FATTY ACIDS AND MINERALS AFFECT THE LIVER-LIKE OFF-FLAVOUR IN COOKED BEEF

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Introduction

Flavour is an important organoleptic trait that consumers use in the determination of acceptability. Meat flavour is a result of reducing sugars and amino acids, differences in fatty acid composition that are responsible for species-specific flavour, off-flavour development due to lipid oxidation, microbial by-products, or other degradative mechanisms (Miller, 2001). Current research in our laboratory has specifically concentrated on the liver-like off-flavour. Miller (2001) indicated that the causes of the livery off-flavour in beef are lipid oxidation, heme iron content and elevated degrees of doneness. James and Calkins (2006) reported that slow cooking (36-40min) and subsequent holding for 1 h of specific muscles from the chuck and round prior to serving reduced off-flavour intensity while Meisinger (2005) found that heme-iron concentration and pH significantly (P=0.0004) accounted for 55% of the variation in the liver-like off-flavour of the *M. rectus femoris* (knuckle center). Although heme-iron content, lipid oxidation, and pH have been implicated as contributing to the liver-like off-flavour, these relationships are weak. Therefore, the objective of this research was to identify factors affecting the liver-like off-flavour in knuckles.

Materials and Methods

Samples were obtained using the screening procedure previously described by Jenschke *et al.,* 2006. Briefly, two trained sensory panelists tasted a 10g piece of the knuckle centre. Knuckles identified as having an off-flavour (n=30) and knuckles not having an off-flavour were vaccum-packaged and shipped to the Loeffel Meat Laboratory at the University of Nebraska. Following a 7d aging period at 1°C, the *M. rectus femoris* was isolated and cut into 2.54cm thick steaks, freezer wrapped and frozen (-16°C) until sensory analysis was conducted. Steaks were cooked to an internal temperature of 70°C on an electric broiler (FSR200, Farberware Inc., Prospect, IL). Internal temperature was monitored with a digital thermometer (Omega Engineering, model 450-ATT, Stamford,CT) with a type T thermocouple (Omega Engineering, Stamford, CT). Once the internal temperature reached 35°C, the steak was turned once until the final temperature was reached. The steak was then cut into 1.27cm x 1.27cm x 2.54cm cubes and served warm to the panelists, approximately 5 minutes post cooking. Panelists for this study were selected and trained according to the guidelines and procedures outlined by Meilgaard *et al.,* (1991). Six samples, identified using three-digit codes, were served on each day. Eight-point descriptive attribute scales (Muscle fibre tenderness: 1=extremely tough, 8=extremely tender; Connective tissue: 1=abundant, 8=none; Juiciness: 1=extremely dry, 8=extremely juicy; Off-flavour intensity: 1=extreme off-flavour, 8=no off-flavour) were used. Off-flavours were rated using a 15-point intensity scale (0=extremely bland; 15=extremely intense). Heme iron was determined using the acidified acetone extraction procedure while pH was determined using a penetrating pH probe. Moisture and ash (expressed as percentages) were quantified using a LECO Thermogravimetric Analyzer-601 while percent fat was determined using an ether extraction method. Minerals were isolated and quantified using an inductively-coupled argon plasma spectrometer. Fatty acids were extracted using a 2:1 chloroform:methanol solution and methylated using boron fluoride-methanol. Data were analysed using the REG procedure of SAS (Version 9.1.3), and the stepwise option was used to determine the final variables to be included in the model while the CORR procedure was used to generate correlation coefficients.

Results and Discussion

Table 1 includes the minerals and fatty acids tested in this study. The final model for predicting liver-like off-flavour is: Liver-like off-flavour rating=-0.21+ 0.0008 (Na) + 0.13 ((20:2 (n-6))- 0.005 (16:1) – 0.002 ((18:1 (n-7)) – 0.033 (20:3) which explained 46% of the variation in the liver-like off-flavour. It should also be noted that non liver-like samples had 3.5 times more vaccenic acid (18:1 n-7) when compared to liver-like samples. Simple correlations from our data indicated that vaccenic (r=-0.32; P=0.02), *cis*-11,14-eicosadienoic (20:2 n-6) (r=0.34; P=0.02) and eicosapentaenoic acid (20:5) (r=0.28; P=0.05) significantly affected the liver-like off-flavour in this study. Camfield *et al.,* (1997) reported simple correlation coefficients of fatty acids and their effect on the livery off-flavour. Vaccenic acid (r= -0.32; P<0.05) and *cis*-11,14-eicosadienoic acid (r=0.38; P<0.05) individually accounted for a significant amount of variation in the livery off-flavour which is in agreement with our data. Yancey (2002) reported in the *M. Gluteus medius* that palmitoleic (16:1), heptadecenoic (17:1), and elaidic (18:1 n-9t) acids were negatively correlated to the livery off-flavour and individually accounted for about 20% of the variation in the livery off-flavour. Although not significant, our results indicate that palmitoleic acid may also play a role in the development of the liver-like off-flavour (r=-0.25;

P=0.08). Meisinger (2005) indicated that heme iron might be a cause of the livery off-flavour in beef, but our data suggests that neither heme iron nor total iron play a role in the development of the liver-like off-flavour.

Table 1: Minerals and fatty acids quantified.

Fatty Acids			Minerals
14:0	18:1 (n-7)	20:4	Zn
14:1	18:2	20:5	Fe
15:0	18:3	22:5	P
16:0	20:0	22:6	Mn
16:1	20:1	24:0	Mg
17:0	20:2		Ca
18:0	20:2(n-6)		Cu
18:1	20:3		Na

Conclusions

Data from this study indicate individual fatty acids and minerals play a significant role in the development of the liver-like off-flavour. Future studies to manipulate the fatty acid and mineral profiles of muscle might prove beneficial in lowering the incidence of the liver-like off-flavour in beef.

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