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ABSTRACT

Distribution of fatty acids and phospholipids in different table cuts and co-products from New Zealand pasture-fed Wagyu-dairy cross beef cattle

Emma N. Bermingham a, Mariza Gomes Reis b, Arvind K. Subbaraj a, David Cameron-Smith a c, Karl Fraser a, Arjan Jonker d, Cameron R. Craigie e

a Food Nutrition & Health Team, AgResearch, Palmerston North, New Zealand
b Dairy Foods Team, AgResearch, Palmerston North, New Zealand
c Liggins Institute, The University of Auckland, Auckland, New Zealand
d Animal Nutrition & Physiology Team, AgResearch, Palmerston North, New Zealand
e Food Assurance & Meat Quality Team, AgResearch, Hamilton, New Zealand

Wagyu beef products are marketed as luxury goods to discerning consumers and the lipid content and composition are important drivers of wagyu product value. Wagyu beef is an extensively marbled meat product, well characterised for its tenderness and flavour. In New Zealand, pasture-fed Wagyu-dairy beef production is increasing to meet demand for ultra-premium meat products. Important for these characteristics is the composition of lipid species and their distribution across the carcass. The aim of this study was to analyse the distribution of fatty acids and phospholipids in 26 table cuts, nine co-products and three fat deposits of carcasses from New Zealand pasture-fed Wagyu-dairy cross beef carcasses (n = 5). Phospholipid and fatty acid levels varied across different cuts of the carcass, but typically cuts with high levels of phospholipids also had high levels of omega-3 fatty acids and low levels of saturated fatty acids. This work will be used in the future to examine the potential health aspects of pasture-fed Wagyu beef.

Introduction

Red meat is a major component of many diets and offers a myriad of highly desired consumer attributes such as texture, taste, flavour and aroma. Particularly well regarded for its culinary properties is Wagyu beef. Wagyu are a cattle breed with genetic predisposition to intense marbling, comprising white flecks of adipose tissue (intra-muscular fat) between the bundles of muscle fibres in the skeletal muscles. Typically Wagyu cattle finished for beef are fed a high-energy grain-based diet for the majority of their lives. It is the high degree of marbling resulting from a grain-based diet that makes this breed so recognisable to the consumer and distinctive in taste. However, very little is known about the nutritional value of grass-fed Wagyu beef. One strategy developed in New Zealand has been the breeding of Wagyu-dairy cross cattle. This enables the development of a unique beef product with marbling from the Wagyu genetics, while ensuring that the hybrid cattle can thrive in an extensive production system on a pasture-based diet. It is well established that both genetics and diet, influence the extent and type of lipids deposited in the carcass. The interest in lipids extends beyond eating quality traits, with increasing interest in the role of meat-derived lipids for human health. Whilst it is well established that seafood, including fish species, provide the highest levels of long-chain omega-3 fatty acids, its overall consumption is low (Byelashov et al., 2015).

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Consequently, red-meat derived omega-3 is estimated to make a significant contribution towards the daily requirements of these fatty acids (Howe et al., 2007; Kronberg et al., 2017; Purchas et al., 2014).

In addition to these health benefits, there is an increasing need among meat producers and processors to increase utilisation and increase the value of the carcass (Mullen et al., 2017). Of the beef and sheep carcass approximately 30% is classified as edible co-products (Ockerman & Basu, 2004). Though the consumption of co-products is highly determined by intrinsic factory trust, culture and religion (Henchion et al., 2016), it is believed that a better understanding of the nutritional profiles of co-products may increase their utilisation as food (Seong et al., 2014a). Therefore, there is an increasing interest in determining the nutritive value of edible co-products, as well as primary and other table cuts. Recent studies have published the composition of co-products from various species including Hanwoo cattle (Seong et al., 2014a), pig (Seong et al., 2014b) and sheep (Cerci et al., 2011; Coskuntuna et al., 2015; Hoffman et al., 2013). However, these studies have mainly focussed on mineral and fatty acid compositions. Due to their roles in many aspects of human health, particularly in the cardiovascular system (Jian et al., 1997; Wat et al., 2009) other bioactive classes of lipid, especially phospholipids (PL), have garnered attention.

The lipid composition of a beef carcass includes the well-known major fatty acids species (saturated, monounsaturated and polyunsaturated fatty acids). However, extending beyond this there are many additional phospholipids that contribute to the taste and aroma of meat. Phospholipids are typically cellular membrane lipids, including those surrounding muscle fibres. They are mainly divided into glycerophospholipids and sphingolipids (Zhou et al., 2010), and comprise phosphatidylinositol (PI), phosphatidylethanolamine (PE), phosphatidylserine (PS), phosphatidylcholine (PC) and sphingomyelin (SM) classes. The positive impact of dietary phospholipids derived from dairy or eggs on human health is established (Blesso, 2015; Kullenberg et al., 2012). On the other hand, though beef muscle contains reasonable quantities of PL (Dannenberger et al., 2007; Vesper et al., 1999), little is known of their distribution across the carcass, especially in non-primal (i.e., tenderloin, striploin, cube roll) cuts and co-products and subsequent impacts on health of the consumer.

Finishing systems (e.g., pasture vs. high grain/concentrates) are known to affect the lipid composition of beef muscles and co-products (Daley et al., 2010). However, these studies have primarily focussed on beef breeds such Angus; relatively little is known about the lipid composition of moderately-marbled pasture-fed Wagyu-dairy cross cattle. The aim of this study was to characterise the grass-fed Wagyu carcass and determine the phospholipid and fatty acid content of table cuts and co-products. We hypothesised that the concentrations of complex lipids would differ between cuts of the pasture-fed Wagyu-cross carcass.

Section snippets

Materials and methods

Five commercially-sourced Wagyu-dairy cross beef carcasses (average carcass weight 291 ± 21 kg) were processed into 38 components (Table 1). The components included 26 table cuts such as including striploin, tenderloin and cube roll, nine co-products (bone marrow, brain, heart, kidney, liver, lung, spleen, tongue and tongue root), and three fat depots (channel fat, intermuscular fat and subcutaneous fat). All five cattle were Wagyu-Friesian cross Heifers sourced from the same farm, and had been ...

Phospholipids

Concentrations of phospholipids in the Wagyu-cross carcass are shown in Table 1. Phosphatidylcholine was the most abundant phospholipid measured, averaging 49% of total phospholipids across all cuts. Phospholipids were below detection limit in bone marrow or in the fat depots (channel fat, intermuscular fat and subcutaneous fat). For table cuts the concentration of phospholipids range from 584 μg/g of wet sample for navel end brisket to 3782 μg/g of wet sample for hindshank.

The concentration of …

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Discussion

This study found that there was a wide distribution of phospholipids and fatty acids across the pasture-fed Wagyu carcass. Generally, co-products had the highest levels of phospholipids and unsaturated fatty acids (including the long chain omega-3 fatty acids) and the lowest levels of saturated fatty acids. In contrast, primal cuts (striploin, tenderloin and cube roll) had lowest levels of complex lipids and higher levels of saturated fatty acids.

Beef lipids arise as a consequence of microbial ...

Conclusions

Co-products such as liver, heart, lung, kidney and spleen had the highest levels of phospholipids (3000–9000 μg/g fresh weight) and long-chain omega-3 fatty acids (1.3–4.2 mg/g fresh weight). It is estimated that common table cuts such as tenderloin, boneless inside skirt, boneless knuckle and hindshank obtained from grass-fed Wagyu-dairy cross could contribute to the recommended daily intakes of omega-3 fatty acids, especially EPA and DPA. Additionally, while there are no defined requirements ...

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