

## ИЗУЧЕНИЕ ЧАСТОТЫ ПОТРЕБЛЕНИЯ ОСНОВНЫХ ПИЩЕВЫХ ИСТОЧНИКОВ ЛИКОПИНА И КОЛИЧЕСТВЕННАЯ ОЦЕНКА ЕГО ПОСТУПЛЕНИЯ С РАЦИОНОМ У СТУДЕНТОВ

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**Цель.** Сравнительная характеристика уровня алиментарного поступления ликопина и оценка частоты включения основных источников ликопина в рацион студентов разного возраста и пола. **Материалы и методы.** Для изучения частоты включения в рацион пищевых источников ликопина и его количественной оценки применялись специально разработанные анкеты-опросники, в которые были внесены названия продуктов со значимым содержанием ликопина. **Результаты.** Сравнительный анализ уровней поступления ликопина не позволил выявить статистически значимых различий между процентными долями мужчин и женщин ( $\varphi_{эмп} < \varphi_{кр}$ ,  $p < 0,05$ ) в группах с высокими уровнями потребления. В обеих гендерных группах ведущими источниками ликопина являлись свежие томаты, кетчуп и томатосодержащие блюда (лазанья, паста), и продукция фастфуда (пицца, сэндвичи). Оценка результатов частотного метода свидетельствует, что чаще других источников в еженедельном рационе студентов, независимо от пола, присутствовали свежие томаты, кетчуп и сэндвичи. В ходе анализа уровней поступления ликопина у студентов 1-го и 5-го курсов не выявлены статистически значимые различия во всех группах потребления ( $\varphi_{эмп} < \varphi_{кр}$ ,  $p < 0,05$ ), кроме группы с поступлением ликопина в количестве 50,0-74,9% от рекомендуемого, в которой преобладают студенты 5 курса. Источники ликопина у студентов разных возрастных категорий также не отличались – основной вклад в обеспечение рекомендуемого уровня вносили свежие томаты, кетчуп и томатосодержащие продукты фастфуда. **Заключение.** У 39,8% студентов благодаря присутствию в рационе свежих томатов, кетчупа и томатосодержащих продуктов фастфуда был достигнут рекомендуемый суточный уровень поступления ликопина. При этом, в рационе 29,6% респондентов отсутствовали регистрируемые источники ликопина, а 16,7% опрошенных включали их в рацион в недостаточном количестве, тем самым обеспечивая его поступление в объеме менее половины от рекомендуемого уровня. Чаще других в еженедельный рацион включались свежие томаты, кетчуп и томатосодержащие сэндвичи. Арбуз, розовые и красные грейпфруты, хурма в рационах большинства участников исследования отсутствовали.

**Ключевые слова:** невитаминные каротиноиды, ликопин, томаты, питание студентов, антиоксидантное действие.



## STUDY OF CONSUMPTION FREQUENCY OF THE MAIN SOURCES OF LYCOPENE AND ITS QUANTIFICATION IN STUDENTS' DIET

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**Aim.** Comparative characteristics of the level of the dietary intake of lycopene and analysis of the frequency of inclusion of the main sources of lycopene in the diet of students of different age and sex. **Materials and Methods.** To study the frequency of inclusion of food sources of lycopene in the diet and its quantitative assessment, specially designed questionnaires were used that included products with a significant content of lycopene. **Results.** Comparative analysis of the levels of lycopene did not reveal any reliable differences between the percentages of men and women ( $\varphi_{emp} < \varphi_{cr}$ ,  $p < 0.05$ ) in the groups with high level of intake. In all gender groups, the leading sources of lycopene were fresh tomatoes, ketchup and tomato-containing fast food products (pizza, lasagna, paste and sandwiches). Evaluation of the results of the frequency method shows that more common sources of lycopene in the weekly diet of students, regardless of gender, are fresh tomatoes, ketchup and sandwiches. Analysis of the levels of intake of lycopene by the 1<sup>st</sup> and 5<sup>th</sup> year students did not reveal any reliable differences in all groups of consumption ( $\varphi_{emp} < \varphi_{cr}$ ,  $p < 0.05$ ), except for the group with the intake of lycopene in the amount of 50.0-74.9% of the recommended, where the 5<sup>th</sup> year students predominated. Sources of lycopene in students of different age groups did not differ – the main contribution to the recommended level was made by fresh tomatoes, ketchup and tomato-containing fast food products. **Conclusion.** In 39.8% of students, due to the presence in the diet of fresh tomatoes, ketchup and tomato-containing fast food products, the recommended daily intake of lycopene was achieved. At the same time, 29.6% of respondents had no registered sources of lycopene in their diet; and 16.7% of the respondents included them in the diet in an insufficient amount, thereby ensuring the intake of lycopene in the amount of less than half of the recommended level. The weekly diet most commonly included fresh tomatoes, ketchup and tomato sandwiches. Watermelon, pink and red grapefruit, persimmon were absent in the diets of the most of participants.

**Keywords:** *non-vitamin carotenoids, lycopene, tomatoes, students' nutrition, antioxidant effect.*

Lycopene is a pigment of natural origin, belonging to the class of carotenoids. Lycopene is a non-cyclic isomer of  $\beta$ -carotene [1]. At the same time, lycopene is not a precursor to vitamin A, and refers to non-vitamin carotenoids. The presence of additional conjugated double bonds in the molecule enhances its pronounced antioxidant effect compared to other carotenoids. This effect consists in inactivation of singlet oxygen and OH-radical and in breakage of free radical oxidation chains,

in influence on the microviscosity and other properties of biomembranes [2].

In plants, lycopene mainly exists in the form of TRANS-isomers, which when heated undergo isomerization to form CIS-isomers. CIS-isomers of lycopene have high bioavailability, due to their ability to be emulsified by bile acids. When consumed in combination with fats, the absorption of lycopene in the intestine increases. In the organism, this pigment is concentrated in the adrenal glands,

prostate, skin, liver, and kidneys [3].

Lycopene is not synthesized in a human body and enters it only with food. It is found

in significant amounts in red tomatoes and tomato-containing products, watermelon, pink and red grapefruits, papaya (Tab. 1) [4].

Table 1

*Content of Lycopene in Food Sources [4]*

№ п/п	Food source	Lycopene content (mg/100 g of product)
1.	Sun-dried tomatoes	45.90
2.	Tomatopaste	28.76
3.	Tomatosauce	13.90
4.	Ketchup	12.06
5.	Tomato juice	9.04
6.	Guavas	5.20
7.	Watermelon	4.53
8.	Lasagna	3.19
9.	Red canned tomatoes	2.64
10.	Red fresh tomatoes	2.57
11.	Pizza	1.90
12.	Papayas	1.83
13.	Grapefruit	1.14
14.	Sandwiches	0.99
15.	Persimmons	0.16

In France and UK the main sources of lycopene are fresh and canned tomatoes and pizza, in Ireland – canned tomatoes, tomato soups and pizza, in the Netherlands – tomato soups, fresh tomatoes and pizza, in Italy – fresh and cooked tomatoes and pizza, in the USA – pasta, fresh tomatoes, tomato juice, salsa and chili sauces [5].

Mechanical and thermal treatment of tomatoes significantly increases the bioavailability of lycopene. This is confirmed by the fact that the concentration of lycopene in plasma after consumption of tomato paste is much higher compared to that after entry of a similar amount of lycopene with fresh tomatoes [6,7].

Studies confirm the link between tomato consumption and reduction in the risk of chronic diseases: the inverse relationship exists between the concentration of lycopene in tissues and plasma and the risk of cancer (prostate cancer, oral cancer and pharynx cancer) and of cardiovascular disease [8-10].

The recommended daily intake of lycopene in Russia is 5 mg [11].

*Aim of study* is comparative characteristics of the level of the dietary intake of lycopene and assessment of the frequency of inclusion of the main sources of lycopene in the diet of students of different age and gender.

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#### Materials and Methods

To estimate the amount of lycopene contained in the diet, specially designed questionnaires were used. The first questionnaire included products with a high content of lycopene, which are widely used in the food market of Moscow: tomato juice, fresh red tomatoes, canned red tomatoes, ketchup and tomato sauces, tomato paste in the first dishes, tomato-containing fast food products (pizza, lasagna, pasta, sandwiches), canned fish in tomato sauce, tomato-containing canned vegetables, pink and red grapefruit, grapefruit juice, watermelon, persimmon. The questionnaire suggested indication of the amount of consumption of sources of lycopene on the day prior to the survey, within the frames of the 24-hour recall method.

The second questionnaire was designed to assess the frequency of inclusion of lycopene sources in the diet. It indicated information on the periodicity of consumption of various sources of lycopene (weekly – 6-7 times

a week, 3-5 times a week, 1-2 times a week; monthly – 1-5 times a month; rarely – once in 2-3 months, lack in the diet) and on the quantity of one-time intake of each source [12].

In total, 294 students at the age of 17-28 ( $21.1 \pm 2.0$ ) years of Sechenov University took part in the survey. For comparative analysis by gender criterion, 122 students aged 20-28 ( $21.9 \pm 1.1$ ) years, 88 women aged 20-28 ( $21.9 \pm 1.1$ ) years and 34 men aged 20-25 ( $21.9 \pm 1.0$ ) years were selected. The survey was conducted in September-October 2017 (autumn period).

For assessment by age criterion, 172 students were divided in two groups of comparison. The first group of comparison – 87 1<sup>st</sup> year students aged 17-27 ( $18.6 \pm 1.3$ ) years; the second group – 85 5<sup>th</sup> year students aged 21-27 ( $22.4 \pm 1.2$ ) years. The survey was conducted in March-April 2016 (spring period).

Statistical processing was performed using Microsoft Excel 2007. The significance of differences between percentages of age and gender samples was determined by Fisher's angular transformation criterion.

## Results and Discussion

Analysis of the data obtained in the autumn period using the 24-hour recall method showed that the recommended daily level (5 mg/day or more) of lycopene intake was recorded in 53 students (43.4%). Intake of lycopene in the amount of 75.0-99.9% of the recommended was noted in 7 students (5.7%); in the amount of 50.0-74.9% of the recommended – in 11 students (9.0%). Intake of lycopene at the level of 25.0-49.9% of the recommended was recorded in 14 participants of the study (11.5%). An extremely low level of lycopene consumption (less than 24.9% of the recommended) was observed in 5 students (4.1%). 32 Respondents (26.3%) had no registered sources of lycopene in their diet.

Comparative analysis of the levels of lycopene did not reveal any reliable differences between the percentages of men and women ( $\varphi_{emp} < \varphi_{cr}$ ,  $p < 0.05$ ) in all groups with high levels of intake, except for the group receiving lycopene in the amount less than 24.9% of the recommended (Fig. 1).

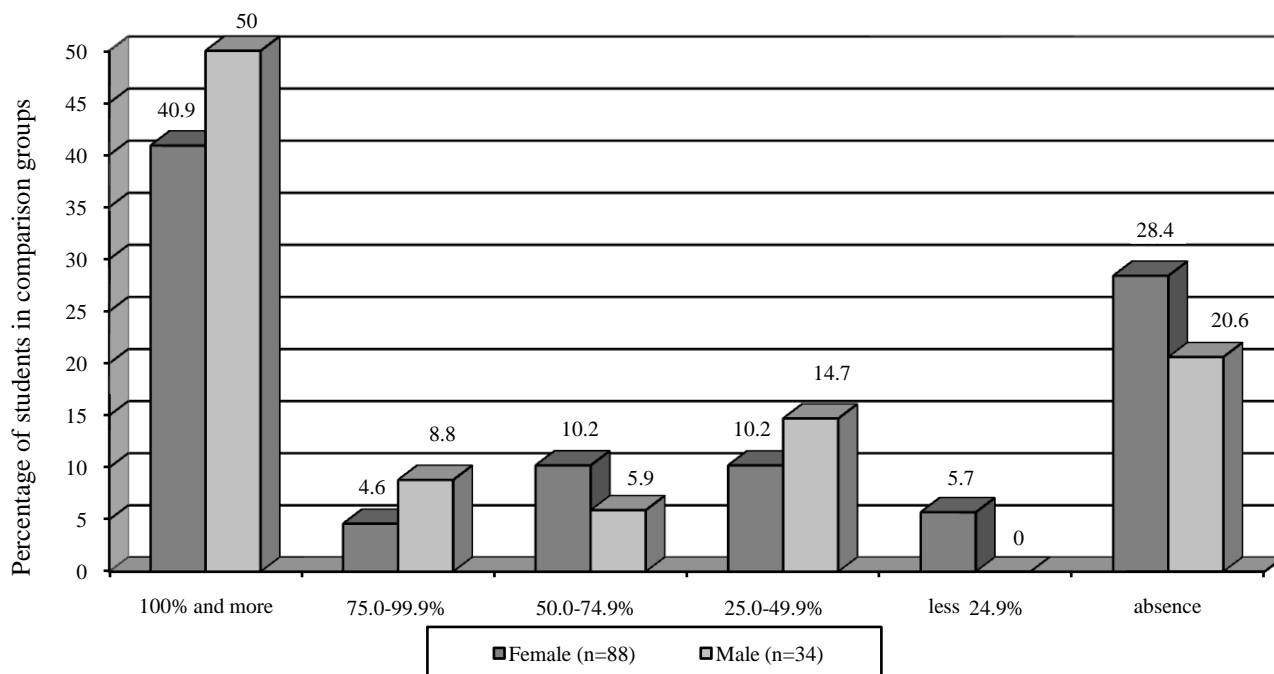


Fig. 1. Distribution of the level of lycopene intake in the analyzed group of students  
 Note: \* – statistically significant differences with males in the given age group ( $p < 0.05$ )

Analysis of the sources of lycopene in the diet of students showed that, regardless of gender, the leading sources of lycopene in the group with a high level of consumption were red fresh tomatoes, ketchup and tomato-

containing products (pizza, lasagna, pasta and tomato-containing sandwiches). Such sources rich in lycopene as pink and red grapefruits, watermelons, persimmons, were much less common (Tab. 2).

Table 2

*Sources of Lycopene in Women and Men with Different Levels of Consumption*

Consumption levels (% of recommended level)	Sources that make the greatest contribution to the intake of lycopene	
	Female	Male
100 % and more	Fresh red tomatoes, ketchup, watermelon, lasagna, pizza, fresh pink and red grapefruits, tomato juice	Fresh red tomatoes, pizza, pasta, ketchup, watermelon, tomato juice
75.0-99.9%	Fresh red tomatoes, sandwiches	Fresh red tomatoes, pizza
50.0-74.9%	Fresh red tomatoes, pizza, sandwiches	Fresh red tomatoes, ketchup
25.0-49.9%	Fresh red tomatoes, sandwiches, ketchup, tomato paste in the first dishes	Fresh red tomatoes, ketchup, sandwiches, tomato paste in the first dishes
less than 24.9%	Canned fish in tomato sauce, ketchup, tomato juice	No registered sources

A comparative assessment of the results of survey of 122 students using the frequency method showed that 74.9% of women and 73.6% of men included fresh tomatoes in the weekly diet: 6-7 times a week – 6.8% of women and 14.7% of men, 3-5 times a week – 50% of women and 41.2% of men and 1-2 times a week – 18.1% of women and 17.7% of men ( $p < 0.05$ ). Ketchup was present in the weekly diet of 39.8% of women and 64.7% of men ( $p > 0.05$ ), tomato paste in the first dishes – of 12.6% of women and 20.6% of men ( $p < 0.05$ ), sandwiches with tomatoes and tomato sauces – of 21.6% of women and 38.3% of men ( $p > 0.05$ ). Pizza was included in the diet from 1 to 5 times a month (38.9% of women and 44% of men) ( $p < 0.05$ ).

Of note, 51.1% of women and 32.3% of men ( $p > 0.05$ ) very rarely included pink and red grapefruits in the diet (once in 2-3 months). Besides, a significant number of respondents did not include in their diet such sources of lycopene as tomato juice (52.3% of women and 64.7% of men), grapefruit juice (51.1% and 50%, respectively), canned red tomatoes (46.6% and 55.9%, respectively), canned fish in tomato sauce (57.9% and 64.7%, respectively) ( $p < 0.05$ ).

In analysis of the results, obtained in the spring period in the survey of 172 students using the 24-hour recall method, it was found that 64 individuals (37.2%) reached the recommended level of lycopene intake. Here, consumption of lycopene in the amount of 75.0-99.9% of the recommended level was observed in 9 students (5.2%), 50.0-74.9% of the recommended level – in 14 students (8.1%). 23 Individuals (13.4%) received from food 25.0-49.9% of the recommended amount of lycopene, and 7 students (4.1%) – less than 24.9% of the recommended amount of lycopene.

There were no registered sources of lycopene in the diet of 55 respondents (32.0%). The main sources of lycopene in all groups were red fresh tomatoes, ketchup and tomato-containing fast food products (pizza, pasta, sandwiches). Intake of canned fish in tomato sauce, persimmon, tomato paste in the soup did not make a significant contribution to the recommended daily level of lycopene, due to the inclusion of these sources in the diet occasionally and in insufficient quantities (Tab. 3).

Comparative analysis of the levels of lycopene intake in students of the 1<sup>st</sup> and 2<sup>nd</sup>

groups of comparison did not reveal any statistically significant differences in all groups of consumption ( $\varphi_{emp} < \varphi_{cr}$ ,  $p < 0.05$ ), except for the group with the intake of lycopene in the

amount of 50.0-74.9% of the recommended level. In this group 5<sup>th</sup> year students predominated ( $\varphi_{emp} > \varphi_{cr}$ ,  $p < 0.05$ ) (Fig. 2).

Table 3

**Main Sources of Lycopene in Students' Diet Determined by Results of 24-Hour Recall Method**

Consumption levels (% of recommended level)	Sources that make the main contribution to the intake of lycopene
100% and more	Fresh red tomatoes, ketchup, pasta, lasagna, pizza, canned red tomatoes, fresh pink and red grapefruits, grapefruit juice, tomato juice
75.0 – 99.9%	Fresh red tomatoes, pasta, lasagna, sandwiches
50.0 – 74.9%	Fresh red tomatoes, tomato juice, fresh pink and red grapefruits
25.0 – 49.9%	Fresh red tomatoes, ketchup, pizza, sandwiches, tomato paste in the first dishes
less than 24.9%	Persimmons, ketchup, canned fish in tomato sauce, grapefruit juice

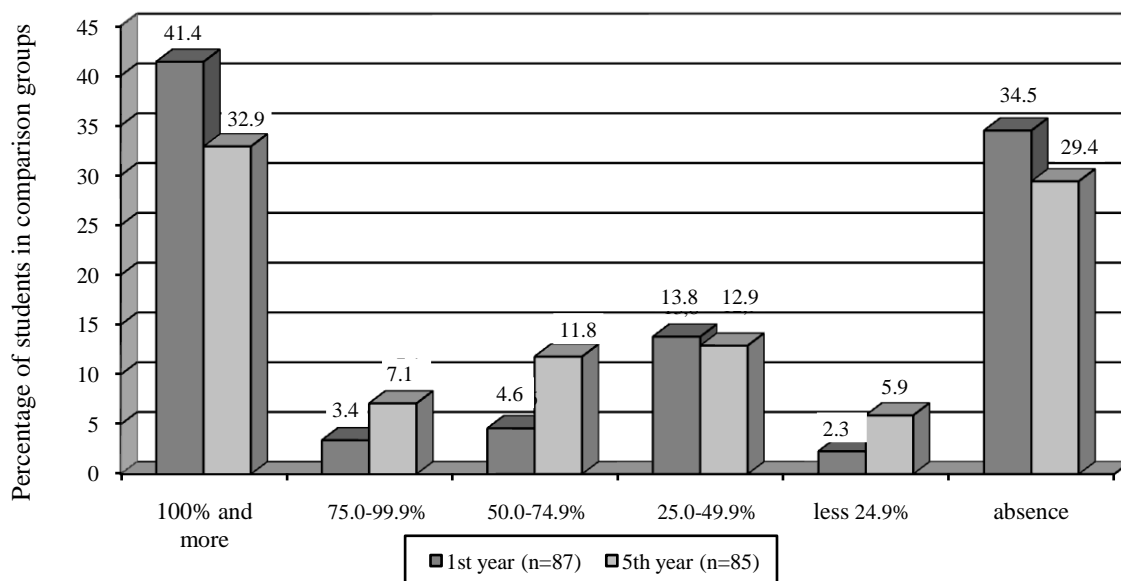


Fig. 2. Proportion of individuals with different levels of lycopene intake (1<sup>st</sup> and 5<sup>th</sup> year students)  
 Note: \* – statistically significant differences with the 5<sup>th</sup> year students ( $p < 0.05$ )

Analysis of the sources of lycopene did not reveal any significant differences between students of the 1<sup>st</sup> and 5<sup>th</sup> year in the spring period. Fresh red tomatoes, ketchup and tomato-containing fast food products were the main contributors to the recommended levels in groups with high levels of lycopene. Canned fish in tomato sauce, grapefruit juice (the second group of comparison) and per-

simmon (the first group of comparison) were the main sources of lycopene in the groups with low level of lycopene intake. In addition, a source of lycopene, such as watermelon, in the spring period of observation was absent in all groups of consumption, due to the seasonality of the product.

According to the data obtained by the frequency method, no significant age differ-

ences were revealed in the frequency of inclusion of food sources of lycopene in the diet ( $p < 0.05$ ). More than half of the respondents, regardless of the age, most often included fresh red tomatoes (75.8% – comparison group 1, 75.3% – comparison group 2) and ketchup (42.5% – group 1 and 41.2% – group 2) in the weekly diet. With this, fresh tomatoes were present 6-7 times a week in the diet of 13.8% of students of the 1<sup>st</sup> comparison group and in the diet of 10.6% of students of the 2<sup>nd</sup> comparison group, 3-5 times a week – in 35.6% and 42.4% of students, 1-2 times a week – in 26.4% and 22.3%, respectively. Ketchup was consumed 6-7 times a week by 4.6% of respondents of the 1<sup>st</sup> comparison group and by 3.5% of students of the 2<sup>nd</sup> comparison group, 3-5 times a week – by 27.6% and 21.2% of respondents, 1-2 times a week – by 10.3% and 16.5% of participants, respectively. The diet of 21.2% of students of the 2<sup>nd</sup> group of comparison was characterized by weekly presence of tomato paste in the first dishes (in the 1<sup>st</sup> group of comparison – of 13.8% of students). Pasta was present in the weekly diet of 12.6% of students of the 1<sup>st</sup> group of comparison and in 5.9% of students of the 2<sup>nd</sup> group of comparison. Pizza was included 1-5 times a month in the diet of 43.7% of respondents of the 1<sup>st</sup> group of comparison and of 44.7% of students of the 2<sup>nd</sup> group. Additional sources of lycopene – fresh pink and red grapefruits ((42.5% (group 1) and 35.3% (group 2)) and watermelon ((75.9% (group 1), and 72.9% (group 2)) were very rarely included in the diet (once in 2-3 months). The majority of respondents reported the absence of tomato juice in the weekly and monthly diet (80.5% – group 1, 80.0% – group 2), canned red tomatoes (86.3% and 74.1%), grapefruit juice (73.6% and 82.4%), canned fish in tomato sauce (90.9% and 82.3%), tomato-containing canned vegetables (82.7% and 70.6%), and persimmons (79.4% and 87.0%, respectively).

Thus, the obtained data agree with the results of other observations [5,7,9] and, in

particular, confirm the priority of inclusion in the diet of tomatoes and tomato-containing products as the main sources of lycopene.

### Conclusion

Intake of lycopene at the level corresponding to the recommended (5 mg/day or more) was recorded in 39.8% of students, mainly due to the inclusion in the diet of red fresh tomatoes, ketchup and tomato-containing fast food products. Here, 29.6% of respondents did not register sources of lycopene in their diet; and 16.7% of respondents included them in the diet in insufficient amounts, thereby making the intake of lycopene less than half of the recommended amount.

There were no significant gender and age differences in most levels of lycopene intake from food sources. The exceptions were the group with the level of intake  $< 24.9\%$ , since among the interviewed men there were no individuals with such level of intake, while in women this figure was 5.7%, and the group with the low level of intake 50.0-74.9%, in which the share of the 5<sup>th</sup> year students reliably exceeded that of the 1<sup>st</sup> year students. There were no statistically significant gender and age differences in the main sources and the frequency of their inclusion in the diet.

The more common sources in the weekly diet of students were fresh tomatoes, ketchup and tomato-containing sandwiches. Other lycopene-rich sources – watermelon, pink and red grapefruits, persimmons – were absent in the diet of most participants.

To increase the dietary intake of lycopene it would be reasonable, on the one hand, to expand the weekly range of its food sources, first of all, by inclusion of available, but rarely used pink grapefruit (including grapefruit juice), persimmon, watermelon. On the other hand, it is necessary to include fresh tomatoes and tomato-containing dishes into the daily diet. Here, preference should be given to tomato-containing multicomponent salads and garnishes, and not to high-calorie fast food and products with high content of salt.

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