JOURNAL OF PROTEOMICS XX (2013) XXX–XXX

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Review

Muscle and meat: New horizons and applications for proteomics on a farm to fork perspective☆

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ARTICLE INFO

Keywords:
Meat
Meat production
Meat processing
Meat safety
Meat frauds
Meat microbial safety

ABSTRACT

Meat consumption is an important part of human diet with strong implications in health, economy and culture worldwide. Meat is a proteinaceous product and therefore proteomics holds a considerable value to the study of the protein events underlying meat production and processing. In this article we will review this subject in an integrated "farm to fork" perspective, i.e. focusing on all the major levels of the meat producing chain: farm, abattoir and transformation industry. We will focus on the use, importance and applications of proteomics, providing clear examples of the most relevant studies in the field. A special attention will be given to meat production, as well as quality control. In the latter, a particular emphasis will be given to microbial safety and the detection of frauds. This article is part of a Special Issue entitled: EUPA 2012: new horizons.

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☆ This article is part of a Special Issue entitled: EUPA 2012: new horizons.

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1874-3919/$ – see front matter © 2013 Published by Elsevier B.V.
http://dx.doi.org/10.1016/j.jprot.2013.01.029

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1. Introduction

Meat consumption is an important part of human culture since the dawn of ages and the formation of early civilizations. Indeed, in several cultures from the *Inuit* in Greenland to the *Sami* of Lapland, as well as the several peoples in the Mediterranean basin or the great plains of North and South America, meat production and consumption are key aspects defining and influencing not only local economy, but also its culture and ultimately its very essence. Meat production involves numerous domestic species, with several degrees of popularity, depending not only on cultural and religious beliefs but also on practical reasons and availability. The most popular species in the industrialized world, not including fish and shellfish, comprise cattle (*Bos taurus*, *Bos indicus* and hybrids), pig (*Sus scrofa*), sheep (*Ovis aries*), goat (*Capra hircus*), rabbit (*Oryctolagus cuniculus*), chicken (*Gallus gallus*), mallards and ducks (respectively *Anas platyrhynchos* and *Cairina moschata*, as well as their hybrids), the turkey (*Meleagris gallopavo*) and the Japanese quail (*Coturnix japonica*). Less familiar species are nevertheless particularly important outside of the Western world. These include the water buffalo (*Bubalus bubalis*), the dromedary (*Camelus dromedarius*), reindeer (*Rangifer tarandus*), Guinea-pigs (*Cavia porcellus*), geese (*Anser anser*), as well as ostriches (*Stuthio camelus*) and other ratites. Generally speaking production methods also vary considerably with species farmed, the location of the farm, availability of resources, etc. In the Western world, meat production systems are usually divided in two types: intensive and extensive, often with a third type in between, semi-intensive; or alternatively in commercial and subsistence farming. On a broad perspective, intensive systems include most of the pig, poultry and dairy production systems whereas grazing cattle, sheep and goats are associated to extensive systems. Nevertheless such boundaries are not clearly defined and tend to change according to the perspective and above all with geographical location. Although the farm is a key component of the meat production chain, there are other agents with equally important roles: the transporter, the abattoir, the meat processing plant, retail, regulatory agencies and ultimately the final consumer. Both quality and safety of a meat product is dependent on events that take place at the level of at least one of such agents. Accordingly, the meat producing sector is more and more often viewed in a "farm to fork" perspective, i.e. a global integrated approach allowing a more efficient, traceable and safe control of the chain and the characteristics of the product. These aspects are particularly important as a consequence of the expected rise in demand for food products of animal origin that are expected to increase significantly in the future particularly in emerging economies [1].

Proteomics can be defined as the science that studies the proteome, i.e. the study of the proteins being expressed in a given cell, tissue or fluid, organ, system or population. The importance of proteomics in animal science has recently been described [2] and demonstrated in numerous areas of animal production such as dairy products [3], *foie gras* [4], aquaculture [5], wool [6], or the monitoring of pollutant effects using shellfish [7]. We have recently reviewed, from the proteomics angle, the major events involved in the transformation of muscle to meat in a multi-species approach [8]. Nevertheless, and as meat is essentially a proteinaceous product, proteomics has necessarily a relevant role in the study of all aspects related to the meat producing chain. In this article, we aim to place proteomics in the context of meat science and in a "farm to fork" perspective, as schematized in Fig. 1. Accordingly, we will thoroughly address all the major components of the meat producing chains. In a first section we will concentrate on the use of proteomics at the level of the live animals that will be used in meat production. We will focus this section on aspects related to breed and genotype differentiation and at levels of feeding and management and handling of the animals. On a second section we will address the importance of proteomics in the slaughtering procedure. We will

Please cite this article as: Paredi G, et al, Muscle and meat: New horizons and applications for proteomics on a farm to fork perspective, J Prot (2013), http://dx.doi.org/10.1016/j.jprot.2013.01.029