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Quality characteristics of Warthog (*Phacochoerus africanus*) meat

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ABSTRACT

Warthogs are hunted for trophies and damage reprisal whilst the meat is consumed. Little is known about the quality profile of the meat, therefore, this study investigated the effect of age (yearlings and adult) and sex on the sensory, physical, and chemical attributes of cooked meat. The meat was high in protein (~32%) and low in total fat (< 2%), while the meat from yearlings tended to be tenderer than adults. Age appeared to have a more pronounced influence than sex on the sensory attributes. Warthog meat had a pork aroma and flavour. Undesirable odours and flavours were described as sour/sweaty and fishy, and adults differed from yearlings regarding sour/sweaty ($P = .025$) and fishy aromas ($P = .006$), and fishy flavours ($P = .045$). Small differences (< 0.5 mg/g) in palmitoleic ($P = .047$) and arachidonic ($P = .038$) acids were found between adults and yearlings. Warthog meat can be regarded as a lean and healthy source of protein.

1. Introduction

The common warthog (*Phacochoerus africanus*) is a free-ranging ungulate species found wide-spread in parts of South Africa as an indigenous and extra-limital species (Nyafu, 2009). The species is valued as a game animal for the hunting industry as local (biltong) and foreign hunters pay to hunt warthogs for trophies and game meat on game farms and reserves (Professional Hunters' Association of South Africa [PHASA], 2014; Taylor, Lindsey, & Davies-Mostert, 2015). Biltong hunting refers to the hunting of wild animals for recreation by local hunters with the benefit of producing game meat (Taylor et al., 2015), while game meat refers to the meat derived from wild and free-ranging ungulate species in southern Africa (Hoffman & Wiklund, 2006). In addition to trophy and biltong hunting, warthogs are also hunted for damage reprisal on agricultural lands as they are regarded by some as agricultural pests (Swanepoel, Leslie, & Hoffman, 2016), and culled on a large scale for population management on farms and reserves as necessitated.

All of these hunting practises produce a carcass that can be utilized by humans for consumption if not compromised by inaccurate shot placement and/or post mortem handling. Utilization of warthog meat has been proposed as a strategy to encourage sustainable management of populations in South Africa (Swanepoel, Leslie, & Hoffman, 2014). There has been a growing interest in the commercial production of game meat in South Africa as a substantial amount is produced annually in the country through hunting activities, although the majority is traded on an unregulated market. Game meat from free ranging ungulates is a unique product promoted on the basis that it is a healthier and organic alternative source of protein for the growing human population (Hoffman & Cawthorn, 2012; Hoffman & Wiklund, 2006), and could therefore contribute to food security. Game meat also has value for producing processed meat products in South Africa such as 'biltong' (a dried meat product similar to jerky) and 'droëwors' (dried sausages) (Jones, Arnaud, Gouws, & Hoffman, 2017) which together with fresh (unprocessed) meat could support a market for export.

However, consumers might associate warthog meat with lower quality and flavour attributes as there have been reports that warthog meat sometimes exhibits an aroma and flavour similar to boar taint, also referred to as "smelly/tainted" by some local hunters and consumers. Boar taint is an undesirable odour and taste which may occur in the meat from entire male domestic pigs (*Sus scrofa*), while a gamey or livery-like flavour has also been associated with the meat from wild ungulates and considered an acquired taste (Neethling, Hoffman, & Muller, 2016). Undesirable flavours are typically believed to pertain to adult male animals compared to other cohorts. However, the undesirable flavour has been reported for warthogs of different ages and both sexes. Since no research has been conducted on the composition and eating qualities of cooked warthog meat, this study aimed to investigate the sensory and chemical profile of the *Longissimus lumborum* muscle of warthogs in order to ascertain its potential as a marketable game meat for commercial production. Age and sex of the warthogs were taken into account as these factors are known to influence the profile of meat

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derived from domestic and game animals, and because negative sensory attributes have been associated with adult and male animals.

2. Methods

2.1. Culling, slaughtering and sampling

Free-roaming male and female yearling and adult warthogs were culled on the Pongola Game Reserve (27° 22′ 09.26″ S, 31° 50′ 42.16″ E) situated in the province of KwaZulu Natal, South Africa. A total of 31 warthogs were culled using single shot bolt action rifles (Ethical clearance number: 11LV_HOF02), during daylight in March 2015 until the desired quota per age and sex group ($n = 8$) was achieved. Unfortunately, only seven yearling males were culled as the full quota could not be obtained within the given time period. Warthogs were selectively shot with a bias towards sex and age, as it was not desired to cull animals unnecessarily. Tusk protrusion was used to classify warthogs ante mortem as yearlings (12–24 months), and adults (> 24 months) (Mason, 1984). The warthogs were exsanguinated in the field by thoracic sticking, transported to a slaughter facility on reserve, and weighed and dressed according to Swanepoel et al. (2014). The slaughter facility used is a government accredited facility approved for processing and selling game meat. The warthogs were weighed after bleeding out to determine body weight and after dressing (warthogs are skinned rather than having their hair scrapped/singed off as is the practise with domestic pigs) to determine hot carcass weight. Carcasses were hung in a cold room at 4 °C and weighed at 24 h post-mortem to determine cold carcass weight. The *Longissimus thoracis et lumborum* (LTL) muscles were excised from the carcass 24 h post-mortem and weighed, vacuum packed and frozen at –20 °C before being transported to Stellenbosch University. The left LTL was used for sensory and chemical analyses. The LTL muscle was analysed as this muscle is the most frequently studied muscle in small animal species due to its size and relative homogeneity.

2.2. pH

At 45 min after exsanguination, the pH (pH_{45}) of the *Longissimus lumborum* muscle (~3rd last rib) was measured by means of a Crison pH 25 handheld portable pH meter (Lasec (Pty) Ltd., South Africa). At 24 h post-mortem a second pH measurement was taken of the excised LTL and considered as ultimate pH (pH_u). The pH meter was calibrated with standard buffers (pH 4.0 and pH 7.0) provided by the manufacturer before taking measurements.

2.3. Sample preparation

The LTL muscles were defrosted overnight (12*h*) at 4 °C. The thawed muscles were gently dabbed dry with a paper towel and weighed to determine thaw loss. The entire excised LTL muscle was then divided to roughly represent the *Longissimus thoracis* (LT) (T_3 to T_{12}/T_{13}) and *Longissimus lumborum* (LL) (T_{12}/T_{13} to L_5) portions and weighed again. The visible fat and tendons were removed before the LT portion was homogenized, vacuum packed and stored at –20 °C for chemical analysis. The LL portion was vacuum packed and stored at 4 °C prior to sensory analysis the subsequent day. The LL portions for sensory analysis were removed from the vacuum package, blotted dry and placed in individually marked oven bags (Glad®), and prepared according to Geldenhuys, Hoffman, and Muller (2014). Thermocouple probes, attached to handheld digital temperature monitors (Hanna Instruments, Bellville, South Africa) were inserted into the approximate centre of each portion. The LL samples were loaded onto oven roasting pans fitted with grids and placed in convention ovens (Defy, Model 385), which were preheated to 160 °C. The ovens were connected to a computerized temperature control system. After cooking to an internal core temperature of 75 °C (± 45 min), the LL were removed from the bags and allowed to cool for 10 min before being blotted dry and weighed to determine cooking loss, and cut into 1.2 cm^3 cubes which were wrapped in aluminium foil. The foil-wrapped cubes were placed in ramekins and reheated at 100 °C for 7 min before serving. After reheating, the samples were covered with petri-dish lids and placed on half-filled cups in water-baths heated to 70 °C in order to maintain temperature.

Table 1
Definition and scale of each attribute used for the descriptive sensory analysis of warthog *Longissimus lumborum*.

Sensory attribute	Description	Reference
Aroma[a]		
Pork aroma	Associated with cooked pork	Pork loin chop
Chicken aroma	Associated with cooked chicken	Chicken breast
Gamey aroma	Associated with cooked game meat	Fallow deer loin
Sour/sweaty aroma	Associated with cooked warthog meat	Warthog fillet
Fishy aroma	Associated with smoked fish	Smoked mackerel
Flavour[a]		
Pork flavour	Associated with cooked pork	Pork loin chop
Chicken flavour	Associated with cooked chicken	Chicken breast
Sour/sweaty flavour	Associated with cooked warthog meat	Warthog fillet
Metallic flavour	Associated with heavily pigmented cooked meat	Fallow deer loin
Gamey flavour	Associated with cooked game meat	Fallow deer loin
Fishy flavour	Associated with smoked fish	Smoked mackerel
Texture (mouth-feel)		
Initial juiciness	Amount of fluid exuded when pressed between thumb and forefinger 0 = Dry, 100 = Juicy	Chicken breast
Sustained juiciness	Impression formed after first 5 chews using molar teeth 0 = Dry, 100 = Juicy	Chicken breast
Tenderness	Impression formed after first 5 chews using molar teeth 0 = Tough, 100 = Tender	Chicken breast
Residue	Amount of residue left in mouth after 10 chews using molar teeth 0 = None, 100 = Abundant	Pork loin chop[b]

[a] Scale for descriptors: 0 = Low Intensity, 100 = High Intensity, unless otherwise stated. Aroma and flavour were analysed orthonasally and retronasally, respectively.
[b] Cooked to internal temperature of 78 °C.

2.4. Descriptive sensory analysis

Ten panellists were recruited from a group of pre-existing panel members who had previous experience with sensory evaluation of meat at Stellenbosch University. The panellists were trained using generic descriptive techniques as described in Lawless and Heymann (2010). During six one-hour long training sessions the panellists made use of reference samples of different domestic and game animal meats to create a list of associated sensory attributes identified in the cooked warthog samples (Table 1), which included aroma, flavour and texture. Only the reference samples that had sensory attributes associated with warthog meat was included in the final training sessions of the panel. The trained panel evaluated the cooked warthog meat samples by scoring each attribute on an unstructured 100-point scale during seven blind-tasting sessions of ± 45 min, where the scale for descriptors indicated 0 = Low Intensity, 100 = High Intensity, unless otherwise stated. Randomly selected left LL warthog muscles from each of the four treatment combinations (two age classes × two sexes) were assigned to each of the seven descriptive sensory analysis sessions. Three blocks of meat from each muscle per treatment were presented to the panellists seated in booths in a temperature (21 °C) and light (artificial daylight) controlled room. Compusense® five software (Compusense, Guelph,