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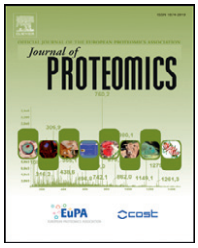

Review

"Muscle to meat" molecular events and technological transformations: The proteomics insight ☆

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ABSTRACT

Cellular death is characterized by a complex pattern of molecular events that depend on cell type. Specifically, muscle cells first undergo rigor mortis due to ATP depletion, and later, on the time scale of days, muscle fiber degradation due to proteolytic enzyme activity. In the present review, we will refer to proteomic investigations on the post-mortem evolution of the protein patterns of animal muscle cells. These studies, carried out with the application of either bottom-up or top-down methods, are relevant for understanding the biochemical reactions that i) convert muscle to meat, ii) are associated with meat aging and iii) impact on meat tenderness, a feature of significant commercial value. We also report on the proteomic investigations that have been made to analyze the transformation of meat in industrial processes. These studies are primarily aimed at identifying protein patterns and/or individual proteins diagnostic of the quality of the final product.
This article is part of a Special Issue entitled: Farm animal proteomics.

Contents

Abbreviations: TCA, tricarboxylic acid cycle; LA, lactic acid; WHC, water holding capacity; PSE, pale, soft and exudative; USDA, United States Department of Agriculture; ES, electrical stimulation; MLC, myosin light chain; CPK, creatine phosphokinase M-type; PGAM1, phosphoglycerate mutase 1; APOA1, apolipoprotein A1; TPI1, triosephosphate isomerase 1; HSP25, heat shock protein 25 kDa; FABP3, fatty acid binding protein 3; iTRAQ, isobaric tag for relative and absolute quantitation; ROS, reactive oxygen species.

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1. Introduction

As far as the general public is concerned, meat is considered as a mere aspect of nutrition, and one could bluntly say that little perception exists from the general public on how meat is obtained and how it is made available commercially. Nevertheless, meat production, preservation, transformation and trade are key components of agricultural production and are an essential element of food supply for all human societies. It has been so since pre-historic men have domesticated animals and plants, launching the foundations of farming in a model, that, apart from technological advances, has kept the same earlier principles and objectives: to feed humankind and to optimize quality as well as quantity. Additionally, meat production forms the basis of the development of entire societies and in specific regions, some as large as continents, is the main or sole economic activity, influencing the way of life, culture and traditions.

Meat production rests heavily on four main industries: live animal production, slaughtering, processing and trade. Albeit, altogether, these four components are essential for obtaining an adequate product suiting consumer's needs, probably the most determining aspect, and crucial step in meat production is the transformation of muscle into meat, i.e., the conversion of live animal tissues into an ultimately edible meat product. However, the conversion of muscle to meat is a complex and intertwined process, where biochemistry, physiology, nutrition, health, technology as well as other factors combine to affect muscle structure, integrity and proteome.

Proteomics may be defined as the science that studies the entire subset of proteins expressed in a certain cell, tissue, body fluid, organ, or organism [1]. Because maturation and processing of meat, using both traditional and industrial methodologies are all processes that greatly rely on many biochemical steps and on changes in protein abundance and structure, the use of proteomics is of exceptional relevance for understanding the conversion of muscle to meat. The importance of proteomics in this field is well reflected by the many research articles and reviews that aim to discuss its applications to characterize the cellular and molecular mechanisms behind meat quality [2], skeletal muscle in the context of livestock production [3] or biological traits and diseases in farm animals [4]. In this article we provide a review on the applications of proteomics to meat production in domestic animals. We will focus firstly and only briefly on the biochemical reactions that convert muscles to meat and on those that are closely associated to meat maturation and discuss their impact on meat tenderness. Subsequently, in Sections 2 and 3 we will thoroughly discuss how proteomics have been used to characterize these processes in molecular details in major meat producing animals, namely cattle and pigs, respectively. In Section 3 we will also discuss major changes in the proteome as a consequence of meat processing in an industrial environment and how this may relate to optimization of meat quality. Sections 4, 5 and 6 will summarize proteome studies aimed at optimizing meat quality in respectively poultry, rabbits and small ruminants. Finally in Section 7 we will provide the major conclusions of this review.

1.1. *Muscle post-mortem biochemistry — a brief introduction*

Biochemical events underlying the conversion of muscle into meat (post-mortem biochemistry) are of key relevance to