



Artículo especial

To eat or not to eat meat. That is the question

Comer o no comer carne. ¿Es esa la incógnita?

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Abstract

Meat is a well accepted food with appreciable appealing. Due to its high nutritional value it plays a central role in human development. Meat/meat derivatives are important sources of proteins, minerals and vitamins. Their nutritional importance is paralleled to their economic impact. Paying attention to the social alarm originated by a recent publication of WHO about the relationship between red and/or processed meat consumption and cancer, this paper reviews the following aspects: a) the present consumption of meat/meat products in Spain; b) the contribution of their macro/micronutrients to the recommended dietary allowances; c) the obliged use of additives (e.g. nitrites and nitrates) to warrant the food safety, and their daily intake. In addition health risks derived from a high consumption, as well as the most appropriate culinary uses in order to reduce the formation of toxic products (e.g. N-nitrosocompounds) are commented. Due to the huge variety of available meat products, this paper concludes that any generalization should be avoided. We also emphasize about the advantages of consuming meat/meat products in the frame of a Mediterranean diet, rich in vegetables, fruits, and bioactive compounds.

Key words:

Cancer. Red meat.
Processed meat.
Diet. Nitrates. Nitrites.
N-nitrosocompounds.

Resumen

La carne es un alimento muy bien aceptado por sus propiedades organolépticas. Es fundamental en el desarrollo del ser humano por su alto valor nutritivo. Fuente importante de minerales, vitaminas y proteínas de elevada calidad. Su importancia nutricional está en consonancia con su repercusión económica. En este artículo, y a la luz del comunicado recientemente emitido por la OMS sobre el peligro para la salud, particularmente de cáncer, del consumo elevado de carne roja y/o procesada y dada la alarma social ocasionada, pretendemos matizar algunos aspectos. Se revisan a) el consumo actual de carnes y derivados en España; b) su contribución en macro/micronutrientes a las ingestas recomendadas; c) el aporte obligado de aditivos (p.ej. nitratos y nitritos) para garantizar la seguridad alimentaria y su ingesta diaria. Se comentan los riesgos del consumo elevado de los productos cárnicos así como los usos culinarios más adecuados para reducir la formación de compuestos tóxicos (p.ej. N-nitrosocompuestos). Dada la enorme variedad de productos cárnicos ofertados, se concluye que cualquier generalización sobre el consumo de carne y derivados sería totalmente inadecuada y se resaltan las ventajas de consumirlos en el marco de una dieta tipo mediterránea, rica en verduras, frutas y compuestos bioactivos.

Palabras clave:

Cáncer. Carne
roja. Carne
procesada. Dieta.
Nitratos. Nitritos.
N-nitrosocompuestos.

Received: 14/11/2015
Accepted: 02/12/2015

Celada P, Bastida S, Sánchez-Muniz FJ. To eat or not to eat meat. That is the question. Hosp Nutr 2016;33:177-181

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"To be or not to be. That is the question"
Hamlet. William Shakespeare

A few hundred years ago, a Danish prince considered the doubt that consciously or unconsciously assaults everybody when he or she makes important decisions. That soliloquy is the model of indecision that the human being implicitly carries with him.

During the last few decades there have been several avian crises, which entailed the killing of hundreds of thousands of ducks and Galliformes, particularly in the Asian zone, quite often because of not being able to guarantee adequate treatment and the fail-safeness of subsequent sales.

In 2001 the *mad cow* disease or bovine spongiform encephalopathy (1) appeared, leading to a very important fall in the consumption of beef and an increase in that of other potentially healthier meats. The crisis meant a revolution in the management of food safety, establishing a plan for the monitoring and controlling of animals. The causal agent is a prion which incorporates into normal proteins modifying them and causing irreversible damage with the appearance of spongiform encephalopathies, existing evidence of those prions transferring from one species to humans giving rise to the Creutzfeldt-Jakob's disease (1). It seems in some way anecdotal that fewer than 250 people in the world have died of Creutzfeldt-Jakob's disease, the majority of them in the United Kingdom and only 5 in Spain (2).

In 2009 experts from the WHO warned us of an apocalyptic avian flu pandemic (3). In the corresponding report it was predicted that the mutated virus of swine fever could severely affect the whole population of the world causing a great number of deaths. The alarm was sounded and governments proceeded to purchase massive amounts of vaccines and antiviral drugs. The such feared avian flu was neither so devastating nor lethal as experts had told us, and the anti-viral drugs are still in storage because they were not necessary. It seems that in this case experts caused unnecessary alarm in the population, ditto for the anti-viral drugs.

Last year the Ebola virus that usually attacks Africa periodically changed geographic zones and appeared in the occidental part of the continent, when it usually happened in the central part of the country. The virus spread much further than it usually did and even arrived to Europe. The number of deaths from this outbreak rose to five thousand (4). For one reason or another, intervention was late and of low quality and the WHO received a lot of criticism for its not having reacted in time.

Last October 26th the WHO issued a press release on the (potential) danger of consuming red and/or processed meat (5). On analyzing the OMS communiqué and checking some central papers on the subject and paying attention to the outcomes, it seems clear that in the epidemiological results that are dealt with, some of them in hundreds of thousands of people, the danger exists and the subject is not trivial. Nevertheless, the news as it was disseminated has created a lot of confusion regarding a group of foods of high nutritional and commercial importance in the world.

After the last communiqué in which we were notified that processed meat products were carcinogenic (5), the headlines did not make us wait and the outrageous things that ended up being said in one or another news program were very serious (e.g., sausages are

as harmful as tobacco or asbestos). A few weeks ago, Doctor Estruch, one of the leading experts on the Mediterranean diet, stressed in an interview (6) that the level of evidence is not enough to show that they have carcinogens that are as dangerous as tobacco and asbestos, even though he referred to our consuming too much sausage, and, in his own words, "demonizing red meat is excessive".

Through all of this we want to clear up certain aspects concerning our judgment's being in dispute.

- From the point of view of human evolution it is taken for granted that the consumption of meat causes the development of certain mental and psychomotor skills (7).
- Meat is an important source of proteins of high biological value, minerals and vitamins; it is also a very good source of haem iron. Besides, their being products which are accepted and appreciated due to their organoleptic properties has to be taken into account (8).
- A large percentage of the recommended dietary allowances of proteins, B₁₂ and B₆ vitamins, among others, is covered in Spain by meat and meat-product consumption (8).
- Adult animal meat contains more fat. Its relatively high saturated fatty acid content suggests that its high consumption should be avoided (8).
- The consumption of meat in Spain is very high (9) (Table I). The variety and composition of such products make a ruling really difficult. The analysis done by the WHO involves and concerns products consumed in important quantities in other countries, mainly in the USA and North of Europe, where culinary practices are different and the consumed ratios of fruit and vegetables are far from those recommended. However, in Spain the consumption of meat-products in which potentially dangerous products to which we will refer are found are on the range recommended by the WHO but fruit and vegetables consumption is rather higher.
- Regarding meat-products, nitrites/nitrates have been added to neither fresh meat, nor fresh sausages; however, such additives are used by mixing them in a homogeneous form with the meat mass or together with salt for meat-product curing. In figure 1A a summary of the nitrite/nitrate contents of some foods is shown. In figure 1B the total intake of additives considering the Spanish consumption of meat-products is summarized. This total intake is far from the maximum admissible daily intake of 3.7 mg/kg body weight (222 mg in a 60 kg person) (10).
- It must be also considered that, in their preparation, foods and antioxidant products such as paprika or ascorbic acid that can greatly lessen the negative effects of their consumption are used.

Now and before the WHO report on the toxicity/danger of processed meat the healthy consumption of these products is being and has been questioned. The most convenient mechanism that links meat and the development of cancer involves various components that are formed during cooking at high temperatures: heterocyclic amines (HCAs), polycyclic hydrocarbon aromatics (PHAs) and N-nitroso-compounds (NOCs) (5).

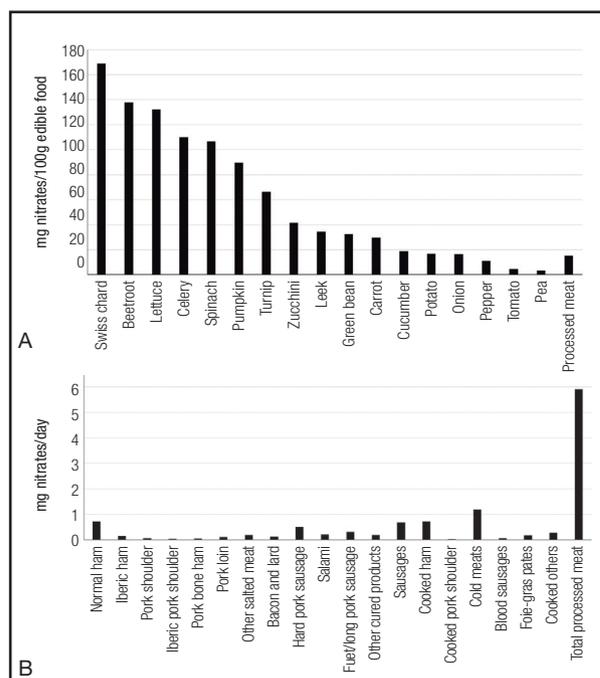
With respect to HCAs, this relationship is not easily established as the amounts considered to be carcinogenic for animals are

Table I. Spanish homes' meat consumption in 2014 (9)

Consumption in Spain (homes)	Consumption per capita (g/day)
Total meat	140.18
Certified	12.81
Fresh meat	103.51
Bovine meat	16.17
Veal	12.23
Baby beef	2.92
Beef	1.03
Chicken	38.93
Rabbit	3.83
Goat/lamb	4.90
Pork	29.51
Despoilments	2.38
Other fresh meat	7.79
Frozen meat	3.89
Processed meat	32.78
Normal cured ham	4.04
Iberian ham	0.84
Cured pork shoulder	0.42
Iberian pork shoulder	0.24
Pork bone ham	0.32
Pork loin N+ IB*	0.60
Other salted meat	1.14
Bacon and lard	0.68
Hard pork sausage	2.87
Salami	1.19
Fuet/long pork sausages	1.78
Other cured products	1.11
Sausages	3.79
Cooked ham	4.04
Cooked pork shoulder	0.19
Cold meat	6.57
Blood sausages	0.38
Foie-gras and pâtés	1.04
Others	1.54

*N + IB: Normal plus Iberian.

much higher than eating reasonable amounts of fried foods (11), thus, the extrapolation to human cancer requires caution. It has to be pointed out that temperatures used in some studies gathered

**Figure 1.**

A. Average content of nitrites and nitrates (mg/100 g edible portion) of some selected highly consumed foods in Spain (14). B. Average intake (mg/day) of nitrites y nitrates expressed as nitrates. Data have been calculated considering results from Spanish homes (9) together with a 20% contribution of extramural consumption.

by the WHO in the HCAs are really high (e.g., 280 °C) and far from those used in habitual frying in the Mediterranean diet.

PAHs are formed when food is directly cooked in the fire, and in much less an amount when performed by any other cooking procedure. In the worst of scenarios evidence relating colon cancer with such products is relatively weak (12).

NOCs are originated when nitrites and nitrogen oxide react with secondary amines and N-alkylamides (13). These are the most controversial compounds and require a more exhaustive study.

Epidemiological studies in humans have intended to reveal a direct relationship between nitrite and/or nitrate consumption and NOC formation with cancer development; nonetheless, non-conclusive results have been found, possibly due to difficulties in establishing time-extension and exposition levels (5).

Nitrates are present in natural form in foods; several plants store nitrates and nitrites in leaves and stems (Fig. 1A). Despite this, the European Food Safety Authority (EFSA) recommends increasing their consumption due to their implicit health benefits (14). Water can also contain nitrates. All these foods relevantly contribute nitrates that can be reduced and accumulated in saliva (13). Twenty-percent of nitrate arriving in the mouth (5% of the amount ingested) is reduced to nitrite by the nitrate reductase enzyme activity of the mouth microbiota (15). Thus blaming only meat products on their negative impact on health seems excessive.

One of the major functions of nitrites/nitrates is meat derivate preservation by virtue of their anti-microbial effect; perhaps this is the most powerful argument for their use, as consumer health is compromised. They have an effect on anaerobic bacteria, mainly on *Clostridium botulinum*, impeding spore germination and avoiding neurotoxin formation responsible for deadly botulism. In addition, they also inhibit other pathogen microorganism such as *Staphylococcus aureus* (16) and *Clostridium perfringens* (17), responsible for gastrointestinal infections and necrotic enteritis, respectively.

These additives intervene in color stabilization (13), nitrite being the main responsible for the rosy-red color of such products which is very appreciated by consumers, improving taste and flavor of cured products and reducing the use of other flavor enhancers such as NaCl.

One more thing must be added: their antioxidant role inhibiting lipid autooxidation (18). When nitrite joins haem iron, it keeps its ferrous status avoiding its oxidation.

The WHO communiqué is centered on the idea that the use of these additives implies some health risks, mainly related to cancer:

- Nitrites at high doses are toxic (2 g can produce death in human) as they produce methemoglobin, that fails in capturing and ceding oxygen, causing hypoxia.
- Another risk is related to N-nitrosamine formation. Those substances are formed by nitrosation of amine, amide and other nitrogen-containing-compounds (10,13). Nitrates are the most common nitrosating agents. The majority of N-nitrosamines possess toxic activity, genotoxic and carcinogenic for an ample number of animal species, including primates (13). However, nitrosation is a complex phenomenon influenced by different factors such as temperature, pH, nitrosating agent activity and the amount and type of amine.
- Gastric pH and high cooking temperatures stimulate nitrosation. At the same time inhibitor agents such as vitamin C block its reaction (13). Salt also exerts a protecting role (13).
- Food heating is another factor accelerating N-nitrosamine formation. However, this is probably the most controversial aspect when evaluating the risk of nitrites and nitrates as additives. The higher the cooking temperature, the higher the nitrosation, thus some culinary treatments are more aggressive than others performed at lower temperature and for shorter periods. Nonetheless, N-nitrosamines are rather volatile; thus, elimination is accelerated when non-hermetic recipients are used during cooking (13).

However, it has also to be taken into account that nitrites elimination as additives does not exclude them from the body, as we have endogenous production. Usually, we take in less than 3 mg/day of nitrites from foods but we secrete 12 mg/day in the saliva and our intestinal microbiota produces about 70 mg/day (15). Therefore, to correctly evaluate N-nitrosamines toxicity all exposures need to be addressed, which is really complex.

We want to highlight that the potential relationship between cancer and meat consumption has been already known for decades, particularly in circles linked to these kinds of products. The

WHO communiqué adds almost nothing new. Thus, we wonder what is under the hat of such an impressive *mise-en-scène*. Why was news presented to the journalist months before the definitive publication of the complete article? And what seems even more important: does anybody, who is not related to the meat sector, remember any such news yet? After the communiqué, have Spanish people changed, for longer than a week, their consumption habits? Absolutely not!

Taking into account these premises, we recommend the following:

- Reducing the nitrite/nitrate presence in food to the maximum, without implying loss of protection against botulism and other infection risks.
- Including nitrosation inhibitors in meat-products, such as vitamin C and other antioxidants.
- Performing thermal treatment as mild as possible by avoiding high temperatures and incorrect culinary practices that would increase NOCs content.
- Performing cooking processes in open-cup recipients to permit N-nitrosamine exit, and avoiding consumption of fat leached from foods during cooking.
- Recovering the Mediterranean diet in its more ample sense: an important base of vegetable products consumption assuring consumption of spoon-dishes (e.g., *cocidos*, *paellas*) where meat and meat products are of high quality and consumed in moderate quantities.
- Avoiding excessive consumption of one-type food, which reduces diet variety and quality. According to Professor Grande Covian, the key to correct nutrition is “eating any food type but in a small dish”.

Thus, research on meat-products –addressed to reduce potential negative compounds and to incorporate functional ingredients in order to improve their quality and health properties– deserves all scientific and institutional support.

When communiqués such as the WHO's are issued by the media, we often forget food symbolism and its implication on alimentary behavior and health. While, for example, in the UK weather is the conversation topic par excellence, in the Mediterranean basin it is food. All Spaniards talk about nutrition. According to Cruz and Cruz (7), food is a symbol for us, something representing generational safety and a pleasure to be shared (19). That means that any alimentary alarm can have very negative implications, especially for people for whom some central foods mean safety, prestige, health, as they definitively contribute to their wellbeing and that of their family (19). In conclusion, when a scientific entity such as the WHO is showing that a food considered to be good or very good or healthy, generation after generation, is potentially/ really carcinogenic, the disarray becomes maximum and the credibility minimum, contributing to people not knowing what to eat. This is highly potentiated when part of the information is skidded, shown out of context and sold as news.

In conclusion, and with no intention of knocking the Danish prince, we can dispel all doubts and answer the question “Eating meat?” with a categorical “Yes, but in moderation and with the correct processing measures and culinary treatment”.

ACKNOWLEDGEMENTS

We acknowledge María Sánchez's collaboration and the support of the "Nutrition and Cardiovascular Health #920536" research group of excellence of the Universidad Complutense de Madrid and the Spanish Project AGL 2011-29644-C02-01.

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