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Evaluation of chemical composition, energy and biological value of typical Bulgarian traditional foods

D.S. Hristov[1], S.K. Velikov [2], V.E. Vodenicharov[1], S.P. Tsanova-Savov[2], F.T. Ribarova[2]*

[1] *Medical University – Sofia, Faculty of Hygiene, 15, Iv. Ev. Geshov Blvd., Sofia 1531*
[2] *Medical College "J. Filaretova", Medical University – Sofia, 3, J. Filaretova Str., Sofia 1606.*

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A great number of recent scientific studies provide data characterizing the chemical composition of traditional foods from different geographical regions and describe their essentiality for healthy nutrition. The information concerning Bulgarian traditional foods is scarce. The aim of the current study is to assess the energy and biological value of Bulgarian traditional foods by implementing modern scientific approaches to food chemical composition data. The study covers a total of 15 products typical of the traditional Bulgarian diet. The original data are obtained by application of routine methods for the determination of total protein and fat, and classical chromatographic analysis of amino acids (AA) composition. New advanced approaches to assess the proteins biological value and energy content of the studied traditional Bulgarian foods were applied. New information is presented about the composition of amino acids and their proteins biological value in the examined Bulgarian traditional foods. Their energy content was determined in compliance with current scientific requirements. The content of saturated fats is also listed and their necessity and essentiality for health is clarified. The new data for the chemical composition of traditional foods in Bulgarian diet will play an important role in the assessment of nutritional intake, supporting human health and contributing to the revitalization of Bulgarian food chemistry, nutrition and technology.

Keywords: food chemistry, Bulgarian traditional foods, energy , saturated fats, biological value

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INTRODUCTION

Numerous scientific studies in the recent years have been focused on studying the chemical composition of traditional foods using up to date analytical equipment and presenting correct data about their role and importance for healthy nutrition [1-5]. The global diet diversity and geographic specificity in the prevalence of different diseases are some of the reasons to search for an explanation of the mechanisms by which food affects health and longevity.

The role of traditional foods in the healthy diet of Bulgarian population identifies a number of controversial issues. For example, traditional foods for Bulgarians in the past as pork, bacon, butter and whole fat dairy products had constituted a high percentage rate of their diet, and despite the high consumption of saturated fats, Bulgaria was known with a high number of centenarians. Today, after more than a century, during which mainly fat-free animal food products have been consumed, with almost total oblivion of fat, grease and oil, the average life expectancy is extended, unfortunately along with many diseases. It is clear that the recommendations for healthy nutrition have had an impact on food production, consumption and consumer preferences but regardless of this fact, not only the lack of reduction of cardiovascular diseases, but also the significant incidence rate of overweight and obesity among our population could hardly be explained.

The view that animal fats mainly consist of saturated fatty acids has already been revised since in their composition except for saturated fatty acids, numerous monounsaturated and some polyunsaturated ones have also been identified, determining the specificity of the products [6].

In response to the scientific advice for healthy nutrition, the food technology was driven to production of new products in which animal fats were replaced with saturated vegetable fats or were defatted. Creating new assortments required additional finances, shifting the old traditional food, but the problems still continued to exist.

Startled by the invasion of various foreign cuisines, and taking into consideration the free movement of food in the global market, the researchers began looking for risk factors suspected in this invasion and came to the conclusion to rediscover the power of traditional foods [7]. The present study addresses those aspects through chemical composition data of Bulgarian traditional foods.

* To whom all correspondence should be sent:
E-mail: fanny.r@mail.bg

The aim of the study was to assess the energy and biological value of Bulgarian traditional foods, implementing modern scientific approaches to food chemical composition data.

MATERIALS AND METHODS

The study covers a total of 15 products typical of the traditional Bulgarian diet: milk and dairy products (4 different products), pork, legumes (beans and lentils), fruits and vegetables (a total of 8 different species). The original data were obtained as results of a random selection of analytical samples from the food market, with subsequent use of classical routine methods for the determination of total protein and fat (Kjeldahl and Folch). Carbohydrates were calculated through the difference. The data for macronutrients were based on our own studies and on published data in the Tables on the composition of Bulgarian food and European food composition database [8-10]. The amino acid (AA) composition of proteins was determined after acid and alkaline hydrolysis, applying the classical ion-exchange chromatography method with post-column ninhydrin derivatization, and UV-detection at 570 nm for amino and 440 nm for imino acids, using amino acid analyser – Hitachi, KLA-5 and HPLC-Perkin Elmer, series-2 [11].

New, advanced approaches to assess the proteins biological value and energy content, based on the chemical composition of the studied traditional Bulgarian food were also applied [12,13].

RESULTS AND DISCUSSION

The results of the study of traditional Bulgarian foods will be presented in the following order: determination of the biological value of the protein components; evaluation of the energy content; biological interpretation of the content of saturated fats.

Quality of food proteins

Currently, the main criteria for assessing the quality of dietary proteins according to current scientific concepts are the amino acid composition and the extent of bioavailability in the body. Therefore, we would like to provide data on the biological value of proteins in some traditional Bulgarian foods, calculated by recommended new scientific approaches, based on their amino acids composition.

Over the past 50 years many analytical methods and computational approaches used to assess the quality of the protein have been modified. The amino acid score calculated from its limiting amino acid in comparison with the reference amino acid pattern, adopted in the past century, appears to be not fully correct. The efficiencies of proteins utilization including their digestibility and metabolic availability of amino acids are also important [12,14]. Therefore, expert advice by FAO and WHO after numerous studies reached the opinion to modify the amino acid score that could take into consideration the level of availability. Therefore, the Expert Advice Committee of FAO/WHO, after extensive research, agreed on modifying the amino acid score, also including the level of digestibility [15]. The application of this new protein digestibility-corrected amino acid score to evaluate the quality of dietary protein requires knowledge of the formula for old *Amino Acid Score* and the formula for the new *Corrected Amino Acid Score*, as follows:

1. *Amino Acid Score* = mg essential amino acids in g of studied protein / mg of essential amino acids in g of reference protein × 100;

2. *Corrected Amino Acid Score* = first limiting amino acid content in the test product / the same amino acid content in egg white × 100;

It has been found that egg white had a high bioavailability.

Table 1 presents the results for the new, *Corrected AA scores* of the studied traditional Bulgarian food, having higher protein content.

Fruits and vegetables were excluded, since they were considered as sources mainly of carbohydrates, vitamins, trace elements and biologically active compounds and not as sources of proteins. The data presented above show the probable digestibility of amino acids included in the overall evaluation of biological value. The amino acids data, calculated with respect to protein content were preferred, as the variation of the results produced by that method was lower. The results in Table 1 provide new, much more correct data regarding the qualitative assessment of dietary proteins. The higher biological value of dairy foods, followed by the results for meat is clearly shown. A positive characteristic of beans is the rich content of the nonessential amino acid arginine which in its metabolic course is a source of nitric oxide - a potent vasodilator and neurotransmitter factor. In this aspect, a number of studies support the importance of arginine as a powerful factor in preventive cardiology and immunology.

Table 1. Corrected amino acids score for quality of proteins in traditional foods

Product	First limiting amino-acid					New Corrected Score %
	Name	Protein %	g/100g product	g/100g protein	g/100g egg protein	
Pork	Methionine and Cystine	12.49%	0.39	3.13	6.41	48.83
Cow's milk - fresh	Methionine and Cystine	3.21%	0.10	3.15	6.41	49.14
Cow's milk - yoghurt	Methionine and Cystine	3.24%	0.10	3.09	6.41	48.21
Cow's cheese	Methionine and Cystine	16.41%	0.49	4.03	6.41	62.87
Balkan yellow cheese	Methionine and Cystine	24.02%	0.72	3.97	6.41	61.93
Bread wheat	Lysine	7.11%	0.17	2.33	7.18	32.45
Beans	Methionine and Cystine	19.14%	0.35	1.79	6.41	27.93
Lentil	Methionine and Cystine	23.33%	0.36	1.53	6.41	23.87

The traditional combination made by Bulgarians consisting of bean meals and bread provides the necessary amount of all essential amino acids. It is recommended that future research focused on assessment of proteins biological value in food and in nutritional intake would implement the new approach - "*Corrected amino acid score"*, providing more precise evaluation of food quality.

The determination of the energy content of the diet depends on the quantitative presence of individual nutrients. In the evolution of knowledge on the energy value of food, three different systems with different conversion factors for estimation of the amount of nutrients converted into energy were implemented. The first and oldest system is that of Atwater and Woods, 1896, known as the *"Main factor system"*, including the energy from proteins, lipids and carbs [11].

The energy content of Bulgarian foods in the Tables for chemical composition of food products, as well as in a number of scientific studies was determined according to this oldest factor system that is nowadays no longer in use in respected analytical laboratories [8]. The carbohydrates in this system were determined by weight, expressed as the difference between the total weight and the sum of the weights of the other ingredients in the food (proteins, fats) without them being individually analysed. Thus, the content of total carbohydrates includes fibers which are, however, not fully utilized and thus the calculated energy is higher in comparison to its real values, resulting in incorrect data, not only for energy, but also for nutrients density as well.

The second system is "*Expanded Factor System of Atwater"*, wherein the factors are increased (for monosaccharides, organic acids, polyols and fibers).

The most accurate third system for calculating energy, applied today in scientific studies, is the "*Specific Factor System of Atwater"* with a wider range of factors related to the different and specific building blocks of protein, fat and carbohydrates [13].

Based on those scientific facts and our efforts to provide correct results, we made a comparative evaluation of the energy content of traditional foods studied in the first and second system, presented in Table 2.

There are differences in the figures presented in the last two columns. Logically, in products from 1 to 6 there was no difference in energy content, because they do not contain fibers. In products with higher carbohydrate content and fibers, respectively, higher energy differences were established. The application of this approach to calculate food energy level results in more correct data, particularly important in the construction of various dietary regimes and achieving low energy levels for each product is a desirable feature for both consumers and manufacturers.

The interpretation of the content of saturated fats has undergone significant development in the international scientific publications from a total ban in the past, to recommendations for their inclusion in healthy diets nowadays [6]. The selected traditional Bulgarian food will be assessed in this aspect by the present study.

One popular but already outdated myth that saturated fats are a major risk factor for development of cardiovascular disease begins to retreat positions, albeit new scientific evidence suggests their biological importance in human nutrition and health [6].

The view that animal fats were constituted mainly of saturated fats has already been revised, since in their composition except for saturated fatty acids, monounsaturated and polyunsaturated ones are also present, which determines the specificity of the product. The task of this study was focused on this aspect, in order to provide data for saturated fats content in traditional Bulgarian food and evaluation of their biological importance, based on current scientific understandings and achievements.

Table 2. Energy content of traditional Bulgarian foods, calculated by two different factor systems

Product	Water	Proteins	Fat	Carbo-hydrates Total	Dietary Fibers	Ash	E1 kJ	E2 kJ
Cow's milk 3%	88	3.2	3	5.2	0	0.7	254	n/a
Cow's cheese	55	16.8	19.7	6	0	4.5	1123	n/a
Sheep's milk	81	5.5	7.7	5.5	0	1	474	n/a
Sheep's cheese	51	15.9	26.5	4.6	0	4	1341	n/a
Balkan yellow cheese	41	24.6	30.7	1.84	0	4.3	1599	n/a
Pork	71	20.4	8	0	0	0.99	642	n/a
Bread wheat	38.8	7.6	1	52	4.0	1.35	1035	1002
Onion old	86	1.72	0.3	9.6	1.9	0.61	201	185
Garlic old	64	6.5	0.1	29.2	2.1	1.33	601	584
Red tomatoes	94.8	1	0.2	3.74	1.4	0.5	87	75
Paprika	92.4	1.22	0.51	5.4	1.7	0.61	130	116
Beans	12	24.9	1.6	59.2	18.4	4.3	1468	1314
Lentil	9.7	26.2	2.6	59.3	11.2	2.4	1529	1435
Apples	84	0.3	0.3	14.9	2.2	0.3	266	242
Pears	84.4	0.3	0.4	14.7	3.2	0.3	266	239

Popular, though without in-depth understanding is the widespread opinion that saturated fats content in contemporary diet in different regions or countries is richer than in traditional diets. The explanation is related to the following two false statements: (i) animal fats are mostly saturated and plant fats - mostly unsaturated; (ii) the modern diet is rich in saturated fats (view of historical value), assuming an inert wrong opinion about the nature of animal fats. Fats and oils with least saturated fats level are of plant origin, but those containing the most saturated fats are also of plant origin, while animal fats have a moderate amount, which is seen very clearly on Figure 1. Table 3 presents data on the content of saturated fatty acids in selected traditional foods.

The high total fat content in pork was clearly outlined, followed by yellow and white sheep's cheese. The saturated fat content, expressed in g/100 g product was highest again in pork meat, as logically the pattern for total fat content was repeated. To a certain extent differences were found in the ratio of saturated fat/total fat content, as the leading place belonged to yellow cheese, followed by cow's and sheep's cheese. These data emphasize that the ratios between saturated and mono- and polyunsaturated fats are specific characteristics of the different food products. The highest total fat content in pork meat can be explained with the hidden fat and the meat structure, when the measurement is based on 100 g fresh weight. The determination of saturated-to- total fat ratio gives more stable results, which in our study gave advantage to pork bacon. Moreover, this pork product contains high quantity of arachidonic polyunsaturated fatty acid (about 2%), with already confirmed physiological role as a precursor of eicosanoids, classified by many authors as essential fatty acids.

Table 3. Total fats and saturated fatty acids content in traditional Bulgarian foods

Product	Total Fats (GF) g/100g	Saturated Fatty Acids (SFA) g/100g	SFA/GF %
Cow's milk 3 %	3	1.94	65
Cow's cheese	19.7	11.2	59
Sheep's milk	7.7	4.62	60
Sheep's cheese	26.5	11.1	42
Balkan yellow cheese	30,.7	22.8	74.3
Pork	52	26.7	51.3
Bread wheat	1	0.25	25
Onion old	0.3	0.06	20
Garlic old	0.1	0.02	20
Red tomatoes	0.2	0.09	45
Paprika	0.51	0	0
Beans	1.6	0.54	34.6
Lentil	1.03	0.27	26.2
Apples	0.3	0.081	27
Pears	0.4	0.04	10

CONCLUSIONS

Traditional foods have established over the centuries a comprehensive food culture. The knowledge of their chemical composition is a basic requirement towards the assessment of their nutritional and biological value. Some of the Bulgarian traditional foods are on the verge of being lost, therefore more efforts are needed to improve them using modern knowledge and technology, to explore and preserve them. Including traditional foods in the Bulgarian diet will play an important role in supporting human health and will contribute to the revitalization of Bulgarian agriculture.

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ОЦЕНКА НА ХИМИЧНИЯ СЪСТАВ, ЕНЕРГИЯТА И БИОЛОГИЧНАТА СТОЙНОСТ НА ТИПИЧНИ ТРАДИЦИОННИ БЪЛГАРСКИ ХРАНИ

Д.С. Христов[1], С.К. Великов [2], В.Е. Воденичаров[1], С.П. Цанова-Савова[2], Ф.Т. Рибарова[2]*

[1] Медицински Университет – София, Факултет по Хигиена, 15, Ив. Ев. Гешов блв., София 1531
[2] Медицински Колеж „Й. Филаретова", Медицински Университет – София, 3, Й.. Филаретова ул., София 1606.

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(Резюме)

Голям брой съвременни научни изследвания предоставят данни за химичния състав на традиционни храни от различни географски региони на света, описвайки тяхната есенциалност за здравословното хранене. Информацията относно българските традиционни храни е много оскъдна.Целта на настоящото проучване е да оцени енергийното съдържание и биологичната стойност на български традиционни храни, прилагайки съвременни научни подходи при анализа на данните за химичния им състав .Проучването обхваща общо 15 хранителни продукта, типични за традиционната българска диета.Използвани са рутинни методи за определяне на общ белтък и мазнини, а аминокиселинният състав е определен чрез приложение на хроматографски анализ. Оценката на енергийното съдържание и биологичната стойност на изследваните традиционни продукти е постигната чрез нови съвременни научни подходи. Предоставена е нова информация за аминокиселинното съдържание и съответно за биологичната стойност на белтъка в изследваните продукти. Нова е и информацията за енергийното им съдържание, определено в съответствие със съвременните научни изисквания.Предоставени са данни за наситените мазнини и е изяснена тяхната есенциалност за здравето. Новите данни за химическия състав на традиционни храни, типични за българската диета, са от значение за оценка на хранителния прием, за поддържане на здравословно хранене и допринасят за възстановяване на виталността на химията на храните в България, на хранителните технологии и общественото хранене.