

## NEUTRON ACTIVATION ANALYSIS OF NUTRITIONAL OIL

L. Marinkov

*Faculty of Sciences, University of Novi Sad*

D. Cvjetičanin, A. Kukoč

*Institute of Nuclear Sciences "Boris Kidrič", Beograd*

B. Matijašević

*Faculty of Technology, University of Novi Sad*

D. Lazar

*Department of Physics and Mathematics, University of Novi Sad*

Fats and oils have an important role in nutrition due to their energetic as well as biological effects. About 30% of calories come from fats and oils in correct diets. As a source of essential fat acids and vitamin E, the fats directly influence the regular growth and operation of organisms. This is the case if the fats are consumed unchanged, because only then the biological effect remains unchanged. Since oils contain predominantly unsaturated fat acids (particularly oleic and linolic) oxidation changes occur very fast. Due to autooxidation first hydroperoxides are formed (primary products) followed by formation of carbonilic compounds and lower fat acids (secondary oxidation products). The formed compounds are exceedingly unwanted, the hydroperoxides being toxic and their degradation products the carbonilic compounds are of rather peculiar tastes and smells. It is therefore very important to preserve oils and fats from oxidation, and special precautions in production and storing are required. Antioxidants are often used to increase the stability of fats.

Since the presence of certain metals even in trace amounts (particularly iron and copper) considerably reduce the stability, due to their prooxidant action, it is the tendency to remove them during refinement. The maximum permissible contents of certain metals and some other elements in nutrition oils are prescribed in corresponding regulations. Thus international regulations for oil<sup>1)</sup> allow for following maximal values: Fe 1.5 mg/kg; Cu 0.1 mg/kg; Pb 0.1 mg/kg; As 0.1 mg/kg. There is

an additional permissible content of nickel of 0.2 mg/kg for vegetable fats because of their production by hydrogenisation in presence of nickel catalysts. In spite of the fact that the catalyst is removed during refinement of fats, it is not always simple to reach the cited values.

One has to mention that oils contain other elements in trace amounts. These come either from the raw materials or are absorbed by oil in the manufacturing process. Irrespective on the influence of these elements it is very important to know the corresponding contents. The determination of the contents of trace elements in general is a rather complicated task. The classical methods (mainly spectrophotometric) are tedious and generally of insufficient sensitivity and were in last few years supplemented by more contemporary ones (atomic absorption analysis, X-ray fluorescence analysis, neutron activation analysis).

The topic of this work is the determination of trace amounts of certain elements in samples of nutritional sunflower oil by neutron activation.

#### EXPERIMENTAL (TECHNIQUE)

Samples were prepared by filling certain amounts of oil (Table 1.) as well as certain amounts of calibration materials (Table 2.) in quartz ampoules and irradiating them for 120 hours in a neutron flux of  $1.2 \times 10^{13} \text{ n/cm}^2/\text{s}$  at the reactor of the "Boris Kirdrič" Institute in Vinča. The samples were allowed to cool off for seven days before measurement.

Table 1.

Sample No.	1	2	3
Weight of oil (g)	0.2689	0.3697	0.3521
Weight of quartz ampoule (g)	2.9926	3.0988	3.5655

Table 2.

Element	Fe	Cu	Br
Weight ( $\mu\text{g}$ )	196	165	145

Since the activity of oil was comparatively low to that of the quartz ampoule the polymerized oil was separated by breaking the quartz ampoules after cooling them to LN temperatures in aluminium foils.

The gamma-ray spectrometric measurements were done in a set-up containing a Canberra Model 7227 Ge(Li) detector and a Nuclear data Model 2400, 4096 channel analyser.

## RESULTS AND DISCUSSION

The amount of present isotopes were determined from gamma spectroscopic data using the well-known equations

$$m = \frac{M \cdot A \cdot e^{-\frac{0.693}{T_{1/2}} t}}{0.602 k \cdot \sigma \cdot \phi \left[ 1 - e^{-\frac{0.693}{T_{1/2}} \tau} \right]} \quad (1)$$

and

$$m_{sa} = m_{st} \frac{A_{sa}}{A_{st}} \quad (2)$$

where  $M$  stands for the atomic weight,  $A$  for the measured absolute activity,  $k$  the isotopic content,  $\sigma$  is the activation cross-section,  $\phi$  the neutron flux in the sample,  $T_{1/2}$  the half-life,  $\tau$  the irradiation time,  $t$  is the time elapsed after irradiation. The mass of the particular isotopic content can be obtained by equation (2) comparing the sample activity  $A_{sa}$  and the activity of the standard  $A_{st}$ . The mass of the standard was determined by weighting on a microbalance.

Table 3. shows the results of the neutron activation analysis of three samples of nutritional oil produced by the same manufacturer. Five trace elements were identified, sodium having the shortest half-life in this group (14 hours). Isotopes having half-lives shorter than that were not determined.

Table 3.

Element →	B $\alpha$	Na	Zn	Sb	Fe
Oil sample	ppm				
↓ 1 ↓	0.07 ± .01	0.20 ± .04	0.06 ± .01	0.048 ± .007	-
2	0.08 ± .01	0.40 ± .08	0.040 ± .008	0.048 ± .007	0.05 ± .01
3	0.10 ± .02	1.4 ± .3	0.030 ± .006	0.06 ± .01	-

The content of iron was established only in one sample and as it may be seen that the concentration of iron is far below the maximal internationally prescribed content. Copper could not be identified because of its characteristic decay (beta plus and electron capture).

Zinc is well-known to have an important role in living organisms and plants<sup>2)</sup>. Its presence was established in trace amounts in oils.

Bromine, sodium and antimony were present in oil in trace amounts also. Most probably these elements are coming from the natural environment where the sunflowers were grown. But they may come also from the manufacturing process.

We may conclude that the neutron activation analysis is an exceptionally powerful method for the determination of trace elements in oils as well in other good stuffs.

This work is only a preliminary one and the experiments will be continued in order to establish the content of yet undetected trace elements in oils.

#### REFERENCES

- 1) Recommended International Standard for Edible Arachis Oil, Issued by the Secretariat of the Joint FAO/WHO Food Standard Programme, FAO, Rome, 1970.
- 2) E. J. Underwood, Trace Elements in Human and Animal Nutrition, p. 208, Academic Press, 1971.