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Effect of Pigmy Mite *Pediculaster fletchmanni* (Acari: Siteroptidae) on Mineral Elements of Button Mushroom *Agaricus bisporous*

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Abstract: The present study indicated that the pigmy mite *Pediculaster fletchmenni* (Acari: Siteroptidae) can cause qualitative losses by influencing on nutritional values of the button mushroom *Agaricus bisporous*. A comparison of dry matter (DM), organic matter (OM) and mineral elements was made by releasing various density of mites consisted of 0, 50, 100 and 250 adult mites per kg of compost. Mineral elements including P, Ca, Mg, Na, Fe, Zn, Cu and Mn were determined by ICP atomic spectroscopy. The samples organic matter varied from 90-93% and the DM contents ranged between 13 to 14%. The ranges of variations for these minerals in control and other treatments were 1230.4- 880.2, 208.3- 66.6, 153.9- 91.1, 154.6- 60.4, 23.4- 5.6, 4.5- 3.4, 3.8-1.3 and 0.911-0.480 (mg/100 g dw), respectively. The amounts of Ca, Cu, Fe, K, Mg, Mn, Na, Zn and P were decreased at highest density of mites, 250 mites per kg of compost, percent of decrease for the above elements are: 61.3, 48.9, 67.2, 12.8, 21.3, 45.1, 27.6, 21.0 and 2.7%, respectively.

Key words: *Agaricus bisporus*, button mushroom, mineral elements, nutritional value

INTRODUCTION

Mushrooms have been consumed by many cultures for centuries, not only for nutritive value but also for medicinal or functional purposes as well (Chang and Miles, 2004). The nutritional value of the mushroom *Agaricus bisporous* (Lunge) originates for it's chemical composition. Analysis of the proximate composition of the commonly cultivated mushrooms reveal that *A. bisporous* is rich in crude protein and carbohydrates, moderate in crude fiber and ash and low in fat content (Chang and Miles, 2004).

Mushrooms are a good source of minerals (Vetter, 2003; Dikeman *et al*., 2005; Matser *et al*., 2000; Vivar-Quintana *et al*., 1999; Hadar and Cohen-Arazi, 1986). The minerals present in the substrate are taken up by the growing mycelia and translocated to the sporophores (Chang and Miles, 2004). As in higher plants, the minerals of highest content are potassium (K), followed by phosphorous (P), sodium (Na), calcium (Ca) and magnesium (Mg) (Li and Chang, 1982). Inorganic elements and their compounds are involved in the metabolism of living organisms. Mineral elements participate in the control of osmotic balance and the maintenance of the potential of cellular membranes, are essential for different enzymatic and hormonal activities and elements such as calcium and phosphorus are bone tissue components. Also, minerals participate in taste and in reactions affecting food texture.

The physicochemical composition of plant foods (such as mineral content) is affected by environmental factors such as soil and water composition and the use of fertilizers, pesticides and fungicides. The process applied in food processing can also affect their mineral content (Nikkarinen and Mertanen, 2004; Mendil *et al*., 2005; Tao *et al*., 2006; Dikeman *et al*., 2005).

Mites species which are found in association with mushrooms can cause sever qualitative and quantitative losses (Mohanasundaram, 1994). The mushroom mite or pygmy mite, *Pediculaster fletchmanni* Wich (Acari: Siteroptidae) is a cosmopolitan nuisance pest in the cultivation of mushrooms *A. bisporus*. Large numbers of mites may cause annoyance and sometimes allergic symptoms in pickers, detract from the appearance of cut mushrooms and occasionally become serious problems in soup processing kitchens (Gurney and Hussey, 1967; Wicht and Snetsinger, 1971). Our preliminary studies indicated that the pygmy mite can seriously influence on the nutritional values of button mushroom. However, quantitative results have not been

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reported on effect of *P. fletchmanni* on the chemical composition, especially on the mineral elements, of mushroom. Therefore, the aim of this study was to evaluate the effect of *P. fletchmanni* on mineral elements, including Ca, Cu, Fe, K, Mg, Mn, Na, Zn and P, in the fruiting bodies of button mushroom (*A. bisporus*) by ICP atomic emission spectroscopy (ICP-AES).

MATERIALS AND METHODS

Plant material and chemicals: This study was conducted at Laboratory of Food Science, Tarbiat Modares University, Tehran, Iran in September 2005. In order to study the effect of various densities of *P. fletchmani* on the amounts of mineral elements of button mushroom, commercially prepared composts were used. The inoculated compost was held at 24-28°C until the mushroom mycelia had colonized the compost after 12- 14 days. The casing layer, composed of neutralized peat moss, was then applied. Button mushroom was cultivated on the compost in containers with 18.5 cm high and 14 cm diameter. Five independent samples of fresh mushrooms, samples were weighed (about 200 g) and the remaining growth medium was removed by rinsing in cold water, were used in each case. The fruit bodies were cleaned, sliced, dried and milled.

All reagents were analytical reagent grade (from Merck). Deionized water was used during all the experiments.

Infestation procedure: The pygmy mites were collected originally from mushroom compost in Mallard, adjacent to Tehran. They were inoculated into *Trichoderma* mycelia in glass Petri dishes (9 cm diameter) and cultured at 22°C, relative humidity of 70±5% and a photoperiod of 16 L: 8D h. Mite infestations were established by releasing various density of *P. fletchmani* consisted of 0 (control), 50, 100 and 250 adult mites per kg of compost, when the mycelia had spawn run. The containers were put in a growth chamber with 17°C, relative humidity of 85% and a photoperiod of 0L: 24D h. This procedure was replicated five times for each treatment. In all of replications, pygmy mites were introduced into each container after casing stage.

Precautions were taken to ensure that the compost used for crop loss assessment experiments was free of *P. fletchmanni.* The zero infestation level not only provided information about maximum qualify yield under our specific experimental conditions but also served as a control to estimate the amount of damage caused by surviving individuals from early infestations. The differences between yield of control and various treatments reflected the levels of qualitative yield loss.

Sampling was done by the emergence of the first flash of button mushroom on a daily program.

Determination of dry and organic matter: All samples were analyzed for Dry Matter (DM) and Organic Matter (OM) according to the AOAC methods (AOAC, 2002).

Mineral elements analysis: The dry digestion was performed weighing 0.5 g of DM and calcining at 600°C for 2 h. Then, 5 mL of conc. HCl were added to the ashes. Samples were transferred to a volumetric flask in a final volume of 25 mL. Then, the samples were analyzed in a Varian model Vista-pro (Australia) inductively coupled plasma atomic emission spectrometer to determine some mineral elements (K, Na, Ca, Mg, Mn, Cu, Zn and Fe) according to the previously reported method (Barnes, 1997; Nolte, 2003). Operating conditions of the instruments were as follows: Plasma power, 1200 W; coolant gas flow, 1.5 L min^{-1}; auxiliary gas flow, 1.5 L min^{-1}; nebuliser pressure, 220 Kpa; sample uptake rate, 1 mL min^{-1}; 3 replicates. An external drift monitor (generally, a calibration standard solution) was used to correct for signal changes with time. Spectral lines determination of these elements was selected experimentally. Tables of spectral data (Wang *et al*., 1985) were used to identify the most sensitive wavelengths for each element. The emission lines chosen were the most sensitive lines having no interferences from other elements in the group. Calibration was achieved using five synthetic multi-element standards, prepared using aliquots of the 1000 ppm single element standard solutions.

Statistical analysis: All experiments were conducted in triplicate and data were averaged and analyzed statistically using analysis of variance (ANOVA) and differences among the means were determined for significance at $p<0.05$ using SNK range test.

RESULTS AND DISCUSSION

As far as we know there is no information about the effect of mites on mineral elements of button mushroom. So, the present study was performed to find out the effect of varying density of *P. fletchmanni* on the DM, OM and some mineral elements of the mushroom. Table 1 shows the DM and OM of the control samples and other treatments. The results of the mineral elements determinations in the mushroom samples are presented in Table 2.

As seen from Table 1, there are no statistical differences between DM and OM of control and other treatments ($p<0.05$). Mushrooms exhibited wide variation in concentrations of proximate constituents. Dikeman *et al*., 2005, have been reported the DM and OM contents ranges to be from 12.5 and 11.9% and 84.6 and 96.0% for immature and mature mushrooms, respectively. The amounts of DM that was found by

Table 1: DM and OM of the control and other treated samples of *Agaricus bisporous**

Mite per kg compost	DM (%)	OM (%)
Control	12.8±1.8[a]	92.6±2.1[a]
50	10.7±0.8[a]	91.9±0.9[a]
100	11.2±4.2[a]	91.2±2.0[a]
250	13.6±4.0[a]	90.4±4.6[a]

* Values expressed are mean±SD of triplicate measurements; Values followed by the same letter(s) in columns are not significantly different (p<0.05)

Table 2: Mineral elements contents of control and treated samples of *Agaricus bisporous* with pygmy mite*

Mineral elements	Mite per kg of compost			
	0	50	100	250
Ca	208.3±12.7[a]	66.9±21.2[b]	69.7±8.1[b]	80.6±11.9[b]
Cu	3.80±0.68[a]	1.93±0.080[b]	1.28±0.15[b]	1.94±0.29[b]
Fe	23.43±10.13[a]	5.67±0.16[b]	5.64±2.25[b]	7.69±1.97[b]
K	6012.0 ±187.8[a]	3757.3±150.4[c]	3966.0±195.4[c]	5240.5±188.3[b]
Mg	153.88±4.53 [a]	97.74±1.29[bc]	91.06±9.27[c]	121.15±9.00[b]
Mn	0.911±0.046[a]	0.480±0.005[b]	0.490±0.028[b]	0.500±0.066[b]
Na	154.6±4.3[a]	60.4±12.6[c]	80.7±4.3[bc]	112.0±17.2[b]
Zn	4.48±0.3[a]	3.37±0.06[b]	3.44±0.25[b]	3.54±0.40[b]
P	1230.4±40.1[a]	1067.7±15.8[ab]	880.2±29.2[c]	1197.5±71.8[a]

*Values expressed are mean±SD of triplicate measurements (mg/100 g dw); Values followed by the same letter(s) in rows are not significantly different (p<0.05)

Sabir *et al.* (2003) for two kinds of edible mushrooms *Volvariella bommbycina* and *Collybia dryophila* were 13.14 and 12.42%, respectively that our results are in agreement with those reported by them.

All mineral concentrations were determined on a dry weight basis. The fruiting bodies of tested mushrooms were rich in K. Potassium concentration was the highest, followed in descending order by phosphorous, calcium, magnesium, sodium, iron, zinc, copper and manganese. Potassium and calcium levels at this study were close with does reported earlier by Rudawska and Leski (2005). But the amounts of Mg and P were slightly higher than the values published by them. As observed from Table 2, there are considerable differences between mineral elements of control and other treated samples. The amounts of Ca, Cu, Fe, K, Mg, Mn, Na, Zn and P were decreased at highest density of mites, 250 mites per kg of compost, (Percent of decrease for the above elements are: 61.3, 48.9, 67.2, 12.8, 21.3, 45.1, 27.6, 21.0 and 2.7%, respectively). The values of Ca, Cu, Fe, Mn and Zn in control samples were significantly higher than their amounts in other treatments. But, no significant differences were observed between the concentrations of the above minerals when the mite's density increased from 50 to 250 mites kg^{-1} of compost. The current study contained similar minimum and maximum values of Cu, Mn and Zn with those found by Soylak *et al.* (2005) and Isildak *et al.* (2004). The content of iron, one of the nutritional benefits of mushrooms, basically decreased to 75.8 and 75.9% when the mite's density increased from 0 to 50 and 0- 100 mites/ kg of compost, respectively. The levels of Fe in our samples were in agreement with literatures values (Isildak *et al.*, 2004; Soylak *et al.*, 2005). In contrast, the concentrations of Ca, Fe, K, Mg, Mn, Na and P of the fruiting bodies of mushrooms, from our study were higher and the amounts of Zn and Cu were lower than the results reported by Vetter (2003). These Differences are related to mushroom variety and different experimental conditions.

In addition, the differences in K, Mg, Na and P contents are important, the concentrations of these minerals showed significant differences at various densities of mites. According to the data in Table 2, the mineral contents were significantly lower at 50 and 100 mites kg^{-1} of compost in comparison to the highest density (250 mites kg^{-1} of compost). These differences may, related to the carrying capacity and intraspecific competition between released mites. In the other hand, as the carrying capacity concept, when the mite's density increased, intraspecific competition will cause high mortality in population.

To conclude, the nutritional benefits of the chemical composition of *Agaricus bisporous* are well known today. The study presents new and comparative data about the characteristic differences in the mineral elements of mushroom samples under the presence and absence of the pygmy mites. Our results for amounts of some mineral elements were confirmed by previously reported values. Based on our results, these mites reduce the nutritional benefits of button mushrooms. Their occurrence during the growing cycle and accumulations on mushroom caps indicates incorrect compost preparation (Martin, 1978). However, if the conditioning has been done correctly, mite survival is of less concern since the mite will not reproduce. This implies uniform temperature, moisture and oxygen levels throughout the composting. Mite development is closely related to temperature and this must be taken into account in designing routine sampling programs.

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