Pandan Leaves (*Pandanus amaryllifolius* Roxb.) As A Natural Cockroach Repellent

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ABSTRACT

Seven compounds and fractions prepared from pandan leaves (*P. amaryllifolius*) were evaluated for repellent activity against *Blattella germanica* (L.) using a modification of the linear tract olfactometer. 2-Acetyl-1-pyrroline, pandan essence and the hexane-pandan extract were repellent (65-93 % repellency) at all concentrations tested; the acetone-pandan extract was attractive at increasing concentrations (minimum of 62 % attractancy); artificial pandan flavouring and the dichloromethane-pandan extract gave erratic results. Undiluted crude aqueous pandan extract displayed an attractancy of 62%. The potential of *P. amaryllifolius* as a natural and environmentally friendly pest management tool is discussed.

INTRODUCTION

It is said that taxi drivers in Singapore and Malaysia keep bunches of pandan leaves (*Pandanus amaryllifolius* Roxb.) in their taxis to ward off cockroaches. An analysis of the volatile essential oils of *P. amaryllifolius* by MacLeod and Pieris (1982) revealed that this species contains mainly terpenes and sesquiterpene hydrocarbons (6-42%), as well as a major aroma component – 2-acetyl-1-pyrroline (2AP) (Yoshihashi, 2002). The presence of essential oils, i.e. mixtures consisting predominantly of mono- and sesquiterpene derivatives, accounts for the insect-repellent and attractant properties associated with some aromatic plants (Herout, 1970; Rice, 1983). Previous studies have established significant repellent activity of *P. amaryllifolius* against American cockroaches (*Periplaneta americana* L.) (Ahmad et al, 1995), but similar effects against other species of cockroaches have not yet been looked into. This study thus evaluates seven components – four essential oils extracted with alcohol, *n*-hexane ($CH_3(CH2)_4CH_3$), acetone (CH_3COCH) and dichloromethane (CH_2Cl_2) respectively, an artificial pandan flavouring (Star Brand), an aqueous crude extract and an aromatic compound, 2-acetyl-1-pyrroline (2AP) (C_6H_9NO) - from *P. amaryllifolius* as repellents against German cockroaches, *Blattella germanica* (L.).

MATERIALS AND METHODS

Test Insects

Nymphs of *B. germanica* (Universiti Sains Malaysia strain),1-6 days old, were used for the experiments.

Test Chemicals

Artificial pandan flavouring (Star Brand) was purchased from a local supermarket, natural pandan essence extracted using 50% alcohol was provided with compliments from PT Haldin

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Pacific Semesta while 2AP (C_6H_9NO) in 1% dichloromethane solution was obtained from JIRCAS[1] (courtesy of Dr T. Yoshihashi). Fresh pandan leaves were provided by Dr Saw Seang Mei, Department of Community, Occupational & Family Medicine, NUS. The plant was also acquired from Malaysia as well as local wet markets. Boiled pandan leaf crude extract was obtained by boiling 19.8 g (wet weight) of mature leaves for 30 min in 800 mL of distilled water and then filtered. The filtrate was used. The rest of the leaves were subjected to cold solvent extraction. Approximately 10 kg of leaf mass were were bathed for one week in analytical grade *n*-hexane ($CH_3(CH2)_4CH_3$), acetone (CH_3COCH) and dichloromethane (CH_2Cl_2) respectively.

Bioassay Procedure

A linear track olfactometer used for detecting the repellency response of nymphs to the aroma in pandan extracts was adapted from Sakuma and Fukami (1985).

Repellency Assay

In the repellency test, the effectiveness of each candidate extract was expressed in terms of the excess proportion of insects on the treatment area (Bentley, 1944):

$$I = \frac{NS - NC}{NS + NC}$$

$$PC = \left(1 - \frac{NS}{NS + NC}\right) \times 100\%$$

$$PS = 100\% - PC$$

where
- I : excess proportion index
- NS : number of insects trapped in the chemical-treated test chamber
- NC : number of insects trapped in the control test chamber
- PC : Percentage repellency (i.e. percentage of animals trapped in control test chamber)
- PS : Percentage attractancy (i.e. percentage of insects trapped in chemical-treated test chamber)

RESULTS AND DISCUSSION

Figure 1 displays the results of the repellency assay. Undiluted crude aqueous pandan extract was tested to establish whether our compound of interest was found in the aqueous fraction. Data collected indicated 62 % attraction of the nymphs by the aqueous pandan extract, thus confirming that repellent compounds, if any, were not present in appreciable amounts in the aqueous fraction. Acetone-pandan extract also demonstrated considerable attractancy (PS > 60 %) at increasing concentrations. Practical applications of these observations might be to enhance cockroach mortality by adding the scented attractants to insecticides.

Repellency against the *B. germanica* nymphs increased with increasing concentrations of 2AP (PC = 65-93 %), whereas repellency increased with decreasing concentrations of pandan essence (PC = 67-85 %) and hexane-pandan extract (PC = 68-83 %). 2AP is a highly effective repellent as its repellency is projected to increase until it tapers off at an optimum efficiency level with higher concentrations, making it possible for its efficiency level to be controlled. However, 2AP in any solvents in higher concentration (1-2 % dichloromethane) will deteriorate by polymerisation. Thus the test stock solution (1%) was only diluted in this study, not concentrated. Purification or synthesis of the chemical was also expensive and time-consuming,

hence making future prospects of exploiting 2AP commercially limited. The trend for repellency of pandan essence and the hexane-pandan extract showed that their minimum working concentrations corresponded to their optimum concentrations. It might thus be worthwhile to investigate further into the effects of these chemicals as repellents to other species of cockroaches.

The artificial pandan flavouring emitted a similar scent to pure 2AP. As the latter showed high repellency when dissolved in dichloromethane, we would expect both the artificial pandan flavouring and dichloromethane-pandan extract to exhibit similar properties. However, no trend was found in the effects of the two test chemicals on the nymphs. The results showed alternating attractancy and repellency, suggesting that 2AP might have been degraded during the extraction process. Interestingly, 2AP is the characterizing flavor of certain species of aromatic rice (e.g. Thai fragrant rice) with its nutty popcorn aroma. It is also important to wheat bread crust aroma. Yet, cockroaches do not shun rice pails in households, and bread is a well-known favourite with the insects. Hence, either certain synergists are present within intact, mature pandan leaves, or only pure 2AP acts as a repellent. It could also be possible that attractancy of the high carbohydrate (choice energy source of cockroaches) content and perhaps other aromatic components of bread and rice effectively masked the repellent effects of 2AP.

Similar studies on the repellent activity of essential oils from six Malaysian aromatic plants, including *P. amaryllifoilus*, had been carried out using another species of cockroaches, *P. americana* (Ahmad et al, 1995). Of the essential oils from lemongrass, cinnamon, ginger, clove, tumeric and pandan leaves, pandan oil was the least potent, requiring a concentration more than a four-fold increase over the other oils to demonstrate 100 % repellency. This observation is in line with the moderate repellency exhibited by *P. amaryllifoilus* against *B. germanica* in this report. It is highly possible that the concentrations tested in this study were too low to produce 100 % repellency. By establishing the optimum working concentrations of repellent components such as 2AP, hexane-pandan extract and pandan essence and subsequently combining them together, it would very likely produce outstanding repellent effects.

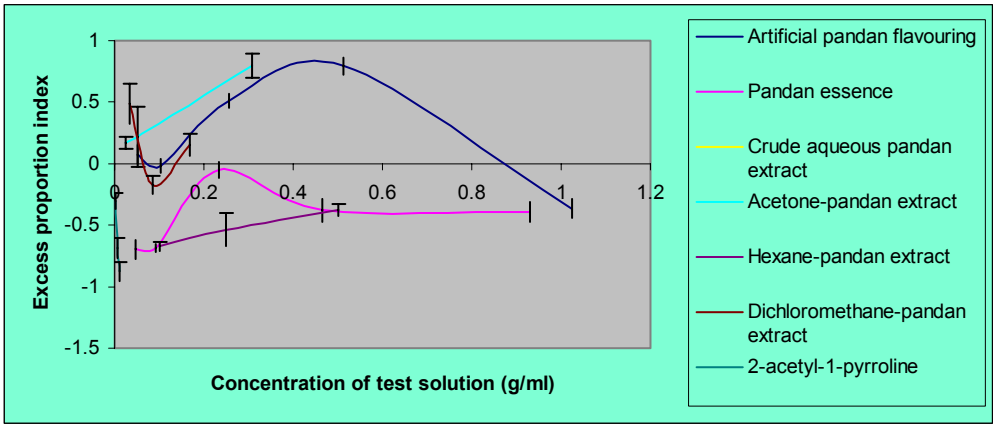

Figure 1. Repellency of various components of *P. amaryllifolius* against *B. germanica*

CONCLUSION

This study has only covered the repellent effects of various components found in the candidate plant, *P. amaryllifolius*, but not on the intact plant. Although both attractive and repellent compounds are present in the plant, it is likely that the proportion of repellent components in mature pandan leaves outweighs that of its attractive counterparts. Hence, bunches of pandan leaves can possibly work well for taxi drivers as the leaves are usually left to dry out at the back of the taxi, evaporating the water and volatile compounds in the leaves. Since leaves are contained within the small confines of the taxi, its scented, cockroach-repellent volatile compounds can permeate the air and possibly be concentrated enough to repel cockroaches.

However, it might be more practical to optimize the repellent components of pandan leaves for use in some instances. Repellent components of pandan leaves, such as 2AP, hexane-pandan extract and pandan essence, could be concentrated to their optimum working concentrations and periodically sprayed onto the walls and floors of warehouses and ships to repel cockroaches. As the repellent is non-toxic, there are also good prospects to develop cockroach-repellent spray cans for domestic use. Dark corners, cabinets and drawers, especially those in the kitchen, could be coated with a layer of repellent to ward off the insects. However, two factors influencing the effectiveness of the fractions, volatility and persistence, were not taken into account in this study. Perhaps more studies can be done to quantify the effects of test chemicals over time to give them more practical values.

Although by no means the most efficient for this purpose, a natural, non-insecticidal means of combating cockroaches is preferred in the face of reported undesirable effects of many synthetic repellents such as DEET (Reynolds, 1989) on humans and the environment. Furthermore, *P. amaryllifolius* has the secondary benefit of adding visual and olfactory pleasure to humans. It would therefore be worthwhile to investigate further into this plant for scented cockroach-repellent components for possible commercialisation.

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