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Effect of Suni-bug (*Eurygaster* spp.) Damage on Some Biochemical Properties of Bread Wheat Variety (Bezostaja)

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In this study, the effect of suni bug (*Eurygaster* spp) damage in different levels (0, 25 and 100 %) on some properties of wheat storage proteins (Bezostaja variety) such as total protein, wet gluten content, Perten gluten indexes, Pelshenke tests, soluble protein fractions (in water, 2 % trichloroacetic acid (TCA) and 70 % EtOH, insoluble protein fractions in 0.05 M acetic acid) have been investigated. It was seen that the sample decreased the Pelshenke test values and residue protein (insoluble in 0.05 M acetic acid) amount but the amounts of albumin, gliadin and non-nitrogen fractions (soluble in 2 % TCA) increased according to the levels of bug damage. The negative changes on the solubility properties of flour proteins with higher damage levels indicated the hydrolysis of peptide bonds by excessive proteolytic activity resulting from the injection of protease by the suni-bug during grain filling.

Key Words: Wheat, *Eurygaster* spp damage, Perten gluten index, Osborne protein fractions.

INTRODUCTION

Damage to wheat yield and its baking quality, due to pre-harvest insect attack, has been widespread in Near East, Central and Eastern Europe, Middle East and North Africa. The insects responsible for the problem have been identified as *Eurygaster intergriceps* and *Aelia rostrata* in Europe and Near East and are commonly called as suni pest/bug, sunn pest or wheat bug. In New Zealand, the insect causing bug damage has also been identified as *Nysius huttoni*. Suni-bug (*Eurygaster* spp.) attack to wheat preharvest and inject proteolytic enzymes which harm the baking properties of the flour. Dough made from suni-damaged wheat has sticky and runny and produces poor quality bread due to excessive insect proteolytic activity and kneading is difficult[1,2]. Rheological and baking studies have been shown that wheat containing < 5 % suni-bug damaged kernels is unaccectable for producing good quality bread[3]. There are some studies on the biochemical effects of insect enzyme damage from suni-bug proetases[4-7].

The objective of this research is to study the influence of the insect enzyme damage on some biochemical properties of storage proteins of a bread wheat variety (Bezostaja) having suni-bug damage at several levels and to help understand the real mechanism of insect action.

EXPERIMENTAL

In this investigation, Russian origin Bezostaja-1 variety known as good quality wheat was used. The test weight of sample was 80 kg/hlt and moisture content 9 % but it has 25 % suni damage level. Wheat kernels showing characteristic puncture marks (black spots surrounded by pale, slightly sunken patches) were selected by hand-picking. The original sample was grouped according to their percentage as 'Control' (no suni pest damage), 'A' (25 % damage or original sample) and 'B' (100 % damage). The amount of suni bug damaged kernels was given as the numbers of visible damage kernels in total 100 wheat kernels. Each group was prepared as 500 g. Then, these groups were ground in a Falling Number Mill type 120 (Falling Number, Stockholm, Sweden) to obtain whole meal passing a 150 μ sieve. The grouped samples were stored at room temperature in glass jars during analysis.

The moisture content (ICC no: 110), the protein content (ICC no:105/1), the wet gluten content (ICC no: 137) were carried out according to ICC standard methods[8]. The glutens were simultaneously washed and separated automatically in a Glutomatic 2100 Washing System (Falling Number, Stockholm, Sweden). The Perten gluten index value was determined according to the method of Perten[9]. All of glutens washed were centrifuged at 6000 rpm for 1 min on an 80 μ sieve in a special holder. Gluten that passed through the sieve was scraped off and weighted. Pelshenke test was applied according to the AACC Approved method No. 56-30[10]. Flour protein was fractioned by the modified Osborne procedure of Chen and Bushuk[11] and Orth and O'Brien[12]. Ten grams of flour was extracted sequentially with water, 70 % aqueous ethanol and 0.05 M acetic acid. Albumins and globulins, both soluble in the water, were determined as a single fraction. The soluble protein in 2 % trichloroacetic acid (TCA) (non-protein nitrogen) fractioned by the method of Kretovich[4]. The nitrogen contents of fractions soluble in samples were determined by the micro-Kjeldahl procedure. The least significant difference (LSD) test was applied when analysis of varience indicated significant differences in mean values.

RESULTS AND DISCUSSION

The results of some technological and physico-chemical properties (wet gluten and total protein contents and Perten Gluten indexes, Pelshenke tests) of Bezostaja-1 wheat having sunn pest damage at several levels is listed in Table-1.

Although Bezostaja-1 wheat sample contain insect damage at high level, it has necessary protein value (about 12 %) to bread making (Table-1). That insect enzyme damage effected on quality properties more than the amount of protein in wheat is known[2,3,13]. Kretovich[4] stated that the analysis of normal and infected kernels, selected by hand, showed that the total nitrogen content decreased as a result of the damage caused by the wheat-bug. The wet gluten content, Perten gluten index and Pelshenke tests has been practically and widely used for determination of flour protein quality

by the cereal industry. Gluten could not be washed from the 100 % bug-damaged Bezostaja-1 wheat sample because of the intensive proteolytic enzyme activity resulting from suni-bug damage. Therefore, Perten gluten index value could not carried out for suni-bug damaged samples[6] (Table-1). If a dough is made from flour of heavy suni-bug infected wheat it is often impossible to wash out the gluten[3]. Pelshenke test values of Bezostaja-1 sample significantly ($p < 0.05$) decreased from 135 to 44 min with increasing amount of damaged kernels due to high proteolytic activity from enzyme damage injected to grains by wheat bugs[2].

TABLE-1
EFFECT OF THE LEVELS OF SUNI-BUG DAMAGE ON SOME TECHNOLOGICAL AND PHYSICOCHEMICAL PROPERTIES OF WHEAT PROTEIN*

Physico-chemical parameters	The levels of suni-bug (*Eurygaster* spp) damage (%)		
	0	25	100
Total protein (%)	14.4 ± 0.23 a	13.8 ± 0.20 b	12.1 ± 0.15 c
Wet Gluten (%)	40.0 ± 1.60 a	39.0 ± 1.24 a	Not determined
Perten gluten index (%)	63.0 ± 5.20 a	0 b	Sticky dough
Pelshenke test (min)	135.0 ± 8.25 a	57.0 ± 3.85 b	44.0 ± 4.00 c

*Mean values of duplicate determinations; mean values with the same letter within a column are not significantly different at ($p < 0.05$) according to LSD test ($n = 4$).

Table-2 shows the changes in some biochemical properties of endosperm proteins of Bezostaja wheat sample according to the levels of suni pest damage.

TABLE-2
EFFECTS OF THE LEVELS OF SUNI-BUG DAMAGE ON AMOUNTS OF OSBORNE FRACTION OF WHEAT STORAGE PROTEIN*

Protein fractions	The levels of suni-bug (*Eurygaster* spp) damage (%)					
	0		25		100	
	Amount (%)	As % of total protein	Amount (%)	As % of total protein	Amount (%)	As % of total protein
Soluble fraction in water (%)	3.1 c ± 0.70	21.50 c ± 0.69	3.9 b ± 0.30	28.30 b ± 0.50	6.6 a ± 0.30	54.60 a ± 0.90
Soluble fraction in 2 % TCA (%)	0.9 c ± 0.10	6.50 c ± 0.19	1.2 a ± 0.09	8.30 b ± 0.10	1.3 a ± 0.08	11.00 a ± 0.11
Soluble fraction in 70 % ethanol (%)**	3.5 b ± 0.40	24.30 c ± 0.55	5.4 a ± 0.38	39.30 b ± 0.50	5.3 a ± 0.40	43.80 a ± 0.48
Insoluble fraction in 0.05 M acetic acid (%)***	9.8 a ± 0.45	68.10 a ± 0.50	8.8 b ± 0.16	63.80 b ± 0.20	7.7 c ± 0.23	63.80 b ± 0.24

*The mean values with the same row within a column are not significantly different at ($p < 0.05$) according to LSD test ($n = 4$).

**Gliadin content: $\frac{\text{Soluble protein fraction in 70 \% ethanol}}{\text{Total protein}} \times 100$.

***Residue content: $\frac{\text{Insoluble protein fraction in 0.05 M acetic acid}}{\text{Total protein}} \times 100$.

The water soluble protein fraction (albumin) amount of samples ranged from 3.1 to 6.6 %. This fraction was significantly ($p < 0.05$) influenced by increasing suni-bug damage levels (Table-2). It was reported that the increasing soluble fraction in water (albumins) of suni-bug damaged samples resulted in proteins and peptide aggregates of high molecular weight (higher than 200,000) due to the hydrolysis of wheat proteins[6].

The soluble protein in 2 % TCA (non-protein nitrogen) amount of suni-damaged sample ranged from 0.9 to 1.3 %. These changes were similar to the findings of previous studies[1,4]. A increase in amount of alcohol soluble protein fraction (gliadins), from 3.5 to 5.4 %, was determined in the suni-bug damaged sample because of the hydrolysis of gluten proteins with effect of insect enzyme (Table-2). These changes on gliadins were similar to the findings of some researcher[4,5,7].

The 0.05 M acetic acid insoluble protein (residue) significantly ($p < 0.05$) decreased with increasing suni-bug damage levels. These changes on residue proteins, showing a considerable the greatest degradation occurring with the high molecular weight glutenin subunits[6], are in agreement with the findings of previous studies[1,5,7]. It is reported that this protein fraction comprised a group of high moleculer weight proteins with amino acid composition possessing active groups, thus favouring interchain reactions[12]. For best bread making performance, there is an optimum ratio of soluble protein to insoluble protein. The high proportion of insoluble protein in overly strong cultivars of wheat has been documented and correlated to their relatively poor baking quality[14]. A decrease in amount of residue protein fraction of sample would be indicate some problems such as difficult kneading of dough, insufficient fermentation and sticky dough stemming, resulting from the excessive proteinases of suni-bug during bread making.

The model of biochemical changes in wheat damaged by the suni-bug is quite different from that of *Nysius*-infested wheat. In New Zealand bug damaged wheat the insect proteinase degrades gluten to acetic acid or SDS-soluble protein fragments, but not water or alcohol soluble degradation products[1]. Extensive proteolysis, with the accumulation of soluble-protein fractions in water and TCA, occurs during the autolysis of flour from insect-damaged wheat[4,6].

Conclusion

The biochemical changes on solubility and insolubility protein fractions of heavy suni-bug damage wheat indicated that there was the negative effects on its bread making quality due to the hydrolyzing of gluten protein fractions occurring by intensive proteolytic activity from bug proteases. It was observed that bug enzyme damage affected its protein quality more than the protein quantity of wheat. This study also indicated that the gluten index method and Pelshenke test could be a very useful way to detec damaged wheat by suni-bug.

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