Biosensors for termite control

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Abstract: Termites are major urban pests in Pakistan and cause damage to wooden structures and buildings. Termite management has two parts: prevention and control. The most difficult part of termite control is termite detection as most of them are subterranean in Pakistan and have tunneling habit. Throughout the world, chemical termiticides are going to be replaced by baits, microwave and sensor technology. Termite species are distinct biologically and have specific foraging behaviors. Termite Detection Radar, Moisture meter and Remote Thermal Sensor with Laser are available throughout the world. These can detect termites underground and use fewer chemicals than traditional methods. For wooden buildings, a termite sensor and an intrusion detection system for detecting termites are designed. A pair of electrodes is disposed inside the container. A pair of terminals is connected to these electrodes, these extend outside the container. Termites are detected by a change of conductivity between the electrodes, when termites are detected a warning device generates a warning signal. In Pakistan, there is dire need to develop such biosensoring devices locally, then apply control methods that would save money and protect the environment.

1. Introduction
Termites are the most important group of insects that destroy cellulosic materials including wood. These social insects having soldier, worker, queen and king caste, are widespread to terrestrial environment and are distributed in Tropical, Subtropical and Temperate regions (Fig 1). They cause destruction to power pole, railway sleepers, many crops plantation and living trees but perhaps of greatest importance is the destruction inflicted on timber used in constructional purposes both outdoors and inside buildings. In Pakistan, there are 53 species of termites [1]. During survey thirteen termite species have been identified as cost-effective species to the residential wooden structures in Pakistan. Some of these are Heterotermes indicola, Coptotermes heimi, Microtermes mycophagus, Microtermes obesi, Eremotermes paradoxalis, Odontotermes horai, Odontotermes gurdasurensis, Odontotermes gurupai, Odontotermes obesus [2]. Worldwide the cost of treatments to eradicate subterranean termite infestations in 1986 has been estimated at approximately US$2 billion [3] but in Pakistan no such survey is available to determine the cost of damage.
The most common traditional termite control techniques are soil chemical barriers pre-construction and post construction treatment. Besides this termite baiting systems, physical treatment to aggregate barriers such as stainless steel mesh barriers and plastic barriers are also used to treat termites in different parts of the world.

2. Results and Discussion

Now the question is why we should use biosensors? The answer is very simple. The biosensors do no help to control termites but help only to detect termites. It gives clarity about activity of termite attack and decrease tension between parties and prevent unnecessary treatments. One more reason is biosensors are used for termite detection in wood due to following wood properties: wood is differentiated as hardwood and softwood, it has dielectric and conductivity properties of wood and show microwave effect. As termites show foraging behavior and go on moving in search of food, this technology also defines the frequency range and wave length of the signals that are generated by termite noises [4].

Currently, three remarkable techniques to identify trace and confirm the termites infestation without substantially searching and destruction of building structures, these are:

- Thermal Imaging
- Moisture Meters
- Termite Detection Radar

2.1. Thermal Imaging

Thermal imaging can be used as a non-destructive and fast method to detect termites in trees and buildings compared to the traditional methods such as knocking and drilling in wood. During thermal imaging, the thermal camera creates images based on thermal energy instead of light, the subsequent image appears as an X-ray containing heat regions. As we know termite activity in nest generates heat that is detected by infra-red camera, so it helps in termite detection in behind walls and other surfaces. This two-dimensional temperature mapping technique has potential for characterizing products during several operations of agricultural and food industries. Thermal imaging has been successfully adopted for studying plant physiology, irrigation scheduling, and yield forecasting in agricultural fields.
2.1.1. Thermal Sensor with Laser Guide. Thermal sensor containing laser guide senses possible termite infested locations through warmer areas. Heat and humidity produced by the subterranean termites in the adjacent environment are the two major factors supporting the operator to detect potential termite threat points by indicating heat differential zones. As there are temperature readings on equipment, so it allows operator to determine high risk areas where termite is present. Similarly, during Acoustic emission, there is rapid localized release of energy and it generates an elastic wave which travels through the material and converts the (ultra)sound waves into small variations of voltage, which can be measured. Drywood termites are normally detected with a small handy device through their entrance in structures, mud tubes and nests without causing any physical damage to structures [5].

2.2. Moisture Meter
Another biosensor device is Moisture Meter which pinpoints the concentrated high moisture level areas to identify termite risk locations. This device identifies, measures and records different moisture levels in building materials without penetrating the buildings physically.

2.3. Termite Detection Radar
These radars are used for accurate detection and confirmation of termite presence. Resistivity imaging survey, Tomography scanning and Millimeter-wave imaging techniques are the modern techniques to detect and control termites. By using these biosensor techniques, it would be far more economical to protect the timber-in-service by using Termite Management Systems (TMS) by sensing a combination of factors such as temperature, moisture, movement, feeding and behaviour of the termites [5] [6].

Another useful tool is boroscope, that would drill a small hole in the wall and the scientists can have a look on termites inside walls and then decide treatment. Besides termites there are also Decay, Fungi and wood borers that are detected by biosensors.

3. Conclusions
In future, we should focus on research that is to examine, screen, develop and refine a non-destructive electronic / microwave techniques for the detection and location of termite damages in wood and at buildings. These biosensor devices would be a combination of factors such as temperature, moisture, movement, feeding and behaviour of the termites in sensing technology.

4. References
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