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Effect of dietary supplementation of camel hump fat on performance, carcass characteristics, antibody responses and blood metabolites in fattening lambs

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ABSTRACT

The present study aimed to investigate the effects of dietary supplementation of camel hump fat (CHF) in substitution with a conventional ruminally protected fat source (palm fatty acids powder) on performance, carcass traits, blood biochemical parameters and immunological responses in fattening lambs. Twenty five Afshari male lambs were randomly assigned to the five diets in a completely randomized design. Diets were a control group (no fat supplementation) and groups received the supplemental fat levels of 2.5 or 5% of diet from either calcium salt of fatty acids (CSFA) or CHF. All diets were formulated to be isoenergetic and isonitrogenous. Three representative lambs from each group were slaughtered on d 90 of trial to measure carcass traits. Average daily gain was greater ($P < 0.05$) for lambs fed CHF and 2.5% CSFA diets than the control and 5% CSFA diets. The highest feed intake was occurred orderly in groups received 2.5% CSFA, 2.5% and 5% CHF, and the least feed intakes were seen in control and 5% CSFA lambs. Feed conversion ratio was lower in lambs fed CHF- or 2.5% CSFA-diets. Among the carcass characteristics, only hot and cold carcass efficiencies were influenced ($P < 0.05$) by supplemental fat sources. Absolute ($P = 0.09$) and relative ($P = 0.06$) pancreas weights tended to be affected by dietary fat supplementation so that, pancreas weight in control lambs was significantly lower than those in other treatments. Dietary supplementation by CHF and CSFA had no significant effect on blood glucose and triglycerides; however, plasma high-density lipoproteins and cholesterol concentrations were affected ($P < 0.05$) by dietary treatments and supplemental CHF and CSFA increased plasma levels of both variables. Utilization of CHF at the levels of 2.5 and 5% increased ($P < 0.01$) IgG titers against ovalbumin over the time ($P < 0.05$). Serum γ-globulin content was increased ($P < 0.05$) as the result of supplemental fat sources with the highest values assigned to the lambs fed on CHF-diets. The present findings suggest that camel hump fat can be used as a proper alternative for ruminally protected fat sources in fattening lambs with beneficial impacts on performance and immunological responses.
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1. Introduction

Supplementing ruminant's diets with supplemental fat has been increased over the past few decades. Dietary supplementation of ruminant rations with fats has been investigated as a mean to influence a variety of physiological processes or to alter fatty acid composition of

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ruminants-derived food products (Kott et al., 2003; Manso et al., 2006; Hess et al., 2008). The overarching goal has been to develop fat supplementation programs that will lead to improvements in the sustainability of beef and sheep production systems. Another main objective of simultaneous interest was to investigate how metabolism of dietary fatty acids by ruminal microflora affects supply of fatty acids available for metabolism by the ruminants (Hess et al., 2008).

Lipids may be supplied in animal's diets via various forage sources, oil-rich cereals, oilseeds, or fish oil, and until recently, tallow was offered as a significant energy source (Kennelly, 1996; French et al., 2000; Loor et al., 2003). In the recent years, novel lipid sources such as marine algae, chia seed, lupin, hemp and camelina have been investigated to be used in animal feeds that their typical oil contents and fatty acid profile have considerable variations, largely due to the botanical species and country of origin (Woods and Fearon, 2009). In this regard, one of the fat and energy sources that do not pay special attention to it, is camel hump fat (CHF). The camel stores its energy reserves in the form of fat in different depots in its body of which, the hump and abdomen depots comprise a considerable amount of the adult body weight; therefore, camels can survive long periods without feed (Kadim et al., 2002).

In the north of Africa, the Middle East, and the south of America, camels are slaughtered for their meat and the fat is mostly consumed directly (Shekarchizadeh et al., 2009). Hump and abdomen fats contain a mixture of fatty acids (Emmanuel and Nahapetian, 1980) and most of these are esterified as triglycerides or phospholipids and vary according to their anatomical location in the body (Duncan and Garton, 1967).

Few studies have examined the fatty acid composition of camel hump and abdomen depot fats (Emmanuel, 1981; Orlov et al., 1985; Rawdah et al., 1994), and most of these have been conducted in a single group. Mirgani (1977) determined the fatty acid composition of hump triglycerides from a single-humped camel (*Camelus dromedarius*) and found that saturated fatty acids (SFA) accounted for 74% of the total fatty acids. Emmanuel (1981), Orlov et al. (1985), Rawdah et al. (1994) and Shekarchizadeh et al. (2009) showed that the SFA contents in hump fats was 64.9, 60.2, 60.5 and 69%, respectively. Ruminally inert fats have been developed to avoid the decline in ruminal fiber fermentation and digestion associated with dietary supplemental fats (Jenkins and Jenny, 1989; Sklan et al., 1990). Thus, considering the fatty acid profile of CHF, this novel fat source could be used in ruminant's diets as a main energy source.

On the other hand, inadequate availability of high-quality feed ingredients and their high cost are the major constraints for improving the productivity of livestock in the developing countries. This adversely affects the health and productivity in farm animals, thereby reduces the profitability of livestock production systems. Hence, reduction of feed costs by incorporating cheaper and unutilized agro-industrial by-products need to be scrutinized. The objective of this study, therefore, was to evaluate the substitution potential of camel hump fat for a conventional protected fatty acid powder and its effects on performance, carcass characteristic and blood biochemical parameters in Afshari fattening lambs.

2. Materials and methods

2.1. Animals

Animals were housed in the Research Station of Guilan University (51,35° E, 32,38° N) during June 23 to November 4, 2011. Average ambient temperature and relative humidity during the trial period were 22.5 °C (ranged from 29.1 °C at the first week to 12.7 °C in the final, 13th, week of trial period) and 22.8% (ranged from 19.3 to 39% during 1st to 13th week), respectively.

Twenty five Afshari male lambs were used in this trial. Lambs were housed in individual pens (1.5 × 1 m) in an open-sided barn. Each pen was equipped with a feeder and waterer, where they were gradually switched from a ration of commercial to experimental. Lamb weights were carefully monitored at the 2 final weeks of acclimation period prior to initiation of the main trial period. Lambs were randomly assigned to one of the 5 dietary treatments (5 lambs per diet).

2.2. Dietary treatments

Five rations were designed with different fat sources and levels. Supplemental fat sources used were calcium salts of fatty acids (CSFA) or CHF. The vegetable-based CSFA used for the experiment predominately consisted of palmitic and oleic acid (Energizer GOLD, IFFCO, Malaysia; >85% fatty acids content). The experimental diets consisted of a control group (no supplemental fat), and diets containing 2.5 or 5% of either CSFA or CHF on dry matter (DM) basis. All rations were formulated to be isoenergetic (digestible energy basis) and isonitrogenous (balanced for intake crude protein), and to meet or exceed NRC (2007) requirements for all other nutrients for growing lambs (Table 1).

2.3. Experimental procedures

Lambs were fed daily ad libitum at 06:00 with 300 g alfalfa hay, thereafter at 07:00 with a mix of concentrate and wheat straw, at 17:00 with 300 g alfalfa hay, after that with a mix of concentrate, wheat straw and remaining proportion of alfalfa at 19:00 and had free access to water all times.

From days 1 to 7, lambs were gradually adjusted to experimental amounts of fat-supplemented diets. Feed was initially offered at a daily rate of feed intake of previous day (as-fed basis) per lamb, and was increased until trace amounts of uneaten feed remained at the subsequent feeding. Trace feed was used as an indication that lambs were being fed ad libitum to maximize the rate of average daily gain (ADG). Lambs were weighed at days 0, 7, 14, 21, 28, 35, 42, 49, 56, 63, 70, 77, 84 and 90, at the morning after 6 h feed withdrawal and with restricted access to water. The 13 periods between weighing days were used to calculate ADG throughout the trial and analyze growth curves. Body weights and DM intake (DMI) were used to calculate feed conversion ratio (FCR).

Three representative lambs from each group were slaughtered on the 90th day of the experiment to measure carcass characteristics. Pre-weighed lambs after 12 h fasting with free access to water were slaughtered by humanely 'Halal' method (Gracey, 1981) in experimental farm abattoir. After skinning and evisceration, hot carcass weights (HCW) were recorded. Separated liver, heart, kidneys, testes, gastrointestinal tract, skin, pancreas, spleen, lungs, abdominal fat and fat-tail of each animal were immediately weighed and expressed as a percentage of HCW. The cold carcass weights (CCW) were obtained after refrigerating (4 °C) for 12 h and carcass loss (CCW/HCW) was measured.

Approximately 3 ml of blood were collected via jugular venipuncture at 18:00 of days 0, 30, 60, and 90. Blood was collected into vacutainer blood collection tubes that contained agglutination activator (BD Vacutainer, Franklin Lakes, NJ). After blood collection, vacutainer blood tubes transferred on ice and immediately centrifuged (IEC Centra GP8, Thermo Fisher Scientific Inc., Waltham, MA) at 5000 × *g* for 5 min at room temperature. Finally, plasma samples were analyzed (Auto-analyzer YSI 2700 Select Biochemistry Analyzer, YSI Inc., Yellow Springs, OH) for glucose, triglycerides, cholesterol and high-density lipoproteins (HDL) concentrations by specific kits (Pars Azmoun, Tehran, Iran).

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