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EFFECT OF ENHANCEMENT ON FLAVOR VOLATILES OF VARIOUS BEEF MUSCLES

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Introduction

Consumers continue to demand high quality, consistent meat products at a reasonable price. Historically, aging of meat products has been used to improve quality (Dransfield, 1994; Mottram, 1998). The enhancement of poultry and in more recent years, pork has been used to ensure that a consistent product reaches the consumer (Grey et al, 1978, Brewer et al., 2002). This same technology can be applied to beef in order to ensure consumers receive consistent, quality products. Tenderness and flavor are the two sensory traits that affect consumer acceptance of beef and therefore influence repeat purchases (Robbins et al., 2003). Enhancement of meat products could alter the volatile flavor compounds found in different muscles (Gasser and Grosch, 1988). By gaining a better understanding of which muscles would profit from enhancement, the beef industry will benefit economically.

Objectives

The objectives of this project were (1) to profile the flavor changes and to evaluate Warner-Bratzler shear and color changes and (2) to identify and quantify the compounds, which change during aging, of ten beef muscles enhanced prior to aging.

Methodology

Phase 1

The *Gluteus medius, Infraspinatus, Psoas major, Rectus femoris, Teres major, Complexus, Serratus ventralis, Vastus lateralis, Vatus medialis* and *Longissimus dorsi* were removed from 20 USDA Select carcasses 48 h after slaughter. Muscles from one side of each carcass were divided into two sections (1/aging period), vacuum-packaged, stored at 4 °C and used as the unenhanced control. Muscles from the remaining side were enhanced to 108% of original weight for a final concentration of 0.3% salt and 0.4% sodium tripolyphosphate for comparison with unenhanced samples. Enhancement solution was injected at 0 °C, 1.5 Barr and 52 strokes/min through injection needles spaced 2.5 cm apart using a multi-injector system (Model N50, Wolf-tec Inc., Kingston, NY). Muscles were weighed before and after pumping to determine the solution uptake.

Each enhanced muscle was divided into two sections (1/aging period), vacuum-packaged, and stored at 4 °C. Sections, both enhanced and control, were aged 7 or 14 d. Sections were removed from vacuum bags, weighed for purge loss determination, measured for pH, faced, sliced into 2.5 cm steaks for sensory evaluation, proximate analysis, cook loss and Warner-Bratzler shear force. Steaks were allowed to bloom for color determination (Minolta L*, a*, b*, Konica-Minolta, Japan), vacuum-packaged and stored for 18 hrs at 4 °C until sensory evaluation.

A 10-member trained sensory panel evaluated raw color (red, brown, green) prior to cooking on a semi-structured 15-cm line scale where 0 = light and 15 = dark. Cooked (70 °C) steaks were evaluated for flavor (tenderness, juiciness, saltiness, beef flavor, oily mouthfeel, rancid off-flavor, liver off-flavor) on a semi-structured 15-cm line scale where 0 = none and 15 = intense. Standards were provided for both color and flavor attributes. For cook loss and shear force, raw steaks were weighed, cooked (70 °C), re-weighed, cooled for 1 h at 4 °C, cored, and evaluated using an Instron Universal testing machine for Warner-Bratzler shear force. Moisture and fat content were determined following each aging period. Samples were trimmed of fat and connective tissue, homogenized, and oven-dried (10-g duplicate samples) for 48 h at 110 °C (AOAC, 1990). Moisture content was determined by weight difference between wet and dry sample. Fat content was determined by extraction with an azeotropic mixture of warm chloroform and methanol (4:1) (Novakofski et al., 1989).

Phase 2

Volatile flavor components were determined using soldi-phase microextraction-gas chromatography (SPME) coupled with a sulfur-selective detector. Homogenized cooked meat samples (5 g) were placed in a 22-mL glass headspace vial and sealed with a Teflon-lined septum. Vials were preincubated for 20 minutes at 50 °C, then headspace volatiles were sampled for 10 min using a Carboxen/PDMS SPME fiber and subsequently thermally desorbed in the injection port of the GC (Zhu et al. 2001). Levels of sulfur-containing compounds were determined by selective detection using a flame photometric detector (Zhu et al. 2001). Parallel detectors (mass spectrometer and flame ionization detector) were used to monitor non S-containing flavor components. Free amino nitrogen was measured as an index of liberated free amino acids (and peptides) as a function of aging or enhancement using the NOPA method (Shively and Henick-Kling, 2001).

Analysis

Data were analyzed as a repeated measures (carcass), factorial design using PROC MIXED (SAS, 2002) with the model accounting for the effects of muscle, aging time, enhancement and appropriate interactions. Effects were considered significant at $p<0.05$. Least squares means were separated using probability of difference. Changes in compounds were correlated with sensory flavor profiles determined in phase 1 of the study.

Results & Discussion

Enhancement generally increased positive sensory attributes (tenderness, juiciness, beef flavor, saltiness, pH and moisture content) and decreased negative attributes (purge loss and off-flavors). Enhancement decreased instrumental color values (L*, a*, b*, chroma) by varying degrees for different muscles. Increasing pH often increases water-holding capacity which increases moisture content, juiciness and tenderness and decreases shear values. The salt in the enhancement solution would be expected to impact flavor by increasing saltiness and beef flavor which in turn may have masked low levels of off-flavors originally present or after aging.

Aging had positive effects on tenderness, flavor and shear values, negative effects on instrumental color values (L*, a*, b*, chroma), and minimal effects on beef flavor. Flavor-active volatiles affected by enhancement and aging in the various muscles include nonanal, 2,3-octanedione, pentanal, 3-hydroxy-2-butanone, 2-pentyl furan, 1-octen-3-ol, butanioc acid, pentanal and hexanoic acid. Enhancement decreased hexanal and hexanoic acid. Aging decreased butanoic acid. Pentanal content varied among muscles depending on enhancement and aging. Some variation in responses may be explained by the original variation (tenderness, moisture, fat content and color) in the 10 muscles.

Conclusions

Enhancement increased quality characteristics of muscles however some benefited more than others. Aging had smaller effects. Volatile compounds known to affect flavor varied due to the specific muscle that was subjected to enhancement and aging.

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