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Developing a cuts-based system to improve consumer acceptability of pork: Impact of gender, ageing period, endpoint temperature and cooking method

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ABSTRACT

The effect of gender (entire male, female and castrate), ageing period (2 or 7 days) and endpoint temperature (70 or 75 °C) on consumer perceptions of cuts from the loin (*Musculus longissimus thoracis et lumborum*), silverside (*Musculus biceps femoris*) and shoulder (*Musculus triceps brachii* (roast) and *Musculus supraspinatus* (stir fry)) when roasted or stir fried (all primals) or grilled as steaks (loin only) was investigated. Higher scores for juiciness ($P = 0.035$), flavour ($P = 0.017$), overall liking ($P = 0.018$), quality grade ($P = 0.026$) were obtained from castrates than entire males, with females intermediate. Neither ageing period nor endpoint temperature, as main effects, influenced sensory scores. Loin steaks and silverside roasts obtained lower ($P < 0.001$) scores for all sensory traits except aroma; scores for shoulder cuts were highest ($P < 0.001$). Cooking to 70 °C improved ($P < 0.05$) juiciness, flavor and overall liking scores of loin steaks compared with 75 °C. Different pathway interventions are required to optimize eating quality of different pork cuts and the cooking methods used to prepare them.

1. Introduction

In Australia, no industry system has yet been developed to consistently supply high quality fresh pork cuts to consumers. In comparison, a cut x cooking method-based system, known as Meat Standards Australia, has been implemented for both beef (Polkinghorne, Watson, Thompson, & Pethick, 2008; Watson, Polkinghorne, & Thompson, 2008) and sheep meat (Pleasants, Thompson, & Pethick, 2005). Whilst many studies have investigated the effects of various production, pre- and post-slaughter management of pigs and carcases as well as cooking methods used on technological and eating quality of pork, additional data is needed to support the development of a flexible and non-prescriptive cuts-based eating quality system for pork (Channon, Hamilton, D'Souza, & Dunshea, 2016).

The Australian pork industry has typically finished males as entire males in response to consumer demand for lean pork cuts and higher feed conversion efficiency on-farm of entire males compared with castrated males. However, the prevalence of boar taint cannot necessarily be managed through liveweight at slaughter of entire males (D'Souza et al., 2011). Issues with boar taint therefore need to be overcome to increase pork consumption frequency since flavour, tenderness and juiciness are the key eating quality attributes that influence overall liking of pork (Channon, Taverner, D'Souza, & Warner, 2014; Crawford et al., 2010; Wood et al., 1996). Current data on eating quality performance of Australian pork sourced from different genders is required to both quantify whether pork from entire male carcases (slaughtered at 90–105 kg liveweight) is as acceptable to that from female and castrated males, given the risk of boar taint and typically lower intramuscular fat levels, and enable gender recommendations to be included in any eating quality system that is developed.

Channon et al. (2016), as part of a quantitative literature review, identified that ageing of pork for 3 days or more post-slaughter can increase sensory tenderness scores by >10% compared with ageing for 2 days. It is notable that, whilst the Meat Standards Australia systems for both beef and sheepmeat include ageing period as a key pathway intervention (Meat Standards Australia 2011; Meat and Livestock Australia, 2015), such benefits of ageing on pork eating quality have not been formally utilized within Australian pork supply chain arrangements as a means of delivering higher quality, with less variability, to consumers.

Notably, many studies that have investigated various treatment effects on sensory quality have primarily utilized the loin (typically grilled, broiled or roasted steaks or chops of varying thicknesses), and

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where different muscles were evaluated, sensory quality was either not determined (eg. Aalhus, Best, Costello, & Schaefer, 1997; Aalhus, Schaefer, Murray, & Jones, 1992; Aaslyng & Barton Gade, 2001; Aluwé et al., 2009; Barton Gade, 2008; Crawford et al., 2010; Sather, Jones, Schaefer, Colyn, & Robertson, 1997) or not directly compared (Channon et al., 2014; Wood, Nute, Fursey, & Cuthbertson, 1995). No published eating quality studies have involved pork stir fry, despite its increasing consumer popularity as a cooking method for pork (Celsius Research 2014).

Improvements in juiciness and/or tenderness when pork is cooked (as a steak or as roasts) to an endpoint temperature of <68 °C have been reported (Bejerholm & Aaslyng, 2003; Ellis et al., 1998; Heymann, Hedrick, Karrasch, Eggeman, & Ellersieck, 1990; Moeller et al., 2010; Saunders, Wilkinson, & Hall, 2000; Simmons, Carr, & McKeith, 1985; Tikk et al., 2007; Wood et al., 1995) compared with pork cooked to higher endpoint temperatures. The minimum endpoint temperatures for whole cuts of meat in the USA, including pork, have been revised to 145 °F (62.7 °C), followed by a rest period of three minutes, before carving or consuming (USDA 2011). However, many Australian consumers are reluctant to cook pork to a medium-rare degree of doneness, comparable to an endpoint temperature of 64–68 °C, due to unfounded cultural perceptions that undercooking of pork may present food safety risks. Whilst inherent overcooking of pork by Australian consumers contributes to poor eating quality performance, resulting in tough, dry, chewy pork with poor flavour (Channon & Warner, 2011), the preference of Australian consumers of pork cooked to a medium-well done to well done degree of doneness led to the use of an endpoint temperature of 75 °C for loin steaks in previous Australian studies (eg. Channon et al., 2014; D'Souza & Mullan, 2002; Moore, Mullan, & D'Souza, 2012). Additional information is therefore needed to both quantify the effect of endpoint temperature on eating quality traits of different pork cuts and support the development of consumer messaging to modify cooking practices to reduce the incidence of overcooking and enable high quality pork meals to be prepared and enjoyed by consumers.

The objective of this study was to determine the effect of gender, ageing period, cut type, cooking method used and endpoint temperature to improve pork consistency and thereby reduce the fail rate of pork to <10%.

2. Methodology

2.1. Animal management

The animal management procedures used in this study were approved by the Animal Ethics Committee at Rivalea Australia Pty Ltd., NSW, Australia (Project 11 M044). A total of 60 pigs (Large White x Landrace, PrimeGro™ Genetics) were sourced from a commercial piggery. At birth, piglets were injected with iron and randomly allocated to gender treatment; females, entire males or castrates. Males allocated to the castrate treatment were castrated at 1 day of age. All animals were conventionally housed indoors on concrete slatted floors. Liveweight was recorded at birth, at the commencement of the finisher phase at 15 weeks of age and on the day prior to slaughter. At 15 weeks of age, pigs were allocated on the basis of liveweight to two slaughter groups within sex (10 pigs per gender per slaughter day). Pigs were individually tattooed on the day prior to slaughter immediately after weighing to enable individual carcases to be identified on the slaughter floor and to utilise liveweight data for individual animals to determine average daily gain during the finisher period. Diet specifications fed to pigs during the finisher phase are shown in Table 1. Animals were slaughtered over two slaughter days at 21–22 weeks of age, one week apart.

Animals were minimally handled on farm, during transport and at the abattoir. Pigs were housed within gender and slaughter date groups for the entire finisher period, during transport and in lairage. Following weighing on the day prior to slaughter, pigs were transported 300 km, for a duration of 3 h, to the abattoir, unloaded and held in lairage for 17 h prior to slaughter in their gender groups, with ad libitum access to water. Each gender group was moved separately to the point of stunning and stunned using 90% carbon dioxide (Butina, Denmark). Following evisceration, a fat sample was obtained from the belly region of each carcase for determination of and rostenone and/or skatole concentration and frozen at −20 °C.

Table 1
Diet specifications fed to pigs during weaner, grower and finisher phases.

	Diet specifications		
	Weaner (5–15 kg liveweight)	Grower (15–60 kg liveweight)	Finisher (60–100 kg liveweight)
Protein (%)	22.53	16.15	13.01
DE/MJ kg	14.46	14.00	13.79
Fat (%)	3.08	2.91	2.96
Fibre (%)	2.45	3.22	4.03
Lysine (%)	1.42	0.92	0.78

Hot carcase weight (AUS-MEAT Trim 1; AUS-MEAT, Brisbane, Australia) and fat depth at the P2 site (located 59 mm from the midline of the carcase at the last thoracic rib) using PorkScan (PorkScan Pty Ltd., Canberra, Australia) were measured and recorded for all carcases. Carcases were then dressed to AUS-MEAT Trim 13, split prior to chilling and placed in a chiller fitted with overhead fans and conventionally chilled (1–2 °C for 24 h), with the same chiller and chiller settings used on both slaughter days. Measurements of muscle pH and temperature decline post-slaughter were made in the loin (*Musculus longissimus thoracis*) adjacent to the P2 site at 45 min, 90 min, 3 h, 6 h and 24 h post-slaughter in both sides of each carcase using a portable pH meter (MPI, Kansas USA) fitted with a polypropylene spear-type gel electrode and a separate temperature probe (Noronix pocket probe thermometer).

Cold carcase weight was obtained immediately prior to boning at 24 h post-slaughter. Whole shoulders and boneless, rind-on loin (*M. longissimus thoracis et lumborum*) and silverside (*M. biceps femoris*) were collected from both sides of each carcase. For the loin, a 2–3 cm slice was firstly removed from the caudal end and a total of four 2.5 cm thick steaks were then sliced and denuded of subcutaneous fat. A 15 cm piece for roasting followed by a 10 cm piece, for later preparation into stir fry samples, were then cut. The remaining loin piece was used to undertaken objective meat quality measurements. For the silverside, a 10 cm roasting piece was firstly cut from the cranial end, followed by another 7–10 cm piece for stir fry. Remaining muscle was used for objective meat quality measurements. The bolar blade (*M. triceps brachii*), and chuck tender (*M. supraspinatus*) were removed from the shoulder and used for roasting and stir fry, respectively. As sufficient quantities of samples for both roasting and stir fry could not be obtained from the bolar blade, the chuck tender was used to ensure that consumers evaluated stir fry from the same muscle. Sections were also retained for objective measurements. Rind and subcutaneous fat on all roast pieces was removed after cooking and roasts were then sliced by the chef for consumer evaluation. All cuts were labelled, individually vacuum packaged, boxed and frozen following ageing at 2 °C for either 2 or 7 days post-slaughter, depending on treatment allocation. Pork was transported by frozen transport to the sensory facility, sorted into their pre-allocated sensory sessions in a controlled temperature room (12 °C) two days after arrival and held at −18 °C until required for sensory assessment.

2.2. Objective measurements

Androstenone (castrates and entire males) and skatole (all genders) concentrations were determined on belly fat samples (Frontage