier materials were estimated using standard methods for soil as described by Ryan *et al*. (2001).

Test organism, inoculum preparation, inoculation of the carrier and curing: A nitrogen fixing bacterium identified as *Enterobacter asburiae* (NC001927) by the National Collections of Industrial Food and Marine Bacteria (NCIMB) UK, under study in our laboratory as inoculant for growing maize was used. The organism was grown in nutrient broth at 30 °C for 48 h. Fifty milliliters of this inoculum containing about 25 X 10^7 cfu/ml was aseptically added into 50 g of carrier material contained in a sterile 500 ml conical flask. Both were mixed thoroughly using a sterile spatula. The flask was stoppered with cotton wool. Curing was carried out at room temperature for seven days.

Chemical and Microbiological analyses: The chemical composition of carriers determine, among others, nutrient availability and toxicity or lack of it to the inoculant. Hydrogen ion concentration (pH) was determined on a Hanna HI 991001 pH/Temperature meter. Viable counts of test organism in carriers were determined at 30°C/ 48 h. on nutrient agar (Biomark Laboratories, India). Counts during various stages of the study were used to determine or deduce toxicity of carrier materials to the test organism and their shelf life during storage of the biofertilizer. Chemical composition of carrier materials was obtained from literature. All physical, chemical and microbiological tests were performed in triplicate.

Preservation and storage: Biofertilizer produced after curing was dried at 40 °C to moisture contents of 18 % and 21 % respectively for rice husk and cassava peel and then stored at room temperature for the entire duration of this study. Viability of the test organism in rice husk after 42 days was tested by inoculating biofertilizer onto 10 seeds of maize (T2BR COMP2-Y) and germinating on moist filter paper held above distilled water for six days. Positive and negative controls were set up by inoculating seeds with a pure culture of the organism and distilled water respectively. Wet weights of resulting seedlings were compared by analyses of variance (ANOVA).

Results and Discussion

Physical properties of carrier materials: The results of characteristics studied for the carrier materials are shown in Table 1. The low moisture content and bulk density, high porosity and water absorption capacity observed for rice husk are consistent with earlier reports (Anonymous, 2009; Mansaray and Ghaly, 1997). Expectedly, higher values were observed for ground cassava peel than for rice husk. Cassava peel contained higher concentrations of smaller and powdery particles as well as a more water soluble starch component. The significance of these results is that both materials under study are of light weight, and thus can be easily transported. Good porosity and water holding capacity will ensure adequate circulation of air and availability of water for the growth and survival of inoculant organisms. These materials were also free of lump-forming materials and therefore easy to process and sterilize by either autoclaving or irradiation.

Chemical and microbiological properties: Both cassava peel and rice husk had slightly acidic pH values. Adegbola and Asaolu (1986) and Panchaban *et al.* (2010) have reported pH of cassava peel flour and rice husk respectively in that range. Increase in pH after curing (Table 1) would be associated with nitrogenase activity and ammonium production by the test organism.

Table 1: Physical properties of cassava peel and rice husk carrier materials

	Bulk density g/cm^3	**Porosity %**	**Water absorption capacity ml/g**	**Moisture %**	**pH raw**	**pH after curing**
Cassava peel	0.407 ± 0.003	87 ± 8.02	6.2 ± 0.53	9.25 ± 0.015	5.0 ± 0.10	5.4 ± 0.13
Rice husk	0.284 ± 0.006	80 ± 5.56	3.6 ± 0.40	9.00 ± 0.013	5.23 ± 0.12	5.95 ± 0.12

Both carrier materials also supported the growth of the test organism (Fig. 1). This suggests the presence of nutrients and absence of toxicity. Proximate composition of cassava peel (% dry weight) as reported by various authors is about: ash, 6.4; protein, 8.2; fat, 3.1; crude fiber, 12.5 and carbohydrate 64.6 with about 44.6 mg/kg cyanide (Oboh, 2006; Adegbola and Asaolu, 1986). On the other hand, rice husk is composed of organic matter of 12 %, Nitrogen, 0.5 % and low concentrations of minerals (Panchaban *et al.*, 2010). However, depending on the efficiency of the milling process, fresh rice husk as used in this study may also contain traces of starch and rice bran scraped from the grain.

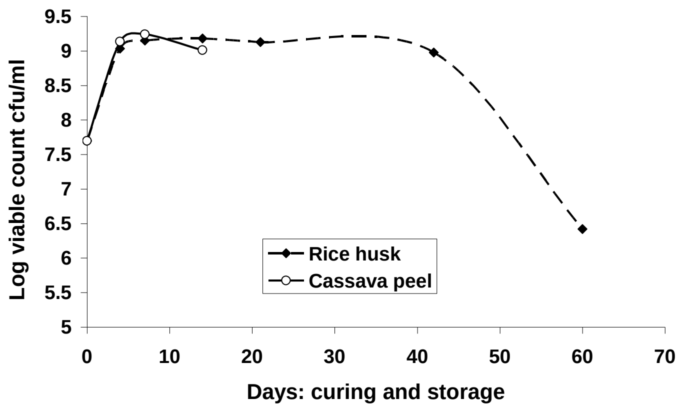

Fig. 1: Growth and survival of test organism in carrier materials

Preservation and storage: The cassava peel experiment was suspended after two weeks because it became infected with molds. Biofertilizer produced with rice husk, even after drying, remained viable for more than six weeks as shown by viable counts on nutrient agar (Fig. 1). The high silica (SiO_2) content, of about 19 % in rice husk makes it less susceptible to microbial attack and therefore easier to preserve. It is noteworthy that the ability of the test organism to promote plant growth was not diminished after the period of storage in carrier made from rice husk at $p \leq 0.5$. Means of wet weight of maize seedlings were respectively, 0.32^a, 0.65^b and 0.77^b for control, pure culture and biofertilizer.

Conclusion

Cassava peel and rice husk meet many of the requirements required of biofertilizer carriers. Rice husk, however, demonstrated extraordinary potentials, particularly in respect of shelf life. Utilization of this material for this purpose will yield the additional benefits of its safe disposal thereby releasing more land for agriculture.

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