T1988TECH02

CONTRIBUTION TO THE INVESTIGATION OF CHEMICAL CHANGES IN SUNFLOWERSEED DURING STORAGE

J. Turkulov, S. Veselinović, E. Dimić, V. Vukša
Faculty of Technology, Institut for meat, milk, oil and fat, fruit and vegetable technology, Novi Sad, Yugoslavia

ABSTRACT

The aim of the laboratory investigations presented in this paper was to determine the dominant promotor of selfheating of stored sunflowerseed. The changes of two seed samples, having 7,0 and 14,2% moisture content were followed in open and closed systems, and in the atmosphere of CO_2, at 20^0 and 44^{0}C during 60 days of storage. The peroxide value, moisture content and FFA were followed. The results confirm that both moisture content and the temperature influence the chemical changes in the stored seed. It has been found that the hydrolytical changes flow permanently, even if the moisture content of the seed is 7,0%.

INTRODUCTION

The proper and safe storage, that is, the quality preservation of the oilseeds til the moment of processing is one of the important factors in the edible oil production. Oilseed storage, especially of sunflowerseed, was always a big problem, as spontaneous selfheating raises from time to time (Goldovskij 1958). The temperature of the heated mass can be from 50^{0}C up to several hundred degrees, depending on the storage conditions and some other factors acting during the selfheating of the seed (Veselinović, Turkulov 1980). The quality of the oil obtained from the heated seed is low, difficulties arrise during the processing of such seed and the yield is decreasing (Turkulov et al. 1980). The storage of sunflowerseed in silo bins and the appearance of high-oil sorts and hybrids made the problem of sunflowerseed storage more pronounced. The technological characteristics of the seed are changed as a consequence of selection (Turkulov et al. 1983). There are several possibilities which explain the beginning of the selfheating during storage (Matijašević, Turkulov 1980): growth of microorganisms, seed germination, oxidation of unsaturated compounds etc., and can be devided into two basic groups of processes: chemical reactions and biological processes (Ščerbakov 1977). However, up to now the dominant factor responsible for the beginning of the selfheating is still not known (Veselinović et al. 1986). Different processes occur in the oilseeds during storage, depending on the moisture and temperature (Ščerbakov 1979). Good results were achieved by storing oilseed in CO_2 or N_2 atmosphere (Francois 1974), and that was the reason why we decided to perform our experiments with CO_2. The aim of our work was to investigate the changes of the sunflowerseed kept in the laboratory and the conditions were in a way similar to the ones of industrial storage. We followed the changes depending on the temperature and moisture content of the seed. The stability was also determined both in seed with 7,0% moisture content - the value being considered as the critical moisture content of the hybrids for the storage, and with higher moisture content - 14,2%.

MATERIAL AND TECHNICS

We performed a series of laboratory experiments and investigated the behaviour of sunflowerseed during keeping under the following conditions:

A - in the open system
B - in the closed system
C - in the system with CO_2

Grain samples weighing 100 g were kept in 500 ml erlenmayer flasks which were equipped as ilustrated in Figure 1. The cotton at one end of the tube 1 - open system - prevents the entrance of micro-organisms with the air. Carbon-dioxide produced as the result of

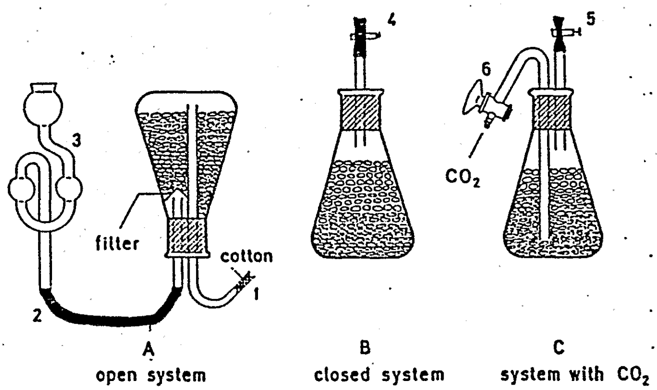

Figure 1 Equipment for the laboratory keeping of sunflowerseed

respiration passes through tube 2 and the hydraulic stopper 3. In the closed system - B - the rubber tube is closed with the clamp 4, so the sample is isolated from the environment. In the case of system with CO_2, the erlenmayer flask is equipped with the tube and clamp 5, and a tube with a faucet 6. After the sample was placed in the erlenmayer, the tube 6 was connected with the bottle with CO_2 which was drawn through the grain for 5 min. After that the faucet and the clamp were closed and the system became isolated. One series of samples was kept at 20°C and the other at 44°C. Series of 5 erlenmayers were prepared for every system. The characteristcs of the samples are given in Table 1.

Table 1. Characteristics of sunflowerseed samples

Characteristic	Sample 1	Sample 2
1. Moisture content, %	7,00	14,20
2. Content of total impurities, %	9,10	9,10
3. Content of dehulled grains, %	1,50	1,50
4. Content of broken seed, %	3,50	3,50
5. FFA, % oleic acid*	2,48	2,50
6. Peroxide value*, mmol O_2/kg	0,00	0,05

* expressed on oil

The following characteristics were determined after 5, 10, 20, 30 and 60 days of laboratory storage: moisture content (JUS 1972), FFA

(JUS 1962) and peroxide value (Pacquot et al. 1967). FFA and peroxide value were determined in the chloroform solution obtained by cold extraction of oil from the seed.

RESULTS AND DISCUSSION

The change of moisture content of samples 1 and 2 is given in Figures 2 and 3.

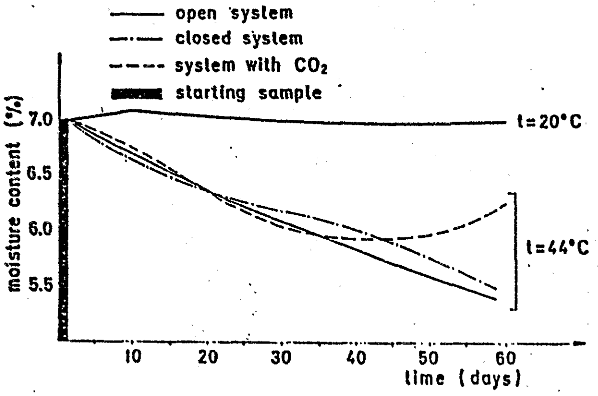

Figure 2. Change of moisture content of the seed during keeping at 20° and 44°C-sample 1

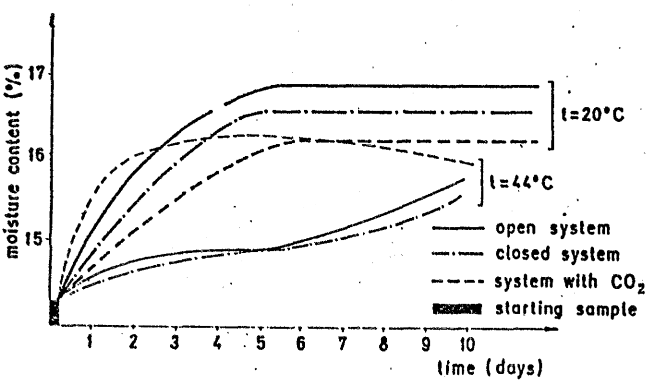

Figure 3. Change of moisture content of the seed during keeping at 20° and 44°C - sample 2

There is no change of moisture content of sample 1, which contained 7,0% of moisture at the beginning of the experiment, during 60 days of holding at 20°C. However, at 44°C the sample became dryer as a consequence of incomplete air-tightness of the system. It is interesting to note the increase of moisture content after 30 days in the CO_2 system. The starting moisture content of the sample 2 was 14,2%, as it can be seen in Figure 3. Dependless on the holding temperature, the moisture content increased during the storage. This occurrence could be explained by biochemical processes that is respiration. An interesting phenomenon has been observed in the CO_2 system. Namely, while keeping the samples at 44°C, the increase of the moisture content at the beginning of the experiment was the biggest in the CO_2 system. The moisture content change in the open and the closed system was somewhat slower.

The change of peroxide value in the seed at the mentioned keeping conditions is given in Figures 4 and 5.

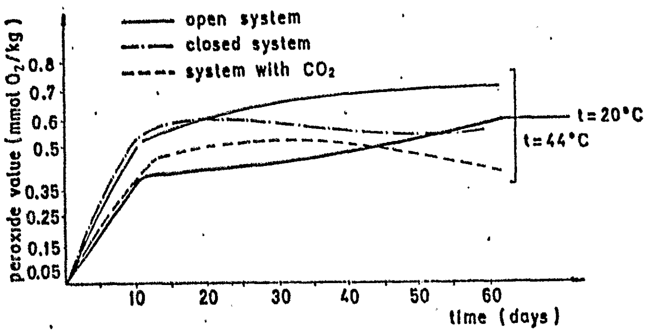

Figure 4. Change of peroxide value of sunflowerseed during keeping at 20° and 44°C - sampe 1

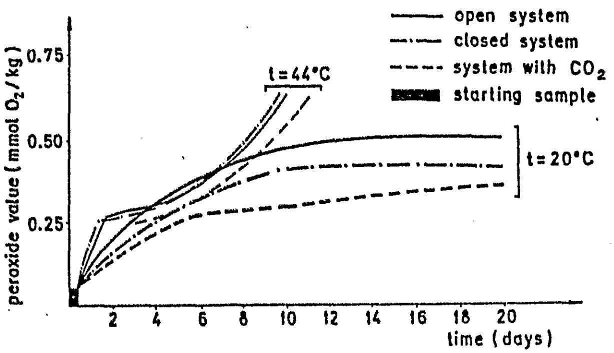

Figure 5. Change of peroxide value of sunflowerseed during keeping at 20° and 44°C - sample 2

The increase of peroxides is the biggest in the open system, it is somewhat lower in the closed system and the smallest in the system with CO_2. When holding the seed at lower temperatures - 20°C - there was a sharp increase of peroxides in the first holding phase, about 5 to 10 days. After that, the peroxides content got settled. At 44°C the curves presenting the peroxides content change have practically the same shape, but the values are different. The increase of peroxide value of sample 2 was constant in all systems. As the moisture content of this sample was higher - 14,2%, it is possible that the influence of lipase was bigger. As a result of this, hydrolytical products were formed which, as it has been proved react more readily with oxygen (Ščerbakov 1979). However, the increase of peroxide value in the CO_2 system, where there is no oxygen for the oxidative processes, is not quite clear. It can be assumed that compounds which contain oxygen and are present in the seed react in this case resulting in the forming of peroxides.

The hydrolytical changes of the seed are shown in Figures 6 and 7.

As it is obvious from the figures, the hydrolytical changes in the seed are occuring all the time, resulting in the increase of FFA content. The FFA content change is slow at low moisture content and low temperatures. However, the higher the temperature - 44°C - the faster the hydrolytical processes, and the FFA content is considerably higher. In sample 2, with the moisture content higher than the

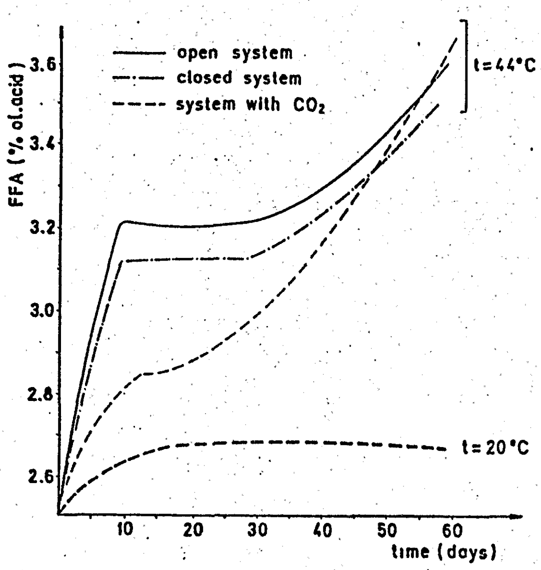

Figure 6. Change of FFA of seed during keeping at 20° and 44°C - sample 1

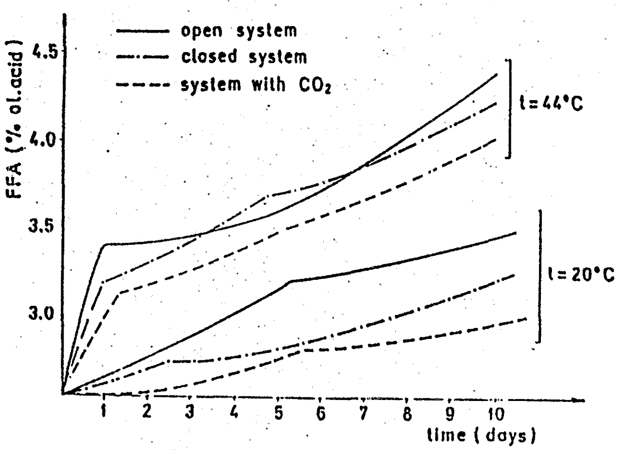

Figure 7. Change of FFA of the seed during keeping at 20° and 44°C - sample 2

equilibrate one, the changes of FFA content are more pronounced. The changes of FFA were expecially big when holding moist seed at 44°C (Figure 7). When the same samples were held at different conditions, the highest FFA value was found in the open system, in the closed system the FFA was lower and the lowest one was found in the sample held in the CO_2 system. This is in agreement with the data found in literature (Matijašević et al. 1980, Francois 1984). However, it is obvious from Figure 7, that a considerable amount of free fatty acids was formed at 44°C when the moisture content was 14,2%, though it was a CO_2 system. This phenomenon can be explained having in mind the characteristics of lipases, which exhibited bigger activity at temperatures ranging from 25° to 50°C and at higher moisture content (Goldovskij 1950, Turkulov et al. 1980, Ščerbakov 1977).

On the bases of the mentioned phenomena, it can be concluded that the holding of seed in the atmosphere of CO_2 has an effect at low moisture content of the seed.

CONCLUSIONS

1. The moisture and the temperature have a crucial influence on the storage of sunflowerseed.
2. The content of primary oxidation products increases sharply during the first 10 days and later on more slowly.
3. The hydrolytical changes of the oil in the seed are permanent even at the moisture content lower than the critical one (7%).
4. The chemical processes are slowered down by storing the sunflowerseed in inert atmosphere (CO_2). These changes are more pronounced at higher moisture content of the seed.

LITERATURE

1. Francois, R. 1974, Les Industries des Corps Gras, Technique et Documentation, Paris
2. Goldovskij, A.M. 1958, Teoretičeskie osnovi proizvodstva rastitelnih masel, Piščpromizdat, Moskva
3. Ščerbakov, V.G. 1977, Himija i biohimija pererabotki maslačnih semjan, Piščevaja promišlenost, Moskva
4. Ščerbakov, V.G. 1979. Biohemija i tovarovedenie maslačnogo sirja, Ibid., Moskva
5. Matijašević, B.O., J. Turkulov 1980, Tehnologija ulja i masti, I deo, Tehnološki fakultet, Novi Sad
6. Veselinović, S., J. Turkulov 1977, Bilten: Biljna ulja i masti 14 (1) 3 - 4
7. Turkulov, J., B.O. Matijašević, Dj. Karlović 1980, Kvalitet ulja dobijen iz suncokretovog semena neadekvatno skladištenog, Savetovanje: Problematika zaštite od požara, Novi Sad
8. Turkulov, J., E. Dimić, M. Sotin 1983, Uljarstvo 20 (1) 19 - 24
9. Veselinović, S., J. Turkulov, Ž. Vrbaški 1986, Über die Selbsterwärmung des Sonnenblumensamens beim Lagern, Gemeinsamer Kongress der Deutschen Gesellschaft für Fettwissenschaft (DGF) und der International Society for Fat Research (ISF), Münster
10. Paquot, C., J. Mercier, D. Lefort, A. Mathieu, R. Perron 1967, Metode analize lipida, Poslovno udruženje proizvodjača biljnih ulja, Beograd
11. Standardna metoda JUS E.B8.012, 1972
12. Standardna metoda JUS E.K8.026, 1962