The interest of meat in the diet of seniors

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Abstract

There seems to be a consensus for a reduction in the consumption of meat products in developed countries. However, due to the specific nutritional needs of the elderly, the place of meat products in their diet requires special attention. Indeed because of its high content in bioavailable minerals such as iron and zinc, and its high content in B vitamins, meat helps to reduce dietary inadequacies in these micronutrients, and their health consequences. This is particularly the case of anemia, a significant part of which is explained by insufficient intakes of iron, vitamins B12 and B9 in the elderly. In addition, most of the epidemiological studies shows a protective effect of meat consumption against skeletal muscle loss of mass and function, because of its high content in proteins of good nutritional quality. While too high consumption of meat products may unbalance the diet reducing the share of plant products, and expose to higher risks of non-communicable diseases, regular consumption of moderate quantities of meat ensures that specific nutritional requirements are met, and prevents the development of anemia and sarcopenia in the elderly.

Keywords: anemia, elderly, iron, meat, protein, sarcopenia

Key points

- Meat: a balanced supply of indispensable amino acids with high digestibility that can boost protein anabolism in the elderly
- Meat: a food of choice to fight sarcopenia and anemia in the elderly
- Meat preparation: a key point for meat to remain present as long as possible in the diet of the elderly.

Elderly people tend to reduce meat consumption for multiple reasons (loss of sense of smell and taste, development of food aversions, chewing difficulties, …). And this trend could be exacerbated in the current context of meat denigration, due to public concerns about animal welfare, environmental impact of livestock farming, and human health.

One of the characteristics of aging is the progressive loss of skeletal muscle mass and function, called sarcopenia. Sarcopenia is diagnosed by a low body percentage of muscle mass (less than 2 times the standard deviation of the mean observed for a young adult of the same sex), impaired muscle strength and performance, and by low movement speed (Cruz-Jentoft et al, 2018). According to studies (depending on the measurements performed and the geographical area considered), the prevalence of sarcopenia over 60 years of age varies from 1 to 29% in people living at home and from 14 to 33% in people living in long-term care units (Cruz-Jentoft et al, 2014). The health consequences of sarcopenia have been the subject of a systematic review of the literature (Beaudart et al, 2017), which showed that the increased risk of functional disability in elderly people with sarcopenia is accompanied by an increase in the rate of falls and the incidence of hospitalizations. This translates into an accelerated onset of dependency and an increased mortality rate among people with sarcopenia. The report of a group of experts clearly highlights the link between nutrition and muscle strength and mass, underlining the important role nutrition can play in the prevention and treatment of sarcopenia (Robinson et al, 2018).

Anemia is another common problem in the elderly. Anemia is diagnosed by hemoglobin concentration<12 g/dl in women and <13g/dL in men (WHO, 1968). Its prevalence was reported to range from 12% in the community to 40% in patients admitted in the hospital and 47% in nursing home residents (Gaskell et al, 2008; Bach et al, 2014). It increases with advanced age (Gurlanik et al, 2004; Bach et al, 2014). About one-third of anemias in the elderly is associated with nutritional deficiencies, including iron deficiency, cobalamin (B12) deficiency, and folate deficiency (Patel, 2008). Part of these deficiencies can be attributed to a poor dietary intake of these nutrients. Like sarcopenia, anemia in the elderly is associated with a number of adverse health outcomes, such as falls, physical performance decline, dementia, and cardiovascular diseases.

This chapter will illustrate how important it is for the elderly to maintain, as much as possible, reasonable amount of meat in their diet to meet nutritional requirements and to minimize the risk of developing sarcopenia and anemia.

Interest of meat proteins in covering body requirements

Proteins

Meat is above all an excellent source of protein. Along with fish, meat is the fresh food that contain the most proteins. These proteins are particularly rich in indispensable amino acids with a distribution close to that of human needs, from children to adults. This means that the indispensable amino acids in meat can be used with great efficiency to increase or renew body proteins and cover most needs. In addition, the digestion of meat proteins, measured at the ileal level in human, is high (90-94%; Silvester & Cummings, 1995; Oberli et al, 2015), ensuring a high bioavailability of amino acids. Moreover, meat does not induce gastrointestinal reactions that could increase the loss of endogenous proteins in the digestive tract (secretions, desquamation of the intestinal mucosa), as can occur with foods of plant origin rich in fiber, or containing lectins. Therefore, meat is a source of dietary protein that is very efficiently assimilated by the body. Modest quantities can satisfy almost all the daily needs in proteins and indispensable amino acids of an adult. In addition, the high content of meat in certain indispensable amino acids, such as lysine or histidine, can make it possible to rebalance diets based on foods less well provided with these amino acids, such as cereals for example.

Because of the key role of contractile proteins in maintaining the animal's position and motor skills, their amino acid sequence, dictated by the genetic code, is one of the most conserved during evolution. Thus, the amino acid composition of meat (regardless of species, breed, or farming method) varies very little. It should however be noted, that it can be slighhtly affected by the collagen content of the meat (up to 20% in cheek), which has a very specific amino acid composition (low in indispensable amino acids, deficient in tryptophan, rich in proline, hydroxyproline and glycine). Thus, the richer the meat is in collagen, the less indispensable amino acids it contains.
It is also interesting to note that protein digestibility is little affected by meat cooking conditions (Oberli et al, 2015; Bax et al, 2013; Hodgkinson et al, 2018).

Meat is thus a food of choice to fight against protein-energy malnutrition which affects a very significant proportion of the elderly population. Epidemiological studies show that 5% of elderly people living at home are malnourished, and that malnutrition affects more than 1/4 of elderly people living in institutions (Rémond et al, 2015).

Although national agencies currently consider that there is insufficient evidence to propose different amino acid recommendations for the elderly, data in the literature suggest an increased requirement for certain amino acids. For instance, an increased demand for sulfur amino acids was observed in healthy elderly (Mercier et al, 2006), probably explained by an elevated level of oxidative stress during aging and an increased demand for glutathione synthesis, a cysteine-containing tri-peptide which is the main antioxidant molecule of the body. In addition, glutathione and sulfate derived from amino acids are involved in the metabolism of drugs, such as paracetamol, the most frequently used analgesic in the elderly. This could further increase sulfur amino acid requirements in the elderly (Mast et al., 2018). Meat, rich in sulfur amino acids, could be interesting to meet this specific need, especially since it contains a significant amount of glutathione.

Minerals and vitamins

None of the nutrients traditionally considered to establish a balanced diet are specific to meat. As such, meat products are not strictly necessary in the human diet. However, beyond their high content of good quality proteins, their nutritional assets are their high content of minerals (iron, zinc, selenium, ...) and vitamins of the B group, such as vitamin B12 which is specific to animal products.

Meat are excellent sources of iron. Indeed, the heme iron present in meat (40-70% of total iron depending on the animal species) is more bioavailable than that of plants. The bioavailability of dietary iron depends on its solubility (low for non-heme iron) and its release from the food matrix. Depending on body iron reserves, it varies from 15 to 35% for heme iron and from 2 to 20% for non-heme iron (Carpenter & Mahoney, 1992). In addition, iron absorption can be promoted by the presence of ascorbic acid or meat, and inhibited by the presence of phytic acid, polyphenols or calcium (Moretti, 2017). Being naturally in chelated form, the absorption of heme iron is less sensitive to other constituents of the meal and generally presents less variability than that of non-heme iron. Thus, although heme iron only contributes 10-15% of ingested iron, due to its high bioavailability its contribution to available iron has been estimated to be over 40% in an omnivorous diet (Hurrell and Egli, 2010). Although in the context of a balanced diet, rich in non-purified plant products, meat intake is not in itself essential for a good iron status, a moderate intake of red meat will thus limit the risk of deficiency. A recent meta-analysis shows that vegetarians, and even small meat eaters, have lower levels of iron stores than non-vegetarians (Haider et al, 2018).

Meat also provides significant amounts of zinc (2.7-6.8 mg/100 g beef) and selenium (9.8-14.6 µg/100 g beef) (Bauchart et al, 2008). Zinc is present in plant and animal products, but the presence of phytic acid in plant products, as with iron, severely limits its bioavailability. Epidemiological studies thus show both lower zinc intake and lower serum zinc concentrations in vegetarians, and even more so in vegans, than in omnivores (Foster et al., 2013). Zinc is involved in many biological functions, and zinc deficiency is a global public health concern (WHO, 2002), particularly because of the links between zinc and the immune system (Sanna et al, 2018).

Because vitamin B12 is not present in plants, the prevalence of inadequate intake is higher in vegans and to a lesser extent in vegetarians compared to omnivores (Pawlak et al, 2014; Allès et al, 2017). Vitamin B12 deficiency affects about 15% of the elderly population (Lindenbaum et al, 1994). They can be explained by alterations in the absorption mechanisms of this vitamin (Rémond et al, 2015), but also by insufficient intake. Meat, and more particularly ruminant meat, which is often rejected by the elderly, is an excellent source of vitamin B12.

Modeling the contribution of meat to global nutrient availability is a good illustration of the nutrient density of meat, indeed while it constitutes only 7% of the total food mass, it provides 56% of the vitamin B12, 24 % of the vitamin A, 15% of the vitamins B1 and B2, 13% of the vitamin B6, 19% of the zinc, 18% of the selenium and 13% of the iron (Smith et al, 2022). This contribution, based on gross composition of meat, is largely increased when considering the bioavailable of these nutrients (Dave et al.2021).

Interest of meat in in preventive nutrition for a healthy ageing

Sarcopenia prevention

A consensus thus seems to emerge on the fact that the requirement for protein is increased in the elderly not only to maintain skeletal muscle mass (Traylor et al, 2018), but also to maintain muscle functionality (Coelho-Junior et al, 2018). Despite this increased requirement, there is generally a decrease in protein consumption with age, largely related to a decrease in meat consumption. This is largely explained by the appearance of chewing difficulties, a change in sensory preferences, and a loss of strength and manual dexterity (Appleton 2016).

The mechanisms involved in the development of sarcopenia are multiple, but all result in an imbalance between muscle protein synthesis and degradation. This imbalance can be partly explained by a decrease in the anabolic response linked to food intake, called anabolic resistance. Indeed, in elderly subjects, the installation of resistance to stimulation by nutrients and hormones results in an increase in the threshold for triggering muscle protein anabolism (Dardevet et al, 2012). Protein synthesis can still be stimulated, but with a higher input of stimuli. To recover, or at least improve postprandial muscle anabolism in the elderly, the nutritional strategies developed therefore consist of optimizing the kinetics of amino acid appearance during meals, in order to exceed the stimulation threshold (Dardevet et al., 2021). For this purpose, it is recommended to ensure a minimum intake of 25-30g of protein per meal (Paddon-Jones et al, 2015) and to prefer rapidly digested proteins (Dangin et al, 2003). To ensure a minimum protein intake, due to its high protein density and its high content in indispensable amino acids, well balanced with respect to the body's requirements, meat is of course a food of choice. A 113-g serving of lean beef was shown to be sufficient to trigger muscle protein (Symons et al, 2009). And, at similar protein intake, meat was shown to be more effective to trigger muscle protein synthesis than a plant protein source such as soybeans, which is yet a good source of indispensable amino acids (Phillips, 2012). Although little data is currently available on meat proteins, it seems that meat can be considered as a source of rapidly digested proteins (Rémond et al, 2007). It should be noted, however, that a significant decrease in chewing efficiency, accompanied by swallowing less unstructured pieces of meat, can slow down the rate of digestion. This slowing down is detrimental to the elderly as it is accompanied by a lesser use of absorbed amino acids for postprandial protein synthesis. Nevertheless, mincing of meat can compensate for the decrease in chewing efficiency, and has been shown to accelerate the rate of digestion and improve the assimilation of meat protein in the elderly (Pennings et al, 2013). Similarly, the speed of digestion can be modulated by cooking (Bax et al, 2013). This effect is not linear, but seems to follow a 'bell-shaped' evolution, the highest digestion rate being observed for a cooking temperature of about 75°C. This evolution could be explained by a progressive denaturation of proteins for cooking temperatures up to 75°C, then by the formation of molecular aggregates for very high temperatures (above 95°C), following the implementation of oxidation processes. These phenomena lead respectively to an increase, then to a decrease of the accessibility of the digestive enzymes to their cutting site (Bax et al, 2012). The differences in speed generated by cooking are sufficient to cause differences in protein assimilation in the elderly. It has been shown that rare meat is less well assimilated by the elderly than well-cooked meat (Buffière et al, 2017).

In addition, meat is characterized by high levels of creatine, carnitine, conjugated linoleic acid and histidine-containing dipeptides, molecules that are essential for proper muscle function and potentially interesting for preventing sarcopenia (Rondanelli et al, 2015; Rémond et al, 2015). The histidine-containing dipeptides, carnosine and anserine, are present exclusively in animal tissues. Beside their buffering capacity, they have the potential to suppress many of the biochemical changes occurring during aging, such as protein oxidation, glycation, and cross-linking, and associated pathologies (Hipkiss 2006). Carnosine could thus play significant role in maintenance of muscle function during aging. However, carnosine content of skeletal muscle was reported to decrease during aging (Tallon et al, 2006), and one explanation could be the reduced meat intake (Everaert et al, 2011), muscle carnosine being highly responsive to its availability in the diet (Harris et al, 2012).

Recently, taurine was also proposed as a good candidate to counteract sarcopenia (Scicchitano & Sica, 2022). Because taurine can be synthesized within the body from sulfur amino acids, it is not considered as an indispensable amino acid, but human capacity for taurine synthesis is limited, which makes it considered as semi-indispensable. It is involved in many biological processes such as cell signaling, membrane stability, calcium-dependent excitation-contraction process and antioxidant defense. Because of its pleiotropic effects, taurine could also play a neuroprotective role during aging, reventing age-related decline in cognitive function (El Idrissi et al, 2013). Meat is one of the most important sources of taurine in the diet (Laidlaw et al, 1990), and taurine in plasma and urine was reported to be lower in vegans than omnivores (Laidlaw et al, 1988). Finally, a link between vitamin B12 status and sarcopenia has been suggested (Ates Bulut et al, 2017).

A systematic review of observational and interventional studies evidence strong and consistent beneficial effect of lean red meat on muscle mass (Granic et al, 2020). Another study suggests that the consumption of less than one portion of meat products per day (100-150g/d) (red meat, hamburgers, sausages or cold cuts; or eating more red meat, hamburgers, sausages or cold cuts than rabbit, chicken or turkey instead of beef, pork hamburgers and sausages) resulted in an increased risk of sarcopenia (Marcos-Pardo et al, 2021). As discussed above, this effect could be explained by the very high content of meat in proteins of good nutritional quality, by a speed of digestion that favors postprandial anabolism, and by the presence of intrinsic factors able to promote skeletal muscle function.

Anemia prevention

The etiology of anemia is multifactorial (Stauder et al, 2018) but can have nutritional origins, iron deficiency (microcytic anemia, reduction in RBC size), but also vitamins B12 and B9 (macrocytic anemia, increase in RBC size). Prevalence of anemia is gradually increasing from 15% to 37% between 65 and over 90 years of age, and iron deficiency anemia accounts for about 15% of cases of anemia observed in the elderly (Bach et al., 2014). Iron deficiency occurs when the body's needs cannot be met by dietary iron intake. Anemia is the final stage of iron deficiency. It was reported that iron deficiency anemia led to more hospitalizations, falls and mortalities than non-nutritional deficiency anemia (Sklarz et al, 2021).

Without reaching the stage of anemia (normal hemoglobin level), an iron deficiency can have negative consequences on health: this is iron deficiency without anemia. Iron deficiency without anemia is diagnosed by a decreased ferritin (<30 µg/L), a reduced mean corpuscular hemoglobin volume and concentration, an increased percentage of hypochromic erythrocytes (<2%), and an increase in soluble transferrin receptors. Iron deficiency without anemia can result in unexplained fatigue, impaired cognitive function, and decreased physical abilities (Shoppi, 2018). It was recently reported that iron deficiency is an independent risk factor for fatigue and poor functional recovery among older hospitalized patients (Neidlein et al, 2021), and that anemia could be independently associated with sarcopenia, and most particularly dynapenia (age-related loss of muscle strength) (Jang et al, 2022).

Although the regions of the world where iron deficiency anemia is highest correspond to regions where meat consumption is lowest, there is no large epidemiological study linking the consumption/non-consumption of animal products to anemia. In contrast, many epidemiological studies have focused on the relationship between diet and iron status, with iron status typically assessed on the criterion of serum ferritin concentration. A recent meta-analysis of these studies (Haider et al., 2018) highlights lower serum ferritin concentrations, and thus poorer iron status, in vegetarians than in omnivores (on average 29.7 µg/L less serum ferritin). The inclusion of semi-vegetarians (meat consumption at most once a week) did not change this result much (on average 23.27 µg/L less serum ferritin). The study also confirms that the risk of iron deficiency without anemia (ferritin < 30µg/L) is higher in vegetarians than in omnivores. More recently, a large study in middle-aged adults, in UK, evidenced lower risk of iron deficiency anemia with unprocessed red meat and poultry meat consumption, for each 50 g and 30g higher daily intake respectively (Papier et al., 2021)

Epidemiological studies have also focused on the relationship between heme iron intake and iron status. A systematic review of the literature shows that in developed countries there is a positive association between animal flesh consumption (85-300 g/d) and iron status (Jackson et al., 2016). In addition, a longitudinal study on an Australian cohort (Reeves et al., 2017) shows that in young women (25-30 years, n =9076) a high heme iron intake is associated with a lower risk of iron deficiency (with or without anemia) 3 and 6 years later.

Anemia can also be due to vitamin B12 deficiency (macrocytic anemia). Based on serum vitamin B12, a meta-analysis highlights a better vitamin B12 status in meat-eaters (303 ± 72 pmol/l) than in vegetarians (209 ± 47 pmol/l) and vegans (172 pmol/l) (Obersby et al, 2013). Vitamin B12 deficiency is also often observed in the elderly either due to a lack of intake, as these individuals tend to consume less meat, or due to a lack of absorption (Rémond et al., 2015). However, there are no specific data on the prevalence of megaloblastic anemia in the elderly.

Taken together all these observations argues in favor of a major role of meat consumption in the prevention anemia in the elderly.

Too much is enemy of health benefit

However, meat consumption should remain moderate. Indeed, if poultry meat seems to have a neutral effect on health (apart from its interest in satisfying nutrient requirements), this is not the case for red meat (beef, sheep, pork and horse), the consumption of which has been associated with an increased risk of cardiovascular disease, type 2 diabetes and cancer. The most recent meta-analyses of the literature (Bechthold et al. 2019; Schwingshackl et al, 2017a; Schwingshackl et al, 2017b; Schwingshackl et al, 2018) suggest that for every 100 g/d increase in consumption of red meat, the risk of hypertension increases by 14%, coronary heart disease by 15%, stroke by 12%, heart failure by 8%, type 2 diabetes by 17% and colorectal cancer by 12%. It should be noted, however, that although considered probable, the causal link is generally not considered convincing, even for colorectal cancer (WCRF 2017). Nevertheless, as a precautionary measure, it is recommended to limit the consumption of red meat to 500 g (cooked) per week (i.e. approximately 700 g of raw meat) (WCRF 2018).

A pioneering study have been recently conducted to objectify the assessment of health risk-benefit of red meat consumption in France (Mota et al, 2021). The study compares the risk of colorectal cancer, cardiovascular disease and foodborne-pathogen diseases, with the benefit obtained by reduction of iron deficiency anemia. The data show that the big meat eaters would gain, in term of disability-adjusted life years (DALY), to adhere to the current recommendations (< 500 g/w). Regarding iron deficiency anemia, a consumption of 375g/w of red meat would be sufficient to eliminate the risk (except for women aged 25-44, who have higher iron requirements due to menstruation). Such approach would gain to be extended to the potential benefit obtained by reduction of sarcopenia in the elderly.

In conclusion, the presence of meat in the diet of the elderly considerably limits the risks of inadequate intake of iron and vitamins B12, and thus limits the risk of nutritional deficiency anemia. Its high protein content and high digestion speed also make it a food of choice in nutritional strategies to limit muscle wasting during aging. Therefore, maintaining meat consumption at least 5 days a week (about 120 g of meat (30 g of protein)/take) seems to be recommended for elderly people, alternating white and red meat (Rondonelli et al, 2015). Fish, eggs or plant protein-rich food can complete the 2 remaining days. Unfortunately, the decrease in chewing efficiency and the reduced appetite for these products (especially for red meat) generally leads to a decrease in meat consumption among the elderly. Maintaining meat products in their diet requires both the dissemination of clear messages on the nutritional value of meat and the development of products adapted to their taste and chewing capacity.

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