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Review

Healthier meat products as functional foods

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ABSTRACT

A promising approach to improving health care would be to produce a healthier food supply as a preventive health care strategy. The food supply could be improved by producing functional foods that have nutritional profiles that are healthier than conventional products. However, production of functional foods is not always easily accomplished since they must also taste good, be convenient and reasonably priced so that consumers will regularly purchase and use the products. Meats have great potential for delivering important nutrients such as fatty acids, minerals, dietary fiber, antioxidants and bioactive peptides into the diet. However, to produce successful products with these ingredients, technologies must be developed to increase their stability and decrease their flavor impact on muscle foods. In addition, many regulatory hurdles must be overcome for the commercial production of meats with added nutrients. These include redefinition of standard of identities and policies that allow front of the package nutritional claims. Without these regulatory changes, production of healthier meat products won't become a reality since these products would not have a competitive advantage over unfortified meats.

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1. Introduction

Each year, in the U.S. alone, medical costs for major chronic diseases including cardiovascular disease, diabetes, cancer, osteoporosis and obesity exceed $400 billion (DHHS, 2010). Many of these disorders are known to be directly linked to the human diet. This means that many challenges in health care could be proactively improved by producing a healthier food supply as a preventive health care strategy. However, this is not easily accomplished since improving the food supply must be done without dramatically altering consumer needs such as food quality, convenience and costs. One way to look at the challenge of improving the food supply is to realize that the success of food-based health care intervention is dependent on both efficacy and compliance. *Efficacy* relates to the ability of the food-based intervention to alter the biological pathways that improve health, whereas *compliance* relates to the propensity for an individual to actually consume the health promoting product. No matter how efficacious an intervention is, it will not be effective if compliance is poor. This is especially true for functional foods as they must be efficacious while also tasting good, being convenient and reasonably priced so that consumers will regularly purchase the products.

Meat and poultry products are a food category with both positive and negative nutritional attributes. Muscle foods are major sources for many bioactive compounds including iron, zinc, conjugated linoleic

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Table 1
Factors to consider when choosing a functional food ingredient for a specific food.

Is the bioactive compound under consumed by general population?
Is the bioactive compound under consumed by a target population?
What is the evidence for efficacy in humans?
Is the form of the bioactive compound being used bioavailable?
What is the stability of the bioactive compound in the food of interest?
○ Oxidative stability
○ Light stability
○ Stability to inherent food enzymes
○ pH sensitivity
○ Heat stability
How does the bioactive compounds impact food quality?
○ Flavor
○ Texture
○ Color
Is an economically generally recognized as safe (GRAS) source of the bioactive compound commercially available?
Are there any regulatory restrictions to added the bioactive compounds to the food of interest?
○ Standard of identify
Can health or nutrient content claims be made about the bioactive compound so that the health benefits of the product can be communicated to the consumer?

acid (mainly ruminants) and B vitamins (Jimenez-Colmenero et al., 2001). However, meats and processed meats are also associated with nutrients and nutritional profiles that are often considered negative including high levels of saturated fatty acids, cholesterol, sodium and high fat and caloric contents (Whitney & Rolfes, 2002). Some of these negative nutrients in meats can be minimized by selection of lean meat cuts, removal of adipose fat, dietary manipulation to alter fatty acid composition and proper portion control to decrease fat consumption and caloric intake. In addition, the nutritional profile of meat products could be further improved by addition of potentially health promoting nutrients. These products would be categorized as functional foods which are defined as foods with nutritional profiles that exceed conventional products. In deciding proper nutrients for functional foods, several factors should be considered including the bioactive compound's current intake level in the diet (e.g. would the consumer benefit from an increase in the bioactive compound in the diet), biological efficacy in humans, stability in the food product and impact on quality parameters such as color, flavor and texture (Table 1). The major nutrients currently under consumed by adults in the U.S. include calcium, potassium, magnesium, fiber as well as vitamins A, C and E (Dietary Guidelines for Americans, 2005). In addition, omega-3 fatty acids are currently under consumed according to recommended intake levels set by associations such as the American Heart Association (for review see Harris, 2007). Finally, several newly recognized health promoting bioactive compounds have potential as functional food components such as conjugated linoleic acid and bioactive peptides. Table 2 shows some examples of bioactive compounds being considered for addition to functional foods.

Table 2
Examples of bioactive compounds being considered as functional food ingredients in meats.

Essential vitamins and minerals	Nonessential nutrients
Vitamin A	Long chain omega-3 fatty acids
Vitamin C	Dietary fiber
Vitamin E	Conjugated linoleic acid
Iron	Bioactive peptides
Potassium	Probiotic bacteria
Magnesium	Antioxidants
Calcium	Prebiotics

2. Unsaturated fatty acids

In many countries, consumers are over consuming saturated fatty acids and under consuming polyunsaturated fatty acids especially the omega-3 fatty acids (Dietary Guidelines for Americans, 2005). Fatty acid intake is a major problem because of the ability of fatty acids to impact low density lipoprotein (LDL) cholesterol levels which are associated with cardiovascular disease. In general, saturated fatty acids increased LDL cholesterol levels in the plasma and thus increase cardiovascular disease risk while polyunsaturated fatty acids decrease LDL cholesterol levels (Whitney & Rolfes, 2002). There is also much interest in incorporating omega-3 fatty acids into function foods. This is because many consumers are currently under consuming omega-3 fatty acids so increased consumption could be beneficial by decreasing blood triacylglycerols, sudden cardiac death, depression and arthritis (Harris, 2007).

The fatty acid composition of meat from ruminants is generally more saturated due to the fact that unsaturated fatty acids are subjected to biohydrogenation in the rumen (Fig. 1). The lack of a rumen means that the fatty acid composition of muscle foods from animals such as pigs, poultry and fish can be altered by diet as many papers have been published on increasing the unsaturated fatty acids composition of pigs and poultry (for review see Bou et al., 2009). This practice already occurs in specialty products such as Iberian hams which are high in oleic acid due to consumption of acorns (Narvaez-Rivas et al., 2008) and aquaculture salmon which are fed fish oils high in omega-3 fatty acids (Blanchet et al., 2005). However, these practices are limited by the fact that increasing levels of unsaturated fatty acids decreases the oxidative stability of the meat product. In contrast, increasing unsaturated fatty acids by dietary manipulation has been very successful in eggs. This is because eggs are naturally very antioxidative with the lipids packaged in oxidative stable lipoproteins, the iron inactivated by binding to proteins such as phosvitin and maintenance of low oxygen environment (Bou et al., 2009). Increasing unsaturated fatty acids is especially a problem in muscle foods since they are high in prooxidative metals, generally low in endogenous antioxidants and subjected to processing operations that greatly increase oxidative stress (e.g. cooking to produce warmed-over flavor). Thus, alteration of dietary fatty acids to change muscle composition is most easily accomplished with oleic acid since it is at least 10 times more oxidatively stable than polyunsaturated fatty acids such as linolenic (McClements & Decker, 2008). However, if dietary manipulation is performed to increase polyunsaturated fatty acids, then antioxidant technologies must also be employed to

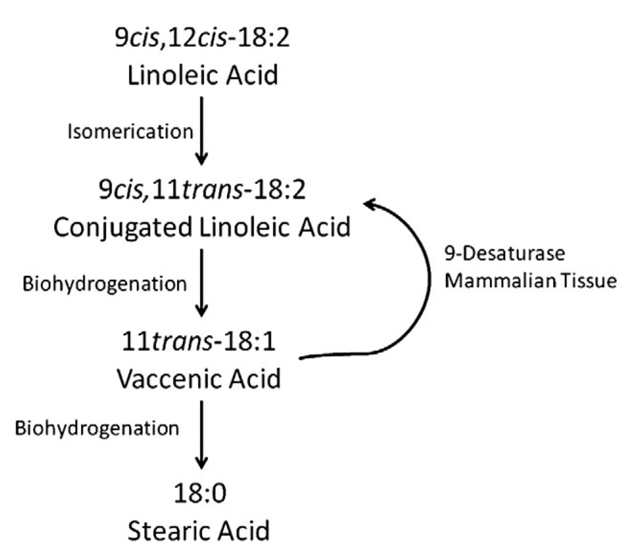

Fig. 1. Biohydrogenation of linolenic acid by rumen bacteria enzymes and endogenous synthesis of conjugated linolenic acid.