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Environmental and Health Cost of Meat: How to Reduce Consumption?

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Abstract

Meat consumption is increasing as global diets change with accompanying environmental and health concerns. Meat production involves the use of antibiotics and additives to promote weight gain and to avoid infectious diseases in livestock; antibiotic resistance is a major concern, as many producers place profit over human and environmental safety. The environmental footprint of producing meat goes from water pollution to deforestation, greenhouse gases, use of energy and fossil fuels. A reduction of meat consumption, particularly beef, can benefit the environment by reducing carbon emissions, pollution, habitat and biodiversity loss, also benefit human health by reducing risks associated to the consumption of meat and meat products. To achieve this goal, it is necessary to consider individual and cultural differences, and to investigate meat consumption drivers and beliefs. Efficient and effective interventions can be designed and applied to target groups, not to the general population. It seems more feasible to promote an informed substitution of meat with plant-based diets instead of seeking to reduce consumption itself.

ABBREVIATIONS

CF: Carbon Footprint; CVD: Cardiovascular Diseases; FDA: US Food and Drug Administration; GGH: Greenhouse Gases

INTRODUCTION

There is a large body of research showing that excessive consumption of meat, particularly beef, is harmful to the environment. This because meat production is one of the main factors contributing to the production of green house gases, it causes deforestation, and loss of ecosystem sand biodiversity [1]. It is also well known, that meat consumption has health consequences because of the use of additives, hormones, and antibiotics in livestock. However, the average person worldwide consumes an estimated 48 kg/105 lbs. of meat annually, and an increase from 29% to 35% is expected in the consumption of animal based products by 2030 [2].

Frequency of meat consumption varies throughout the world as it seems to be related to countries' cultural, geographical and economic features. In the coming years the highest increase in consumption is expected from developing countries [3], because meat consumption tends to increase with economic development [4]. It is possible that the demand for meat will double in developing countries by 2020 [5].

Excessive meat consumption has negative health impacts [6]. Therefore, a decrease in red meat consumption has begun in some developed countries [7] mainly due to health concerns [8] related to the use of antibiotics and additives in the livestock industry, and to environmental risks such as climate change [9]. In addition, aging population's diet restrictions, and an enhanced awareness of meat consumption health risks, are likely to result in a slowing consumption growth [3]. Furthermore, a reduction in meat consumption could have benefits for developing countries. It could improve food security by reducing cereal prices and raising cereal consumption, increase food availability, and lead to shifts in dietary preferences [5].

ENVIRONMENTAL FOOTPRINT

Meat production causes severe environmental problems. Livestock production, including feed crops, currently use almost a third of the world's entire land surface [10,11], and a third of the global cereal production [12]. The conversion of natural ecosystems into pasture fields and industrial production crops results in habitat and biodiversity loss [13,14]. Once vegetation cover is lost, there is extensive soil erosion and downstream sedimentation of waterways, streams, and coastal habitats followed by the concomitant loss of biodiversity [15-17]. Fertilizers used in cattle feed crops and pastures, as well as manure from industrialized cattle production, end up in rivers and coasts causing eutrophication and oxygen depletion, resulting in dead zones where habitat is compressed and fauna is lost [16,18].

Feedlot operations not only contaminate soil and water, they can also pollute air and cause bad odor affecting the health and the quality of life of the surrounding communities [19].

Meat is the food product with the greatest environmental impact [11,20] due to the large amount of greenhouse gases [GHG] and its Carbon Footprint [20]. Livestock production is responsible for an equal amount of greenhouse gas emissions to that emitted from transportation (14.5%) [21,22]. The processes with the major contribution to GHG emissions during meat production are: 1) deforestation and desertification, resulting from the crops for livestock feeding [10]; 2) manure handling that pollutes soil and water; 3) energy used in pens[11,21,23]; and 4) enteric fermentation from the digestion of ruminants, which produce methane [11,24].

CLENBUTEROL

Clenbuterol is an additive used by producers of cattle, sheep, pigs and chicken, to increase muscle mass and protein content, to increase weight, growth speed and to reduce fat content in meat [25,26]. Clenbuterol is useful to satisfy lean meat demand, which brings several economic benefits for producers, making it a common practice in livestock rearing although its use is commonly illegal [25].

High amounts of Clenbuterol in meat have serious effects on human health such as tachycardia, necrosis of heart muscle, muscular tremors, nervousness, headaches, vomit, and fever [27,28]. There has been reported several cases of intoxications by the consumption of meat with added Clenbuterol [29-32], and as possible source for inadvertent doping in sports, especially in countries like Mexico and China [33,34].

ANTIBIOTICS

Livestock producers use antibiotics to treat, prevent, and control animal diseases and to increase the productivity of animals and production operations. The indiscriminate use of antibiotics causes bacteria to become resistant and contributes to the spread of drug-resistant pathogens in both, livestock and humans [35,36]. The use of antibiotics in animals represents a threat to public health, since resistant pathogens in animals may be transmitted to humans, and cause treatment failures [23,36]. Eighty percent of the antibiotics sold in the United States during 2009 (13.1 million kilograms) were used on farms [37]. In 2012 the US Food and Drug Administration (FDA) recommended a greater restriction in the use of antibiotics for livestock, resembling regulatory authorities in countries from the European Union [38].

NITRITES AND SODIUM

High consumption of red meat, especially processed meat, may increase all-cause mortality [39]. Processed meats are an important source of sodium in a diet (an average of 846 mg/100g) [40], since contain about 400% more sodium and 50% more nitrates per gram than non-processed meat [41].The meat industry uses brine injections to enhance and tenderize meat [42]. Depending on the type of meat, cut and final use, brine proportion can vary. Brines contain an alkaline base (sodium chloride) or a phosphate base (sodium phosphate) [43,44]. This process adds extra sodium and phosphates to meat cuts and products. Processed meat consumption could increase the risk of cardiovascular diseases, due to the blood-pressure effects of sodium [45,46], because high sodium consumption is a well-recognized factor for the development of hypertension [45].

Sodium nitrite is use to cure meat, it fixes color, influences flavor and is a bacteriostatic and bactericidal agent [47]. Several studies have found an association between total red meat and processed meat consumption, with type 2 diabetes risk [48-50]. Nitrates and their derivatives have been reported to be associated with insulin resistance, endothelial dysfunction, type 2 diabetes and some types of cancer [48]. They may also have a toxic effect on pancreatic beta cells, mediated by the formation of nitrosamines in the stomach or in the meat product itself [51]. Nitrosamines could also be formed during meat cooking, with the production of carcinogenic heterocyclic amines (HCAs) and/or polycyclic aromatic hydrocarbons (PAHs) [51,52]. Additionally, heme iron could also promote the endogenous formation of nitrosamines [51] .

The International Agency for Research on Cancer Working Group has reported plenty of evidence about the carcinogenicity of processed meat [53]. High consumption of red meat and processed meat is associated with an increase in the risk to develop colorectal [54], pancreas, prostate and stomach cancer [53]. If red meat nitrite is added to the daily nitrite consumption, bladder cancer risk raises too [51].

PHOSPHATES

Phosphate additives are used in the meat industry as preservatives, and its use has been increasing [55]. Phosphates reduce prepared/cooked/processed food losses, delay the oxidative rancidity, maintain color, improve protection against microbial growth, and improve textural properties [56].

Phosphates are found mainly in protein-rich foods. Processed meat have large amounts of added phosphate which, contrary to organically bound phosphorus from natural sources, is absorbed very effectively in the gastrointestinal tract causing damage to the cardiovascular system [55,57]. Current eating habits with high consumption of processed foods (including soda, canned fish and processed meats), represent a growing health risk because of the excessive phosphorus consumption. Phosphate can also disrupt the hormonal regulation of phosphorus, calcium, and vitamin D, contributing to impaired peak bone mass and bone resorption, raising the risk of fractures [58]. However, health risks could be reduced if the real amount of natural or added phosphorus contained in food was clearly reported [56].

FAT

Fat content of meat can vary depending on species, feeding, cut and other factors. However, the lipid content of lean meat nowadays is about 5%. This is not the case of meats products, which can contain up to 40-50% fat [59]. Saturated fat (animal origin foods as main source) and *trans*-fatty acids (from beef, lamb and derived products) could have a detrimental effect in the development of type 2 diabetes due to adverse metabolic effect on insulin sensitivity [51].

CHALLENGES

Population growth and changes in diet are leading to the consumption of more livestock products [12,60]. Complex carbohydrates like whole cereals, roots or tubers, are being replaced with refined flours, vegetable oils, sugar and animal products [60]. As income increases so does the consumption of meat in most countries [10,11,61,62]. In developed countries meat consumption per capita is 80 kg/year while it is only 27.9 kg/year in developing countries [12]. In low income groups, people consume low quality meat or processed meats [63], and in developed countries, processed meat products account for almost half of all meat consumed [60]. Meat production and consumption by modern societies carry an array of environmental and health problems [10].

Despite the large amount of information on the environmental and health risk of meat consumption, it is difficult to achieve a reduction. People´s perception of meat as healthy food appears to be an obstacle to consumers in moderating their meat consumption [62]. Also, many consumers consider meat products to be an important source of nutrients and a traditional component of their diet [64].

According to Onwezen & Van der Weele [9], there are different kinds of consumers. *In different consumers* who are not worried about their consuming patterns; *struggling consumers* who experience conflicting thoughts and accompanying negative emotions between avoiding or reducing consumption and the desire to eat meat; *coping consumers* capable of changing their behavior, and *strategically ignorant consumers* who ignore the meat-related issues. The existence of different kinds of consumers make intake reduction much harder. Moreover, livestock marketing strategies and lobbying of the meat production chain put pressure on governments and consumers making it difficult to establish plant-based diets [45].

To reduce health and environmental risks, a reduction in global animal product consumption is needed. People in developed countries must reduce their meat intake as per capita consumption is almost three times higher than in developing countries [12] [65,66]. On the other hand, developing countries are required to maintain stable consumption levels, not to increase per capita consumption, and reduce it if possible.

Currently dietary recommendations, even for developing countries, are focusing on patterns which include an increase of fruits, vegetables, nuts, whole grains, and fish consumption, and avoidance of processed food high in sodium, trans fatty acids and sugar [46].

If global ruminant numbers decrease, it could make a substantial contribution to climate change mitigation goals and would benefit society, public health and environment [22]. The extent to which consumers can become agents of sustainable change depends on the opportunities and incentives offered or created by the socio-cultural context of meat consumption [44].

DISCUSSION AND CONCLUSION

The social, economic, and geographical context as well as cultural differences among social groups, determine the behavioral and cognitive characteristics of individuals, as behavior is learned in the interaction of the subject in a particular social environment.

Researchers need to develop multifactorial and multilevel models to better understand the factors that encourage consumers to eat meat in order to design more effective interventions and policies for achieving a reduction in meat consumption as it requires a profound societal transition [67].

Trying to convince people to eat less meat may result in a resistance to change habits [68]. Health organizations have changed their message to the consumer, promoting the increase in plant-based food consumption, especially whole grains [69]. In order to reduce meat consumption, information campaigns probably should not focus on showing people the negative effect so meat consumption and promoting its reduction, but should promote knowledge about products that can replace meat, without affecting protein requirement or balance in diet. Pulses (beans, lentils, chickpeas and other legumes), nuts, seeds and whole grain cereals can replace the meat and fish products [69]. Mesoamerican diets were low in animal protein, however, basic amino acids were obtained by a combination of maize, beans, chili and zucchini [70]. Another example is the Indian vegetarian diet, which has an adequate content of essential trace elements compared to non-vegetarian oriental and western diets [71] and is also high in plant protein (pulses).

It is also necessary to consider individual and cultural differences to promote a change. Apostolidis & McLeay [67] found that information campaigns are useful instruments to increase consumers awareness and encourage substitution of meat [and the consequent decrease in consumption] if specific groups of consumers are targeted instead of targeting the average consumer.

If the different factors that determine meat intake are known and if the interventions are designed for specific populations, it will be more likely to partially replace meat consumption with plant-based substitutes. Promotion of traditional cuisine could have a better impact on people [69] and could be used to empower and gather communities.

Replacing meat intake with partially plant-based diet will reduce the impacts of meat production as it will reduce the number of animals to be reared [13]. Moreover, crops could be used for feeding human populations and not for animals [13,66]. Likewise, it is possible to replace consumption of cattle meat with pork or poultry, and aquaculture or high protein plants like legumes [10,12,13].

It is also necessary to reintegrate livestock production into diverse, coupled systems designed around the structure and functions of ecosystems that conserve energy and nutrients [13], and allocate resources to less environmental damaging alternative uses [65]. A healthy plant based diet worldwide could reduce the required area of arable land globally by 10%, and the area of grassland by 40%, compared to the FAO projections [72].

Population health especially in countries with high meat consumption, will benefit from a reduction in meat consumption due to all health and environmental implications of consuming

meat. Health risks have motivated groups in some countries towards a healthier diet with more plants and less meat [10]. In terms of the planet, at the moment, our best option to provide rapid and lasting climate benefits, is to encourage behavioral changes to reduce meat consumption [particularly ruminant meat] [22]. To achieve this, we need to investigate meat consumption drivers, the factors that motivate people to consume beef, and which beliefs are behind meat consumption. Based on this kind of research, efficient and effective interventions can be designed and applied to target groups.

CONFLICT OF INTEREST

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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