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NEW ASPECTS OF BIOLOGICAL AND FOOD VALUE OF SUNFLOWER SEEDS

The use of oil seeds as food for people is now a more complex and important problem than ever before, owing to the exacerbation of food situation.

In the past sunflower and cotton seeds were used largely for oil production and the rest oil-seed meal as a fodder, while nowadays overywhere in the world systematic research is being conducted to elaborate economical methods for obtaining protein isolates and subsequently foodstuffs from them.

Now we have a lot of new data about biological properties of various fat products, particularly of vegetable oils.

Today, linoleic acid is not counted as an essential fatty acid, owing to which fatty products containing this acid in great quantities, such as linseed and hemp oils, formerly considered highly useful, should be thoroughly revised. Moreover, there are many changes in the methods of evaluating biological properties of various fatty products. Let us recall that not long ago virtually the only method of the biological evaluation of fats was the investigation of their influence on the growth of animals and on changes in lipid metabolism.

Now more attention is paid to the correlation between the criglyceride's fatty acid composition and the influence of fat on various functions of the organism. Recently we have found a new aspect in the physiological action of fats and particularly essential fatty acids on the organizm. The fact is that these acids are indispensable for the organism because they are predecessors of substances involved in the synthesis of the liquid crystal structure of cell and subcell membranes. In the course of our studies we confirmed the earlier established ability of most animals to accumulate the fatty acids of food in lipid depots. It was also shown that phospholipids of cell and subcell membranes can accumulate considerable amounts of long chain polyenic fatty acids which are virtually absent in rations. First of all it is arachidonic acid. In other words the organizm must of necessity synthesize these acids needed to form the structural components of membranes, polyenic acids being predecessors. In this connection we studied the influence of fats on the structure and functions of membranes so as to work out methods of defining the biological value of fats.

Significant changes in the fatty acid spectra of the lipid fraction of liver's mitochondrias were found during studies of (1) olive and mustard oils (with various content of erucic acid), (2) some lipids of microbe origin enriched with heptadecanoic, heptadecanoic and other acids, (3) hydrogenized fat with various content of fatty acids transisomers, and (4) linetole - preparation of ethyl ethers of fatty acids of flax oil. We also found significant changes in the membranes' fatty acid composition evoked by mustard oil, hydrogenized fat and linetole and expressed in a reduced content of arachidonic acid.

We tried to describe the intensity of the synthesis of fatty acids (with long carbon chain /C_{20} - C_{22}/) by the extent of changes in the fatty acid spectrum of mitochondria and accordingly proposed an efficiency coefficient of the fatty acid metabolic activity (CEM) which is a ratio of the concentration of arachidonic acid (the principal one among highly saturated fatty acids in normal mitochondrial lipids) to the sum of the other polynonsaturated fatty acids with 20 and 22 carbon atoms.

$$CEM = \frac{20:4}{20:2 + 20:3 + 20:5 + 22:5 + 22:6}$$

The CEM ranges within 3-4 units in liver mitochondrias of check animals fed on the mixture of lard and sunflower oil. The deviation of the fatty acids formula of food from the optimal one leads to a significant decrease of this value. Characteristically, the revealed differences well correlated with figures on the experimental animals' growth when fats of varied quality were used in the ration.

These data give grounds to affirm that food lipids can expressly influence the structure and the functional properties of membranes, change their fatty acid spectra and can be useful for working out fodder quality evaluation methods.

As for sunflower oil it is a most valuable source of essential fatty acids from the angle of fatty acid content. The typical fatty acid formula of sunflower oil from seeds of high linoleic commercialized variety "Voskhod" is:

Fatty acids	%
Palmitic	5.8
Palmitoleic	0.1
Stearic	3.7
Oleic	22.6
Linoleic	67.8

Meanwhile Soviet breeders of the Academician V.S. Pustovoit school are credited with having achieved a high variability of this major indicator. The all Union Research Institute of Oil Crops has handed us for testing sunflower oil of high-oleic population. Oil from seeds of this sample seems to be more like olive oil as 70% of it is oleic and only 23% linoleic acid, which to a much larger extent corresponds to the futty acid formula of olive oil. The conducted research has shown that this oil is a highly valuable fat. The low content of linoleic acid makes this oil more stable to oxidation, which opens up new possibilities of its use. It should be noted that this kind of sunflower oil is rich in natural antioxidizers-tocopherols (vitanim E). Sunflower oil may contain up to 70 mg% of tocopherols, 85% of which is the most physiologically active isomer α of tocopherol (in corn oil the α tocopherol is only 12% of total tocopherols and 88% is less active γ and δ isomers.

Thus, a high content of polynon-saturated fatty acids in sunflower oil is paralleled by a sufficient level of vitamin E.

The possibility of changing the fatty acid content of sunflower oil to such a great extent as it was achieved in the VNIIMK suggests the question which fatty acid formula should be considered optimal. In our view attempts to suggest the formula of "ideal" fat is rather disputable. In this respect one may not be certain about the formula adopted by the International Nutrition Conference in Paris (1958) which provided for the following correlations of fatty acids in rations (% of the sum of fatty acids):

Polynonsaturated fatty acids	10
Oleic acids	60
Saturated fatty acids	30

We think that this formula cannot be adopted without some reservations both for all ages and for various areas of the world which differ in nourishment and climate, etc.

Data from literature sources allow us to affirm that the fatty acid formulas must assentially differ depending on the nourishment level, age, climate and historical peculiarities of nourishment of some ethnic groups.

When specific fats are being elaborated on it is necessary to take into consideration first of all their culinary designation and assumed periods of storage. These considerations fully pertain both to animal fats and vegetable oils and margarines.

On order to choose the more perspective ways for the utilization of various kinds of fats in the country and reasonable proportions of their production it is necessary to proceed from the conception of the total fat fund of the country. According to this conception all ways of fat production and consumption must be taken into consideration. From the point of view of nutrition science and on the basis of biological research fat products should be preliminary divided into the following 7 groups: 1. milk fats, 2. basting and visceral fats, 3. cod liver oil and sea animal oils, 4. natural vegetable in particular hydration, re-etherification as also products in which fats are the basic component, as well as oils, 5. vegetable oils subjected to various technological treatments, margarines, 6. fats of unicellular organizms, 7. synthetic fats.

At present, the fat fund of this country and especially of other countries of the world is mainly formed from plant and animal fat products. The main edible oil in this country is sunflower oil which is accounts for 71.1% of all oils produced in 1975.

Margarines will hold a special place in the people's diet.

The conversion of vegetable oils into margarines betters their taste and enhances their durability in storage. Thus margarines must be defined as a fully expedient form of fat products and must be included in the range of quality substitutes of more expensive animal fats. "Margarinization" of vegetable oils will no doubt make them more pleasant in taste and consistence than initial products. At the same time their biological value is lower than that of butter, as was demonstrated by experiments with young animals. A definite role in this decreased biological effect is probably ployed by both cis - and transisomers of fatty acids, formed in the process of catalytic hydrogenation.

According to the research conducted in the Dictology Institute of the USSR Academy of Medical Sciences, fatty acid transisomers in hydrogenated fats are actually capable of producing a pronouncely negative biological effect which is expressed in the animals' inhibited growth and development and in a drastic decrease of the coefficient of effective metabolization of essential fatty acids of food.

This makes it advisable to devise methods of hydrating vegetable oils so as to minimise the amount of fatty acid transisomers. Moreover, to produce margarines it would also be expedient to use oil with smaller quantities of unsaturated links. In other words, we should make a fuller use of processes of fermentative, natural hydration of vegetable oils, the clues of which are no doubt in the hands of specialist geneticists. The creation of several rather than one type of fatty acid spectrum of oil crops with a greater or less percentage of polyunsaturated fatty acids is all the more expedient because these types of vegetable oil will no doubt possess a varied extent of storing ability and meet the varied needs of the food industry and technology.

It appears that vegetable oils can be differentiated by their seasonal use. The oils with a high content of polynonsaturated fatty acids should be used in the few first months after harvest while oils with a low content of nonsaturated fatty acids should be used in later periods, as is the case with fruits. Our breeders have a wide range of opportunities in this respect and must find the most rational ways of using the new, and economically expedient oil crop varieties in food.

Now I would like to mention still another way of employing sunflower oil bearing on the correction of some fat products of animal origin, e.g. butter.

Research into the effect of milk fats on lipid metabolism led scientists to maintain that milk fats have aterogenous properties and accordingly attempts are being made in several countries to enrich butter with essential fatty acids. We proposed that butter made from quality cream be enriched with linoleic acid contained in purified sunflower or corn oil. Study of the biological properties of this new kind of butter has revealed its positive effect on several features of lipid metabolism. At the same time it would be wrong to think that the nutritive value of fat is higher the more essential acids it has. It has been demonstrated that the use in nutrition of highly nonsaturated fats can also inhibit the animals' development. This is especially true of the case when fats have been stored for a long time and subjected to a prolonged impact of high temperatures.

It was proved at the Dietology Institute of the USSR Academy of Medical Sciences that such fats can have a pronounced toxic and even cancerogenic effect. When highly nonsaturated fats are heated they undergo deep oxidation in the course of which hydroperoxides and the subsequent condensation products are formed. Their systematic consumption above all impairs liver cells.

In conclusion we would like again turn on the comprehensive use of sunflower feeds which contain, apart from oil, also significant quantities of protein. The expert estimate by

Table 1

Aminoacid Content of Some Sunflower Protein Sources

Aminoacids	Protein sunflower isolate	Oil-seed sunflower meal	Ideal scales	
	g per 100 g of protein		Eggs protein	Scale of FAO and VOS 1973
1	2	3	4	5
Tryptophan	1.09	0.51	1.7	1.0
Histidine	2.55	2.29	2.2	-
Methionine	1.46	1.03	3.3	3.5
Cystine	0.58	1.04	2.4	
Threonine	2.70	3.84	4.7	4.0
Phenylalanine	4.89	4.51	5.7	6.0
Tyrosine	2.19	2.22	4.1	
Isoleicine	3.79	4.14	5.14	4.0
Valine	4.38	3.70	6.6	4.0

Table 1 (continued)

1	2	3	4	5
Lysine	2.26	3.10	7.0	5.5
Leucine	5.39	5.92	8.6	7.0
Arginine	8.68	5.92	6.0	
Alanine	4.3	5.47	6.5	
Asparagin acid	9.34	9.32	8.2	
Glutaminic acid	17.81	18.42	12.6	
Glycine	3.65	5.18	3.6	
Proline	4.08	4.39	4.5	
Serine	3.21	4.21	7.8	

the in group of Protein Councillors of prospects to increase the world fund of edible protein led one to conclude oil seeds are a promising source of protein. Soybean proteins are currently being used widely to prepare a wide range of meat substitutes on the basis of spinning process.

The Dietology Institute of the USSR Academy of Medical Sciences conducts systematic studies of the biological effectivity of protein isolates obtained from oil crops (sunflower, cotton and soybean meal) according to the technological patterns worked out in the All-Union Research Institute of Fats and its branch, as well as in the Institute of the Chemistry of Nutritive Substances, Uzbek SSR. Sunflower protein isolates and the corresponding meals, as can be seen from the table, contain considerably less lysine and sulphur-containing aminoacids than egg protein taken for the check, and this limits their biological value. An experiment with animals which had special rations with sunflower protein isolate and sunflower meal has shown that judging by weight gains the biological effectivity sunflower protein isolates is lower than that of the initial meal and the two protein sources are considerably less biologically effective than caseine used as inner cheek. Enrichment of sunflower protein isolates with specified quantities of Cysine substantially enhanced the biological value of the ration.

The coefficient of effectivity of sunflower protein isolate was 1.0 in terms of the ratio of weight gains in grams per 1 g of the protein consumed. For sunflower meal the coefficient was 1.55 and for caseine 2.5.

The data of the chemical analysis (amino acid composition) and the biological analysis (experiment with animals) have shown the biological effectivity of sunflower protein isolate is not higher than that of cereals protein.

Though the protein isolates obtained are not very good in quality further research into the comprehensive use of both oil and protein components of sunflower seeds as food is no doubt of some importance.

Thus in evaluating sunflower seeds from the angle of balanced nutrition one should stress (1) their prime importance in meeting the people's requirements in fats, essential fatty acids and vitamin E; (2) an important contribution made by this product in satisfying the organism's requirements in energy; and (3) its certain importance in raising the country's protein resources.