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Extended Abstract

Proteomics and animal nutrition: Differential tolerance to seasonal weight loss in domestic animals

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Abstract

During domestication, farm animals have adapted to constraints typical of their production systems, such as diseases, parasitosis product demand or seasonal weight loss (SWL). SWL is in fact one of the major constraints to animal production in tropical and Mediterranean regions. Coupled to production studies, the study of the metabolic changes to food restriction, highlighting energy and protein metabolic saving mechanisms, can be a useful approach to identify the physiological pathways relevant in breed selection, allowing the identification of biomarkers that could be used for the selection of breeds and varieties with metabolic pathways more capable of energy and nitrogen retention, thus increasing productivity. Over the last 15 years, we have been conducting studies on several aspects related to weight loss physiology, focusing primarily on small ruminants after using the rabbit as a model. We have conducted a Systems Biology approach aiming to combine proteomics with transcriptomics and more recently metabolomics. Here, we present the results of three major experiments: 1. Experiments with rabbits; 2. Experiments with meat producing sheep and 3. Experiments with dairy goats. In the three cases breeds of animals susceptible to SWL were compared to breeds of animals that show a certain tolerance to SWL. An overview of the major results and conclusions herein obtained will be described as well as major implications on research directions.

Ruminant production plays an important role in the economy and livelihood of countries all across the world. Cattle and small ruminant production are particularly important in developing countries. Small ruminants, mainly sheep (Ovis aries) and goats (Capra hircus), are adapted to extensive production systems, particularly in drought-prone areas of the world. Such regions are characterized by the existence of dry seasons that affect growth, quality and availability of pastures, which directly impacts animal performance. Consequently, animals raised under extensive conditions are frequently subjected to feed restriction, a problem known as Seasonal Weight Loss or SWL.

Seasonal Weight Loss is considered one of the most significant problems for animal production worldwide. In fact, in regions such as the tropics or the Mediterranean basin, animals may lose up to 30% of their body weight (BW). Seasonal Weight Loss has been described in various regions of the globe such as West Africa South Africa Western Australia and the Canary Islands The use of supplementation (either fodder, grain or concentrate feeds) is a possible solution to overcome SWL. Nevertheless, it is very costly and challenging, particularly in extensive production systems. Alternatively, the use of local breeds, known to be tolerant to SWL, is a very interesting and sustainable possibility for those regions as it is much less expensive and easy to implement in comparison to supplementation

The Canary Islands (Spain) is a subtropical archipelago, with different climates across the islands. The western islands, namely La Palma, have a humid temperate climate. On the contrary, the easternmost islands, particularly Fuerteventura and Lanzarote have a dry climate These two different parts of the archipelago have in turn different rainfall that lead to differences in pasture availability and therefore in animal production systems. As a result of specific animal adaptations to the divergent climates of the islands, three local goat breeds are found. Goats from the Canary Islands descend from ancestors brought in from North Africa and Spain in the fifteenth and sisteenth centuries These breeds are the Majorera (from Gran Canaria and Fuerteventura), the Palmera from the island of La Palma and finally the Tinerfeña (from Tenerife island) Majorera goats have considerably high milk yields (500–550 kg of milk per lactation), being well adapted to dry regions with limited water and pasture availability and are therefore tolerant to SWL On the contrary, Palmera goats are adapted to regions with higher rainfall, with better pastures, being susceptible to SWL [12]. We have demonstrated such different adaptation levels in previous work on productive and clinical biochemistry physiological parameters

The advent of Next Generation Sequencing (NGS) led to important developments in the field of animal science through the application of these techniques with different examples in reproduction and physiology found in the literature. In fact, and similarly to proteomics numerous applications may be found in the literature, for mammary gland physiology, growth and involution, productive function, etc.

Previous studies from our group have studied growth and productive traits [8] as well as different blood metabolites and hormone profiles in Majorera (SWL tolerant) and Palmera (SWL susceptible) goat breeds subjected to feed restriction in order to simulate SWL. In such studies, significant differences between breeds were observed for blood metabolites (creatinine, urea, non-esterified fatty acids, cholesterol, IGF-1

and T3) as a consequence of underfeeding, highlighting major differences between breeds. We have recently extended that study to the effects of feed restriction on the mammary gland secretory tissue proteome], metabolome and fatty acid profiling. We highlighted that the Majorera breed had a persistent accretion of proteins related to the immune system by comparison to Palmera goats. Additionally, weight loss led in the Palmera breed to an accumulation of proteins related to apoptosis, overall confirming that the two goat breeds have different physiological reactions to SWL.

In this research, we hypothesize that differences observed between breeds and their response to feed restriction are reflected at the transcriptomic level. We therefore characterized the effects of feed restriction on the mammary gland secretory tissue transcriptome using an RNA sequencing (RNA-Seq) approach. The results highlighted major genes and biochemical pathways affected by weight loss in the two breeds.

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