Anxieties, concerns and facts about meat consumption and health: A Short Review

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Abstract

Meat from food animals is an important and long established dietary source of protein and essential nutrients. Many studies consistently reported that red and white meat can act as an important source of nutrients like iron, zinc, selenium and vitamin B12. However, various reports have also confirmed a positive correlation between meat consumption and the risk of cardiovascular disease and colon cancer, which led to a negative perception of the role of animal protein source in health. The aim of this review is to highlight on existing literature on risks and benefits of meat consumption, focusing on anxieties, myths, concerns and accurate facts. While we investigate many such reports about the correlation between meat consumption and the risk of such diseases, we could identify several methodological limitations and inconsistencies, which may affect the validity of their research findings. There is no well-built report or study to support the recent conclusion from the World Cancer Research Fund (WCRF) about red meat and its suspected role in colon cancer. Several cohort studies indicated the role of lean meat as positive moderator of lipid profiles as well as dietary source of anti-inflammatory long chain (LC) ω 3 PUFAs and conjugated linoleic acid (CLA). In conclusion, moderate level of meat consumption as part of a balanced diet is unlikely to increase risk for cardiovascular disease or colorectal cancer, but may unquestionably influence nutrient bioavailability and fatty acid profiles, thereby positively lead to better health benefits.

Keywords: Meat consumption, red meat, conjugated linoleic acid, meat nutrients

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Introduction

In recent years, several groups of people express lot of anxieties and concerns about meat consumption and its relation to chronic heart diseases and cancers. A lot more is being discussed about the “red meats”, fats and cholesterol. Lobbies are strongly working to popularise vegetarianism. Scientists have been working hard to elucidate the facts about meat consumption and its effects on health and as a result have come up with several contradictory results. In this context, we feel that it is necessary to analyse the results and bring out some of the facts about meat for the information of the consumers and the public. Let us not be carried away by the propaganda of certain lobbies who have vested interests.

Meat consumption and human evolution

From time immemorial, meat had been an integral component of human diet. The diet of the earliest hominins was much similar to the diet of this world chimpanzees: omnivorous, including large quantities of fruit, leaves, flowers, bark, insects and meat (Watts, 2008). It has so become in the evolutionary development of mankind (Teaford & Ungar 2000; Luca et al., 2010). Meat had been

associated with the male adult bravery and as such recognised with high status (Ligia and Adrian, 2015). We, humans are omnivorous. We are not destined to be pure vegetarians. Our dentition, gut structure, enzyme range, adaptability and our dependence on both plant and animal sources for our essential nutrients are all supportive evidence for our omnivorous status (Landt, 2007; Delaney-Rivera et al., 2009; Fernandez-Jalvo and Andrews, 2011; Pickering et al., 2013). As babies in uterus, we receive all nutrients of animal origin.

In the evolution of mankind, we have adapted well as omnivore with the hunting of animals for meat in addition to the consumption of fruits and vegetables. It is important to note that the modern diseases such as obesity, cancer, diabetes and coronary heart diseases were absent in the Paleolithic men (Mann, 2001). They had a high reliance on animal foods rather than on plant foods. Their diet was high in animal protein and low in carbohydrates whereas the modern man eats more carbohydrates and less protein (Leroy and Praet, 2015). Studies have shown that the Australian aborigines have low blood cholesterol level when they have their traditional high reliance on animal foods. In spite of all controversies, meat has been accepted as a high protein diet having several micronutrients, minerals and vitamins.

Fig. 1. Total consumption of meat (in million metric tons) in different regions and (inset) globally. (Godfray et al., 2018)

Meat Composition and Nutritional Value

Fig. 2. Nutritional composition of meat

Benefits to health

Meat is a highly nutritious and versatile food. It is endowed with high satiety value and its proteins are having high biological value (Miller, 2002). As such meat consumption can influence the frequency of other foods and reduce the size of meals (Hayley et al., 2015). On the contrary, carbohydrates and fats have less satiety value and may influence in larger meal size and resultant obesity (De Backer and Hudders, 2015). Many of the health problems of man can be attributed to high-energy diets and obesity. Meat in general has about 16 – 20 percent proteins of high biological value and it contain all the essential amino acids (Miller, 2002). Plant proteins are limiting in some of the amino acids. As such, the vegetarians will have to depend on a variety of vegetable protein foods to provide the essential amino acids. Taurine is an essential amino acid for the newborns. Meat is rich source of taurine whereas it is absents in vegetables (Chesney et al., 1998).

Twenty to 50% of the world's population

is affected with iron deficiency and anemia (Morse and Kevin, 2015). Iron deficiency anemia is the only widespread nutritional deficiency occurring in both developed and developing countries. The most common result of iron deficiency is anemia (Morse and Kevin, 2015). Among the causes of iron deficiency like hookworm infestation, low iron intake, low bioavailability of dietary iron and increased demand due to physiological requirements, low bioavailability is far more important. Meat is recognised as the chief food source of haem iron, which is readily absorbed by our body whereas the non-haem iron is mostly derived from cereals, fruits and vegetables (Buzala et al., 2016). Meat has its distinction in having both haem and non haem iron. Human body readily absorbs the haem iron. Meat also positively influences the bioavailability of non-haem iron that is absorbed and utilised by our body. However, apart from being the major source of haem iron, meat can influence and enhance the bioavailability of non-haem iron present in other foods. This effect is now referred to as the “meat factor” but the exact nature by which it works is yet to be elucidated (Bonsmann et al., 2007).

Table 1. Amino acid composition in fresh meat (Schweigert and Payne, 1956; Mahan and Shields, 1998)

Essential amino acids				
Amino acids	Category	Beef	Lamb	Pork
Lysine	Essential	8.2	7.5	7.9
Leucine	Essential	8.5	7.2	7.6
Isoleucine	Essential	5	4.7	4.8
Cystine	Essential	1.5	1.5	1.2
Threonine	Essential	4.2	4.8	5.2
Methionine	Essential	2.2	2.4	2.6
Tryptophan	Essential	1.3	1.2	1.5
Phenylal- anine	Essential	4.1	3.8	4.3
Arginine	Essential	6.4	6.8	6.6
Histidine	Essential	2.8	2.9	3.1
Valine	Essential	5.6	5.1	5.2
Non-essential amino acids				
Amino acid	Category	Beef	Lamb	Pork
Proline	Non- essential	5.2	4.7	4.4
Glutamic acid	Non- essential	14.3	14.5	14.6
Aspartic acid	Non- essential	8.9	8.6	8.8
Glycine	Non- essential	7.2	6.8	6
Tyrosine	Non- essential	3.3	3.3	3.1
Serine	Non- essential	3.9	3.8	4.1
Alanine	Non- essential	6.3	6.2	6.4

Meat exerts a profound influence on the iron absorption and iron status of children, adolescents, pregnant women and the elderly. It is therefore, advisable to introduce meat in the diet of infants at an early stage of 6-8 months. A Spanish study showed that children who first ate meat before eight months of age showed a better iron status than those who were introduced to meat later than eight months (Higgs and Mulvihill, 2002). High demand of iron is experienced in adolescents for muscle development and increased

blood volume. Onset of menstruation in females adds to the iron deficiency. Half the female population of the age group 15 – 18 years living in UK are suffering from low iron intake. It is also reported that during pregnancy, more lactovegetarians suffer from iron deficiency than omnivores. It is demonstrated that meat supplements are more effective than iron tablets for the vulnerable groups to improve the iron status. Studies have shown that despite higher intake of iron among vegetarians, their iron status is lower compared to omnivores. Therefore, the bioavailability of iron plays an important role in determining the iron status. (Higgs, 2002.)

Zinc is necessary for growth, healing, the immune system, reproduction and cognitive development (Sandstead, 2000). Long-term zinc deficiency may become a public health problem. A recent survey showed that one in ten among 7-10 year old girls and one in three of 11 – 14 year old girls have zinc levels below the recommended level (Brown et al., 2002). Beef is an excellent source of dietary zinc. 4 oz of meat supply zinc equal to that supplied by 41 oz of milk, 15 oz of tuna or 7 eggs (USFDA, 2016). Inhibitors such as oxalates and phytates, which are found in plant foods, suppress zinc absorption. On the contrary, meat facilitates the absorption of zinc. The bioavailability of zinc from plant foods is very low (Hunt, 2003).

Selenium acts as an antioxidant and is considered to protect against coronary heart disease and certain cancers such as prostate. Twenty five percent of our daily dietary requirement of selenium can be met from 100 g of meat (Yang and Xia, 1995). Beef and pork contain more selenium than mutton (Rabia et al., 2018). Meat also provides phosphorous, copper, magnesium, iodine and chloride in useful amounts.

Meat is a rich source of B vitamins especially thiamin (B_1), riboflavin (B_2), niacin, pantothenic acid, Vitamin B_6 and vitamin B_{12} (Rabia et al., 2018). B-vitamins being water soluble, some percentage are lost to during cooking, the amount lost depends on the duration, temperature and method of cooking (Baik and Russel, 1999). Thiamine is required as part of a co-enzyme that converts carbohydrates and fat into fuel. It also promotes normal appetite and contributes to normal nervous system function. A typical serving of pork will supply all the daily requirement of thiamin. Offal meats like kidney and liver are very

Table 2. Polyunsaturated fatty acids and cholesterol in lean meat and offal (as % total fatty acids) (Paul and Southgate, 1978; Williams et al., 2002)

Meat source	Cholesterol (mg/100 g)	C-18:2	C-18:3	C-20:3	C-20:4	C-22:5	C-22:6
Mutton	74	2.4	2.4	Nil	Nil	Trace	Nil
Beef	58	2.1	1.4	Trace	1.1	Trace	Nil
Pork	63	7.5	1	Nil	Trace	Trace	1.1
Brain	2200	0.5	Nil	1.6	4.1	3.5	0.4
Pig's Kidney	415	11.6	0.4	0.5	6.72	Trace	Nil
Sheep's Kidney	399	8.2	4.1	0.6	7.2	Trace	Nil
Ox's kidney	401	4.9	0.6	Trace	2.7	Nil	Nil
Sheep's Liver	429	5.1	3.9	0.7	5.2	3.1	2.3
Pig's Liver	262	14.8	0.4	1.2	14.4	2.4	3.9
Ox's Liver	271	7.5	2.4	4.5	6.5	5.4	1.3

good source of riboflavin. Meat is the richest source of niacin. Niacin helps to supply energy to the body by converting fats and carbohydrates to fuels. Liver and kidney are rich source of pantothenic acid. Vitamin B₆ is a co-factor for several cellular enzyme reactions including those related to amino acid metabolism and inter-conversion (Rabia et al., 2018).

Vitamin B₁₂ is exclusively of animal origin as it is a product of bacterial fermentation, which occurs in the intestine of ruminant animals. This important vitamin is required to produce red blood cells and acts as a co-factor for many enzyme reactions. Deficiency of B₁₂ causes megaloblastic anemia, neuropathy and gastrointestinal symptoms (Baik and Russel.1999.). Vegetarians are at risk of vitamin B₁₂ deficiency since it is exclusively of animal origin A 100g daily intake of trimmed beef will supply all the daily requirement of this vitamin. Raised homocysteine, an amino acid metabolite, is an independent risk factor for cardiovascular disease. Vitamin B₆ and B₁₂ are cofactors for enzyme reactions that reduce homocysteine levels by catabolising homocysteine to cysteine. Research shows that deficiency of these two vitamins will significantly raise homocysteine levels which, is a risk factor for cardiovascular diseases (Mann et al., 1999).

Vitamin D is essential for skeletal development; severe deficiency with defective mineralisation will

lead to rickets in children and osteomalacia in adults. Severe insufficiency will lead to increased bone loss and osteoporotic fractures. Sunlight exposure on the skin is the main source of vitamin D (Rajarajan et al., 2020). However, there are certain subgroups in the population who are more at risk of vitamin D deficiency and so they have to depend on diet in addition to sunlight to obtain adequate vitamin D. These subgroups include infants, toddlers, pregnant and lactating women, elderly and those who have low sunlight exposure.

Meat and meat products contain sufficient quantities of 25-hydroxycholecalciferol, which has five times biological activity than cholecalciferol. Thus meat is now recognised as the richest dietary source of vitamin D. (Gibson and Ashwell, 1997). Low intake of meat and meat products, has emerged as an independent risk factor for Asian rickets and pure vegetarianism in adults as a risk factor for Asian osteomalacia. It has been hypothesised that there may be a "magic factor" in meat, which is protective against rickets and osteomalacia. It is important for toddlers and children to eat foods rich in iron and vitamin D such as meat and meat products and exposure to sunlight to prevent diseases like rickets and anemia.

Risks to human health

In spite of the above-mentioned favourable

factors to the credit of meat, there are growing anxieties and concerns regarding health risks said to be associated with meat consumption. The most common problems encountered among the population are cancers, adult onset-diabetes, overweight, obesity, coronary heart diseases and nutritional inadequacies. In the evolutionary history of man, hunting of animals for dietary requirement had been of significant importance and consumption of meat became a key evolutionary development factor in providing protein and energy. Meat has been a major part of the human diet for at least two million years. Human genetic make up and physical features have been adapted for over 4.5 million years for a diet containing meat.

Traditionally meat was considered a highly nutritious food, valued and associated with good health and prosperity. However, this healthy image of meat started eroding when reports came in regarding the saturated fats it contributed. It has been correlated with coronary heart diseases and other degenerative disorders. Though the multifactorial nature of coronary heart diseases has been widely accepted, red meats have been related as a factor in some of the studies. Some reports also implicated red meats with certain cancers, especially colorectal cancer. During 1990s, there had been wide publicity on issues like bovine spongiform encephalopathy, which eroded the healthy image of meats. This negative image that surrounded red meats, caused a decrease of about 25% in its use in UK and some other countries. Added to this blow, there had been wide lobbying for vegetarianism in certain countries.

Large number of research studies were undertaken consequent to this publicity to elucidate the facts about the relationship of red meats to cancers. The reports were reviewed and summarized by Hill (2000) and showed that 20 out of 30 case-control studies and 10 out of 14 prospective studies showed no relationship between meat intake and colorectal cancer with some of the results of the remaining studies being confused and one prospective study showing an inverse correlation between meat consumption and CRC (colorectal cancer) risk. If meat consumption were associated with increased risk for cancer, one would expect mortality from cancer to be much lower among vegetarians.

In a meta-analysis of five cohort studies, results have shown no significant differences in

mortality from cancer in general, and more specifically mortality in stomach, breast, lung, prostate and colorectal cancer between vegetarians and omnivores. One would naturally expect a decrease in the incidence of CRC with decrease in red meat consumption, if it were associated with increased risk for CRC. During the past two decades, red meat consumption in UK has decreased approximately 25%, while during the same time, the incidence of CRC has increased by about 50% (Amy and Barbara. 2010). Similarly, if meat consumption were associated with increased risk for CRC, one would expect the rates of CRC to be higher in countries with high meat consumption. The Mediterranean countries eat more red meat than UK and many other countries, yet the Mediterranean's have lower CRC rates.

Colorectal cancer is multifactorial; it is confounded by diet, smoking, alcohol, physical activity, obesity, and aspirin use, age and family history. It is well known that daily consumption of meat along with vegetables reduces the risk of cancer. The method of cooking meat and the degree of browning are important to this issue. Severe browning or blackening of meat results in maillard reactions and produce heterocyclic amines. These amines are produced during grilling; barbecuing and frying whereas it is absent during steaming, microwave and marination. The most abundant heterocyclic amine that is produced in meat is phenylimidazo pyridine, which is relatively weak carcinogen compared to other heterocyclic amines. It is sensible to consider that there must be an optimal range for meat intake in order to ensure a balanced diet. With this practical perspective, the Committee on Medical Aspects of Food Policy (COMA) UK, suggested intake range of 90 – 140 g cooked meat per day (COMA.1998). Evidence also suggests that the risk of cancer can be reduced by intake of plenty of fruits and vegetables with meat.

Fats in meat

Coronary Heart Diseases, though multifactorial, have been associated epidemiologically with red meat consumption, due to its fat content. Conversely, a growing bank of evidence is showing that a healthy diet that includes lean red meat is protective and can produce positive blood lipid changes. It is essential to bring out an important finding that there is considerable difference in the fat content of red meats available in foreign countries

Table 3: Potential limitations and Summary of prospective, cohort and case-control studies investigating the associations between meat (red & processed) and risk of CVD and colon cancer (McAfee et al., 2010)

Author (year)	Study, country	Type of meat studied	Significance	Outcome examined	Potential limitations of study
Cardiovascular disease					
Azadbakht and Esmailzadeh (2008)	Cross-sectional study, Iran	Red meat	Sig	Metabolic syndrome risk	Red and processed meats grouped together; potential bias with dietary recall
Kontogianni et al. (2008)	Case-control study, Greece	Red meat	Sig	Acute coronary syndrome risk	Case-control study prone to misreporting of dietary data; no definition of red meat
Heidemann et al. (2008)	NHS, USA	Western dietary pattern	Sig	CVD mortality	Finding is for dietary pattern only, does not isolate red meat
Keleman et al. (2005)	Iowa Women's Health Study, cohort study, USA	Red meat	Sig	CHD mortality	Red and processed meats grouped together; potential error in dietary assessment
Steffen et al. (2005)	Coronary Artery Risk Development in Young Adults (CARDIA) Study, prospective study, USA	Red & processed meat	Sig	Elevated blood pressure	Red & processed meat grouped together; dietary data collected only twice over 15 y
Colorectal cancer					
Norat et al. (2005)	European Prospective Investigation into Cancer and Nutrition (EPIC), 10 European countries	Red	NS	Colorectal cancer risk	Age ranges differ by country, potential error associated with meat intake measurement & calibration method
		Processed	Sig		
Robertson et al. (2005)	The Antioxidant & the Calcium Polyp Prevention clinical trials, USA	Red	NS	Adenoma recurrence risk	Did not control for all variables in results presented; 4 years could be considered as too short a follow-up period; no definition of red or processed meat
		Processed	NS		
Sinha et al. (2005)	Prostate, Lung, Colorectal and Ovarian (PLCO) Cancer screening trial case-control study, USA	Red	NS	Colorectal cancer risk	Large imbalance in No. of controls (34,817) and cases (3,696); large number of multiple comparisons may affect the reported findings
		Processed			

Chao et al. (2005)	Cancer Prevention II Nutrition cohort, USA	Red	NS	Colon cancer risk	Red and processed meats grouped together; short-term meat consumption a crude measure of cancer risk; potential error associated with FFQ and measurement of long-term intakes owing to major differences in questionnaires at two timepoints
		Processed	NS		
English et al. (2004)	Melbourne Collaborative Cohort Study, Australia	Red	NS	Colorectal cancer risk	Did not control for all variables in analysis, including BMI or alcohol consumption
		Processed	Sig		
Flood et al. (2003)	Breast Cancer Detection and Demonstration Project (BCDDP) cohort study, USA	Red	NS	Colorectal cancer risk	Did not control for other covariates in analysis; red and processed meats grouped together
		Processed	NS		
Cross et al. (2007)	NIH-AARP, USA	Red	Sig	Colorectal cancer risk	Red and processed meats were grouped together
		Processed	Sig		
Larsson et al. (2005)	Swedish Mammography Cohort prospective study, Sweden	Red	Sig	Distal colon cancer risk	13 years could be considered a long follow-up period between dietary assessment & case identification; some processed meats were grouped with red meats; unable to control for PA
		Processed	NS		
Sinha et al. (2005)	PLCO cancer screening trial case-control study, USA	Red meat cooked: medium	NS	Colorectal cancer risk	Large imbalance in No. of controls (34,817) + cases (3696); large number of multiple comparisons may affect the reported findings; potential error associated with meat-specific questionnaire used
		well-done	Sig		

NS, non-significant; Sig, significant

and in India. In most of the developed countries and in some of the developing countries, meat is produced from animals that are solely bred and reared for meat purpose. Such meat breeds are fattened at an early age and are slaughtered young (1 - 2 years) (Lamberson,

1994). The fat content of the meat derived from such animals used to vary from 20 - 25% (Valsta et al., 2005). However, with the growing evidence of the correlation of fats with coronary heart diseases, those countries are now reducing the fat content of meat by

new breeding policies and by trimming. As a result, the range of fat content varies in red meats from 10 – 15%.

Studies conducted at the Centre of Excellence in Meat Science and Technology, Kerala Agricultural University revealed that the fat content in beef produced at the centre varied from 2 – 4% only with an average of 2.5%. We have also found that the cholesterol content of beef was only 60 mg/100g of meat. Beef available in the market have also been examined and the results do not vary much except in certain fatty animals. The main reason for this reduced fat content is because we use the dairy type of animals for production of meat. Generally we do not find enough fat for trimming during slaughter operations. Therefore, there is a genuine need to change our concept about red meat and its fat content when we are discussing about Indian beef or buffalo beef.

Probably the main misconception about meat is that it is assumed to be totally saturated. Meat contains a mixture of fatty acids both saturated and unsaturated. Nowadays, less than half in pork and beef and 51% of fat in mutton are saturated. The predominant saturated fatty acids in meat are stearic acid (C18:0) and palmitic acid (C16:0). In general, saturated fats are known as “bad fats” as they tend to raise blood cholesterol and cause atherosclerosis. However, stearic acid does not appear to raise blood cholesterol or other thrombotic risk factors. Stearic acid is the prominent saturated fat in meat accounting for one third of the saturated fats in beef. Similarly, palmitic acid, another major saturated fat in meat does not consistently raise blood lipids. On the other hand, Myristic acid (C14:0), which is the most atherogenic fatty acid, is found only in minor quantities in meat (Valsta et al., 2005).

Meat contains a mixture of unsaturated fatty acids, polyunsaturated fatty acids (PUFAs) and monounsaturated fatty acids (MUFAs). Approximately, 40% of the total fat in meat are MUFAs and it is neglected fact meat is the main source of MUFAs in diet. MUFAs are considered to be neutral with respect to blood cholesterol levels. The principal MUFA in meat is Oleic acid (cis C18:1n-9), which is also found in olive oil which is associated with the healthy Mediterranean diet.

There are two types of polyunsaturated fatty acids, the omega-3(n-3) and the omega-6 (n-6). Meat supplies 17% n-6 and 19% n-3 PUFAs. Linoleic acid

(C18:2 n-6) and linolenic acid (C18:3n-3) are essential fatty acids that are not synthesised in our body and hence we have to depend on diet to provide them. In the body, they are further elongated and desaturated to longer chain derivatives: arachidonic acid (C20:4n-6), docosapentaenoic acid (C22:5n-6), eicosapentaenoic acid (C20:5n-3) and docosahexaenoic acid(C22:6n-3). These are found in useful quantities in meat. Evidence now indicates that it is the n-3 PUFAs that are cardio protective, in particular, the very long chain n-3 PUFAs eicosapentaenoic and docosahexaenoic acids. The results of the trials conducted by GISSI-Prevenzione Investigators (1999) showed that one-gram of eicosapentaenoic acid and docosahexaenoic acid daily reduced coronary heart disease deaths by 20% (Mohebi-Nejad and Bickdeli, 2014). Meat and fish are the only significant source of preformed very long chain n-3 PUFAs in the diet. It has also been found that these PUFAs have other beneficial effects including anti-inflammatory and anti-tumorigenic properties (Wang and Huang, 2015). In a report on n-3 fatty acids, the British Nutrition Foundation has stated that “red meat is likely to rival fish as a source of n-3 PUFAs in many peoples diet”.

Long chain n-3 PUFAs are absent in vegetarian diets since plants cannot produce these long chain PUFAs. Studies have shown that vegetarians have lower n-3 PUFA intake than their omnivore counterparts which, will result in nutritional consequences for vegetarians. It has also been reported that n-3:n-6 ratio in plasma phospholipids was significantly lower in vegetarians which, may be responsible for an increased platelets aggregation tendency among vegetarians, which is a risk factor for cardiovascular disease (Li et al., 1999). Nowadays, the researchers have successfully enhanced the n-3 PUFAs in meat by modifying the feeding regimens of animals (Zárate et al., 2017). The current recommendation for intake of n-6:n-3 ratio is less than 4. The n-6:n-3 ratio in trimmed beef and mutton are at acceptable levels, that of pork is at higher level.

One of the most important emerging benefit of meat is Conjugated Linoleic Acid (CLA). It is a fatty acid found in ruminant meats and beef and mutton are the best dietary source of CLA. CLA appears to have a variety of potential health benefits including tumour-reducing, atherosclerotic-reducing (Gavino et al., 2000). It also delays the onset of diabetes and reduces adiposity. Different isomers of CLA are responsible for these different biological effects. It is found that

the c-9, c-11 isomers have anti carcinogenic effect and c-10, c-12 isomers reduce adiposity. The American Dietetic Association has endorsed beef and lamb as functional foods because of the anti-tumorigenic properties of CLA they contain.

Trans fatty acids raise LDL cholesterol and decrease HDL cholesterol. Trans fats have been highlighted as contributing to atherosclerosis. The hydrogenated fats from vegetable sources used in bakery goods and in cookery appear to be more of a concern than the natural trans fats found in ruminant meats.

In the United States, the National Cholesterol Education Programme (NCEP) recommends dietary guidelines for people with hypercholesterolaemia (raised blood cholesterol). The NCEP dietary guidelines are a first-line therapy for the management of high blood cholesterol. A recent study by NCEP compared the effect of including lean red meats (beef, veal, pork) and lean white meat (fish, poultry) in the diet, on blood cholesterol of people with hypercholesterolaemia (Davidson et al., 1999). This study revealed that the inclusion of approximately 170 g lean red meat per day, five to seven times per week in NCEP diet was as effective as lean white meat in reducing both total and LDL cholesterol while simultaneously raising HDL cholesterol. Thus the inclusion of lean red meat in the diet had a positive beneficial impact on blood cholesterol level. Similar results were obtained in a study conducted in UK, where hypercholesterolaemic men were given 180 g lean red meat per day in their diet, a quantity we would consider too high (Watss et al., 1988).

Comparative studies of vegetarians and omnivorous children of 9-17 years found that saturated fat intakes were not lower in the vegetarian children. There was also no significant difference in the energy intake and the percentage energy from fats or saturated fats intakes between vegetarians and omnivores. Vegetarian women have lower zinc intake and status than their omnivore counterparts. A recent study conducted in Australia showed that vegetarians had a lower intake of beneficial very long chain n-3 PUFAs. A study showed that plasma homocysteine, an independent risk factor for heart disease was significantly higher in vegetarians (Mann et al., 1999). Vegetarians have lower intake of proteins, vitamin D, B₁₂, zinc, and selenium. The vegetarian convenience

foods, though seems to be attractive, was having high content of fats, trans fats ranging from 2 – 58% and nearly a third supplying more than 50% of their energy from fats.

Today's busy lifestyle gives rise to more erratic dietary practices and food intakes from outside the home as snacks, and quick meal. A study revealed that energy intake of young people is 20% below required level. Lower physical activity level of all age groups and the lower intake of iron, zinc, copper and many other essential nutrients is a matter of concern. It is important to recognise the health benefits, derived from meats including proteins and other nutrient supplements and to plan a healthy balanced diet, which includes lean meats in daily life. Most of the valuable nutrients of meat are located in the lean component and so reducing visible fats in meat is recommended (Marangoni et al., 2015).

Researchers are focusing on further improving the fatty acid composition of meat. It is recognised that meat derived from grass fed animals contains high levels of both n-3 PUFAs and CLA content. This may lead to potential protection against many of the predicted future health hazards including coronary heart diseases, diabetes, cancers and obesity. N-3 PUFAs are cardio protective and have anti-inflammatory and anti-tumorigenic properties. CLA can prevent formation of tumours, reduce atherosclerosis and can help normalise blood glucose levels and prevent adult-onset diabetes. Further studies are needed to elucidate the effects of CLA on human health. Prevalence of overweight and obesity is increasing steadily. Obesity is a risk factor for many diseases. During a ten-year follow-up study, the incidence of colon cancer, diabetes, heart disease, hypertension, stroke and gallstones increased in line with the degree of overweight among adults (Field et al., 2001). Thus reducing the obesity and overweight, is a public health priority. Factors regulating food intake are hunger, appetite, satiation and satiety.

Meat-containing meals have higher satiety values than vegetable-containing meals. Meat can play a role in curtailing obesity as a result of its high satiety value. Lean meat is already low in fat. Research has shown that an increase in consumption of meat protein among elderly women correlates with a decrease in the risk of hip fracture (Fung et al., 2017). As people live longer, the incidence of hip fracture is an inevitable consequence. Vegetarian women tended to have lower

spinal bone mineral density than non-vegetarians do. The “magic factor” in meat is highly useful in preventing rickets and osteomalacea. Another emerging benefit of meat is the selenium that it supplies. Recent studies have found that selenium may reduce risk of heart disease and certain types of cancers and enhance the body’s ability to fight infection (Fung et al., 2017).

Dr. Lynnee Cobiac has summarised some of the potential health promoting properties of meat as follows (Cobiac, 2000):

- Lipoic acid has antioxidant properties and has shown to be beneficial in diabetes and in prevention of cataract development in animal models and cell lines. Organ meats contain higher quantities of lipoic acid than muscle meat.
- Carnosine is a dipeptide composed of alanine and histidine. Carnosine is found in meats and its antioxidant properties may confer protection against oxidative stress. It is an anti-inflammatory agent and has anti-tumorigenic properties in rats and it plays a role in cellular homeostasis.
- Biogenic amines are naturally formed from bacterial decarboxylation of amino acids. They have been linked with improving gut health and cognitive performance.
- Nucleotides are found in organ meats, which enhance the general immune function.
- Glutathione is a tripeptide, which has major role in meat factor beneficial in absorption of non-haem iron.
- Choline is an essential nutrient that is necessary for central nervous system development, homocysteine metabolism and plays a role in immune system, fat metabolism and improves athletic performance. Beef, in particular liver is one of the richest source of Choline.
- Carnitine mainly is provided by red meats, which is necessary for oxidation to provide energy and improve athletic performance. It also has antioxidant properties and is critical for brain development by providing acetyl groups to synthesise acetylcholine, a neurotransmitter.

It is also reported that these range of components of meat may have the ability to fight cancers, coronary heart diseases and cataracts and enhance immunity and cognition, improve gut and bone health, regulate body weight and may be used in sports nutrition.

Conclusion

There had been considerable emotive and public health debate over the last two decades on the importance of meat in the diet of modern man. Early dismissive arguments have more recently been challenged as a result of research results and informations available now. The early focus on fats as a route cause of diseases of affluence and blamed meat for diet related problems. More recently the focus on the diets of our ancestors has effectively reversed this thinking and lean red meat has been rediscovered as a mainstay of human diet evolution. A serious rethinking based on the new information is necessary for a holistic approach to diet and lifestyle. Lean meat is the ultimate natural functional food which, should be regularly consumed in moderate quantities along with good vegetables and fruits.

Authorship contribution statement

J. Abraham : Conceptualization, Writing - original draft, Writing - review & editing, **Irshad A.**: Writing - review & editing.

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