Prevalence of subclinical diabetes in a commercial flock of dairy goats in India and its interaction with milk quality

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ABSTRACT

Blood plasma concentrations of random glucose, fasting glucose, intravenous glucose tolerance test (IVGTT) glycated haemoglobin, fructosamine, cholesterol, triglycerides and insulin were measured 5 times in 379 goats in 5 different days in order to evaluate the prevalence of subclinical diabetes in the commercial flock of dairy goats. Milk composition and milk antioxidant capacity was also evaluated after screening. Of the 379 goats that were screened for diabetic biomarkers, 45 animals had abnormal levels of the above mentioned indices. 16 animals out of the 45 had normal values on subsequent tests and in 5 animals out of the 45, only one or two diabetic biomarkers slightly elevated at a particular measurement; hence these goats were considered as normal. 24 animals (6.3%) were diagnosed a subclinical diabetic, based on the clinicopathological findings and subsequent monitoring: these goats had significantly higher levels of random glucose, fasting glucose, IVGTT, glycated haemoglobin, fructosamine and lower levels of insulin in all measurements. Milk of the subclinical diabetic goats had higher milk fat and lactose concentrations in comparison to non-diabetic goats ($P < 0.05$). No significant difference between subclinical diabetic goats and non-diabetic goats ($P \geq 0.05$) in solid not fat, protein, total solids and ash contents were found. A positive and significant correlation ($P < 0.05$) was found between fat content in milk and plasma concentrations of fructosamine ($r = 0.794$) and triglycerides ($r = 0.715$), and between milk lactose and plasma triglycerides ($r = 0.669$). The antioxidant capacity of milk was lower in subclinical diabetic goats than in non-diabetic goats and the content of lipid peroxides was higher in subclinical diabetic goats than in non-diabetic goats ($P < 0.05$). Our study revealed the prevalence of subclinical diabetes in commercial flock of dairy goats and showed that it is associated with impairment of milk quality, which was most likely associated with oxidative stress.
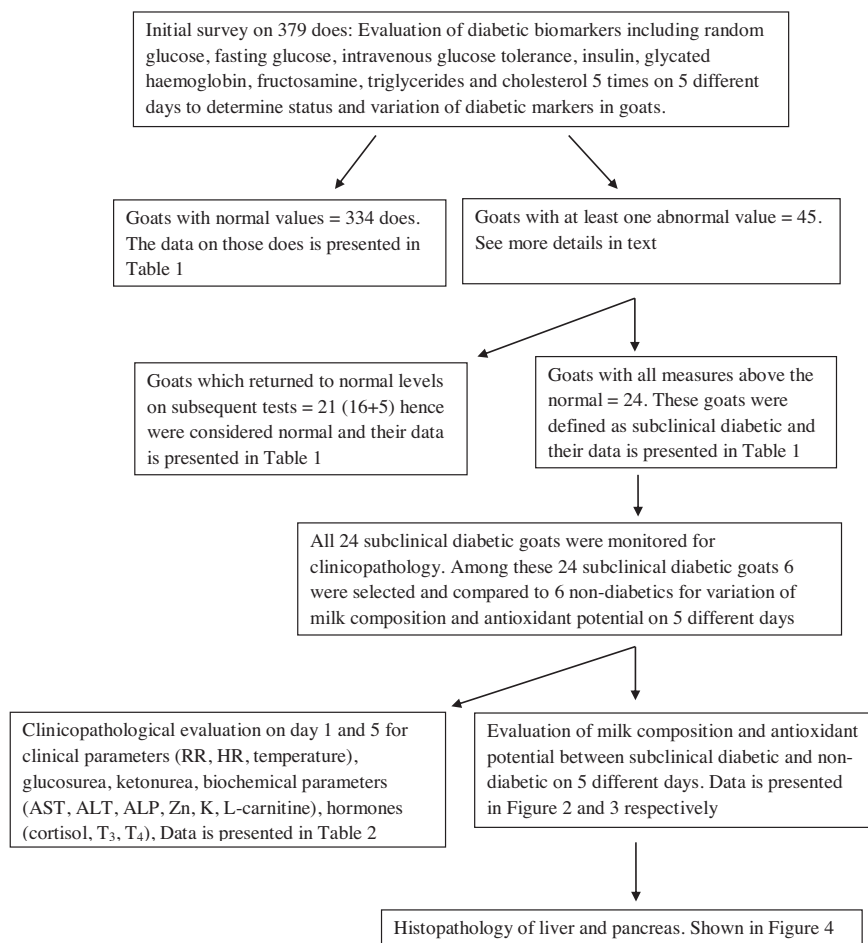
1. Introduction

Diabetes is a metabolic disorder that affects many body functions and hence widespread repercussions. In ruminants, most research on diabetes was carried on animals in which diabetes was induced experimentally that in turn affected milk synthesis, milk composition and yield (Hove, 1978a,b; Annison and Linzell, 1964; Leenanuruksa and McDowell, 1988) and milk oxidative balance (Chilliard et al., 2003; Deepa et al., 2014). Thus diabetes affects quality and quantity of milk. However there is paucity of information on prevalence of diabetes under commercial farming conditions.

It was found in experimentally induced and rare events of spontaneous diabetes in ruminants that the levels of glucose, glycated haemoglobin, fructosamine in blood plasma raise whereas insulin levels fall (Jarrett, 1946; Deepa et al., 2014). The concentration of cholesterol and triglyceride changes irregularly under diabetes. The above mentioned biomarkers are involved in carbohydrate, fat and protein metabolism and thus are linked to milk synthesis of fat and lactose (Annison and Linzell, 1964; Pethick and Lindsay, 1982). Hyperglycemia is linked to oxidative stress (Deepa et al., 2014). Hence changes in the levels of clinicopathological biomark-

Initial survey on 379 does: Evaluation of diabetic biomarkers including random glucose, fasting glucose, intravenous glucose tolerance, insulin, glycated haemoglobin, fructosamine, triglycerides and cholesterol 5 times on 5 different days to determine status and variation of diabetic markers in goats.

Goats with normal values = 334 does. The data on those does is presented in Table 1

Goats with at least one abnormal value = 45. See more details in text

Goats which returned to normal levels on subsequent tests = 21 (16+5) hence were considered normal and their data is presented in Table 1

Goats with all measures above the normal = 24. These goats were defined as subclinical diabetic and their data is presented in Table 1

All 24 subclinical diabetic goats were monitored for clinicopathology. Among these 24 subclinical diabetic goats 6 were selected and compared to 6 non-diabetics for variation of milk composition and antioxidant potential on 5 different days

Clinicopathological evaluation on day 1 and 5 for clinical parameters (RR, HR, temperature), glucosurea, ketonurea, biochemical parameters (AST, ALT, ALP, Zn, K, L-carnitine), hormones (cortisol, T_3, T_4), Data is presented in Table 2

Evaluation of milk composition and antioxidant potential between subclinical diabetic and non-diabetic on 5 different days. Data is presented in Figure 2 and 3 respectively

Histopathology of liver and pancreas. Shown in Figure 4

Fig. 1. Schematic description of the ontogenesis of the analytical procedures during the study.

ers of diabetes may be related to milk composition and antioxidant capacity (Deepa et al., 2014).

Since domesticated ruminants are under continuous selective pressure toward productivity, it may be assumed that animal with clinical diabetes will not survive. Indeed, clinical diabetes is reported sporadically in ruminants (Lutz et al., 1994; Deepa et al., 2014). However, subclinical form of diabetes may remain unnoticed and thus may prevail in commercial herds. Recent report on cattle supports such possibility (Taniyama et al., 1999; Clark, 2003; Nazifi et al., 2004; Tajima et al., 2010; Matsuda and Taniyama, 2013; Deepa et al., 2014). The aim of this study was to explore the possibility for prevalence of subclinical diabetes in commercial herd (s) in Bareilly district of Uttar Pradesh, India.

2. Materials and methods

2.1. Study area and animal management

The present study was conducted at the Indian Veterinary Research Institute (IVRI) farm, polyclinic and adjoining areas of Bareilly district of Uttar Pradesh state (India) which is located at an altitude of 172 meters above mean sea level, having latitude of 28.20°N and longitude of 79.24°E with humid subtropical and dry winter type climate. Average annual temperature ranges from 18.9°C to 31.5°C and humidity from 38% to 84%.

Goats are usually reared under semi-intensive management with stall feeding in open or semi covered paddocks during day time and housed under shelter at night. Diet of animal consists of 40% concentrate mixture and 60% roughages. Concentrate mixture includes maize/barley/wheat (40%), ground nut cake (30%), wheat bran (10%), deoiled rice bran (13%), molasses (5%), mineral mixture (2%) and salt (1%) fortified with vitamins A, B_2, D_3 and is usually offered at the level of 100–200 g/animal/day with protein content of 16–18%. Lucern, green maize, oats, berseem and cow pea are the main roughages offered at level of 160–320 g/animal/day with ad libitum wheat straw as basal roughage having composition as described by Patra et al. (2002). Animals have access to water ad libitum.

2.2. Animal selection and diagnosis

A total of 379 Black Bengal does and their crosses were screened for diabetic biomarkers. All animals were above 2 years of age and in 3–5 lactation with milk yield ranging from 0.24 to 1.83 l per day during lactation period. Selected animals were at the 7th week of lactation. Medical history revealed that some of these goats had previous exposure and infections with Peste des petits ruminants (PPR), blue tongue (BT), foot and mouth disease (FMD), bovine viral diarrhoea (BVD), paratuberculosis or contagious caprine pleuropneumonia (CCPP). Some were vaccinated against these diseases or had history of dystocia and treatment with corticosteroids/drugs during previous pregnancies, which may have affected beta cells of