Determining the Fitness Components of Rice Weevil and their Effect on the Biochemical Composition of Wheat Grains

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ABSTRACT: Four imported wheat samples from Russia, Poland, Australia, Ukraine with one Egyptian wheat were tested against *Sitophilus* weevils by different techniques such as survey, natural mixing, fitness components, heterosis, chemical characterizations and assess the sensory tests in the final wheat product. The results indicated that *S. oryzae*, as it was found from the survey data to be the only dominant species in all wheat samples except the Australian wheat. Study of fitness components are very helpful to know the behaver of weevils and to compare the effect of maxing wheat together on one container. Australian grain bread exhibited a high acceptance score for texture and taste due to non-weevil's infection. On the other hand, both Russian and Ukrainian grain bread show the lowest acceptance to all the panelists, because the high grains infection by *S. oryzae* (L.). Save the Australian grain which was not infected, the healthy grain bread demonstrates higher acceptance score than the infected grain bread.
Key words: *S. oryzae, wheat. Imported, fitness component.*

INTRODUCTION

After harvest, grains are necessarily to be stored for consumption. Farmers retain about 70% of their agricultural produce for seed purpose, consumption and for sale (Reddy and Pushpamma, 1980). Most of the farmers are small and medium farmers who have no proper facilities for drying and storage. Consequently, many times grains are subjected to attack by insects resulting in both quantitative and qualitative loss. *Sitophilus* species are among the most widespread and destructive primary pests of stored cereals in the world (Grenier *et al.,* 1994). Changes in reproductive behavior of mass-reared insects have been investigated in a wide range of species (Trematerra *et al*., 2013; Benelli *et al*., 2014). Behavioral changes in laboratory-reared insects could occur due to adaptation to the laboratory conditions, either through environmental or genetic factors (Trematerra *et al*., 2013; Benelli, 2015). In addition, the geographical origin, as well as different mass rearing practices, may affect the existence and magnitude of lateralization in insects (Rogers *et al*., 2004). Egypt remains the world's largest wheat importer. Wheat imports for the 2015/16 marketing year are estimated at 11 million tonnes, about the same as the previous year and the average for the last five years. The overall cereal import requirements in the 2015/16 are forecast at around 19.3 million tonnes, about the same as the previous year and 9% higher than the five-year average. Several insects have been reported to be associated with stored wheat worldwide. In the present study collecting of the imported wheat samples from Russia, Poland, Australia, Ukraine with Egyptian wheat were tested by survey the types of insects on the previous samples, study the effect of crossing or natural mixing among the different wheat population, calculate the fitness components and heterosis for weevil’s parents and their hybrids, determine the chemical characterizations and losses of healthy and infected wheat grains and assess the sensory tests in the final wheat product.

MATERAILS AND METHODS

The present study was carried out from 2015 to 2018 in the Faculty of Agriculture Saba Basha, Alexandria University, Department of Agricultural Botany and Food Sciences. Samples of 30 kg were drawn at random and divided into four replicates. 12 kg (four replicates) from each wheat samples were collected and sieved separate in glass jars to determine and survey the different insect types "feral weevils" in all samples during the first two months by one time/week. Three lots (3 kg, each) of wheat samples were taken randomly. Wheat lots were sieved to obtain the so-called "feral weevils". These wild weevils were bred separately in glass jars through one generation using an incubator conditioned at 28 ±1˚C and 70 ± 5% R.H. The resulting adults (F_1) could be considered as five different geographical populations. These population were used in the biological studies. All the five wheat populations were store for six months and three possible hybrids were obtained from crossing of three population (five males x five females from each) with the Egyptian wheat. No insects were obtained from the Australia wheat after six months of storage. All the laboratory cultures resulting from the abovementioned crosses were kept under controlling incubator at 28±1˚C and 70±5%R.H. Heterosis of an individual cross was determined for each character as the increase in mean of F_1 hybrid over its better parent, according to Bhat *et al.* (1971). To determination of the proximate composition of the wheat grains, analyses were performed on ground samples (20g each) according to AOAC approved procedures (AOAC, 1990). The analysis includes moisture content (%), ash content, crude fiber, fat content, protein content, carbohydrate % and essential and non- essential amino acid (Classen *et al*., 1990). The wheat grain samples were grounded well, and the wheat flour was collected from each country infected and healthy sample. The Balady bread making was prepared according to Yaseen *et al*., (2007). The sensory evaluation test was used for assessing the sensory acceptability of Balady bread using an acceptance test according to (El-Porai *et al.*, 2013).

RESULTS AND DISCUSSION

a- Survey of weevils on different wheat population

Data in Table (1) showed that at the first month (May) no weevils were appearing (non), while the increase of storage time data indicated high numbers of weevils in the grains (October). Within the current wheat populations, Ukraine wheat showed very high infected percentage by *S. oryzae* (L.) forward by Russia wheat and Egyptian wheat at the same level. Poland wheat population showed the second grade for weevil’s infections. The results showed that no weevils were survey in Australia population (Table 1). The survey divided into five different categories i.e. (-/non) for zero weevils, (+/normal) for weevils from 1:10, (++/high) from 10:50, (+++/very high) for 50:100 and (++++/huge) for more than 100 weevils after six months of storage. Ukraine and Russia wheat showed the highest average by 2.18 and 2.0 in respect, comparing with the lowest one was zero in Australia wheat. The data showed that just one type of weevil was found in the sored wheat in Egypt, thus was *S. oryzae* (L.) and this insect cause huge dame for all cereal crops such as wheat, rice, maize, sorghum etc.

Table (1). Survey for *S. oryzae* (L.) on different wheat population during six months of storage

Population	Storage months						Mean
	May	June	July	August	September	October	
Egypt	-	-	+	++	+++	+++	1.5
Russia	-	+	++	+++	+++	+++	2.0
Ukraine	-	+	++	+++	+++	++++	2.17
Poland	-	-	-	+	++	++	0.83
Australia	-	-	-	-	-	-	0.0
Description	Non	Normal	High	V. high	V. high	Huge	2.6

-=0 weevils, +=<10 weevils /kg, ++=10:50 weevils /kg, +++=50:100 weevils /kg, ++++=>100 weevils /kg.

b- Parents biology of different wheat populations

For adults' longevity (day), data in Table (2) showed that the weevils which found in Egyptian wheat had the highest value was 214.12 day. Analysis of variance in Table (2) showed that no significant variations between the Russia and Ukraine wheat populations in relation to this character and the average values were 203.16 and 200.6 day, respectively. Poland wheat population showed the lowest adult longevity was 188.11 days with high significant values with other wheat populations.

For life cycle (day) ranged from 27.20 to 32.56 days with high significant variations between Egyptian, Poland and other two wheat population Russia and Ukraine was 2.01 (Table 2). The highest value was recorded to the weevils on Egyptian wheat by 32.56 days, forward by Poland wheat (31.94 days) and finally was the lowest one 27.20 days for Ukraine wheat population. Concerning to number of resulting weevils, data in Table (2) showed that high significant variations between all infected wheat populations by *S. oryzae.* The highest values were recorded to Russia and Ukraine by 247.11 and 231 weevils comparing with 201.13 and 197 for the infected Egyptian and Poland wheat populations. Although, the infected Egyptian wheat population showed high adult longevity comparing with Russia and Ukraine, but it achieved the less number of resulting weevils (201.13) comparing with others were 247.11 and 231 weevils. Another biological parameter was calculated such adult length (mm) was shown in Table (2). The data showed high significant values between the tested population for adult length. Russian weevils were the largest one (0.07 mm) comparing with Poland weevils (2.21 mm).

The Egyptian weevils was 2.88 mm and finally Ukraine weevils was 2.96 mm. Finally, for the parent's biology adults were weighted and results in Table 2 showed that Egyptian weevils was the heaviest (0.032 mg) and no significant variation was observed between Ukraine and Russian weevils.

c- Hybrids biology of different wheat populations

Data in Table (3) showed that the first hybrid (E x R) had the highest values in adult's longevity (day) comparing with (E x P) by 256.11, 245.1 and 202.1 days, in respect. When comparing with their parent's data showed there are increase in adult longevity from ~ 45 to 53 days, while when mixing with Poland wheat the value was 202.1 and this value is less that adult longevity in parent Egyptian wheat which was 214.12 days. That mean mixing or hybridization between the Russian, Ukraine with the Egyptian *S. oryzae* population increase the chance for increase adult longevity. The same trend for our data was observed in life cycle (day), E x R recorded in Table (3), the highest value was 33.30 days forward by E x P by 32.90 and finally E x U was 30.10 days. These hybrids achieved high values comparing with their parents for this character. Huge variation was observed for number of resulting weevils in the hybrids comparing with their parents as recorded in Table (3). There were almost 25% increase in resulting weevils when comparing with the overall of parent's population. The overall between Russia and Egypt parent population was 224 and in their hybrid, was 298 weevils. The same results were observed between the Ukraine and Egyptian population and the parents average was 216 comparing with their hybrids was 278 weevils with increase 62 weevils or ~ 20%. On the other hand, nearly good results were observed for the Poland and Egyptian hybrids that recorded 203 weevils comparing with general mean was 198 weevils as presented in Table 3. For adult's length (mm) the results showed that the first hybrids E x R and E x U had the highest values were 3.44 and 3.16 mm comparing with their parents were 3.07, 2.96 and 2.88 (Table 3). The data showed that due to mixing between the wheat cultivars or population which infected by *S. oryzae* (L.) cause high dame for wheat and the length of these weevils increased and its will eat more and more to complete their life cycles.

In fact, with increase of life cycle and longevity, the weight of weevils will increase (Table 3) for all the hybrids. The hybrids values were 0.033, 0.030 and 0.0301 comparing with control. Study of fitness components are very helpful to know the behaver of weevils and to compare the effect of maxing wheat together on one container. Our results confirmed with those of Lucas and Riudavets (2000) who studied the biological parameters of rice weevils in white and brown rice grain. These results indicated that, the size is 0.665 mm in length. Egg and larval development take place inside the grain and the life cycle of the weevils lasted 34.8 days at 27C and 69% R.H. Finally, our results agree approximately with Asmanizar *et al.* (2012) who summarized the life cycle of the rice weevil *S. oryzae.* The author detected that, females can lay 300 to 400 eggs in their lifetime. They have been 3 to 4 instars, which require an average of 18 days for development. The pupal stage required an average of 6 days and upon transformation, the adult insect will remain within the kernel for 3 to 4 days until it tans (hardens) and matures. The life cycle (egg to egg) may be as short as 32 days in the summer. The adult may live for 3 to 6 months.

Table (2). Biological characteristics of *S. oryzae* (L.) parents on different wheat populations

Characters / Country	(R)	(U)	(P)	(A)	(E)	L.S.D.0.05
Adults longevity (day)	203.16	200.6	188.11	0.0	214.12	5.71
Life cycle (day)	30.60	27.20	31.94	0.0	32.56	2.01
№ of resulting weevils	247.11	231.0	197.16	0.0	201.13	9.95
Adults length (mm)	03.07	02.96	02.21	0.0	02.88	0.03
Weight of adults (mg)	0.028	0.0271	0.022	0.0	0.032	0.01

*R: Russia, U: Ukraine, P: Poland, A: Australia and E: Egypt

Table (3). Biological characteristics of *S. oryzae* (L.) hybrids on different wheat populations

Characters / Country	(E x R)	(E x U)	(E x P)	L.S.D.0.05
Adults longevity (day)	256.11	245.1	202.1	10.01
Life cycle (day)	33.30	30.1	32.90	1.79
№ of resulting weevils	298.3	278.3	203.14	8.91
Adults length (mm)	03.44	03.16	02.55	0.04
Weight of adults (mg)	0.033	0.03	0.0301	0.01

*(E x R): Egypt x Russia, (E x U): Egypt x Ukraine, (E x P): Egypt x Poland.

d- Heterosis percentage (H)

Hybrid vigor was calculated for the three weevil's hybrids to study the effect of maxing or natural storage. The same biological characters were used. Data in Table (4) showed that for the first character adults longevity (day) there were high percentage of heterosis for the Egyptian materials with both Russian and Ukraine weevils. For example (E x R), the heterosis percentage was 22.75 % and the second one was (E x U) by 18.20%, that mean the fertility of these insects/weevils was very high and that cause in increase the longevity of these adults. While, when seen to the other third hybrid (E x P), the results indicated that very low percentage of heterosis reached to 1.48%. Heterosis percentage for life cycle ranged from 2.01 to 5.71% as recorded in Table (4). The highest values recorded to the Soviet Union countries, Russia and Ukraine with the Egyptian weevils. They recorded 5.75 and 3.73% and the lowest one with Poland was 2.01%. The high damage for any cereals crops is the number of resulting weevils which found. When crossing the Russian and Ukraine wheat with the Egyptian wheat, they gave very high heterosis that was in average more than 30% (Table 4). The hybrids (E x R) and (E x U) showed very high percentage of heterosis were 33.09 and 28.80%, this percentage is very high and cause high losses in wheat grains. While, with the Poland population weevils the percentage was very low 5%.

Table (4). Heterosis for biological characteristics in *S. oryzae* (L.) attached different wheat populations

Heterosis / Characters	Heterosis (H)		
	E (♂) x R (♀)	E (♂) x U (♀)	E (♂) x P (♀)
Adults longevity	22.75	18.20	1.48
Life cycle	05.71	03.73	2.01
No. of resulting weevils	33.09	28.80	5.00
Adults length (mm)	15.63	08.21	1.19
Weight of adults (mg)	10.0	07.52	1.48

e- Chemical analysis of healthy and infected wheat by *S. oryzae*

Twenty grams for each infected and healthy wheat grains were analyzed (Table 5). For moisture percentage (%), data showed that the maximum value was 11.2% in healthy Ukraine wheat and the minimum value was 8.72 % in healthy Australia wheat population (Table 5). The data clearly that based on the previous biology results there are high relationship between the moisture percentage and infection, that increase with the high percentage of moisture. Ukraine wheat population showed the highest value (11.2%) and this percentage was decreased to 9.82% in infected wheat by *S. oryzae* (L.). for Egyptian, Russian and Poland healthy wheat this value was ~10% as shown in Table (5). The Australian wheat population have one value because the grains after six storage months were clear and no weevils were observed.

The next character was ash content which found in Table 5. When the grains are infected with high number of weevils, that can cause decrease in ash content due to the weevil's nutrition, this fact was showed for the Ukraine and Russian wheat population. For the first one the decrease percentage was ~50% from 2.81 to 1.45 and for the second one was 20% from 1.58 to 1.28. while for the Egyptian wheat population ranged from 2.4 to 2.08. No significant variation was observed for the Poland wheat population between the healthy and infected wheat. (Table 5). The crude fiber was decreased in all the wheat population. In the Egyptian wheat decrease from 2.6 to 0.94, Ukraine wheat population from 2.91 to 2.0, Poland wheat population from 2.0 to 1.0 and for the last population Australia it was 2.02. Russian wheat achieved the highest mean of protein content was 8.83 forwarded by Poland population by 7.74 then Ukraine population by 7.53 and finally Egyptian wheat population by 7.11. the percentage of protein content was decreased with the increase of infection (Table 5). For the first wheat population from Egypt it ranged from 7.11 to 6.55, for Ukraine was 7.53 to 7.09, Poland population was 7.74 to 6.85, Russia was 8.83 to 6.41 and finally Australia wheat population was 6.54 (Table 5). Finally, carbohydrates percentage, the general mean percentage was ~83% for the healthy wheat grains and 84% for the infected grains with no significant variations, but within the healthy and infected there were observation that with the infections there are increase in the carbohydrate percentage (Table 5).

Table (5). Chemical composition of healthy and infected wheat grains by *S. oryzae* (L.) from different populations (20 g, each)

Populations	Egypt		Ukraine		Poland		Russia		Australia	
Characters	A	B	A	B	A	B	A	B	A	B
Moisture (%)	10.64	9.14	11.2	9.82	10.2	10.8	10.5	9.49	8.72	0.0
Ash content	2.4	2.08	2.81	1.45	1.18	1.08	1.58	1.28	2.7	0.0
Crude Fiber	2.6	0.94	2.91	2.0	2.0	1.0	2.32	1.62	2.02	0.0
Protein	7.11	6.55	7.53	7.09	7.74	6.85	8.83	6.41	6.54	0.0
Fat (%)	5.4	6.98	1.55	4.1	4.11	3.98	3.19	4.71	3.92	0.0
Carbohydrates	82.49	86.4	82.1	84.9	85.2	84.9	83.4	85.1	86.8	0.0

*A: Healthy, B: infected grains

As shown in Table (6), ten essential and eight non-essential amino acids were estimated for the wheat samples. Significant differences were noticed among the four populations in the total of E.A.A. values which were 46.85, 61.25, 36.52 and 49.47 mg/100g for healthy wheat sample Egypt, Ukraine, Poland and Russia wheat populations, respectively, while for the infected wheat samples were 42.84, 47.88, 35.29 and 40.08 mg/100g, in respect. Among the essential amino acids Leucine acid registered the higher constituent for all samples. According to non-essential amino acid in Table 6, the values for healthy wheat samples were 66.52, 75.31, 52.11 and 57.08 mg/100g, in respect for the same populations, while for the infected wheat samples by *S. oryzae* (L.) weevils, were 60.96, 66.21, 49.10 and 49.75 mg/100g, Among the non-essential amino acids glutamic acid and proline registered the higher constituent for all samples.

The data showed that there are decrease in essential and non-essential amino acids in the infected wheat samples, but the highest decrease was pointed to the Ukraine wheat population that was 61.25 and decreased to 47.88 mg/100g. for the Poland wheat population no significant variations were observed, and the means were 36.52 mg/100g and 35.29 mg/100g for healthy and infected wheat samples as recorded in Table (8). The same results were observed for the non-essential amino acids were 75.31 mg/100g and decreased to 66.21 mg/100g in the same previous population Ukraine, while were 52.11 and 49.10 for the Poland wheat population (Table 6).

Table (6). Constituent amino acids of wheat samples collected from the different countries before and after infection by *S. oryzae* (L.)

Amino acids	Amino acids (mg/100g)	Egypt		Ukraine		Poland		Russia	
		A	B	A	B	A	B	A	B
Essential amino acids (E.A.A)	Isoleucine	4.11	4.00	5.89	4.11	3.00	3.00	5.65	3.65
	Leucine	9.81	9.01	9.65	8.01	7.30	7.30	8.98	7.23
	Lycine	3.10	3.00	6.37	5.12	3.35	3.00	5.01	3.45
	Methionine	2.78	2.48	4.00	3.00	2.44	2.11	3.43	2.54
	Cystine	6.65	6.00	8.00	7.01	5.54	5.14	6.21	5.55
	Phenylalnine	5.44	5.00	7.54	6.50	4.11	4.01	5.67	4.87
	Tyrosine	3.14	3.01	4.32	3.37	2.30	2.30	3.29	3.10
	Threonine	4.17	4.00	5.50	4.11	3.16	3.11	4.12	3.99
	Tryptophan	2.43	1.34	3.66	1.34	1.32	1.32	2.89	2.55
	Valine	5.22	5.00	6.32	5.31	4.00	4.00	4.22	3.87
Total		**46.85**	**42.84**	**61.25**	**47.88**	**36.52**	**35.29**	**49.47**	**40.8**
Non- essential amino acids (N.A.A)	Arginine	7.65	7.32	7.66	7.13	6.76	6.00	5.21	4.98
	Histidine	4.88	4.11	5.70	4.45	3.63	3.11	3.98	2.98
	Alanine	6.65	6.05	7.6	6.06	4.98	4.65	5.72	4.88
	Aspartic acid	8.98	8.42	10.2	9.21	6.00	6.00	6.54	5.98
	Glutamic acid	17.23	16.03	18.89	17.12	14.43	14.11	16.32	14.89
	Glycne	5.80	4.80	6.00	5.01	3.98	3.11	5.71	3.98
	Proline	9.88	9.14	12.26	11.22	8.01	8.00	8.00	7.30
	Serine	5.45	5.09	7.00	6.01	4.32	4.12	5.60	4.76
Total		**66.52**	**60.96**	**75.31**	**66.21**	**52.11**	**49.1**	**57.08**	**49.75**

A: Healthy and B: infected (Reference: AOAC 2000)

f- Sensory evolution of balady bread

Sensory properties are the prospect of food as experienced by the senses, including taste, sight, smell and touch. Color, texture, odor, taste and overall acceptability of Balady bread were evaluated by panelists in Table (7). Australian grain bread exhibited a high acceptance score for texture and taste due to non-weevil's infection. On the other hand, both Russian and Ukrainian grain bread show the lowest acceptance to all the panelists, because the high grains infection by *S. oryzae* (L.). Save the Australian grain which was not infected, the healthy grain bread demonstrates higher acceptance score than the infected grain bread. Texture is a major sensory parameter of cereal products. Texture acceptance was decreased in all the infected grain samples. Moreover, both taste and odor have lower score in the infected grain than the healthy one. No significant change was observed for the Egyptian wheat (infected and non-infected) as recorded in Table 7, and the average of overall acceptability was 4.00 and 3.50 for infected and non-infected wheat grains, in respect, sharing with the Australian wheat grain was 4.30. While, there are decrease almost 50% in overall acceptability for the other wheat population from Russia and Ukraine and the data ranged from 2.15 to 2.75 (Table 7). This result agrees with the chemical composition result as in the infected grain the fiber and protein content were decreased. It is well demonstrated in literatures that fiber and protein content a in grain is very critical for bread characteristics.

More fiber and protein in the healthy grain gave the bread better texture and elasticity (Sidhu *et al.*, 2007, Šramkováa *et al.,* 2009, Kowieska *et al.*, 2011).

Table (7). Mean sensory scores for color, texture, odor, taste and overall acceptability of balady bread

Wheat source	Color	Texture	Odor	Taste	Overall acceptability
Egypt A	4.50 ± 0.54	4.00 ±0.34	4.00± 0.55	4.00 ±0.37	4.00
Egypt B	4.00 ±1.00	3.5 ± 0.21	3.0 ± 0.41	3.50 ± 0.45	3.50
Poland A	3.00 ± 0.03	4.00 ± 0.45	3.00 ± 0.06	3.50 ± 0.27	3.25
Poland B	2.10 ± 0.07	3.00 ± 0.35	2.00 ± 0.89	3.00 ± 0.25	2.70
Russia A	2.50 ± 0.09	3.50 ± 0.29	3.50 ± 1.14	2.70 ± 1.14	3.00
Russia B	2.50 ± 0.23	3.00 ± 0.17	3.00 ± 0.84	2.50 ± 0.19	2.75
Ukraine A	1.50 ± 0.07	3.50 ± 0.12	2.10 ± 0.14	2.20 ± 0.10	2.35
Ukraine B	1.50 ± 0.12	3.00 ± 0.30	1.50 ± 0.09	2.00 ± 0.17	2.15
Australian	4.50 ± 0.57	4.60 ± 0.55	4.00 ± 0.35	4.00 ± 0.35	4.30

REFERENCES

AOAC (1990). Official Methods of Analysis, Association of Official Analytical Chemists (AOAC), Washington DC., 1 - 50.

Asmanizar AD,and AB. Idris (2012). Evaluation of *Jatropha curcas* and *Annona muricata* seed crude extracts against *Sitophilus zeamais* infesting stored rice. J. Entomol., 9(1):13-22.

Benelli, G., (2015). Research in mosquito control: current challenges for a brighter future. Parasitol. Res., 114: 2801-2805.

Benelli, G., K.M. Daane, A. Canale, C.Y. Niu, R.H. Messing, R.I. Vargas (2014). Sexual communication and related behaviours in tephritidae e current knowledge and potential applications for integrated pest management. J. Pest Sci., 87: 385-405.

Bhat, M. P., V. R. Dawadi and M. R. Lastrab (1971). Second year of testing locally available plant materials against *S. oryzae* in stored wheat. Pakhribas Agric. centre Working Paper, Dhankuta, 88: 7-11.

Classen, D., J. T. Arnason, J. A. Serratos, J. D. H. Lambert, C. Nozzolillo and B. J. R. Philogene (1990). Correlations of phenolics acid content of maize grain to resistance to *S. zeamais* in CIMMYT's collections. J. Chem.Ecol.,16:301-315.

El-Porai, E., A. Salama, A. Sharaf, A. Hegazy, and M. Gadallah (2013). Effect of different milling processes on Egyptian wheat flour properties and pan bread quality. Ann. of Agric. Sci., 58: 51–59.

Grenier, A. M., B. Pintareau, and P. Nardo (1994). Enzymatic variability in three species of Sitophilus (Coleoptera: Curculionidae). J. Stored Product Res., 30: 201-213

Kowieska Agnieszka, Roman Lubowicki, Izabela Jaskowska (2011). Chemical composition and nutritional characteristics of several cereal grain, Acta Sci. Pol., Zootechnica, 10 (2): 37–50.

Lucas, E. and J. Riudavets (2000). Lethal and sublethal effects of rice polishing process on *S. oryzae* (Coleoptera: Curculionidae). J. Econom. Entomol., 93: 1842–1847.

Reddy, U. K. and P. Pushpamma (1980). Effect of insect infestation and storage on the nutritional quality of different varieties of pigeonpea. Proceedings of International Work Shop on Pigeonpea, Intern. C. Res. Inst. for Semi-arid Tropics, A.P. 451-453.

Rogers, L.J., P. Zucca, G. Vallortigara (2004). Advantages of having a lateralized brain. Proc. R. Soc. Ser., B 271 (S6): S420-S422.

Sidhu J.S., Y. Kabir, G.G. Hoffman (2007). Functional foods from cereal grain. International J. Food Prop., 10 (2): 231–244.

Šramkováa Zuzana, Edita Gregováb, Ernest Šturdíka (2009). Composition and nutritional quality of wheat grain, Acta Chimica Slovaca., 2(1): 115 – 138.

Trematerra, P., C. Lupi, C. Athanassiou (2013). Does natal habitat preference modulate cereal kernel preferences in the rice weevil? Arthropod. Plant Interact., 7: 287-297.

Yaseen, A. A., A. A. Shouk and M.M. Selim (2007). Egyptian balady bread and biscuit quality of wheat and triticale flour blends. Pol. J. Food Nutr. Sci., 57(1): 25–30.

الملخص العربي

تحديد مكونات المواءمة لسوسة الأرز وأثرها على التركيب الكيموحيوى لحبوب القمح

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جمهورية مصر العربية من أولى دول العالم إستيرادا للقمح على مستوى العالم. ويتم إستيراد كل هذة الكميات على الموانى المصرية وتخضع للفحص فى الحجر الزراعى المصرى داخل الموانى المختلفة للتاكد من سلامتها من الإصابة بالامراض والحشرات وغيرها. إلا إنة بعد ذلك يحدث خطا شائع هو تخزين هذة الاقماح المختلفة فى صوامع واحدة بما تحملة تلك العشائر من بيض موضوع للحشرات أو نسب إصابة قد يكون مسموح بها. وعلية كانت هذة الدراسة بغرض حصر لاهم انواع الحشرات الموجودة على العينات موضوع الدراسة من روسيا واوكرانيا وبولندا واستراليا ومصر التخزين لتلك الاباء بصورة منفردة تحت درجات حرارة ورطوبة ثابتة لمدة ستة اشهر ومتابعتها عن طريق قياس الدلائل البيولوجية او مكونات المواءمة لحشرة سوسة الارز وعمل خلطات مختلفة (تهجينات) بين هذة العشائر وتخزنها لنفس الفترة السابقة (محاكاة للطبيعة) وذلك لتقدير نفس مكونات المواءمة السابقة للابناء الناتجة من عملية الخلط تقدير قوة الهجين الناتجة من اثر عملية الخلط بين تلك العشائر ومقارنتها بالاباء وإجراء تحليل كيمائى للاقماح السليمة والمصابة من ناحية نسبة الرطوبة والبروتين والدهون والكربوهيدات والاحماض الامينية لتقدير التغير الحادث قبل وبعد الاصابة واجراء الاختبارات الحسية لنفس الاقماح السليمة والمصابة لمعرفة الفروق الناجمة من خلال اللون والملمس والتزوق وغيرها تحليل بيوكيمائى لتلك العشائر المختلفة لبيان مدى التقارب الوراثى من عدمة فيما بينها. اظهرت النتائج الخاصة ان حشرة سوسة الارز *S. oryzae* هى الحشرة الاكثر شيوعا ووجودا بعد فترة التخزين للحبوب الا انة لم توجد اى حشرات على الحبوب الواردة من استراليا طوال فترة التخزين. كما اظهرت النتائج ايضا ان عشائر القمح الواردة من كلا من روسيا واوكرانيا هى الاكثر اصابة بتلك الافة يليها الواردة من بولندا. مع زيادة فترة التخزين من شهر مايو حتى شهر اكتوبر كان هناك زيادة فى عدد الحشرات الناتجة حيث تفوق القمح الروسى والاوكراني على باقى الاقماح فى الحشرات الناتجة علية خلال عملية الحصر. كما اظهرت الاختبارات الحسية للخبز البلدى المصنع بعينات دقيق القمح السليم والمصاب تدهور اللون والقوام والرائحة للخبز المصنع من الاقماح المصابة مقارنة بالاقماح السليمة. بالاضافة لذلك لوحظ انخفاض الخواص الحسية للخبز الناتج من القمح السليم الروسى والاوكرانى مقارنة بالقمح المصرى والقمح الاسترالى والاخير كان افضلهم حسب متوسط التقيمات.