UNIVERSITI PUTRA MALAYSIA

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This project report is a part of the fulfillment for Bachelor Science (Honor).

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ABSTRAK

Anai-anai jenis subterranean, *Coptotermes curvignathus* Holmgren merupakan spesies bagi kajian ini. Anai-anai didedahkan kepada blok-blok kayu yang telah direputkan oleh dua spesies fungi iaitu *Pycnoporus sanguineus* dan *Phellinus noxius*. Tempoh masa bagi proses pereputan adalah berbeza. Dengan menggunakan blok-blok kayu yang direputkan oleh *P.sanguineus* dalam ujian pemakanan berpilihan dan ujian pemakanan tiada pilihan, keputusan tidak menunjukkan sebarang kegemaran secara anai-anai yang bererti. Bagi *P. noxius* pula, anai-anai menunjukkan kegemaran secara yang bererti kepada blok kayu sihat dan blok kayu yang direputkan selama tiga minggu dalam kedua-dua ujian pemakanan berpilihan dan ujian pemakanan tiada pilihan. Secara amnya, kadar kematian anai-anai dalam semua ujian adalah agak tinggi. Kadar kematian anai-anai yang didedahkan kepada blok kayu yang direputkan oleh *P. noxius* selama 3 minggu adalah seratus peratus. Dalam ujian yang bertujuan menentukan respon anai-anai kepada blok-blok kayu yang berbeza, anai-anai lebih berkumpul pada blok kayu sihat bagi empat jam pertama. Selepas empat jam, tiada perbezaan yang bererti ditunjukkan. *C. curvignathus* mengamalkan corak pencarian makanan yang rawak.

ABSTRACT

The subterranean termite species *Coptotermes curvignathus* Holmgren was observed feeding on test block decayed by two white rot fungi species: *Pycnoporus sanguineus* and *Phellinus noxius*, FP 54, over the different lengths of time. For test blocks decayed by *P. sanguineus*, neither in choice-feeding nor force-feeding test, showed no significant difference on their feeding preference. When the test blocks were decayed by *P. noxius*, termites consumed more on the sound test block and the test block that had been decayed for 3 weeks. Generally, the mortality rate of termites was high in the study. Termites exposed to the force-feeding test, using the test blocks decayed by *P. noxius* for 3 weeks, were completely dead at the end of the fourth week. In the test to determine the responses of termites towards different test blocks, termites were noticeable gathered at the sound test block randomly and non-directionally.

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LIST OF SYMBOLS

^{0}C	Centigrade
cm	Centimeter
g	Gram
kPa	Kilopascal
mg	Milligram
oz	Ounce
SE	Standard error
spp.	Species

1.0 INTRODUCTION

Termites, just like ants, bees, and wasps, are social insects, each individual acting as part of a group governed by the demands of the colony and ultimately by the queen (Pearce, 1997). They live permanently together, in more or less fixed, organized communities (Snyder, 1948).

Termites are well recognized as the most damaging wood feeding insect in the world (Flemmich, 1956; Cain, 1970 & Harris, 1970). Grace (1997) as cited by Pearce (1997) noted that they were indeed serious pests of trees, structures and wood products. Within their geographical boundaries, termites are a threat to structural timbers, to manufactured goods of wood, paper and material such as books, carpets, textiles, poles, post and fur (Flemmich, 1956; Spear, 1970; Harris, 1970).

Wood feeding insects and wood-decay fungi play central role in forest nutrient cycles by degrading dead wood (Waller, 1993). This is a measure of the importance of their nature-breaking down and returning to the soil and atmosphere the enormous tonnage of dead and fallen trees and other cellulosic material that is continuously accumulating in the earth surface (Snyder, 1948). Although insects and decay fungi frequently attack the same logs, the interactions between these taxa are complex and poorly understood. Subterranean termites frequently eat decay wood, perhaps to augment the nitrogen content of the diet (Waller, 1993).

Many mobile animals generally move in a random, non-directional, non-optimized pattern called kinesis (Fraenkel & Gunn, 1940). Delaplane (1991), Oi, *et* *al.* (1996), Hoare & Jones (1998), Miura & Matsumoto (1998) and Mora *et al.* (1996) as cited by Soato (1999) noted that although there is a fair amount of published information on the foraging behavior of termites cited from, but no quantitative studies have been done to observe how termites to begin their search of food by using the various stages of decaying rubber wood. Two fungi are chosen; they are white rot fungi, *Pcynoporus sanguineus* and *Phellinus noxius*, FP 54.

Desh (1940), Dhanarajan (1977), Rahim (1981) and Lim 1982 as cited by Mahpar (1986) noted that the major types of termites found degrading timber and wood products in this country are subterranean termites and drywood termites. *Coptotermes curvignathus* is selected for this study because this species of termites has been reported to have cause a lot of damage to the wood product in the tropics (Harris, 1961). Khoo *et al.* (1991) as cited by Sajap (1999). It attacks orchard trees such as mango, durian and papaya and industrial plantation crops as *Hevea* and oil palm.

This study is conducted to determine whether termite preferred to eat wood decayed with fungus or undecayed. The objectives of this study are:

1 To determine the preference of subterranean termite to various stages of decaying wood blocks.

2 To determine the responses of subterranean termite to various stages of decaying wood blocks.

3 To establish the foraging pattern of subterranean termite.

2.0 LITERATURE REVIEW

2.1 Introduction

Insects of the order Isoptera are known as termites or "white ant", the latter being an unfortunate terms since the insects are more closely related to cockroaches (Blattaria: Dictyoptera) than to the true ants (Formicoidea: Hymenoptera). Isoptera means 'equal-winged' on account on the winged adults having two pairs of wing of similar shape and size (Hickin, 1971).

There are three major types of termites: Drywood, Subterranean and Formosan . Termites are identified by the appearance of the swarmers or soldiers, their damage, and the droppings they leave behind.

Termites always live in communities. They may be complex and may number several million individuals or may be relatively simple, the community consisting of a few dozen individuals only (Hickin, 1971). They are highly socialized. Their grouping are, in extreme cases, very intricately differentiated and organized. A termite colony consisting winged and wingless reproductive forms and numerous wingless sterile workers, nymphs, and soldiers (Krishna, 1969). In termites both sexes lived together and probably had similar behavioral repertoires. They continued so and evolved similar polymorphism comprising a reproductive and a worker caste with, almost invariably, a soldier caste defensive as well (Hickin, 1971).

Termites are almost wholly decomposers of wood, humus, organic matter and foliage. They associate with fungi, termophiles and parasites, and symbiotic relationship with protozoan and bacteria (Lee & Wood, 1971). They nest and live for the most part in or near the soil where they often attain high densities and considerable microclimatic regulation. Termites live almost exclusively in tropical and sub-tropical zones but these may vary from very wet to very dry (Pearce, 1997).

2.2 Classification

A thousand and nine hundred living and fossil species of termites have been described, the vast majority being found within the tropics (Krishna, 1969). The oldest fossil termites known is from the mid-Permian deposits in the Ural Mountains. It is a wing just three–quarters of an inch long (*Uralotermes perianum*) (Hickin, 1971).

The known species of termite are divided into families and subfamilies, which followed the classification of Kishna (1969), largely based on the works of Snyder (1949) and Emersan (1955).

Table 1: The classification of termites.

Family I	Mastitermitidae	
Family II	Kalotermitidae	
Family III	Hodotermitidae	
	Subfamily 1	Termopsinae
	Subfamily 2	Stolotermitinae
	Subfamily 3	Porotermitinae
	Subfamily 4	Cretatermitinae (fossil)
	Subfamily 5	Hodoterminae
Family IV	Rhinotermitidae	
	Subfamily 1	Psammotermitinae
	Subfamily 2	Heterotermitinae

	Subfamily 3	Stylotermitinae
	Subfamily 4	Coptotermitinae
	Subfamily 5	Termitogetoninae
	Subfamily 6	Rhinotermitinae
Family V	Serritermitidae	
Family VI	Termitidae	
	Subfamily 1	Amtermitinae
	Subfamily 2	Termitinae
	Subfamily 3	Macrtermitinae
	Subfamily 4	Nasutitermitinae

The first five families are known collectively as the lower termites. The termites in these five families posses symbiotic protozoans in the hind intestine on which they depend for digestion of cellulose (Krishna & Emerson, 1969). The sixth family (Termitidae), which includes 75% of the known species, as the higher termites. This family is the most advanced and diverse, exhibiting wide variety of social specializations and does not possess symbiotic protozoans (Lee & Wood, 1971).

2.3 Foraging Behavior of Termite

All termites construct a system of galleries or runways, either covered or uncovered, along which they travel in search of requisites such as food, moisture and soil particles. They construct special foraging galleries in the soil or make covered runways or sheeting on the soil surface, low grow plant, fallen logs, or on the outside of standing trees, leading from the central nest system to sources of food and often these are very extensive (Lee & Wood, 1971). Some termites, notably the wood feeding Calotermitidae, Termopsinae, Stolotermitinae and Porotermitinae, excavate their nest and galleries solely within their food supply. Other species With similar habits are *Ahamitermites* and *Incolitermers* (Amitermitinae) which are obligate inquilines in the nest of *Coptotermes* in Australia, and excavate galleries within, and feed on, the carton on their hosts' nest (Lee & Wood, 1971).

Soil galleries are made by moistening the soil with saliva, moulding it into a soft pellet with the mouthparts and applying it with a rocking movement (Pearce, 1997). Soil runways as found in *Macrotermes*, are usually made with high proportions of clay some sand particles moistened with saliva. Soil runways (small tunnels of soil) can be built over the outside plants (Wood, 1971).

Greaves (1962) as cited by Wood (1971) noted subterranean termites, *Coptotermes acinaciformis* and *Coptotermes brunneus* formed their subterranean galleries by pressing sol away from a central starting point to form a compact layer around the gallery. Excavation has already noted as a method of constructing subterranean nests (Lee & Wood, 1971).

Depending on species, runways are constructed of excreta or of soil particles cemented together with excreta or salivary secretions. The construction of covered runways follows odor trails laid by secretions of pheromones from the sternal gland (Stuart, 1969). The pheromone is secreted by the sternal glands of the workers and soldiers of all termites' families (Stuart, 1969). This gland is less developed in younger workers (Pearce, 1997). Secretion is made through pores into a cavity formed by a segment in front. Possibly, the extend to which the aperture at the posterior end of this reservoir is opened is regulated by the pressure exerted by the abdomen as it is pressed against the ground (Stuart, 1969). A strong trail will cause the termites to produce wider galleries, though trails are less important where soil runways are used as guides.

The concentration of the trail increases with the number of workers on the trail and therefore affects the locomotion rate and the direction (Stuart, 1969). A normal trail leads to the nest so the food trail needs to be more attractive to encourage other workers to follow. The odor trails may serve varied purposes. It has been observed, for example, that breaks in the nest structure of *Zootermopsis* stimulate the laying of trails to for repair work (Pearce, 1997).

2.4 Wood-Rotting Fungi

Wood-rotting fungi are, by definition, those, which can bring about significant weight loss and structural change in woody tissues. The fungi are saprophytic or parasitic members of the Thallophyta, entirely devoid of chlorophyll, reproduced by spores which may be sexual in origin, and possessing in most species a thallus made up of filaments, or hyphae, which are usually colourless and together constitute the mycelium (Gwynne-Vaughan, 1962).

There are three basic classes of decay fungi have been identified which differ in the nature of their attack on major cell wall components, white-rots, brown-rot and soft-rot (Cooke, 1984).

2.5 Termite-Fungi Relationship

The significance of termite fungi relationship is whether they provide special nutrient to termites or decompose the cellulose and lignin or play some important roles that are still unclear. A lot of termites are closely associated with fungi; some are symbiotic, while others are parasitic and saprophytic (Krishna, 1969).

Symbiotic relationship between termites and fungi has been found in their feeding habit and digestive process (Sand, 1969). The fungus helps in partial digestion of cell-wall material. In white rot, where fungi attack both lignin and cellulose, the cellulose becomes easily available to termites (Bakshi, 1951). Hendee (1934) as cited by Krishna (1969) observed improved growth of termites in presence of fungi. In her experiment, *Zootermopsis angusticollis* made more vigorous growth on decayed wood than on sound wood. Unger (1973) reported that pine and beech wood increase the termites feeding activities after the woods are exposed to brown rot fungi. For example, William (1965) as cited by Krishna (1969) stated that cubical brown rot fungus (Lentinus pallidus. Berk) breaks down lignin to provide extra assimilable carbohydrate to termites (*C. niger*. Synder). Studies reported that percentage of weight loss (*C. formassanus*) increase when there is greater decay of wood (*Pinus*). It is not certain whether the improved growth of termites is due to superior nutritional qualities of infected wood (fungi being a source of proteins) or to the neutralization by the fungi of some toxic factor in the substrate or to both conditions (Bakshi, 1951).

Actinomucor corymbosus appeared to be the source of vitamin and protein for young termites of *Reticulitermes lucifagus* (Krishna, 1969). Hungate showed that there was no significant growth and increase of nitrogen in *Zootermopsis* when they are fed on sound pinewood. There was a great increase of nitrogen of the wood at the expense of the nitrogen in the soil presumably due to fungus action (Krishna, 1969). Luscher (1951) observed that the spheres are eaten so rarely that they scarcely play a large part in the nutrition of termites. It is believed that the spheres may serve as a source of food and vitamin to termites.

The association between fungi and termites can be one of parasitism of the fungus on termites. Becker (1974) found that fungus (*Entomophtora coronata* could killed 100% of the samples of *C. curvignathus* Holm. In Malaysia, these fungi are very commonly found in laboratory culture of termites. Thaxter (1920) as cited by Krishna (1969) established a genus Termitaria, one species of which, *T. synderi* was found parasitic on workers and soldiers of some species of *Reticulitermes*, while *T.coronata* attacked *Eutermes morio* var *St. lucinae*. A closely related fungus was occasionally parasitic on *R. lucifugus*. Bakshi (1951) established the parasitism of the fungus and infectious nature of the disease. Infected termites weaken, become sluggish and others devour mould with difficulty, and in extreme cases.

2.6 Reponses of Termite to Stages of Decay

There is little precise information available although its significance to termites. This subject was reviewed by Sands (1969). Certain fungi produce substances, which positively attract some termites but repel others, while some fungi are toxic. The symbiotic relationship between the Maccrotermitinae and fungi belonging to the genus *Termitomyces* is a special case of dependence on decay degree of plant material (Wood, 1971). Josens (1970) as cited by Wood (1971) estimated that the time between deposition of faeces on the fungus comb and their consumption by termites was approximately five to six weeks in *Odontotermes pauperans* (Silvertri) and two months in *Ancis trotermes cavithorax* (Sjöstedt) and *Microtermes toumodiensis* Grassé but it is not certain whether or not this time interval is related to degree of decay by the *Termitomyces* or to the nutritional requirements of the colony. Skaife (1955) as cited in Wood (1971) showed *hat Amitermes hastatus* had a distinct preference for partially decay of stems Restionaceae, the preferred state being soft stems still retaining their original form.

2.7 Effect of Decayed Wood on Foraging Behavior

Kovoor, (1964) as cited by Sand (1969) found that the termites (*Microtermes odentatus*) preferred to feed on decayed rather than healthy wood. Becker *et al.* (1971) found that runway of termites (*Reticulitermes spp*) tends to go straight to decaying wood. Wood rotting species act as an attractant or stimulant substance, which lead the termites to the food source (Hickin, 1971). Termites are very attracted to odors of wood decaying fungi that, through the decay process, make the wood easier to penetrate..

Moisture is important to subterranean termites, which have very little resistance to dehydration. To survive, they must maintain contact with the soil (their primary moisture source) or other above ground moisture source. Studies noted fungally attacked wood hold an increased amount of moisture. Luscher (1951) observed that humidity and temperature in the fungus-garden area were higher than elsewhere and conclude that fungus-gardens play a large part in the conditioning the microclimate inside termite nests. Further, in breaking down cellulose, both fungi and termites occupy important places in nature.

2.8 Feeding Behavior of Termite

There is different way in which termites feed. Cellulose is the basic food for all termites. There are two basic patterns in the subterranean termites foraging. The first pattern is species, which often forage over long distances to the food sources (Harris, 1970). Species of termites with this behavior pattern are *Coptotermes* spp., *Amitermes* spp., *Globitermes* spp., and *Nasutermes* spp. The second pattern is found in some species of all groups and is especially associated considered abnormal if one or more of its protozoan species is absent (unhealthy termites) (Carter *et al.*, 1975). Lower termite contained protozoa that play a important part in digestion system. However, the protozoa are absent in the higher termite. The absence of protozoa in the higher termites but complex and variable association of bacteria replaces them. Apparently these latter termites do not have an exchange of proctodeal food.

3.0 MATERIALS AND METHODS

3.1 Termite

Subterranean termite *Coptotermes curvignathus* (Holm), Rhinotermitidae was selected in this study because *C.curvignathus* is the most economical termite species in Malaysia (Tho, 1992).

3.2 Termite Collection

The subterranean termite was collected from infested trees, in University Putra Malaysia campus. A plastic container with, opening at the bottom where the termite could pass through, was filled with wood. This container was buried near infested trees underground. Termite was collected and brought back to the laboratory after a week.

Termite was transferred to other container, which was filled with moistened filter paper to ensure the survival of the termites. This particular termite is sensitive to changes in the environmental condition and is liable to attack by ants (Tho, 1974).

3.3 Preparation of Decayed Wood

3.3.1 Wood

Rubber wood, free of knots and visible concentration of resins, and showing no visible evidence of infection by mold, stain, or wood-destroying fungi was used in this study.

Test blocks were cut as accurately as possible to 2.54 cm square by 0.64 cm in radial direction (Figure 1). The blocks were weighed after they come to approximate equilibrium moisture content in storage, and to sort them into fairly narrow-rage weight groups. One feeder strip was needed for each block in the culture bottle. The feeder strips were approximately 0.3 by 2.8 by 3.4 cm.

3.3.2 Test Fungi

Two white-rot fungi, *Pycnoporus sanguineus* and *Phellinus noxius*, FP 54 were used in this study. *P. noxius* was collected from the Forest Research Institute Malaysia (FRIM) (Figure 1).

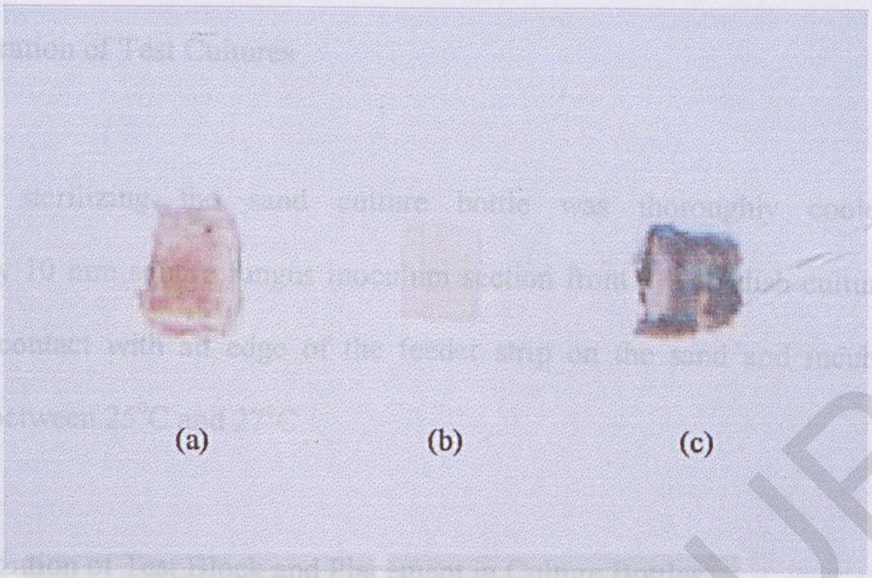


Figure 1. Test block decayed by *P. sanguineus* (a); sound test block (b); test block decayed by *P. noxius* (c).

3.3.3 Culture Media

A nutrient medium consisting of about 2-weight percent malt extract and 1.5 weight percent agar was used for petri dish cultures of the test fungi. The medium was sterilized at 103 kPa for 20 minutes and cooled before inoculations.

A culture bottle was half-filled sieved and oven-dried sand. The amount of sand about was 120 cm^3 for an 8-oz. culture bottle. The sand was moistened up to 130 percent of the water-holding capacity. Forty-six grams of reagent water was added to each culture bottle. The feeder strip was placed directly on the sand. The prepared bottles were steam sterilized at 103.4kPa for 60 minutes.

3.3.4 Preparation of Test Cultures

After sterilizing the sand culture bottle was thoroughly cooled. A approximately 10 mm square fungus inoculum section from a petri dish culture was placed it in contact with an edge of the feeder strip on the sand and incubate at temperature between 25°C and 27°C.

3.3.5 Sterilization of Test Block and Placement in Culture Bottles

Test blocks were exposed under open laboratory room conditions for 48 to 72 hours. The individual block was weight to the nearest 0.01g just before they were sterilized and subsequently placed in contact with the test fungus on the feeder strip.

Before putting the test blocks in the culture bottles, they were placed by the relention groups into closed containers and steamed at 100±2°C for 20 minutes. After cooling, the test block was placed aseptically with a cross-section face centered in contact with the mycelium-covered feeder strip, in the previously prepared culture bottles (Figure 2).

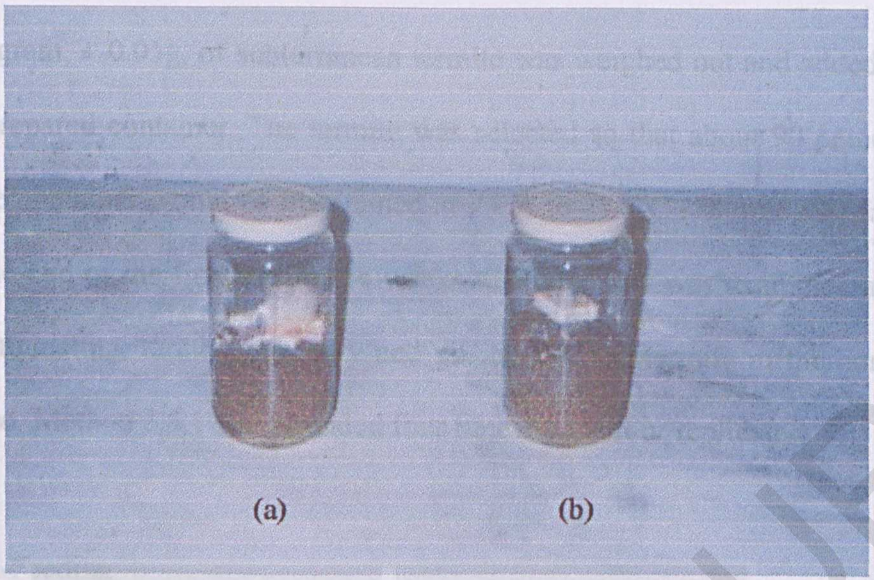


Figure 2. The culture bottle contained test block and feeder strip decayed by *P. sanguineus* (a); test block decayed by *P. noxuis* (b).

3.4 Preference of Termite to the Various Stages of Decaying Wood Blocks

3.4.1 Choice-Feeding Test

Clear container with loosely fitting tops with liners removed, 284 to 568cc (8 to 16 oz.) was washed, rinsed antiseptic solution, and dried. Four different test blocks, sound test block, 1week decayed test block, 2 weeks decayed test block and 3 weeks decayed test block were placed in the bottom of the container with one edge of the each test block against the side of the container. Two hundred grams of sieved, washed, heat-sterilized sand were added to the container. Forty grams distilled water was added to the container. After addition of the water the container was allowed to stand overnight (Figure 3).

One gram, ± 0.05g, of subterranean termite was weighed out and added to the previously prepared container. The termite was selected so that about 90 percent are workers. The container would be maintained at 25.5^{0} to 27.7^{0}C (78^{0} to 82^{0}F) for four weeks. At the end of the first and fourth weeks, the container was examined and the presence of tunneling, termite mortality and position of the termite in the container were recorded. Method 3.5.1 was repeated four times to get four replicates.

3.4.2 Force-Feeding

Method 3.5.1 was repeated with each container filled with one test block. Four containers were needed for four different test blocks. Four replicates were needed in this test.

Figure 3. The plastic container contained sand, test block and termite.

3.5 Responses of Termite to the Various Stages of Decaying Wood Blocks

Four plastic containers contained dried sand and test block, with a 1cm diameter hole were connected to another container contained 25 termites ie. 20 workers and 5 soldiers, with 1 cm diameter on each side by 3 cm transparent tube (Figure 4). The position of test block was rotated between replicates to preclude any position effects. The number of termite that entered the container was recorded every minute for first hour and every hour for following hours. The foraging pattern was observed and tracked on the graph paper.

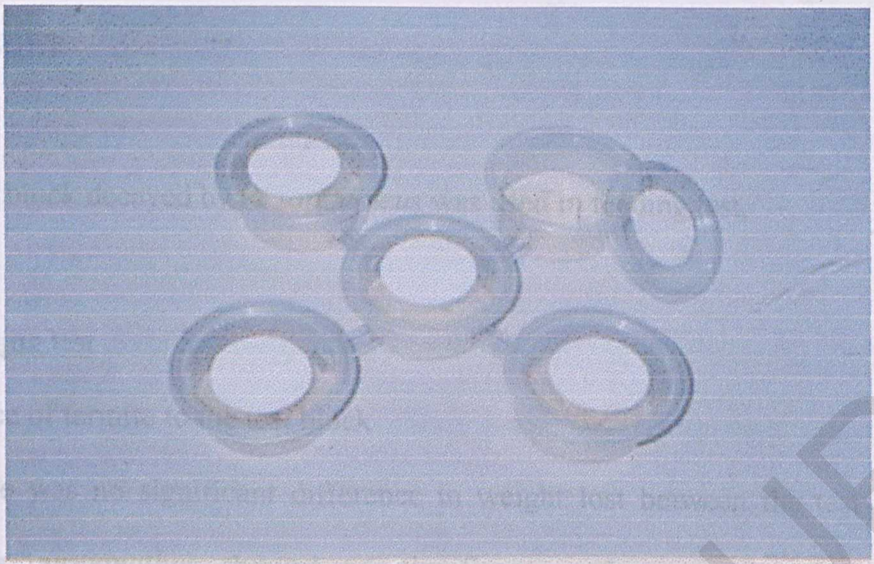


Figure 4. Five containers are needed to determine the responses of termite to different test blocks.

4.0 RESULT

Test block decayed by *P. sanguineus* was used in feeding test,

Choice-feeding test

(i) Preference of termite to the test block

There was no significant difference in weight lost between the test blocks. *Coptotermes curvignathus* showed no significant preference to the test block (ANOVA, F = 0.204, *P* = 0.891).

(ii) Mortality

High rates of mortality had been showed in this test (91.3±5.86 SE) (Table 3).

Force-feeding test

(i) Preference of termite to the test block

C. curvignathus showed no significant preference to the test block (ANOVA, F = 1.886, *P* = 0.186).

(ii) Mortality

The complete mortality of termites had been shown in the test by using the 3 weeks decayed test block. In comparison, the result showed no significant difference over the sound test block, 1 week decayed test block, 2 weeks decayed test block and 3 weeks decayed test block (ANOVA, F = 2.001, *P* = 0.168).

When the test block decayed by *P. noxius* was used in feeding test,

Choice-feeding test

(i) Preference of termite to the test block

Mean of the weight lost of test blocks was significantly different (ANOVA, F = 7.307, P = 0.005). Termites significantly consumed more sound test block (576.2±87.49 SE) and test block decayed for 3 weeks by *P. noxius* (377.9±17.53 SE) (Table 2).

(ii) Mortality

This test showed high mortality rate (79.1±11.59 SE) (Table 3).

Force-feeding test

(i) Preference of termite to the test block

Mean of the weight lost of test blocks was significantly different (ANOVA, F = 11.809, P = 0.001). Termites significantly consumed more sound test block (850.0±54.42 SE) and test block decayed for 3 weeks by *P. noxius* (698.1±70.74 SE) (Table 2).

(ii) Mortality

The mortality rate of termites in the test was no significantly difference over the sound test block, 1 week decayed test block, 2 weeks decayed test block and 3 weeks decayed test block (ANOVA, F = 1.780, P = 0.204).

Table 2. Mean of the weight lost (mg±SE) of the test blocks. (n=4).

	Pycnoporus sanguineus		*Phellinus noxius*	
	Choice-feeding test	Force-feeding test	Choice-feeding test	Force-feeding test
Sound test block	298.2±66.77	712.3±67.54	576.2±87.47	825.0±54.42
1 week decayed test block	339.3±68.89	698.2±199.71	242.8±67.76	459.4±28.62
2 weeks decayed test block	303.6±38.82	687.1±121.82	192.4±59.60	445.8±53.98
3 weeks decayed test block	266.9±80.65	350.5±73.76	377.9±17.53	698.1±70.74

Significant F values at $P \leq 0.05$.

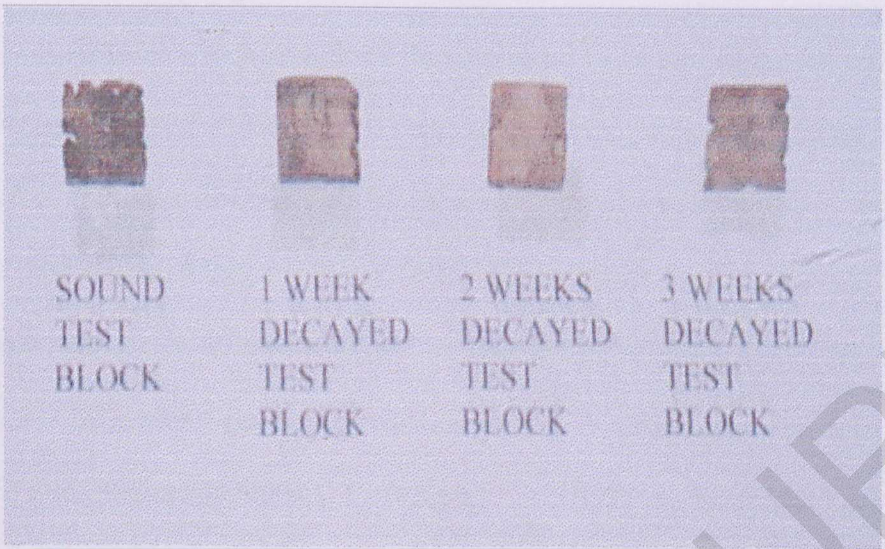
Table 3. Mean of the mortality (%±SE) of termites. (n=4).

Pycnoporus sanguineus		*Phellinus noxius*	
Choice-feeding test	Force-feeding test	Choice-feeding test	Force-feeding test
91.3±5.86	i. 72.7 ±13.04	79.1±11.59	i. 77.8±7.86
	ii. 90.3±7.28		ii. 85.3±8.81
	iii. 89.3±5.80		iii. 95.4±3.30
	iv. 100.0		iv. 77.0±3.70

i., sound test block; ii., 1 week decayed test block; iii., 2 weeks decayed test block; iv., 3 weeks decayed test block.
Significant t values at $P \leq 0.05$

When comparing between the two fungi, *P. sanguineus* and *P. noxius*, no trend had been shown in both feeding test. Termites did not showed preference to any fungi species. Termite mortality in forced feeding test by using the third weeks *P. sanguineus* decayed test block was greater then other fungus species (100%; 77.0±3.70% SE) (Table 3).

Termite were placed on the surface of the sand at the beginning of the test. Tunneling was observed after the end of the first and fourth weeks. *Coptotermes curvignathus* tunneled into the sand and stayed beneath undersurface, close to the test block. Each block was examined. The damage on the wood is shown in Figure 5 and 6.



(a)

(b)

Figure 5. *P. sanguineus* decayed test blocks evaluation after attacked by termite in choice-feeding test (a) and force-feeding test (b).

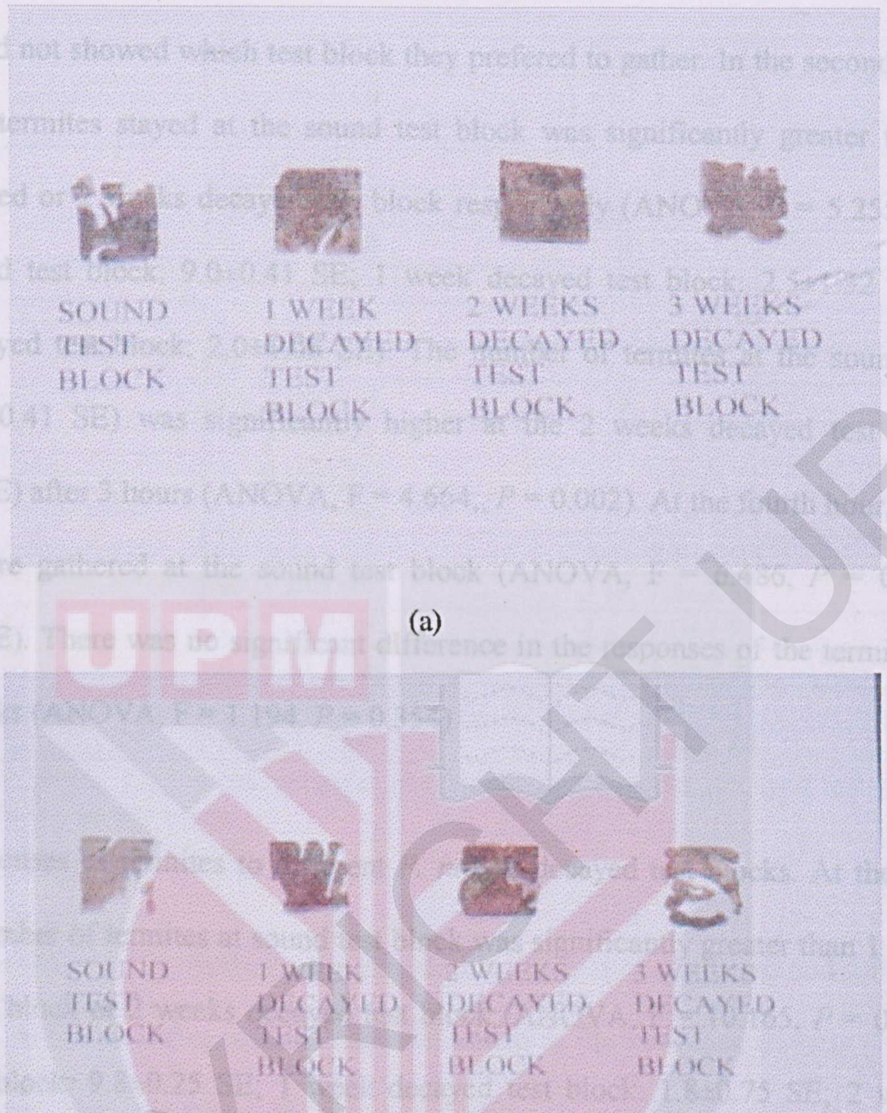


Figure 6. *P. noxuis* decayed test blocks evaluation after attacked by termite in choice-feeding test (a) and force-feeding test (b).

Responses of termites to different *P. sanguineus* decayed test blocks were recorded. Generally, termites contacted all test block at the first five minutes. There was no significant difference over the test blocks (ANOVA, F = 1.227, $P = 0.343$).

Termites did not showed which test block they prefered to gather. In the second hour, number of termites stayed at the sound test block was significantly greater than 1 week decayed or 2 weeks decayed test block respectively (ANOVA, F = 5.255, P = 0.15) (sound test block: 9.0±0.41 SE; 1 week decayed test block: 2.5±1.32 SE; 2 weeks decayed test block: 2.0±1.08 SE). The number of termites at the sound test block (9.0±0.41 SE) was significantly higher at the 2 weeks decayed test block (2.0±1.08 SE) after 3 hours (ANOVA, F = 4.664,, P = 0.002). At the fourth hour, most termites were gathered at the sound test block (ANOVA, F = 6.486, P = 0.007) (9.0±0.71 SE). There was no significant difference in the responses of the termites to the test blocks (ANOVA, F = 1.194, P = 0.354).

Responses of termites to different *P. noxius* decayed test blocks. At the first hour, the number of termites at sound test block was significantly greater than 1 week decayed test block or 2 weeks decayed test block (ANOVA, F = 10.165, P = 0.001) (sound test block: 9.8±0.25 SE; 1 week decayed test block: 1.8±0.75 SE; 2 weeks decayed test block: 1.3±0.75 SE). The number of termites at the sound test block (9.0±0.41 SE) was significanty different to the 2 weeks decayed test block (2.0±1.08 SE) after the second hour (ANOVA, F = 10.165, P = 0.001). However, there were no significant differences at the fifth hour (ANOVA, F = 1.194, P = 0.354) (Table 4).

Table 4. The number of termites contacted to different decayed stages of test blocks. (n=4).

	Pycnoporus sanguineus	*Phellinus noxius*
Fifth minute	i. 2.5±1.19	i. 7.0±1.58
	ii. 0.3±0.25	ii. 0.3±0.25
	iii. 1.5±1.19	iii. 1.5±0.87
	iv. 0.8±0.48	iv. 4.0±2.82
First hour	i. 7.5±2.53	i. 9.8±0.25

	ii. 4.0±0.71	ii. 1.8±0.75
	iii. 3.5±3.18	iii. 1.3±0.75
	iv. 1.5±0.87	iv. 6.8±2.32
Second hour	i. 9.0±0.41	i. 9.0±0.41
	ii. 2.5±1.32	ii. 2.5±1.32
	iii. 2.0±1.08	iii. 2.0±1.08
	iv. 6.5±2.33	iv. 6.5±2.33
Third hour	i. 9.0±0.41	i. 9.3±0.48
	ii. 3.0±1.47	ii. 3.0±1.47
	iii. 2.0±1.08	iii. 1.8±1.03
	iv. 6.5±2.33	iv. 6.8±2.93
Fourth hour	i. 9.0±0.71	i. 9.0±0.71
	ii. 3.0±1.58	ii. 3.0±1.58
	iii. 3.1±1.58	iii. 1.8±1.03
	iv. 1.8±1.03	iv. 7.3±2.50
Fifth hour	i. 7.0±1.83	i. 7.0±1.83
	ii. 4.5±2.96	ii. 4.5±2.96
	iii. 2.0±1.15	iii. 2.0±1.15
	iv. 7.5±2.84	iv. 7.5±2.84

i., sound test block; ii., 1 week decayed test block; iii., 2 weeks decayed test block; iv., 3 weeks decayed test block.
Significant F values at $P \leq 0.05$

Coptotermes curvignathus moved randomly. They moved around and followed the periphery of the plastic container. They did not go to the test block directly (Figure 7). Even though they contacted the test block they did not stay there and kept on searching around. Some of them did not leave after contacted with the test block until they died.

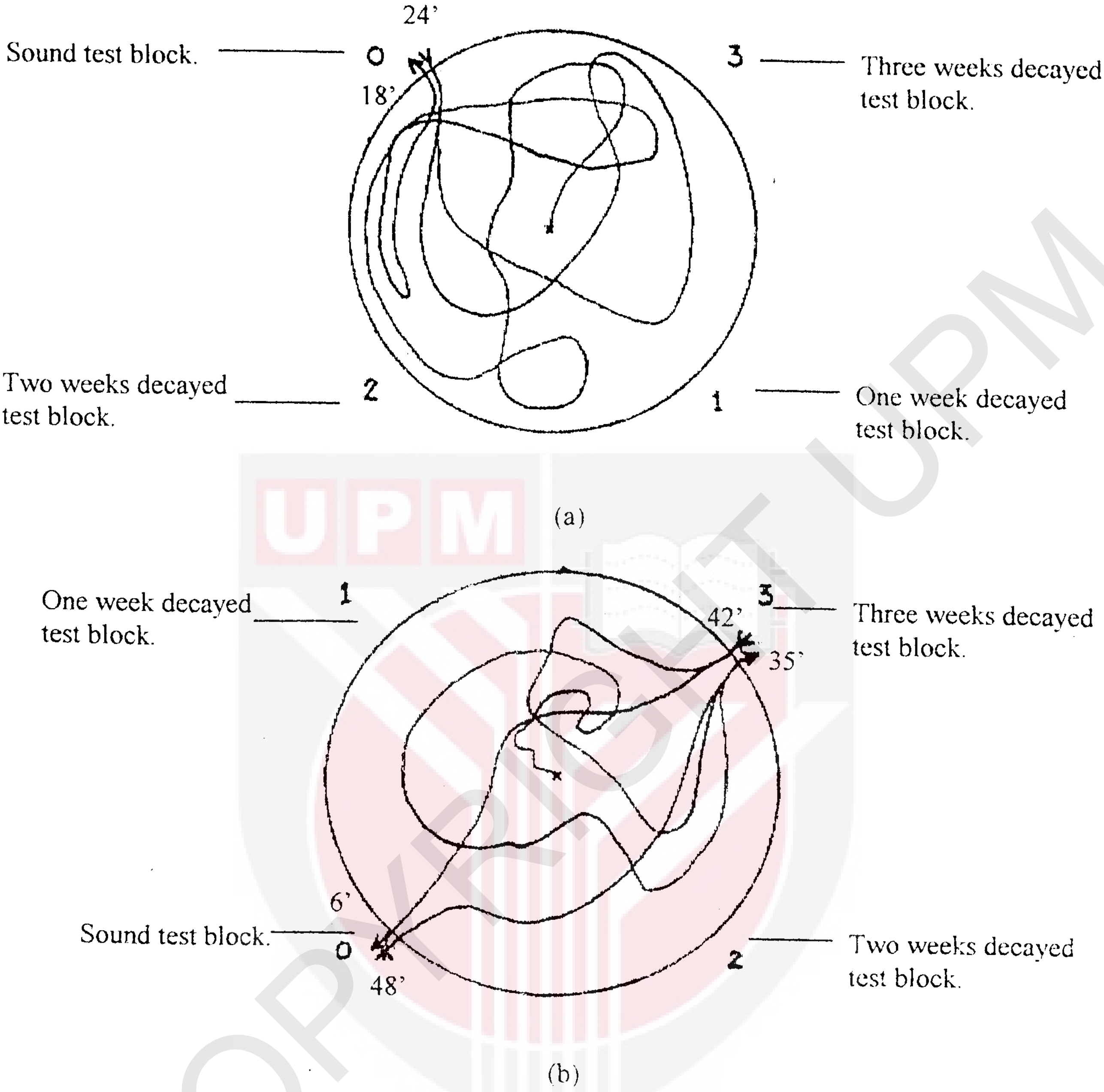


Figure 7. The foraging pattern of termites. The workers of *C. curvignathus* searching for *P. sanguineus* decayed test block (a) and *P. noxius* decayed test block (b) in 1 hour.

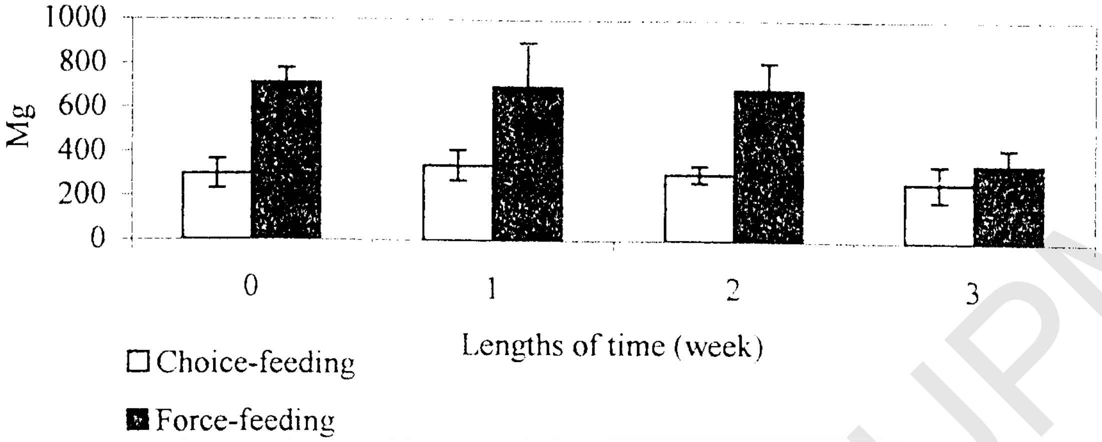


Figure 8. Consumption by *C. curvignathus* on wood at varying *P. sanguineus* decaying stages.

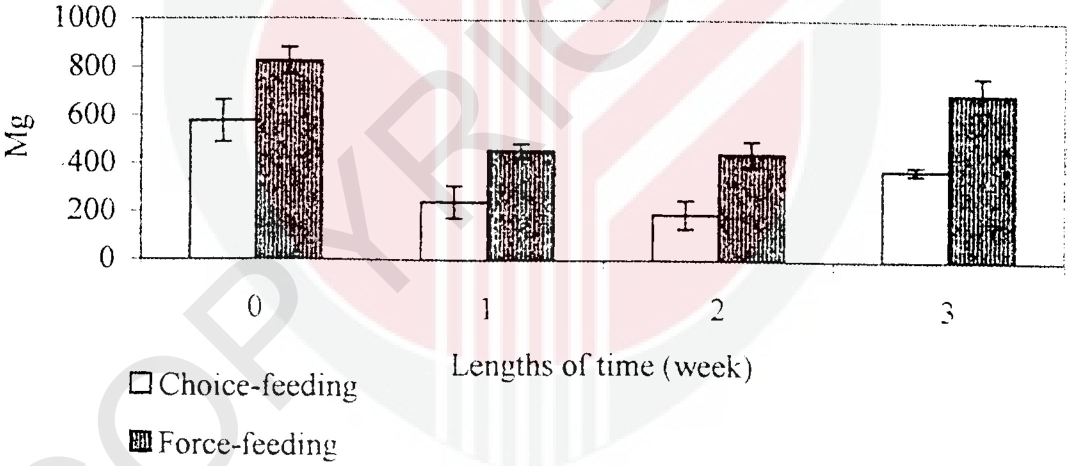


Figure 9. Consumption by *C. curvignathus* on wood at varying *P.noxius* decaying stages.

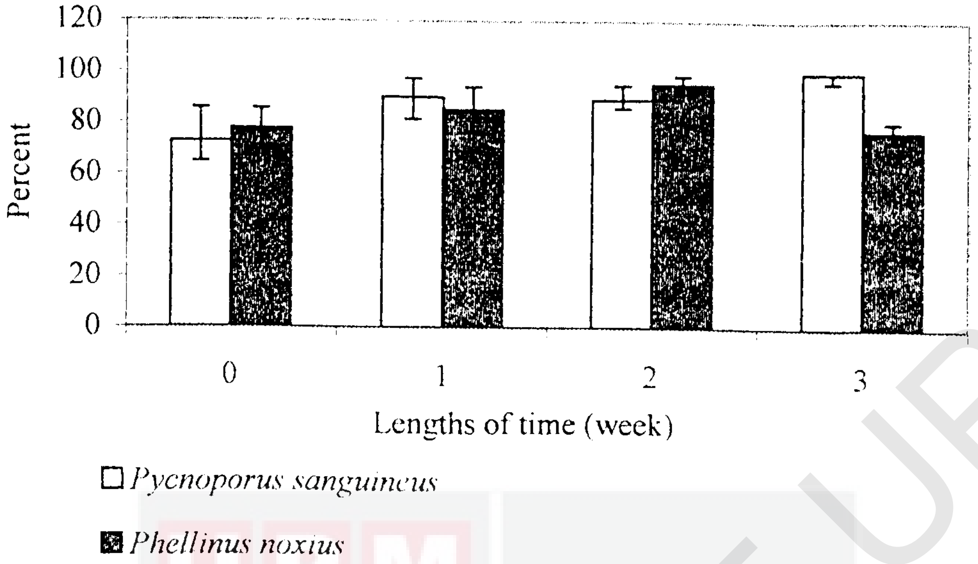


Figure 10. Mortality of termites in force-feeding on decayed wood.

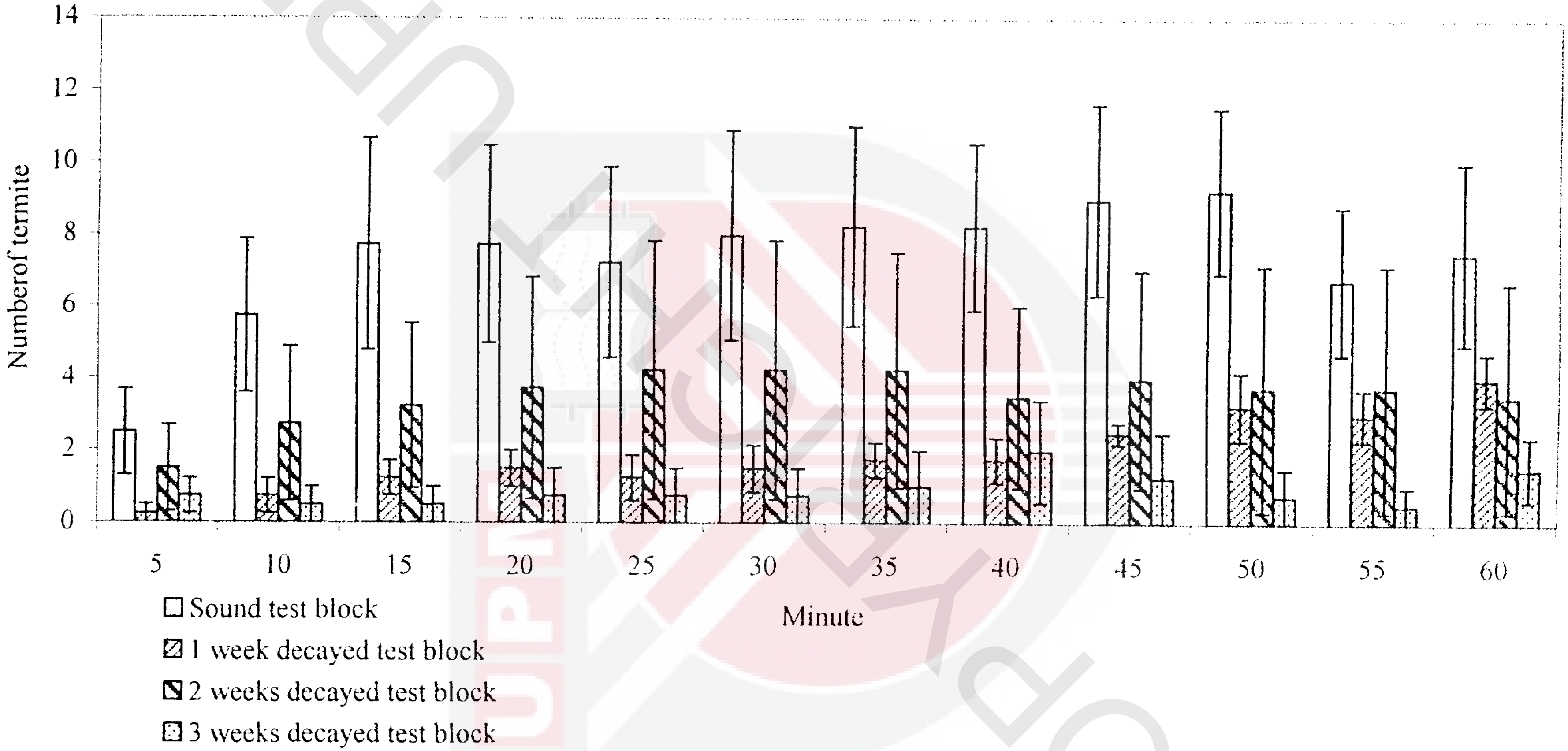


Figure 11. Number of termites in contact with the test block decayed by *P. sanguineus* in the first hour.

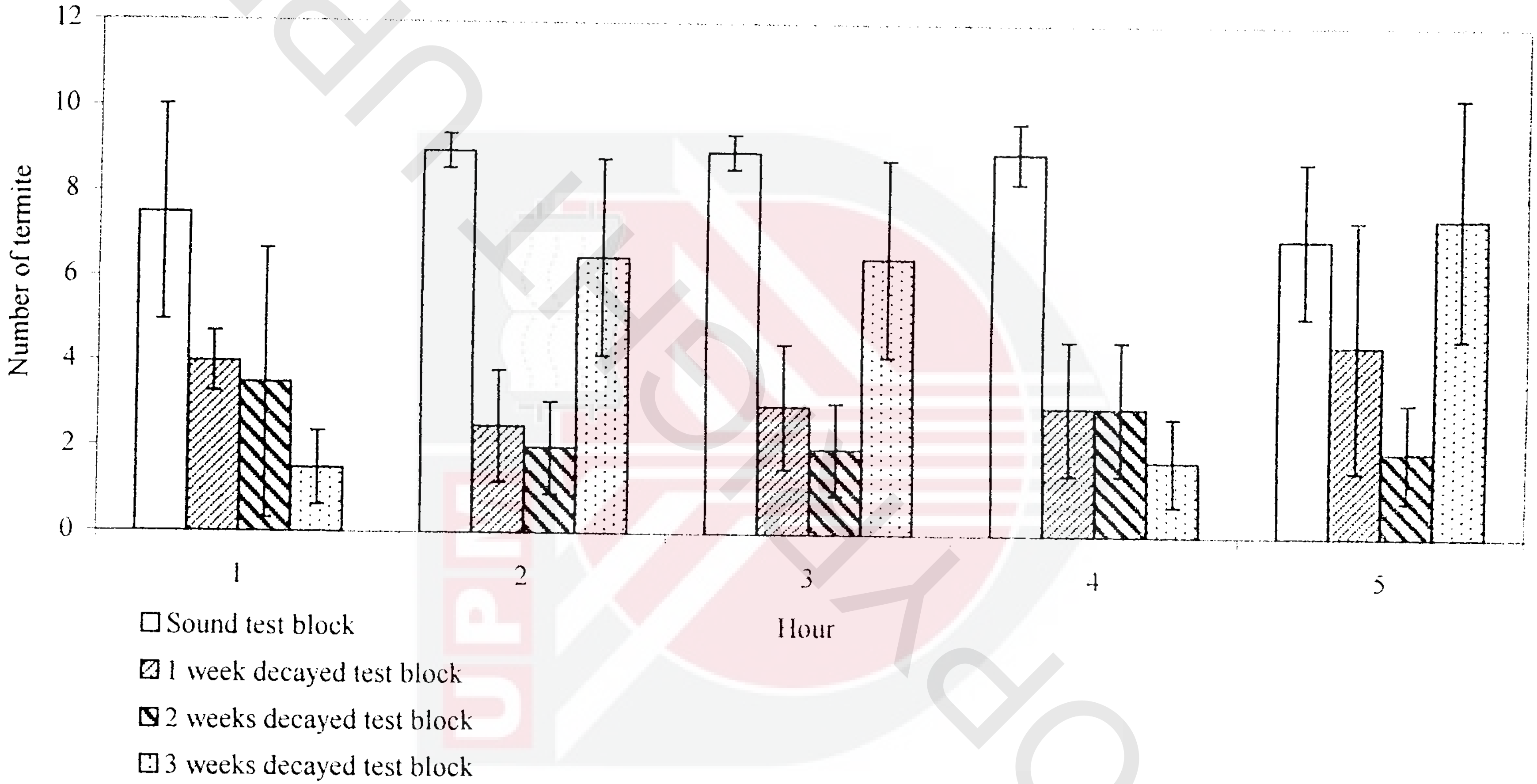


Figure12. Number of termites in contact with the test block decayed by *P. sanguineus* within five hours.

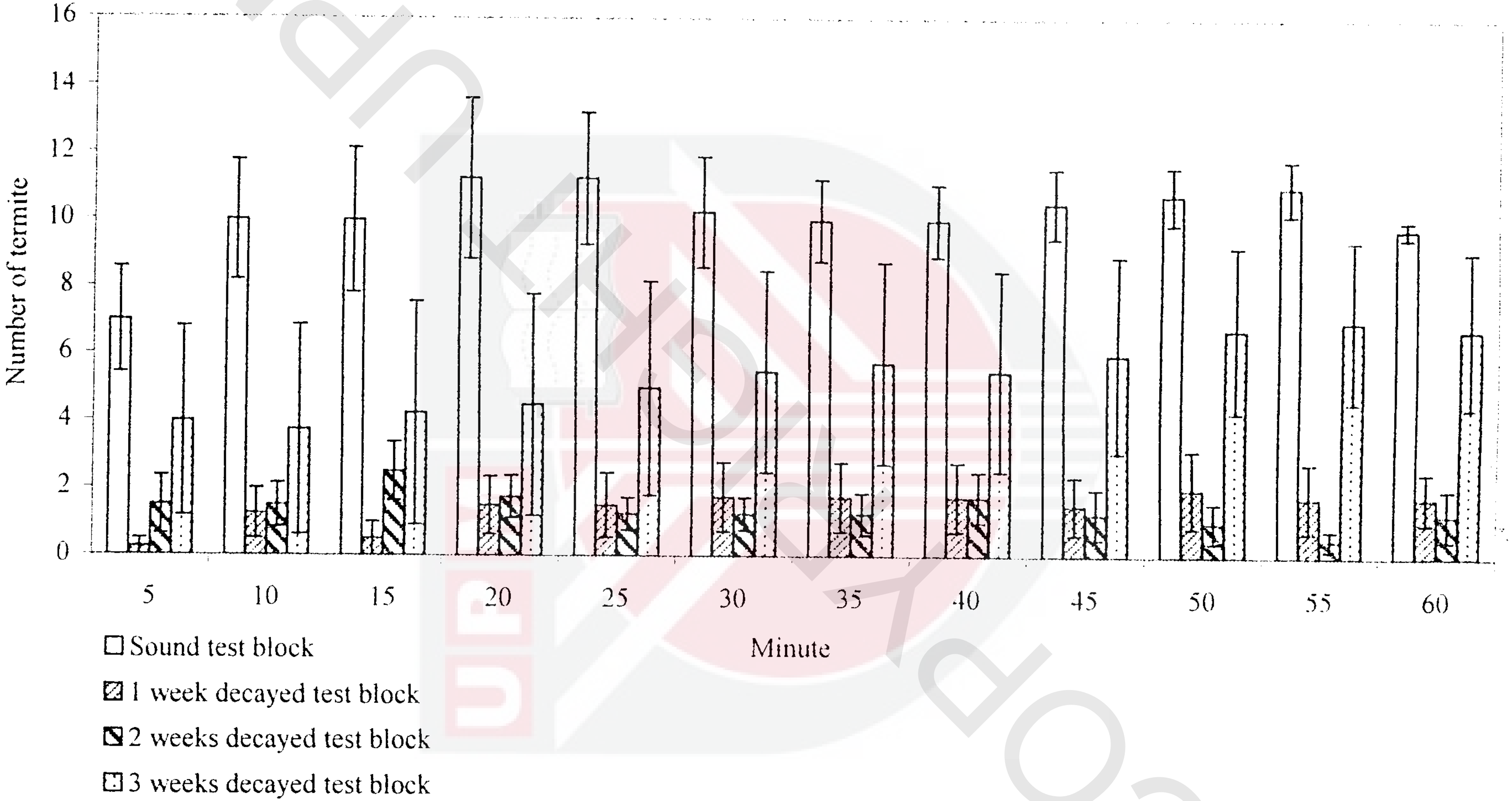


Figure 13. Number of termites in contact with the test block decayed by *P.noxius* in the first hour.

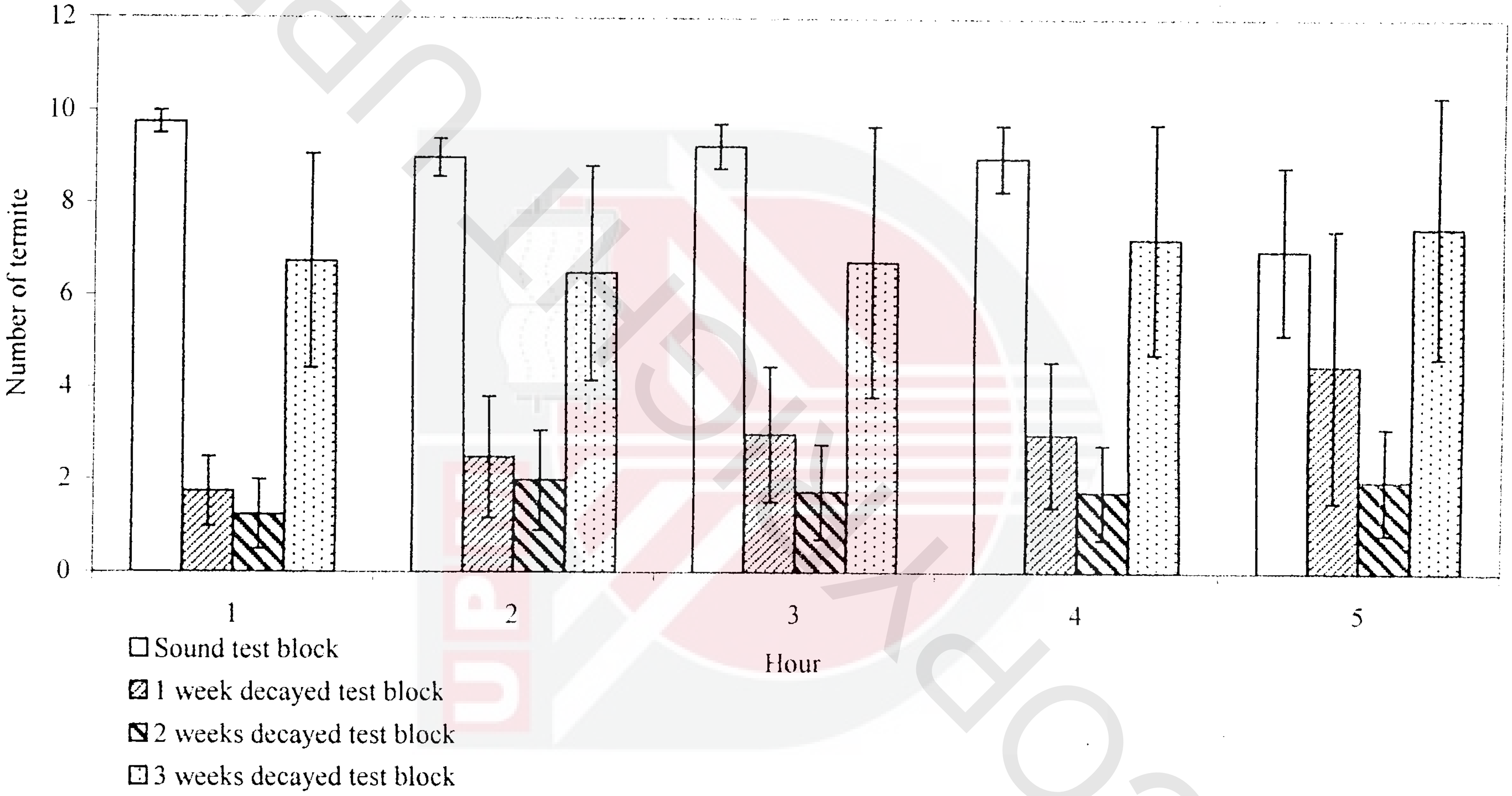


Figure14. Number of termites in contact with the test block decayed by *P. noxius* within five hours.

5.0 DISCUSSION

The experiments on choice-feeding test or force-feeding tests, *C.curvignathus* did not show any preference to the *P. sanguineus* decayed test block. The consumption of the test blocks was not significantly different. Although termites fed more on the sound test block and the *P. noxius* decayed test block that had been decayed for 3 weeks (forced feeding test), but there was no significant different between two of them. The study showed that *C. curvignathus* was not necessary dependent upon fungi to break down cellulose into available forms to food. Even though subterranean termites and fungi are each capable of independently destroying the wood, they often work together and this is proven by the previous literature. It may be that there is an association for even greater and quicker efficiency in obtaining the destruction of wood but the termite does consume the wood without the assistance of fungi. The protozoa, which constitute an important role in the digestion of cellulose in the lower termites. *Coptotermes curvignathus* contained three major protozoa species, *Pseudotrichonympha grasii*, *Holomastigotoides harmanii* and *Spirotrichonympha leidyii* in the alimentary system. Thus, *C.curvignathus* can survive without association with fungi.

Certain fungi produce substances, which positively attract some termites but repel others, while some fungi are toxic. In this study, neither fungi species repelled the termite and termite did not showed preference to any fungi. Williams (1965) demonstrated that resins and turpentine in heartwood of *Pinus caribaea* Morelet were both repellent and toxic to *Coptotermes niger* Synder but that when these substances were broken down by a brown –rot fungus *Lentinus pallidus* the rotting heartwood was readily attacked. The existent of fungi is not attributing this beneficial effect in the study. Rubber wood was used in the study and it is not toxic *C. curvignathus*. The termites do not need the fungi to breakdown the repellent or toxic chemicals. Cellulose is an abundant material and it is not too hard to bite, it may be consumed by many termite species for the commensal protozoa to digest.

The time taken for the decaying process may be should be prolonged. The destruction of the test block is not complete. The test blocks still contain cellulose even they had been decayed for 3 weeks. Cellulose is the main food for the termite and they will go for it.

Generally, mortality rate of termites in the test was high in the test. Especially the third week *P. sanguineus* decayed test block in forced feeding test, the mortality is complete (100%). The accumulation of the substances produced by fungi will created unfavourable environment to the *C. curvignathus*. Termites can live for many months on cellulose of the highest purity. It can be demonstrated that in the absence of bacteria and fungi cellulose disappears from termites within 24 hours after the protozoa are removed and does not reappear until the protozoa are replaced. The termites die unless these protozoa are replaced. The decreasing of the intestinal protozoa may cause the death of termite. It will take much careful research work to prove or disprove this. Many termites eat only sound dry wood in which the destructive action of fungi is reduced to a minimum. Some termites, species of *Neotermes* in the Orient, feed mostly on the wood of living tree. The rapid decomposition of wood by fungi hinders the growth of termites.

In the test to determine the responses of termite to the different decayed stages test blocks, the result shows that most of the termite gather at sound test block in the first four hours. They know where the food is and they go for it with non-directional pattern. Becker (1972, 1976) and Goldberg (1973, 1974) as cited by Rcinhard et al., 1997 found that the direction of foraging galleries built by subterranean termite species of the genus *Heterotermes, Reticulitermes*, and *Coptotermes* was beside other physical and chemical factors positively influenced by the presence of wood. Food is detected over distance by perceiving volatiles emanating from the wood. Then *Reticulitermes santonensis* appear more frequently and undertake longer exploratory runs (up to 15 cm), which are directed towards the odour source (Rcinhard *et al*., 1997). In current study, the observation showed *C. curvignathus* foraged randomly. The foragers are not go directly to the food source. As termites are blind, they find their way by relying on senses other than sight. Termites possess a sense of smell, olfactory sense sufficient for them to distinguish between odours which are acceptable and which attract them, and odours which are not acceptable and repel them. When approaching and selecting a food source, odour perception does not appear to play a part until the termite is within a few centimetres because the olfactory sense general appears to be weaker. In the test, the result showed no significant difference over the different stages decayed test block after five hours. This may because of termite already habituate themselves to the odours. They could not differentiate the odour of the test blocks after five hours.

On the other hand, the influence of the dimensions of particular sources of food on food selection has received little attention, but for certain species observations indicate that a minimum size is required to initiate foraging. For example, William

(1973) as cited by Wood (1971) found that feeding by *Pseudanthotermes militaris* was more intense on large wood baits than on small ones.

In *C. curvignathus* foraging is initiated and conducted by workers. After contacting food, the worker apparently laid a recruitment trail on the way back. Thus, more workers are attracted. Runcie (1987) as cited by Reinhard (1997) found a phenomenon in *Reticulitermes santonensis* where trails laid after discovery of a food source appeared to be more attractive and far more persistent than trails laid by exploring termites. This may explain why termites gathered more at the sound test block in the first four hours, for the sound test block was the first food they contacted.

6.0 CONCLUSION

Coptotermes curvignathus does not rely upon fungi for digestion of cellulose. The intestinal protozoa of the termites, are primarily responsible for the digestion of the cellulose content of the wood they eat. The two fungi species: *P. sanguineus* and *P. noxius* do not affect the preference of the termites. However, they may be hindering the growth of the termites thus cause the high mortality. Decreasing of the number of termite may also be one of the causes for the mortality. More studies should be done to prove this. Termites forage randomly non-directionally. They are more attracted to the sound wood then decayed. Nevertheless, they do consume both either sound wood or decayed wood.

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APPENDIX

Appendix 1. Weight lost (mg) of test block decayed by *Pycnoporus sanguineus* in choice feeding test and forced feeding test.

	Replicate	Choiced feeding test	Forced feeding test
Sound test block	i.	241.90	805.80
	ii.	166.90	788.10
	iii.	480.00	741.50
	iv.	304.00	513.80
1 week decayed test block	i.	535.60	965.90
	ii.	275.90	1095.00
	iii.	325.50	485.40
	iv.	220.10	246.30
2 weeks decayed test block	i.	222.80	788.50
	ii.	251.70	907.90
	iii.	356.10	709.30
	iv	374.90	342.80
3 weeks decayed test block	i.	147.20	290.90
	ii.	475.60	516.70
	iii.	312.50	416.30
	iv.	132.40	177.90

Appendix 2. Weight lost (mg) of test block decayed by *Phellinus noxius* in choice feeding test and forced feeding test.

	Replicate	Choice feeding test	Forced feeding test
Sound test block	i.	663.80	796.30
	ii.	403.80	919.00
	iii.	778.10	683.40
	iv.	459.20	901.30
1 week decayed test block	i.	443.20	423.00
	ii.	201.80	493.80
	iii.	146.40	399.90
	iv.	179.90	520.90
2 weeks decayed test block	i.	200.20	391.20
	ii.	358.20	604.90
	iii.	104.80	369.10
	iv.	106.40	417.80
3 weeks decayed test block	i.	408.20	781.40
	ii.	389.80	647.10
	iii.	327.30	840.00
	iv.	386.10	523.80

Appendix 3. Mortality of termite (%) in choiced feeding and forced feeding test by using *Pycnoporus sanguineus*.

		Replicate			
		i.	ii.	iii.	iv.
Choice feeding test	Sound test block	95.60	76.40	57.60	81.60
	1 week decayed test block	100.00	76.40	64.80	100.00
	2 weeks decayed test block	100.00	86.00	100.00	95.60
	3 weeks decayed test block	83.20	71.20	70.00	83.60
Forced feeding test		93.60	100.00	48.40	74.40

Appendix 4. Mortality of termite (%) in choice feeding and forced feeding test by using *Phellinus noxius*.

		Replicate			
		i.	ii.	iii.	iv.
Choice feeding test	Sound test block	90.00	50.40	50.40	100.00
	1 week decayed test block	100.00	69.20	92.00	100.00
	2 weeks decayed test block	98.40	77.20	81.60	100.00
	3 weeks decayed test block	100.00	100.00	100.00	100.00
Forced feeding test		90.00	75.20	100.00	100.00

Appendix 5. The number of termite contacted with the test block in which decayed by *Pycnoporus sanguineus*

Minute	Sound test block				1 week decayed test block				2 weeks decayed test block				3 weeks decayed test block			
	i.	ii.	iii.	iv.	i.	ii.	iii.	iv.	i.	ii.	iii.	iv.	i.	ii	iii.	iv.
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	1	0	0	0	0	0	0	3	0	0	0	1	0	0	0
3	1	6	2	1	0	0	1	0	3	0	0	0	1	0	0	0
4	1	6	2	1	0	0	1	0	4	0	1	1	1	0	0	1
5	1	6	2	1	0	0	1	0	5	0	0	1	2	0	0	1
6	3	10	2	1	0	0	1	0	6	0	0	1	2	0	0	1
7	3	9	3	1	0	0	2	1	6	0	0	1	2	0	0	0
8	3	10	3	1	0	0	2	1	7	0	0	1	2	0	0	0
9	3	11	5	3	0	0	2	1	9	0	0	2	2	0	0	0
10	3	12	5	3	0	0	2	1	9	0	0	2	2	0	0	0
11	3	12	6	3	2	0	2	1	8	0	0	2	2	0	0	0
12	3	12	7	3	2	0	2	1	8	0	0	2	2	0	0	0
13	3	15	8	3	2	0	2	1	9	0	0	2	2	0	0	0
14	3	16	8	4	2	0	2	1	10	0	1	2	2	0	0	0
15	3	16	8	4	2	0	2	1	10	0	1	2	2	0	0	0
16	3	15	8	6	2	1	2	1	10	0	1	2	3	0	0	0
17	3	16	8	6	2	1	2	1	12	0	1	1	3	0	0	0
18	3	16	8	6	2	2	2	1	12	0	1	1	3	0	0	0
19	3	16	8	6	2	2	2	0	12	0	1	1	2	0	0	0
20	3	15	9	4	2	2	2	0	13	0	1	1	3	0	0	0
21	3	15	9	4	2	2	1	0	13	0	1	1	3	0	0	0
22	3	15	9	4	2	2	1	0	15	0	1	1	3	0	0	0
23	3	15	9	4	3	2	1	0	15	0	1	1	3	0	0	0
24	3	14	9	3	3	1	1	0	15	0	1	1	3	0	0	0
25	3	14	9	3	3	1	1	0	15	0	2	0	3	0	0	0
26	3	14	9	3	3	2	1	0	16	0	2	0	3	0	0	0
27	3	15	9	3	3	2	1	0	16	0	2	0	3	0	0	0
28	3	14	9	3	3	2	1	0	16	0	2	0	4	0	0	0
29	3	14	11	3	3	2	1	0	15	0	2	0	3	0	0	0
30	3	14	12	3	3	2	1	0	15	0	2	0	3	0	0	0
31	3	15	12	3	3	2	1	0	15	0	2	0	3	0	0	0
32	3	15	12	3	2	3	1	0	16	0	2	0	3	0	0	0
33	3	15	12	3	2	3	1	0	14	0	2	0	3	0	0	0
34	3	16	12	13	2	3	1	1	14	0	2	0	4	0	0	0
35	3	14	12	14	2	3	1	1	14	0	2	1	4	0	0	0
36	3	14	12	4	2	2	1	1	12	0	2	1	5	0	0	0
37	3	14	12	4	2	2	0	1	12	0	2	2	5	0	0	0
38	4	13	12	5	3	2	0	2	12	0	2	2	6	0	1	0
39	4	14	10	5	3	2	0	2	12	0	1	2	6	0	1	0
40	4	14	10	5	3	2	0	2	11	0	1	2	6	0	2	0
41	4	14	10	5	3	2	0	2	12	0	1	2	5	0	0	0
42	4	15	10	5	3	3	1	2	12	0	1	2	5	0	0	0

43	4	15	10	5	3	4	1	2	12	0	1	2	5	0	0	0
44	4	16	10	6	3	3	2	2	12	0	1	2	5	0	0	0
45	4	16	10	6	3	3	2	2	13	0	1	2	5	0	0	0
46	4	15	10	6	3	3	2	2	13	0	0	2	5	0	0	0
47	4	15	10	7	3	4	3	2	13	0	0	2	3	0	0	0
48	4	16	11	7	3	5	3	2	13	0	0	2	3	0	0	0
49	4	15	11	7	3	5	3	2	13	0	0	1	3	0	0	0
50	4	15	10	8	3	6	2	2	14	0	0	1	3	0	0	0
51	4	15	10	8	3	5	2	2	14	0	0	1	2	0	0	0
52	4	13	10	8	3	5	2	2	14	0	0	1	2	0	0	0
53	4	14	12	8	3	4	3	2	14	0	0	1	2	0	0	0
54	4	14	12	8	3	4	3	2	14	0	0	1	2	0	0	0
55	4	3	12	8	3	5	2	2	14	0	0	1	2	0	0	0
56	5	3	12	8	3	5	3	2	13	0	0	1	2	0	0	0
57	4	3	13	8	3	4	4	2	13	0	0	1	2	1	0	0
58	4	3	14	9	3	4	4	2	13	0	0	1	2	1	0	0
59	4	3	14	9	3	5	5	3	13	0	0	1	2	1	0	1
60	4	3	14	9	3	4	6	3	13	0	0	1	4	1	0	1
120	11	14	13	14	5	3	9	4	4	0	0	2	6	1	0	1
180	12	12	12	12	5	4	6	4	3	0	1	0	4	3	2	0
240	9	11	12	10	5	7	7	2	6	0	0	1	3	4	3	3
300	12	10	11	9	4	3	8	2	5	0	0	1	5	6	2	4

i., first replicate; ii., second replicate, iii., third replicate; iv., fourth replicate.

Appendix 6. The number of termite contacted with the test block in which decayed by *Phellinus noxius*.

Minute	Sound test block				1 week decayed test block				2 weeks decayed test block				3 weeks decayed test block			
	i.	ii.	iii.	iv.	i.	ii.	iii.	iv.	i.	ii.	iii.	iv.	i.	ii.	iii.	iv.
1	2	3	1	3	0	1	0	0	0	2	1	2	0	3	0	0
2	2	4	2	6	0	1	0	0	0	1	1	2	2	4	0	0
3	3	9	3	6	0	1	0	0	0	1	2	2	2	4	0	0
4	4	9	5	7	0	1	0	0	0	1	3	2	6	4	0	0
5	3	10	6	9	0	1	0	0	0	1	1	4	12	4	0	0
6	3	10	10	10	0	1	2	0	0	2	2	4	12	3	0	4
7	3	10	11	10	0	1	2	0	0	2	2	4	12	3	0	0
8	3	10	12	12	0	1	2	0	0	3	2	4	13	2	0	0
9	3	9	12	12	0	0	3	0	0	2	1	4	13	4	0	1
10	5	10	12	13	0	2	3	0	0	2	1	3	13	2	0	0
11	5	10	14	13	0	2	3	0	0	2	3	4	13	2	0	0
12	5	9	14	13	0	2	0	0	0	2	3	4	12	3	0	0
13	5	10	13	13	0	2	1	0	0	2	4	4	13	3	0	0
14	4	10	13	12	0	2	1	0	1	2	3	4	14	2	0	0
15	4	10	14	12	0	2	0	0	0	3	3	4	14	3	0	0
16	4	10	14	11	0	2	0	0	0	3	3	1	14	3	0	0
17	4	9	13	12	0	2	0	0	0	3	3	1	14	3	1	0
18	4	9	14	14	0	3	1	0	0	3	3	2	14	3	1	0

19	6	9	14	14	0	3	1	0	0	3	3	2	14	3	0	0
20	6	9	13	17	0	3	3	0	0	3	2	2	14	4	0	0
21	8	9	13	15	0	3	2	0	0	3	2	2	14	5	0	0
22	8	8	13	16	0	3	3	0	0	2	3	2	14	6	0	0
23	8	8	13	16	0	3	2	0	0	2	2	2	14	6	0	1
24	8	7	13	18	0	3	2	0	0	3	2	1	14	5	0	1
25	8	8	13	16	0	4	2	0	0	2	2	1	14	5	0	1
26	8	7	13	16	0	4	4	0	0	2	1	1	14	5	0	1
27	8	7	14	15	0	4	4	0	0	3	1	1	14	5	0	1
28	8	7	13	13	0	4	3	0	0	3	0	1	14	5	0	2
29	8	7	14	12	0	4	4	0	0	2	1	1	14	4	0	2
30	8	7	14	12	0	3	4	0	0	2	2	1	14	5	0	3
31	8	8	12	12	0	3	4	0	0	4	1	1	14	6	0	3
32	8	8	12	12	0	3	4	0	0	4	1	1	14	6	0	3
33	8	9	12	11	0	3	4	0	0	4	1	1	14	6	0	3
34	8	9	12	11	0	3	6	0	0	3	1	1	14	6	0	3
35	8	8	13	11	0	3	4	0	0	3	1	1	14	6	0	3
36	8	9	13	10	0	3	5	0	0	3	1	1	14	5	1	3
37	8	10	13	11	0	3	5	0	0	3	1	0	14	5	0	4
38	8	10	13	10	0	3	5	0	0	3	1	1	14	4	0	4
39	8	10	13	11	0	3	4	1	0	3	1	1	14	4	0	4
40	8	10	13	9	0	3	4	0	0	3	3	1	14	4	0	4
41	8	10	13	12	0	3	3	0	0	3	3	0	14	5	0	4
42	8	10	13	12	0	3	3	0	0	3	3	0	14	5	0	4
43	8	10	14	12	0	3	3	0	0	2	3	0	14	5	0	4
44	8	10	14	10	0	3	3	0	0	3	3	0	14	5	0	4
45	8	10	13	11	0	3	3	0	0	2	3	0	14	5	0	5
46	8	10	13	13	0	3	3	0	0	2	3	0	14	5	0	4
47	8	10	13	13	0	3	3	1	0	2	2	0	14	5	0	4
48	9	11	11	14	0	3	4	0	0	2	2	0	14	5	0	4
49	9	10	11	14	0	4	4	0	0	2	2	1	14	5	3	4
50	9	10	11	13	0	4	4	0	0	2	2	0	14	5	3	5
51	9	9	12	13	0	4	5	0	0	1	1	0	14	5	3	6
52	9	9	11	14	0	4	4	0	0	1	1	0	14	5	2	6
53	9	9	11	13	0	2	3	0	0	1	1	0	14	7	2	6
54	9	9	11	13	0	2	3	0	0	1	1	0	14	7	3	6
55	9	11	11	13	0	3	4	0	0	1	1	0	14	6	3	5
56	9	11	11	11	0	3	5	1	0	1	1	3	13	6	3	5
57	9	11	11	10	0	3	6	1	0	1	1	3	13	7	2	5
58	9	11	11	12	0	3	3	1	0	0	2	3	13	7	2	5
59	9	11	11	11	0	3	4	1	0	0	3	2	13	6	2	6
60	9	10	10	10	0	3	3	1	0	0	3	2	13	7	2	5
120	9	8	9	10	0	6	3	1	0	1	5	2	13	6	2	5
180	9	8	10	10	0	5	6	1	0	0	3	4	14	8	0	5
240	9	8	11	8	0	7	4	1	0	0	3	4	14	7	2	6
300	9	3	11	5	0	13	4	1	0	0	4	4	14	5	1	10

i., first replicate; ii., second replicate, iii., third replicate: iv., fourth replicate.

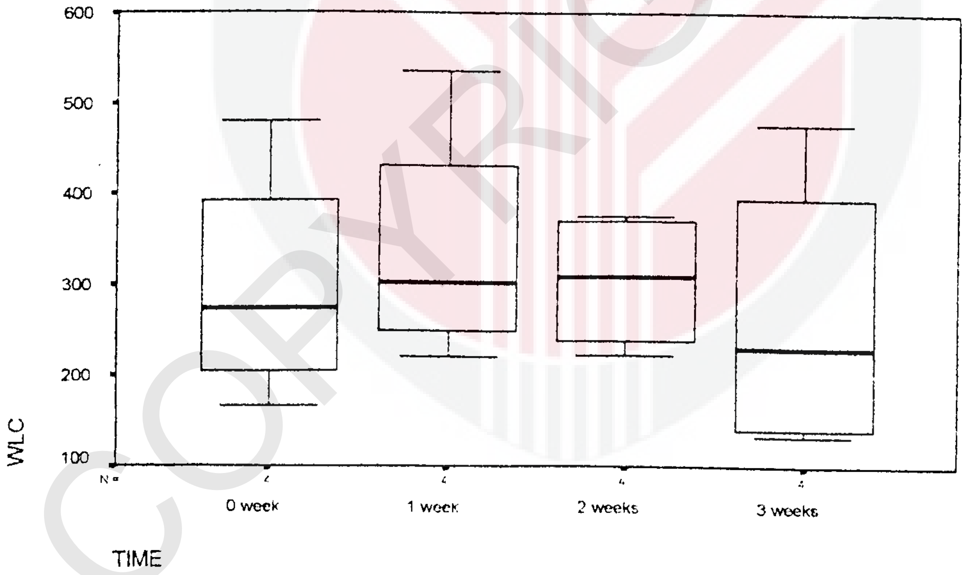
Appendix 7. Output analysis for consumption by *C. curvignathus* on wood at varing *P. sanguineus* decaying stages.

Tests of Normality

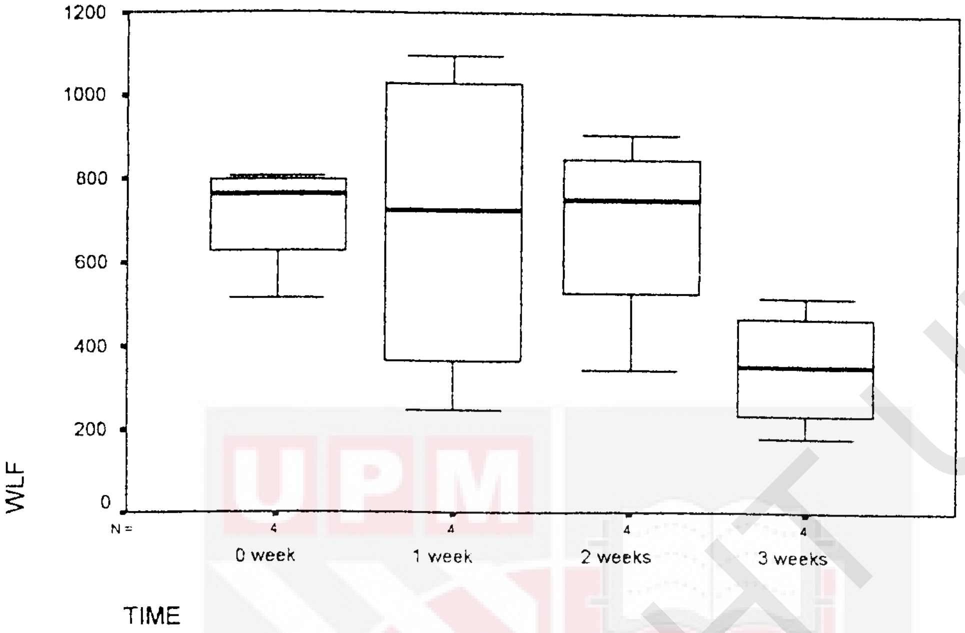
	TIME	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
WLC	0 week	.233	4	.	.951	4	.720
	1 week	.290	4	.	.890	4	.381
	2 weeks	.286	4	.	.842	4	.201
	3 weeks	.271	4	.	.889	4	.377
WLF	0 week	.336	4	.	.794	4	.091
	1 week	.249	4	.	.919	4	.531
	2 weeks	.286	4	.	.905	4	.459
	3 weeks	.172	4	.	.986	4	.935

a. Lilliefors Significance Correction

WLC



WLF



Oneway

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
WLC	Between Groups	10547.047	3	3515.682	.204	.891
	Within Groups	206588.2	12	17215.680		
	Total	217135.2	15			
WLF	Between Groups	366136.3	3	122045.441	1.886	.186
	Within Groups	776718.7	12	64726.556		
	Total	1142855	15			

Homogeneous Subsets

WLC

	TIME	N	Subset for alpha = .05
			1
Student-Newman-Keuls[a]	3 weeks	4	266.9250
	0 week	4	298.2000
	2 weeks	4	303.6250
	1 week	4	339.2750
	Sig.		.862
Tukey HSD[a]	3 weeks	4	266.9250
	0 week	4	298.2000
	2 weeks	4	303.6250
	1 week	4	339.2750
	Sig.		.862
Duncan[a]	3 weeks	4	266.9250
	0 week	4	298.2000
	2 weeks	4	303.6250
	1 week	4	339.2750
	Sig.		.483

Means for groups in homogeneous subsets are displayed.

[a] Uses Harmonic Mean Sample Size = 4.000.

WLF

	TIME	N	Subset for alpha = .05
			1
Student-Newman-Keuls[a]	3 weeks	4	350.4500
	2 weeks	4	687.1250
	1 week	4	698.1500
	0 week	4	712.3000
	Sig.		.237
Tukey HSD[a]	3 weeks	4	350.4500
	2 weeks	4	687.1250
	1 week	4	698.1500
	0 week	4	712.3000
	Sig.		.237
Duncan[a]	3 weeks	4	350.4500
	2 weeks	4	687.1250
	1 week	4	698.1500
	0 week	4	712.3000
	Sig.		.086

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

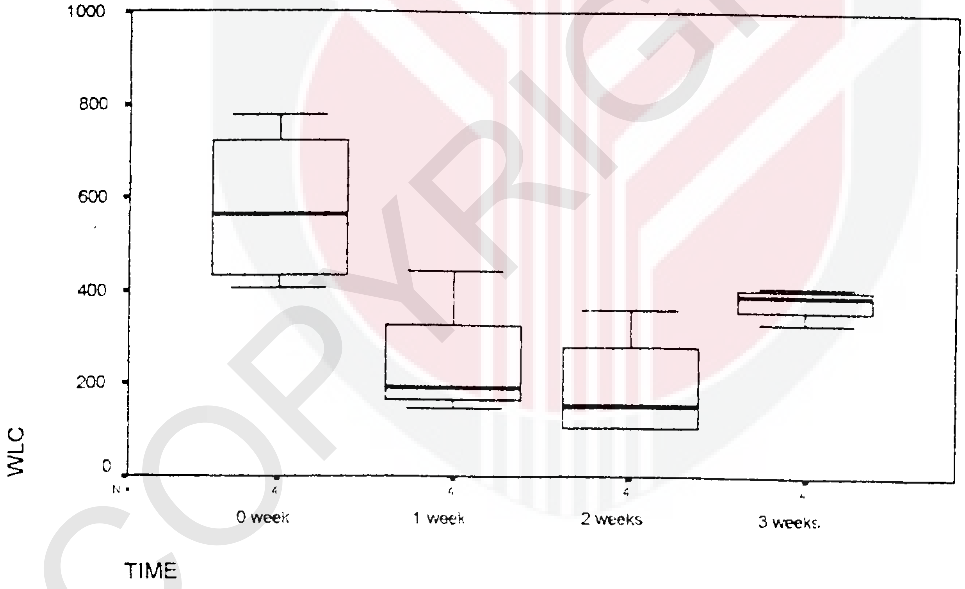
Appendix 8. Output analysis for consumption by *C. curvignathus* on wood at varing *P. noxius* decaying stages.

Tests of Normality

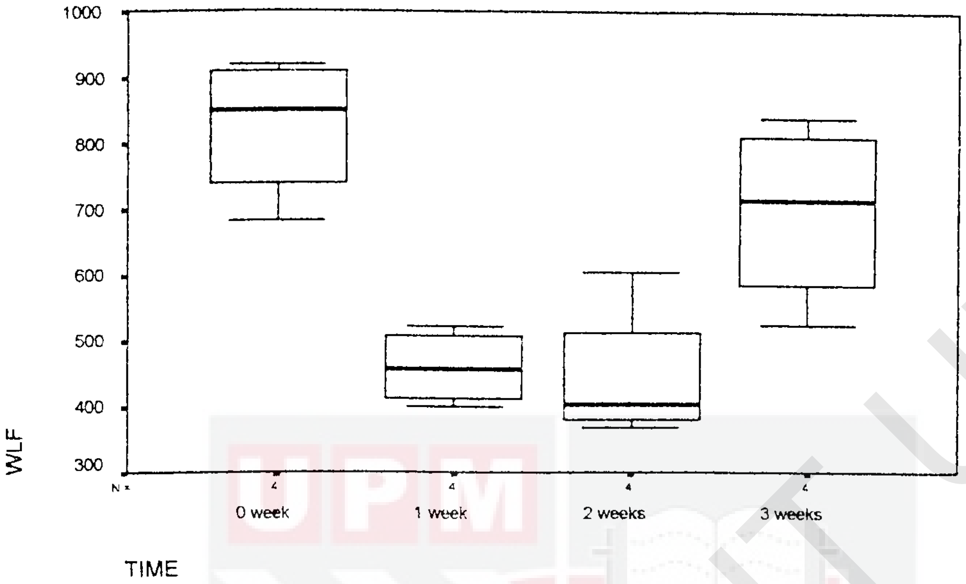
	TIME	Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
WLC	0 week	.248	4	.	.924	4	.558
	1 week	.369	4	.	.782	4	.074
	2 weeks	.265	4	.	.845	4	.210
	3 weeks	.343	4	.	.857	4	.250
WLF	0 week	.258	4	.	.906	4	.460
	1 week	.238	4	.	.917	4	.519
	2 weeks	.352	4	.	.793	4	.090
	3 weeks	.222	4	.	.956	4	.756

a. Lilliefors Significance Correction

WLC



WLF



Oneway

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
WLC	Between Groups	352996.0	3	117665.322	7.307	.005
	Within Groups	193246.2	12	16103.849		
	Total	546242.1	15			
WLF	Between Groups	414423.9	3	138141.287	11.809	.001
	Within Groups	140379.6	12	11698.300		
	Total	554803.5	15			

Homogeneous Subsets

WLC

			Subset for alpha = .05	
	TIME	N	1	2
Student-Newman-Keuls[a]	2 weeks	4	192.4000	
	1 week	4	242.8250	
	3 weeks	4	377.8500	
	0 week	4		576.2250
	Sig.		.139	1.000
Tukey HSD[a]	2 weeks	4	192.4000	
	1 week	4	242.8250	
	3 weeks	4	377.8500	377.8500
	0 week	4		576.2250
	Sig.		.219	.175
Duncan[a]	2 weeks	4	192.4000	
	1 week	4	242.8250	
	3 weeks	4	377.8500	
	0 week	4		576.2250
	Sig.		.072	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

WLF

			Subset for alpha = .05	
	TIME	N	1	2
Student-Newman-Keuls[a]	2 weeks	4	445.7500	
	1 week	4	459.4000	
	3 weeks	4		698.0750
	0 week	4		825.0000
	Sig.		.861	.123
Tukey HSD[a]	2 weeks	4	445.7500	
	1 week	4	459.4000	
	3 weeks	4		698.0750
	0 week	4		825.0000
	Sig.		.998	.385
Duncan[a]	2 weeks	4	445.7500	
	1 week	4	459.4000	
	3 weeks	4		698.0750
	0 week	4		825.0000
	Sig.		.861	.123

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Appendix 9. Output analysis for the termite mortality in choice-feeding test.

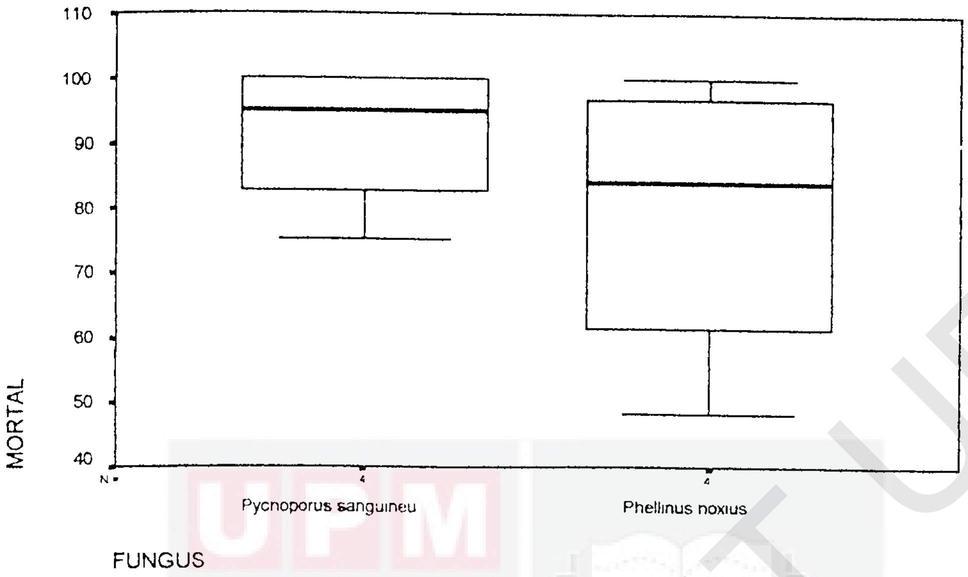
Descriptives

	FUNGUS			Statistic	Std. Error
MORTAL	Pycnoporus sanguineus	Mean		91.3000	5.86146
		95% Confidence Interval for Mean	Lower Bound	72.6462	
			Upper Bound	109.9538	
		5% Trimmed Mean		91.7111	
		Median		95.0000	
		Variance		137.427	
		Std. Deviation		11.72291	
		Minimum		75.20	
		Maximum		100.00	
		Range		24.80	
		Interquartile Range		21.1000	
		Skewness		-1.183	1.014
		Kurtosis		.382	2.619
	Phellinus noxius	Mean		79.1000	11.58893
		95% Confidence Interval for Mean	Lower Bound	42.2188	
			Upper Bound	115.9812	
		5% Trimmed Mean		79.6444	
		Median		84.0000	
		Variance		537.213	
		Std. Deviation		23.17786	
		Minimum		48.40	
		Maximum		100.00	
		Range		51.60	
		Interquartile Range		43.5000	
		Skewness		-.903	1.014
		Kurtosis		-.520	2.619

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	FUNGUS	Statistic	df	Sig.	Statistic	df	Sig.
MORTAL	Pycnoporus sanguine	.271	4	.	.849	4	.223
	Phellinus noxius	.234	4	.	.927	4	.578

a. Lilliefors Significance Correction


110
100
90
80
70
60
50
40
MORTAL
N =
4
Pycnoporus sanguineu
4
Phellinus noxius
FUNGUS

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PYCNO	91.3000	4	11.72291	5.86146
	PHELLI	79.1000	4	23.17786	11.58893

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PYCNO & PHELLI	4	-.814	.186

Paired Samples Test

		Paired Differences		
		Mean	Std. Deviation	Std. Error Mean
Pair 1	PYCNO - PHELLI	12.2000	33.41936	16.70968

Paired Samples Test

		Paired Differences	
		95% Confidence Interval of the Difference	
		Lower	Upper
Pair 1	PYCNO - PHELLI	-40.9777	65.3777

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PYCNO - PHELLI	.730	3	.518

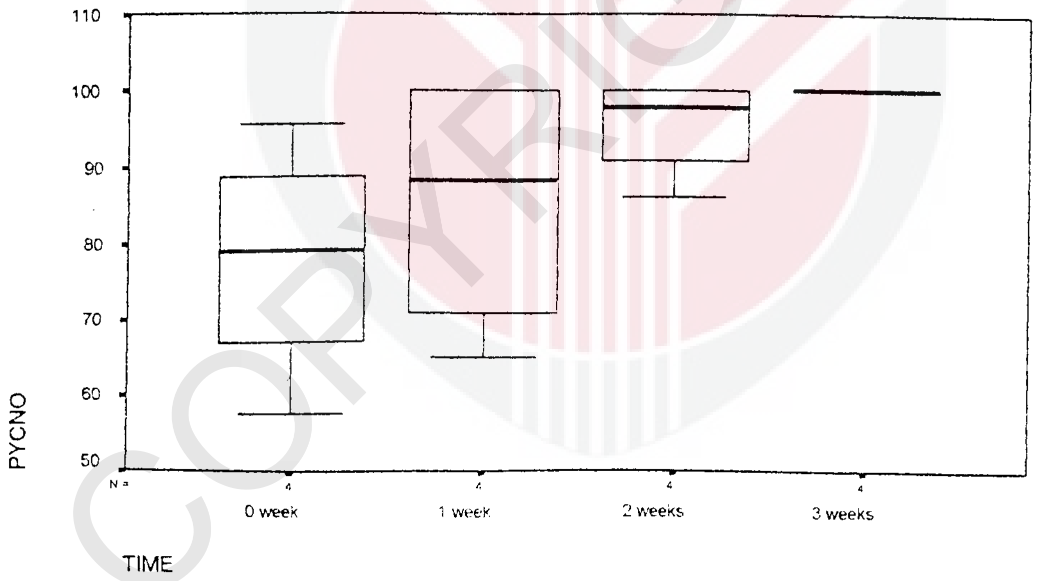
Appendix 10. Output analysis for the termite mortality in force-feeding test.

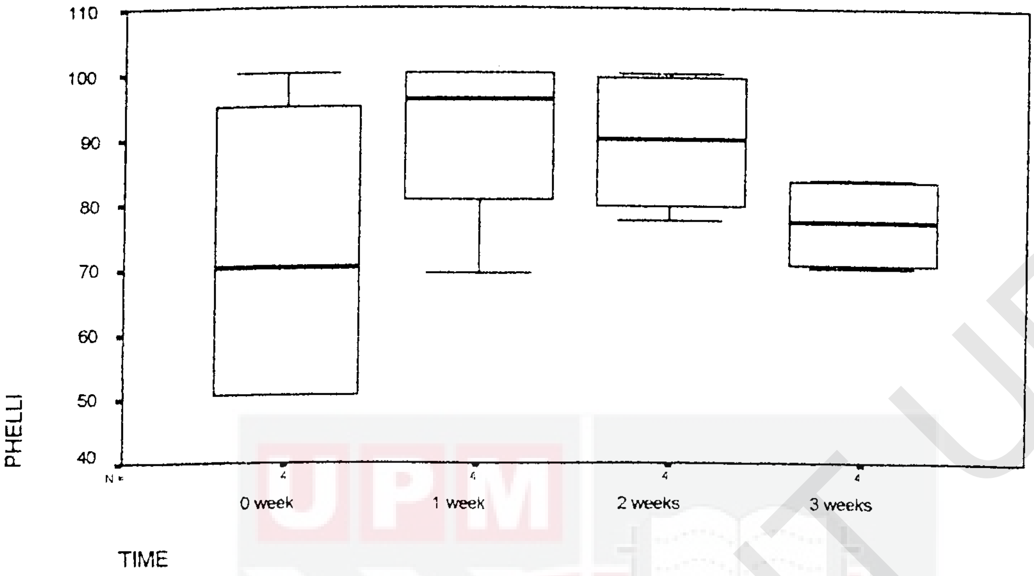
Tests of Normality[b]

	TIME	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
PYCNO	0 week	.215	4	.	.982	4	.914
	1 week	.298	4	.	.849	4	.222
	2 weeks	.262	4	.	.820	4	.143
PHELLI	0 week	.304	4	.	.811	4	.124
	1 week	.296	4	.	.796	4	.094
	2 weeks	.284	4	.	.846	4	.213
	3 weeks	.299	4	.	.781	4	.073

a. Lilliefors Significance Correction

b. PYCNO is constant when TIME = 3 weeks. It has been omitted.





Oneway

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
PYCNO	Between Groups	1198.110	3	399.370	2.657	.096
	Within Groups	1803.640	12	150.303		
	Total	3001.750	15			
PHELLI	Between Groups	932.990	3	310.997	1.151	.369
	Within Groups	3243.080	12	270.257		
	Total	4176.070	15			

Homogeneous Subsets

PYCNO

			Subset for alpha = .05	
	TIME	N	1	2
Student-Newman-Keuls[a]	0 week	4	77.8000	
	1 week	4	85.3000	
	2 weeks	4	95.4000	
	3 weeks	4	100.0000	
	Sig.		.100	
Tukey HSD[a]	0 week	4	77.8000	
	1 week	4	85.3000	
	2 weeks	4	95.4000	
	3 weeks	4	100.0000	
	Sig.		.100	
Duncan[a]	0 week	4	77.8000	
	1 week	4	85.3000	85.3000
	2 weeks	4	95.4000	95.4000
	3 weeks	4		100.0000
	Sig.		.077	.132

Means for groups in homogeneous subsets are displayed.

[a] Uses Harmonic Mean Sample Size = 4.000.

PHELLI

			Subset for alpha = .05
	TIME	N	1
Student-Newman-Keuls[a]	0 week	4	72.7000
	3 weeks	4	77.0000
	2 weeks	4	89.3000
	1 week	4	90.3000
	Sig.		.460
Tukey HSD[a]	0 week	4	72.7000
	3 weeks	4	77.0000
	2 weeks	4	89.3000
	1 week	4	90.3000
	Sig.		.460
Duncan[a]	0 week	4	72.7000
	3 weeks	4	77.0000
	2 weeks	4	89.3000
	1 week	4	90.3000
	Sig.		.185

Means for groups in homogeneous subsets are displayed.

[a] Uses Harmonic Mean Sample Size = 4.000.

Appendix 11. Output analysis for number of termites in contact with the test block decayed by *P. sanguineus* within five hours.

Descriptives

	TIME			Statistic	Std. Error
SECH	0 week	Mean		9.0000	.40825
		95% Confidence Interval for Mean	Lower Bound	7.7008	
			Upper Bound	10.2992	
		5% Trimmed Mean		9.0000	
		Median		9.0000	
		Variance		.667	
		Std. Deviation		.81650	
		Minimum		8.00	
		Maximum		10.00	
		Range		2.00	
		Interquartile Range		1.5000	
		Skewness		.000	1.014
		Kurtosis		1.500	2.619
	1 week	Mean		2.5000	1.32288
		95% Confidence Interval for Mean	Lower Bound	-1.7100	
			Upper Bound	6.7100	
		5% Trimmed Mean		2.4444	
		Median		2.0000	
		Variance		7.000	
		Std. Deviation		2.64575	
		Minimum		.00	
		Maximum		6.00	
		Range		6.00	
		Interquartile Range		5.0000	
		Skewness		.864	1.014
		Kurtosis		-.286	2.619
	2 weeks	Mean		2.0000	1.08012
		95% Confidence Interval for Mean	Lower Bound	-1.4374	
			Upper Bound	5.4374	
		5% Trimmed Mean		1.9444	
		Median		1.5000	
		Variance		4.667	
		Std. Deviation		2.16025	
		Minimum		.00	
		Maximum		5.00	
		Range		5.00	
		Interquartile Range		4.0000	
		Skewness		1.190	1.014
		Kurtosis		1.500	2.619

Descriptives

	TIME			Statistic	Std. Error
SECH	3 weeks	Mean		6.5000	2.32737
		95% Confidence Interval for Mean	Lower Bound	-.9067	
			Upper Bound	13.9067	
		5% Trimmed Mean		6.3889	
		Median		5.5000	
		Variance		21.667	
		Std. Deviation		4.65475	
		Minimum		2.00	
		Maximum		13.00	
		Range		11.00	
		Interquartile Range		8.5000	
		Skewness		1.190	1.014
		Kurtosis		2.123	2.619
THIRDH	0 week	Mean		9.0000	.40825
		95% Confidence Interval for Mean	Lower Bound	7.7008	
			Upper Bound	10.2992	
		5% Trimmed Mean		9.0000	
		Median		9.0000	
		Variance		.667	
		Std. Deviation		.81650	
		Minimum		8.00	
		Maximum		10.00	
		Range		2.00	
		Interquartile Range		1.5000	
		Skewness		.000	1.014
		Kurtosis		1.500	2.619
	1 week	Mean		3.0000	1.47196
		95% Confidence Interval for Mean	Lower Bound	-1.6844	
			Upper Bound	7.6844	
		5% Trimmed Mean		3.0000	
		Median		3.0000	
		Variance		8.667	
		Std. Deviation		2.94392	
		Minimum		.00	
		Maximum		6.00	
		Range		6.00	
		Interquartile Range		5.5000	
		Skewness		.000	1.014
		Kurtosis		-4.891	2.619

Descriptives

	TIME			Statistic	Std. Error
THIRDH	2 weeks	Mean		2.0000	1.08012
		95% Confidence Interval for Mean	Lower Bound	-1.4374	
			Upper Bound	5.4374	
		5% Trimmed Mean		1.9444	
		Median		1.5000	
		Variance		4.667	
		Std. Deviation		2.16025	
		Minimum		.00	
		Maximum		5.00	
		Range		5.00	
		Interquartile Range		4.0000	
		Skewness		1.190	1.014
		Kurtosis		1.500	2.619
	3 weeks	Mean		6.5000	2.32737
		95% Confidence Interval for Mean	Lower Bound	-.9067	
			Upper Bound	13.9067	
		5% Trimmed Mean		6.3889	
		Median		5.5000	
		Variance		21.667	
		Std. Deviation		4.65475	
		Minimum		2.00	
		Maximum		13.00	
		Range		11.00	
		Interquartile Range		8.5000	
		Skewness		1.190	1.014
		Kurtosis		2.123	2.619
FORTHH	0 week	Mean		9.0000	.70711
		95% Confidence Interval for Mean	Lower Bound	6.7497	
			Upper Bound	11.2503	
		5% Trimmed Mean		8.9444	
		Median		8.5000	
		Variance		2.000	
		Std. Deviation		1.41421	
		Minimum		8.00	
		Maximum		11.00	
		Range		3.00	
		Interquartile Range		2.5000	
		Skewness		1.414	1.014
		Kurtosis		1.500	2.619

Descriptives

	TIME			Statistic	Std. Error
FORTHH	1 week	Mean		3.0000	1.58114
		95% Confidence Interval for Mean	Lower Bound	-2.0319	
			Upper Bound	8.0319	
		5% Trimmed Mean		2.9444	
		Median		2.5000	
		Variance		10.000	
		Std. Deviation		3.16228	
		Minimum		.00	
		Maximum		7.00	
		Range		7.00	
		Interquartile Range		6.0000	
		Skewness		.632	1.014
		Kurtosis		-1.700	2.619
	2 weeks	Mean		3.0000	1.58114
		95% Confidence Interval for Mean	Lower Bound	-2.0319	
			Upper Bound	8.0319	
		5% Trimmed Mean		2.9444	
		Median		2.5000	
		Variance		10.000	
		Std. Deviation		3.16228	
		Minimum		.00	
		Maximum		7.00	
		Range		7.00	
		Interquartile Range		6.0000	
		Skewness		.632	1.014
		Kurtosis		-1.700	2.619
	3 weeks	Mean		1.7500	1.03078
		95% Confidence Interval for Mean	Lower Bound	-1.5304	
			Upper Bound	5.0304	
		5% Trimmed Mean		1.7222	
		Median		1.5000	
		Variance		4.250	
		Std. Deviation		2.06155	
		Minimum		.00	
		Maximum		4.00	
		Range		4.00	
		Interquartile Range		3.7500	
		Skewness		.200	1.014
		Kurtosis		-4.858	2.619

Descriptives

	TIME			Statistic	Std. Error
FIFTHH	0 week	Mean		7.0000	1.82574
		95% Confidence Interval for Mean	Lower Bound	1.1897	
			Upper Bound	12.8103	
		5% Trimmed Mean		7.0000	
		Median		7.0000	
		Variance		13.333	
		Std. Deviation		3.65148	
		Minimum		3.00	
		Maximum		11.00	
		Range		8.00	
		Interquartile Range		7.0000	
		Skewness		.000	1.014
		Kurtosis		-3.300	2.619
	1 week	Mean		4.5000	2.95804
		95% Confidence Interval for Mean	Lower Bound	-4.9138	
			Upper Bound	13.9138	
		5% Trimmed Mean		4.2778	
		Median		2.5000	
		Variance		35.000	
		Std. Deviation		5.91608	
		Minimum		.00	
		Maximum		13.00	
		Range		13.00	
		Interquartile Range		10.5000	
		Skewness		1.545	1.014
		Kurtosis		2.229	2.619
	2 weeks	Mean		2.0000	1.15470
		95% Confidence Interval for Mean	Lower Bound	-1.6748	
			Upper Bound	5.6748	
		5% Trimmed Mean		2.0000	
		Median		2.0000	
		Variance		5.333	
		Std. Deviation		2.30940	
		Minimum		.00	
		Maximum		4.00	
		Range		4.00	
		Interquartile Range		4.0000	
		Skewness		.000	1.014
		Kurtosis		-6.000	2.619

Descriptives

	TIME			Statistic	Std. Error
FIFTHH	3 weeks	Mean		7.5000	2.84312
		95% Confidence Interval for Mean	Lower Bound	-1.5481	
			Upper Bound	16.5481	
		5% Trimmed Mean		7.5000	
		Median		7.5000	
		Variance		32.333	
		Std. Deviation		5.68624	
		Minimum		1.00	
		Maximum		14.00	
		Range		13.00	
		Interquartile Range		11.0000	
		Skewness		.000	1.014
		Kurtosis		-1.868	2.619

Tests of Normality

		Kolmogorov-Smirnov[a]		
	TIME	Statistic	df	Sig.
SECH	0 week	.250	4	.
	1 week	.215	4	.
	2 weeks	.250	4	.
	3 weeks	.293	4	.
THIRDH	0 week	.250	4	.
	1 week	.252	4	.
	2 weeks	.250	4	.
	3 weeks	.293	4	.
FORTHH	0 week	.260	4	.
	1 week	.236	4	.
	2 weeks	.236	4	.
	3 weeks	.302	4	.
FIFTHH	0 week	.208	4	.
	1 week	.284	4	.
	2 weeks	.307	4	.
	3 weeks	.170	4	.

Tests of Normality

	TIME	Shapiro-Wilk		
		Statistic	df	Sig.
SECH	0 week	.945	4	.683
	1 week	.946	4	.689
	2 weeks	.927	4	.577
	3 weeks	.918	4	.528
THIRDH	0 week	.945	4	.683
	1 week	.882	4	.348
	2 weeks	.927	4	.577
	3 weeks	.918	4	.528
FORTHH	0 week	.827	4	.161
	1 week	.940	4	.653
	2 weeks	.940	4	.653
	3 weeks	.827	4	.161
FIFTHH	0 week	.950	4	.714
	1 week	.848	4	.218
	2 weeks	.729	4	.024
	3 weeks	.983	4	.921

a. *Lilliefors Significance Correction*

Oneway

ANOVA

		Sum of Squares	df	Mean Square
SECH	Between Groups	134.000	3	44.667
	Within Groups	102.000	12	8.500
	Total	236.000	15	
THIRDH	Between Groups	124.750	3	41.583
	Within Groups	107.000	12	8.917
	Total	231.750	15	
FORTHH	Between Groups	127.688	3	42.563
	Within Groups	78.750	12	6.563
	Total	206.438	15	
FIFTHH	Between Groups	77.000	3	25.667
	Within Groups	258.000	12	21.500
	Total	335.000	15	

ANOVA

		F	Sig.
SECH	Between Groups	5.255	.015
	Within Groups		
	Total		
THIRDH	Between Groups	4.664	.022
	Within Groups		
	Total		
FORTHH	Between Groups	6.486	.007
	Within Groups		
	Total		
FIFTHH	Between Groups	1.194	.354
	Within Groups		
	Total		

Post Hoc Tests

Homogeneous Subsets

SECH

			Subset for alpha = .05	
	TIME	N	1	2
Student-Newman-Keuls[a]	2 weeks	4	2.0000	
	1 week	4	2.5000	
	3 weeks	4	6.5000	6.5000
	0 week	4		9.0000
	Sig.		.115	.249
Tukey HSD[a]	2 weeks	4	2.0000	
	1 week	4	2.5000	
	3 weeks	4	6.5000	6.5000
	0 week	4		9.0000
	Sig.		.183	.631
Duncan[a]	2 weeks	4	2.0000	
	1 week	4	2.5000	
	3 weeks	4	6.5000	6.5000
	0 week	4		9.0000
	Sig.		.059	.249

Means for groups in homogeneous subsets are displayed.

[a] Uses Harmonic Mean Sample Size = 4.000.

THIRDH

	TIME	N	Subset for alpha = .05 1	 2
Student-Newman-Keuls[a]	2 weeks	4	2.0000	
	1 week	4	3.0000	
	3 weeks	4	6.5000	6.5000
	0 week	4		9.0000
	Sig.		.125	.259
Tukey HSD[a]	2 weeks	4	2.0000	
	1 week	4	3.0000	3.0000
	3 weeks	4	6.5000	6.5000
	0 week	4		9.0000
	Sig.		.198	.062
Duncan[a]	2 weeks	4	2.0000	
	1 week	4	3.0000	
	3 weeks	4	6.5000	6.5000
	0 week	4		9.0000
	Sig.		.065	.259

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

FORTHH

	TIME	N	Subset for alpha = .05 1	 2
Student-Newman-Keuls[a]	3 weeks	4	1.7500	
	1 week	4	3.0000	
	2 weeks	4	3.0000	
	0 week	4		9.0000
	Sig.		.774	1.000
Tukey HSD[a]	3 weeks	4	1.7500	
	1 week	4	3.0000	
	2 weeks	4	3.0000	
	0 week	4		9.0000
	Sig.		.899	1.000
Duncan[a]	3 weeks	4	1.7500	
	1 week	4	3.0000	
	2 weeks	4	3.0000	
	0 week	4		9.0000
	Sig.		.524	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

FIFTHH

	TIME	N	Subset for alpha = .05 1
Student-Newman-Keuls[a]	2 weeks	4	2.0000
	1 week	4	4.5000
	0 week	4	7.0000
	3 weeks	4	7.5000
	Sig.		.376
Tukey HSD[a]	2 weeks	4	2.0000
	1 week	4	4.5000
	0 week	4	7.0000
	3 weeks	4	7.5000
	Sig.		.376
Duncan[a]	2 weeks	4	2.0000
	1 week	4	4.5000
	0 week	4	7.0000
	3 weeks	4	7.5000
	Sig.		.145

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Appendix 12. Output analysis for number of termites in contact with the test block decayed by *P. noxius* within five hours.

Descriptives

	TIME			Statistic	Std. Error
FSTH	0 week	Mean		9.7500	.25000
		95% Confidence Interval for Mean	Lower Bound	8.9544	
			Upper Bound	10.5456	
		5% Trimmed Mean		9.7778	
		Median		10.0000	
		Variance		.250	
		Std. Deviation		.50000	
		Minimum		9.00	
		Maximum		10.00	
		Range		1.00	
		Interquartile Range		.7500	
		Skewness		-2.000	1.014
		Kurtosis		4.000	2.619
	1 week	Mean		1.7500	.75000
		95% Confidence Interval for Mean	Lower Bound	-.6368	
			Upper Bound	4.1368	
		5% Trimmed Mean		1.7778	
		Median		2.0000	
		Variance		2.250	
		Std. Deviation		1.50000	
		Minimum		.00	
		Maximum		3.00	
		Range		3.00	
		Interquartile Range		2.7500	
		Skewness		-.370	1.014
		Kurtosis		-3.901	2.619
	2 weeks	Mean		1.2500	.75000
		95% Confidence Interval for Mean	Lower Bound	-1.1368	
			Upper Bound	3.6368	
		5% Trimmed Mean		1.2222	
		Median		1.0000	
		Variance		2.250	
		Std. Deviation		1.50000	
		Minimum		.00	
		Maximum		3.00	
		Range		3.00	
		Interquartile Range		2.7500	
		Skewness		.370	1.014
		Kurtosis		-3.901	2.619

Descriptives

	TIME			Statistic	Std. Error
FSTH	3 weeks	Mean		6.7500	2.32289
		95% Confidence Interval for Mean	Lower Bound	-.6425	
			Upper Bound	14.1425	
		5% Trimmed Mean		6.6667	
		Median		6.0000	
		Variance		21.583	
		Std. Deviation		4.64579	
		Minimum		2.00	
		Maximum		13.00	
		Range		11.00	
		Interquartile Range		8.7500	
		Skewness		.875	1.014
		Kurtosis		1.128	2.619
SECH	0 week	Mean		9.0000	.40825
		95% Confidence Interval for Mean	Lower Bound	7.7008	
			Upper Bound	10.2992	
		5% Trimmed Mean		9.0000	
		Median		9.0000	
		Variance		.667	
		Std. Deviation		.81650	
		Minimum		8.00	
		Maximum		10.00	
		Range		2.00	
		Interquartile Range		1.5000	
		Skewness		.000	1.014
		Kurtosis		1.500	2.619
	1 week	Mean		2.5000	1.32288
		95% Confidence Interval for Mean	Lower Bound	-1.7100	
			Upper Bound	6.7100	
		5% Trimmed Mean		2.4444	
		Median		2.0000	
		Variance		7.000	
		Std. Deviation		2.64575	
		Minimum		.00	
		Maximum		6.00	
		Range		6.00	
		Interquartile Range		5.0000	
		Skewness		.864	1.014
		Kurtosis		-.286	2.619

Descriptives

	TIME			Statistic	Std. Error
SECH	2 weeks	Mean		2.0000	1.08012
		95% Confidence Interval for Mean	Lower Bound	-1.4374	
			Upper Bound	5.4374	
		5% Trimmed Mean		1.9444	
		Median		1.5000	
		Variance		4.667	
		Std. Deviation		2.16025	
		Minimum		.00	
		Maximum		5.00	
		Range		5.00	
		Interquartile Range		4.0000	
		Skewness		1.190	1.014
		Kurtosis		1.500	2.619
	3 weeks	Mean		6.5000	2.32737
		95% Confidence Interval for Mean	Lower Bound	-.9067	
			Upper Bound	13.9067	
		5% Trimmed Mean		6.3889	
		Median		5.5000	
		Variance		21.667	
		Std. Deviation		4.65475	
		Minimum		2.00	
		Maximum		13.00	
		Range		11.00	
		Interquartile Range		8.5000	
		Skewness		1.190	1.014
		Kurtosis		2.123	2.619
THIRDH	0 week	Mean		9.2500	.47871
		95% Confidence Interval for Mean	Lower Bound	7.7265	
			Upper Bound	10.7735	
		5% Trimmed Mean		9.2778	
		Median		9.5000	
		Variance		.917	
		Std. Deviation		.95743	
		Minimum		8.00	
		Maximum		10.00	
		Range		2.00	
		Interquartile Range		1.7500	
		Skewness		-.855	1.014
		Kurtosis		-1.289	2.619

Descriptives

	TIME			Statistic	Std. Error
THIRDH	1 week	Mean		3.0000	1.47196
		95% Confidence Interval for Mean	Lower Bound	-1.6844	
			Upper Bound	7.6844	
		5% Trimmed Mean		3.0000	
		Median		3.0000	
		Variance		8.667	
		Std. Deviation		2.94392	
		Minimum		.00	
		Maximum		6.00	
		Range		6.00	
		Interquartile Range		5.5000	
		Skewness		.000	1.014
		Kurtosis		-4.891	2.619
	2 weeks	Mean		1.7500	1.03078
		95% Confidence Interval for Mean	Lower Bound	-1.5304	
			Upper Bound	5.0304	
		5% Trimmed Mean		1.7222	
		Median		1.5000	
		Variance		4.250	
		Std. Deviation		2.06155	
		Minimum		.00	
		Maximum		4.00	
		Range		4.00	
		Interquartile Range		3.7500	
		Skewness		.200	1.014
		Kurtosis		-4.858	2.619
	3 weeks	Mean		6.7500	2.92617
		95% Confidence Interval for Mean	Lower Bound	-2.5624	
			Upper Bound	16.0624	
		5% Trimmed Mean		6.7222	
		Median		6.5000	
		Variance		34.250	
		Std. Deviation		5.85235	
		Minimum		.00	
		Maximum		14.00	
		Range		14.00	
		Interquartile Range		11.2500	
		Skewness		.233	1.014
		Kurtosis		.283	2.619

Descriptives

	TIME			Statistic	Std. Error
FORTHH	0 week	Mean		9.0000	.70711
		95% Confidence Interval for Mean	Lower Bound	6.7497	
			Upper Bound	11.2503	
		5% Trimmed Mean		8.9444	
		Median		8.5000	
		Variance		2.000	
		Std. Deviation		1.41421	
		Minimum		8.00	
		Maximum		11.00	
		Range		3.00	
		Interquartile Range		2.5000	
		Skewness		1.414	1.014
		Kurtosis		1.500	2.619
	1 week	Mean		3.0000	1.58114
		95% Confidence Interval for Mean	Lower Bound	-2.0319	
			Upper Bound	8.0319	
		5% Trimmed Mean		2.9444	
		Median		2.5000	
		Variance		10.000	
		Std. Deviation		3.16228	
		Minimum		.00	
		Maximum		7.00	
		Range		7.00	
		Interquartile Range		6.0000	
		Skewness		.632	1.014
		Kurtosis		-1.700	2.619
	2 weeks	Mean		1.7500	1.03078
		95% Confidence Interval for Mean	Lower Bound	-1.5304	
			Upper Bound	5.0304	
		5% Trimmed Mean		1.7222	
		Median		1.5000	
		Variance		4.250	
		Std. Deviation		2.06155	
		Minimum		.00	
		Maximum		4.00	
		Range		4.00	
		Interquartile Range		3.7500	
		Skewness		.200	1.014
		Kurtosis		-4.858	2.619

Descriptives

	TIME			Statistic	Std. Error
FORTHH	3 weeks	Mean		7.2500	2.49583
		95% Confidence Interval for Mean	Lower Bound	-.6928	
			Upper Bound	15.1928	
		5% Trimmed Mean		7.1667	
		Median		6.5000	
		Variance		24.917	
		Std. Deviation		4.99166	
		Minimum		2.00	
		Maximum		14.00	
		Range		12.00	
		Interquartile Range		9.2500	
		Skewness		.862	1.014
		Kurtosis		1.738	2.619
FIFTHH	0 week	Mean		7.0000	1.82574
		95% Confidence Interval for Mean	Lower Bound	1.1897	
			Upper Bound	12.8103	
		5% Trimmed Mean		7.0000	
		Median		7.0000	
		Variance		13.333	
		Std. Deviation		3.65148	
		Minimum		3.00	
		Maximum		11.00	
		Range		8.00	
		Interquartile Range		7.0000	
		Skewness		.000	1.014
		Kurtosis		-3.300	2.619
	1 week	Mean		4.5000	2.95804
		95% Confidence Interval for Mean	Lower Bound	-4.9138	
			Upper Bound	13.9138	
		5% Trimmed Mean		4.2778	
		Median		2.5000	
		Variance		35.000	
		Std. Deviation		5.91608	
		Minimum		.00	
		Maximum		13.00	
		Range		13.00	
		Interquartile Range		10.5000	
		Skewness		1.545	1.014
		Kurtosis		2.229	2.619

Descriptives

	TIME			Statistic	Std. Error
FIFTHH	2 weeks	Mean		2.0000	1.15470
		95% Confidence Interval for Mean	Lower Bound	-1.6748	
			Upper Bound	5.6748	
		5% Trimmed Mean		2.0000	
		Median		2.0000	
		Variance		5.333	
		Std. Deviation		2.30940	
		Minimum		.00	
		Maximum		4.00	
		Range		4.00	
		Interquartile Range		4.0000	
		Skewness		.000	1.014
		Kurtosis		-6.000	2.619
	3 weeks	Mean		7.5000	2.84312
		95% Confidence Interval for Mean	Lower Bound	-1.5481	
			Upper Bound	16.5481	
		5% Trimmed Mean		7.5000	
		Median		7.5000	
		Variance		32.333	
		Std. Deviation		5.68624	
		Minimum		1.00	
		Maximum		14.00	
		Range		13.00	
		Interquartile Range		11.0000	
		Skewness		.000	1.014
		Kurtosis		-1.868	2.619

Tests of Normality

		Kolmogorov-Smirnov[a]		
	TIME	Statistic	df	Sig.
FSTH	0 week	.441	4	.
	1 week	.298	4	.
	2 weeks	.298	4	.
	3 weeks	.229	4	.
SECH	0 week	.250	4	.
	1 week	.215	4	.
	2 weeks	.250	4	.
	3 weeks	.293	4	.
THIRDH	0 week	.283	4	.
	1 week	.252	4	.
	2 weeks	.302	4	.
	3 weeks	.165	4	.
FORTHH	0 week	.260	4	.
	1 week	.236	4	.
	2 weeks	.302	4	.
	3 weeks	.270	4	.
FIFTHH	0 week	.208	4	.
	1 week	.284	4	.
	2 weeks	.307	4	.
	3 weeks	.170	4	.

Tests of Normality

	TIME	Shapiro-Wilk		
		Statistic	df	Sig.
FSTH	0 week	.630	4	.001
	1 week	.849	4	.224
	2 weeks	.849	4	.224
	3 weeks	.962	4	.792
SECH	0 week	.945	4	.683
	1 week	.946	4	.689
	2 weeks	.927	4	.577
	3 weeks	.918	4	.528
THIRDH	0 week	.863	4	.272
	1 week	.882	4	.348
	2 weeks	.827	4	.161
	3 weeks	.997	4	.989
FORTHH	0 week	.827	4	.161
	1 week	.940	4	.653
	2 weeks	.827	4	.161
	3 weeks	.947	4	.697
FIFTHH	0 week	.950	4	.714
	1 week	.848	4	.218
	2 weeks	.729	4	.024
	3 weeks	.983	4	.921

a. *Lilliefors Significance Correction*

Oneway

ANOVA

		Sum of Squares	df	Mean Square
FSTH	Between Groups	200.750	3	66.917
	Within Groups	79.000	12	6.583
	Total	279.750	15	
SECH	Between Groups	134.000	3	44.667
	Within Groups	102.000	12	8.500
	Total	236.000	15	
THIRDH	Between Groups	142.188	3	47.396
	Within Groups	144.250	12	12.021
	Total	286.438	15	
FORTHH	Between Groups	141.500	3	47.167
	Within Groups	123.500	12	10.292
	Total	265.000	15	
FIFTHH	Between Groups	77.000	3	25.667
	Within Groups	258.000	12	21.500
	Total	335.000	15	

ANOVA

		F	Sig.
FSTH	Between Groups	10.165	.001
	Within Groups		
	Total		
SECH	Between Groups	5.255	.015
	Within Groups		
	Total		
THIRDH	Between Groups	3.943	.036
	Within Groups		
	Total		
FORTHH	Between Groups	4.583	.023
	Within Groups		
	Total		
FIFTHH	Between Groups	1.194	.354
	Within Groups		
	Total		

Post Hoc Tests

Homogeneous Subsets

FSTH

			Subset for alpha = .05		
	TIME	N	1	2	3
Student-Newman-Keuls[a]	2 weeks	4	1.2500		
	1 week	4	1.7500		
	3 weeks	4		6.7500	
	0 week	4		9.7500	
	Sig.		.788	.124	
Tukey HSD[a]	2 weeks	4	1.2500		
	1 week	4	1.7500	1.7500	
	3 weeks	4		6.7500	6.7500
	0 week	4			9.7500
	Sig.		.992	.072	.388
Duncan[a]	2 weeks	4	1.2500		
	1 week	4	1.7500		
	3 weeks	4		6.7500	
	0 week	4		9.7500	
	Sig.		.788	.124	

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

SECH

	TIME	N	Subset for alpha = .05	
			1	2
Student-Newman-Keuls[a]	2 weeks	4	2.0000	
	1 week	4	2.5000	
	3 weeks	4	6.5000	6.5000
	0 week	4		9.0000
	Sig.		.115	.249
Tukey HSD[a]	2 weeks	4	2.0000	
	1 week	4	2.5000	
	3 weeks	4	6.5000	6.5000
	0 week	4		9.0000
	Sig.		.183	.631
Duncan[a]	2 weeks	4	2.0000	
	1 week	4	2.5000	
	3 weeks	4	6.5000	6.5000
	0 week	4		9.0000
	Sig.		.059	.249

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

THIRDH

	TIME	N	Subset for alpha = .05	
			1	2
Student-Newman-Keuls[a]	2 weeks	4	1.7500	
	1 week	4	3.0000	3.0000
	3 weeks	4	6.7500	6.7500
	0 week	4		9.2500
	Sig.		.145	.062
Tukey HSD[a]	2 weeks	4	1.7500	
	1 week	4	3.0000	3.0000
	3 weeks	4	6.7500	6.7500
	0 week	4		9.2500
	Sig.		.228	.102
Duncan[a]	2 weeks	4	1.7500	
	1 week	4	3.0000	
	3 weeks	4	6.7500	6.7500
	0 week	4		9.2500
	Sig.		.075	.328

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

FORTHH

	TIME	N	Subset for alpha = .05 1	2	3
Student-Newman-Keuls[a]	2 weeks	4	1.7500		
	1 week	4	3.0000	3.0000	
	3 weeks	4	7.2500	7.2500	
	0 week	4		9.0000	
	Sig.		.076	.052	
Tukey HSD[a]	2 weeks	4	1.7500		
	1 week	4	3.0000	3.0000	
	3 weeks	4	7.2500	7.2500	
	0 week	4		9.0000	
	Sig.		.125	.087	
Duncan[a]	2 weeks	4	1.7500		
	1 week	4	3.0000	3.0000	
	3 weeks	4		7.2500	7.2500
	0 week	4			9.0000
	Sig.		.592	.086	.455

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

FIFTHH

	TIME	N	Subset for alpha = .05 1
Student-Newman-Keuls[a]	2 weeks	4	2.0000
	1 week	4	4.5000
	0 week	4	7.0000
	3 weeks	4	7.5000
	Sig.		.376
Tukey HSD[a]	2 weeks	4	2.0000
	1 week	4	4.5000
	0 week	4	7.0000
	3 weeks	4	7.5000
	Sig.		.376
Duncan[a]	2 weeks	4	2.0000
	1 week	4	4.5000
	0 week	4	7.0000
	3 weeks	4	7.5000
	Sig.		.145

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Appendix 13. Output analysis for weight lost of test block comparing between two fungi *P. sanguinues* and *P. noxius* in choice-feeding test.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair	PYCNO	298.2000	4	133.53434	66.76717
1	PHELLI	576.2250	4	174.97441	87.48720

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PYCNO & PHELLI	4	.767	.233

Paired Samples Test

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	PYCNO - PHELLI	-278.0250	112.36884	56.18442	-456.8289	-99.2211

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PYCNO - PHELLI	-4.948	3	.016

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair	PYCNO	339.2750	4	137.76283	68.89142
1	PHELLI	242.8250	4	135.51203	67.75601

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PYCNO & PHELLI	4	.906	.094

Paired Samples Test

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	PYCNO - PHELLI	96.4500	59.19181	29.59590	2.2626	190.6374

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PYCNO - PHELLI	3.259	3	.047

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PYCNO	303.6250	4	77.64918	38.82459
	PHELLI	192.4000	4	119.19206	59.59603

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PYCNO & PHELLI	4	-.747	.253

Paired Samples Test

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	PYCNO - PHELLI	111.2250	184.58724	92.29362	-182.4945	404.9445

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PYCNO - PHELLI	1.205	3	.315

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PYCNO	266.9250	4	161.30033	80.65016
	PHELLI	377.8500	4	35.05847	17.52924

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PYCNO & PHELLI	4	-.268	.732

Paired Samples Test

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	PYCNO - PHELLI	-110.9250	174.01911	87.00955	-387.8282	165.9782

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PYCNO - PHELLI	-1.275	3	.292

Appendix 14. Output analysis for test block comparing between two fungi *P.sanguinues* and *P. noxius* in force-feeding test.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PYCNO	712.3000	4	135.08365	67.54183
	PHELLI	825.0000	4	108.83005	54.41503

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PYCNO & PHELLI	4	-.336	.664

Paired Samples Test

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	PYCNO - PHELLI	-112.7000	199.95980	99.97990	-430.8807	205.4807

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PYCNO - PHELLI	-1.127	3	.342

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PYCNO	242.8250	4	135.51203	67.75601
	PHELLI	459.4000	4	57.24456	28.62228

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PYCNO & PHELLI	4	-.294	.706

Paired Samples Test

		Paired Differences				
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference	
					Lower	Upper
Pair 1	PYCNO - PHELLI	-216.5750	161.86040	80.93020	-474.1310	40.9810

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PYCNO - PHELLI	-2.676	3	.075

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PYCNO	192.4000	4	119.19206	59.59603
	PHELLI	445.7500	4	107.95192	53.97596

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PYCNO & PHELLI	4	.909	.091

Paired Samples Test

		Paired Differences				
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference	
					Lower	Upper
Pair 1	PYCNO - PHELLI	-253.3500	49.73748	24.86874	-332.4934	-174.2066

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PYCNO - PHELLI	-10.187	3	.002

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PYCNO	377.8500	4	35.05847	17.52924
	PHELLI	698.0750	4	141.48732	70.74366

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PYCNO & PHELLI	4	-.450	.550

Paired Samples Test

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	PYCNO - PHELLI	-320.2250	160.34121	80.17060	-575.3636	-65.0864

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PYCNO - PHELLI	-3.994	3	.028