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Adaptive profile of Garfagnina goat breed assessed through physiological, haematological, biochemical and hormonal parameters

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ABSTRACT

This study was conducted to investigate the adaptive profile of the Garfagnina goat breed in two different seasons (spring and summer) through physiological, biochemical, haematological, and hormonal parameters. Fifty adult lactating females were studied twice a day (morning and afternoon) in each season. The air temperature, black globe temperature and air relative humidity was recorded using an automatic weather station. Physiological parameters recorded were rectal temperature, respiratory rate, heart rate, skin temperature and rectal-skin temperature gradient. The results of this study showed that there was a significant effect of season and period on all environmental variables. Physiological variables, rectal temperature, respiratory rate, heart rate and skin temperature showed higher values in the afternoon in both seasons. Both biochemical and hormonal parameters were significantly affected by season of the year. Biochemical and hormonal characteristics undergo changes during different seasons such that metabolism is reduced during heat stress and accelerated during cold stress; these metabolic changes are controlled by the thyroid hormones and cortisol. It has been shown from this study that these hormones facilitates the physiological parameters involved with the adaptation process confirming that adaptive capacity of animals cannot be described solely by rectal temperature and respiratory rate.

1. Introduction

Over centuries natural selection has acted on local breeds resulting in improved animal fitness in different environmental conditions. Consequently, changes in environmental variables are recognized as potential hazard in livestock growth and production. In particular, seasonal variations are considered physiological stressors, which affect the animal's biological systems (Aengwanich et al., 2009; Al-Eissa et al., 2012). During this process, animals have acquired unique adaptive traits such as disease resistance and tolerance to heat and cold (Silanikove, 2000).

Goats are warm-blooded animals and as such are characterized by the ability to maintain body temperature within narrow limits, for this purpose, in addition to the exchange with the environment, they need to alter their metabolism for internal heat production (Nardone et al., 2010). Few studies have been conducted on the adaptive profile of local goat population, especially in rural marginal areas. These studies are extremely important for the definition of management and conservation strategies. Even in some developed countries, many local populations were not adequately characterized in this aspect (Ribeiro et al., 2015). To improve farming efficiency, the interaction between animals and the environment must be considered; knowledge on climate variables and their effects on the physiological, haematological, blood biochemical, hormonal and genetic responses is critical for the optimization of livestock-raising systems.

Animals respond differently to drastic temperature changes by changing several aspects of their physiology and behaviour (Silva et al., 2010). These include alterations in physiological parameters (rectal temperature, heart rate, respiratory rate and surface temperature) (Marai et al., 2007), erythrogram (Al-Eissa et al., 2012), blood biochemical parameters (Abdelatif et al., 2009), cortisol (Sejian et al., 2010) and thyroid hormones (Helal et al., 2010). These parameters may vary within the same species due to factors

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such as diet, age, physiological status, breed, level of production, handling and especially climate stress. Therefore, the aim of this study was to investigate the adaptive profile of Garfagnina goat breed in two different seasons (spring and summer) by means of physiological, biochemical, haematological, and hormonal parameters.

2. Materials and methods

2.1. Experimental site and animals

The study was performed in Bagni di Lucca, Italy (44′01° latitude and 10′58° longitude) at an altitude of approximately 634 m. According to Thornthwaite's classification, the climate at this location is type A with average annual temperatures ranging from 2.0 to 29.0 °C, average relative humidity of 68% and average annual rainfall of 1851–2050 mm.

The study was carried out with 100 lactating (30 primiparous and 70 multiparous) females of the Garfagnina goat breed: 50 animals were evaluated during spring (two days in March) and 50 were evaluated during summer (two days in July) (Mattiello et al., 2011; Srikandakumar et al., 2003). Measurements were made twice a day at morning (9:00 h) and at afternoon (15:00 h). The study was performed in one family farm using semi-extensive farming practices. The key part of the goat diet was natural pasture and water *ad libitum*. The goats were on pasture between morning and evening milking while they were confined overnight. Few feed integrations with mixed hay were given during the unfavourable periods of the year. The lambing period (beginning of the lactation) took place generally in January and February. The age of the animals was estimated indirectly by dental chronology, and all animals were classified as adult (two–five years old). Females with body condition score of 2.0 in the spring and summer 2.25 and average weight of 45.5–50.0 kg.

2.2. Climatological data and thermal comfort index

On the days of data collection climatological data were also recorded using an automated meteorological station installed at the location where the animals spent the day. Dry-bulb temperature (DBT), wet-bulb temperature (WBT), black globe temperature (BGT) and relative humidity (RH) were recorded every 15 s. The black globe humidity index (BGHI) was then derived using black globe temperature (BGT) and dew point temperature (DPT), according to Buffington et al. (1981). The thermal radiation load (TRL) was calculated according to Esmay (1969) where the mean radiant temperature (MRT) is the temperature of a surrounding region considered uniformly black capable of eliminating the effect of reflection, with which the body (black globe) exchanges so much energy as the environment under consideration (Bond et al., 1954). The time at the beginning and at the end of each animal's sampling were registered and the average values of the environmental variables registered between these periods were assigned to the corresponding animal. The values obtained were then used to estimate the differences between season and period of the day for the environmental parameters.

2.3. Physiological parameters

Rectal temperature (RT) of animals was measured with a digital clinical thermometer with range 32.0 °C–43.9 °C. The thermometer was inserted into the rectum of each animal, with the bulb in contact with the mucosa, remaining in the rectum until the thermometer made a beep, which was indicative of temperature stabilization. The respiratory rate (RR) and heart rate (HR) were measured through auscultation of the heart sounds with the aid of a flexible stethoscope at the level of the laryngo tracheal region by counting the number of movements and beats for 20 s, and the results multiplied by 3 to report at a minute time scale. The skin temperature (ST) was recorded using a digital infrared thermometer Minipar MT-350 at a distance within 10–50 cm from the body (there is no difference in measurements between those distances), measured in left flank. The RT–ST gradient was calculated.

2.4. Haematological, blood biochemical and hormonal parameters

Blood samples were collected from each animal only during the afternoon sampling (15:00 h) by puncturing the jugular vein after disinfection with iodine alcohol, the analysis of the samples was performed on the day following collection. The animals were also evaluated for the presence of ectoparasites, lymphadenitis or other types of skin problems just after the blood collection. For haematological analysis, blood was collected in 5 ml vacuum tubes containing 10% anticoagulant ethylene diamine tetra acetic acid (EDTA). The haematological studies were carried out according to Jain (1993).

For the analysis of biochemical and hormonal parameters, blood was collected in vacuum tubes of 7 ml containing separating gel and sodium fluoride (used for glucose analysis), and then centrifuged in a digital centrifuge at 4 °C at 3000 × g for 15 min. After centrifugation, the supernatant was separated into 1.5-ml aliquots for biochemical and hormonal tests; the analysis was performed on the day following collection. Analyses were carried out using a biochemical-analysis apparatus (VegaSys) with a multiple wave length photometer, on the following biochemical parameters: total protein (PRT), albumin (ALB), glucose (GLU), triglycerides (TRI), cholesterol (CHO), urea (URE), creatinine (CRE), gamma glutamyl transferase SL (GGT), and aspartate aminotransferase (AST). All tests were performed using commercial kits (ASSEL S.r.l.). Intra- and interassay coefficients of variation (CV) were 1.35% and 2.39%, 0.79% and 1.78%, 1.59% and 4.54%, 2.08% and 2.00%, 1.86% and 2.76%, 3.3% and 3.8%, 1.07% and 2.15%, 1.5% and 3.0%, 2.9% and 3.1% for PRT, ALB, GLU, TRI, CHO, URE, CRE, GGT and AST respectively. The analytical sensitivity of the assays were 1 g/dL for PRT and ALB, 1 mg/dL for GLU, TRI, CHO, URE, CRE and 1 UI/I for GGT and AST respectively. The plasma concentrations of cortisol (COR), total thyroxine (T4) and total triiodothyronine (T3) were measured in duplicate and quantified by the method Enzyme Linked ImmunoSorbent Assay (ELISA by competition) using kits (*In Vitro* diagnostic Ltda.) developed for quantitative evaluation of hormones (Uribe-Velasquez et al., 1998). The sensitivity is reported to be lower than 0.05 ng/dL, 0.22 g/dL and 1.1 ng/dL for T3, T4 and COR respectively. Intra and inter-assays coefficients of variation are 2.3–7.7%, 1.6–5.0% and 4.58–6.33% for T3, T4 and COR respectively.

2.5. Statistical analyses

All the data were analysed with the Statistical Analysis System (SAS, 2004) using GLM procedures, and the Tukey test for significant variables was applied. The following mathematical model was used: $y_{ijk} = \mu + S_i + P_j + (SP)_{ij} + e_{ijk}$ in which: y_{ijk} is the dependent variable; μ is the overall mean; S_i is the fixed effect of season (summer and spring), P_j is the fixed effect of period (morning and afternoon), $(SP)_{ij}$ the interaction between i^{th} season and j^{th} period and e_{ijk} is the random error with mean 0 and variance σ^2. The haematological, blood biochemical and hormonal parameters were analysed using a similar model including season as the only fixed effect. Pearson correlations among all variables were estimated using the CORR procedure of the Statistical Analysis System (SAS, 2004). Relationship between thermal gradient (RT-ST), corti-