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When man met meat: meat in human nutrition from ancient times till today

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Abstract

Meat is one of the most valuable sources of proteins, and also contains fats, B vitamin complex, vitamins A and D, large amounts of iron, zinc, and other mineral substances. Although nowadays meat consumption is associated with a number of diseases including cardiovascular disease, cancer and diabetes, meat has a significant role not only for maintenance of proper growth, development and health, but in human evolution as well. There is evidence that meat consumption has had an influence on cranial-dental and intestinal morphologic changes, human erect posture, reproductive characteristics, longer lifespan, and maybe most importantly, on brain and intellectual development.

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1. Introduction

Meat is one of the most valuable foods from a nutritional viewpoint[1]. Although there are implications about the correlation between meat and some disorders, the role of meat in human diet during evolution should not be neglected[1,2,3]. In order to obtain sufficient data about human diet and meat consumption during evolution, scientists use indirect and direct approaches. The indirect approach is based on evidence from the fossil morphology and

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remains of plants and animals found in archaeological sites[4,5]. The direct approach includes isotope analysis in bones and teeth, because chemical composition of tissues in the body can reveal the chemical composition of ingested food. This approach is based on analysis and comparing presences and ratios of stable isotopes of carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$). Relative measures of stable isotopes of carbon and nitrogen can be useful in insight in the relation of food of animal and plant origin in the diet[4,5].

The aim of this paper is to contribute to better understanding of the role of meat not only in human diet, but in evolution and how meat eating makes us what we are today, affecting our anatomy, physiology, emotions and social characteristics.

2. Impact of meat eating on human evolution

The diet of early hominin species was mainly based on plant (fruits, seeds, grasses, and tubers) supplemented with some animal foods. Results of paleontological and archaeological research supported theory that incorporation of larger amounts of animal proteins started with the earliest *Homo*. It is supposed that *H. habilis* obtained meat from scavenging and a smaller part by hunting, while hunting was the predominant method for *H. erectus* to obtain animal proteins, and it appears to be a major adaptive shift in human evolution[6].

Hunting and meat eating resulted in increased body size. *H. erectus/ergaster* males had an average body mass of 66 kg compared to *H. habilis* which weighed 37 kg, while body mass of females increased by 53%, from 32 kg for *H. habilis* to 56 kg for *H. erectus/ergaster.* The height increased, from 131 cm to 180 cm (by 33%) for males and from 100 cm to 160 cm (by 37%) for females[7].

Bipedalism, which distinguished ancient humans from other apes, appeared in the oldest known species of *Australopithecus*, who lived in Africa about four million years ago[8]. According to some investigations 'postural' bipedalism was found in *A. afarensis*, and locomotor bipedalism did not appear until the emergence of *H. ergaster* between 1.9 and 1.5 million years ago. Some authors consider that bipedalism in *H. ergaster* was associated with climate changes in Africa where more open habitat leaving food resources patchily distributed forced humans to move in order to find food. Moreover, bipedalism can be considered as one of the first strategies in human nutritional evolution[8,9].

As meat become more common in nutrition, it was inevitable for changes in the digestive tract to occur. Even though during evolution of the australopithecines, total surface area of the grinding teeth increased from 460 mm^2 in *A. afarensis* to 756 mm^2 in *A. boisei*, in early species from genus *Homo,* reduction in the posterior dentition is noted. The tooth surface area of postcanines decreased from 478 mm^2 in *H. habilis* to 377 mm^2 in early *H. erectus*[6]. While changes in decreases in molar teeth size and stronger front teeth could be contributed to diet changes and tearing and chewing meat, changes in intestinal morphology reflected the impact of high quality diet[10]. Generally, large primates have an expanded colon which is necessary for extraction of additional energy in the form of volatile fatty acids obtained by fermentation process from plant fibers. On the other hand, humans have a small colon and enlarged small intestine. These differences in intestinal morphology are result of adaption to easy digested animal proteins in human nutrition[6]. Along with body, brain size also increased, from 400 cm^3 in the earliest australopithecines to 1300–1400 cm^3 in modern humans, although the equal changes in brain size were not detected in regular periods during evolution. The greatest level of encephalization was found in *H. erectus* who had a larger brain compared to body mass than any other primate during evolution. *H. erectus* brain size reached 800 to 900 cm^3, which is about 200-300 cm^3 larger than *H. habilus* brain size[6].

Larger brains were needed for complex foraging behaviour and the use of tools[11]. There are some indications that *A. garhi* was the first stone tool-user and that *A. africanus* made Oldowan tools, but without doubt, *H. erectus* used stone tools[12]. Development of Oldowan industry tools allowed successful hunting and easier processing of carcasses and increased access to meat, bone marrow and brains[6]. Hunting needs a cooperative interaction which led to pantomiming and vocalisation which was a turning point in language development[11]. Archaeological findings indicate that after killing and butchering, animals were transported back to a central location where the resources were shared within foraging groups[6]. Cooperation in hunting and meat sharing was one of the first steps in sociogenesis. Even today, hunting can be considered as way to escape social tensions in the presence of close friends and meat- and general food-sharing remain a bonding mechanism[11,13]. Furthermore, origins of art are connected with hunting rituals and animals hunted as prey like aurochs, became indeed the first known objects of animal art during

the Upper Palaeolithic. Later, hunting and animal sacrifice rituals were inseparably part of different religions and strongly embedded in the cultural scaffold of myth and folk tales[11].

3. Meat today - benefits and concerns

Meat is a food of high nutritive value, which is why it is present in the everyday diet of humans[13,14,15]. Along with increasing meat production, increased demand for animal protein highlights the important role of meat in the global food supply. Proteins provide energy and are essential for growth, development, maintenance and the repair of the tissues[16]. Malnutrition and stunting are of increasing concern in developing countries. According to some data, protein-malnutrition is a causative factor in 49% of the approximately 10.4 million annual deaths of children under five years of age[17]. Meat protein contains eight essential amino acids and histidine, which is considered to be an additional essential amino acid for children[16]. Meat also contains taurine, essential in newborn infants who are less able to synthesis this amino acid from cysteine. This amino acid enters through breast milk, which is why meat is important in mothers' nutrition[18]. Taurine exhibits antioxidant and anti-inflammatory activity, which can be related to cardiovascular disease prevention and is almost exclusively found in animal products[1]. Meat is a rich source of many micronutrients, especially iron[2,13]. Iron deficiency anemia affects nearly 600 million pre-school and school aged children. ESPGHAN Committee on Nutrition suggested that "good sources of iron (e.g., meat)" should be included in diets of children in order to support cognitive development[2]. Aside from iron, meat is an important source of zinc, also contains useful amounts of Se, Cu, Mg, Co, Pb, Cr and Ni, and these minerals are absorbed by a more efficient mechanism than those found when plants are ingested. Foods of animal origin, especially meat provide dietary source of vitamin B_{12} and deficiency of this vitamin occurs in vegetarians and vegans[1,13,18].

Despite its nutritional value, consumption of meat, especially red meat, is linked to number of diseases and disorders. Colorectal cancer is the cancer type most often associated with red meat consumption. Fat, heterocyclic aromatic amines (HAAs), polycyclic aromatic hydrocarbons (PAHs), N-nitroso compounds (NOc) and heme iron are substances isolated from red meat and which are considered to influence the occurrence of cancer[3,18]. Many studies indicate that fresh meat *per se* is not carcinogenic and that, as well as other types of cancer, the risk of colorectal cancer is mainly associated with cooking methods and carcinogens produced during meat processing and preparation[19]. Although meat processing, especially at high temperature, reduces risk of food borne diseases, this practice may cause formation of chemical compounds which can be carcinogens and mutagens[20]. Most common are HAAs and PAHs, genotoxic substances which act directly on DNA, cause point mutations, deletions, insertions and initiate carcinogenesis processes for numerous cancers[3,19]. Their formation depends on meat type, temperature, and method of cooking[19]. Higher risks were observed for darkly browned surfaces produced by barbecuing or iron-pan cooking at temperatures above 150°C, and these risks were explained due to the formation of HAAs, while there was no association found with roasted and boiled meat[21].

Diet is one of the most important risk factors for cardiovascular diseases (CVD) including coronary heart disease (CHD), stroke and myocardial infarction[22]. Meat is often associated with CVD mostly due its fat content, especially saturated fat content[1,2]. Excessive consumption of saturated fatty acids could promote white adipose tissue expansion and hypertrophy leading to apoptosis. This promotes the release of inflammatory proteins like cytokines and chemokines, inducing inflammation and insulin resistance, thus increasing the risk of cardiovascular disease and metabolic syndrome. Fat content in meat is highly variable depending on species, origin, cut and feeding system[1,13]. During recent years, numerous studies have focused on improving the composition of fat in meat and increasing the amount of n-3 fatty acids due animal nutrition. Beneficial effects of n-3 fatty acids have been well documented and include anti-atherogenic, anti-thrombotic and anti-inflammatory effects. Consumption of meat with higher concentration of these fatty acids may lead to reduced risk of CVD[23]. On one hand, as mentioned above, fat may have negative impacts on human health, but on the other hand, fat contributes to taste and nutritional value, which are two important quality attributes of meat. Furthermore, dietary lipids also provide metabolic energy, and play an important role in the structure of biological membranes. Linoleic acid is an important structural constituent of cellular membranes as well as for the synthesis of tissue lipids, and helps reduces serum cholesterol[24]. The n-3 and n-6 fatty acids are essential in the human diet and cannot be synthesized *de novo*[14,24]. These fatty acids function as carriers of the fat-soluble vitamins and play a crucial role in the immune response of man and animals[24]. Docosahexanoic acid (DHA) is an n-3 fatty acid which is essential in the development of the CNS in the new-born,

and lower concentrations of DHA are seen in cord artery phospholipids of vegetarians and in the breast milk of vegan mothers. DHA is mostly found in fish and for those who do not consume fish, meat is the most important source of this fatty acid[18].

4. Conclusion

Meat is indubitably an important factor in human evolution. During evolution, the consumption of meat was of great benefit to hunters. Today different trends influence the choice to eat or not to eat meat. Meat nutritional composition makes an important contribution to human diets, affecting proper grow and physical and cognitive development. However, awareness of animal welfare, environmental pollution and some disorders and diseases linked to meat production and consumption have created a trend of meat avoidance. On the other hand, millions of people, mostly children, from third world countries are starving as a result of animal protein deficiency. Having all the facts the choice is ours. So, we are what we eat.

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References

1. Pereira PMDCC, Vicente AFDRB. Meat nutritional composition and nutritive role in the human diet. *Meat Sci* 2013;**93**:586-92.
2. McNeill S, Van Elswyk ME. Red meat in global nutrition. *Meat Sci* 2012;**92**:166-73.
3. Baena Ruiz R, Salinas Hernández P. Diet and cancer: Risk factors and epidemiological evidence. *Maturitas* 2014;**77**:202-8.
4. Larsen CS. Animal source foods and human health during evolution. *The Journal of nutrition* 2013;**133**:3893-97.
5. Ulijaszek SJ, Mann N, Elton S. *Evolving human nutrition: implications for public health* (Vol. 64). Cambridge University Press; 2012.
6. Leonard WR, Snodgrass JJ, Robertson ML. Effects of brain evolution on human nutrition and metabolism. *Annu Rev Nutr* 2007;**27**:311-27.
7. McHenry HM, Coffing K. Australopithecus to Homo: transformations in body and mind. *Annu Rev Anthropol* 2000;**29**:125-46.
8. Leonard WR. Dietary change was a driving force in human evolution. *Sci Am* 2002;**287**:106-16.
9. Wang WJ, Crompton RH. The role of load-carrying in the evolution of modern body proportions. *J Anat* 2004;**204**:417–30.
10. Speth JD. Early hominid hunting and scavenging: The role of meat as an energy source. *J Hum Evol* 1989;**18**:329–43.
11. Leroy F, Praet I. Meat traditions. The co-evolution of humans and meat. *Appetite* 2015;**90**:200-11.
12. Plummer T. Flaked stones and old bones: biological and cultural evolution at the dawn of technology. *Am J Phys Anthropol* 2004;**125**:118-64.
13. Ivanovic S, Teodorovic V, Baltic ZM. Kvalitet mesa–bioloske i hemijske opasnosti. Prvo izdanje, Naucni institut za veterinarstvo Srbije, Naucna KMD; 2012.
14. Baltic M, Nedic D, Djuric J, Dimitrijevic M, Karabasil N. Hrana i vecna briga za zdravlje. *Veterinarski zurnal Republike Srpske* 2010;**1**:5-9.
15. Baltic ZM, Nedic D, Dragicevic O. Meso i zdravlje ljudi. *Veterinarski zurnal Republike Srpske* 2003;**3**:3-4.
16. Wyness L, Weichselbaum E, O'Connor A, Williams EB, Benelam B, Riley H, Stanner S. Red meat in the diet: an update. *Nutr Bull* 2011;**36**:34-77.
17. Food and Agriculture Organization of the United Nations (FAO), World Livestock 2011: Livestock in food security. FAO: Rome; 2011.
18. Higgs JD. The changing nature of red meat: 20 years of improving nutritional quality. *Trends Food Sci Tech* 2011;**11**:85-95.
19. Berjia FL, Poulsen M, Nauta M. Burden of diseases estimates associated to different red meat cooking practices. *Food Chem Toxicol* 2014;**66**:237–44.
20. Aaslyng MD, Duedahl-Olesen L, Jensen K, Meinert L. Content of heterocyclic amines and polycyclic aromatic hydrocarbons in pork, beef and chicken barbecued at home by Danish consumers. *Meat Sci* 2013;**93**:85–91.
21. Navarro A, Muñoz SE, Lantieri MJ, del Pilar Diaz M, Cristaldo PE, de Fabro SP, Eynard AR. Meat cooking habits and risk of colorectal cancer in Cordoba, Argentina. *Nutrition* 2014;**20**:873-77.
22. McAfee AJ, McSorley EM, Cuskelly GJ, Moss BW, Wallace JM, Bonham MP, Fearon AM. Red meat consumption: An overview of the risks and benefits. *Meat Sci* 2010;**84**:1-13.
23. Givens DI, Kliem KE, Gibbs RA. The role of meat as a source of n-3 polyunsaturated fatty acids in the human diet. *Meat Sci* 2006;**74**:209-18.
24. Webb EC, O'neill HA. The animal fat paradox and meat quality. *Meat Sci* 2008;**80**:28-36.