Effects of preslaughter stress on meat quality and phosphocalcic metabolism in camels (*Camelus dromedarius*)

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Abstract

It is widely accepted that nutrition and the conditions under which the animals are produced, transported and slaughtered may influence the oxidative stability of the meat and several other physiological functions. The purpose of this study was to determine the effects of preslaughter stress on meat quality and physiological responses in dromedary camels and their correlation with phosphocalcic metabolism. Animals used in this experimentation were clinically healthy. The animals were subjected to a long road transportation stressor (TS) for 2 hr by a truck, or remained unstressed before slaughter (i.e. non-transported, NS). Blood samples were collected from the jugular vein. Ten hours after transportation of the TS camels, they and the NS camels were slaughtered. Muscle glycogen and pH were measured on samples from longissimus muscle collected at 15 min and 24 h postmortem. The TS camels had higher plasma cortisol, thyroxine and glucose ($P < 0.05$) concentrations than NS camels. In contrast, plasma concentrations of sodium, potassium, calcium, inorganic phosphorus, parathormone and 25-Hydroxyvitamin D in TS and NS camels were similar ($P>0.05$). These results indicate that long-term preslaughter transport can cause noticeable changes in stress responses and muscle metabolism, without any variation of phosphocalcic metabolism hormons in camels.

Key Words: Dromedary camels, Thyroxine, Cortisol, 25(OH) Vit D, Preslaughter stress.

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1. Introduction

The dressing percentage of camels is in a range of 52% to 77%, and the meat is considered as a healthful food, because of its low fat content content, low concentration of saturated fatty acids and high concentration of polyunsaturated fatty acids (El-Faer et al., 1991; Elgasim and Alkanhal, 1992; Rawdah et al., 1994; Dawood and Al-Alkanhal, 1995; Kadim et al., 2008). Road transportation of animals is a potent stressor, which results from vehicle motion, noise and vibration, and can change several of the animals' physiological systems (e.g. cardiovascular, immune, and endocrine via the activation of Hypothalamo-Pituitary-Adrenal gland axis; Apple et al., 1994; Nwe et al., 1996; Heiman et al., 1997; Broom, 2003). To our knowledge, there are no reports evaluating the endocrine responsivness in camels subjected to stress. Therefore, this study was undertaken to investigate the effect of a road transportation stress on cortisol, thyroxine, parathormone, 25-hydroxyvitamin D and other biochemical parameters (Ca, P, Na, K, glucose, muscle pH and glycogen) in Moroccan dromedary camels.

2. Materials and Methods

To assess the physiological stress responses, 14 male camels (4 to 6 years of age, average weight of 360 ± 40 kg) were divided to 2 groups of 7 animals: group TS were subjected to a 2 hr stressful road transportation event (70 km from Settat to Tit-Mellil) and NS group which remained unstressed before slaughter (i.e. no transportation). All animals were clinically healthy, feed deprived overnight and were slaughtered 10 hr after transportation at the Tit-Mellil Municipality slaughterhouse according to traditional procedures. Blood samples (8 ml) were taken at 0600 h into heparinized tubes from the jugular vein. The camels bladders were removed from the carcasses and urine collected from it and then stored in aliquots (1 ml) at -20 ^{0}C until cortisol analysis. Plasma was separated by centrifugation at 750 g for 15 min, pipetted into aliquots and then stored at -20 ^{0}C until analyses. Plasma concentrations of Ca, Na, and K levels were measured using an atomic absorption spectrophotometer. Phosphorus level was measured by colorimetry. Approximately 2 g of *longissimus thoracis* muscle were collected at 24 hr postmortem from the left side of each carcass, and frozen immediately (glycogen analysis) or directly homogenized (pH measure). Muscle pH was assessed at each sampling time on duplicate samples using the iodoacetate-KCl homogenate procedure (Bendall, 1973). Glycogen concentrations were obtained using the iodine-binding procedure described by Dreiling et al. (1987). Plasma glucose was measured using a commercial kit. (GESAN, Italy). Hormone levels were analyzed by radioimmunoassay method in the National Center of Science and Nuclear Technical Energy in Maamoura. Validation for hormone assays included limits of detection, and precision in standard curve following sample dilution, inter- and intra-assays. The data were expressed in SI units and analyzed by the Mann-Whitney *U* test for comparison between groups. All values were expressed as mean and standard error (SE), and $P<0.05$ was seen as statistically significant.

3. Results and discussion

There were no significant differences ($P>0.05$) in plasma minerals between the TS and NS groups (Figure 1). The plasma and urinary levels (nM) of cortisol, and plasma levels (nM) of thyroxine are significantly ($P<0.05$) higher in the TS group (165±32; 98±3.1 and 216.7±24.3 respectively) compared to the NS group (57±4.7; 18±1.6 and 154.3±12.6 respectively) (Figure 2). Elevation of plasma cortisol due to transport stress has been reported for goats (Kannan et al., 2000). Transportation not only includes physical stress, but also emotional stress caused by loading and unloading, noise, vibration, and social disruption. In camels, physical exercise (4 km, 6.1 m s^{-1}, 25 °C) resulted in elevatated plasma concentrations of cortisol (Riad, 1995). However, Dahlborn et al. (1992) reported that, in camels, food deprivation for 4 days did not induce a change in plasma cortisol, thyroxine, and glucose levels. Furthermore, Riad (1995) had observed that IV infusion of synthetic human ACTH (1-24) fragment (10 mg kg^{-1}) or A II (24 mg kg^{-1}) over 1 hr induced high plasma levels of cortisol since 30th or 20th min of infusion respectively until 60 min after the cessation of the infusion. The elevated cortisol concentrations in the TS camels of the current study suggest an activation of the hypothalamo-pituitary-adrenal gland axis by road transportation.

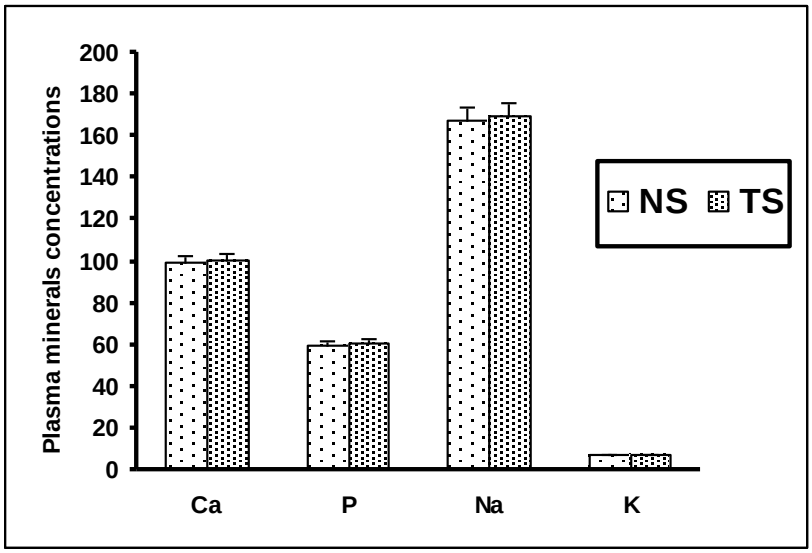

Figure 1. Effects of transportation stress on plasma concentrations of calcium (Ca), phosphorus (P) (mg l^{-1}), sodium (Na) and potassium (K) (mmol l^{-1}).
NS: unstressed camels; TS: stressed camels).

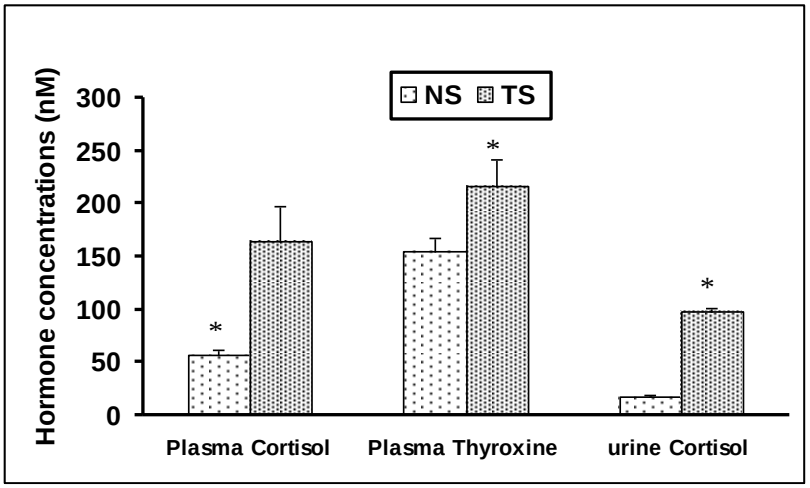

Figure 2. Effects of transportation stress on plasma and urine concentrations of cortisol (nM) and plasma thyroxine levels (nM).
NS: unstressed camels; TS: stressed camels; * = P <0.05: differences between NS and TS.

The plasma levels of parathormone and 25-hydroxyvitamin D were not affected by road transportation (Figure 3). The TS group had lower ($P<0.05$) muscle glycogen concentration and higher plasma glucose (34.5 – 37.5 mmol kg^{-1} and 7.8 – 8.4 mM) compared to the NS group (39.4 – 42.6 mmol kg^{-1} and 5.8 – 7.3 mM). There were no differences ($P>0.05$) in ultimate pH between the treatments (Table 1). In goats, the trend of plasma glucose concentrations during the immediate preslaughter period was similar to those of plasma cortisol concentrations. In the same species, elevation of plasma glucose is preceded by an increase in the plasma cortisol concentrations (Sanhouri et al., 1992) and remained higher for approximately 3 h after 2 h transportation (Kannan et al., 2000).

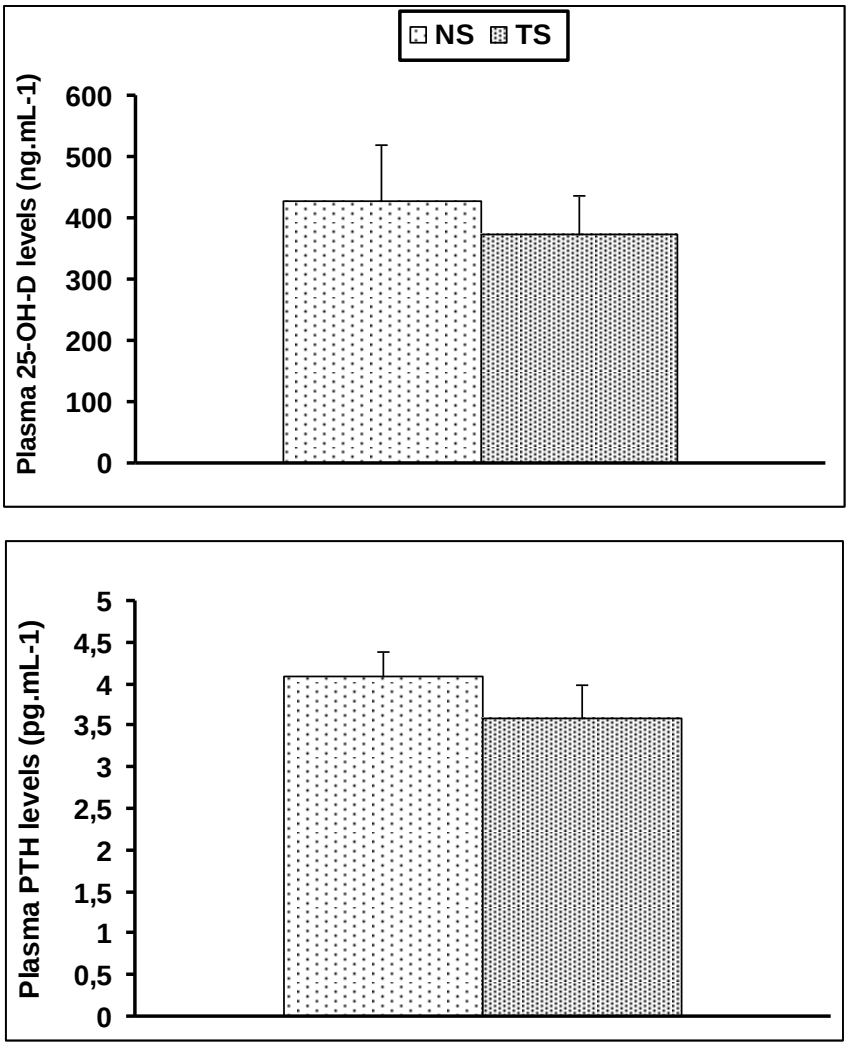

Figure 3. Effects of transportation stress on plasma concentrations of parathormone (PTH) and 25-hydroxyvitamin D (25-OH-D).
NS: unstressed camels; TS: stressed camels.

Table 1. Effects of transportation stress on plasma glucose concentrations and 24 h post-mortem muscle pH and glycogen levels in camels.

	Ultimate pH	Glycogen [Mmol kg^{-1}]	Glucose [Mmol l^{-1}]
NS	5.54 – 6.10	$39.4 – 42.6^{a}$	$5.8 – 7.3^{a}$
TS	5.47 – 6.08	$34.5 – 37.5^{b}$	$7.8 – 8.4^{b}$

NS: unstressed camels; TS: stressed camels; $^{a, b}$: values within the same column with different letters are different ($P < 0.05$).

In regards to meat quality, the important metabolic changes due to preslaughter stress are a depletion of glycogen and the consequent inability of muscles to develop adequate acidity levels postmortem (Gregory and Grandin, 1998). Dark muscle color is characterized by an elevated postmortem pH and it is a common condition encountered when animals are exposed to situations that deplete muscle glycogen levels prior to slaughter (Smith et al., 1992). Transportation stress causes a depletion of muscle glycogen and results

in formation of dark-cutting meat in sheep (Warriss et al., 1990), primarily due to the release of catecholamines (Tarrant, 1989). In addition, adrenocortical response to transportation stress seems to be similar in sheep and goats (Greenwood and Shutt, 1992). In the present study, there was no effect of transportation on the ultimate pH, possibly because the stress imposed was not intense enough.

In conclusion, short-term preslaughter transport may cause significant changes in the stress responses of camels (increased plasma concentrations of cortisol, glucose, and thyroxine, and decreased muscle glycogen concentrations) without any impact on ultimate pH or metabolism phosphocalcic hormones. Further studies of an eventual reduction of stress responses by other parameters such as vitamin C and tocopherols are needed.

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