STUDY OF THE SAFETY AND BIOAVAILABILITY OF ORGANICALLY CONNECTED IODINE FORMS FROM IODIZED FATS

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Abstract

Sunflower oil and margarine take up the biggest specific weight among food fats used in nutrition in the Republic of Moldova. Manufacturing and consumption of iodinated sunflower oil and margarine is a perspective direction for elimination of alimentary dependent iodine deficiency disorders. With the aim of revelation of influence of process iodination on degree of merit of sunflower oil and margarine were determined physicochemical properties of examined product. In consequence of studies was demonstrated high quality of fortified products with iodine. Through in vivo study was demonstrated efficiency of fortification of lipid products with iodine under iodine status.

Keywords: *Iodine deficiency, food fortification, sunflower oil, margarine, in vivo study.*

Introduction

The problem of iodine deficiency (ID) is one of the main problems of the world society (Delange, 1999). ID affects all population at all stages of life, from the intrauterine stage to old age (Hetzel, 1983; Stranbury, 1998).

Researches of WHO and UNICEF on the territory of the Republic of Moldova have demonstrated that prevalence rate of endemic goiter among children and teenagers make up 37%. The most marked ID exists in central and northern regions of Moldova, where the Dniester and the Prut rivers wash iodine away (WHO, 1996; UNICEF, 2002).

The most appropriate way of fighting the iodine deficiency is considered the production of foodstuff for functional purposes which contain stable forms of iodine (Hurrell, 1999).

In order to eliminate the iodine deficiency disorders 1 June 2007 was approved Government Decision nr. 585 "*Decision regarding the approving of national system of eradication of disorders caused by iodine deficit till the*

2010". It was adopted the Law regarding foodstuffs that provide for the fortification of foodstuffs with insufficient food (MO, 2007).

The aim of the research consisted in examination of quality indexes and metabolic displacement in the animals' organism at the correction of experimental and spontaneous thyroid pathology by means of iodinated food products (sunflower oil, margarine).

Experimental

- *Sun flower oil fortification with iodine*

In this study, double rafinated and deodorated oil was used purchased from local stores) (STAS – 1129-93).

To obtain the iodinated oil, in sunflower oil chemicaly pure, cristaline iodine (I_2) (STAS – 4159- 79) was administrated. After the establishement of the equilibrium, iodinated oil was used as sample for the present study.

- *Manufacturing of iodinated margarine*

In proposed iodinated margarine a part of sun-flower oil is replaced by iodinated double refined and deodorated sun-flower oil with content of iodine 10μg I/cm^3.

Fatty basis constitutes 82,00-80,25% and includes following ingredients: double refined and deodorated sun-flower oil; iodinated sun-flower oil with content of iodine 10μg I/cm^3; extract of natural colour, obtained from carrot, on basis of double refined and deodorated sun-flower oil; refined maize oil; vegetable monoglycerides (emulsifiers) and soya lecithin (emulsifier). Liquid phase constitutes 19,75-18.00% and includes following ingredients: nonfat dry milk; bakery salt; potassium sorbate and water.

- *Phisical and chemical indices of sun flower oil and margarine fortified with iodine*

All the measurements were made according to the standard methods (STAS 1129-93, STAS 240-85). The quality indices for oils were determined (physico-chemical indices) (figure 1).

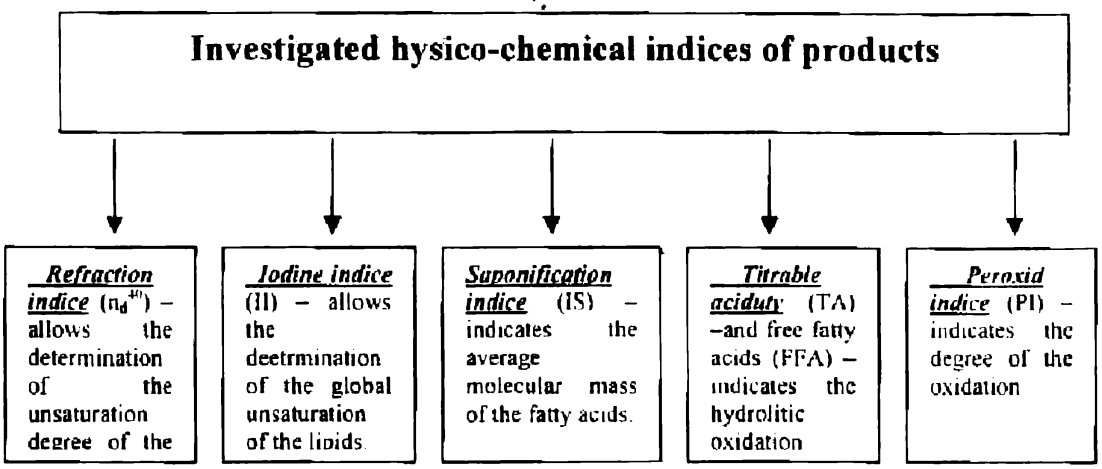

Fig 1: Investigated hysico-chemical indices of iodinated oil and margarine

➢ *Investigations in vivo*

For the purpose of elucidation of the influence of food regimes with different content of iodine on bioavailability of iodine of fortified lipid products and the dynamics of evolution of experimental hypothyroidism were realized 2 series of experiments.

The experiment was realized with the lot of white rats line Wistar with the mass 180 – 210 g. The feed was realized on standard ration with free access to water. Duration of the experiment – 42 days. The animals were kept in individual cages, 5 heads in every cage.

The experiment provided 2 stages:

I stage – experimental reproduction of hypothyroidism with the help of mercazole for blocking of thyroid gland function (Teppermen et al., 1989). Daily (14 days) the rats were given to drink water with mercazole. At the same time they were fed by bread without addition of iodinated salt (produce in the laboratory of Technical University of Moldova), with the purpose to exhaust the reserves of iodine of the organism.

II stage – feed of animals with experimental hypothyroidism (28 days) by:

- Group II - standard ration, without addition of iodine;
- Group III - with additive of sunflower non-iodinated oil;
- Group IV - with addition of iodinated oil with iodine content 3 μg/rat;

- Group V - with addition of iodinated margarine with iodine content 3 μg/rat;
- Group VI - with addition of iodinated oil with iodine content 30 μg/rat (group VI).

All the six groups of rats during the experiment got the following foodsuffs: well-milled frumenty welded on beef tea, so they got the lipidic products. The frumenty was given daily, for dinner, on the assumption of daily consumption of 12g product/rat.

➢ *Analysis of iodine content in thyroid glands of investigated rats*

After every stage of the experiment there were weighed the thyroid glands of animals and was determined the total content of iodine in thyroid glands of investigated rats. For analysis was used spectrophotometer method of iodine determination. The Method consists in mineralization of the sample with the following extraction of iodine with carbone tetrachloride in presence of sodium nitrite in acidic medium, measurement of absorption of reaction products on wavelength 514 nm. Relative error of average result consists ±2.05% (ACTES du seninaire,2004).

➢ *Determinations of errors and statistical analysis of obtained results*

Investigations realized in triplication and processed statistically by the method of those small square with application of coefficient Student and determination of interval of investigation (Snedecor et al., 1989; Lakin, 1990; Kuzeahmetov, 2001).

Results and Discussion

The physico-chemical properties of the lipids, which have a enormous importance for the food technology are determined by the chemical composition and their structure.

In order the evaluate the influence of the administration of iodine in the sunflower oil, main quality indices of the oil were studied, which were compared with the standards for the product.

Physico – chemical indices of the iodinated oil are indicated in figure 2:

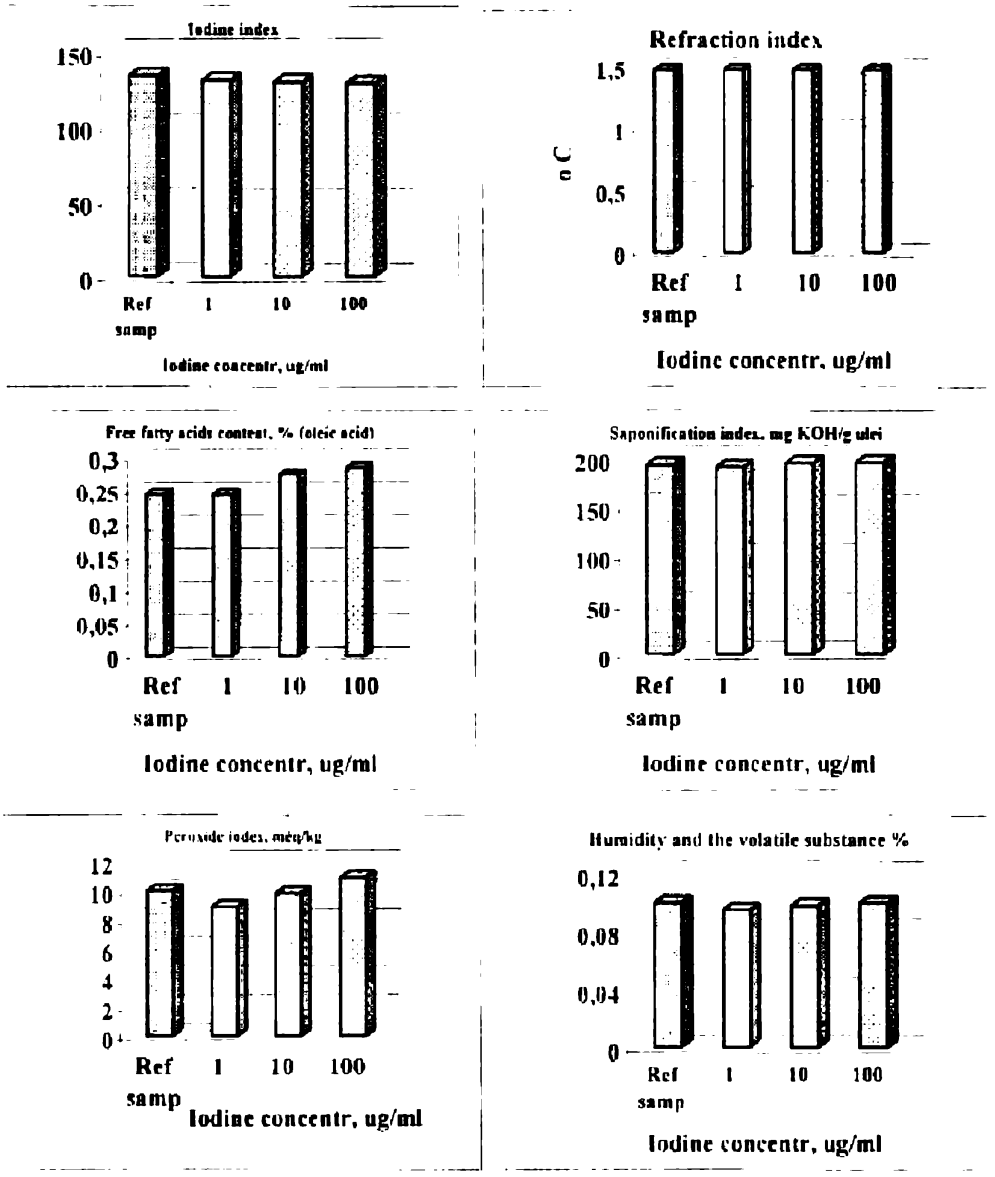

Fig. 2: Phisico – chemical indices of the iodinated oil

Refraction indice varies insignificantly, which disputes the presence of the free iodine in the samples with that contain 1-100 μg/ml iodine.

It was seen that the iodine indice varies little, so that even in the case of the sample with the highest iodine amount (100 $\mu g / ml$) its value does not surpass the allowed limits. *This indisputably certifies the fact that administrated iodine does not settle to the double bond through covalent bonds.*

It is common knowledge, that halogens are capable of saturating double bonds present in the unsaturated lipids (Karleskind, 1992). The addition of the active halogens to the double bonds is possible according to the mechanism of the nucleophile bimolecular substitution. The speed of saturation depends on the figure 3:

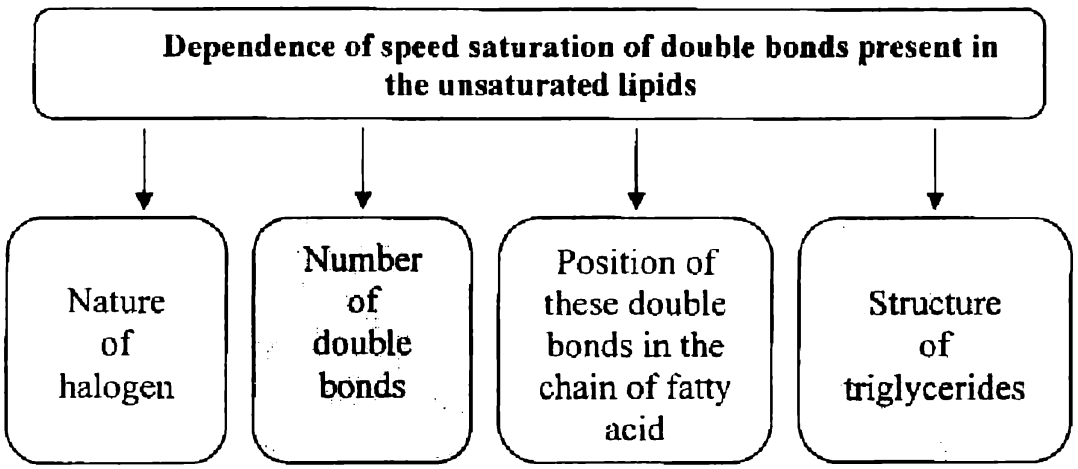

Fig 3: Dependence of speed saturation of double bonds present in the unsaturated lipids

It was established that, while the number of the carbon atoms between the carboxyl group –COO- and the double bond increases, the probability that the addition of the halogen reaction will take place decreases. Since fatty acids, present in sunflower oil have double bonds situated in the position -9=10- and -11=12- (linoleic acid), the probability that the iodine addition in these conditions will take place is very low.

It is obvious that, *during iodination of the studied sunflower oil the iodine addition cannot take place.* The activity of the double bonds is weaker when they are away from the carboxyl group. The growth of the carbon atoms in the acid chain decreases the activity of the double bonds and reduces the saturation speed.

At the same time verification of grade of widening of the product confirms the non-variability of connections number. There has its place the fixing of iodine molecules on double connection of the fatty acids, non-enriched by formation of the compounds of π type:

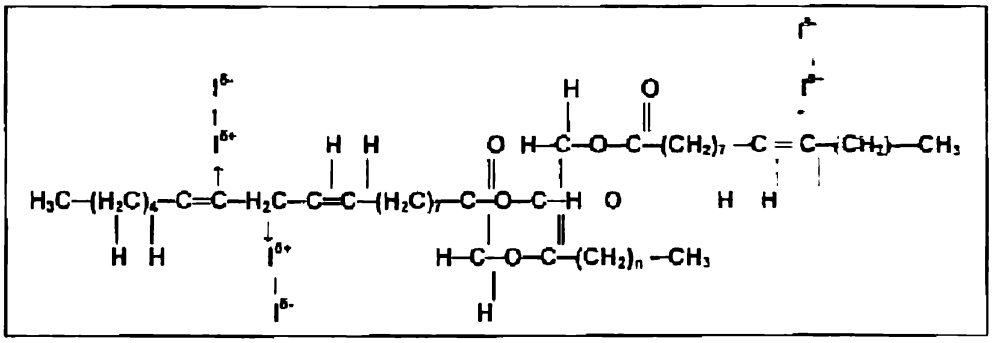

Fig. 4: The formation of π - type compounds

Formation of the compounds of π type is possible because of stabilization by resonance of excitation state that includes the both components, the fact established by analysis of the spectra IR of iodinated oil in correlation with the sample. In the field of UV/VIS has the place the displacement of absorption maximum characteristic for double bonds of the non-saturated acids A6 (Figure 5).

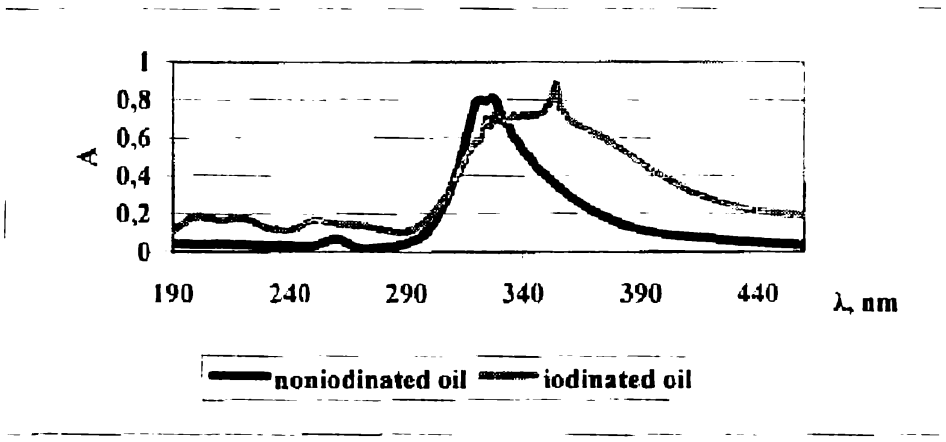

Fig. 5: Spectrum of the sunflower oil before and after iodination in the UV/visible field

In the case of the sunflower oil the fixation of the molecular iodine takes place to the double bond of the unsaturated fatty acids, thus forming type π complexes, without breaking the double bond of the acid molecules. In the compounds type π the link between electrons acceptor (iodine) and electrons donor (unsaturated fatty acids) is formed with the participation of the electrons from the π bond of the donor group (double bond of the unsaturated fatty acids).

In the compounds that formed displacement of the double bond takes place with the displacement of the electronic density towards the iodine molecule which is more electronegative and this ensures the stability of the complex that formed. Administrated iodine is fixed but not through covalent bonds, that occur as a result of the molecular iodine addition and disruption of the double bonds from the triglyceride molecules but through the formation of the molecular complexes due to displacement of the double bonds.

Physical and chemical indices of iodinated margarine were determined in comparison with reference sample (figure 5) according to the standard methods (STAS 240-85).

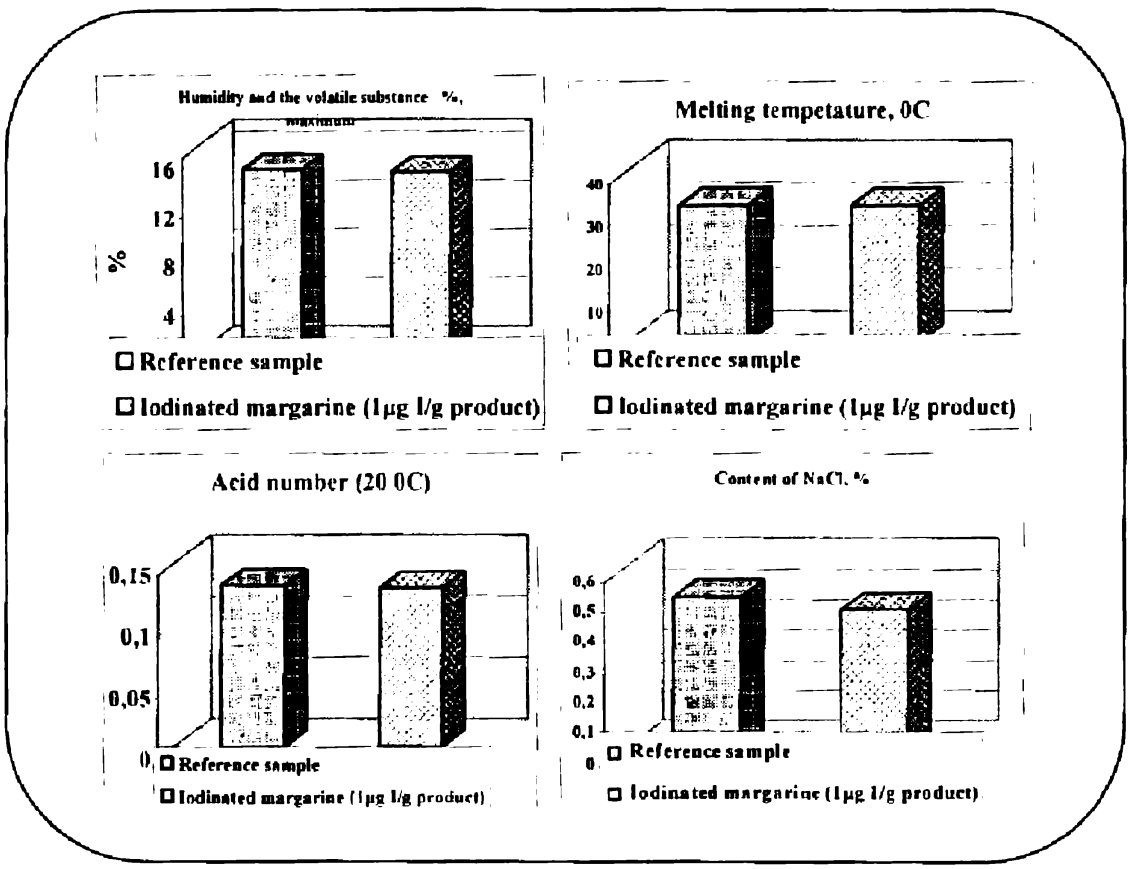

Fig. 6: Physical and chemical indices of iodinated margarine

The physical and chemical properties of the iodinated margarine do not vary insignificantly in comparison with the reference sample. Connection of iodine and vegetable oil gave the fixed organic connection with increased

biological value, which is available for obtaining and does not require the creation of additional voluminous technologies.

But the problem of rise of biological availability of iodine from its connections with fats is studies not sufficiently and needs specification.

In the connection there were realized the investigation of study of influence of iodinated fats of different concentration of the capacity of iodine accumulation by thyroid gland of rats.

For getting of the model of artificial hypothyroidism there was used mercazole for blocking of thyroid gland function. Peroxidase catalyzes the oxidation reactions. It is known that the activity of oxidation ferments decreases on hypothyroidism and increases on hyperthyroid states (Alioshin, 1982).

Mercazole depresses the ferment activity of iodineperoxidase – the ferment which provides the iodination of α – thyroxine, because in the content of thyroxine being the obligatory ingredient is iodine that provokes hypothyroidism (Dedov et al., 1998).

For hypothyroidism confirmation we effectuated the determination of iodine content in thyroid glands of rats (table 1).

Table 1: Effect of iodine intake on iodine content of thyroid gland

Group of rats	Iodine content of diet, μg/rat	Weight of thyroid gland, mg	Thyroid iodine, mg%
I	0,4 ± 0,1	25,8 ± 1,5	4,8 ± 0,9
II	0,4 ± 0,1	34,2 ± 1,7	1,2 ± 0,7
III	0,6 ± 0,2	18,2 ± 0,9	1,1 ± 0,6
IV	3,5 ± 0,8	24,8 ± 2,2	5,4 ± 0,7
V	3,6 ± 0,7	31,4 ± 3,8	13,0 ± 1,5
VI	30 ± 1,9	39,4 ± 5,7	28,0 ± 1,9

*average daily quantity of feed for rats– 12 ± 4 g

Earlier the similar investigations were effectuated by Berenstein F.Ia. (Berenshtein, 1966). It was established by him that addition to feed of iodine and of potassium iodic positively influence of function of thyroid gland. Iodic preparations assisted not only the improvement of thyroid gland functioning but also made better the use of feed by animals.

The obtained by us investigations results let us suppose that application of iodinated fats supplies the lack of iodine in animals' organism, and also it has not side effects.

Iodine content in thyroid glands characterizes the intensity and direction of iodine exchange of animals. Realized by us investigations on

iodine accumulation in thyroid glands confirmed the positive influence of optimal iodine level (3 μg/rat) on organism of experimental animals. Obtained by us data on investigation of iodine content in thyroid glands agree with the works of Baranov V.G. (1970), Seleatitskaia V.G. (1994).

Feeding of experimental animals by optimal iodine level (3 μg/rat) increased the functional activity of thyroid gland and iodine concentration in it. The obtained data agree with the investigation results of Fenchenco N.G. (2003), Kashin V.K. (1990).

The investigation data indicate that iodinated fats influence on metabolism processes to the accumulation by animals' organism of the iodine, as a result of more effective digestion and assimilability of iodine from present connections.

In whole the investigations of thyroid gland realized by us, proved that is on experimental hypothyroidism the iodine content of rats decreased from 4,8 to 1,2 mg% (groups I and II), so on addition of iodinated fats with iodine content (3 μg/rat) the iodine quantity in thyroid gland increased from 5.4 to 13,0 mg% (groups III and IV). On addition of considerable quantities of iodine (30 μg/rat) the iodine content also increased, but the capacity of thyroid gland to iodine accumulation decreased (figure 7, 8).

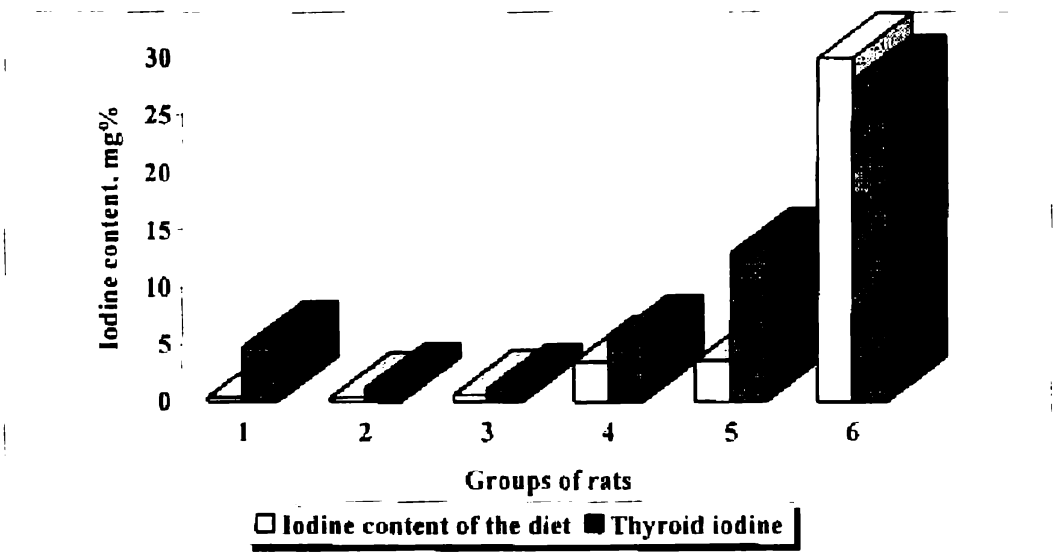

Fig. 7: Influence of consumption by animals of iodinated fats on the process of its metabolism.

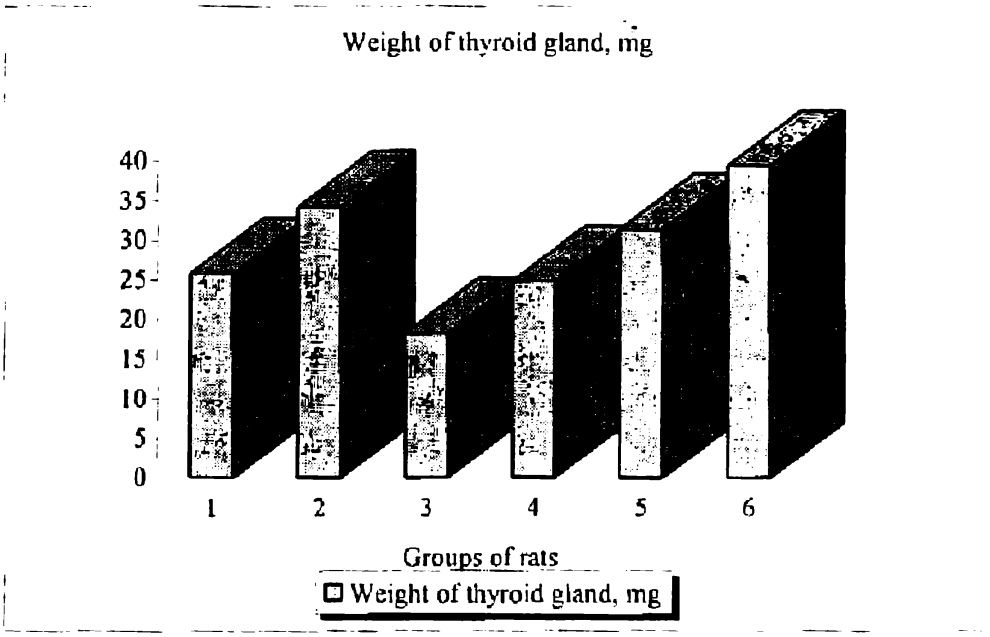

Fig. 8: Influence of consumption by animals of iodinated fats on the process of the accumulation capacity by thyroid gland.

Analysis of iodine content in thyroid glands, which was obtained from rats after correction of iodine-critical state, at the expense of introduction in their ration of iodinated fats gives the possibility to mention the improvement of functioning and the capacity of iodine accumulation by thyroid gland.

Conclusion

The performed study permits to establish that fixation of molecular iodine to double bond takes place with formation of π - type compounds, without breaking of double bond from molecules of unsaturated fatty acids.

Physical and chemical properties of the iodinated sunflower oil vary insignificantly with regard to the reference sample.

The investigation data indicate that iodinated fats influence on metabolism processes to the accumulation by animals' organism of the iodine, as a result of more effective digestion and assimilability of iodine from present connections.

Application of iodinated fats supplies the lack of iodine in organism, does not have side effects and they can be used in prevention of diseases, provoked by iodine deficiency.

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