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[1] Department of Food Engineering, Faculty of Engineering, Osmaniye Korkut Ata University, Osmaniye, Turkey
[2] Department of Plant Protection, Faculty of Agriculture and Natural Sciences, Usak University, Usak, Turkey

Effects of Sunn Pest (*Eurygaster maura* L. Heteroptera; Scutelleridae) sucking number on physical and physicochemical characteristics of wheat varieties

Halef Dizlek*[1], Mahmut Islamoglu[2]

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Summary

In this study, we analysed the effects of Sunn Pest sucking number (0, single and double) on some physical and physicochemical characteristics of wheat varieties. We obtained that sucking number on the kernel had effects on wheat and some varieties (Zenit and Ziyabey-98) are more sensitive than others. Considering six different wheat varieties, for the same wheat variety, two number of sucks caused a decrease in thousand kernel weight of up to 2.8 %, hectoliter weight up to 2.2 %, Zeleny sedimentation test up to 7.1 %, delayed Zeleny sedimentation test up to 37.5 %, dry gluten content up to 8.6 % and gluten index value up to 58.9 % rather than one number of suck. These decrements were statistically significant in 16 of 42 evaluations in seven quality analyses of six different wheat varieties. In addition, Sunn Pest sucking ratio (0 % and 3 %) and Sunn Pest sucking number, cause to decline in the analyses of our findings. This was significant ($P < 0.05$) in 14, respectively 25 of the total 42 evaluations of Variety×Quality interactions. For these reasons, kernels with double sucking should be considered as two damaged kernel instead of one damaged kernel during classification of the Sunn Pest damaged wheat mass.

Abbreviations
SP: Sunn pest; WS: Wheat stinkbug; TKW: Thousand kernel weight; HW: Hectoliter weight; ZST: Zeleny sedimentation test; DZST: Delayed Zeleny sedimentation test; WGC: Wet gluten content; DGC: Dry gluten content; GIV: Gluten index value.

Introduction

Cereal crops are grown on 218.458.858 hectare throughout the world, and 713.217.069 tons of grains were produced in 2013. Wheat, with the 7.772.600 hectare growing area and 22.050.000 ton annual production, takes the first place in field crops in Turkey (FAO, 2014), and it retains its features of having the feedstock of human beings basic nutrients. Especially from North Africa to Central Asia, it accounts for half of the total dietary calories (Reynolds et al., 2008) and is an essential dietary component in many countries.

Physicochemical (technological) features of wheat were affected dramatically by cultivar genetic properties, weather conditions, soil features, fertilizing and agronomical applications, cereal diseases and harmful insects in both vegetative and storage periods (Koksel and Sivri, 2002; Altenbach et al., 2002; Torbica et al., 2007). Certain species of sap-sucking insects (*Eurygaster*, *Aelia*, *Nysius huttoni*, *Chlorochroa sayi* and *Stodiplosis mosellana* Gehin, etc.) feeding on wheat may damage the grain in different countries (Karababa and Ozan, 1998). In Turkey, the *Eurygaster integriceps* Put. Sunn Pest (SP) (Hemiptera: Scutelleridae) and *Aelia spp*. Wheat Stinkbug (WS) (Heteroptera; Pentatomidae) are the most important insects of cereals, which cause serious damage almost every year especially wheat and barley (Lodos, 1982). SP and WS feed grains at different stages of development (Ravan et al., 2009). Overwintered adults of the SP and WS attack the leaves and stems of young, succulent wheat and barley plants causing them to wither and die prior to spike formation. They also feed at the base of the spike during the early growing period, resulting in grayish white spikes without kernels (called white spikes). Fourth and fifth nymph instars and new-generation adults of the SP and WS feed grains (Lodos, 1982; Memisoglu and Ozer, 1992). Yield losses are estimated at 50-90 % in wheat and 20-30 % in barley. In addition to direct yield reduction during feeding, they excrete abundantly digestive secretions with proteolysis enzyme activities. These secretions become active at a suitable temperature, moisture and a certain time. When flour is processed into dough by kneading with water, and suitable temperature and moisture are provided, enzymes are activated and degrade gluten proteins. Hence, dough softens and its elasticity decreases, so further procession by hand or machine gets difficult. Moreover, gas absorption capacity of dough during fermentation decreases, and swelling as well as other quality characteristics of the bread such as crumb structure and texture are affected (Hariri et al., 2000; Vaccino et al., 2001; Koksel et al., 2002; Kinaci and Kinaci, 2004; Aja et al., 2004; Ozberk et al., 2005; Diraman et al., 2013).

For years, the SP has reduced both wheat yield and quality in Turkey and its neighboring countries (Karababa and Ozan, 1998). In Turkey, thousands of dollars are spent annually struggling with the SP; in 2014, an area of about 636.000 hectare were made SP control (General Directorate of Food and Control, 2014). According to the calculations of the Turkish Ministry of Food, Agriculture and Livestock, in 2011, the national economy contributed about 370 million dollars to the fight against the SP in 22 provinces. However, farmers lost about 20 million dollars due to the damage SP caused to coarse wheat (Union of Turkey Agriculture Chambers, 2014).

Characterizing wheat masses correctly is possible by evaluating the wheat kernels with SP and WS sucking properly. However, different methods are used to determine the rate of sucked wheat kernels in Turkey (Dizlek and Islamoglu, 2010). In the analysis based on the weigh, sucked kernels are chosen and then weighed. Later, they are proportioned with the first weight of kernel mass (Albayrak, 1999). In the physical analysis, sucked kernels are chosen and counted by either inspection or binocular and proportioned with healthy kernels to find % sucking ratio. However, in both methods only sucked kernel was considered, sucking number on the kernels were not regarded (Dizlek and Islamoglu, 2010). These cases have caused misleading results in evaluating the sucked kernel analysis. Because the kernels are exposed to more SP and WS damage, they have more proteolysis activity and thus a stronger decline is observed in the quality of flour products (Kretovich, 1944; Anon., 1983; Lorenz and Meredith, 1988b; Koksel et al., 2002; Dizlek et al., 2008).

Dizlek et al. (2008) determined that increase in infection ratio (1/4, 2/4, 3/4 and 4/4) in SP damaged wheat (Golia) caused a decrease ($P < 0.05$) in physical characteristics of wheat very quickly, so infection ratio is a very important factor for insect damage in wheat. Therefore, the cereal industry should not only take damaged kernel ratio into consideration but also consider infection ratio of insect damaged wheat.

* Corresponding author

KARABABA and OZAN (1998) reported that an allowable ratio of damaged kernels can be increased with high quality varieties. Therefore, technological effects of bug damage should be investigated on a wide range of Turkish cultivars.

In this study, we categorized the single sucked kernels (one sucking point on a kernel) and double sucked kernels (two sucking points on a kernel) separately. We investigated the effects of SP (*Eurygaster maura*) sucking number (0, 1 and 2) on the properties of wheat varieties grown in Turkey. The physical characteristics of wheat (thousand kernel weight [TKW], hectoliter weight [HW]) and physicochemical characteristics of wheat flour (Zeleny sedimentation test [ZST], delayed Zeleny sedimentation test [DZST], wet and dry gluten content [WGC and DGC, respectively] and gluten index value [GIV]) were evaluated.

Materials and methods

Materials

Six wheat varieties (Golia, Panda, Adana-99, Ziyabey-98, Ceyhan-99 and Zenit) were harvested ten days after the harvest time instead of being harvested on the right time. Thus, these varieties were exposed to more SP sucking damage and more than one sucking was formed on the kernels. Meanwhile, one hundred SP were collected from each wheat field and their varieties were determined. On average, two kilograms from each variety of wheat was taken to the laboratory.

Methods

In order to comprise the groups of wheat, damaged and undamaged by SP were identified by using binocular (SIVRI and KOKSEL, 2000; KOKSEL et al., 2002; OLANCA et al., 2008). SP damaged kernels were grouped according to the damaging degrees as single or double sucked kernels and the kernels not included in these groups were discarded.

In the present study, 3 % sucking ratio which deteriorated the technological (bread and pasta) characteristics of the wheat was selected (KOSMIN, 1933; EL-HARAMEIN et al., 1984; MATSOUKAS and MORRISON, 1990; KOKSEL et al., 2002; SIVRI et al., 2004; KACAR et al., 2008). Then, 3 sucked grains (single sucked kernels for the single sucked group and double sucked grains for the double sucked group) were added to a kernel mass including 97 healthy grains for each group. This procedure was repeated numerously to obtain sufficient amount of samples of each wheat varieties. Thus, in every wheat variety three different wheat groups including kernels with control (without SP sucking), single SP sucking 3 % and double SP sucking 3 % were formed. Great care was taken in choosing almost the same sized damaged kernels to form groups, whereas the weak and broken kernels were eliminated.

Physical and physicochemical analyses

Physical and physicochemical analyses were carried out for the blended healthy and SP damaged wheat kernels. According to ULUOZ (1965) TKW and HW of the wheat groups were assigned. Prepared blended wheat kernels were milled with a laboratory type mill (Yucebas, Izmir, Turkey) including four rolls to determine some important physicochemical characteristics of wheat flours. Flour samples were objected to ZST (AACC Method 56-60.01; AACC, 2000), DZST (GREENAWAY et al., 1965), WGC and DGC (AACC Method 38-10.01; AACC, 2000) and GIV (AACC Method 38-12.02; AACC, 2000). Standard hydration time (5 min) in ZST was extended to 120 min in DZST.

Data analyses

Analyses were carried out in three replicates. Analyses of variance (ANOVA) were conducted by using the SPSS procedures (SPSS, version 18.0 for Windows, SPSS Inc., Chicago, USA). When a significant difference was found among treatments, Duncan's multiple range tests were performed to determine the differences among the mean values ($P < 0.05$).

Results and discussion

SP species collected in the research areas were identified. It was determined that 98 % of them were *Eurygaster maura* L. (Heteroptera: Scutelleridae) and 2 % were *Eurygaster integriceps* in the town of Karaisalı (37º 05' N 35º 08' E). In another study, it was determined that 97 % of them were *Eurygaster maura* and 3 % were *Eurygaster integriceps* (SAYAN, 2010).

The effects of different sucking numbers on the TKW and HW are given at Tab. 1. SP sucking numbers on the TKW caused different variations result on wheat varieties. In this context, SP sucking numbers were determined not to effect on the TKW in Golia ($F_{2,6} = 0.364$, $P = 0.709$) and Zenit ($F_{2,6} = 0.389$, $P = 0.694$). The effects of the sucking numbers on the TKW were found important in Panda ($F_{2,6} = 17.898$, $P = 0.003$) and Adana-99 ($F_{2,6} = 17.064$, $P = 0.003$). In Ceyhan-99, for damaged samples by SP, number of sucking (single and double) on kernel was not effective on the TKW, however sucking ratios (0 % and 3 %) were found to be effective ($F_{2,6} = 10.597$, $P = 0.011$). TKW was affected significantly from the number of sucking on kernel ($F_{2,6} = 99.214$, $P = 0.000$) for Ziyabey-98.

Tab. 1: The effects of different SP sucking numbers on physical characteristics (TKW and HW) of wheat varieties.

Variety	SP Sucking Ratio (%)- SP Sucking Numbers	TKW [1] (g) [3]	HW [2] (kg)
Golia	0-no sucking (Control)	30.20±0.40a [4]	84.56±0.16a
	3-single sucking	29.84±0.37a	83.61±0.30b
	3-double sucking	30.29±0.40a	83.80±0.29b
Panda	Control	43.40±0.17a	84.00±0.30a
	3-single sucking	43.54±0.20a	83.85±0.40ab
	3-double sucking	42.33±0.34b	83.21±0.34b
Adana-99	Control	43.56±0.92a	87.44±0.22a
	3-single sucking	43.49±0.55a	86.58±0.14b
	3-double sucking	43.04±0.49b	84.69±0.20c
Ziyabey-98	Control	39.92±0.37a	83.78±0.40a
	3-single sucking	39.51±0.34b	83.56±0.26a
	3-double sucking	39.27±0.25c	82.19±0.19b
Ceyhan-99	Control	38.97±0.22a	84.86±0.21a
	3-single sucking	38.45±0.12b	85.07±0.27a
	3-double sucking	38.39±0.10b	84.17±0.10b
Zenit	Control	46.86±0.32a	85.09±0.30a
	3-single sucking	46.60±0.20a	85.21±0.31a
	3-double sucking	47.02±0.44a	85.14±0.30a

[1] Thousand kernel weight
[2] Hectoliter weight
[3] Calculations based on the dry matter basis.
[4] Mean values in the table in the same column in same wheat followed by different superscript with lowercase are significantly different $P < 0.05$.

The same situation was observed in HW of the samples. SP sucking numbers were not effective on HW in Zenit ($F_{2,6} = 0.120$, $P = 0.889$) and Panda ($F_{2,6} = 4.373$, $P = 0.067$). In Golia, although SP sucking ratio was effective on HW, number of sucking, whether single

sucking or double sucking, had no influence on HW ($F_{2,6}$ = 11.627, P = 0.009). In Adana-99, the number of suckings on kernels have effects on HW ($F_{2,6}$ = 169.955, P = 0.000). An important result is seen in the Tab. 1 for Ziyabey-98 ($F_{2,6}$ = 25.506, P = 0.001) and Ceyhan-99 ($F_{2,6}$ = 15.715, P = 0.004). Although researchers reported that two or three sucking were acceptable as only one sucking (ATLI et al., 1988a), the results in the Tab. 1 indicated that every single sucking on a kernel has effect on HW.

In terms of sucking number effects on HW, while differences were observed between wheat varieties, some of them were affected lesser or never. These differences between varieties were thought to be derived from genetic differences. Similarly, it was reported that there were variations in yield and quality losses caused by SP damage in wheat varieties (KINACI et al., 1998; SIVRI et al., 2002; KINACI and KINACI, 2004).

TKW and HW are important quality parameters for determining the suitability of wheat for milling (KARABABA and OZAN, 1998). TKW is positively correlated with flour yield (LEE et al., 1983). Soundness of the grain also directly influences flour yield and quality. According to CRITCHLEY (1998), the TKW of SP damaged wheat can be 8-22 % lower than that of the undamaged kernel. HARIRI et al. (2000) detected that the average reduction in TKW due to SP damage was about 24 % in bread wheat and 20 % in durum wheat samples. In this study, considering 6 different wheat varieties together (Tab. 1), two number of sucks on kernel cause decrease in TKW till 2.8 % and HW till 3.2 % compared to one number of suck on kernel or undamaged control sample.

ZS, DZS, WGC, DGC and GI tests were carried out for the determination of the effect of SP sucking number damage on the physicochemical characteristics of wheat flour samples. In these analyses especially DZST, as improved by GREENAWAY et al. (1965), is used for the detection of SP damage in wheat flour. The effects of different sucking numbers on the ZST, DZST, WGC, DGC and GIV are given in Tab. 2. It was found that while sucking ratios and sucking numbers on the kernels did not affect ZST in the varieties of Adana-99 ($F_{2,6}$ = 0.627, P = 0.874), Ziyabey-98 ($F_{2,6}$ = 0.750, P = 0.512) and Ceyhan-99 ($F_{2,6}$ = 0.750, P = 0.514) on the contrary to Golia ($F_{2,6}$ = 42.000, P = 0.000) and Zenit ($F_{2,6}$ = 57.000, P = 0.000) varieties were affected by these factors significantly (P < 0.05). In Panda wheat variety, number of sucking on kernel have relative effects on ZST ($F_{2,6}$ = 3.814, P = 0.085). Examining the DZST, in Golia ($F_{2,6}$ = 124.000, P = 0.000), Panda ($F_{2,6}$ = 74.000, P = 0.000), Ziyabey-98 ($F_{2,6}$ = 148.000, P = 0.000) and Ceyhan-99 ($F_{2,6}$ = 75.000, P = 0.000) except of Adana-99 and Zenit varieties, it was determined that the effects of sucking numbers (no, single or double) on the DZST values were significant (P < 0.05).

Sedimentation tests (ZST and DZST) were done to determine whether the wheat was exposed to SP damage, or to what extent it was. As expected, ZST and DZST values were found to decrease when the SP damage increase in wheat varieties. It was reported that how much the value in DZST is lower than the value in ZST means more SP-WS damage (ELGUN et al., 1998; OZKAYA and OZKAYA, 2005).

As ZST and DZST values are considered together (Tab. 2), it is observed that gluten quality in control samples is improved. The reason is that control samples include no damaged kernels and therefore, temperature (30 ºC), at which flour slurry (flour + solution of brome phenol blue) are kept in DZST, increase strength of gluten network structure. Differences between the varieties in terms of the resistance against SP damage were found with Panda being the

Tab. 2: The effects of different SP sucking numbers on physicochemical characteristics (ZST, DZST, WGC, DGC and GIV) of wheat (flour) varieties.

Variety	SP Sucking Ratio (%) -SP Sucking Numbers	ZST [1] (ml) [6]	DZST [2] (ml) [6]	WGC [3] (%)	DGC [4] (%)	GIV [5] (%)
Golia	0-no sucking (Control)	29.0±0.5a [7]	36.0±1.0a	31.12±0.50a	10.90±0.50a	99.9±0.1a
	3-single sucking	28.0±0.0b	29.0±1.0b	31.40±0.80a	11.10±0.50a	99.9±0.1a
	3-double sucking	26.0±0.5c	25.0±0.5c	30.96±0.50a	10.70±0.50a	99.9±0.1a
Panda	Control	32.0±0.5a	40.0±1.0a	30.54±1.00a	10.38±0.13a	99.9±0.2a
	3-single sucking	31.5±0.5ab	36.0±0.5b	30.92±0.97a	10.20±0.15ab	99.7±0.3a
	3-double sucking	31.0±0.3b	33.0±0.5c	30.48±0.88a	10.00±0.20b	99.9±0.1a
Adana-99	Control	37.0±1.0a	42.0±1.0a	27.36±1.01a	9.36±0.36a	99.8±0.2a
	3-single sucking	37.0±1.0a	35.0±1.0b	27.85±0.97a	9.56±0.36a	99.7±0.3a
	3-double sucking	37.0±1.5a	35.0±1.0b	27.28±1.00a	9.38±0.33a	99.9±0.2a
Ziyabey-98	Control	23.0±1.0a	24.0±1.0a	28.24±1.00a	9.54±0.09a	98.6±1.0a
	3-single sucking	22.0±1.0a	16.0±1.0b	28.01±0.90a	9.08±0.08b	99.6±0.4a
	3-double sucking	22.5±1.0a	10.0±1.0c	28.38±0.87a	9.18±0.16b	94.7±0.2b
Ceyhan-99	Control	36.5±1.0a	45.0±1.0a	26.36±0.91a	9.50±0.10a	99.9±0.0a
	3-single sucking	37.0±1.0a	40.0±1.0b	26.32±1.00a	9.32±0.14ab	99.9±0.1a
	3-double sucking	36.0±1.0a	35.0±1.0c	26.02±0.04b	9.20±0.12b	99.9±0.1a
Zenit	Control	20.5±0.5a	20.5±1.0a	35.12±0.92a	12.84±0.15a	93.7±2.7a
	3-single sucking	19.0±0.0b	9.0±0.0b	35.32±1.01a	12.91±0.21a	68.6±2.6b
	3-double sucking	18.0±0.0c	9.0±0.0b	34.84±0.98a	11.80±0.05b	28.2±1.2c

[1] Zeleny sedimentation test
[2] Delayed Zeleny sedimentation test
[3] Wet gluten content
[4] Dry gluten content
[5] Gluten index value
[6] Adjusted to 14 % moisture basis.
[7] Mean values in the table in the same column in same wheat flour followed by different superscript with lowercase are significantly different P < 0.05.

most resistant variety followed by Ceyhan-99, Golia and Adana-99. Ziyabey-98 and Zenit varieties were sensitive to SP damage and even though 3 % SP damage caused an obvious decline in gluten quality in these two varieties.

In general, number of sucking on kernel was not effective on WGC values of wheat varieties (Tab. 2). There were no differences ($P > 0.05$) between single sucking and double sucking of the WGC of five wheat varieties (Golia; $F_{2,6} = 392.000$, $P = 0.692$, Panda; $F_{2,6} = 171.000$, $P = 0.847$, Adana-99; $F_{2,6} = 286.000$, $P = 0.761$, Ziyabey-98; $F_{2,6} = 0.105$, $P = 0.902$ and Zenit; $F_{2,6} = 0.174$, $P = 0.844$), limited difference occurred only in Ceyhan-99 ($F_{2,6} = 14.389$, $P = 0.005$) variety. SP and the other insects had the same damaging effect on cereals protein quality rather than the protein content as the results in many other conducted studies also suggest (Lorenz and Meredith, 1988a, 1988b; Atli et al., 1988a, 1988b; Every et al., 1990; Rosell et al., 2002; Perez et al., 2005).

SP sucking ratio and SP sucking number on the grain affected DGC much more than WGC values (Tab. 2). In Ziyabey-98 ($F_{2,6} = 13.040$, $P = 0.007$) sucking ratio and in Zenit ($F_{2,6} = 50.331$, $P = 0.000$) sucking number were found significant ($P < 0.05$) on DGC values. While DGC of Golia ($F_{2,6} = 0.480$, $P = 0.641$), Adana-99 ($F_{2,6} = 0.297$, $P = 0.754$), Ceyhan-99 ($F_{2,6} = 4.664$, $P = 0.060$) and Panda ($F_{2,6} = 4.096$, $P = 0.076$) varieties were not affected by SP sucking ratio or SP sucking number on the grain, DGC of other varieties were affected by SP sucking ratio or SP sucking number on the grain to a limited extent. A possible reason for higher WGC and DGC of Zenit may be its descent from a durum wheat variety.

The GIV is defined as the percentage of wet gluten remaining on the sieve after automatic washing in a salt solution and centrifugation; it is a fast method to analyze gluten characteristics, indicating whether the gluten is weak, normal or strong. It is also used for the detection of gluten quality (Perten, 1990). The GI method can be used to determine SP damage in flour, since SP damaged wheat is composed of proteolytic enzymes which weaken the gluten bonds. This results in a significant decrease of the GIV (Aja et al., 2004).

Examining the GIV in Tab. 2, while SP sucking ratio or SP sucking number on the grain effects on the gluten quality were found significant in Zenit ($F_{2,6} = 334.515$, $P = 0.000$) and Ziyabey-98 ($F_{2,6} = 50.275$, $P = 0.000$) varieties, no difference was found between gluten qualities, in terms of GIV, in the other varieties (Golia; $F_{2,6} = 0.470$, $P = 0.740$, Panda; $F_{2,6} = 0.923$, $P = 0.447$, Adana-99; $F_{2,6} = 0.562$, $P = 0.597$, and Ceyhan-99; $F_{2,6} = 0.814$, $P = 0.742$).

As the level of SP sucking number in wheat increased, in general, ZST, DZST, WGC, DGC and GIV decreased (Considering six different wheat varieties together (Tab. 2), two number of sucks on kernel cause decrease in ZST till 12.2 %, DZST till 58.3 %, WGC till 2.1 %, DGC till 8.6 % and GIV till 69.9 % compared to one number of suck on kernel or undamaged control sample). However, these decreases were not statistically significant ($P > 0.05$) for Adana-99, Ziyabey-98 and Ceyhan-99 varieties in ZST; Golia, Panda, Adana-99, Ziyabey-98 and Zenit varieties in WGC; Golia and Adana-99 varieties in DGC; Golia, Panda, Adana-99 and Ceyhan-99 in GIV. The DZST is the most important indication of the SP damage level of wheat kernels. In this study, DZST values decreased dramatically with the increase of SP sucking ratio and SP sucking number in all wheat varieties (Tab. 2).

These results showed a clear decreasing in sedimentation tests especially DZST and gluten quantity and quality which can be attributed to the effect of enzyme injected to grains by SP (Tab. 2; Kretovich, 1944; Every et al., 1989). It was observed that SP damage affected the protein quality of wheat more than its protein quantity. This data was supported by some early studies (Johnson and Miller, 1953; Greenaway et al., 1965; Redman, 1971; Lorenz and Meredith, 1988a, 1988b; Atli et al., 1988a, 1988b; Every et al., 1990). Kinaci and Kinaci (2004) showed that the damage caused by SP pierced grain affects the TKW, protein content and ZST value depending on the variety and grain type.

Six wheat varieties used in this study shows that wheat quality was significantly ($P < 0.05$) affected by SP sucking ratio and SP sucking number. However, there were variations derived from the geneticall-ly differences between varieties in terms of the flour qualities. Ziyabey-98 and Zenit varieties were determined to be affected excessively. It was observed that these results were in accordance with the findings of Kinaci et al. (1998), Karababa and Ozan (1998), Sivri et al. (2002), Kinaci and Kinaci (2004), Dizlek et al. (2008). As expected, the control sample had higher results than the SP damaged samples for all physical and physicochemical quality parameters (Tab. 1 and 2).

Dizlek et al. (2008) reported that each wheat variety was affected from SP damage differently and wheat varieties cannot be damaged by SP at the same degree. Atli et al. (1988a) reported that there were differences between the methods applied for determining the sucked kernels by SP and these differences were originated from that amount of the sucked kernels given on the base of weight and percentage. Although researchers reported that two or three sucking were able to be acceptable as only one sucking, they indicated that every single sucking on a kernel contains enzyme spoiling the quality.

Single sucked and double sucked kernels are considered in the same group in practice. Results in Tab. 1 and Tab. 2 show that number of sucking in wheat grain play an important role in quality characteristics of wheat varieties (The results of this study clearly demonstrated that the quality parameters of wheat varieties and its flours were influenced by the increasing sucking number of SP damaged kernels in wheat samples). For this reason, double sucking kernel has to be handled in different groups than single sucking kernel.

Conclusions

The findings of this study could be summarized as follows:

1. SP sucking ratio (0 % and 3 %) and SP sucking number (0, single and double), cause to decline in the analyses of our findings. And they were significant ($P < 0.05$) in 14 and 25 through total 42 evaluations pertaining to Variety × Quality interactions, respectively.
2. The investigated factors were affected on the wheat varieties and some varieties were more sensitive to SP damage than others.
3. Quality losses caused by SP damage appear in both physical and physicochemical measurements. With observing and evaluating the data together (Tab. 1 and 2) a general decline in quality at limited level was observed. Carrying out research with more SP damaged grains (≥ 5 %) would be more useful to obtain better results.
4. In general, while the levels of SP sucking number in kernel increased, TKW, HW, ZST, DZST, GIV, WGC and DGC values of wheat varieties decreased.
5. Gluten quality (DZST and GIV) of the samples was affected higher than gluten quantity (WGC, DGC, TKW and HW) by SP sucking number.
6. SP sucking number on the grains affected the quality in some varieties especially Zenit and Ziyabey-98 significantly. The classification of the damaged grains should be adepted and single sucked grains and double sucked grains should not be evaluated in the same way. It is concluded that double sucked grains can be dealt with properly as two number single sucked grains.
7. In order to conduct the SP sucking analysis correctly, sucking number on a kernel must be taken into consideration as well as the sucking ratio. This case will the industry on handling SP damaged wheat and to elect additives used in preparing wheat blends and/or making bread.

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Address of the authors:
Halef Dizlek, Department of Food Engineering, Faculty of Engineering, Osmaniye Korkut Ata University, 80000 Osmaniye, Turkey
E-mail corresponding author: hdizlek@osmaniye.edu.tr
Mahmut Islamoglu, Department of Plant Protection, Faculty of Agriculture and Natural Sciences, Usak University, 64200 Usak, Turkey
E-mail: mahmut.islamoglu@usak.edu.tr