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STUDY OF TEMPERATURE AND TIME EFFECT ON STORED GRAIN WHEAT

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ABSTRACT: Grain wheat had been being stored at different storage temperatures for five months in order to investigate the effectiveness of temperature and duration on this food in Bani Waleed city. The bad storage condition is not significantly proper for a reserve human food. The high rate of insects infestation and weight loss is the main problem during storage period. The grain wheat had been being stored for 5 months (from 20th of April up to 20th of September) at 20 °C (a room with air conditioner), 37 °C (inside a room at ambient conditions) and 55 °C (outside under sun rays with a simple cover which is represent the local traditional store). A kilogram had been taken from each sample and all samples were weighted every (15, 30, 45, 60,75, 90, 105, 120,135 and 150) days in order to calculate number of insects/kg and the weight loss. The data had been analyzed by IBM SPSS software version 25 statistics and expressed as mean± standard deviation using Two-way ANOVA. The obtained results at the end of storage period demonstrated that weight loss and insects' population were at the highest values of 34% and 348 insect/kg into storage of 37 °C. In addition, the weight loss and insects' population were 23% and 183 insect/kg into storage of 55 °C. However, the weight loss and insects' population were 0.40% and 25 insect/kg into storage of 20 °C. Furthermore, the Duncan's multiple range test analysis exposed that is a significant difference between whole samples at different temperatures and time ($P\text{-value} < 0.05$). In conclusion, the lower temperature storage is the appropriate method in order to limit insect invasion and post harvested food loss. Moreover, the domestic traditional store is not a convenient way for postharvest grain wheat.

Keywords: Grain wheat, different temperature storage, insect population, weight loss

INTRODUCTION

Many foods are very sensitive to storage conditions. Stored product insects may cause a significant damage and loss to food in stores (De Groote, *et al.,* 2013) as well as during processing, manufacture or transportation (Begum, *et al.,* 2007) (Mullen, *et al.,* 2012) as a result of improper facilities (Oerke, 1994). Therefore, the inconvenient condition of storage food is a very serious problem. The major determinants of storage risk are temperature, and time of storage. Consequently, the high environmental temperatures can create satisfactory circumstances that might accelerate insect development within the food mass (Vassilakos and Athanassiou, 2013) which results to increase food losses. For instance, moisture content is an important factor that influences rice quality such as developing fungi which lead to increase the rate of rice deterioration. The harvested maize remained in improper stores for about twelve months without industrial insecticide treatment. This improper storing condition results to contaminate the maize by insect pest infestation (Alonso-Amelot and Avila-Núñez, 2011). Stored produce of agricultural can be attacked by many species of beetle pests such as moths and mites which causing quantitative and qualitative losses (Mansour, *et al.,* 2012). Furthermore, the shelf life of a food product depends upon the environmental conditions. For example, the initial quality of food such as taste, color, texture, nutrition content which includes carbohydrates, fat, minerals, vitamins, potassium, sugar, proteins etc., can be lost as a result of storing at ambient temperature and humidity (Baeza, *et al*., 2007). In addition, a study shown that the rate of losing vitamin B (thiamine) in pasta is high at ambient condition fluctuated from 25 to 45 ^{o}C in the storage (Baeza, *et al*. 2007; Kamman, *et al*., 1981). These nutrition content which have positive impact to the human health may be affected by inconvenient temperature. However, deterioration of stored food leads to decrease the nutrition value due to infestation of insects and microorganisms which results to be unhealthy food. Therefore, the bad storage conditions cause damage and lose to food quality and quantity. On the other hand, the proper storage facilities are very important to keep food in safe and it is the main challenge today and, in the future, which reflects a good quality food supply (Kaale and Eikevik, 2014). The most important physical factor in food storage is the temperature. This determinant drastically provides appropriate conditions that some of species such as insects which can attack the reserved foods in the storages. Therefore, the population of these pests can be increased inside the food materials which cause to grow the mold. It is generally accepted that climatic conditions that lead to physical changes in quality and quantity of commodity through the movement of moisture and rising of temperature level. Therefore, the whole food might be thoroughly deteriorated. Grain wheat has been selected for experiment run to investigate the changes in quality that occurred during storage for about 5 months at average temperature of 22.5 ^{o}C. The results shown that population of rice weevil (Sitophilus oryzae) which infested the grains increased and the growth of storage fungi increased (Fourar-Belaifa, *et al*., 2010). The grain maize stored for 6 months in the ambient conditions at about 21^{o}C. The results shown that the grain maize weevil (Sitophilus zeamais) has been infested with large numbers weevils from the second month and the numbers increased gradually up to 95 weevils over the next months. In addition, the investigation showed that the grain damage reached about 80% which depict that the most of food has been deteriorated. Similarly, the weight of grain loss increased up to 33% during this period (De Groote, *et al.,* 2013). Similarly, grain maize remained for 6 months at 22.5 ^{o}C. The maize has been attacked by larger grain borer (*Prostephanus truncates*) and the its population increased sharply till about 31 weevils and 225 of maize grain weevils (*Sitophilus zeamais*) after 4 months (De Groote, *et al.,* 2013). The maize grain damage has been estimated and the study shown that about 80% of damaged grain. Furthermore, the estimation shown that weight loss was about 26% (De Groote, *et al.,* 2013). Likewise, grain maize sample were infested in the storage with larger grain borer (*Prostephanus truncates*) and maize grain weevils (*Sitophilus zeamais*) at ambient storage condition of 26 ^{o}C. The number of weevils increased dramatically up to 60 weevils during six months. In addition, the damaged grains were about 12% (De Groote, *et al.,* 2013). Therefore, the objective of this work study is to investigate the effectiveness of temperature and duration on the stored food.

1 Materials and Methods

1.1 Source of Grain Wheat

Domestic fresh grain wheat samples without any apparent physical or organisms damage were selected from a Bani Waleed valley for this experiment run. The grain wheat samples were harvested at the end of April, 2021. The grain wheat samples were harvested at the last stage of growth which were brown and hard. After harvest, the all grain wheat samples were kept in plastic sacks and completely prepared to be stored at different locations whereas temperature is the very important factor which affects the produce.

2.2 Storage conditions

There were three storage conditions that used for the experiment. The first storage was a room contains an air conditioner which was set at 20 °C. The second storage was a room at ambient temperature of 37 °C. The third storage was outside under sun rays at average temperature of 55 °C with a simple traditional cover such as medium thick linen. Each sample contains 20 kilograms of grain wheat. The duration of store started from 20th of April 2021 till 20th of September 2021. In other word, the period of storage was 5 months, this period has been chosen to simulate the domestic traditional average storage time in this city.

2.3 Insects Estimation

The power of the insects to gnaw may be affected by the size and shape of the mouthparts, and the position of the mandibles relative to the axis of the body. For instance, larvae of red flour beetle (*Tribolium castaneum*) have penetrated cellophane and polyethylene bags when sealed in without food. Furthermore, such penetration might not result simply from a search for food. Larvae of many stored-product insects pupate preferentially amongst edible or inedible debris, and chewing at a film creates debris. Consequently, the food and products which are sealed by polyethylene bags or cellophane could be prone to insect pest infestation during storage or at the processing stage and the products are easily infested and after a period of time the numbers of insects increase due to their reproduction and the whole materials or food completely becomes physically damaged (Newton, 1988). A kilogram of grain wheat had been being taken randomly from each sample per 15 days in order to calculate the number of insects that infested the samples prolonged storage period of 5 months.

2.4 Measurement Weight Loss

The food weight loss may refer to the vanishing of food which can be calculated as a percentage of weight loss. The calculation of weight loss in the sample can be carried out by the differential between initial and final weight of grain wheat divided by the initial weight. The following equation can be used to estimate the percentage of grain wheat loss (Fregonesi, *et al.,* 2014) and (Alonso-Amelot and Avila-Núñez, 2011). All samples were weighted per 15 days in order to calculate the weight loss of samples prolonged storage period of 5 months.

$$\text{Weight loss\%} = \left(\frac{\text{initial weight} - \text{final weight}}{\text{initial weight}}\right) \times 100 \quad (1)$$

2.5 Statistical Analysis

The IBM SPSS software version 25 statistics was used for analyzing obtained samples data. Variance analysis (Two-way ANOVA) and Duncan's multiple range method were utilized to compare any significant differences between grain samples. Values were expressed as means ± standard deviations. Differences were considered significant at P-value < 0.05. All the analyses were carried out in triplicates.

3 Results and discussion

The effectiveness of duration and storage temperature on postharvest of grain wheat samples was drastically revealed after the statistical analysis work.

3.1 Weight loss

From the ANOVA runs, it can be noticeable that the effectiveness of the different independent variables on the grain wheat weight was very clear. Therefore, the percentage of weight loss at temperature of 20 °C can be negligible. On the other hand, the findings illustrated a remarkable weight loss differences at 37 °C compared to the other storage conditions. Figure 1 shows that grain weight loss percent significantly increased during storage, so the highest value was about 34% at 37 °C and 23% at 55 °C. Consequently, ANOVA runs revealed that is a significant difference between whole storage conditions as a result of influences of times and temperature as show in Table 1 (P-value < 0.05). Additionally, Table 2 shows the mean and significant differences between effectiveness parameters. Figure 2-4 depict percentage of weight loss of different samples with different storage temperatures.

Table 1: Dependent variable: Weight loss, %

Parameter	df	Mean Square	F	P-Value
Temperature	2	742.591	1528.315	0.00
Time	9	433.028	891.208	0.00
Temperature * Time	18	121.693	250.454	0.00
Error	60	0.486		
Total	90			

Table 2: Weight loss, %: Mean ±standard deviation and significant differences

Duncan's multiple range test		
Parameter		Mean of Weight loss %
Temperature, °C	20	0.04±0.127c
	37	9.95± 0.127a
	55	5.74± 0.127b
Time, day	15	0.00000 g
	30	0.00000 g
	45	0.000233 ±0.232g
	60	0.3671 ±0.232g
	75	1.377 ±0.232f
	90	3.022 ±0.232e
	105	4.933 ±0.232d
	120	8.277 ±0.232c
	135	14.988 ±0.232b
	150	19.478 ±0.232a

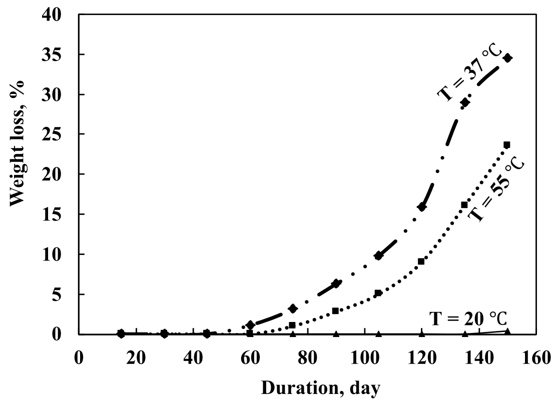

Fig. 1: Weight loss % at different temperatures

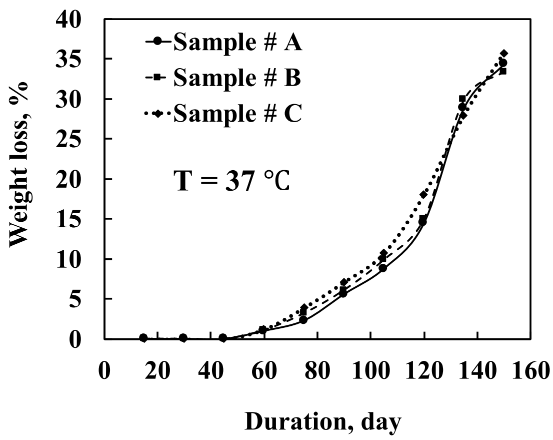

Fig. 2: Weight loss % at 37 °C

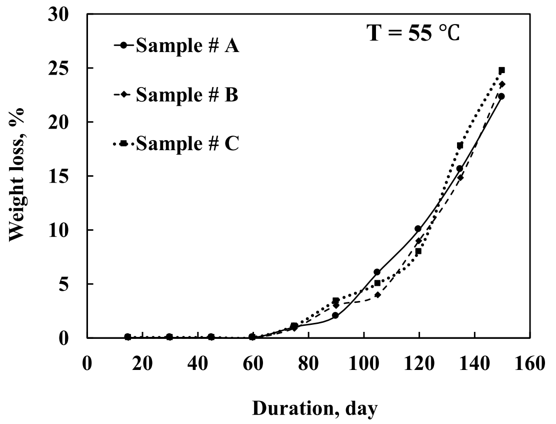

Fig. 3: Weight loss % at 55 °C

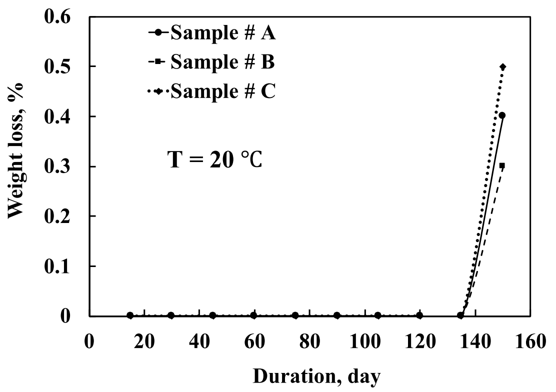

Fig. 4: Weight loss % at 20 °C

3.2 Insects population

Similarly, the ANOVA run demonstrated that number of insects per kilogram of grains wheat was drastically affected by temperature and time. Figure 5 displays the higher insects' population in the whole storage conditions. The population of insects at room with air conditioner was not significantly affected by temperature. However, the population sharply increased at the end of storage period up to 348 and 183 insects/kg at temperature of 37 °C and 55 °C respectively. Consequently, the Duncan multiple mode illustrated that number of insects was a significantly vary by time and temperature in all storage (P-value < 0.05) as shown in Table 3. This study is in agreement with previous study that conducted by Fourar-Belaifa, *et al.*, (2010) who have shown the population of rice weevil increased inside the storage at temperature of 22.5 °C. In addition, Figure 6-8 depict percentage of insects' population per kilogram of grain wheat of different samples with different storage temperatures. Moreover, Table 4 depicts the mean value and significant differences between effectiveness parameters.

Table 3: Dependent variable: Number of insects/kg

Parameter	df	Mean Square	F	P-Value
Temperature	2	185,619.478	5,076.194	0.00
Time	9	58,926.425	1,611.479	0.00
Temperature * Time	18	15,848.688	433.419	0.00
Error	60	36.567		
Total	90			

Table 4: Number of insects/kg: Mean ±standard deviation and significant differences

Duncan's multiple range test		
Parameter		Mean of number of insects
Temperature, °C	20	11.43±1.10^{c}
	37	168.73± 1.10^{a}
	55	87.96± 1.10^{b}
Time, day	15	0.44 ±2.02^{g}
	30	2.55 ±2.02^{g,f}
	45	7.89 ±2.02^{f}
	60	27.77 ±2.02^{e}
	75	47.44 ±2.02^{d}
	90	100.11 ±2.02^{c}
	105	156.88 ±2.02^{b}
	120	182.33 ±2.02^{a}
	135	183.11 ±2.02^{a}
	150	185.22 ±2.02^{a}

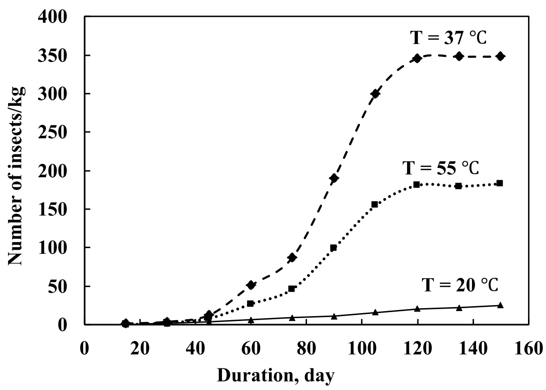

Fig. 5: Number of insects of different storages

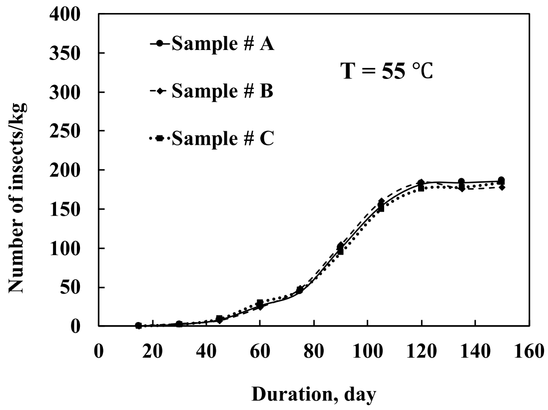

Fig. 6: Number of insects a 55 °C

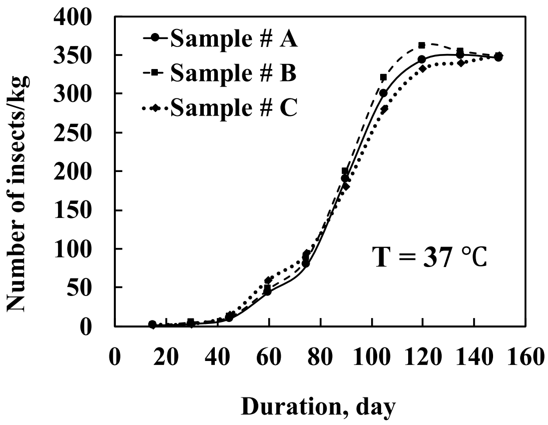

Fig. 7: Number of insects at 37 °C

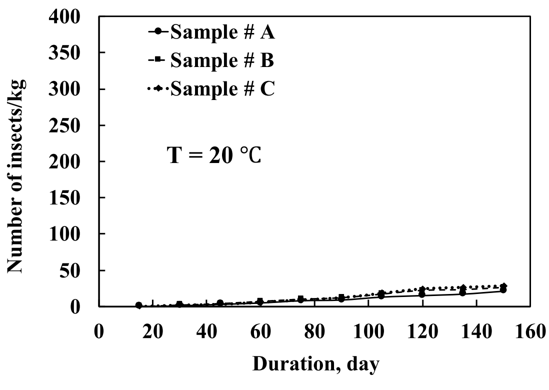

Fig. 8: Number of insects a 20 °C

4 Conclusion

This study displayed overall Bani Waleed food such as grain wheat which can be influenced by traditional storage condition as seen in the around local markets where the grain wheat susceptible to high temperature and sun rays while the cover is not proper. Consequently, the temperature and time can sharply effect the food into storage. The weight loss and insect population increase at high temperatures. However, low temperature storage is the best condition to keep the food in better situation.

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