

Research on Accumulation of Zinc (Zn) and Cadmium (Cd) in Sunflower Oil

N. Tahsin

B. Yankov

Department of Plant Growing, Agricultural University, Plovdiv, Bulgaria

The research was conducted in both polluted (with heavy metals zinc and cadmium) and unpolluted regions. Bulgarian hybrids Albena, U-41, U-70 were used as materials. The aim of the research was to determine contamination and accumulation of heavy metals zinc and cadmium in sunflower oil. The researches which were conducted for accumulation of zinc and cadmium in leaf- stem mass show significant differences from standard hybrid Albena and the last two hybrids in the polluted region. The trend goes on to the made experiments for accumulation of heavy metals zinc and cadmium in sunflower oil.

Key words: sunflower, hybrids, oil, heavy metals, accumulation

Ayçiçeği Yağında Çinko (Zn) ve Kadmiyum (Cd) Birikimi Üzerine Araştırma

Ayçiçeği yağındaki çinko ve kadmiyum içeriği ve birikiminin belirlenmesi amacıyla yapılan araştırmada, Bulgaristan kökenli hibrit Albena, U-41 ve U-70 ayçiçeği çeşitleri kullanılmıştır. Çalışma, ağır metallerle kirlenmiş ve kirlenmemiş iki farklı bölgede yapılmıştır. Ağır metallerle kirlenmiş bölgelerde ayçiçeği yağındaki kadmiyum birikimi bakımından önemli farklılıklar belirlenmiştir.

Anahtar kelimeler: Ağır metal, ayçiçeği, birikim, hibrit, yağ

Introduction

Sunflower oil is described with high nutritive and biological value as well as very good taste quality. These qualities make the oil daily and irreplaceable component from the table of the mankind (Voynar, 1960). Data show that the consumption of sunflower oil in the world increases every year (FAO, 2004). At the same time it is paid great attention to ecologically clean production of sunflower seed (Karamian- Teherani et al., 1983; Pacyna, 1987; Kastori, 1998), oil (Davis et al., 1993; Gorchach et al., 1992; Korenovska et al., 2000; Reeves, 2001; Khurana et al., 2001) and margarine (Iskander, 1995). As in many countries all over the world in Bulgaria as well there are standards for admissible concentration of heavy metals in vegetable oils and margarine. In view of this the discussion of the experiments for accumulation of zinc (Zn) and cadmium (Cd) in sunflower oil will be made upon LAC (Limited Admissible Concentrate) – The standards for

admissible concentration of heavy metals, published in Decree № 15 /DV, 18.05.1984, v.34/.

Some of the researches of sunflower oil show that there is no accumulation of Cd in the oil (Cruz et al., 2001), while the others just the opposite (Bednarova, 1988).

The aim of the research was to determine the opportunities for contamination the oil of two sunflower hybrids with wild American parents, in comparison with the standard for Bulgaria Albena hybrid.

Materials and Methods

This research had been conducted for three years (2001-2003) in two separate regions in a different distance from the main contaminator - the Plant for Production of Non Ferrous Metals – Plovdiv.

-Ist region – close to the Plant for Production of Non Ferrous Metals – Plovdiv on the land of Kuklen village in distance 1 km.

-IInd region – at the experimental field of Plant growing Department in Agricultural University – Plovdiv in a distance 15 km from the Plant for Production of Non Ferrous Metals – Plovdiv.

The experiment was established as split plots of completely randomized blocks with 4 replications and the plot size was 25 m². Three different sunflower hybrids, which were used as materials, selected in Dobroudja Agricultural Institute (D21)-Gen. Toshevo, Bulgaria.

To determinate the content of Zn and Cd in sunflower oil was used Cruz et al. (2001) method.

For reporting content of Zn and Cd in sunflower oil is used Varian's, Atomic – absorption spectrometer (AAS) – Spectra A 220 as well as AAS- DU^R- 7500, Beckman model and AAC 1100B Perkin- Elmer AS- 90 Controller with wave length for Zn- 213.9 nm and for Cd- 228.8 nm.

The statistic of experimental data was made by computer program for dispersion analyses Biostat version 5.1 (Penchev, 1998).

Results and Discussion

A possibility for accumulation of heavy metals in seeds and in the oil of sunflower is problem that stands seriously not only for Bulgaria but for the world as well. In many polluted with heavy metals regions in Bulgaria and in the world sunflower seeds are used for eating, production of oil, margarine and food flour.

World researches for content of heavy metals in the oil are narrow and mainly refer to some of them lead (Pb) and Cd.

Considering the fact that once the heavy metals fall in human body do not decompose but are accumulated and in certain quantities harm irreparably some organs, that's why it is necessary to pay great attention when seeds and products of grown in polluted regions sunflower is used for food.

It is proven that the Cd is highly accumulate in human kidney and liver and causes leucaemia. Zn harms some physiological processes like breathing and other. (Kaloyanova, 1983).

I. Content of Zn in the sunflower oil

LAC (Limited Admissible Concentration) of Zn in vegetable oil and margarine in Bulgaria is 10.0mg/kg. Statistical analysis of data show different content of Zn in the oil of investigated hybrids of sunflower (Table 1).

The content of Zn in the oil in both studied regions is considerably under the LAC norms. Nevertheless that there is essential difference between the hybrids according to content of Zn in the oil, the total quantity of zinc is within the limits and considerably under the LAC norms for Bulgaria (10.0mg/kg). The differences between the contaminated (close to the Plant for Production of Non Ferrous Metals – Plovdiv) and the distant (the experimental field of Plant growing Department in Agricultural University – Plovdiv) regions are very small. On the ground of that fact we can advise producers to grow sunflower in contaminated with Zn region and soil.

The conclusion based on the results show that the investigated sunflower hybrids grown at industrially polluted with Zn regions do not accumulate Zn in the oil in quantities above the standardized LAC for the country.

II. Content of Cd in the sunflower oil

The Cd characterizes with high solubility in fats and determines great possibility for accumulation in organized matter and consequently high toxicity for organisms. It has high accumulation in kidney and liver by reason of interaction with cistein in formation of metalotionein.

According to Voynar (1960) cadmium is microelement, and its presence in non biological doses in living organisms bring to appearance of high toxic effect.

Cadmium intoxication and its accumulation in the liver and kidney are connected with the formation of the low-molecular protein metalotionein that contains cistein that combines with Cd. While the time of accumulation goes on the quantities of metal in organs also increase. These properties of Cd make it especially dangerous.

The requirements of BNS (Bulgarian National Standard) about Cd content in vegetable oil and margarine are more elevated from these for lead and copper – 0.05 mg/kg.

The statistical analysis of data does not indicate essential difference as regards the content of Cd in the oil of the studied sunflower hybrids.

From the results in table 2 it is evident that the contents of Cd in sunflower oil do not change extremely according to years and regions of investigation. In 2001 accumulation of Cd in oil in both regions of investigation is under LAC. Much Cd is in the oil of hybrid Albena and U- 70 – 0.03 mg/kg in the region of Plant for Production of Non Ferrous Metals – Plovdiv and in the oil of hybrid U- 70 – 0.03 mg/kg in the region of the Field for education of Plant growing Department in Agricultural University – Plovdiv.

The results from waterless 2002 do not differ quite from those of 2001 and 2003. In this year of investigation with highest values are again Albena and U- 70 hybrids – 0.04 mg/kg in the region of Plant for Production of Non Ferrous Metals – Plovdiv, and U- 41 and U- 70 hybrids have one and the same values - 0.03mg/kg in the region of the Field for education of Plant growing Department in Agricultural University – Plovdiv.

In the unsuitable climatic conditions 2003 the results for the sunflower hybrids that are investigated are identical with the previous two years. In 2003 the values vary between 0.02 to

0.03 mg/kg for the region of Plant for Production of Non Ferrous Metals – Plovdiv, and 0.02 mg/kg for the region of the Field for education of Plant growing Department in Agricultural University – Plovdiv. These results do not exceed the admissible LAC.

From the results we can conclude that the studied sunflower hybrids grown in industrially polluted regions do not accumulate Cd in vegetable oil over the regulated LAC for Bulgaria.

Conclusion

The studied sunflower hybrids grown in polluted regions with Zn regions do not accumulate zinc in vegetable oil over the regulated LAC for Bulgaria. The distinction between polluted (Plant for Production of Non Ferrous Metals – Plovdiv) and the distant (Experimental field of Plant growing Department in Agricultural University – Plovdiv) regions is slight. On the grounds of that I recommend growing sunflower for vegetable oil and margarine production on soil and in regions with zinc pollution. All the three sunflower hybrids grown in industrially polluted region do not accumulate Cd in oil in quantities above the standardized LAC for Bulgaria.

References

- Voynar, A. 1960. Biologicheskaya rol microelementov v organizme jivotnyih I cheloveka. Moskow. Vishaya shkola, p. 365-375.
- Penchev, E. 1998. Ocenka na produktivnostta I pokazatelite na kachestvoto pri pshenitsata s matematicheski moduli. Disertation. Sofia.
- Bednarova, J. 1988. Hromadei olova vybranymi populacemi roslin - Acta Univ. palack. olomuc fac. rerum natur Biol.93, 28: 21 - 25.
- Cruz, A. R., C. Cabrera Vique, M. L. Lorenzo Tovar and M.C. Lopez Martinez, 2001. Lead and cadmium content in sunflower oil. Grassas y Aceites. 52: 229 - 234.
- Davis, J.G. and M.B. Parker, 1993. Journal of plant nutrition, 16: 2353.
- Gorlach, E. and F. Gambus, 1992. A comparison of sensitivity to the toxic action of heavy metals in various plant species. Polish Journal of Soil Science 25: 207 – 213.
- Iskander, F.Y. 1993. Determination of seventeen elements in edible oils and margarine by instrumental neutron activation analysis. Journal of the American Oil Chemists Society 70: 803- 805.
- Kastori, R., M. Plesnicar, Z. Sakac, D. Pankovic, 1998. Effect of excess lead on sunflower growth and photosynthesis. Journal of Plant Nutrition 21: 75 – 85.
- Karimian Teherani, D., I. Kiss, H. Altmann, 1983. Accumulation and distribution of elements in plants. Acta Alimentaria 12: 301-318.
- Khurana, N. and C. Chatterjee, 2001. Influence of variable zinc on yield, oil content and Physiology of sunflower. Communications in Soil Science and Plant Analysis 32: 3023-3030.
- Korenovska, M. and O. Polacekova, 2000. Trace elements content in virgin sunflower oil production. Czech Journal of Food Sciences 18: 61-65.

- Pacyna, J. M. 1987. Atmospheric emissions of arsenic, cadmium, lead and mercury from high temperature processes in power generation and industry: In Hutchinson, T. C. and Meema, K. M. (Eds) Lead, Mercury, Cadmium and Arsenic in the Environmental SCOPE Vol. 31. John Wiley, New York, pp. 69-87.
- Reeves, P.G., E.J. Nielsen, O. Brien, C. Nimens and R.A. Vanderpool, 2001. Cadmium: Bioavailability from Edible Sunflower Kernels: A long - term Study with men and women volunteers. Environmental Research section A87, pp. 81-91.
- Kaloyanova, F. 1983. Higienna toksikologia .Sofia. Izd. Medicina i Fizkultura.