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Multivariate characterization of the adaptive profile in Brazilian and Italian goat population

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ABSTRACT

The aim of this study was to characterize the adaptive profile and identify variables with great discriminatory power of the Brazilian *Azul* goat population and Italian Garfagnina population, through the use of principal component and canonical discriminant analysis. A total of 110 Garfagnina milking females (60 in winter and 50 in summer) and 80 Brazilian *Azul* (40 in winter and 40 in summer) were considered. Air temperature (°C), black globe temperature (BGT) and relative humidity (%) were measured with the aid of an automatic weather station. Some physiological parameters (rectal temperature – RT, respiratory rate – RR, skin temperature – ST and heart rate – HR), some anatomical parameters (hair diameter – HD and hair length – HL), some hematological parameters (erythrocyte – RBCs, packed cell volume – PCV and mean corpuscular volume – MCV), some blood biochemical parameters (glucose – GLI, cholesterol – COL, triglycerides – TRI, creatinine – CRE, urea – URE, total protein – PRT, albumin – ALB, globulin – GLO, albumin and globulin ratio – A/G, gamma – glutamyl transferase – GGT and aspartate aminotransferase – AST) and some stressed hormones (thyroxine – T4, triiodothyronine – T3 and cortisol – COR) were measured. The variables with greater discriminant power were T3, ST, COR, T4, GGT, HD, GLO, HL and PCV to Garfagnina population and PRT, MCV, PCV, ALB, T4, ST, HL, RBCs, TRI and GGT in the *Azul* Brazilian population. Classification of the animals was more accurate when considering morphological, physiological, hematological, biochemical and hormonal variables jointly.

1. Introduction

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 population were not adequately characterized in this aspect. Many studies have performed molecular and phenotypic characterization of local population, especially small ruminants (Martini et al., 2010; Hoffman, 2011; Francesch et al., 2011; Yakubu and Ibrahim, 2011). Few have been conducted that considered the adaptive profile with a multivariate approach. In Brazil, Bianchini et al. (2006), McManus et al. (2009), Castanheira et al. (2010a, 2010b), McManus et al. (2011a, 2011b), Correa et al. (2013) and in other countries as Yakubu et al. (2012) have considered this approach.

The Brazilian *Azul* and the Italian Garfagnina populations have great adaptive potential. The *Azul* ecotype

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is widespread throughout the Northeast of Brazil with higher concentrations in Paraíba, Pernambuco, Rio Grande do Norte and Piauí States (Ribeiro et al., 2004). Predominates in family production systems having key role in the development of rural marginal areas. They contribute to improving the quality of life, to fight poverty and hunger of hundreds of families in the region. Despite its economic and social importance, the Brazilian *Azul* population is classified as endangered (FAO, 2007) and may disappear even before it was officially recognized as a national population. The Garfagnina, originating in the Garfagnana, in the Tuscany region of Italy, is also an endangered population, with greatly reduced herd numbers despite of the important role in the maintenance of several families of small holders in the region. This breed is very important to the local production system, which generally aims to produce high quality foods such as cheese and other dairy products.

Goats, like other mammals have different ways of dealing with climate change and they use several mechanisms to cope with climate stress. Physiologically, animals react differently to drastic temperature changes by changing behavior and production. Endothermic animals maintain their body temperature within a thermal comfort zone, maintaining core body temperature with thermoregulatory mechanisms. Several physiological variables are used to evaluate the suitability of an animal to adverse weather. It helps to select animals capable of producing satisfactorily in harsh environments and outside the thermal comfort zone (Starling et al., 2002). There are numerous statistical tools available to study the adaptive profile of domestic animals. Individual analysis allows for the description of single variables and their variation, which enables the definition of maximum and minimum general standards. However, individual analysis does not describe a phenomenon on a global level. A better comprehension may be obtained by the multivariate approach, which help define the adaptive profile of a population by considering all variables simultaneously. Multivariate methods are based on correlations between variables and allows for simultaneous analysis, enabling more consistent and useful interpretations (Ferreira et al., 2009). Thus, multivariate analysis techniques may improve the interpretation of a large set of variables (Zepeda et al., 2002). Principal component analysis has been used to define those variables that explain better the total variation (Hair et al., 2006). This technique permits evaluation of interrelationships between variables, reducing an original set of variables to a smaller number of independent factors, facilitating interpretation (Cruz and Regazzi, 2003). A large group of qualitative and quantitative variables of different populations may be analyzed using a group of multivariate techniques simultaneously (Gould and Johston, 1972; Dossa et al., 2007). The objectives of this research were determine the adaptive profile (biochemical, hormonal, physiological and morphological) for two local populations in their environments and determine which variables have the greatest discriminating power to the adaptive profile, through the use of principal component and canonical discriminant analysis.

2. Materials and methods

2.1. Local and experimental animals

One hundred and ten lactating Italian Garfagnina (60 in winter and 50 in summer) and 80 Brazilian *Azul* females (40 in winter and 40 in summer) were used in this study. Measurements were made in the morning (9 am) and afternoon (3 pm). Due to lack of control data, the age of the animals was obtained indirectly by analysis of dental chronology according to Quitett (1978) and all were classified as adult (over 2 years old).

Data from the Garfagnina population was collected at a farm located 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 according to Table 1.

Data from the Brazilian *Azul* population was collected in a farm located in Caiçara do Rio do Vento, Rio Grande do Norte (latitude 5° 45′36″ south and longitude 35° 59′52″ west), 175 m altitude. The climate is tropical with a summer and winter season (Koppen climate classification; type A), with a maximum of 33.0 °C minimum of 21.0 °C; average annual temperature of 27.2 °C (Table 1).

2.2. Data measurement

Phenotypic characterization of the animals was performed and data compiled into individual spreadsheets. Each animal was evaluated for the presence or absence of small ears, horns, earrings, long hair, beard, roan color (presence of white, black and red colors in the same coat), brown eumelanin and eumelanic pigmentation pattern. Hair samples were collected from animals in both seasons; the sample was obtained manually from a lateral region beneath the spinal column of the animals. The same region was used for surface temperature measurements.

The hair samples were cataloged and stored in paper envelopes. Morphological variables such as hair diameter (HD) and hair length (HL) were measured using a digital micrometer attached to a microscope; the longest hair in each sample was used to measure the HL (Kassab, 1964).

A digital thermometer with a scale from 32 to 43.9 °C was used to measure the rectal temperature (RT). The respiratory (RR) and heart rate (HR) was measured by indirect auscultation of the heart sounds in the laryngo tracheal region using a flexible stethoscope; the numbers of movements and beats in a 20-second period were recorded, and the results were multiplied by 3 to obtain the rates per minute. A digital infrared thermometer was used to measure skin temperature of the animals (ST).

Blood samples were collected from each animal during the afternoon in both seasons (winter and summer) by puncturing the jugular vein after disinfection with iodine alcohol. For erythrocyte analysis, blood was collected in 5 ml vacuum tubes containing the anticoagulant sodium ethylene diamine tetraacetic acid (EDTA) at a final concentration of 10%. The number of erythrocytes (RBCs) was measured in a modified Neubauer-type chamber by diluting 20 microliters of the cells using a semi-automatic pipette (Vallada, 1999). The packed cell volume (PCV in %) was determined using capillary tubes in a micro-centrifuge as described by Ayres et al. (2001). The hematological index, mean corpuscular volume (MCV) was calculated as described by Ferreira Neto et al. (1977).

For analysis of blood biochemical and hormonal parameters, blood was collected in 7-ml vacuum tubes containing separating gel. The glucose analysis was made with a vacuum tubes containing sodium fluoride. The blood samples were immediately transported to the laboratory in isothermal boxes and centrifuged in a digital centrifuge at 4 °C and 3000 rpm for 15 min. After centrifugation, the supernatant was separated into 1.5-ml aliquots for biochemical tests. The following tests were used to measure the serum concentration of different compounds: the biuret colorimetric test for total protein (PRT), bromocresol colorimetric test for albumin (ALB), enzymatic colorimetric tests for glucose (GLU) and triglycerides (TRI), the enzymatic CHOD-POD test for cholesterol (COL), an enzymatic kinetic test for urea (URE), the Jaffe kinetic test for creatinine (CRE), the Szasz-Tris kinetic test for gamma glutamyl transferase SL (GGT), and a UV kinetic test for aspartate aminotransferase (AST). All tests were performed using commercial kits (ASSEL S.r.l) and data collected using biochemical-analysis apparatus with multiple wave length photometer.

Plasma concentrations of cortisol (COR), thyroxine (T4) and triiodothyronine (T3) were measured in duplicate by ELISA (Enzyme-Linked Immunosorbent Assay) using commercially available laboratory kits (Invitro).