PUTATIVE PREJUDICIAL AND BENEFICIAL BIOLOGICALLY ACTIVE COMPONENTS OF RUMINANT MEATS

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Background

There has been recently an explosion of consumer interest in the health enhancing role of specific foods, containing beneficial biologically (physiologically) active components in addition to the nutrients, so-called functional foods [1]. In fact, all foods are functional, as they provide taste, aroma and nutritive value. However, within the last two decades the term functional has adopted a different connotation: that of providing an additional physiological benefit beyond that of meeting basic nutritional needs. The position of the American Dietetic Association (ADA) is that functional foods have a potentially beneficial effect on health when consumed as part of a varied diet on a regular basis, at effective levels [2]. ADA also refers that the knowledge of the effects of biologically active food components, both from plant and animal sources, has changed the role of diet in health. Functional foods have evolved as food and nutrition science has advanced beyond the treatment of deficiency syndromes to reduction of disease risks. However, each functional food should be evaluated on the basis of scientific evidence to ensure appropriate integration into a varied diet.

Ruminant meats (mainly, beef and lamb meat) have been suffered from a negative health image related to the nature of their lipid fraction (high fat content and undesirable balance of fatty acids). Rumen lipid metabolism, through microbial hydrogenation, originates the presence of saturated lipids and *trans*-fatty acids in ruminant tissues. Recently, scientific evidence has been accumulated that meat itself is not a risk factor for Western lifestyle diseases, such as cardiovascular diseases (CVD), but rather the risk stems from the excessive fat and particularly saturated fat associated with the meat of modern domesticated animals. In fact, Mann [3] reported that diets high in lean red meat can actually lower plasma cholesterol, contribute significantly to tissue n-3 polyunsaturated fatty acids and provide a good source of essential amino acids, iron, zinc and vitamins B_6 and B_{12}. Actually, ruminant meats contain a number of biologically active components with negative as well as positive properties, mainly in the class of lipids.

Objectives

Foods can no longer be evaluated only in terms of macronutrient and micronutrient intake, but the analysis of other biologically active components will be necessary [2]. In addition, research into the emerging area of physiologically active food components should be more widely and effectively communicated to the scientific community and consumers in order to advance public health. This work describes ruminant meat components that have been linked with human physiological drawbacks and benefits. The spread of this topic is very important among meat scientists and technologists in order to optimise public health, through healthier meat products, by improving animal nutrition and meat processing.

Discussion

Putative prejudicial bioactive components

The possible prejudicial bioactive components of ruminant meats are: total fat (calorific value), saturated fatty acids (SFA), *trans*-monounsaturated fatty acids (*trans*-MUFA), n-6 polyunsaturated fatty acids (n-6 PUFA) and total cholesterol (table 1).

Fat content, with a calorific value of 9 kcal/g, is the nutrient responsible for the high calorific values of some foods. The lipid content in edible lean meat today is less than 5%, contrarily to some meat products (20-30%), by that it can no longer be considered an energy-rich food [4]. In fact, nutritional guidelines suggest that dietary fat should provide between 15 and 30% of total calories and that each one of SFA and PUFA should be no more than 10%, and the remaining 10-15% should come from MUFA (WHO, 1990 quoted in [5]). Meat lipids usually contain less than 50% SFA, of which 25-35% have atherogenic properties, and about 50% of unsaturated fatty acids (MUFA and PUFA). The ratio between PUFA and SFA for ruminant meats (0.11-0.15) is below to that recommended for human diet (0.45). In the Mediterranean-type diet, approximately 34% of the calories come from lipids, 10% from SFA, 18% from MUFA and 6% from n-6 PUFA.

The n-6 (omega-6) PUFA include linoleic acid (C18:2), essential for humans, and arachidonic acid (C20:4). A too high value of n-6 PUFA to n-3 PUFA (higher than 2) is associated to an increased risk of CVD and cancer. The values of this ratio are comprised between 1 and 2 for ruminant meats, but is 7 for pork [6]. In fact, linolenic acid from fresh forrages is not completely converted by ruminant biohydrogenation to its saturated equivalent, stearic acid (C18:0), being also stored in significant amounts in ruminant tissues. The *trans*-MUFA, which are also formed by ruminant biohydrogenation, seem to increase the risk for some chronic CVD.

Meat cholesterol content, which has small variations between muscles and animal species, is about 50 mg/100 g [5]. It is also recommended, by World Health Organisation (WHO), that total cholesterol intake should not exceed 300 mg per day. Limitations in total fat and cholesterol intakes seem to decrease the risk of obesity and hypercholesterolemia, which are conditions that predispose to various chronic CVD. Additionally, a high-saturated fat intake seems to be associated with an increased risk for some malignant tumours, mainly colon, breast and prostate cancers.

Putative beneficial bioactive components

By another way, ruminant meats also contain several bioactive components which may have an important role in human health promotion, namely: *cis*-monounsaturated fatty acids (*cis*-MUFA), n-3 polyunsaturated fatty acids (n-3 PUFA), conjugated linoleic acid (CLA) and several vitamin-like substances (table 2).

The *cis*-MUFA seem to be beneficial for reducing plasma total cholesterol and total low-density lipoprotein cholesterol. In addition, oleic acid is positively related with meat flavour and palatability. The n-3 (omega-3) PUFA are an essential class of PUFA derived primarily from fish oil but also present in meat fats. The major n-3 PUFA are linolenic acid (C18:3), which is an essential fatty acid, eicosapentaenoic acid (EPA, C20:5) and docosahexanoic acid (DHA, C22:6). Canada has established the Canadian Recommended Nutrient Intake (CRNI) of n-3 PUFA at 0.5% of daily energy (*e.g.* 1.1 g/2000 kcal). It has been suggested that the Western-type diet is currently deficient in n-3 fatty acids, which is reflected in the current estimated n-6 to n-3 dietary ratio of 20:25-1, compared to the estimated 1:1 ratio on which humans evolved [7]. This has prompted researchers to examine the role of n-3 fatty acids in a number of diseases, particularly cancer and CVD. That n-3 fatty acids may play an important role in CVD was first brought to light when Bang and Dyerberg, in 1972, reported that Eskimos had low rates of this disease despite consuming a diet which was high in fat.

CLA, which was first isolated from grilled beef in 1987, refers to a mixture of positional and geometric isomers of linoleic acid (C18:2, n-6) in which the double bonds are conjugated instead of existing in the typical methylene interrupted configuration. These conjugated fatty acids are formed by ruminant *trans*-isomerization of plant linoleic and linolenic acids. Nine different isomers of CLA have been reported as occurring naturally in food, specially in ruminant fats. CLA is unique in that it is found in highest concentrations in fat from ruminant animals. Beef fat contains 3.1 to 8.5 mg CLA/g with the *9-cis* and *11-trans* isomers contributing 57-85% of the total CLA [8]. Interestingly, CLA increases in foods that are cooked and/or otherwise processed. This is significant in view of the fact that many mutagens and carcinogens have been identified in cooked meats. In the mammary tumour model, CLA is an effective anti-carcinogen in the range of 0.1-1% in the diet, which is higher than the estimated consumption of approximately 1 g CLA/person/day in the USA [1]. CLA isomers exhibit a protective effect also in atherosclerotic disease at a concentration similar to that found in food. Studies are being carried out to assess the health protecting effect of CLA in humans. More recently, CLA has been investigated for its ability to change body composition, suggesting a role as a weight-reduction agent, possibly by reducing fat deposition and increasing lipolysis in adipocytes.

Several compounds widely diffused in meats, the vitamin-like substances or conditionally-essential nutrients (L-carnitine, coenzyme Q_{10}, α-lipoic acid, choline and taurine), are deserving an increasing attention and have already been suggested as possible beneficial biologically active components [9]. The ergogenic agent carnitine, which is mainly present in meat, has a fundamental biological role as a long-chain fatty acid carrier across the mitochondrial membrane and in ketone body formation. Several considerations suggest that carnitine is a truly essential nutrient in infancy and in other situations where the energy requirement is particularly high, *e.g.* pregnancy and breast feeding. The knowledge of toxicity of these meat components is crucial to increase the benefit/risk ratio.

Conclusions

Increasing evidence supports the observation that ruminant meats may, beyond their nutritive role, enhance human health (functional foods). However, the field of functional foods is only in its infancy. Moreover, the presence of several bioactive components in ruminant meats, in some cases with antagonic effects, complicate the establishment of a strong scientific basis. Additional research is necessary to substantiate the potential health benefits of those meat components for which the diet-health relationships are not sufficiently scientifically validated. Anyway, ruminant meats seem to be a healthy and beneficial component of any well-balanced and varied human diet.

Pertinent literature

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Table 1. Possible prejudicial biologically active components in ruminant meats and their suggested risks for human health.

PUTATIVE PREJUDICIAL BIOLOGICALLY ACTIVE COMPONENTS	SUGGESTED HEALTH RISKS
Total fat (calorific value)	Increase risk for obesity, hypercholesterolemia and CVD
Saturated fatty acids	Increase risk for CVD and cancer
***trans*-Monounsaturated fatty acids**	Increase risk for CVD
n-6 Polyunsaturated fatty acids	Increase risk for CVD and cancer
Total cholesterol	Increase risk for obesity, hypercholesterolemia and CVD

Table 2. Possible beneficial biologically active components in ruminant meats and their suggested benefits for human health.

PUTATIVE BENEFICIAL BIOLOGICALLY ACTIVE COMPONENTS	SUGGESTED HEALTH BENEFITS
***cis*-Monounsaturated fatty acids**	Reduce risk for hypercholesterolemia and CVD
n-3 Polyunsaturated fatty acids	Reduce risk for CVD and cancer
Conjugated linoleic acid	Reduce risk for CVD and cancer, weight-reduction agent
Vitamin-like substances (*e.g.* carnitine)	Ergogenic agent