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Izlaganje sa znanstvenog skupa
Conference paper

THE ROLE OF MEAT IN BALANCED NUTRITION

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Abstract

Meat is a rich source of nutrients which human nutrition often lacks. It is a rich and important source of essential amino acids, vitamins, minerals and also long chain polyunsaturated fatty acids. Moderate intake of lean meat enables easier composition of balanced diet. On the other hand, excessive meat intake supersedes from the diet foodstuffs which supply dietary fibers, vitamins, and also non-vitamin antioxidant active substances and minerals. Not meat itself but imbalanced nutrition with too much fat and saturated fatty acids and deficient intake of ω-3 fatty acids, anfioxidant vitamins and phytochemicals, minerals and dietary fiber present a risk for the development of cardiovascular disease and cancer. Because of its distinct and high nutritional value meat preserves its role in a rational human nutrition.

Keywords: meat, balanced nutrition, health, proteins, fatty acids, vitamins, minerals, nutritional value

Ever since the ancestors of human species, about 7.5 to 4.5 million years ago, gave up vegetarianism (mainly frutarianism) and started to consume more and more meat, meat has obtained a special place throughout the evolution of human history.

It is believed that about 2 million years ago *Homo habilis* started to produce stone tools and after that his follower *Homo erectus*, about 1.8 to 1.6 million years ago started to consume much more meat. However, *Homo erectus* and *Homo sapiens* (about 400.000 years ago) still consumed diet with more than half of the food of plant origin. Nutrition reconstruction (Table 1), on the basis of paleonthological finds and the comparison of the sources of food of that time with contemporary human tribes, who still today live of

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hunting and gathering food, showed that the Paleolithic man of the modern human species (*Homo sapiens sapiens*), 400.000 years ago, consumed daily about 913 g of meat and 1697 g of food of plant origins (Eaton, 1992; Eaton and Konner, 1985; Eaton et al., 1997). In these, at least 4.5 million years long period of meat consumption, the human being has become omnivorous. It means, he has developed a suitable structure and constitution of digestion and metabolism. Human digestive tract has a relatively small volume of which only relatively small part presents large intestine designed for the fermentative digestion of non-starch polysaccharides. For that reason humans have to consume food with high digestibility and relatively high concentration of nutrients, in order to provide proper balance of energy and nutrients.

Table 1 illustrates that Paleolithic nutrition was very rich. It contained a big amount of proteins. This amount actually nearly exceeds the amount which is today considered still tolerable. The proportion of energy provided by the proteins is greater than the one found in modern nutrition. The diet was poor in fats, however, the ratio between unsaturated and saturated fatty acids was very high.

Table 1. - AVERAGE NUTRITIONAL VALUE OF PALEOLITHIC NUTRITION AND MODERN NUTRITION RECOMMENDATION ACCORDING TO RDA (COMPARISON ACCORDING TO EATON ET AL., 1997)

Parameter of reconstruction	Paleolithic nutrition	Modern nutrition	Parameter of reconstruction	Paleolithic nutrition	Modern nutrition
Meat, g/day	913		Vitamins:		
Food of plant origin, g/d	1697		Vitamin E, mg/day	32.8	8-10
Energy, kJ/day	12558	9200-12140	Tiamin, mg/day	3.9	1.1-1.5
Kcal/day	3000	2200-2900	Riboflavin, mg/day	6.5	1.3-1.7
Proteins, g/day	123	50-63	Folic acid, mg/day	0.357	0.18-0.20
Proportion of energy:	37	10-15	Vitamin C, mg/day	604	60
in proteins, %			Minerals:		
in carbohydrates, %	41	55-70	Calcium, mg/day	1956	800-1200
in fats, %	22	15-30	Sodium, mg/day	768	500-2400
Fatty acids ratio P/S	1.4	>0.5	Potassium, mg/day	10500	3500
Ratio ω-6/ω-3	1÷1 to 4÷ 1	4÷1 to 10÷1	Iron, mg/day	87	10-15
Cholesterol, mg/day	480	<300	Zinc, mg/day	43	12-15
Dietary fibers, g/day	100	20-30			

This was due to abundance of food of plant origin and quality of game, which is rich in unsaturated fatty acids. Because of high meat consumption, the Paleolithic man consumed also a great amount of cholesterol. His diet was rich

in dietary fibers, vitamins especially with antioxidants and minerals. All nutritional parameters exceed modern nutritional recommendation.

It is because of the quality of nutrition that the Paleolithic man was of bigger build than his successor of later period who turned to agriculture. It is only in the latest era, as man started to consume more meat again, that his body constitution is becoming bigger (Eaton and Konner, 1985). The current meat consumption also shows its importance. Nowadays the average world consumption of meat per inhabitant is modest. However, the calculated total world consumption is much greater than the one in the Paleolithic Age. Rosegrant et al. (1999) summarise the annual consumption of meat in different parts of the world in 1993 and predicted consumption in 2020 (Rosegrant et al., 1999). It is clear from these data that the consumption of meat in different parts of the world varies greatly. It is lower in poor countries, higher in rich countries. A distinctive trend of increase is visible. The increase is relatively greater if the current consumption is lower. In countries with low consumption they strive to increase the consumption of meat to create a good diets with favourable effects on the health of inhabitants. In contrary to developed countries, the official Chinese nutritional recommendation is consumption of lean meat (McNutt, 1999). Pensel (1997), on the other hand, foresees that in countries with a high level of meat consumption the meat consumption will decrease to the benefits of more diverse nutrition. The countries with a low level of meat consumption will for the same reason increase the level of meat consumption as the growth of economy increases. However, Rosegrant et al. (1999) calculated that such an increase of meat production to cover the needs is not possible to attain. He predicted a possible realisation of 65% of the calculated increase.

Also in Slovene diets less meat is consumed nowadays compared to "Slovene Paleolithic" period. Koch (1997) assessed on the basis of a survey that Slovenes consume an average of 114 g of meat a day. On the other hand, Čepin (1997) calculated, on the basis of data of the production, export and import of meat, that Slovenes consume annually 67.7 kg (185 g/day) of meat (including fish), which by converting to edible part of meat presents 44.2 kg per year (120 g/day).

This raises the question what should be the recommended meat consumption. None of nutritionists advocate the amount consumed in The Stone Age. On the contrary, it is advised to consume meat in moderate amounts. Proportionally small amount of meat meets substantial part of requirements for proteins, essential amino acids, vitamins and some mineral elements. The proportion of requirements that can be met with a 100 g of lean beef, pork or chicken is illustrated in Table 2.

Table 2. - THE PART (%) OF RDA (1989) THAT CAN BE MEET WITH A 100 G OF MEAT IN WOMEN AGED BETWEEN 25 AND 50 (CALCULATED ACCORDING TO THE DATA BY SOUCI ET AL., 1994; OSTER, 1994; WENK AND LEONHARDT, 1996)

Criteria of allow.	Beef, lean	Pork, lean	Chicken	Criteria of allow.	Beef, lean	Pork, lean	Chicken
Energy	4.9	4.8	7.5	Minerals: Fe	14.6	7.3	4.6
Fats	2.7	2.7	13.7	Zn	35.8	16.6	8.0
Proteins	49.0	44.0	40.0	I	4.6	6.0	-
Essential amino a.	>100	>100	>100	Se	9.0	9.0	10.9
Vitamins: B1	21.0	81.8	7.3	Ca	0.4	0.3	1.5
B2	20.0	17.7	12.3	Mg	10.1	10.3	13.2
Niacin	51.0	33.3	45.3	K	20.9	23.2	17.9
B6	11.2	35.0	31.2	Na	13.2	7.8	16.5
B12	250.0	100.0	20.0				

The table 2 shows the nutritional characteristics of meat as part of requirements that can be met with a 100 g of meat. The characteristics with the value greater than the proportion of energy supplied by the meat indicates that the meat is according to these characteristic a supplement. It is evident that an appropriate daily intake of lean meat meets only small part of energy requirements, supplies only small amount of fat, but provides a substantial amount of crucial nutrients. Meat is the most valuable as source of proteins, essential amino acids, vitamins B group, iron and zinc. The importance of meat as significant source of zinc has been established in recent years. Red meat in particular is an excellent source of zinc. Zinc, as the essential constituent of most enzymatic systems, is involved in many cell functions, as for example in the immune mechanisms, and also in the protection of cell structure against free radicals. Fortes et al. (1997) found that in elderly population zinc supplementation reduces the concentration of plasma lipid peroxides. Consequently, an appropriate supplementation of zinc can play a major role in the prevention and development of diseases in the elderly population. This can also be applied to the younger population. Golub et al. (1999) investigated the influence of iron and zinc deficient diets and the influence of powdered beef supplementation on the haematology parameters and behaviour of adolescent monkeys. They concluded that the marginal iron-zinc supply in the earlier stage of growth leads to the behavioural and haematological disturbances, which can be prevented and some even abolished by nutritional supplementation with beef.

Due to its rich composition and therefore its great value as supplement, meat is very important in the nutrition of the most sensitive groups of

population: pregnant women, lactating mothers, children and elderly. Very interesting and also surprising are the results of the recently published study by Campbell et al. (1999) in which the effects of a lactoovovegetarian and omnivorous diet on changes of skeletal muscle mass in older men under 12 week training conditions were compared. Both groups were supplied with equal amount of proteins. Half of the proteins in the omnivorous diet were provided with meat (beef, poultry, pork and fish). The training increased muscle mass in the omnivorous diet group for 16.2% and in the laktoovovegetarian diet for 7.3%. It is not possible to attribute favourable results in the omnivorous diet only to differences in protein quality, since the quality of milk proteins is equal or even superior. It is certain that the effect is a consequence of more complex way of complementing a diet. Meat adds up a different and wider spectrum of nutrients, which are needed as co-factors in the formation of muscle tissue, and which should not be deficient for the efficient amino acids utilisation in the muscle protein synthesis (vitamins, trace elements).

Meat is also a significant source of ω-3 polyunsaturated fatty acids, especially long-chain fatty acids (C_{20} and longer). To these fatty acids more and more importance has been attributed due to their importance in the process of growth and development, and also in the prevention of cardiovascular disease and cancerogenesis. Connor (1997) summarised positive effects of ω-3 fatty acids in fish and fish oil as follows: prevents ventricular arrhythmias and cardiac arrest, have an antithrombotic effect; lower the level of plasma lipids, especially VLDL and triglycerides, and inhibit the growth of atherosclerotic plaques, inhibit interieukin-α and cytokins; promotes endothelial relaxation, which is induced by nitric oxide. In the continental diet (exception diets for babies) which does not include fish, is meat apart from eggs, the only important source of long-chain ω-3 fatty acids and cannot be ignored. For those who do not consume fish it is even more important.

In recent years meat has been exposed to great criticism because it contains fats, saturated fatty acids, cholesterol, purine and also carcinogenic substances. Meat is often considerate as energy reach food. Because of the above mentioned points of view, meat is often related to diseases of "civilization" such as: overweight, increased blood pressure, diabetes, gout, cardiovascular diseases and cancerous diseases. All these reproaches can be supported only in the case that the excessive meat consumption leads to an imbalanced diet.

Excessive consumption of meat or any other foodstuffs in a diet supersede other foodstuffs which would add to the diet the nutrients missing in the excessively consumed foodstuff. Meat, for example, does not contain any dietary fibers, some of the vitamins and antioxidant active substances.

Most unfavourable influences on health, on the account of meat, holds true for the meat with a greater proportion of fats. Therefore, lean meat has a low energy value, which, in an appropriate diet, even lowers the concentration of plasma lipids (stated for example by: Watts et al., 1988 and Wolmarans et al., 1999). Scott et al. (1994) assessed that lean beef and skinless chicken have similar effects on the plasma lipoproteins and that they are mutually exchangeable in diets for the reduction of cholesterol level. In a similar research, Davidson et al. (1999) compared the effect of lean red meat and lean white meat. In the 36 week long experiment they stated that in the selected population diets with either of the two kinds of meat reduced the level of LDL and increased the level of HDL-cholesterol in plasma.

The use of meat in diets for the lowering of blood cholesterol level holds true only for lean meat. Already in 1990 O'Dea et al. discovered that a diet with a very low proportion of fat (9% energy from fats) and containing 500 g of lean beef per day decreased the concentration of cholesterol already after one week from 5.9 to 4.7 mmol/I. After three weeks of experiment the diet was supplemented with beef fat (19% energy from fat in week 4 and 29 % in week 5) which led to the increased cholesterol concentration (5.45 mmol/I).

Animal fats contain a great proportion of saturated fatty acids, which is especially high in deposited fats of ruminants. However, only three of these unsaturated fatty acids increase the level of cholesterol in the blood, namely: lauric (12:0), myristic (14:0) and palmitic (16:0), also stearic acid (18:0) is undesirable since it is considered to be thrombogenic (Ulbricht and Southgate, 1991). The effect of individual fatty acids on plasma cholesterol is very significant, the undesirable influence of saturated fatty acids on the total and LDL-cholesterol is really high. Thus it is necessary to avoid the consumption of fats with high proportion of these fatty acids, this is, particularly animal fats. Proportion of fat in the diet is also positively related to the frequency of cancer formation on different organs (Carol et al., cit. FAO/WHO, 1994). Therefore, it is necessary to avoid fats in general, including animal fats. Addressing the undesirability of fats in the meat through the use of animal selection and animal nutrition has led to a considerable decrease in carcass fats (Garrow et al., 2000).

The nutrition of animals or rather the dietary fatty acid composition has a great impact on the fatty acid composition of animal fats. By using specially adjusted animal nutrition it is possible to considerably increase the proportion of ω-3 fatty acids in fats of various foods of animal origin as well as in the meat. In monogastric animals it is possible to change the fatty acid composition of animal fats (fats in the fat tissues as well as in the muscle tissues, and also egg lipids) to a large extent by changing the quality of dietary

fats. In ruminants, on the other hand, the effect of dietary fats, due to microbiological hydrogenation of double bonds of fatty acids in the rumen, is less evident. However, from many aspects even more important. Also our investigations show that for example in chicken meat, following the addition of ω-3 fatty acids in feed, the weight proportion of ω-3 fatty acids of the total of fatty acids increases by 5 times (from 1.6 to 8.4%), whereas long-chain fatty acids up to even 9 times (from 0.79 to 6.83 %) (Peterka, 1998).

Much attention concerning fatty acid was recently provoked by publications on the content and effects of conjugated linoleic acid (CLA). CLA contain fats of ruminants, milk as well as body fats. Already in 1979, Pariza et al. (cit. Pariza and Ha, 1990) discovered in the extracts of roasted beef a substance inhibiting the activity of mutagenic substances. Later on, it was demonstrated that this substance was a conjugated dien derivate of linoleic acid, in other words, conjugated linoleic acid, which carries a very strong anticancerogenous properties (Pariza and Ha, 1990; Belury, 1995; Parodi, 1997). Conjugated linoleic acid shows its anticancerogenous activity already in relatively small concentrations, that is in less than one percent of food. The action does not depend on the presence, or rather, the combination of other fatty acids in the food. Conjugated linoleic acid functions antiatherogenously. This was also proved in the investigation carried out on rabbits (Li et al., 1994). It is interesting that among other effects CLA also influences the metabolism of fats and in experimental animals reduces the amount of body fat (Park et al., 1997). The content of conjugated linoleic acid in milk and meat of ruminants is affected by the diet, especially by the content of polyunsaturated fatty acids in it (Enser et al., 1999) and conditions in the rumen. Dietary CLA intake in our diet is practically completely dependent on the intake of fats of ruminants, especially on the intake of milk fats and meat.

Many researches have shown that there is a positive relation between the intake of red meat and frequency of cancer, especially cancer of the large intestine (Willett et al., 1990; Primic-Žakelj, 1997; Bingham, 1999). However, these relations are very weak and mostly linked to other accompanying risk factors, and not to consumption of meat alone. On the opinion of Hill (1999) the cohort studies have not discovered any links between the consumption of meat and colon-rectal cancer, yet protective factors, such as the consumption of vegetables and non-refined cereal products are the main determinants to trigger the formation of that type of cancer. Also Cox (1997) established that the consumption of meat and cancer of the large intestine are not related, yet the frequent consumption of fruits and vegetables significantly reduces the risk of its formation.

Cox and Whichelow (1997) investigated the effect of fruit consumption on the morbidity and mortality due to coronary diseases. They established small amount of relative risk (rr) 1 in those who frequently consumed fruits in winter and summer, rr 1.3 in those who consumed moderate amount in winter and more frequently in summer, rr 1.35 in those who rarely consumed fruits in winter and frequently in summer, and rr 1.88 rarely in winter and moderately to rarely in summer.

In recent years, apart from studying fats, the research was focussed also on other factors, which could be related to the frequency of cardiovascular diseases and cancer. In a cohort study on 73757 people in the health service, aged between 40 and 75 years, Ascherio et al. (1996) studied the relation between the consumption of fats, fatty acids and cholesterol and frequency of coronary diseases. A significant positive relation was found between the frequency of coronary diseases and consumption of some saturated fatty acids, cholesterol and trans-fatty acids, and also an independent negative relation between the consumption of α-linolenic acid and the risk for coronary diseases. Ascherio et al. (1996) recommends (according to their results and the results of other studies), for a rational prevention of coronary diseases, a reduction in the intake of saturated fat, cholesterol and trans-fatty acids, which should be accompanied by a greater consumption of food rich in fibers and should include cereals, vegetables and fruits in the diet. Similarly, also Hu et al. (1999) established that an increase in consumption of α-linolenic acid reduces the incidents of coronary infarction.

The meat consumption is frequently being related to the diseases of civilisation or diseases of abundance, such as: overweight, cancer, coronary artery diseases. All three are related to an excessive intake of calories and fat, disproportional relationship among fatty acids or quality of fats and also to carcinogenic substances originating from the termal meat preparation. These diseases are related especially to red meat and meat products (beef, mutton and pig). For these reasons, the Department of Health (Department of Health, 1998) in Great Britain recommends a moderate consumption of meat.

The importance of meat in the diet is evident from the research carried out by EImstDhl et al. (1999) who investigated the dietary patterns in people with high and low meat consumption. The increased consumption of red meat, expressed in quintiles and corrected to energy intake, is in both sexes related to the reduced intake of poultry, fish, fruit, bread, cereal products and cheese. A negative correlation between the consumption of meat and consumption of vitamin C and fibers was shown. Average consumption of fats originating from meat was 13.6% in men and 11.9% in women. However, no relation between the consumption of meat and consumption of some fatty acids (neither the

blood cholesterol increasing fatty acids nor arachidonic and linolenic acid) was established. Also these authors conclude that the high meat intake reduces the consumption of the group of foodstuffs, which are rich in antioxidants and fibers. The positive relation between the consumption of meat and frequency of cancer and coronary diseases (which was found by some experts) is according to Elmstahl et al. (1999) most likely not related to the composition of meat but to the fact that high meat intake supersedes from the diet already mentioned foodstuffs and protective substances.

The importance of the antioxidants for the protection against atherosclerosis is illustrated in the research carried out by Sharma et al. (1999) on rhesus monkeys weighing 6-8 kg. The monkeys were consuming an atherogenic diet, daily containing one gram of cholesterol and 15 g of butter. Two groups of monkeys were supplemented daily with 25 and 50 mg of E vitamin per kg body weight, respectively. The vitamin E supplemented groups had a much lower level of blood cholesterol, triglycerides and smaller and less frequent atherosclerotic changes on the aorta.

Table 3. - INFLUENCE OF DIET WITH AN INCREASED PROPORTION OF ω-3 FATTY ACIDS AND OLEIC ACID ON EVENTS IN THE 5-YEAR PERIOD AFTER FIRST MYOCARDIA INFARCTION (DE LONGERIL ET AL., 1998)

Parameters	Control group	Group on diet with more ω-3 fatty acids	P
Number of patients	303	302	
Cancers	17	7	0.05
Total deaths (including cancer deaths)	24	14	0.03
Cardiac death	19	6	0.01
Total deaths + nonfatal cancers	35	18	0.01
Total deaths + nonfatal cancers + nonfatal myocardial infarction	60	26	0.001

One of the most interesting and most frequently cited studies regarding the frequency of coronary diseases is most likely the one from Lyon reported by De Lorgeril et al. (1994,1996,1998 and 1999). The objective of the study was to found out the effects of a rich Mediterranean type of diet in patients, who had already once recovered from myocardial infarction. The diet differed from an ordinary coronary diseases preventive diet in that that it contained more bread, vegetables, legumes, fruits and fish, margarine rich in α-linolenic acid (rapeseed oil) and less red meat, butter and cream. The diet did not exclude meat but contained somewhat less calories, less fats and saturated fatty acids, more oleic and α-linolenic acids, and less linoleic acid and less

cholesterol. Although there is a rather small difference between the two diets, the effect is surprising and is mainly seen in the changes of the content of fatty acids in plasma lipids and in the number of fatal and non-fatal myocardial infarctions (Table 3). Within four years this experiment also showed distinct effect on the rate of cancer cases, as illustrated in Table 3.

Trying to define the importance of meat in modern diets on the basis of the refereed investigations, it could be concluded that new researches actually establish a special place for meat of »modern« quality (lean meat) in a balanced diet as a nutrient rich and physiologically safe foodstuff. In one way or the other, meat complements diets with the greater proportion of food of plant origin and assures a safe way of meeting dietary recommendations without demanding daily diet calculations. In addition, meat adds up to a diet the needed diversity and taste Excessive meat intake supersedes from the diet foodstuffs which supply dietary fibers, vitamins, and also non-vitamin antioxidant active substances and minerals. Every one-sided diet, meat or vegetarian diet can present risk for health.

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ULOGA MESA U URAVNOTEŽENOJ PREHRANI

Sažetak

Meso je bogat izvor hranjivih tvari koje često nedostaju u ljudskoj prehrani. Ono je bogat izvor esencijalnih aminokiselina, vitamina, minerala te dugog lanca polinezasićenih masnih kiselina. Umjereno uzimanje mršavog mesa omogućuje lakše sastavljanje uravnotežene prehrane. S druge strane, prekomjerno uzimanje mesa istiskuje iz prehrane sastojke koji opskrbljuju prehrambenim vlaknima te nevitaminskim antioksidacijskim aktivnim tvarima i mineralima. Ne samo meso već i neuravnotežena prehrana s previše masnoće i zasićenih masnih kiselina te nedovoljno uzimanje masnih kiselina α-3, antioksidacijskih vitamina i fitokemikalija, minerala i prehrambenih vlakana predstavljaju rizik za razvoj kardiovaskularnih bolesti i raka. Zbog svoje izrazite i visoke hranidbene vrijednosti meso zadržava svoju ulogu u racionalnoj ljudskoj prehrani.

Ključne riječi: meso, uravnotežena prehrana, zdravlje, bjelančevine, masne kiseline, vitamini, minerali, hranidbena vrijednost

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