THE METHODS REDUCING OF FAT CONTENT IN MEAT AND MEAT PRODUCTS[1]

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ABSTRACT

In recent years, with the change in the level of awareness and expectations of consumers about healthy nutrition, research and development studies have accelerated in the food industry to formulate healthier food products with reduced fat content and functionally improved food products. Consumers demand healthier meat products that are low in fat, in general. On the other hand, consumers expect these meat products with altered formulations to taste, look and smell the same way as their traditionally counterparts. This review deals with the three major aspects to be considered in the context of reduction methods the fat content in meat and meat products. The first aspect involves removing of visible external fat. The second aspect involves changing of ruminants feedstuff. The third aspect involves using of fat replacer such as lean meats or low-fat meats, added water, carbohydrate-based substances, protein-based substitutes, vegetable oils in meat products.

Keywords: *Health, Low-fat, Fat replacer, Reduced-fat, Meat and meat products*

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INTRODUCTION

Meat and meat products are important in the diet of developed countries. Their principal components, besides water, are proteins (high biological value, containing amino acids essential to human health) and fats (including saturated fatty acid, unsaturated fatty acid, cholesterol, triacylglycerol and phospholipids) with a substantial contribution of vitamins (mainly those of the B complex) and minerals (mainly iron and zinc) of a high degree of bioavailability **[1, 2, 3]**. Both meat and meat products can be modified by adding ingredients considered beneficial for health or by eliminating or reducing components that are considered harmful for health. In this way, a series of meat and meat products can be obtained which are considered "healthy" **[1]**.

Present day consumers are very much aware about nutrition and health. Thus they demand healthier meat products that are low in fat, cholesterol and calories. In meat products fat plays an important role in stabilizing meat emulsions, reducing cooking loss, improving water holding capacity and providing organoleptic quality (taste, odor, mouth feel, juiciness, hardness, etc.) **[4]**. However, high animal fat used in meat products provides higher amounts of saturated fatty acid and cholesterol **[5]**. Saturated fatty acid and cholesterol has been correlated with chronic disease events like cardiovascular diseases, cancer, type 2 diabetes, and others related to obesity **[6]**. The average composition, cholesterol content and calorific value of some representative types of meat and fat are shown in Table 1 **[7]**.

Besides serious health concerns of animal fat, oxidation of lipids and proteins being a major threat to meat quality. The onset of oxidative reactions in muscle foods during handling, processing and storage leads to undesirable sensory changes and deterioration of nutritive value **[8, 9]**. Therefore fat reduction has generally been seen as an important strategy to improve the fat content of foods and produce healthier products. This aspect is particularly relevant to the meat industry since some meat products contain high proportions of fat **[10, 11]**.

Table 1. Average composition, cholesterol content and calorific value of some representative types of meat and fat **[7]**

Type of Meat and Fat	Water (%)	Protein (%)	Fat (%)	Cholesterol (mg/100 g)	Energy Value (kcal/100 g)
Beef (muscle)	75.10	22.00	1.90	60.00	115
Veal (muscle)	76.40	21.30	0.81	70.00	101
Pork (muscle)	74.70	22.00	1.86	65.00	114
Mutton (fillet)	75.00	20.40	3.41	70.00	122
Chicken (average)	72.70	20.60	5.60	81.00	144
Turkey (average)	63.50	20.20	15.00	74.00	231
Lamb (intermuscular fat)	25.80	5.49	68.30	75.00	673
Beef (intermuscular fat)	20.20	8.20	70.90	99.00	710
Pork (intermuscular fat)	18.00	4.70	76.70	93.00	749

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The first step in developing healthy meat products is to reduce the high-fat content of meat products **[12]**. Some processed meat products contain up to 20-30% fat content. However, the reduction of fat content results in inferior product quality in terms of technological and sensory attributes, which affects the marketability and consumer acceptance of low-fat meat products **[13]**. Hence, the meat industry is facing the problem to produce low-fat processed meat products with desired quality attributes **[14]**.

In this review, studies on the methods used to reduce the amount of fat in meat and meat products have been analyzed based on the literature.

There are basically 3 ways to reduce the fat content in meat and meat products: (1) removing of visible external fat, (2) changing of ruminants feedstuff, and/or (3) using of fat replacer in meat products **[15]**.

Removing of Visible External Fat

The easiest way to reduce fat in the diet is to keep the amount of fat in the meat as low as possible and to consume lean meat with visible external fats in meat can be removed by trimming process. This process highly reduces the total fat content of the meat. The first trimming process can be applied to the internal and external fats in the carcass, and then the trimming process can be applied to the cut parts where necessary **[15]**. Trimming of subcutaneous fat could be effective for reducing both dietary cholesterol and fat (and calories) **[16]**. Trimming of excess fat from carcass even though highly reduces the fat content of overfat carcasses, this is short term solution for providing low-fat products **[17]**.

Changing of Ruminants Feedstuff

Changes in the diet of ruminants can lead to major differences in the fat content and fatty acid profile of edible tissues **[15]**. One way to increase unsaturated fat in the human diet without giving up meat is to feed meat-producing animals with feeds that contain high levels of unsaturated fats. Such a modification in the diet of animals can increase the level of unsaturated fatty acids and reduce the amount of saturated fatty acids **[18]**. The fat composition of meats is necessary to produce healthier meat with higher monounsaturated and polyunsaturated fatty acids than saturated fatty acids, and to establish an appropriate balance between n-6 and n-3 polyunsaturated fatty acids **[15]**.

Monounsaturated fatty acid content in meat can be enhanced by increasing these fatty acids in the animal diet. Feeding strategies involving plant (vegetable oils, n-3 polyunsaturated fatty acid-rich plants, forages) and marine sources (fish or algae) have been successfully used to significantly increase polyunsaturated fatty acids **[3]**. Dietary supplementation such as α-linoleic acid, conjugated linoleic acid, docosahexaenoic acid, eicosapentaenoic acid has been used to enrich

chicken, pork, beef and lamb **[19]**. In another study found that feeding pigs diets containing 20% canola oil (60-65% oleic acid) decreased the level of saturated fatty acids in muscle tissue and adipose tissue by 19% and 25%, respectively **[20]**.

Using of Fat Replacer in Meat Products

Normal fat contents of meat products are shown in Table 2 **[21]**. Low-fat meat products have been rejected by the consumers since they were considered less juicy, firmer, more rubbery, darker in color and overall less acceptable than traditional meat products **[22]**. On the other hand, consumers hope that these low-fat meat products with altered formulations to taste, look and smell in the same way as their traditionally formulated and processed meat products. In this respect, manufacturers have introduced several modifications. These modifications include the use of fat replacers such as lean meats or low-fat meats, added water, carbohydrate-based substances, protein-based substitutes, and vegetable oils. **[15, 22, 23]**.

Table 2. Normal fat content of meat products **[21]**

Meat Product	Fat Content (%)
Frankfurter	20-30
Bologna	20-30
Fresh pork sausage	30-50
Nugget	20-25
Liver sausage	30-45
Salami	30-50
Beef patty	20-30
Ham	<10

Lean meats or low-fat meats

Lean meats or low-fat meats can be used instead of fat in the formulation to reduce the fat content of meat products. However, this process does not cause a reduction in the amount of cholesterol in the product. In addition, while the use of lean meat and low-fat meat in meat product formulations is not economically

preferred because it increases the cost; it is not preferred technologically because it creates harder and drier products compared to standard products **[15]**.

Added water

Alternative methods have been considered to ensure that low-fat meat products are at an acceptable level in terms of taste, and it has been reported that adding water instead of fat can be one of the possible solutions **[15]**. Water can be used as a substitute for fat in sausages and other heat treated meat products. The addition of water causes changes in properties such as structure, softness and hardness in meat products with reduced fat **[24, 25]**. The use of water instead of fat can cause the product to be too hard and excessive water loss from the product. In addition, the addition of water affects the microbial shelf life of the product and the product flavor **[26, 27]**. In low-fat meat products, with different additives with water, sensory it is possible to increase the quality characteristics. Juiciness and softness can be improved by using agents that keep moisture in the product **[28]**.

In the study carried out, sweet potato powder and water were added as fat substitute in low-fat pork patties. Low-fat pork patties were developed by replacing the added fat with combinations of sweet potato powder and chilled water. Three different levels of sweet potato powder/chilled water 0.5/9.5%, 1.0/9.0%, and 1.5/8.5% were compared with a control containing 10% animal fat. Results concluded that low-fat pork patties with acceptable sensory attributes, improved cooking yield and textural attributes can be successfully developed with the incorporation of a combination of 1.0% sweet potato powder and 9.0% chilled water **[29]**.

Carbohydrate based substances

Dietary fibers, cellulose, starch, maltodextrin, dextrin, hydrocolloids, gums, etc. are often used as carbohydrate-based fat substitutes. Carbohydrates are formed of polymers of repetition sugar and sugar derivatives which can bind water and increase viscosity or gel **[30]**. Starches and fibers of various including corn starch, rice starch, potato starch, and tapioca starch can be efficiently used in meat formulations. Starch granules swell when hydrated, then gelatinize when heated. They may increase in viscosity or gel as they are cooled. Fibers can add bulk, assisting in hydration and contributing to mouth feel in low-fat meat products.

Carbohydrate-based fat replacers mimic fat by stabilizing the added water in a gel-like matrix that can release the water in a way similar to fat release **[12]**. Gums such as carrageenan, alginate, xanthan, locust bean and guar gum are also frequently used as carbohydrate-based fat replacers **[15]**.

In the study carried out investigated that guar-xanthan gum mixture as a partial fat replacer in meat emulsions. Partial replacement of fat with guar-xanthan gum resulted in higher emulsion stability and cooking yield but lower penetration force. In addition, the guar-xanthan gum mixture improved the physicochemical and oxidative quality of low-fat meat emulsions than the control formulations **[31]**.

In another study carried out, the technological properties were evaluated for low-fat meat emulsions containing various levels of prebiotic fibers (inulin, fructo-oligosaccharide, polydextrose, and resistant starch) as fat substitutes. The fiber addition delayed the aggregation of globular myosin heads; thus, the gelation process occurred at higher temperatures. The microscopy assays showed porous structure in the formulations containing prebiotic fiber and more compact and denser structures in the control formulations **[32]**.

Protein-based substances

Blood plasma, egg protein, caseinate, skimmed milk powder, soy protein flour/concentrate/isolate, whey protein, wheat gluten, etc. are often used as protein-based fat substitutes. Vegetable and animal originated proteins are used in various meat products in terms of emulsion stability due to their fat and water binding properties **[15]**. The three dimensional structure of proteins can be changed by pH, heat or enzymatic denaturation and providing to behave more like fat **[33]**. Denaturation can change the textural, gel forming and water holding capacity particularly of vegetable based proteins such as soy, wheat, pea, and peanut **[17]**. Whey, collagen and soy protein as protein-based fat replacers are often used in meat industry **[12]**.

In the study carried out investigated that plasma protein and soy fiber contents effect on bologna sausage properties as influenced by fat level. Plasma protein and soy fiber contents favored the formation of harder, chewier structures with

improved fat and water binding properties. Fat reduction decreased textural properties and increased weight loss. Plasma protein influenced binding and textural properties more than soy fiber and was, therefore, thought best to limit the effect of fat reduction **[34]**.

In another study carried out, whey powder at levels of 0%, 2% and 4% was added to beef meatballs formulated with 5%, 10% and 20% fat levels. Addition of 2% or 4% whey protein significantly increased cooking yield regardless of the fat level. Both fat level and whey protein level significantly affected fat retention values of meatballs **[35]**.

Vegetable oils

The general nutritional profile of meat products is influenced by the ratio of n-6/n-3 fatty acids, polyunsaturated fatty acids/monounsaturated fatty acids content. This has led to the use of fat source with healthier fatty acid profile, instead of animal fat, for improving of health meat products. Thus, vegetable oils have been studied in place of animal fat and a large amounts of saturated fatty acids have been substituted with monounsaturated fatty acid/polyunsaturated fatty acid **[36, 37]**.

In the study carried out, into salami products, found that the partial substitution of pork backfat by extra virgin olive oil did not significantly influence the chemical, physical, and sensory characteristics of the products, with the exception of water activity and firmness. The addition of the extra virgin olive oil, which is rich in unsaturated fatty acids, did not reduce the shelf life in terms of lipid oxidation, perhaps because of the antioxidant effect of both polyphenols and tocopherols **[38]**.

Table 3 summarized the use of various fat replacer substitutes obtained from different sources in different meat products and their effects on meat products.

Table 3. Articles about meat and meat products with fat replacer

Meat Product	Fat Replacers	Impact on Product	Reference
Chicken patties	Cashew apple fiber (*Anacardium occidentale* L.)	Increased the cooking yield Did not negatively affect shortening and shear force values Appearance, texture, flavor, juiciness, overall impression values were not different from control	**[39]**
Beef sausage	Hazelnut oil Hazelnut powder	Decreased the saturated fats and increased the unsaturated fats Equivalent texture, sensory, technological quality to standard	**[40]**
Goshtaba (traditional meat product of India)	Apple pomace powder	Decreased the hardness, cohesiveness, gumminess, chewiness Increased the springiness	**[41]**
Fermented sausage (Sucuk)	Pre-emulsified olive oil	Decreased the cholesterol content about 41.3%	**[42]**
Beef meatball	Adzuki beans (*Vigna angularis*) flour	Increased the cooking yield and moisture content Increased the hardness, chewiness Decreased the fat and calorie contents	**[43]**
Bologna type sausage	Pork skin Green banana flour	Decreased the cooking loss Increased the emulsion stability	**[13]**

Frankfurter type sausage	Citrus fibre Soy protein concentrate	Addition of soy protein concentrate increased the water holding capacity and cooking losses Addition of citrus fiber increased the water holding capacity and decreased the cooking losses	**[44]**
Frankfurter type sausage	Inter-esterified palm, cotton seed and olive oils	Improved the nutrient quality, due to changes in fatty acid profile	**[45]**
Hamburger	Soy flour, split-pea flour and wheat starch	Soy flour in combination with starch leads to increase in cooking yield and addition of split-pea flour in mixed formula decreases shrinkage while improving textural properties.	**[46]**
Ostrich meat patties	Modified corn starch, soya isolate and water	Decreased the saturated fatty acids and increased the unsaturated fatty acids	**[47]**

CONCLUSION

Meat and meat products can be modified by adding ingredients considered beneficial for health or by eliminating or reducing components that are considered harmful for health. The add of these ingredients considered beneficial and the eliminate and reduce the ingredients considered harmful in meat products offers processors the opportunity to improve the nutritional and health qualities of their products. Although the demand is present for low-fat meat products, formulating a low-fat meat product equal in quality to its full-fat counterpart is a difficult task. The key ingredient in a low-fat meat formulation is the fat replacer or combination of fat replacers chosen. Good fat replacers have must a particle size and water holding capacity that mimics the mouth feel and juiciness of real fat. The final product should be equal to the full-fat product in all aspects, except for fat.

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