J. King Saud Univ., Vol. 5, *Science* (2), pp. 127–135 (A.H. 1413/1993)

Growth of *Podaxis pistillaris* Collected from Saudi Arabia at Different Concentrations of Cadmium and Lead

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(Received 22 October 1991; Accepted for publication 28 September 1992)

Abstract. Fruiting bodies of *Podaxis pistillaris* were collected from Riyadh region, Saudi Arabia. Mycelia were aseptically isolated from these fruiting bodies. The effects of different concentrations of cadmium and lead on the mycelial growth of *Podaxis pistillaris* were studied. The results provide evidence of considerable interspecific differences in resistance to cadmium and lead within this fungus.

Introduction

'Al-Arjoon' is a classic Arabic word for *Podaxis*. They are generally eaten as a delicious food in parts of Saudi Arabia [1]. According to Morse [2] *Podaxis* is an edible mushroom which grows in sandy loam soil in areas with a long dry spell, around the world between 40°N and 40°S latitude.

Podaxis fruiting bodies appear after rains, generally in the spring and early summer [3]. In Saudi Arabia, large quantities of *P. pistillaris* are collected from vast plains and desert by nomads during the rainy season, the fruiting bodies are used as food either alone or in combination with other food as a source of flavor [4]. The nutrient composition of *P. pistillaris* is reported by Khaliel *et al.* [4] and Ramasamy and Kandaswamy [5]. Cultivation of *P. pistillaris* has been done without success in Saudi Arabia [6]. Cadmium is reported to inhibit the DNA-mediated transformation in microorganisms, to interfere with symbiosis between microbes and plants, as well as to increase plant predisposition to fungal invasion [7;8]. Several plant species, ectotypes and bacterial strains are able to develop Pd-tolerance mechanisms. This tolerance seems to be associated with the properties of cell membranes. Lead becomes strongly bound to cell walls and pectic acid is most active in Pb absorption, thus lead has a marked influence on cellwalls, resulting in an increase in tissue wall rigidity [9]. The presnt study was undertaken to determine the responses of *P. pistil-*

laris to cadmium and lead. It is a part of a more extensive investigation to which the heavy metal content of fungi growing in different environments in Saudi Arabia is being determined.

Materials and Methods

A) Collection and isolation of *P. pistillaris*

Fresh fruiting bodies of *P. pistillaris* used in these studies were collected from the Riyadh region during the rainy season of 1989 (Plate 1). Pure cultures were prepared from the fresh fruiting bodies and maintained on malt extract agar slants (Plate 2).

Plate 1. Fruiting body of *Podaxis pistillaris*.

Plate 2. Mycelium of *Podaxis pistillaris*.

B) Effect of metals on the growth of *P. pistillaris*

Using a 4 mm diam. sterile cork borer, discs of mycelium were cut from the margin of actively growing colonies on malt extract agar plates, replicates were taken from different colonies, and transferred to 100 ml conical flasks (1 disc/flask) containing malt extract agar (malt extract 15 g, agar 20 g and 1000 ml distilled water) to which $CdSO_4$ and $PbSO_4$ were added to final concentrations of 0, 100, 200 and 300 μg/ml. The pH of the solutions were adjusted to 5.0 before they were sterilized by filtration through millipore filters (0.4 μm). All flasks were incubated at room temperature. The mycelia were transferred to pre-weighed filter papers, thoroughly washed with deionized water, oven dried at 80°C for 24 h., and weighed. Cadmium and lead concentrations in the mycelium were determined by atomic absorption spectrophotometry after nitric acid decomposition. The results are expressed in terms of the tolerance index [10]. Tolerance index (TI) was calculated according to the following formula:

$$TI = \frac{\text{Growth of fungi in metal concentration}}{\text{Growth of fungi in control}}$$

Results

The growth curves for *P. pistillaris* at different concentrations of cadmium and lead are given in Figs 1 and 2. Generally, increase in Cd and Pb concentrations in the medium reduced the growth rates of the fungus tested. There was a significant reduction in yield at 200 and 300 μg/ml Cd and Pb. Results of analysis of Cd and Pb concentrations in mycelia of *P. pistillaris* are given in Figs 3 and 4. There was a progressive increase in Cd and Pb content, the largest increase taking place with 3250 μg/g Cd and 2990 μg/g Pb. Tolerance of cadmium and lead concentration by *P. pistillaris* is expressed by Tolerance Index (Figs 5 and 6).

Discussion

The resistance of different fungi to metals has been investigated earlier [11-21]. To the authors knowledge, no informaiton concerning the resistance of *P. pistillaris* to metals have been reported. *P. pistillaris* showed a decrease in growth at 100 μg/ml of Cd and Pb. In a study of the effect of lead by *Hymenoscyphus ericae* and *Coprinus micaceus*, Hashem [20;21] found that the growth of these fungi was significantly increased by the lowest level of added Pb (100 and 200 μg/ml). The phenomenon of stimulation by low levels of a metal has also been noted for root growth in species of high plants tolerant to the metals [22].

Little attention has been paid to Pb accumulation and resistance by fungi. Kussi *et al.* [23] reported lead levels between 3300 and 3800 μg/g in fruiting bodies of *Coprinus comatus* and *Coprinus atramentarius*. According to Lodenius *et al.* [24] the concentrations of lead in the fruiting bodies of *Coprinus comatus* and *Coprinus atramentarius* were between 900 and 3000 μg/g. The values are closer to those obtained when mycelia were grown in culture medium containing 100-300 μg/ml Pb, in the present study.

Duddridge and Wainwright [25] reported that *Pythium* sp., *Scytalidium lingnicola* and *Dictyuchus sterile* accumulated 300, 450 and 600, μg/g Pb from the medium. These results indicated a considerable amount of lead accumulation from their growth medium, which suggest that these fungi would also be able to accumulate Pb from different types of metal contaminated environments.

In the present study, Cd and Pb presumably are transported into the cell, since growth at high Cd and Pb concentrations is severely inhibited. pH is known to affect Cd and Pb uptake. Thus, a low pH increases the solubility of Cd and Pb. It must be noted in the culture medium, increasing Cd and Pb concentrations were associated with increasingly unfavourable pH levels for growth of *P. pistillaris*.

In summary, it appears that the level of growth inhibition and Cd and Pb accumulation in the mycelia of *P. pistillaris* are related to the concentration of these in the environment.

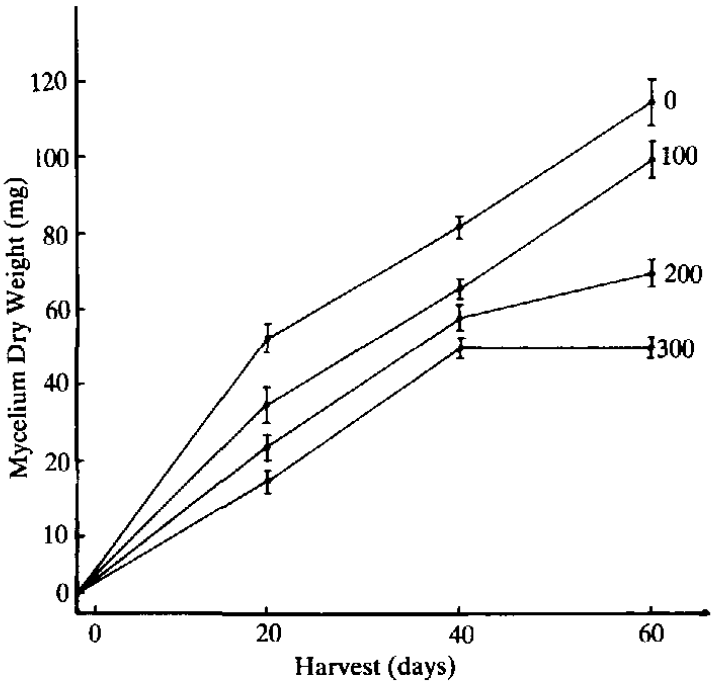

Fig. 1. Mycelium dry weight (mg) of *P. pistillaris* at different concentrations of Cd (ug/ml). Values given are means of 5 replicates. Vertical bars represents 95% confidence limites.

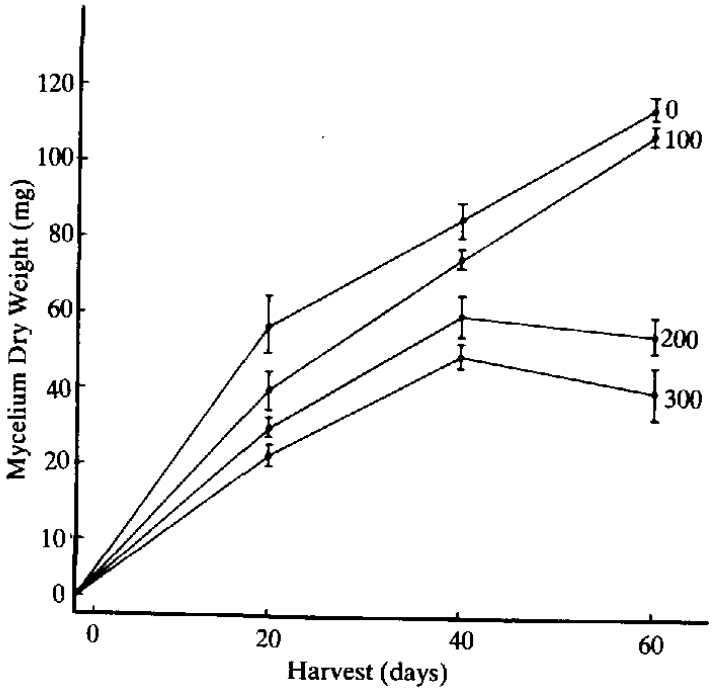

Fig. 2. Mycelium dry weight (mg). *P. pistillaris* at different concentrations of Pb (ug/ml). Values given are means of 5 replicates. Vertical bars represents 95% confidence limits.

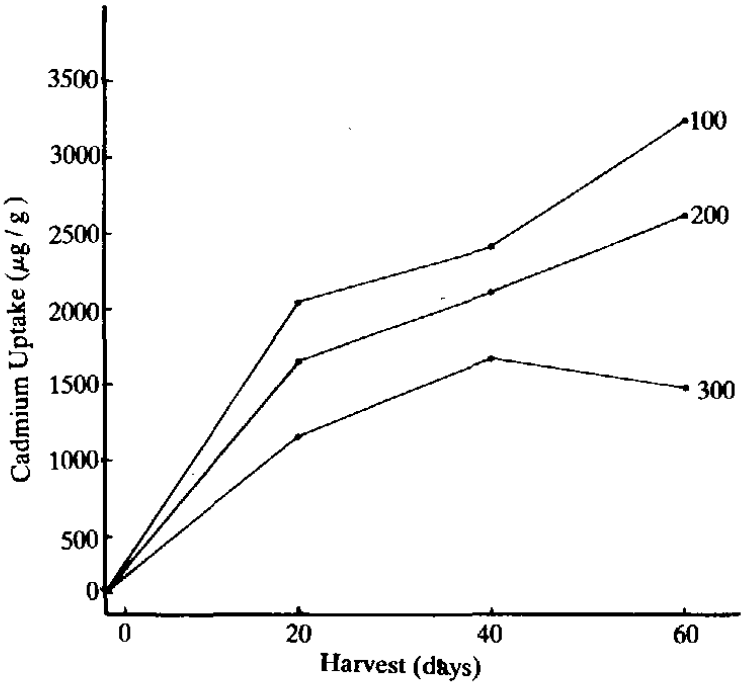

Fig. 3. Cadmium uptake by *P. pistillaris* after 20, 40 and 60 days growth at different Cd concentrations. Values given are means of 5 replicates.

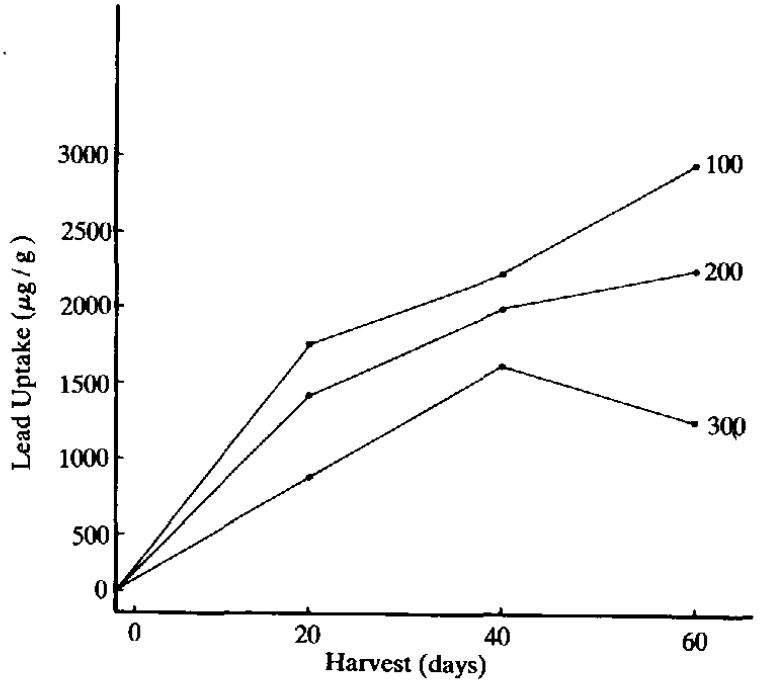

Fig. 4. Lead uptake by *P. pistillaris* after 20,40 and 60 days growth at different Pb concentrations. Values given are means of 5 replicates.

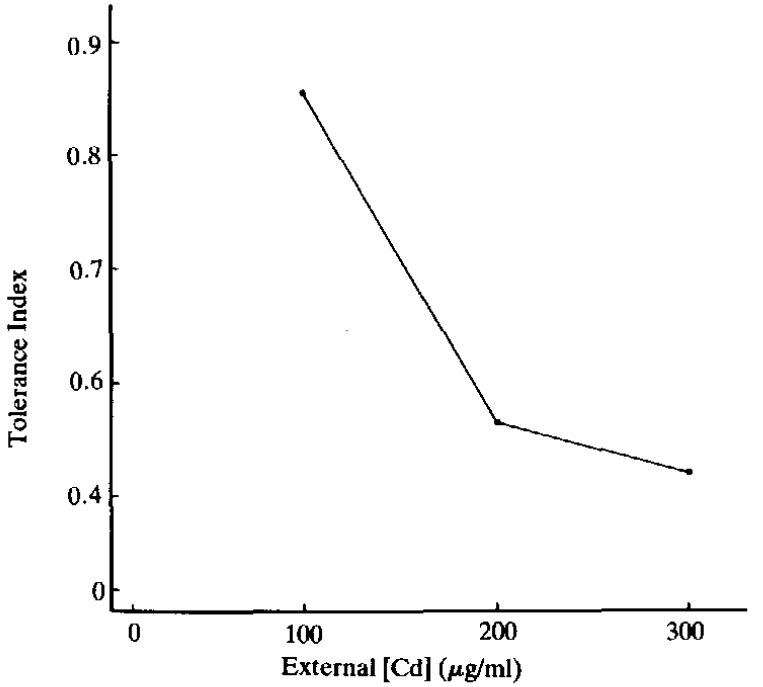

Fig. 5. Tolerance index from mycelium dry weight (mg) for *P. pistillaris* and Cd concentrations (ug/ml).

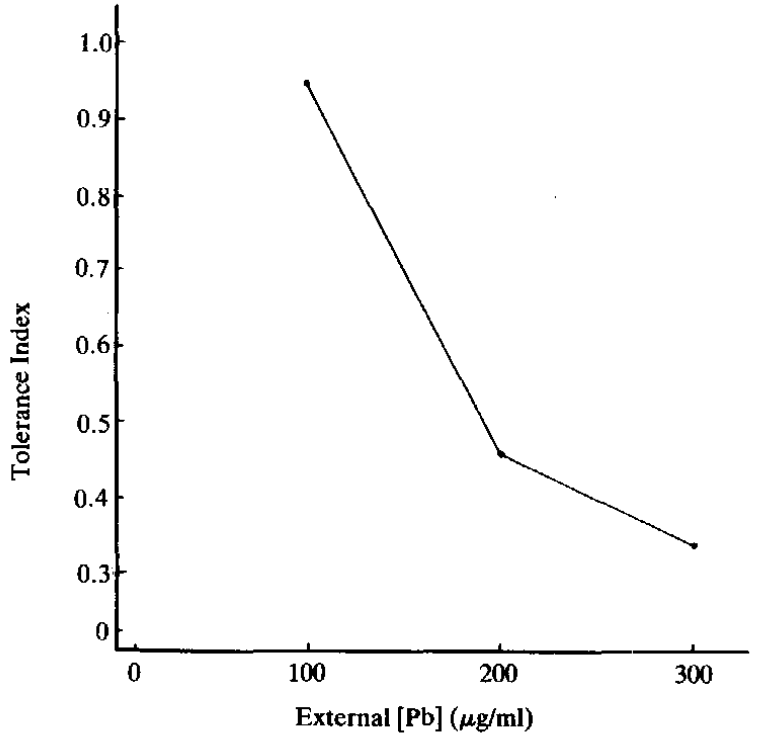

Fig. 6. Tolerance index from mycelium dry weight (mg) for *P. pistillaris* and Pb concentrations (ug/ml).

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نمو فطر العرجون الذي تم جمعه من تربة المملكة العربية السعودية على تركيزات مختلفة من عنصري الكادميوم والرصاص

عبدالوهاب رجب هاشم بن صادق و عبدالله ناصر الرحمة

قسم النبات والأحياء الدقيقة، كلية العلوم، جامعة الملك سعود، ص. ب ٢٤٥٥، الرياض ١١٤٥١، المملكة العربية السعودية

(سُلِّمَ في ١٥ ربيع الآخر ١٤١٢هـ، وقُبل للنشر في ٢ ربيع الأول ١٤١٣هـ).

ملخص البحث. تمّ جمع الأجسام الثمرية لفطر العرجون من المنطقة المحيطة بمدينة الرياض بالمملكة العربية السعودية، حيث تمّ عزل الغزل الفطري منها بطريقة نقية، ثم تمت دراسة تأثير التركيزات المختلفة لعنصري الكادميوم والرصاص على نمو الغزل الفطري لفطر العرجون.

ودلّت النتائج على وجود اختلافات واضحة لمقاومة الفطر لعنصري الكادميوم والرصاص.

هذه الدراسة تعتبر المحاولة الأولى وجزءًا من الدراسات الواسعة لملاحظة المحتوى المعدني لفطر العرجون ومقاومته للتركيزات المختلفة من المعادن الثقيلة.