There is a large number of publications dealing with the occurrence of invisible gold in arsenopyrite and other sulphides of gold ore[8–10] and different methods have been proposed (some of these are commercially adopted) for recovery of invisible gold in the refractory sulphide gold ores[11–15].

Factors that control the concentrations of structural or chemically bound gold in arsenopyrite include the gold content of the ore-forming solution, the prevalent physicochemical parameters during ore formation and subsequent metamorphism, the chemistry of the host rock and coprecipitation of gold together with arsenopyrite crystallization. The presence of submicroscopic intracrystalline inclusions of gold in arsenopyrite depends on the suitability of the host substrate for gold nucleation and on the initial gold solubility, which obviously decreases with changing conditions, leading to exsolution phenomena[3, 5].

It is needless to emphasize the economic importance of invisible gold in the arsenopyrite constituting the auriferous zones of Gadag as well as other gold deposits in the country, as the invisible gold may significantly account for the gold tenor. The fact that it is economically viable to extract ultrafine, invisible refractory gold adopting methods like bacterial leaching (as is presently being done in Wiluna mining operations in W. Australia[16], Santa Barbara mine in Brazil[17], Ashanti gold mine in Ghana[18], Barrik Goldstrike mine in USA[19] and Fairview mines in S. Africa[20]) or by additional treatment such as floatation coupled with smelting or oxidation of the concentrate and cynidation should stimulate a more detailed examination of the gold ores of our country to identify the quantum of invisible gold and its possible recovery.

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Heteropigmentation of plant impressions, Karai, Ariyalur, Tamil Nadu

Hema Achyuthan, R. Nagendra and C. Mohanadoss

Department of Geology, Anna University, Madras 600 025, India

We present here the plausible causes for heteropigmentation of leaf impressions formed within the Karai-laminated clays. Geomorphic, mineralogical and sedimentological studies reveal that the different colouration of the leaf impressions are due to anaerobic, reducing, oxidizing, micro-environmental conditions formed in a shallow to deep, near-shore lake environment.

PLANT impressions, especially of the Upper Gondwana age, have played an important role in understanding the palaeo-vegetational canopy and palaeoclimate of sedimentary depositional basin. But not much work has been carried out in understanding genesis and colouration of the plant impressions. In this paper we have made an attempt to understand the plausible processes involved in pigmentations of the plant and palaeoenvironmental depositional conditions of sedimentations.

Karai is a small village lying 14 km west of Ariyalur (78°46'19":11°09'07") (Figure 1). Geomorphologically this area is dotted by isolated monadnocks and inselbergs of Archaeans lying towards the southwest of the study area. Presently, this area receives a mean annual rainfall of 800–1000 mm and the mean annual summer and winter temperatures vary between 20° and 28°C. The vegetational canopy is largely the subtropical plants. Karai is important because of the Karai clay mine, which is the chief source of clay for the ceramic industries.

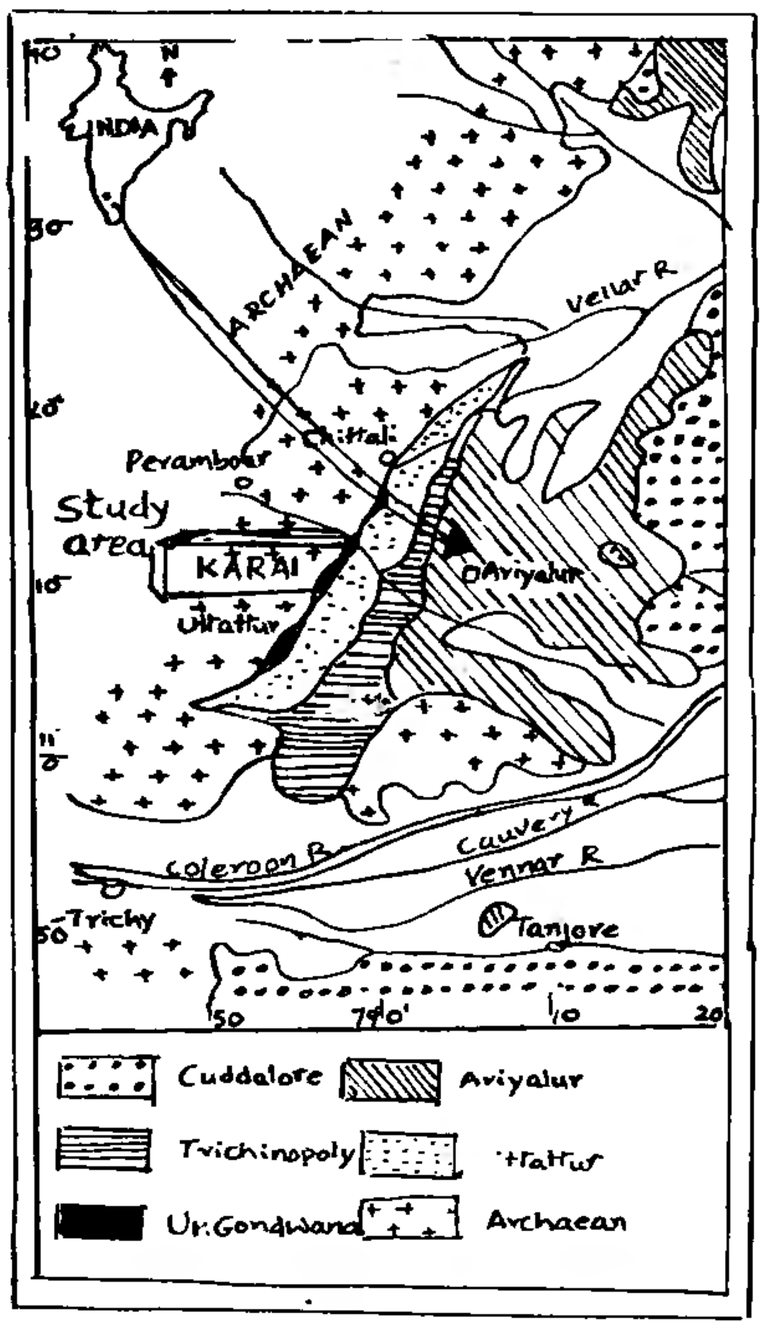
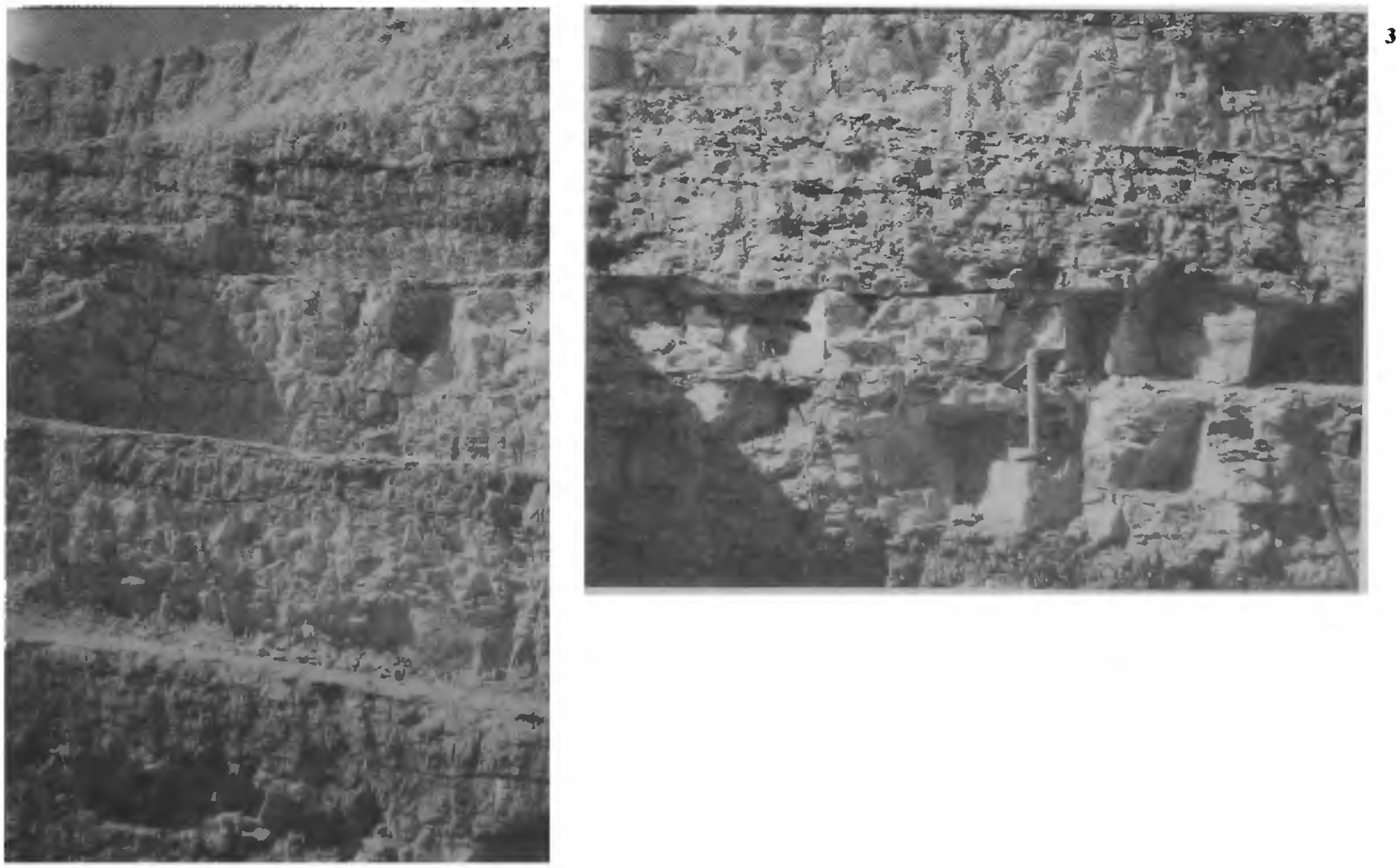


Figure 1. Location map of study area (After M. S. Krishnan[1])

The type section of the Karai is the clay mine itself which is an open quarry site. Stratigraphically the basement archaean rocks are overlain by boulder beds of varying thickness of 35–40 m (bore hole litho-log data) (Figures 2 and 3) (Unit I). Unit I gradually grades into gritty ferruginous feldspathic sandstone towards the top, (GFFS). The GFFS unit is overlain disconformably by white buff-coloured, very fine clay deposit, which is highly indurated, laminated (0.1–0.001 mm) with high fissility, slakability and limonitic mottlings. The dip of the clay unit varies from 5° to 8° in the NNE direction (Unit II) (10 m thick). In the vertical section of the Unit II (Figures 2 and 3), the clays exhibit interfingers of feldspathic sandstone, which are predominantly of fine to medium grained quartz with silts, mica and rutile (3 to 4%) as accessory minerals. The feldspathic sandstone is highly indurated with ferruginous purple-coloured matrix.

The fine white clays have yielded plant impressions of *Ptilophyllum* and *Pterophyllum*. These plant impressions exhibit different colourations varying from black to gray, pale yellow to reddish to orange in colour. This entire unit is covered by the recent soil sediment. The lithostratigraphy of this area has been worked in detail[1] and they have assigned Necomian–Aptian age to Terani Formation (144 Ma–133 Ma) and reported the plant impressions of Coniferals, Filicales, Cycadophytes and



Figures 2, 3. Type litho-section of Karai area

Ptillophyllum from this study area. The mineralogical composition of the clays preserving the plant impressions could not be identified under the optical mineralogical microscope and hence these clays were subjected to XRD analysis. The clays are dominantly composed of illite (10.4 Å) and kaolinite (7.1 Å). The mineral constituent of feldspathic sandstone are predominantly quartz, mica and garnet. Based on lithology and mineralogical analyses the entire lithosection at Karai reveals that the mode of sediment deposition was not a continuous process. This is inferred by the interfingers of coarse grained ferruginous feldspathic sandstone (10–20 cm thick) bands between the clay units of 30 and 40 cm. The geometry of the interfingering ferruginous feldspathic deposit reveals that they are coarse-grained channel point bars[2], ferruginized on exposure and fluctuating water table. This also reveals that there was a break in the subsequent sedimentation of clays probably due to the change in the course of sediment budget and source in the catchment area. These coarse-grained bands indicate that they might have been deposited by flashfloods in a semi-arid to sub-humid environment and are a result of rapid sedimentation. This process of deposition brought about the shallowing of the basin, following the local palaeobasin topography, while on the contrary, the thin laminations of clay (0.1–0.001 mm) are the result of calm, deep, and slow depositional lake environment. There is little correlation between the fissility and burial depth of clays due to the general orientation of clay mineral lying parallel to bedding. In kaolinite, illite sediments, occurrence of any laminations is probably due to the flaky-shaped minerals.

Nearly all the chemical elements have been determined in vegetation. Iron and manganese content variations were studied in different species, different organs of the same tree, under different climatic conditions, over different geologic formations and in pine twigs from the area of the Sullivan mine[3]. These analyses were conducted to understand bio-geo-chemical activity between the plants and soils and their relationship in the process of ore mineralization.

The ecology of any plant community is greatly influenced by the microenvironmental conditions, microclimate and the pH of the soil and also by the presence, excess or deficiency of mineral nutrients[4]. The palaeoenvironment during the deposition of clays was congenial to support thick vegetational canopy of *Ptillophyllum* and *Pterophyllum*. The leaf impressions were not observed in ferruginous feldspathic sandstone units. The mineral properties of the clays have helped in preserving leaf impressions.

XRD analysis of the clays preserving the different coloured leaf impressions confirmed the uniform clay mineralogy but different pigmentation (see Figure 4). These variations in colouration may be primarily due to

Figure 4. Heteropigmentation of plant impressions.

reducing anaerobic microenvironmental conditions releasing iron and iron oxides. The process being fast, the ferruginous or limonitic coloured impressions may also be due to the iron content within the leaves themselves. The availability of elements such as Fe, Mn, Mg, Co, etc. are affected by the pH of the substrate. The pH of the soil exerts an influence on the oxidation potential reactions. And these reactions are pH-dependent[5]. Black pigmentation may be due to carbonization of the leaves along the mid-rib and venation in reducing microenvironmental conditions. The soft tissues of the leaves decay and get destroyed during the process of diagenesis that favours the best preservation of organic carbon impressions on the indurated clay surfaces. The process of carbonization is slow and long. The gray colouration may be due to bleaching and washing off the pigmentation, where only the impressions of the leaves are preserved.

The depositional environment of the clays and the occurrence of leaf impressions of heteropigmentation nature help to infer that these processes have taken place in a shallow to deep swamp near shore lake environment.

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A bioassay technique for the detection of aflatoxin by using *Chlorella pyrenoidosa*

G. Uma Muralimohan and C. N. Reddy
Department of Botany, Gulbarga University, Gulbarga 585 106, India

The chlorophylytic activity of aflatoxin on *Chlorella pyrenoidosa* is clearly evident and the degree of toxicity of aflatoxin is found to vary in proportion to the amount of the toxin present. This bioassay technique is found to be quite simple and sensitive, and can be used to detect the aflatoxin content produced by the aflatoxigenic fungi either in culture or in the substrate on which it grows.

SEVERAL biological methods such as brine–shrimp bioassay, hen's egg embryo assay and tissue culture bioassays have been suggested[1] for the estimation of aflatoxins. However, they are not much in use as they are not as sensitive as TLC and are mostly used as confirmatory tests. Schoental and White[2] have reported that 1–10 µg aflatoxin/ml is an inhibitor of chlorophyll synthesis in the leaves of cress (*Lepidium sativum*) and suggested that this effect could be elaborated into a simple test for aflatoxin detection in suspected material. Slowatizky *et al.*[3] have also reported the inhibition of chlorophyll synthesis due to aflatoxins, resulting in virescence and albinism in maize leaves. Since chlorophylytic toxin activity of many pathogenic fungi and bacteria has been tested on *Chlorella*[4], an attempt is made in this paper to develop an easy method of identification of aflatoxigenic activity of fungi that produce aflatoxins, by using *Chlorella*.

Two *Aspergillus flavus* isolates from garlic (*Allium sativum*) and chillies (*Capsicum fruitense*) contaminated with aflatoxins[5] were grown on Czapek's broth supplemented with caesin to give 0.5 g nitrogen/litre at pH 4.5, as stationary cultures at room temperature (26 ± 2°C). After 7 days of growth, the culture filtrates were obtained through seitz filter. In a separatory funnel 50 ml of cell-free culture filtrate was extracted with double the volume of chloroform. The chloroform extracts were collected and concentrated to dryness by heating on a hot-water bath. The residues were dissolved in 5 ml of chloroform and treated as culture extracts; 100 µl of each of these extracts was loaded on TLC plate for chromatographic separation. The quantitative estimations of aflatoxins were done by comparing the intensity of the fluorescent spots of the sample with the corresponding spots of the standards[6, 7]. The remaining extract was subjected to evaporation again and the residue was further dissolved in 5 ml of sterile distilled water and treated as water wash, and used to determine the degree of aflatoxin toxicity by employing the modified method of Warren and Winstead[4]. Two ml of *C. pyrenoidosa* liquid culture was taken in three test tubes (8 mm diameter) and in two of these test tubes 100 µl of water wash having aflatoxin (from both isolates) was added separately. The third one, without any extract, was treated as a control. All the test tubes were sealed with aluminium foil and incubated at room temperature (26 ± 2°C). After 24 h the test tubes were observed under UV light for chlorophylytic activity.

It is evident from Table 1 that both the isolates of *A. flavus* are found to be potentially aflatoxigenic and produced AfB1 and B2 in cultures. Garlic isolate produced more toxin (112.5 µg/ml) than the isolate from chillies (75.0 µg/ml) in culture. Both the isolates produced AfB1 and AfB2 and the amount of AfB1 was found to be more than AfB2 (Table 1). A similar degree of toxin elaboration by these two isolates was observed in their respective commodities[5]. The chlorophylytic nature of aflatoxin from these two cultures on *C. pyrenoidosa* was more clear when observed under long-wave UV light. The degree of toxicity was found to vary in proportion to the quantity of the toxin present in the test sample, as could be seen from the emission of strong violet brown colour by *Chlorella* in control and dull green or greenish colour in test sample, with its intensity depending on the amount of aflatoxin. This change in the intensity of colour depending upon toxin, as evidenced in the present test provides a clear clue to the detection of aflatoxin and can be used even to determine the amount of aflatoxin present in an unknown sample by comparison with a standard index of known concentrations.

Table 1. Amount of aflatoxin produced in culture filtrates of *A flavus* isolates

Source of *A flavus* isolate	Amount of aflatoxin µg/ml				
	B1	B2	G1	G2	Total
Garlic	75 0	37 0	0 0	0 0	112 5
Chillies	50 0	25 0	0 0	0 0	75 0

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