

BURLEIGH DODDS SERIES IN AGRICULTURAL SCIENCE

Achieving sustainable production of pig meat

Volume 1: Safety, quality and sustainability

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Introduction

Pig meat is the most widely-consumed meat in the world. Previous growth in production has relied, in part, on more intensive systems, but in meeting rising demand, these systems face challenges such as the ongoing threat of zoonotic diseases, the need to improve feed efficiency in the face of rising costs, the need to reduce the environmental impact of pig production and increasing concerns about animal welfare. These challenges are addressed by the three volumes of *Achieving sustainable production of pig meat*:

- Volume 1: Safety, quality and sustainability
- Volume 2: Animal breeding and nutrition
- Volume 3: Animal health and welfare

This volume, Volume 1, reviews the latest research on controlling pathogenic and non-pathogenic safety risks associated with pig meat. It then surveys the latest research on aspects of meat quality such as flavour, colour, texture and nutritional quality. Finally, it assesses ways of monitoring and reducing the environmental impact of pig production.

Part 1 Safety

The first part of the volume deals with safety issues associated with the production of pig meat. The focus of Chapter 1 is on zoonoses affecting pigs. Zoonoses are defined as diseases and infections that are transmitted between vertebrate animals and humans. Major food animal species occupy a special position within the framework of zoonotic disease. This is particularly the case in developed societies, where direct livestock contact has become relatively rare, and where for much of the population the food supply has become the predominant route of exposure to livestock-associated pathogens. The chapter provides a broad overview of the zoonotic hazards associated with pigs, including leptospirosis, tuberculosis, brucellosis, influenza A viruses (IAV) and *Streptococcus suis*. The chapter examines emerging zoonoses such as livestock-associated *Staphylococcus aureus*, hepatitis E and novel paramyxoviruses, as well as foodborne pathogens. The chapter concentrates on the agents and pathways which most contribute to zoonotic risk, and looks at how these risks may be modulated by changing conditions at the human-swine interface.

Complementing the preceding chapter's focus on the main zoonoses affecting pigs, Chapter 2 examines the challenge of effective control of zoonoses in pig production. *Salmonella* infections of zoonotic origin are one of the most frequent causes of zoonotic infections worldwide, and there are clear indications that, at least in some countries, pork is an important source of human salmonellosis. The chapter describes the epidemiology of *Salmonella* and possible interventions in the pig and pork production chain. The chapter addresses animal surveillance and monitoring, control of feed and environment, and the role of replacement animals and finisher herds. The chapter also considers vaccination as a reduction strategy and measures that can be adopted at the slaughterhouse stage. The chapter also includes a detailed case study on *Salmonella* reduction in Danish pig and pork production.

Moving from the challenge of controlling disease to a challenge resulting from disease control itself, Chapter 3 addresses the issue of antibiotic resistance in pig production. The chapter describes the practice of antibiotic use in pig production. The chapter begins with a brief history of antibiotic use in livestock production, before examining the current state of research focused on developing non-antibiotic means of controlling bacterial infections in livestock. Finally, the chapter provides a case study of research in phage therapy as a case study of a (re)emerging technology that could be utilized in biocontrol of bacterial pathogens in agriculture.

The final chapter of the section, Chapter 4, deals with detecting veterinary drug residues in pork. The United States Food and Drug Administration (FDA) new animal drug approval process evaluates veterinary drugs intended for use in food-producing animals for safety and effectiveness. As part of the human food safety evaluation process, new animal drugs are evaluated for microbial food safety, toxicology and residue chemistry. The chapter summarizes the evaluation process that includes the assignment of tolerance(s) and withdrawal periods. It also establishes the criteria for violative residues i.e. residues above the established tolerance limits which may have potential adverse health effects in humans.

Part 2 Quality

The focus of the second part of the book is on ensuring the quality of pig meat. Chapter 5 provides an overview of the process of producing meat of consistent quality from the modern pig. Pork producers have focused, over many years, on producing pork more efficiently in order to remain competitive and to satisfy consumer demand for lean pork. Increases in efficiency and leanness have been achieved through genetics, targeted nutrition, the use of entire males and metabolic modifiers. The chapter first discusses the importance of visual appearance, sensory quality and protein functionality in assessing pork products. It then discusses recent developments in genetics such as the identification of gene markers for tenderness as well as breeding to achieve a desirable muscle pH. The chapter also discusses the role of nutrition in such areas as minerals, vitamins, fishmeal and other supplements high in polyunsaturated fatty acids (PUFAs), as well as slaughter and post-mortem operations. The chapter concludes with a detailed case study on optimizing pork quality in Australia.

The focus of Chapter 6 is on the factors affecting pork flavour. Pork-related products such as bacon, sausage, and ham comprise a large portion of the meat products sold in today's market due to their desirable flavor. The application of various processing methods such as cooking, curing, deboning, grinding, canning, etc., as well as additives or spices applied during processing, greatly contribute to the characteristic aromas of specific pork-related products. The chapter provides an integrated overview of current research on essential flavor constituents in pork products and the factors affecting pork flavor. Despite large differences among animals, genetics, and methods used in processing and cooking, the chapter highlights common odorants that underpin pork flavour, emphasizing the heat-induced pathways for formation of pork odorants.

Moving from flavour to other features of pig meat, Chapter 7 considers the factors affecting the colour and texture of pig meat. In pork, colour and texture are the two most significant factors influencing consumer perceptions of quality. It is therefore important to understand the many factors that can affect pork colour and texture. The chapter

explores the biological and environmental factors that affect colour and texture in pig meat, including both antemortem and postmortem factors. The chapter then discusses existing and potential methods for the measurement and assessment of the colour and texture attributes of pig meat, including imaging technology.

Concluding Part 2, Chapter 8 concentrates on the nutritional composition and value of pig meat. The chapter provides an overview of the nutritional content of pork, examining pork consumption and dietary guidance in the USA. The chapter looks at the challenge of studying the influence of nutrition on human health, concentrating on the effects of pork consumption on weight control and body composition as well as the effects of consumption on cardiometabolic health and other health indices.

Part 3 Sustainability

The focus of the third part of the book is on the sustainability of pig meat production. The subject of Chapter 9 is assessing the environmental impact of swine production. The swine production industry has reduced its environmental impacts during the past 50 years due to productivity gains. However, there are increasing demands on the industry's resource base, making clear the need for robust tools to continue to support the best decisions in the face of environmental challenges. The chapter presents a review of the environmental sustainability impacts of swine production, focused at the farm level because the majority of environmental impacts occur by this stage of the supply chain. Two case studies comparing European and US swine production and the adoption of gestation pens to replace gestation stalls demonstrate the value of using life cycle assessments (LCA).

Complementing the preceding chapter's focus on sustainability, Chapter 10 examines nutritional strategies to reduce emissions from waste in pig production. Gaseous emissions of ammonia, odour, and greenhouse gases from livestock housing and storage and application of manure are major concerns in the environmental sustainability of pig production. The chapter addresses dietary strategies to reduce these emissions. The chapter examines the relationship between nutrition and ammonia emissions and between nutrition and odour emissions. It then considers the impact of nutrition on greenhouse gas emissions before evaluating the effectiveness of dietary solutions for reducing gaseous emissions and improving animal performance. The volume's final chapter, Chapter 11, addresses organic pig production systems, welfare and sustainability. The chapter describes standards for organic pig production, as well as the current state of organic pig production. The chapter then moves on to consider the issue of animal welfare in organic pig production and its environmental impact, providing an authoritative overview of the contribution of organic farming to pig production.

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