A Note on Plausible Initial Pesticide Residues on Selected Mushrooms: Hen of the Wood, Shiitake, and Portabello

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ABSTRACT

Measurements of planar surface area and weight of selected mushrooms suggest that initial pesticide residues on mushrooms that are directly sprayed will be comparable to residues on fruits or broadleaf vegetation.

Introduction

The PNW initiated an interesting series of emails concerning whether or not the estimates of exposure based on the consumption of contaminated fruit (a common scenario in FS risk assessments) would be sufficiently protective in the case of the consumption of contaminated mushrooms. Gary Smith asserted that using a HQ of 0.1 as a level of concern would be adequate. Pat Durkin (♀) speculated that this assertion was probably correct and that the residue rates for mushrooms would likely be in the range of those for fruit and broadleaf vegetation based on the standard values given by Fletcher et al. (1994).

Materials and Methods

On July 30, 2005, Pat Durkin (♀) went to the store (Wegman's in Dewitt, New York) and purchased three types of mushrooms: Hen of the Wood (a.k.a. Maitake) , Shiitake, and Portabello. Pat Durkin (♂) weighed all of the purchased mushrooms using a common postal scale (Stamps.com) with a nominal accuracy of 0.1 ounce.

Pat Durkin (♂) then measured the diameter of each mushroom in centimeters using either a 6 inch (15 cm) desk ruler (Westcroft) or a workshop caliper (The Executive Pocket Chum). For roughly circular mushrooms, only a single measurement was made. For mushrooms with an oval shape when viewed overhead, the longest and shortest diameters were averaged. All values were recorded to the nearest 0.25 cm.

The planar surface area (SA_{Pln}) was calculated in EXCEL as:

$$SA_{Pln} = \pi \, (\boldsymbol{D}/2)^2 \qquad \text{(Eq. 1)}$$

where $\boldsymbol{D}$ is the diameter in centimeters.

The theoretical maximum deposition (Dep_{Max}) on the mushroom in mg was calculated as the product of the planar surface area and an application rate of 0.01121 mg/cm^2, which is equivalent to 1 lb/acre:

$$Dep_{Max} = SA_{Pln} \times 0.01121 \text{ mg/cm}^2 \qquad \text{(Eq. 2)}$$

The weight of each mushroom in kilograms (Wgt_{Kg})was calculated from the measured weight in ounces (Wgt_{Oz}) as:

$$Wgt_{Kg} = Wgt_{Oz} \div 35.274 \text{ oz/kg} \qquad \text{(Eq. 3)}$$

The residue rate (***RR*** in mg pesticide/kg mushroom) per lb pesticide/acre was calculated as:

$$\boldsymbol{RR} = \mathrm{Dep}_{\mathrm{Max}} \div \mathrm{Wgt}_{\mathrm{Kg}} \qquad \text{(Eq. 4)}$$

All calculations and analyses were conducted in EXCEL (see **Mushrooms Raw Data.xls**).

Results

As indicated in Table 1, the estimated residue rates on mushrooms are between those of fruit and broadleaf vegetation from the standard values given by Fletcher et al. (1994).

Discussion

In a very rapid and far from complete survey of the literature, the worst-case residue rate on mushrooms appears to be about 6 ppm per lb/acre and the residue rates on mushrooms appear to be similar to those on berries (Erne and Uvon 1973). Similarities between residues on mushrooms and berries have also been reported by INCHEM (1984).

In general, small mushrooms will tend to have greater residues than larger mushrooms. The geometry of the mushroom, however, will be important. This is illustrated in the current study with Shiitake (average weight of 12.2 grams) and Portabello (average weight of 14.1 grams) mushrooms. While the weights of the two samples of mushrooms are not substantially different, the residue rates for Shiitake mushrooms are much higher due to the elongated geometry of these mushrooms relative to the more compact geometry of the Portabello variety.

The estimated residue rates for mushrooms that are summarized in Table 1 are based on direct spray with no foliar interception. In general, these are plausible maximum average residue rates that could be seen after a direct spray of many types of mushrooms. Rates observed in the field are likely to be less if there is significant foliar interception. A possible exception to this general rule might involve small capped but highly elongated mushrooms that are dispersed as opposed to growing in tightly packed groups. For such mushrooms, lateral deposition could be important and could lead to higher residue rates. This could be considered by calculating lateral rather than overhead planar surface area.

Conclusion

GS appears to be correct in asserting that an HQ of 0.1 would be adequate as a level of concern for the consumption of mushrooms. Nonetheless, the utility of Forest Service risk assessments could be enhanced by explicitly considering the consumption of broadleaf or forage plants by humans. Doing this would appear to cover potential residues on mushrooms and could encompass residues on other types of vegetation that some individuals might consume. The need to provide quantitative exposure assessments for the consumption of short grasses by humans – i.e., the scenario that would lead to the highest estimate of exposed dose – is not apparent.

As a follow-on investigation, a bioassay of the specimens covered in this report was conducted using human volunteers (n=2). The NOAEL was estimated at 4 mg/kg bw.

Table 1: Comparison of estimates of initial residues on mushrooms (based on surface area and weight) to standard values from Fletcher et al. (1994).

		Estimated residues after application in ppm/lb per acre		
		Central	Upper	SD
Estimates of residues on mushrooms from SERA				
Hen of the Wood (Maitake)	(n=1)	6.41		
Shiitake	(n=13)	25.69	37.27	6.75
Portabello	(n=21)	10.14	14.56	1.95
Standard values from Fletcher et al. (1994)				
Short grass		85.00	240.00	
Tall grass		36.00	110.00	
Broadleaf/forage plants and small insects		45.00	135.00	
Fruits, pods, seeds, and large insects		7.00	15.00	

Hen of the Wood [Maitake]

n=1

Shiitake

n=13

Portabello

n=21

Figure 1: The mushrooms

References

Erne K; Uvon H. 1973. Phenoxy herbicide residues in woodland berries and mushrooms. Var Foeda. 25(8-9): 146-154. (TOXLINE abstract only).

Fletcher JS; Nellessen JE; Pfleeger TG. 1994. Literature review and evaluation of the EPA food-chain (Kenega) nomogram, an instrument for estimating pesticide residues on plants. Environ. Toxicol. Chem. 13(9):1383-1391.

INCHEM (International Programme on Chemical Safety). 1984. Environmental Health Criteria 29: 2,4-dichlorophenoxyacetic Acid (2,4-d). Available at: http:// www.inchem.org/pages/ehc.html.