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QUANTITATIVE AND QUALITATIVE LOSSES IN FRUITING BODY OF MUSHROOM DUE TO *TYROPHAGUS PUTRESCENTIAE* SCHRANK (ACARINA: ACARIDAE) INFESTATION

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ABSTRACT

The present study on quantitative and qualitative losses in fruiting body of mushroom due to *Tyrophagus putrescentiae* Schrank (Acarina: Acaridae) infestation revealed significant effect of initial inoculums levels. The number of *T. putrescentiae* was statistically more (31.52 mites/ 10 g fruiting body) on highest initial inoculum (30 *T. putrescentiae* pairs) as compared to 20 mite pairs (18.52 mites/ 10 g fruiting body) and 10 mite pairs (5.90 mites/ 10 g fruiting body). The weight loss in fruiting body was 1.3, 4 and 4.5 percent at 10, 20 and 30 pairs of mites as initial inoculums. At the highest initial inoculation of 30 mite pairs, highest percent reduction in weight was recorded at all durations (0.47, 3.13, 5.13, 6.95, 7.70 and 8 % at 5, 10, 15, 20, 25 and 30 days, respectively). Significant reduction in total sugar, non reducing sugar, protein content of fruiting bodies was recorded during present study. It was 1.77, 1.73, 1.18 mg/10g fruiting body at 30 mite pairs as compared to 1.89, 1.80, 1.38 mg/10g fruiting body in control. Reducing sugar (0.04 mg/10g fruiting body) and starch content (0.02 mg/10g fruiting body) were statistically comparable with control (0.08, 0.03 mg/10g fruiting body, respectively).

KEYWORDS: *Agaricus bisporus*, qualitative loss, *Tyrophagus putrescentiae*, weight loss.

INTRODUCTION

Button mushrooms are natural products comprise a good nutritious diet for all ages and under all conditions of health (Singh and Sharma, 2016). Mushroom is an excellent source of proteins with lysine and tryptophan that are normally deficient in cereals, vitamins, minerals, folic acid and is a good source of iron for anemic patient (Moon and Lo, 2013). The carbohydrate content (glycogen, chitin and hemicelluloses) ranges from 4.5 to 5.0 percent, the fat is low (0.3%) but is rich in linoleic acid, which is an essential fatty acid (Yang *et al*., 2001). Among vitamins, it is a good source of vitamin C and B complex, particularly thiamine, riboflavin, niacin, biotin and pantothenic acid in addition with dietary fiber (Manzi *et al.*, 2004).

Among the mites occurring in mushroom houses, *Tyrophagus putrescentiae* Schrank is considered as economically important pest. *T. putrescentiae* feeds on mycelium and sporophores resulting in small irregular pits on stalk and caps (Singh *et al*., 2011) and has the ability to destroy the mycelium within 40 days (Thapa and Seth, 1982). Mites can cause surface discoloration (Morris *et al.*, 1995). Additionally, *T. putrescentiae* is responsible for dispersal of *Mycogone perniciosa*, a causative agent of wet bubble disease in *Agaricus bisporus* (Itisha *et al.*, 2017). In view of its damaging potential, the present study has been undertaken to estimate the quantitative and qualitative losses in fruiting body of *Agaricus bisporus.*

MATERIALS AND METHODS

The stock culture of *T. putrescentiae* was maintained on wheat flour in laboratory at 27±1^{0}C and 80-85 percent relative humidity. Copulating pairs were picked from the culture and released in observation arenas for various experiments.

Population buildup of *T. putrescentiae* on fruiting body of *Agaricus bisporus*

The experiment was set with in complete randomized block design consisting of three sets and three replicate per set. Treatment one consists of fruiting bodies in which 10 *T. putrescentiae* pairs were released. Treatment second and third contained 20 and 30 *T. putrescentiae* pairs per replicates as initial inoculums. The number of *T. putrescentiae* in each replicates of three set was monitored every sixth day under sterozoom microscope. At each observation period mixed population of *T. putrescentiae* was counted and recorded.

Estimation of weight in fruiting body

After the separation of mites, weight of the fruiting body of *A. bisporus* was measured with the help of electronic balance after 0, 5, 10, 15, 20, 25 and 30 days in all the three infestation levels. Simultaneous weight of control samples were also recorded before processing for quality parameters. Corrected weight loss was measured by deducting the weight loss in control from mite infested compost or fruiting body. Weight was expressed in mg/10 g compost/fruiting body.

Effects of *T. putrescentiae* infestation on qualitative losses in fruiting bodies

To study the effect of initial inoculums of *T. putrescentiae* on biochemical parameters of fruiting body of *A. bisporus*, duplicate samples were taken from each three replicates of three treatments (10, 20 and 30 *T. putrescentiae* pairs/10g fruiting body) at the end of population study. Estimation of biochemical parameter on 0 day acted as corresponding control in different sets. Biochemical parameters *viz.*, protein (A.O.A.C, 1980), total soluble sugars (Yemm and Willis, 1954), reducing sugars (Nelson, 1944), non reducing sugars and starch (Clegg, 1956) were carried out following standard procedures.

Statistical analysis: Critical Difference (CD) was calculated for *Tyrophagus putrescentiae* population on fruiting body to see the effect of observation periods. The Software 'OPSTAT', developed at the Computer Centre, College of Basic Sciences and Humanities, CCS Haryana Agricultural University, Hisar, was used for the analysis.

RESULTS

Population of *Tyrophagus putrescentiae* on fruiting body of *Agaricus bisporus*

Different initial inoculums levels (10, 20, 30 pairs of *T. putrescentiae*) at different durations were compared to see the susceptibility of fruiting bodies in terms of harbouring *T. putrescentiae* during weekly data analysis Table 1. A comparison of initial inoculums levels revealed that the number of *T. putrescentiae* was statistically more (31.52 mites/ 10 g fruiting body) on highest initial inoculum (30 *T. putrescentiae* pairs) as compared to 20 mite pairs (18.52 mites/ 10 g fruiting body) and 10 mite pairs (5.90 mites/ 10 g fruiting body)as initial inoculums (CD=0.12; p= 0.05). Statistical analysis showed a significant effect of observation period on *T. putrescentiae* population (CD= 0.19; p= 0.05). Irrespective of initial infestation level, maximum number of mites was witnessed at 0 day (40 mites/ 10 g fruiting body) which declined significantly to 32.88, 25.11, 17.11, 10.77, 3.66 and 1.00 at 6, 12, 18, 24, 30 and 36 days. Interaction between initial infestation level and observation period was also significant (CD=0.34; p= 0.05)(Table 1) which revealed that at each observation period, lowest number of mites was recorded at lowest initial infestation level as compared to the other infestation levels .

Quantitative loss in fruiting body infested with *Tyrophagus putrescentiae*

The result of impact of different levels of *T. putrescentiae* on weight of fruiting body of *A. bisporus* was assessed in terms of weight in g and per cent weight loss. As is evident from Table 2 significant effect of initial mite inoculums was recorded on weight of fruiting body. It was statistically higher at 9.87 g at lowest mite release (10 pairs) which decreased to 9.60 and 9.55 at 20 and 30 pairs of initial inoculums respectively (CD= 0.01; p= 0.05). Fruiting body weight exhibited a significant decrease with increase the duration of infestation (CD= 0.026; p= 0.05).

It was 10.00 g at 0 day which reduced to 9.95, 9.78, 9.63, 9.51, 9.42 and 9.41 g significantly after 0, 5, 10, 15, 20, 25 and 30 days of observation period. Decrease in weight loss ranging from 0.27 percent to 1.93 percent, 0.63 percent to 7.73 percent and 0.47 percent to 8.00 percent in 10, 20 and 30 pairs of initial inoculums of mites. Statistical analysis done by ANOVA revealed a significant interaction between fruiting body and observation period. It indicated that at all observation period, mite feeding caused significant decrease in weight loss in fruiting body of *Agaricus bisporus*. The weight of fruiting body decreased from 10 g at 0 day to 9.97, 9.89 and 9.83 g after 5, 10 and 15 days at initial mite release of 10 pairs. The lowest weight of the fruiting body 9.80 g was recorded after 20, 25 and 30 days. Similar trend was witnessed at 20 and 30 pairs of mite release.

The percent reduction in fruiting body weight over control as affected by *T. putrescentiae* infestation at different release levels is depicted in Fig. I. At the highest initial inoculation of 30 mite pairs, highest percent reduction in weight was recorded at all durations (0.47, 3.13, 5.13, 6.95, 7.70 and 8 % at 5, 10, 15, 20, 25 and 30 days, respectively). At intermediate releases of 20 mite pairs, fruiting body weight showed reduction of 0.63 to 7.73 percent over control. Lowest release of 10 mite pairs caused minimum loss in the compost weight which was recorded as 0.27, 1.10, 1.70, 1.93, 1.93 and 1.93 percent at 5, 10, 15, 20, 25 and 30 days, respectively.

Effect of *Tyrophagus putrescentiae* on qualitative losses in fruiting body

Changes in the protein, total sugar, reducing sugar, non reducing sugar and starch contents of fruiting body of mushroom at three level of mite infestation (10, 20, 30 mite pairs as initial count) were assessed after 10 days and data generated are presented in Table 3.The data showed a significant effect of initial infestation level. With the increase in *T. putrescentiae* infestation, the protein contents were decreased significantly to 1.28, 1.22, 1.18 mg/10g fruiting body at 10, 20 and 30 pairs of initial inoculums (CD= 0.03; p= 0.05).

The comparison of total soluble sugars at different initial inoculums also revealed a similar trend of significant decrease at each level (CD= 0.01; p= 0.05). It was 1.87, 1.81 and 1.77 mg/ 10g fruiting body at 10, 20 and 30 pairs of initial mite infestation level as compared to 1.89 mg/ 10g fruiting body in control. Reducing sugars exhibited non significant decrease when subjected to different initial inoculumss levels. Reducing sugar content was 0.08 mg/ 10g fruiting body in uninfested fruiting body which decreased to 0.07, 0.05 and 0.04 mg/ 10g fruiting body at 10, 20 and 30 mites pairs respectively. The non reducing sugar content in uninfested fruiting body (1.80 mg/ 10g fruiting body) of *A. bisporus* and at lowest level of initial mite infestation level (1.80 mg/ 10g fruiting body) was statistically comparable with each other. It decline significantly at 20 (1.75 mg/ 10g fruiting body) and 30 (1.73 mg/ 10g fruiting body) initial mite infestation level. Similarly starch content did not show any variation when subjected to different mite infestation level significant. It was 0.03, 0.03, 0.03 and 0.02 mg/10g fruiting body in control 10, 20 and30 pairs after 10days respectively (CD= 0.00; p= 0.05).

Table 1: Population of *Tyrophagus putrescentiae* on fruiting body at different durations.

Observation period	Average number of mites/10 g of fruiting body			Mean
	10 pairs	20 pairs	30 pairs	
Day 0	20.00(4.58)	40.00(6.40)	60.00(7.81)	40.00(6.26)
Day 6	13.66(3.82)	32.66(5.80)	52.33(7.30)	32.88(5.64)
Day 12	6.66(2.75)	26.66(5.25)	42.00(6.55)	25.11(4.85)
Day 18	1.00(1.38)	18.66(4.43)	31.66(5.71)	17.11(3.84)
Day 24	0.00(1.00)	10.66(3.41)	21.66(4.75)	10.77(3.05)
Day 30	0.00(1.00)	0.66(1.27)	10.33(3.36)	3.66(1.87)
Day 36	0.00(1.00)	0.33(1.13)	2.66(1.86)	1.00(1.33)
Mean	5.90(2.22)	18.52(3.96)	31.52(5.33)	

Figures in parentheses are √n+1 transformation

CD (p= 0.05) for Observation period= 0.19; CD (p= 0.05) for Mite pairs= 0.12;
CD (p= 0.05) for Mite pairs × Observation period = 0.34

Table 2: Effect of *Tyrophagus putrescentiae* on weight of fruiting body of *Agaricus bisporus.*

Observation period	Weight (g) of fruiting body at different initial mite infestation level			Mean
	10 pairs	**20 pairs**	**30 pairs**	
Day 0	10.00	10.00	10.00	10.00
Day 5	9.97(0.27%)*	9.93(0.63%)	9.95(0.47%)	9.95(0.50%)
Day 10	9.89 (1.10%)	9.79(2.10%)	9.68(3.13%)	9.78(2.20%)
Day 15	9.83(1.70%)	9.59(4.10%)	9.48(5.13%)	9.63(3.70%)
Day 20	9.80(1.93%)	9.42(5.73%)	9.30(6.95%)	9.51(4.90%)
Day 25	9.80(1.93%)	9.23(7.70%)	9.23(7.70%)	9.42(5.80%)
Day 30	9.80(1.93%)	9.22(7.73%)	9.20(8.00%)	9.41(5.90%)
Mean	**9.87(1.30%)**	**9.60(4.0%)**	**9.55(4.50%)**	

*Figures in parenthesis are weight loss in percentage

CD (p= 0.05) for Observation period= 0.026; CD (p= 0.05) for Mite pairs= 0.017;
CD (p= 0.05) for Mite pairs × Observation period = 0.045

Table 3: Effect of *Tyrophagus putrescentiae* on qualitative losses in fruiting body.

Treatments	Protein (mg/ 10g)	Total Sugar (mg/ 10g)	Reducing Sugar (mg/ 10g)	Non reducing Sugar (mg/ 10g)	Starch (mg/ 10g)
Control/10g Fruiting body	1.38 ±0.00	1.89±0.00	0.08±0.00	1.80±0.00	0.03±0.00
10pairs/10g Fruiting body	1.28 ±0.01	1.87±0.00	0.07±0.00	1.80±0.00	0.03±0.00
20pairs/10g Fruiting body	1.22 ±0.01	1.81±0.00	0.05±0.00	1.75±0.00	0.03±0.00
30pairs/10g Fruiting body	1.18 ±0.00	1.77±0.00	0.04±0.00	1.73±0.00	0.02±0.00
SE(m)	0.01	0.00	0.00	0.00	0.00
CD (p=0.05)	0.03	0.01	0.00	0.01	0.00

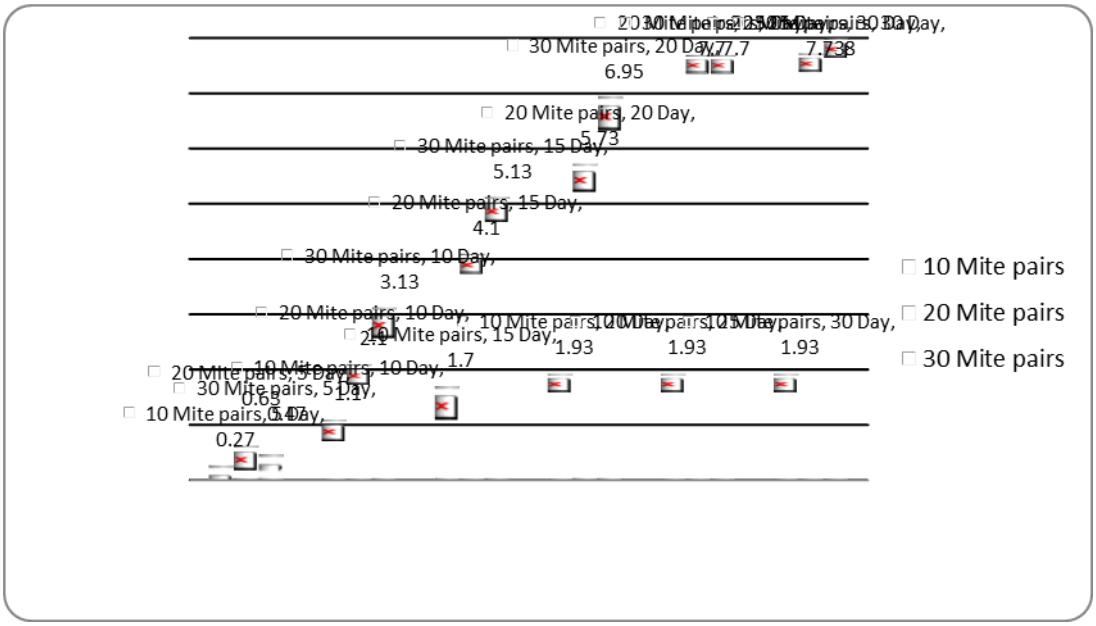

Fig. I: Percent weight loss in fruiting body at different infestation levels.

DISCUSSION

Mushrooms are attacked by a host of pests right from spawning to harvest. Since mushroom is an indoor crop, pests find very suitable and protected environment for their unhindered multiplication. During present investigation, observations on the average population of *T. putrescentiae* on *Agaricus bisporus* fruiting bodies revealed that irrespective of initial infestation level, mite number decreased significantly at each observation period due to excessive water loss and decomposition of fruiting bodies. Studies conducted by Itisha (2017) on *A bisporus* culture plates revealed that mites flourished and within 22 days population of 172.75 mites were recorded from *A bisporus* culture with initial inoculums of 30 pairs. Earlier González (2008) observed that initial inoculums of 25 mites completely consumed the aerial mycelial layer of *Coprinopsis cinerea* within 28 days.

During present study, weight loss in fruiting body of *A. bisporus* was 4.5 percent at the 30 pairs infestation level. Broekhuizen (1938) was the first to report mites as most damaging pests of mushroom. Thereafter, it was corroborated by various studies (Clift, 1978; Zou *et al.* 1993). Thapa and Seth (1982) revealed that inoculated mites into spawn run compost destroyed the mycelium within 40 days. Das (1986) reported 90 percent loss in mushroom yield due to mite, *H. heinemanni*. *T. putrescentiae* feeds on mycelium and sporophores resulting in small irregular pits on stalk and caps (Singh *et al*., 2011). The weight of *Pleurotus sajor-caju* fruiting body was statistically higher at 9.89g at lowest mite release (10 pairs) which decreased to 8.82 and 8.71 g at 20 and 30 mite pairs, respectively. Weight loss of the fruiting body was found to be 0.00 to 20.5 percent at these levels (Duhan *et al.*, 2018).Significant reduction in total sugar, non reducing sugar, protein content of fruiting bodies was recorded during present study. It was 1.77, 1.73, 1.18 mg/10g fruiting body at 30 mite pairs as compared to 1.89, 1.80, 1.38 mg/10g fruiting body in control. Reducing sugar (0.04 mg/10g fruiting body) and starch content (0.02 mg/10g fruiting body) were statistically comparable with control (0.08, 0.03 mg/10g fruiting body, respectively). Duhan *et al.* (2017) reported significant reduction in total sugar, reducing sugar, non reducing sugar, starch, protein content of *Pleurotus sajor-caju* fruiting bodies at 30 mite pairs.

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