QUALITY LOSSES IN TEMPORARY SUNFLOWER SEED STORES AND INFLUANCES OF STORAGE CONDITIONS ON QUALITY LOSSES DURING STORAGE

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ABSTRACT

The aim of storage is to preserve properties of products and their freshness. If suitable storage conditions are not supplied according to product variety, quality and quantity losses increase. Decreasing these losses is possible with providing suitable storage conditions and storage management.

In this study were aimed at determining of storage losses in the temporary sunflower seed stores and investigating the influences of storage condition on quality losses of sunflower during storage.

KEY WORDS: Storage, sunflower, temporary storage, storage conditions, quality losses

INTRODUCTION

Because of the nourishment necessity of population in the world, sources in the world must be used sustainably. Recently, increased farm production based on obtaining more product from a unit area. However processing and evaluating of these products are more impotant. Majority of farm products are consumed after the process. Hence, storage of products after the process until marketing is a necessity. The aim of the storage is to preserve properties of products and their freshness until marketing or consuming. If suitable storage conditions are not supplied according to product variety, quality and quantity losses increase.

Majority of oil, which is one of the most important food for human because of high energy, are vegetable origin (86%). Sunflower in the oil plants leads due to 25-50 % oil content. Aproximately 12.6 % of vegetable oil production in the world is covered by sunflower [1]

Turkey is the 9th largest sunflower producer in the world with the average of 843 000 t from 578 000 ha area. An important part of sunflower production (60 %) in Turkey (500 000 t) is produced in the Thrace Region [2]. Majority of sunflower produced in the Thrace Region (70%) are stored in temporary stores. Because these stores are very sensitive to weather condition, losses during storege are economicaly very important. Using temporary stores widespreadly in this region leads to losses of approximately 10 million US $ per year [3].

The objective of this study is to determine quality losses in temporary sunflower seed storege in Thrace Region, to identify the reason effective for the quality losses during storages.

MATERIAL AND METHODS

Material

The study was carried out in one of the stores of Thrace Union, which is the state oil production company in Tekirdag, Yagcı Village temporary store and a model store built specifically for this research in the Agricultural Faculty's area. Sunflower seeds were collected from these stores every month regularly during nine-month storage period started from September 2001 and all analysis were done on these samples.

Temporary sunflower store in Yagcı village was settled up in East-West direction and this store was 10 m in width and 3.6 m in height. During its consturuction, first soil was compressed, drainage ditches were opened at side of the store and a nylon canvas was spread over the soil. 1.3 m height store walls were formed by stacking sacks full of sunflower one on the top of the other. Sunflowers seeds were heaped between the walls and covered with canvas and then it was tied firmly. Sunflower seeds harvested in 2001 having 6 % moisture content and 3 % foreign material were placed in this store.

A model store having an aeration system and 2 m^3 capacity was built and the quality losses in this store were compared to the losses occurred in the temporary store in the region. The floor of the model store was concrete, walls were bricks and plaster. The aeration in the store was done using two duct systems on the floor having 1.5x 0.1 m cross sectional area for 2 m^3 store capacity as suggested by Hellevang [4] and Proctor [5]. Air flow was supplied with a fan having 0.3 m^3/min capacity and 0.2 m in diameter for 2 m^3 store capacity as proposed by Hall [6], Hellevang [4], Cloud & Morey [7], Bloome et al. [8], Hofman & Hellevang [9], Harner et al. [10]. The size of the open area in the roof was 0.75 m^2 (cross sectional area) for 2 m^3 store capacity as recommended by Hellevang [4], Proctor [5] and Bloome et al. [8]. Sunflower seeds having 6 % moisture content and 3 % foreign material was placed in this store.

Methods

Mass temperature and relative humidity into the stores as storage conditions and moisture content due to its effect on quality criteria, oil content and free fatty acidty as sunflower quality criteria were determined on the sample collected from each stores during the storage.

Measurements of mass temperature and relative humidity in the stores were recorded using a digital humidity/temperaturemeter recorder reweekly as recommended by Harrier [11], Thompson & Shelton [12] and Noyes et al. [13]. Temperature and humidity measurements were done at eight different points in each store.

Weather temperature and relative humidity were measured by a termohydrograph and these records regulated when to operate the aeration system in the model store. Aeration was operated as soon as the air temperature was 8ºC cooler than that of the mass and was continued until the temperatures became equal. Aeration system was also shut and covered when the relative humidity exceeded 75 % and during the rainy period [11] [4] [7].

Sunflower samples were taken every month regularly in the stores to determine the losses occurred in the stores during storage period. The samples were taken in eight different points of the mass according to Turkish Standarts no 163 related to Taking Sample from Oil Seed (Turkish Standard Institute, 1980) [14]. Partitioned hand probe was used for taking samples.

Analyzes of moisture content, oil content and free fatty acidty in the laboratory were done on the samples. Moisture contents were determined on basis of dry weight [15]. To determined the oil contents Soxheled method, which adjust oil content to a constant moisture, (IUPAC method no: 1.122) was used [16]. Free fatty acidty was determined using titratable acidity in IUPAC method no: 2.201 [16].

The results obtained were evaluated using SPSS computer programs for statistical analysis.

RESULTS AND DISCUSSIONS

Storage Conditions

Changes in the average temperatures and humidities during the storage period in the temporary and model stores were presented in Figure 1 and 2.

As seen in Figure 1, in general, mass temperature in the stores varied parallel to changing weather temperature. Mass temperature decreased in the autumn and increased in the spring. In the autumn, mass temperature in the model store was lower than temporary store because of aeration. Temperature in the stores decreased to 0 ºC during December and January. In the spring, mass temperature in the stores begun to increase apart from increasing the weather temperature and especially in the temporary store it quickly increased beginning from March because of increasing the outside temperature, crop respiration and insect's activity. In this period, increasing temperature in the model store was less than temporary store due to operate the aeration system.

Generally mass temperature in the model store was maintained below 17ºC as recommended by [4], Cloud & Morey [7], Brooker et al. [17] and Navarro [18] for optimum storage in terms of insect control as a result of aerating 220 h during autumn and 125 h during spring. Owning to aeration (total 345 h), temperature differences occurred between the zones in the store were prevented and homogenous temperature distribution in the model store was provided according to the measurements. Therefore moisture migration in the store in a great extend was prevented.

As seen in Figure 2, in general, while mass humidity in the model stores varied parallel to changing weather humidity, mass humidity in the temporary store increased especially during autumn. The reason of this increase in the humidity of the temporary store was the decreasing weather temperature and rains in this period. Mass humidity in the spring decreased slightly in windy days and low relative humidity days, but it rose again because of crop respiration.

The most suitable storage conditions were recorded in the model store with 16ºC temperature and 78 % mass humidity and this value were around the recommended value for suitable sunflower seed storage conditions in terms of insect control [11; 19; 4, 7, 17; 9; 20; 21]. While temperature differences and moisture migration between the zones in the model store was prevented through aeration, important temperature differences between the zones in the temporary stores were determined and moisture migration occurred. This was because the temporary store was affected by the weather temperature changes more.

Sunflower Quality Criteria

Moisture Content

Moisture content is one of the most important criteria effective on the losses during the storage. Therefore, moisture contents of sunflower samples taken regularly from the stores were determined and changes in the moisture contents with time during the storage were presented in Figure 3.

As shown in Figure 3, while the moisture content in the temporary store increased during initial storage months, it did not change in the model store because of aeration. This incerease in the temporary store resulted from entering rain water in this months and the moisture migration which arised from temperature differences between the zones. Afterwards, moisture content in this store decreased with warming up the outside temperature, but moisture content increased again because of rainy periods, high relative humidity and increasing the crop respiration and mass temperature. Although moisture content decreased minimally in windy and cloudless days, increasing outside temperature, crop respiration and insect's activity caused to increase in the moisture content. In the model store, increase in the moisture content was prevented by means of aeration, but when the aeration stopped in the winter, it increased. When the moisture content in the temporary store investigated during storage period, it is seen that the moisture content in this store exceeded 8% suggested level for safely storage by Harrier [11], Patterson [19], Brooker et al.[17], Anonymous[22], Hofman & Hellevang 89], Hellevang [20] and Hellevang [21] in the beginning from second month of the storage and it remained over 8% until end of the storage.

Oil Content

Changes in the oil contents, which is the most important feature of sunflowers, was determined by analyzes that was regularly done on the samples taken from stores and changes in the oil contents with time were presented in Figure 4.

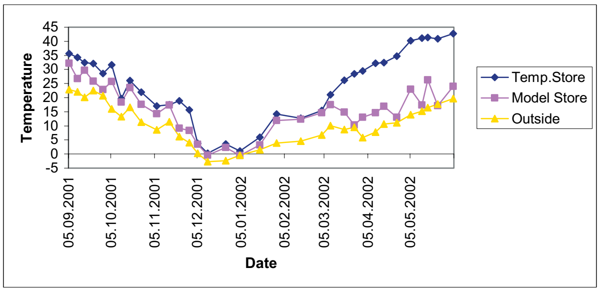

Figure 1. Changes in the average temperatures during the storage period in the stores

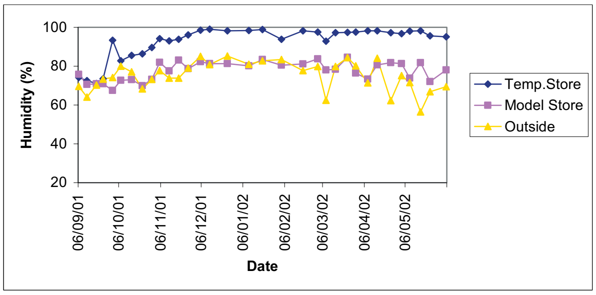

Figure 2. Changes in the average humidity during the storage period in the stores

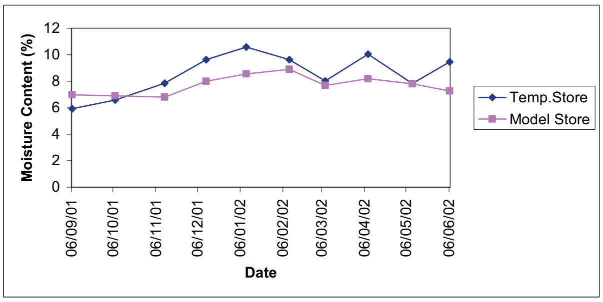

Figure 3. Changes in the average moisture content during the storage period in the stores

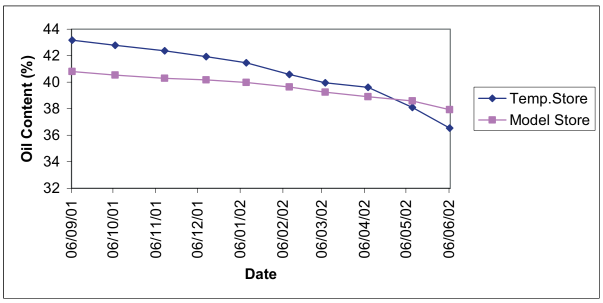

Figure 4. Changes in the average oil content during the storage period in the stores

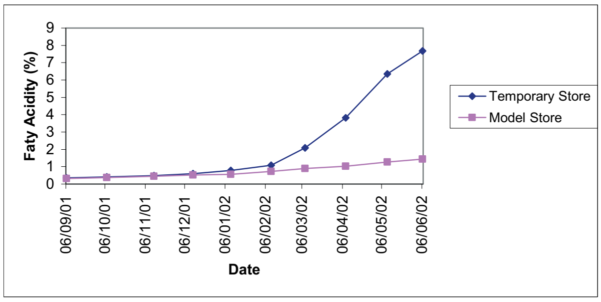

Figure 5. Changes in the free faty acidity during the storage period in the stores

As shown in Figure 4, oil contents of both temporary and model store decrease continuously however the magnitude of decrese in the temporary store was higher, from about 43.2 % to 36.5 % corresponding 0.3 to 0.7 % each month against only 2.9 % decrease, 0,1 to 0,3 % each month in the model store. A rapid decrease in the oil content of temporary store during the last three months when compared to the previous months and a relatively more decrease in the temporary store in comparison to the model store was because of keeping low temperature and humidity by means of aeration and moisture content which was lower than 8 %, suggested for a safe storage [11; 4; 17; 5; 21]. Decreasing moisture content in the model store continued to same level during storage and it decreased 0.1-0.3% per month.

Acorrding to these results, temporary stores must not be used for long time because of high losses as determined by Hall [6], Patterson [19], Hellevang [4], Jones & Shelton [23], Hellevang [24], Hofman & Hellevang [9], Hellevang [20], Hellevang [21].

Free Fatty Acidty

Free fatty acidity which affects losses occured during the refinement was determined by analysis that was regularly done on the sample taken from the stores and changes in the free fatty acidity with time were presented in Figure 5.

Free fatty acidity of sunflowers in both of the stores continuously increased during the storage. While free fatty acidity in the model stores did not exceed 1.2-1.5 % suggested for suitable free fatty acidity by Nas et al. [15], in the temporary store, beginning from February, acidity in this store quikly increased and it rose 7.683 % in June. In this period, high temperature and moisture content in the store caused to increase in the free fatty acidity.

As seen in Figure 5, free fatty acidity in the model store increased 0.05 to 0.06 % per month during the first five months of storage and then the montly increase in the free fatty acidity was recorded as 0.2% because of the increase in the mass temperature and moisture content in this period. The decreases in the mass temperature and moisture content with aeration limited the increase the acidity in this period in some extends.

3.3. Effects of Storage Conditions on the Quality Losses

Statistical evaluation done to determine the relationship between the sunflower quality losses and storage conditions and correlation coefficients for temporary store and model store were given Table 1 and Table 2 respectively.

As seen in Table 3.1, influences of storage conditions on sunflower quality losses were significant at the 0.01 confidence level. While temperature and humidity of the mass affected adversely, moisture content and oil content of the sunflower affected free faty acidity positively. A strong negative correlation between oil content and free faty acidity was determined.

When correlation coefficients for model store were investigated, in this store a negative correlation between the oil content and only humidity whereas a positive relation between free faty acidity and humidity were determined.

When the stores were compared, negative influances of mass temperature and moisture content on oil content and free faty acidity disappeared, influence of humidity on these quality criteria was reduced approximately 50 % due to aeration. This proves the importance of aeration.

CONCLUSION AND RECOMMENDATION

In this study conducted in the Thrace Region, influences of the storage conditions of temporary stores widespreadly used for storing sunflower on the quality losses occurred during storage was investigation. For this aim, in the selected temporary store and a model store built specifically for this research, mass temperature and humidity as storage conditions and moisture content, oil content and free fatty acidty as sunflower quality criteria were determined and evaluated during the storage.

In the temporary store, mass temperature decreased and mass humidity increased during autumn when the outside temperature decreased, because the store was quikly affected by the outside conditions. In this period, while the side of the store on the blowing direction of wind got quikly cold, the other side and the middle of the store got colder by time. Therefore, significant temperature differences in the store occurred and lead to increase the magnitute of moisture migration. In this period in which mass was generally cold and the mass temperature of 35°C at the beginning decreased to 2.29°C in January and mass humidity of 74 % increased 98 % in January. Mass temperature fell below the suitable storage temperature of 17°C given by Cloud & Morey [7], Thompson & Shelton [12], Jones & Shelton [23], Hellevang [24] and Hellevang [21] after November. From the early January, mass temperature increased until end of storage and it exceeded suitable storage temperature after March. In the same period, although mass humidity decreased slightly with increasing the temperature sometimes, generally it remained at the level of 97 % because of crop respiration and raining.

The criteria for sunflower in the temporary store were negatively affected by weather condition more and rain water entrance into the store. Moisture content of the crop in this store exceeded 8 % which was recommended level for a safe storage by Harrier[11], Patterson [19], Brooker et al. [17], Anonymous [22], Hofman & Hellevang [9], Hellevang [20] and Hellevang [21] and the highest moisture content occurred in January and April. This was because of warming weather conditions and rain. In April, sunflower in the upper part of the mass germinated owning to increase in the moisture content and high temperature. The result of unfavorable storage conditions in the store, oil content and free fatty acidity of crop were negatively affected. While oil content and free faty acidity of crop did not change significantly during the Autumn, in the Spring, oil content quikly decreased unlike acidity. At the end of the storage, oil content of the crop decreased by 6.60 %, acidity of crop increased 7.33 %.

Temporary storage widwspreadly used in the Thrace Region caused losses in significant amount. The raw oil losses of crops stored in the temporary stores in the Thrace region are around 19 500 tone per year and this correspounds 16 million US $ according to the price of 2002. Therefore temporary stores should not be used for sunflower storage, but if used, the durations should be less than five months in Autumn when the weather temperature decreases continuously. This kind of stores should not be also used in the districts having much rain.

Mass temperature of 32°C in the model store at the beginning decreased below 17°C that is recommended for safely storage when the aeration began from the end of October and remained below this level until June [7; 12; 23; 24; 21]. Mass humidity in this store increased 81 % from December to March because of not operating the aeration in this period, but it again decreased with aeration. Moisture content of crop during the storage period except for February kept under 8 % suggested for safely storage by Harrier [11], Patterson [19], Brooker et al. [17], Hofman & Hellevang [9], Hellevang [21]. Supplying suitable storage conditions and recommended moisture content in this store lowered the losses. At the

Table 1. Corelation coefficients of covariance analiysis for temporary store

	Oil Content	Moisture Content	Free Faty Acidity	Temperature	Humidity
Oil Content (Pearson Correlation)	1,000				
Moisture Content (Pearson Correlation)	-0,411**	1,000			
Free Faty Acidity (Pearson Correlation)	-0,871**	0,218*	1,000		
Temperature (Pearson Correlation)	-0,343**	-0,417**	0,578**	1,000	
Humidity (Pearson Correlation)	-0,583**	0,620**	0,421**	-0,384**	1,000

** Corelation is significant at the 0,01 confidance level
* Corelation is significant at the 0,05 confidance level

Table 2. Corelation coefficients of covariance analiysis for model store

	Oil Content	Moisture Content	Free Faty Acidity	Temperature	Humidity
Oil Content (Pearson Correlation)	1,000				
Moisture Content (Pearson Correlation)	-0,168	1,000			
Free Faty Acidity (Pearson Correlation)	-0,921**	0,149	1,000		
Temperature (Pearson Correlation)	0,059	-0,611**	-0,001	1,000	
Humidity (Pearson Correlation)	-0,278**	0,630**	0,281**	-0,675**	1,000

** Corelation is significant at the 0,01 confidance level

end of the storage, oil losses occurred 2.8 % and free fatty acidity increased 1.44 %. Losses in the model store appeared quite low level compairing with temporary store and losses reduced approximately 70 %. Therefore using this store for sunflower storage will provide important economical benefit.

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