RESEARCH REPORT
PORK QUALITY

Project Title: "Pork Muscle Profiling Study" - **NPB #02-189**

Investigator: Dennis R. Buege

Institutuion: Meat Science and Muscle Biology Laboratory, University of Wisconsin-Madison

Date Received: December 16, 2003

Abstract: Sixty four pork carcasses were selected from a single packer which purchases pigs on the open market from a variety of producers employing a wide range of genetic lines. Carcass selection followed pre-determined guidelines for specific carcass weight ranges, estimated carcass percent muscle and pH at 45 minutes postmortem (an indicator of lean quality), to assure an appropriate distribution of carcasses varying in these criteria. After 24 hours of chilling, carcasses were transported to the Meat Science Laboratory at Iowa State University.

Between 48 and 80 hours postmortem hams and shoulders from both sides of selected carcasses were fabricated into individual muscles. Muscles of significant size (0.5 pounds or larger) were evaluated by meat scientists from Iowa State, Michigan State and the University of Wisconsin for the following properties: weight, physical dimensions, pH, sensory properties, objective tenderness, objective color, water-holding capacity, protein solubility, gel strength, pigment concentration, total collagen and nutrient content.

Based upon this muscle-specific information, now available for each of the significant muscles of the shoulder and ham, the generation of novel value-added product ideas, and the application of muscles for new value-added uses, is greatly enhanced. Representatives of the pork processing industry have access to these results to use in product development. Several of the muscles studied hold considerable potential for development of new pork products.

Introduction: The shoulder and ham primals of pork carcasses have traditionally been marketed to processors and retailers in intact form, for fabrication and manufacture into consumer products containing the variety of muscles found in those cuts. In recent years the meat processing industry has sought to develop new value-added products by discovering unique properties of single muscles or groups of muscles from primal cuts. To facilitate this effort, it is very important to understand the characteristics of individual muscles.

Objectives: The objective of this project was to determine the physical and chemical properties of significant muscles from the ham and shoulder, to enhance selection of raw materials from these primals to use in developing new value-added pork items.

Materials and Methods: This research was cooperatively conducted by scientists and technical staff from Iowa State University, Michigan State University and the University of Wisconsin.

Sixty four pork carcasses were selected from a single packer which purchases pigs on the open market from a variety of producers employing a wide range of genetic lines. Carcass selection followed pre-determined guidelines for specific carcass weight ranges, estimated carcass percent muscle and pH at 45 minutes postmortem (an indicator of lean quality), to assure an appropriate distribution of carcasses varying in these criteria. After 24 hours of chilling, carcasses were transported to the Meat Science Laboratory at Iowa State University.

Between 48 and 80 hours postmortem hams and shoulders from both sides of selected carcasses were fabricated into individual muscles. Muscles of significant size (0.5 pounds or larger) were evaluated for the following properties: weight, physical dimensions, pH, sensory properties, objective tenderness, objective color, water-holding capacity, protein solubility, gel strength, pigment concentration, total collagen and nutrient content.

The principal investigator submitting this report on behalf of the University of Wisconsin was specifically involved in the determination of the proximate chemical composition (protein, fat, moisture and ash) for each of the muscles. These analyses were performed according to approved A.O.A.C. procedures by Covance Laboratories of Madison, Wisconsin.

Results: The results from the chemical, physical and nutritional evaluation of 25 significant shoulder and ham muscles were organized into a multi-level classification system for each parameter measured. For example, the mean pH value of each muscle is classified as low, medium or high pH, and the mean sensory tenderness of muscles is described according to a five descriptor scale, encompassing very tender, moderately tender, average tenderness, moderately tough and very tough. With such descriptions defined for all muscle parameters evaluated, a determination can be considered for the most appropriate potential use of individual muscles or closely-adjacent muscle groups.

A section of longissimus muscle from each carcass (from the fifth rib forward) was included in these evaluations, to serve as a familiar benchmark. As an example of the output generated from this work, Table 1 presents the results of the evaluations and

analyses performed on the Semitendinosus ("eye" muscle of the ham) and Longissimus dorsi (loin muscle).

Representatives from the pork processing industry and the National Pork Board are working with these findings on the characteristics of individual muscles of the ham and shoulder, to develop applications for adding value to their merchandising potential. Not only are the size, shape and characteristics of individual muscles important to their potential application, but also the accessibility of the muscles and their ease of removal from the shoulder and ham primals, using current and possible future fabrication methods, will be critical factors in determining muscle use.

The desired outcome of this comprehensive determination of the properties of the individual ham and shoulder muscles is to identify those muscles which possess appropriate characteristics and realistic fabrication potential, to be able to be merchandised as higher-value products. Such an outcome would increase the overall value of these primals to the processing industry, and ultimately add value to the total pork carcass, to the benefit of pork producers and pork processors.

Discussion: This study collected a great deal of information on the 25 principal muscles of the pork ham and shoulder. This is the most comprehensive study ever performed to describe the chemical and physical features of these muscles. It is extremely valuable information which can be used to support efforts of adding value to the pork carcass by matching the properties of individual or groups of muscles with needs of potential added-value products.

Below is a list of the muscle properties determined in this study, and how those factors might impact muscle use in value-added products:

Muscle weight - will size provide single portion, multiple portions, or must several muscles be combined to achieve useful weight?

Muscle pH - can affect the water-holding ability and the color of the product

Water-holding capacity - a direct measure of the muscle's ability to retain moisture during processing and cooking

Objective color measurements and heme pigment content - will determine the color intensity of the product, including its appearance after curing with nitrite.

Color uniformity - will affect the overall appearance of products.

Fat, protein, cholesterol, fatty acids and iron - will reflect on the nutrient content of each muscle, and particularly its suitability for use in low fat products, which are sought after by some consumers. Iron, beside being an important mineral in the diet, is a component of the muscle pigment myoglobin, and is an indirect measure of expected red color intensity.

Collagen - the principal component of connective tissue in muscle. The amount of collagen can be a measure of expected tenderness, and also can affect the processing characteristics of the muscle and its final texture.

Protein solubility - the ability of proteins to be extracted from a muscle by salt and dissolve in a salt brine, can affect the strength of bind developed in comminuted or re-structured products, and the ability of the muscle to hold onto moisture during cooking.

Tenderness - it goes without saying the importance of tenderness to product acceptability. Muscle lacking in tenderness are best destined for some type of processed products which can address the tenderness characteristics during manufacture.

Flavor - different muscles vary in their flavor profile. Many flavors are considered very acceptable and suitable for stand-alone fresh products. Muscles of less desirable flavor profile are best used in combination with other muscles, and processed to alter or control the flavor.

Based upon this type of muscle-specific information, now collected for each of the significant muscles of the shoulder and ham, the generation of novel value-added product ideas, and the application of muscles for new value-added uses, is greatly enhanced.

Lay Interpretation: Traditionally muscles of the shoulder and ham have been marketed in groups as part of commodity primals (Boston shoulder, picnic shoulder, and ham). However, merchandising is evolving such that these primals sometimes are (or more often could be) subdivided into individual muscles or smaller muscle groups to meet specific value-added product needs. Understanding the properties of the individual muscles of these primals will enhance and encourage the development of new value-added uses for muscles possessing characteristics which match product needs.

In this study, scientists and staff from the meat science groups at Iowa State University, the University of Wisconsin and Michigan State University studied the properties of the 25 major muscles from the ham and shoulder of 64 pork carcasses. These carcasses were selected from a packer buying a wide range of genetics, and represented defined broad ranges of carcass weight, percent muscle, and muscle pH at 45 minutes after slaughter (an indicator of eventual muscle quality).

The muscles from each carcass were evaluated for many chemical and physical factors including: weight; final pH: color and color uniformity; nutrients such as fat, protein, cholesterol, fatty acids and iron; protein quality factors such as solubility and collagen content; tenderness and flavor.

Based upon this muscle-specific information, now available for each of the significant muscles of the shoulder and ham, the generation of novel value-added product ideas, and the application of muscles for new value-added uses, is greatly enhanced. Representatives of the pork processing industry have access to these results to use in product development. The goal of this research is to stimulate greater use of suitable individual muscles or small muscle groups to create higher value pork products, increasing pork carcass value and improving economic returns to pork producers.

Table 1. A comparison of the chemical and physical properties of raw pork Semitendinosus and longissimus dorsi.

	Semitendinosus	Longissimus dorsi
Weight (lbs).	1.23	1.53
pH Classification - mean value	average (6.12)	low (5.81)
Water-Holding Capacity - mean value (%)	low (91.77)	low (92.29)
Color - mean L* - mean a* - mean b*	average (48.3) (20.1) (6.1)	light (53.0) (17.5) (5.3)
Color Uniformity	two-toned	uniform
Fat Content - mean fat (g/100	average (5.7)	average (3.2)
Total Iron - mean iron (mg/100 g)	(0.98)	(0.78)
Heme Pigment - mean value (mg/g)	(0.99)	(0.82)
Collagen - mean value (mg/g)	(6.53)	(3.96)
Protein Solubility	high	high
Overall Tenderness - mean sensory - mean star probe	average (102/150) (4.18)	moderately tender (104/150) (4.49)
Texture	fine-textured	average
Flavor	moderate pork flavor	light meat pork flavor
Recommended Category	fresh-- enhanced	fresh -- enhanced
Product Suggestions	medallions, roast	chops, roast

npbfinal.wmd.wpd (12-16-03)