

ESTIMATION OF NUTRITIONAL LOSSES CAUSED BY *Rhizoglyphus tritici* (ACARI: ACARIDAE) IN STORED WHEAT

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The stored grain mites which are one of the important pests of stored grains can modify the chemical composition of the stored wheat. The change in quality of wheat grains in terms of physical characteristics (thousand kernel weight, moisture, wet and dry gluten), chemical characteristics (crude protein, crude fat, fiber, ash and starch) and flour quality tests (falling number and dough rheological characteristics) of wheat variety Lasani-08 when infested by varying levels of mite infestation for six months were observed under laboratory conditions. Maximum moisture contents (18.13%) were observed in grains having highest number of mites (7513), while minimum moisture contents (16.40%) were found in the grains without mites. Thousand kernel weight, wet gluten, dry gluten, crude protein, fat and starch contents were found minimum in the treatments having maximum number of mite population that was 26.07g, 23.33%, 7.13%, 10.07%, 0.72% and 64.14% respectively as compared to control which was 38.50g, 30.47%, 9.20%, 13.85%, 1.28% and 66.17% after six months of storage. The fiber contents increased significantly in highly infested grains (3.47%) as compared in control (1.07%). The ash contents increased in the infested grains, which was from 1.23% in control to 3.47% in the treatment initially treated with 20 pairs of mites. Falling number, water absorption, dough development time, dough stability, mixing tolerance index and softening of dough was also decreased to 428.33 sec, 56.03%, 3.27 min, 4.30 min, 49.67 BU and 76.67 BU, respectively in the highly infested grains as compared to control which was 651.67 sec, 60.73%, 5.13 min, 6.03 min, 67.67 BU and 141.67 BU, respectively. The results will help to determine the nutritional changes in mite infested wheat during storage.

Keywords: Wheat storage, mites, grain loss, moisture, *Rhizoglyphus tritici*

INTRODUCTION

Man has depended on the wheat for thousands of years because it is staple food of a large number of people all over the world. Globally wheat covers maximum area and gives more production as compared to other food grain crops. Pakistan is one of the important wheat producing countries in the world. The area and production of wheat in Pakistan were 9046 thousand hectares and 25 million tons respectively. It contributes 13.1% to agriculture and 2.8% to GDP (Anonymous, 2010). Wheat is the main staple food of the country's population and major grain crop of the country (Gulzar *et al.*, 2010).

Wheat is one of the most important cereal grains world wide, in terms of production and utilization (Nadeem *et al.*, 2010). It is a major source of nutrients in many regions of the world. Wheat comprises of numerous valuable nutrients. The prime components of interests in the grain are starch (60-70%), proteins (10-15%) and non-starch polysaccharides (Saulnier *et al.*, 2007; Leon *et al.*, 2010). Among these, proteins and carbohydrates are crucial nutritive components while minerals, vitamins and dietary fiber are non-nutritive in nature (Slavin, 2008; Rakha *et al.*, 2010). It is an

important source of carbohydrates, minerals, vitamins and proteins.

Storage losses occur in wheat grains due to the abiotic and biotic factors. It is estimated that the post-harvest losses of wheat are about 8 per cent. The stored grain mites are major pests of wheat during its storage and accountable for the qualitative as well as quantitative losses (Mahmood *et al.*, 2011). Mites infested grains undergo a series of changes in their chemical composition and consequently resulting in nutritional losses (Ashfaq *et al.*, 1995). Stored grain and stored product mites were found contributing 40% towards non-germinating seeds of stored wheat grains (Ashfaq and Wahla, 1989). The positive correlation between stored grain mites population and viability loss of wheat grains shows that mites mainly destroy the germ part of the grains.

The wheat grain comprises of three distinct parts, bran (12 to 14%), germ (2 to 4%) and the endosperm that is 82 to 83% (Posner, 2000). Most of the nutrients in the wheat kernel except starch are congregated in the embryo. It is a very good source of proteins, minerals, vitamin, dietary fiber, calories and some functional micronutrients (Shurpalekar and Rao, 1977). Mites preferably feed on germ and demolish its contents, mites also consume other parts of the grain and

can consume up to 3 percent of grain weight (Soloman, 1946). The infested grains show very little decrease in weight, but they are deprived of many important nutrients. Keeping in view these facts the present research was planned to estimate the nutritional changes caused by infestation of mites during storage.

MATERIALS AND METHODS

Wheat variety (Lasani-08) was collected from Ayub Agriculture Research Institute, Faisalabad. The present research was carried out at Acarology Research Laboratory of Department of Agricultural Entomology, University of Agriculture, Faisalabad in 2011.

Grains were fumigated with Aluminum phosphide tablets to nullify the possibility of previous infestation. The grains were cleaned by sieving through 3/8, 3/16, 1/8, 1/12 inch mesh sieves as described by Proctor (1994). One kg wheat grains were taken into glass jars. All the jars were covered with lid having fine mesh (size 400µm). These jars were later placed in incubator at 27±2°C, 70±5% R.H. Following treatments were applied:

- T₀ Control (no mite)
- T₁ 05 pairs of mites per Kg
- T₂ 10 pairs of mites per Kg
- T₃ 20 pairs of mites per Kg

Jars without mite served as control. The results were calculated after 6 months of storage.

The whole wheat flour was evaluated for physical properties in terms of thousand kernel weight, moisture, wet gluten and dry gluten, chemical properties in terms of crude protein, fat, fiber, ash and starch and flour quality characteristics in terms of falling number, water absorption, dough development time, dough stability, mixing tolerance index and softening of dough according to their respective methods as given below. The experiment was laid out in completely randomized design (CRD), with three replications. Means were compared by LSD test at P≤0.05.

Physical properties: Wheat grains were tested for physical properties such as moisture content and wet and dry gluten by following the procedure described in AACC (2000) method No. 44-15A and 38-12, respectively. Thousand kernel weight was recorded by counting clean and unbroken kernels and was expressed as grams per 1000 kernels.

Chemical properties: Chemical properties of wheat grains such as crude protein, fat, fiber, ash and starch contents were determined according to the procedure described in AACC (2000), methods # 46-10, 30-25, 32-10 and 08-01, respectively. The NFE or the starch was calculated according to the following expression:

$$\text{NFE} = 100 - (\% \text{ moisture} + \% \text{ crude protein} + \% \text{ crude fat} + \% \text{ crude fiber} + \% \text{ ash})$$

Flour quality tests: Flour quality tests such as falling number and dough rheological studies were determined by using falling number apparatus and Farinograph (Brabender D-4100 SEW; Germany) respectively according to the procedure described in AACC (2000). The farinograms were interpreted for different characteristics like water absorption, dough development time, dough stability, mixing tolerance index and softening of the dough

RESULTS AND DISCUSSION

There was a significant increase in mite population, % moisture and % ash contents of the grains having different levels of mite population. Mite population was significantly increased after six months of storage ($F = 67230$; $df = 3, 8$; $P \leq 0.0000$), having 2525, 3567 and 7513 mites in the grains treated with 5, 10 and 20 pairs of mites, respectively.

After six months of storage thousand kernel weight of the infested grains was significantly decreased ($F = 4060$; $df = 3, 8$; $P \leq 0.0000$). The grains treated with 20 pairs of mites showed the maximum mite population and hence the lowest (26.07g) thousand kernel weight after six months. Grains without mite showed the highest thousand kernel weight that was 38.50g (Table 1).

Moisture was significantly increased in all the infested grains after six months of storage ($F = 211$; $df = 3, 8$; $P \leq 0.0000$). Maximum moisture was found in the treatment having 20 pairs of mites that was 18.13% (Table 1). Moisture contents in treatments with 0, 5 and 10 pairs of mites were 16.40%, 17.03% and 17.43%, respectively (Table 1).

Wet gluten significantly decreased with increased mite population ($F = 211$; $df = 3, 8$; $P \leq 0.0000$). Wheat grains initially treated with 20 pairs of mites was having highest mite population and hence the lowest wet gluten (23.33%) after six months of storage. Control having no mites showed

Table 1. Effect of mites on different physical characteristics of wheat after six months of storage (Means±S.E)

Treatments	Mites population	TKW (grams)	Moisture%	Wet gluten %	Dry gluten %
Control (T ₀)	0d	38.50±0.03 a	16.40±0.05 d	30.47±0.02 a	9.20±0.00 a
05 pairs (T ₁)	2525±12 c	33.17±0.07 b	17.03±0.07 c	26.17±0.4 b	8.45±0.03 b
10 pairs (T ₂)	3567±14 b	29.77±0.09 c	17.43±0.04 b	25.43±0.12 c	7.83±0.03 c
20 pairs (T ₃)	7513±14 a	26.07±0.12 d	18.13±0.04 a	23.33±0.09 d	7.13±0.03 d

Means sharing similar letters are not significantly different by LSD test at P≤0.05 in columns

TKW= Thousand kernel weight

the maximum (30.47%) wet gluten (Table 1).

Dry gluten of the infested grains significantly decreased after six months of storage ($F=1015$; $df=3, 8$; $P \leq 0.0000$). After six months of storage minimum dry gluten (7.13%) was found in the grains treated with 20 pairs of mites. Grains without mites showed the maximum dry gluten that was 9.20% (Table 1).

Protein contents of the grains after six months of storage were significantly decreased in the infested grains ($F=1416$; $df=3, 8$; $P \leq 0.0000$). Protein contents after six months of storage in T_0 , T_1 , T_2 and T_3 were 13.85%, 12.53%, 11.27% and 10.07%, respectively (Table 2).

Fat contents were significantly decreased in the infested grains after six months of storage ($F=330$; $df=3, 8$; $P \leq 0.0000$). Fat contents decreased from 1.28% in control to 0.72% in the grains with maximum mite population (T_4), fat contents in the grains treated with 5 and 10 pairs of mites were 1.11% and 0.96%, respectively (Table 2).

Fiber contents were significantly increased in the treated grains after six months of storage ($F=1071$; $df=3, 8$; $P \leq 0.0000$). Fiber was increased from 1.07% in control to 3.47% in the grains treated with 20 pairs of mites, while in T_1 and T_2 was 1.60% and 2.22% respectively (Table 2).

Ash contents were also significantly increased after six months of storage in the infested grains ($F=1978$; $df=3, 8$; $P \leq 0.0000$). Maximum ash contents (3.47%) were found in the treatment having 20 pairs of mites, treatments with 5 and 10 pairs of mites have 1.88% and 2.77% (Table 2).

Starch contents were significantly decreased after six months of storage in the infested grains ($F=87.4$; $df=3, 8$; $P \leq 0.0001$). Minimum starch (64.14%) was found in the treatment having 20 pairs of mites (Table 2).

Falling number was significantly decreased after six months of storage in the infested grains ($F=741$; $df=3, 8$; $P \leq 0.0000$). Means regarding falling number in wheat infested with varied levels of mite populations are given in Table 3.

Falling number ranged between 428.33 sec in grains initially treated with 20 pairs of mites to 651.67 sec in control after six months of storage (Table 3).

Water absorption was significantly decreased after six months of storage in the infested grains ($F=137$; $df=3, 8$; $P \leq 0.0000$). Means regarding water absorption in wheat infested with different levels of mite populations are given in Table 3. Water absorption ranged between 56.03% in grains initially treated with 20 pairs of mites to 60.73% in control after six months of storage (Table 3).

Dough development time was also significantly decreased after six months of storage in the infested grains ($F=228$; $df=3, 8$; $P \leq 0.0000$). Maximum dough development time (5.13 min) was recorded in the control. Grains initially treated with 20 pairs of mites showed minimum dough development time that was 3.27 min (Table 3).

Dough stability was significantly decreased in the infested grains after six months of storage ($F=249$; $df=3, 8$; $P \leq 0.0000$). Dough stability decreased from 6.03 min in control to 4.30 min in the grains with maximum mite population (Table 3).

Mixing tolerance index was significantly decreased in the infested grains after six months of storage ($F=333$; $df=3, 8$; $P \leq 0.0000$). Mixing tolerance index decreased from 67.67 BU in control to 49.67 BU in the grains with maximum mite population (T_4), Mixing tolerance index in the grains initially treated with 5 and 10 pairs of mites were 61.00 BU and 58.33 BU respectively (Table 3).

Softening of dough was significantly decreased in the infested grains after six months of storage ($F=270$; $df=3, 8$; $P \leq 0.0000$). Softening of dough decreased from 141.67 BU in control to 76.67 BU in the grains with maximum mite population (T_4), Softening of dough in the grains initially treated with 5 and 10 pairs of mites were 105.67 BU and 90.00 BU respectively (Table 3).

Table 2. Effect of mites on different chemical characteristics of wheat after six months of storage (Means \pm S.E)

Treatments	Crude protein%	Crude fat%	Crude fiber%	Ash%	Starch%
Control (T_0)	13.85 \pm 0.03 a	1.28 \pm 0.01 a	1.07 \pm 0.01 d	1.23 \pm 0.02 d	66.17 \pm 0.03 a
05 pairs (T_1)	12.53 \pm 0.04 b	1.11 \pm 0.01 b	1.60 \pm 0.03 c	1.88 \pm 0.02 c	65.84 \pm 0.1 b
10 pairs (T_2)	11.27 \pm 0.07 c	0.96 \pm 0.01 c	2.22 \pm 0.04 b	2.77 \pm 0.01 b	65.35 \pm 0.15 c
20 pairs (T_3)	10.07 \pm 0.06 d	0.72 \pm 0.02 d	3.47 \pm 0.05 a	3.47 \pm 0.05 a	64.14 \pm 0.04 d

Means sharing similar letters are not significantly different by LSD test at $P \leq 0.05$ in columns

Table 3. Effect of mites on different flour quality parameters of wheat after six months of storage (Means \pm S.E)

Treatments	Falling No. (Sec)	WA%	DDT (min)	DS (min)	MTI (BU)	SOD (BU)
Control (T_0)	651.67 \pm 1.67 a	60.73 \pm 0.32 a	5.13 \pm 0.03 a	6.03 \pm 0.03 a	67.67 \pm 0.33 a	141.67 \pm 0.33 a
05 pairs (T_1)	580.00 \pm 5.77 b	59.27 \pm 0.09 b	4.27 \pm 0.03 b	5.13 \pm 0.03 b	61.00 \pm 0.58 b	105.67 \pm 0.67 b
10 pairs (T_2)	535.00 \pm 2.89 c	57.90 \pm 0.06 c	3.77 \pm 0.03 c	4.70 \pm 0.06 c	58.33 \pm 0.33 c	90.00 \pm 2.89 c
20 pairs (T_3)	428.33 \pm 1.67 d	56.03 \pm 0.07 d	3.27 \pm 0.09 d	4.30 \pm 0.06 d	49.67 \pm 0.33 d	76.67 \pm 1.67 d

Means sharing similar letters are not significantly different by LSD Test at $P \leq 0.05$ in columns

WA= Water absorption; DDT= Dough development time; DS= Dough stability

MTI- Mixing tolerance index; SOD= Softening of dough; BU= Barbender Units

Table 4. Correlation between mite population and qualitative and quantitative nutritional parameters of wheat

	Mite	TKW (grams)	Moisture %	Wet gluten %	Dry gluten %	Crude protein %	Fat %	Fiber %	Ash %
TKW (grams)	-0.967								
Moisture %	0.990	-0.992							
Wet gluten %	-0.940	0.979	-0.963						
Dry gluten %	-0.977	0.997	-0.997	0.963					
Crude protein %	-0.971	0.996	-0.994	0.957	0.999				
Fat %	-0.991	0.983	-0.997	0.942	0.993	0.991			
Fiber %	0.991	-0.957	0.984	-0.903	-0.975	-0.972	-0.993		
Ash %	0.965	-0.988	0.988	-0.937	-0.995	-0.997	-0.990	0.975	
Starch %	-0.982	0.927	-0.965	0.866	0.951	0.948	0.979	-0.996	-0.952

TKW= Thousand kernel weight

Table 5. Correlation between mite population and flour quality parameters of wheat

	Mite	Falling No. (Sec)	WA%	DDT (min)	DS (min)	MTI (BU)
Faling number	-0.997					
WA%	-0.986	0.995				
DDT (min)	-0.957	0.960	0.981			
DS (min)	-0.941	0.953	0.967	0.997		
MTI (BU)	-0.998	0.998	0.990	0.971	0.958	
SOD	-0.928	0.940	0.956	0.994	0.999	0.947

WA= Water absorption; DDT= Dough development time; DS= Dough stability

MTI- Mixing tolerance index; SOD= Softening of dough

Correlation between mites and different quantitative and qualitative parameters has been shown in Table 4. Mites showed a highly significant and negative correlation with thousand kernel weight (-0.967), wet gluten (-0.94), dry gluten (-0.971) crude protein (-0.971), crude fat (-0.991) and starch (-0.982). Percent moisture (0.990), fiber (0.991) and ash (0.965) showed a highly significant and positive correlation with mites. Correlation between mites and flour quality parameters are given in Table 5. Flour quality parameters showed a negative correlation with mites population.

Findings of the current investigations have disclosed significant changes in the quality of wheat grains of Lasani-08 when subjected to artificial mite infestation. It was observed that there is negative relation between mites levels and different quality parameters of wheat kernels. Literature has revealed that storage mites infestation cause weight losses and germination losses in the stored grains (Soloman, 1946; Ashfaq *et al.*, 1995; Franz *et al.*, 1997; Zdarkova, 1998; Stejskal *et al.*, 2003; Mahmood *et al.*, 2012). The present findings can be compared with those of Sinha and Wallace (1966), Tabassum and Ahmed (1989) and White and Jayas (1993) who reported the stored grain mites cause an increase in the moisture of stored grains because of their faeces content, fungal growth and other metabolism. Results regarding decrease in protein and fat content can be compared with those of Hughes (1976) and Parkinson

(1990) who reported that mites prefer to feed on commodities with high protein and fat contents. Water absorption decreases with a decrease in protein content (Matz, 1972), since the mites preferably eat the embryo of the wheat kernel which contains protein as a major part of it and thus causes a decrease in water absorption. Flour prepared from mite infested grains is lower in nutritional value and is more acidic, has fusty smell and bitter in taste (Stejskal *et al.*, 2002). It may be concluded from the present investigation that nutritional value of wheat grains during storage is affected by mite infestation at different levels.

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