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Muscle profiling to improve the value of retail meat cuts

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ABSTRACT

Nutrition and meat quality are always important to consumers, but vary by individual muscle or muscle groups in retail meat cuts. Muscle profiling of nutrient content and palatability for all retail beef cuts is necessary to suggest healthy and tasty beef cuts and to inform consumers of the benefits of beef consumption. The current paper reviews numerous studies that provide muscle profiles for nutrients and palatability attributes of muscles or muscle groups in retail beef cuts. The composition of nutrients including protein, fat, moisture, vitamins, and minerals in beef cuts is documented as well as the nutritive role as a part of a healthy diet. In addition, this review presents knowledge in relation to innovative carcass fabrication and value-added cuts to improve the value of beef carcass. Finally, the current work emphasize the palatability assessment of individual beef muscles, and concludes that all retail beef cuts should be merchandised for proper cooking according to the palatability profiles of beef muscles.

1. Introduction

Meat is a valuable component of the human diet with modern consumers and producers having an increased awareness of the composition and nutritive value of meat cuts. Nonetheless, the demand for nutritive and quality meat cuts continues to grow due to income increases in most developed countries. In fact, healthy nutrition and high quality of meat cuts at reasonable prices have always been important to consumers, but these factors are not equal across all meat cuts, and a lack of consistency in meat quality is a problem which has plagued the red meat industry for several decades. Variation of the proximate composition and meat quality, especially in beef, arises from a heterogeneous mix of muscles in conventional beef cuts. Consequently, the meat industry in developed countries is showing trends toward marketing individual muscle cuts to improve the value of retail meat cuts (Joo, Kim, Hwang,, & Ryu, 2013).

Numerous studies provide the nutrient database and meat quality profiles of individual muscles and muscle groups (primal or subprimal cuts) within the beef carcass (Acheson et al., 2015; Hunt et al., 2014; Jeremiah, Dugan, Aalhus, & Gibson, 2003a, 2003b; Jeremiah, Gibson, Aalhus, & Dugan, 2003c; Jung, Hwang, & Joo, 2015; Roseland et al., 2015). The nutrient and meat quality profiles are basically dependent on muscle fiber composition as well as the proximate composition of meat cuts (Jung et al., 2015; Jung, Hwang, & Joo, 2016), and the meat quality can be classified by AQT (appearance quality traits), EQT (eating quality traits) and RQT (reliance quality traits) (Joo et al., 2013). These nutritive and quality characteristics are affected by various intrinsic and extrinsic factors, however, up-to-date profiles for individual meat cuts it is essential to enable accurate evaluation of nutritive and quality cuts, so that consumers may be empowered to make better selections. In addition, understanding the nutrition and meat quality profiles of individual bovine muscles can improve the utilization of many retail cuts from beef carcasses.

For over half a century, efforts have been made to profile the characteristics of individual muscles from beef carcass (Jeremiah et al., 2003a). Since 70 years ago, the physical and sensory properties of major muscles of beef carcass have been characterized (Ramsbottom & Strandine, 1948; Ramsbottom, Strandine, & Koonz, 1945; Strandine, Koonz, & Ramsbottom, 1949). However, during the past 70 years, the composition and physical properties of beef muscles have changed considerably, and these are also significantly different among cattle breeds of the world. Therefore, it is necessary to assess the nutritive and quality attributes of the retail cuts or individual muscles from modern cattle breeds. In addition, the individual retail cut is the most important factor when choosing beef meat followed by quality certification (origin), production technique, the type of breed and price (Scozzafava, Corsi, Casini, Contini, & Loose, 2016). From this perspective, the current paper reviews the scientific literature in nutritive and meat quality characteristics of major bovine muscles so as to improve the utilization of many retail beef cuts and the value of a beef carcass.

2. Nutrient profiles of beef cuts for a healthy diet

Worldwide, the food industry is scrutinized more today than it has been in the past because of consumers' concerns about product composition, labeling, health claims, safety, and sustainability (Troy & Kerry,

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2010). In particular, the health claims are critical issues for the red meat industry in the 21st century. In this respect, it is necessary to obtain nutrient information or profiles of beef muscles in relation to the role of beef in a healthy diet. According to a number of epidemiological studies conducted in Western countries, red meat consumption was associated with the development of two major chronic diseases, cardiovascular disease (CDV) and colon cancer (Cross et al., 2007; Kontogianni, Panagiotakos, Pitsavos, Chrysohoou, & Stefanadis, 2008). In particular, fat content and fatty acid composition in red meat have been indicated to be responsible for these associations (Bingham, Hughes, & Cross, 2002). In addition, the possible formation of carcinogenic compounds such as heterocyclic amines (HCAs) by cooking meat at a high temperature is proposed as a possible cause of these diseases. There are numerous studies documenting these relationships, however, results are not always consistent.

Although many studies have reported on the relationship between red meat consumption and CVD or colon cancer, other studies have shown the benefits of lean beef as a part of a healthy diet (Campbell & Tang, 2010; Layman, Clifton, Gannon, Krauss, & Nuttall, 2008; Roussell et al., 2012). The fat and cholesterol content of beef have been reported to be linked to cancer, heart disease, and obesity (Micha, Wallace, & Mozaffarian, 2010; Pan et al., 2012). However, several methodological issues which could limit their findings have been indicated. According to McAfee et al. (2010), moderate consumption of lean red meat as part of a balanced diet is unlikely to increase the risk for CVD or colon cancer. They suggested that the moderate consumption of red meat may positively influence nutrient intakes and fatty acid profiles, thereby impacting positively on long-term health. Therefore, due to their unique properties and different cooking methods, maintaining data for a variety of retail beef cuts is important. Needless to say, nutrient data for all primal or sub-primal cuts are needed to enable accurate evaluation of healthy cuts so that consumers can make healthy selections (Jung et al., 2015).

Meat's nutritional composition and its nutritive role in the human diet have been well documented. Meat has played a crucial role in human evolution and, due to its nutritional richness, is an important component of a healthy, well balanced diet (Pereira & Vicente, 2013). However, even though the role of meat, particularly red meat, as a protein source is obvious, meat protein content can vary substantially by individual retail cuts (Desimone et al., 2013; Jung et al., 2015, 2016; Roseland et al., 2015). In addition, meat proteins are distinguished by their essential amino acid content, which varies between muscles or muscle groups in beef cuts. Also, fat content differs significantly among retail beef cuts, and cooking can have a major influence on meat fat content and fatty acid composition (Roseland et al., 2015). Gerber, Scheeder, and Wenk (2009) reported considerable fat losses in several meat cuts submitted to grilling, broiling, or pan-frying without any additional fat added.

On the other hand, meat is an excellent source of several vitamins and minerals. In particular, red meat provides approximately 25% of the recommended dietary intakes for riboflavin, niacin, vitamin B6, and pantothenic acid per 100 g and almost two thirds of the daily requirement (DR) of vitamin B12 in the same serving (Williamson, 2007). Meat is also one of the best sources for zinc, selenium, phosphorus and iron. Lean cuts of beef provide approximately 37% of selenium DR, 26% of Zinc DR, and 20% of potassium DR in a 100 g portion (USDA, 2011). The selenium content can range from 40 to 50 μg/100 g of fresh meat, and the bioavailability of selenium in meat cuts is quite variable (Fairweather-Tait, Collings, & Hurst, 2010). However, contents of all of these minerals can also vary substantially by individual bovine muscles or retail beef cuts, thus data on these nutrients for all primal or sub-primal cuts are needed to inform the benefits of beef consumption.

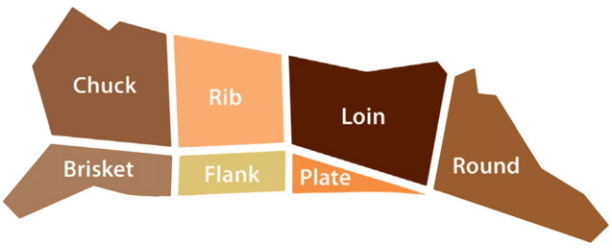

Fig. 1. Beef primal cuts (National Cattlemen's Beef Association, 2013). Adapted from Roseland et al. (2015).

3. Nutrient database for retail beef cuts

It has been reported that muscles in beef are extremely variable, and they differ considerably in size, weight, components, and meat quality traits due to muscle fiber composition (Joo et al., 2013). Early studies have demonstrated that beef muscles differ in protein (Strandine et al., 1949; Swift & Bauman, 1959), fat (Hunt & Hedrick, 1977; McKeith, De Vol, Miles, Bechtel, & Carr, 1985), and moisture (Briskey, Hoekstra, Bray, & Grummer, 1960; Ramsbottom & Strandine, 1948) content. Recently, to ensure data for retail beef cuts in USDA's National Nutrient Database for Standard Reference (SR), a comprehensive, nationwide, multi-phase study was conducted (Roseland et al., 2015). For this study, samples were collected and analyzed based on 7 primal cuts, including chuck, rib, loin, round, brisket, flank, and plate (Fig. 1), and full nutrient profiles were made available in SR (http://www.ars.usda.gov/nutrientdata).

With the results of Roseland et al. (2015), SR has updated nutrient profiles for 32 retail cuts of beef with up to 12 profiles per cut, including profiles for raw, cooked, separable lean only, separable lean and fat, Choice, Select and "all grades" cuts. Results for 16 beef retail cuts were compared for cooking yield and concentrations of chemical components. This study clearly showed patterns of protein, fat and moisture concentration among different beef cuts and cooking methods, but these patterns were not consistent among all comparisons. Furthermore, this study demonstrated the importance of maintaining specific data for a variety of retail beef cuts for studying the nutritional properties of beef. Consequently, it was proposed that unique characteristics of beef muscles or retail cuts from different primal cuts and cooking methods may affect their nutrient composition. Thus, data for a variety of retail beef cuts can have value for researchers and consumers for detection of a subtle difference in small nutrients content (Roseland et al., 2015).

Acheson et al. (2015) also reported on the nutrient composition of ten beef loin and round cuts to update the nutrient data in the USDA's National Nutrient Database for SR. They investigated 10 retail beef cuts, including short loins, strip loins, tenderloins, inside rounds, and eye of rounds (NAMP # 173, 175, 190A, 169A, and 171C) from 72 carcasses representing a national composition of Yield Grade, Quality Grade, sex classification, and genetic type. The proximate composition results of this study have provided updated information regarding the nutrient status of beef. They suggested that this information could be rapidly adapted for use on retail beef nutrition labels, and utilized to provide support for the consumption of lean beef as a part of a healthy diet.

From the point of view of a healthy diet, the fat content is a critical factor for retail beef cuts, and it is related to quality grade of beef carcass. Recently, Jung et al. (2015) investigated chemical components and meat quality traits of 10 primal cuts (Fig. 2) and 39 retail cuts (Table 1) from Hanwoo (Korean native cattle) carcasses. In this study, 25 Hanwoo carcasses representing 5 quality grades were used to obtain proximate data, and significant differences in fat, protein, and moisture content were found among the 10 primal cuts. Because the 5 quality grades were primarily determined by the degree of marbling using the Korean BMS (Beef Marbling Standard), the fat content increased as the quality grade increased. Brackebusch, McKeith, Carr, and McLaren (1991))