117 Current market trends of sheep and goat milk, farm structures and production costs. G. Pulina*1, M. J. Milàn Sendra2, M. P. Lavín3, A. Theodoridis4, E. Morín2, and J. Capote2, 1University of Sassari, Sassari, Italy, 2University Autonoma of Barcelona, Barcelona, Spain, 3Consejo Superior de Investigaciones Científicas, León, Spain, 4Aristotle University of Thessaloniki, Thessaloniki, Grece, 5Institut de l’Élevage, Paris, France, 6Canary Islands Institute of Agricultural Research, Canary Islands, Spain.

Produced sheep (10.2 Mt) and goat milk (17.8 Mt) are only 1.3 and 2.3%, respectively, of world total milk. Sheep dairy breeds and farms are well specialized and it is expected an increase of 2.5 Mt milk for 2025. The leader in sheep cheese export is IT, followed by FR, BG, GR and ES, whereas the larger importers are the US and DE. Protected Designation of Origin cheeses play a major role in the international trade (Pecorino Romano, Roquefort, Feta and Manchego) and have a growing market. In contrast, only few goat breeds are dairy specialized and most goats are double purpose. Asia and Africa contribute to about 95% the heads and approximately 82% the milk, whereas Europe accounts for 14% goat milk. World goat’s milk increased by 30% in the last 20 yr, and it is expected to increase by 4.1 Mt for 2025. In Italy, dairy sheep are raised in semi-extensive systems, where grazing natural pasture represents the main feeding source, whereas goats are intensive or extensive. Their production costs represent 80 to 120% of the gross income. In France, dairy sheep farms are mainly located in mountainous, in semi-extensive systems, based on local breeds and natural or cultivated grasslands. Milk is processed into PDO cheeses and production costs represent 80 to 120% of the gross income. In Spain, traditional semi-extensive farms (based on local breeds) and modern farms (based on foreign or improved local breeds), coexist. A large variability in profitability has been reported, but the rise of milk prices during the last decade (19% for sheep and 37% for goat), supported the Spanish sheep and goat industry during the economic crisis. Greek dairy sheep sector is characterized by the greatest diversity of systems, goat being more extensive than sheep. Production costs are lower than in other countries, but milk share (46% incomes) indicates a low specialization. Increase of production costs, decrease of milk prices and financial stress, severely affected the sector and to intensive farms. On the contrary, the extensive farms are less vulnerable to economic conditions due to low capital endowments and family labor.

Key Words: dairy sheep, dairy goat, production system

118 ADSA®-EAAP Speaker Exchange Presentation: Compositional and functional differences of ewe and goat’s milk and dairy products with regard to cow’s milk and dairy products. P. Roncada*1, P. de Frutos2, A. Nudda3, and N. Castro Navarro3, 1Istituto Sperimentale Italiano Lazzaro Spallanzani, Milano, Italy, 2CSIC-Universidad de L, Grulleros, León, Spain, 3Università degli Studi di Sassari, Sassari, Italy, 4Universidad de Las Palmas de Gran Canaria, Arucas, Gran Canaria, Spain.

As the substitute of human milk in infant food, milk from cattle and small ruminants species has been studied extensively to address their nutritional value. In the last 20 yr, proteomics gave a great contribution in understanding the proteins component, including isoforms, post translational modification, interaction, functional properties, to evaluate casein fractions, whey fractions, and milk fat globule. The study of polymorphisms of caseins at the protein level are key characteristics to be specifically considered in the cheese-manufacturing industry. Different genotypes of αs1-casein have been observed depending on species and breeds. These types have been associated with allergic processes and may affect digestibility, milk and cheese properties. Higher levels of some of the essential amino acids observed in goat milk may play an important role on the intestinal absorption. Lower size of fat globule in goat milk has been associated with higher digestibility. Regarding to immune variables, no differences in milk immunoglobulins (IgG and IgM) have been described when sheep and goat milk are compared with cow’s milk. Proteomics elucidated also some differences in proteins with immune function between cow, sheep and goat milk whey. The IgG heavy chain C region showed higher intensity in sheep than in the other 2 species while lactoperoxidase was higher in cow milk whey. Conversely, the polymeric immunoglobulin receptor isoform 1 was higher in small ruminants whey milk than in bovine. Concerning fatty acid composition, concentrations of C6:0, C8:0, and C10:0, responsible for the flavor of cheeses, are much higher in sheep and goat’s milk and dairy products than in cows. The opposite occurs with the content of cis-9 C18:1, which is lower in caprine and ovine milk fat. CLA and trans-11 C18:1 contents seem to be slightly higher in ewe’s products. Another important achievement is the study the specific composition of the milk microbiota that directly impacts on the subsequent development of dairy products. Microorganisms can bring about the fermentation of milk through the production of lactate and have a variety of different impacts on the sensory, texture, flavor and organoleptic properties of resultant products.

Key Words: proteomics, immunity, fatty acid

119 Update on lactation biology and milking strategies of small ruminants. M. Rovai*1, G. Caja2, A. Argüello3, C. Peris4, X. Such5, and P.-G. Marnet6, 1South Dakota State University, Brookings, SD, 2University Autonoma of Barcelona, Bellaterra, Barcelona, Spain, 3University of Las Palmas de Gran Canaria, Gran Canaria, Spain, 4Polythecnic University of Valencia, Valencia, Spain, 5Agrocampus-Ouest, Rennes, France.

Sheep and goats markedly differ in mammary gland structure and milk secretion processes, which modifies the characteristics of their milk and dairy products. Whereas ewe’s milk is mainly secreted in the MEC by a merocrine process, the goat’s is apocrine with high shedding of cytoplasmic particles and SCC in milk. Presence and dynamics of stem and progenitor cells in the mammary glands of ewes and does, also help explain their differences in plasticity during lactation. Prolactin is essential for milk secretion and modifies milk yield by regulating MEC functionning, proliferation and exfoliation, all being suppressed by dopamine agonists. Serotonin plays a paracrine-autocrine role inhibiting lactation in ewes and does, but with differences in receptors by species. Udder cistern compartment is larger in goat (70–80%) than in sheep (40–60%) depending on breeds, which conditions milking machine settings, routines and schedules. Milk ejection and component yields are influenced by the presence of offspring and milking-suckling strategy used. Milking from parturition increases the amount of milk sold, especially in sheep, although results vary according to breed and conditions (e.g., udder morphology). Consequently, a short suckling period (2 to 4 wk) and sale of milk-fed lambs are widely used. Today, machine milking is widespread, resulting in better milk hygiene and higher quality of dairy products. Intensification increased the size of the flocks/herds and milking time is a major constraint for farmers. Simplification of
milking routines and extension of intervals are usual ways to solve the problem. Both ewes and does are able of being milked once-a-day for the entire lactation, with cost-efficient milk losses (5 to 15%), no effects on udder health, small variations of milk composition and inconsistent effects on dairy products. Automation of milking routines (e.g., cluster removal) and automated milk recording (i.e., electronic identification and milk flowmeters) are now generalized trends, with benefits in milking throughput and genetic improvement. As a result, a greater dairy specialization and easy milkability are expected at the mid-term in dairy small ruminants.

**Key Words:** small ruminant, dairy sheep, dairy goat

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120  **Currently available genetic resources in the United States for dairy sheep and dairy goat production.** D. Thomas*1, J.-M. Astruc2, A. Carta3, M. D. Pérez-Guzmán4, and J.-M. Ser-radilla5, 1University of Wisconsin-Madison, Madison, WI, 2Institut de l’Élevage, Castanet-Tolosan, France, 3DIRPA-AGRIS, Olmedo, Sardegna, Italy, 4Instituto Regional de Investigación y Desarrollo Agroalimentario y Forestal, Valdepeñas, Castilla-La Mancha, Spain, 5Università di Còrdoba, Córdoba, Andalusia, Spain.

Industries using specialized dairy breeds of sheep and goats for commercial milk production are well established in Europe and the Middle East but much more recent in North America. Dairy goats were first imported into North America in the early 1900s, but the commercial industry is only about 40 years old. The dairy sheep industry in North America is younger with the first importation of dairy sheep breeds in the early 1990s. Dairy goat breeds of the greatest importance in North America are the breeds of Alpine, LaMancha, Nubian, Saanen, and Toggenburg. Production of genetic evaluations for dairy goats in the US is a cooperative effort by the American Dairy Goat Association, regional dairy records processing centers, and the Council on Dairy Cattle Breeding. There were 589 herds with 17,381 does in this milk-recording program in 2016. Canadian dairy goat genetic evaluations are produced by goatgenetics.ca through cooperation of the Canadian Goat Society, Canadian Livestock Records Corporation (CLRC), Canadian DHI, and Holstein Canada. The primary dairy sheep breeds for commercial production in North America are East Friesian and Laacaune with smaller numbers of British Milk Sheep and Awassi. In Canada, genetic evaluations for dairy sheep have started through GenOvis in cooperation with CLRC. There are no organizations in the US for maintaining pedigree records or calculation of genetic evaluations for dairy sheep. Several successful programs for dairy small ruminants are in operation in Europe for genetic improvement of both production and functional traits (e.g., sheep: French Lacaune and Manech, Spanish Manchega and Latxa, and Italian Sarda; and goats: Spanish Murciano-Granadina, Malagueña, Florida, and Payoya and French Alpine and Saanen). Some of these programs use genomic data as well as traditional pedigree and performance information. These European programs can serve as a source of imported genetics to improve the production efficiency of North American dairy small ruminants and also as examples of the types of improvement programs that could be implemented in North America for continual improvement of local populations of dairy small ruminants.

**Key Words:** dairy sheep, dairy goat, breed

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121  **Intake prediction and energy requirements for lactating dairy small ruminants: Comparison of systems.** A. Cannas*1, F. Bocquier2,3, P. Hassoun4, S. Giger-Reverdin4, D. Sauvant4, L. O. Tedeschi5, and G. Caja6, 1University of Sassari, Sassari, Italy, 2INRA-Montpellier SupAgro, Montpellier, France, 3INRA, Montpellier, France, 4INRA-AgroParisTech-Université Paris-Saclay, Paris, France, 5Texas A&M University, College Station, TX, 6University Autonoma de Barcelona, Bellaterra, Barcelona, Spain.

Feeding systems use similar feed evaluation approaches for all dairy ruminants, whereas feed intake prediction and requirement assessment are species-specific. This review compares the most recent models currently used to predict dry matter intake (DMI) and energy requirements in lactating dairy small ruminants (DSR), i.e., the Small Ruminant Nutrition System (SRNS, 2004 and 2010, updated in the Ruminant Nutrition System, 2016), the NRC(2007), and the new INRA-Systali (2017) systems, to highlight differences in approach, inputs required and flexibility used. Because DSR are normally group fed, accurate prediction of feed intake is necessary to adjust diet composition according to their requirements. However, when predicting DMI for ewes and goats, the approaches used, variables considered and predicted values vary considerably. All the models used are empirical and species-specific, and use body weight and milk yield as main predictors. Variables associated with diet composition and/or type of feeds are also considered, but vary among models, while dietary particle size is not considered. The SRNS and NRC do not have specific models to predict intake on pasture, while INRA uses the Fill Unit system (i.e., based on a forage of reference) to predict DMI considering both housing and grazing conditions. For energy requirements, the SRNS uses the same model for both species, while NRC and INRA use species-specific models. The INRA (2017) largely updated these predictions for all productive functions. For maintenance energy requirements, besides some variability in the basal metabolic rate and energy units used (i.e., ME or NEL), most differences regard the additional factors affecting these requirements (e.g., age, gender, body condition, growth, previous nutrition, movement, cold and heat stress, dietary nitrogen unbalance). Differently, energy requirements for milk production and pregnancy are estimated using similar approaches and values. Overall, the feeding systems for dairy sheep and goats have markedly evolved in the last decade, by improving their ability to account for the great diversity of production systems in which they are raised worldwide.

**Key Words:** intake, energy requirement, lactating small ruminant

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122  **ADSA®-EAAP Speaker Exchange Presentation:** Animal–environment interactions in dairy small ruminants: Cause-and-effect relationships and strategies of alleviation. A. A. K. Salama*1, D. R. Yaheiz-Ruiz2, C. Fernandez3, N. Koluman4, M. Ramon5, N. Silanikove6, A. Goetsch7, and G. Caja1, 1Group of Ruminant Research (G2R), Universitat Autonoma de Barcelona, Bellaterra, Spain, 2Estación Experimental del Zaidín (CSIC), Armilla, Granada, Spain, 3Research Centre ACUMA, Animal Science Department, Polytechnic University of Valencia, Valencia, Spain, 4Cukurova University, Agricultural Faculty, 5Research Centre ACUMA, Animal Science Department, Polytechnic University of Valencia, Valencia, Spain, 6Research Centre ACUMA, Animal Science Department, Polytechnic University of Valencia, Valencia, Spain, 7Research Centre ACUMA, Animal Science Department, Polytechnic University of Valencia, Valencia, Spain.

Carbon footprinting can be useful to assess how activities such as different types of livestock production impact climate change. Sheep and goats represent approximately 55% of ruminants in the world, although they produce just 12 to 14% of greenhouse gases emitted, with CH4 from enteric fermentation contributing over 60% of total emissions. Concentrate feedstuffs often used to meet nutrient requirements decrease CH4 emission but can increase diet cost. Alternatively, the partial replacement of grains with agricultural byproducts in combination with sources of
lipids or essential oils is a cost-effective mitigation strategy to reduce ruminal methanogenesis. Furthermore, maintaining good animal health and longevity will reduce CH₄ emission per kg of milk produced. As a result of climate change, dairy small ruminants are expected to be more subject to periods of thermal stress, both heat and cold conditions. Heat stress (HS) frequently decreases feed intake, impairs fertility, causes discomfort, and alters behavior. Concomitantly, milk yield is depressed and cheese-making properties deteriorate. The HS decreases sensitivity of adipose tissue to lipolytic signals and less insulin is released by the pancreas when glucose is administered. Transcriptomics and metabolomics of blood and milk indicate alteration of immune cell function and inhibition of mammary cell synthetic capacity. Exposing the goat fetus in utero to HS not only modifies postnatal response to HS but also behavior reactions to other stresses such as isolation in an unfamiliar environment. Moreover, cold stress decreases milk yield by dairy ewes and goats as a result of adverse effects on many different physiological conditions. Sensor systems allow collection of information relating to rumen characteristics and behavior in thermal-stressed sheep and goats that will be valuable in production system of the future. Conventional and modern strategies of alleviation include ventilation, sprinkling, dietary supplementation with vegetable oils, coat shearing, and genomic selection to increase thermo-tolerance.

**Key Words:** carbon footprinting, thermal stress, omics