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Review

Review: Nutrient density and nutritional value of meat products and non-meat foods high in protein

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ABSTRACT

Background: Dietary **protein**, particularly essential amino acids, is important in the adult diet to help the body repair and regenerate cells and is important in the diet of children and adolescents for growth and development. In recent years, consumers are becoming more diverse when choosing foods to consume. Specifically, there is an increase around the world in the population of people who choose to consume a non-meat diet, and eat non-meat foods as their source of protein.

Scope and Approach: This review focused on comparing **nutrient density** and **nutritional value** (based on US dollars) of **meat products** and **non-meat foods** high in protein. Twenty-five meat products (beef, pork, lamb, and poultry), six fish products, and eighteen non-meat foods were compared for nutrient composition. Nutrient composition information was used to assign value based on nutrient density. Nutrient cost was expressed in nutrients available per US dollar and prices were assessed from the USDA economic research service and the USDA agricultural marketing service when available, and with a marketplace assessment when information was unavailable otherwise.

Key Findings and Conclusions: Consideration needs to be made when replacing meat in the diet with non-meat foods, because most non-meat foods contain only 20–60% protein density of meat. Additionally, when protein cost was evaluated, meat and non-meat foods had a similar cost when expressed as grams of protein/US dollar. While the total amount of zinc and iron was similar in meat and some non-meat foods, more investigation of digestibility and availability of nutrients is warranted.

1. Introduction

In most places in the world, the consumption of meat is held in high esteem and is widely regarded as a food product with high nutritional value (Bender, 1992, p. 91; Pellett & Young, 1990; Williams, 2007). Specifically, meat and meat products are considered an excellent source of zinc, heme-iron, bioavailable B vitamins, and essential amino acids (Biesalski, 2005; McAfee et al., 2010; Pereira & Vicente, 2013; Williams, 2007). The percentage of individuals choosing not to consume meat is a relative small percentage of people (estimated 2–10% in developed nations; The Vegetarian/Vegan Society of Queensland, 2010; The Local, 2014; Corrin & Papadopoulos, 2017). However, this small percentage of people still makes up a significant population of people around the world, and this demographic of people have a significant influence on the food marketplace. This is further validated by the 2014 internet chatter measurements (number of mentions on the internet) that ranked the dietary trend vegan as number one (591% growth) and dietary trend vegetarian as number three (152% growth) of all dietary trends evaluated (Best, 2015). There have been many studies that evaluate and discuss the health benefits and challenges of a well-planned vegetarian or vegan diet (Biesalski, 2005; Craig & Mangels, 2009; Key, Appleby, & Rosell, 2006; McAfee et al., 2010; McEvoy, Temple, & Woodside, 2012). However, it is important to consider and review the nutritional content of the food products making up a well-planned vegetarian or vegan diet when compared with the food products making up a more traditional meat-consuming diet.

Several scientific reviews have independently summarized the nutritional content of meat products (Fernández-Ginés, Fernández-López, Sayas-Barberá, & Pérez-Alvarez, 2005; Pereira & Vicente, 2013; Williams, 2007; Wood et al., 2008), seafood (Ackman, 1988; Sikorski, 2012), and crop or legume products (Endres, 2001; Erdman & Fordyce, 1989; Iqbal, Khalil, Ateeq, & Khan, 2006; Multari et al., 2016). Yet, this literature is scattered and a comprehensive review is necessary to fully compare nutritional content of

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meat products with non-meat products deemed high in protein. Additionally, there is no current review of the relative cost or value per unit of nutrient of meat products compared with non-meat products deemed high in protein. Thus, the objective of this review was to investigate the nutrient density, nutritional value, and cost of nutrients in meat products and non-meat products high in protein.

2. Foods high in protein

2.1. Meat and meat products

Meat is defined by the American Meat Science Association (2016) as:

> "Skeletal muscle and its associated tissues (including nerves, connective tissues, blood vessels, skin, fat, and bones) and edible offal derived from mammals, avian, and aquatic species deemed as safe and suitable for human consumption. Terrestrial and aquatic species intended for human consumption, are also included."

While this definition includes aquatic species, many preceding definitions of meat have separated fish and other seafood as its own entity and for the purpose of this review it will be discussed separately. Meat quality is an indistinct term that is typically thought of as a singularity or combination of eating quality (fresh meat appearance and palatability), shelf-life (color stability, lipid oxidation, and retention of initial quality), composition (lean-to-fat ratio and intramuscular fat), ease of processing (water-holding ability, pump uptake retention, and ability to work into an emulsion), convenience (method and ease of preparation), and microbiological safety (Apple & Yancey, 2016; Grunert, Bredahl, & Brunsø, 2004; Valous, Zheng, Sun, & Tan, 2016). Less consideration of meat quality is often given to nutritional density, nutritional value, and nutritional benefit to meat in the human diet. These considerations will be the focal point of this review.

Meat as a component of the human diet provides a source of nutritional protein, essential amino acids, and in most cases an above average source of vitamin B12, zinc, phosphorus, iron, and zinc (Biesalski, 2005; McAfee et al., 2010; Williams, 2007). Meat is low in carbohydrates and does not contain dietary fiber. While many things that influence product quality may vary between meats, the protein content, vitamins, and minerals available from meats are generally consistent (Biesalski, 2005; Kerry, Kerry, & Ledward, 2002). There has been a significant amount of research dedicated linking meat consumption, and particularly red meat consumption, with adverse health effects (Aune, Ursin, & Veierød, 2009; Cross et al., 2007; Micha, Wallace, & Mozaffarian, 2010). Discussing this relationship or lack of relationship is not the purpose of this review; however, health concerns is undoubtedly a factor in the rise of individuals choosing not to consume meat (Fox, 2013; Janssen, Busch, Rödiger, & Hamm, 2016).

2.2. Fish

Fish and other seafood represent an integral part of the human diet throughout the history of mankind (Lands, 1986; Tacon & Metian, 2013). Fish and other types of seafood are an excellent source of protein, minerals, and vitamins (Bender, 1997; Friedman, 1996; Sikorski, 2012). A recent statistic reported fish and other seafood accounted for 17 percent of the intake of animal protein globally, with many countries far exceeding this figure (Thilsted, James, Toppe, Subasinghe, & Karunasagar, 2014). The nutritional composition of fats in fish and seafood are considerably different (contains less saturated fats) than in red meat and poultry, and from a health perspective may offer added benefits for consumers wishing to limit or monitor their intake of saturated fats, but may also not contain the same abundance of nutrients found in red meats; such as, iron and zinc (Ackman, 1988; Kaushik et al., 2009; Mozaffarian, 2005).

2.3. Non-meat foods high in protein

It is difficult to provide an accurate estimation of the world population that does not consume meat, poultry, or seafood products; however, it is assumed to that between 2 and 10% of the world population are vegetarian or vegan with the greatest percentage in India where it is estimated over 30% of people are vegetarian or vegan for religious and other non-nutrition related reasons (Alexandratos & Bruinsma, 2012; Cummins, Widmar, Croney, & Fulton, 2015; Leitzmann, 2014). While a diet that does not include meat, poultry, or seafood products may have some health benefits (McEvoy et al., 2012; Pilis, Stec, Zych, & Pilis, 2014; Slavin & Lloyd, 2012), it is also important to consider the nutrients not available from non-meat foods that are readily available in meat, poultry, and seafood. According to recent American dietary guidelines, a healthy and well-planned vegetarian diet replaces meats, poultry, or seafood with legumes (beans and peas), soy products, nuts and seeds, and whole grains (U.S. Department of Health and Human Services, 2016). The purpose of this review will be to evaluate density of nutrients that may not be as readily available in non-meat protein foods and provide an estimation of cost associated with those nutrients.

3. Estimated average dietary requirements and calculations of nutrient density and cost of nutrients

Dietary reference intake provided by the Food and Nutrition Board, Institute of Medicine (2016) for protein, vitamin B12, phosphorus, iron, and zinc were presented in Table 1. These values were intended to be used as an indicator of recommended levels for individuals of unique life groups, ages, and weights (in the case of protein). Nutrient composition information was collected from the USDA Food Composition Database (2016) and used to assign value based on nutrient density. Nutrient composition information was summarized in Table 2, and this table is referenced throughout the review when specific values for nutrients were discussed. Nutrient cost was expressed in nutrients available per US dollar. Nutrients were assessed based on the information from Table 2 and prices were assessed from the USDA economic research service and the USDA agricultural marketing service when available, and with a marketplace assessment when information was unavailable otherwise (Table 3).

4. Nutrient density

4.1. Energy

A healthy diet satisfies an individual's need for energy and essential nutrients (Caballero, 2012). The recommended level of dietary energy requirements often fluctuates depending on an individual's body size, lifestyle, and level of activity (Westerterp, 2014). The main sources of dietary energy are fats and carbohydrates, yet proteins are capable of providing dietary energy (O'Neil, Keast, Fulgoni, & Nicklas, 2012). It is uncommon for people in developed and even underdeveloped nations to have deficiencies in energy intake, and most people in developed nations are actually more concerned with monitoring their intake of dietary energy. Excess intake of dietary energy is stored in the body as fat, which