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Preliminary studies on growth and survival of long winged (*Macrotermes subhyalinus* Rambur) raised in three different organic substrates under laboratory conditions

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ABSTRACT: Forty long winged reproductive termites (*Macrotermes subhyalinus* Rambur) of weights ranging from 0.16 – 0.23g and lengths 0.17 – 0.84 cm were cultured in soil substrate, cellulose substrate and agricultural waste substrate in boxes (0.9m x 0.3m x 0.14m) for 28 days. The best mean weight gain (0.08g), relative growth rate (47.06%), specific growth rate (0.62%) and feed conversion ratio of 0.80 were recorded from the soil-substrate raised termite while the lowest were from cellulose substrate. The best survival rate of 75% was from the control substrate followed by 50% from agricultural wastes while the lowest of 25% was recorded from cellulose substrates.

Key Words: *Macrotermes subhyalinus*; Culture substrates; Condition factor; Growth and survival.

Introduction

Termites are social insects that swarm seasonally, especially at the onset of the rainy season or after heavy rainfall. The long winged reproductive termite is edible and highly sought after as a delicacy (Fasoranti and Ajiboye, 1993). During swarming, a lot of these termites are wasted. Del Valle et al. (1982) noted that since insects have a short life cycle they should be fairly easy to cultivate thus making their protein relatively abundant and cheap.

Termites are pale coloured, soft-bodied social insects of the family Termitidae. Like other isopteran insects they are unique because they consist entirely of species whose nutrition depends on the destruction of woody tissues. Members of the family Termitidae are fungus growers and have been reported to cultivate fungus garden in the storage region of their nests which helps to digest cellulose before ingestion (Malaka, 1996).

Macrotermes subhyalinus (Rambur) used for this study has been reported as the commonest termites in New-Bussa area of Nigeria. The cultivation of termites under laboratory conditions will ensure its availability as a non-conventional source of animal protein as a component of fish feeds. The present study

is aimed at proffering this solution, that is the cultivation of termites using some agricultural and industrial wastes, to the high cost of fish feed.

Materials and Methods

Composition and preparation of culture substrate

Three culture substrates were investigated for raising termites: Ts1-Termitarium soil substrate (control), Ts2 – Cellulose substrate and Ts3 – Agricultural wastes.

Ts1: Termitarian soil substrate (Control):

Soil was collected from a termitarium within the premises of NIFFR. New-Bussa and used as control. The soil comprised of 45% clay loamy soil at a ratio of 2:1 (clay to loam) and 55% coarse sand.

Ts2: Cellulose substrate

A modified composition of cellulose substrate following the method of Razon-Arceno et al. (1981) was used for the culture. Thirty percent sawdust (collected from Kainji Sawmill, New-Buss, Nigeria), 20% rice bran (collected from the major feed mill in New-Bussa Monday Market, New-Bussa, Nigeria) and 20% mushroom (*Termitocytes* sp.) harvested from farms in the hatchery complex of NIFFR were thoroughly mixed together in an outdoor concrete tank of 2.0m x 2.0m x 1.0m using a spade and water was added. The mixture was covered with jute bag and allowed to ferment for 4 weeks. Fifteen percent freshly collected poultry droppings from the poultry pens of the Integrated Livestock cum Fish Culture Unit of NIFFR were mixed separately with water to form a paste in another outdoor concrete tank of the same dimension and covered with a polythene bag to protect it from houseflies.

The fermentation process lasted for four weeks for the two mixtures. During the fermentation, thorough mixing of the fermenting mixtures was done with a spade. In the first week, the fermenting materials were mixed every other day, then twice a week during the second week and once a week during the third and fourth weeks. During each mixing process, enough water was added to the pastes to enhance the fermentation process. Two days before the end of the fourth week, 15% Centro leaves (*Centrosema* sp.) was soaked in water overnight and added to the mixture containing sawdust, rice bran and mushroom. At the end of the fourth week, the fermented mixtures were sun-dried separately. The sun-dried poultry droppings alone formed chunks and these were crushed into a powdery form, using mortar and pestle, after which the two dried mixtures were mixed together thoroughly. The final material was packed into three of the fibre glass tanks for the culture of the termites.

Ts3 Agricultural wastes substrate

The method of Farina et al. (1991) was sued to culture the termites. The stem of sorghum (*Pennisetum* sp.), millet and maize (*Zea mays*) were hand picked from nearby farms within NIFFR Hatchery Complex, chopped, placed in two glass tanks (0.9m x 0.3m x 0.14m) and moistened with water. The glass tanks were covered with jute sacs to prevent desiccation.

Collection of long-winged reproductive termites

Forty long-winged reproductive termites weighing between 0.16 and 0.23g and with lengths ranging between 0.17 and 0.84 cm were used for this culture. They were caught using scoop net during the nuptial flight of the insects on the 15th of August, 2004, at night. They were transferred immediately to a clay pot covered with jute sac prior to stocking (Farina et al, 1991). Only the paired ones were selected for the culture.

Culture tanks

Nine glass tanks of dimension 0.9m x 0.3m x 0.14m were used for the experiment. The top of each glass tank was screened with net. The glass tanks were covered with jute sac and black polythene bag for desiccation and photoperiodicity.

Bedding and stocking

The tanks were filled with the culture substrates in duplicates. Water was sprinkled on the substrates once a day. The tanks were stocked with the long-winged reproductive termites of known weights and lengths at the rate of two pairs (each pair included a male and a female) per tank. The cultured termites were monitored for growth performance and survival for 28 days. The culture substrates were not renewed during the culture period.

Feeding of termites

The termites were fed with cellulose at 5% of the body weight once daily for the culture period of 28 days.

Sampling of termites

Sub-sampling of termites was done on weekly basis. Two termites were collected at random for weight and length measurements and returned. Dead termites were removed and the number recorded.

Harvesting of termites

At the end of the experimental period, all the termites were harvested using hand net, counted and their lengths and weight were measured and recorded.

Results

There was a continuous increase in the weekly growth pattern of the cultured termites from the three substrates throughout the experimental period as shown in Fig. 1. The survival rate of the termites cultured in the three substrates, as shown in Fig. 2, indicates a drastic decrease in the survival on cellulose substrate from the second week of the experiment. The prediction equations from linear regression analysis for termites raised from the three substrates are shown in Table 1.

Table 1: Prediction equation for raising long winged reproductive termites from the three different culture substrates.

Culture medium	Prediction equation	R^2	r	Level of Significance
Soil substrate	W = 0.019t + 0.17	0.9810	0.9904	P < 0.05
Cellulose substrate	W = 0.013t + 0.16	0.9826	0.9912	p < 0.05
Agricultural waste substrate	W = 0.016t + 0.17	0.9550	0.9774	p < 0.05

W = weight; t = culture duration in days.

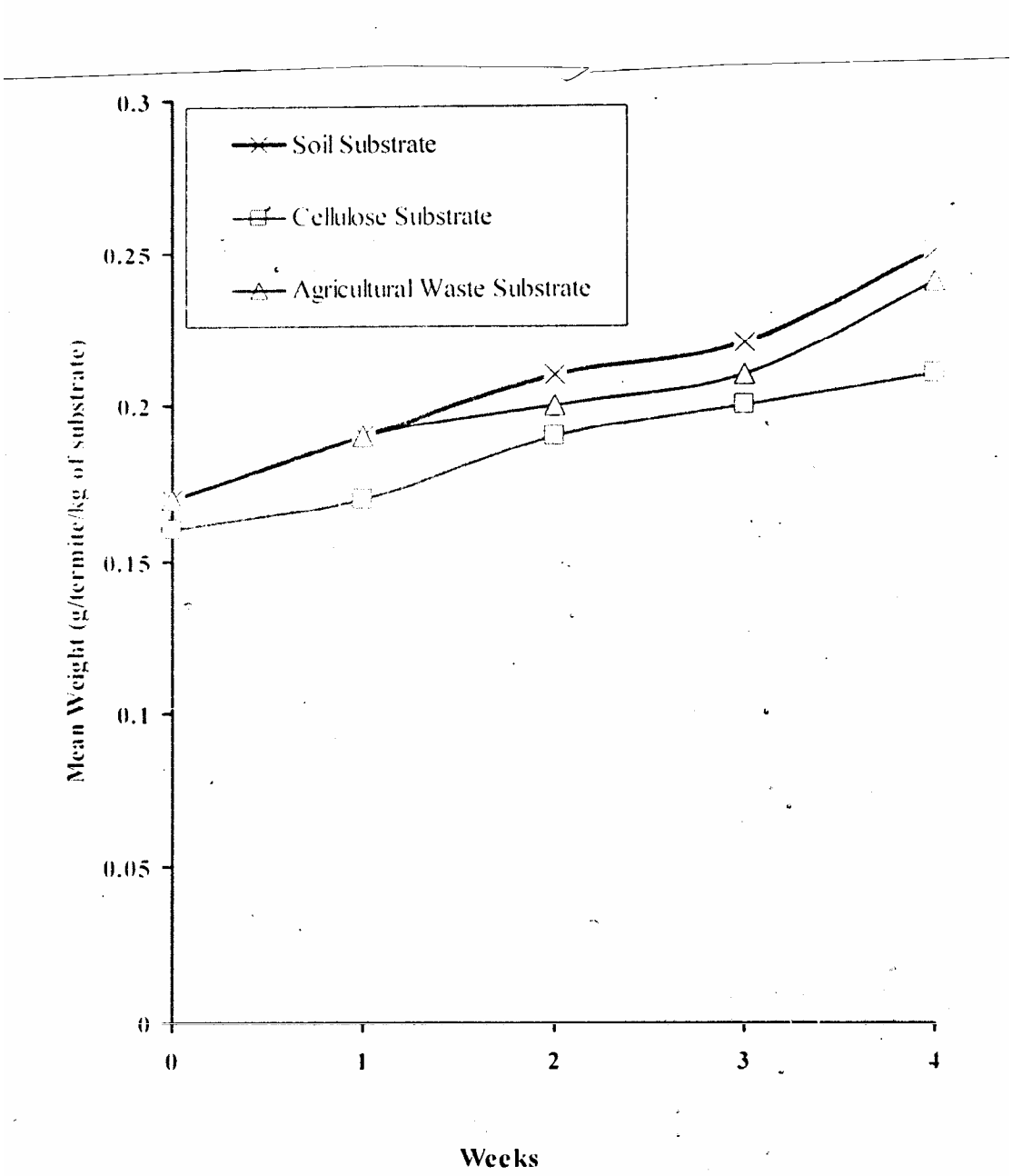

Figure 1. Weekly growth pattern of termite (*Macrotermes subhyalinus*) raised in three different substrates

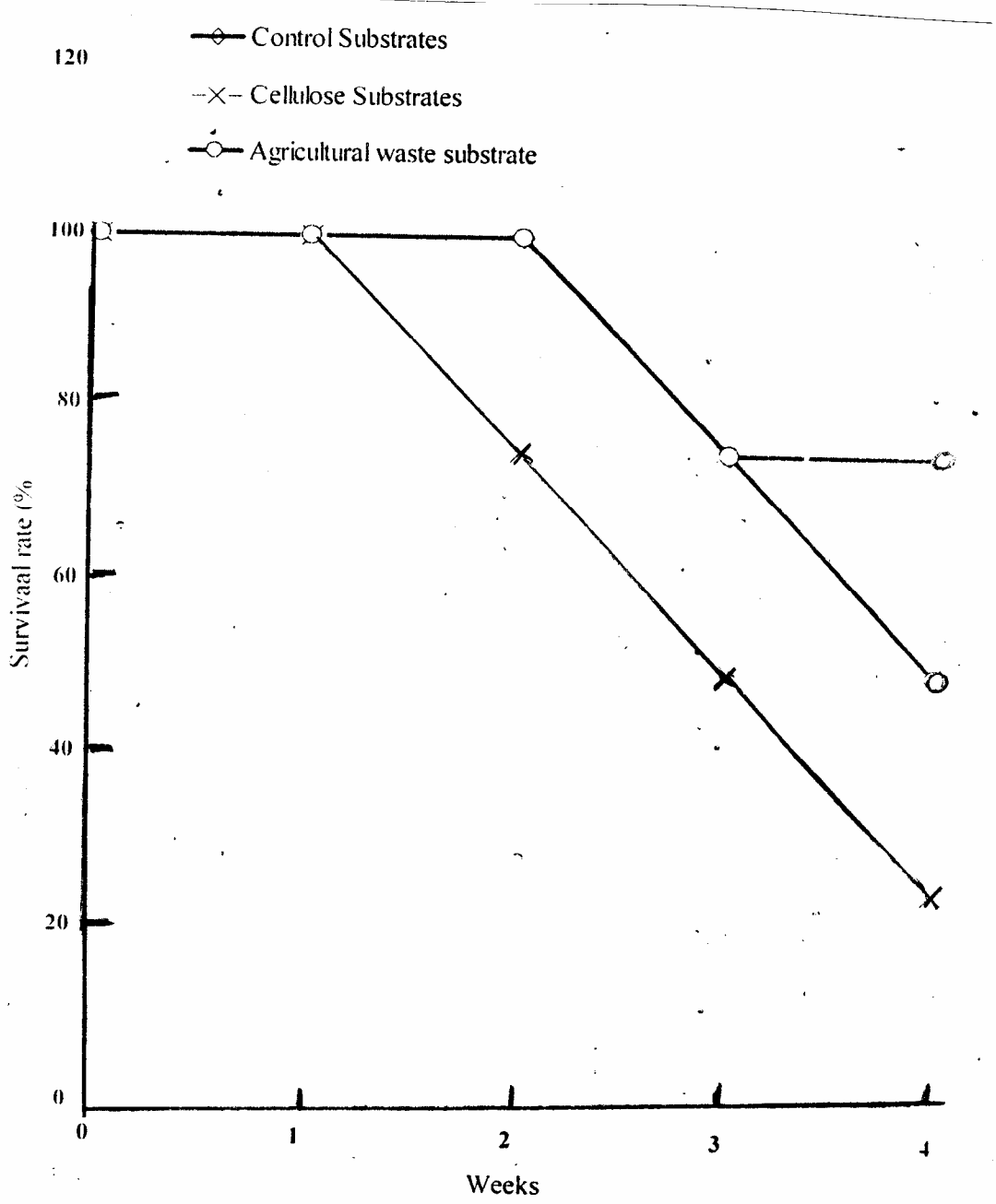

Figure 2. Percentage survival rate of *Macrotermes subhyalinus* cultured in three different substrates under laboratory condition

The highest mean weight gain of 0.08 g/termite/week was recorded in soil substrate, followed by 0.07 g/termite/week in agricultural waste substrate while the lowest weight gain of 0.05 g/termite/week was from cellulose substrate (Table 2). There was no significant difference $p > 0.05$) between the mean weight gain recorded for all the treatments. The relative growth rates recorded during this study were 47.06%, 41.18% and 31.25% for termite agricultural waste substrate, soil and cellulose substrates respectively as shown in Table 2. There was significant difference ($p < 0.05$) between the relative growth rate for all the substrates. The lowest specific growth rate of 0.42% was recorded for cellulose substrate while the highest of 62% was recorded for soil substrate. There was also a significant difference ($p < 0.05$) between the specific growth rates for all the substrates.

The initial condition factor ranged from 3.63 – 3.93 for the three substrates. The final condition factor fro termites raised in soil substrate was the lowest, 3.22, while the highest value of 3.48 was recorded for cellulose (Table 2). There were significant differences ($p < 0.05$) between the initial condition factors for all the three substrates, as well as between the initial and final condition factors for the three substrates.

The highest food conversion ratio of 0.81 was recorded for termites raised in cellulose substrate, while the lowest value of 0.80 was recorded for termites cultured in agricultural waste and soil substrates. There was no significant difference ($p > 0.05$) between the food conversion ratios for the three substrates.

Table 2: Growth performance, condition factor and feed conversion ratio of termites grown on different substrates for 28 days.

Parameters	Soil substrate	Cellulose substrate	Agricultural waste substrate
Mean initial weight (g)	0.17	0.16	0.17
Mean final weight (g)	0.25^{a}	0.21^{a}	0.24^{a}
Mean weight gain (g)	0.08^{a}	0.05^{a}	0.07^{a}
Mean initial length (cm)	1.67	1.64	1.63
Mean final length (cm)	1.98	1.82	1.91
Mean increase in length (cm)	0.31^{a}	0.18^{c}	0.28^{b}
Relative growth rate (%)	47.06^{a}	31.25^{b}	41.18^{a}
Specific growth rate (%)	0.62^{a}	0.42^{c}	0.53^{b}
Daily growth index (g/day)	0.27^{a}	0.18^{c}	0.24^{b}
Initial condition factor (k_1)	3.65^{a}	3.63^{a}	3.93^{b}
Final condition factor (k_2)	3.22^{a}	3.48^{a}	3.44^{a}
Feed conversion ratio	0.80^{a}	0.81^{a}	0.80^{a}
Number stocked	4	4	4
Number at the end of experiment	3	1	2

All values in the same row with different superscripts are significantly different ($p < 0.05$).

Discussion

The specie used in this study has been reported to have highest incidence in comparison to other common termites in Nigeria (Malaka, 1996). The poor growth and low survival reported from cellulose substrate shows that this substrate does not favour the cultivation of termites. Although termites have been reported to invade cellulose materials (Malaka, 1996; Ben, 2003), the present study has shown that the

poorest growth responses and highest mortality rates were observed in cellulose substrates. This may be as a result of poultry manure (in the cellulose substrate) which has been reported to be very rich in nitrogen but has low energy content (Ologhobo and Oyewole, 1987).

Termites are really decomposers but they behave differently when in contact with dung which have the tendency of being rich in pathogenic bacteria (Ologhobo and Oyewole, 1997; Myles, 2004). Their guts contain only protozoans that help them to break down cellulose (Malaka, 1996) and not bacteria as previously assumed. The food conversion ratio recorded from the termite grown on cellulose substrate and agricultural waste was probably as a result of the presence of soft cellulose in the growth medium which is a good diet for termites (Myles, 2004).

Malaka (1996) had reported that *M. subhyalinus* is a fungus growing termite which secretes its own cellulase thereby making it possible for it to digest the cellulose substrate in the medium. It has been reported that cellulase and its component enzymes endo-β-1,4-gluconase and β-1,4-glucosidase which digest cellulose and its components have been identified in the midgut of workers in *M. subhyalinus* and *M. michaelseni* (Veivers et al., 1991).

The problem if inability to breed in isolation encountered by most termite culturists (Ben, 2003) was also encountered in this study towards the fifth week of the experiment, the entire stock of reproductive termites died. One would think of imbalances in the physiological differences between the culture environment and the natural habitat because at this stage termites are highly sensitive to environmental conditions in their microclimate and can be easily affected by these environmental imbalances.

It has also been reported by Malaka (1977) that the mould of macrotermitinae in Africa appeared to have low organic content as compared to their surrounding soils because members of this group use sub-soil for construction of their mould without incorporating excreta used by other termite species. Inability to feed could be due to the fact that there is a delay in foraging activity when in a new environment as reported by Rouland et al. (2003). These authors also suggested that this species has a preference for cane sugar and ground millet compared to dead wood and Acacia leaves. Other workers have suggested collection from mould and during swarm activity as alternative solutions to the problems of culture in isolation (Darlington, 1990; Fasoranti and Ajiboye, 1993; Umeh and Ivbijaro, 1997).

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References

Ben, E. (2003) Culture of baby termites. Sourced from the Internet.

Darlington, J. P. E. C. (1990) Populations in nests of the termite *Macrotermes sublivalinus* in Kenya. Insects Sociaux 37(2), 158 – 168.

De Valle, F. R.; Mena, M. H. and Bourges, H. (1982) An investigation into insect protein. Journal of Food Processing and Preservation. 16(2), 99 – 110.

Farina, L.; Demey, F. and Hardouin, J. (1991) Production de termites pour l'aviculture villageoise au Togo. Tropicultura 9(4), 181 – 187.

Fasoranti, J. O. and Ajiboye, D. O. (1993) Some edible insects of Kwara State, Nigeria. Amer. Entomol. 39(2), 113 – 116.

Malaka, S. L. O. (1977) A study of the chemistry and hydraulic conductivity of mound materials and soils from different habitats of some Nigerian termites. Australian Journal of Soil Research 15(1), 87 – 92.

Malaka, S. L. O. (1996) Termites in West Africa. University of Lagos Press, 165pp.

Myles, T. G. (2004) Selected North American Termites, Their Distribution, Habitats and Natural Diets and Potential Use as Decomposers. Sourced from the Internet.

Ologhobo, A. D. and Oyewole, S. O. (1987) Replacement of groundnut meal by dried poultry dropping (DPD) and dried activated sewage sludge (DASS) in the diets for broilers. Biological Wastes 12, 275 – 281.

Razon-Arceno, C.; Beningo, E. and Rason, E. (1981) How to raise red earthworms profitably. Rosemarie de los Reyers Ed. Vermi-Farms Philippines Inc., Suite 401, Rufino Bidg, Ayala Avenue, Makati, Philippines. 42pp.

Rouland, C.; Lenoir, F. and Lepage, M. (1991) The role of symbiotic fungus in the digestive metabolism of several species of fungus-growing termites. Comp. Biochem. Physiol 99A, No. 4, 657 – 663.

Rouland, C.; Lepage, M.; Chotte, J. L.; Dioufr, M.; Adiaye, D.; Ndiaye, S.; Seuge, C. and Brauman, A. (2003) Experimental manipulation of termites (Isoptera: Macrotermitidae) foraging patterns in sahelo-sudanese savanna: effect of litter quality. Insectes-Sociaux 50(4), 309 – 316.

Veivers, P. C.; Muehlemann, R.; Slaytor, M.; Euthold, R. H. and Bignell, D. E. (1991) Digestion, diet and polytheism in two fungus-growing termites: *Macrotermes subhyalinus* (Rambur) and *M. michaelseni* (Sjoestedt). J. Insect Physiol. 37(9), 675 – 682.