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Effect of palm kernel expeller as supplementation on production performance of Jersey cows grazing kikuyu-ryegrass pasture

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ABSTRACT

The aim of the study was to determine the effect of different inclusion levels of palm kernel expeller (PKE) in dairy concentrates for grazing Jersey cows on lactation performance and rumen fermentation patterns. Forty-eight multiparous, Jersey cows, grazing kikuyu-ryegrass during spring, were blocked according to 4% fat corrected milk, days in milk and lactation number and randomly allocated to three treatments based on PKE level in the concentrate. The PKE inclusion in the control (C), low PKE (LP), and high PKE (HP) treatment concentrates was 0, 200, and 400 g/kg, respectively, and was fed for a 60 d period, preceded by a 21 d adaptation period. The PKE partially substituted some of the maize and soybean in the concentrate. Additionally, eight rumen-fistulated, lactating dairy cows were randomly allocated to the C and HP treatment in a two period cross-over design. Cows received 6 kg (as is) concentrate per day divided over two milkings and strip-grazed pasture as one group. Milk yield and milk fat content did not differ between treatments and were 21.3, 21.3 and 20.7 kg/cow/d and 46.3, and 46.5, and 46.6 g/kg for the C, LP and HP treatment, respectively. Milk protein, milk urea nitrogen, body weight and body condition score did not differ between cows on all treatments. Total volatile fatty acid, mean ruminal pH, ammonia nitrogen, and *in situ* pasture dry matter and neutral detergent fibre degradability did not differ between cows on all treatments. The acetic to propionic acid ratio was higher (P=0.006) for cows receiving treatment HP compared to cows receiving treatment C (3.40 *vs.* 3.22). It was concluded that PKE can sustain milk yield and milk fat components at a level of up to 400 g/kg of concentrate when fed at 6 kg/cow/d to cows grazing kikuyu-ryegrass pasture. A more practical recommendation might be to limit PKE to 200 g/kg of concentrate due to potential palatability problems and a slow rate of intake when fed during milking in the parlour.

Abbreviations: PKE, palm kernel expeller; PKC, palm kernel cake; PKM, palm kernel meal; SEPKC, solvent extracted palm kernel cake; TMR, total mix ration; RPM, rising plate meter; DMI, dry matter intake; FCM, fat corrected milk; C, control treatment; LP, low PKE treatment; HP, high PKE treatment; MUN, milk urea nitrogen; BW, body weight; BCS, body condition score; DM, dry matter; CP, crude protein; ME, metabolisable energy; NDF, neutral detergent fibre; ADF, acid detergent fibre; ADL, acid detergent lignin; EE, ether extract; *IVOMD*, *in vitro* organic matter digestibility; OMD, organic matter digestibility; VFA, volatile fatty acid; A:P, acetic to propionic acid ratio; DM_d, dry matter degradability; NDF_d, neutral detergent fibre degradability; NDF k_d, neutral detergent fibre degradability rate.

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1. Introduction

The nutrient requirements of high-producing dairy cows cannot be satisfied by only grazing high quality pasture (Dixon and Stockdale, 1999). Allen (2000) stated that energy supply is the first limiting factor for increasing productivity of lactating dairy cows. Supplements can overcome the nutrient gap, but at the cost of potentially substituting pasture dry matter intake (DMI). Supplements are also cost sensitive and are affected by the continuous fluctuation of feed ingredient prices. Therefore, improving the efficiency of production and reducing cost of supplemental concentrates for dairy cows are becoming increasingly important both for the smallholder and commercial dairy farmer. High maize and oilcake prices have a substantial impact on the production cost of milk. Maize grain can constitute up to 700–800 g/kg of a conventional dairy concentrate and soybean oilcake can constitute up to 80–120 g/kg of the concentrate (Meeske et al., 2009). According to Meeske et al. (2006), concentrates contribute up to 66% of the total feed cost in pasture dairy grazing systems and, therefore, expensive energy and protein sources are subject to replacement by less expensive by-product feeds. High fibre by-products can contribute to maintaining a normal ruminal pH, enhance pasture digestion and hence result in increased DMI (Bargo et al., 2003). Bradford and Mullins (2012) stated that the replacement of grain with a non-forage fibre source is profitable in some scenarios and often increases DMI.

Palm kernel cake (PKC), also known as palm kernel meal (PKM), is a residue or by-product from the palm kernel oil extraction process of the African Palm (*Elaeis guineensis*) seed, representing *ca.* 50% of the original kernel (Abdullah and Hutagalung, 1988; Carvalho et al., 2006) and has long been recognised to be a significant ingredient in animal feed formulation (Collingwood, 1958). There is considerable variation in chemical composition of palm kernel by-products depending on the method of fat removal and the proportion of endocarp remaining (Hindle et al., 1995). Two types of PKC are commercially available: (1) oil extracted by screw presses, termed palm kernel expeller (PKE; brown colour) or (2) solvent extraction, termed solvent extracted palm kernel cake (SEPKC; white grey colour) (O'Mara et al., 1999). Palm kernel expeller is usually used for animal feeds rather than SEPKC, especially in ruminant diets because of its fibrous nature (Abdullah et al., 1995). According to MAFF (1992), PKE is considered as a medium quality energy feed with a moderate crude protein (CP) content. O'Mara et al. (1999) added that PKE is a moderate quality feed in terms of digestibility for ruminants (organic matter digestibility (OMD) <710 g/kg), but high in fibre, coarse and granular, and lowly palatable (Chanjula et al., 2010). Zahari and Alimon (2003) stated that PKE is used as a source of energy and fibre for dairy cattle at inclusion levels of 300–500 g/kg of the total diet, however Carvalho et al. (2006) stated that PKM is generally included in small amounts (<100 g/kg) in dairy concentrates due to its low palatability. Only one study investigating the effect of PKM on performance of dairy cows could be found. In this study, Carvalho et al. (2006) reported no significant treatment effects on DMI, milk yield, or milk composition when PKM was included in a total mix ration (TMR) at different inclusion levels (50, 100 and 150 g/kg inclusion). However, the milk lactose content tended to increase as PKM inclusion increased ($0.10>P>0.05$). This study also reported that feed costs decreased without negative effects on productive responses when PKM was included up to 150 g/kg in a TMR. However, the PKM evaluated in the latter study was SEPKC and not PKE.

Further research on the use of PKE in grazing dairy cows is justified as the majority of studies regarding PKE on animal production were performed on goats, beef cattle and water buffalo. Feeding recommendations on inclusion levels cannot be made with confidence, because the number of studies in which fibre-based concentrates replaced starch-based concentrates is limited and half of the studies were conducted in confinement (Bargo et al., 2003). The energy value of a dairy concentrate will decrease when PKE replaces maize and this should decrease milk production. The question is to what extent improved pasture digestion will compensate for the lower ME intake on concentrates containing more PKE and less maize.

The objectives of this study were to determine the effect of partially replacing maize with PKE in concentrates for dairy cows on milk production, milk composition, BW, BCS and rumen environment of cows grazing kikuyu-ryegrass pasture during spring.

2. Materials and methods

2.1. Location description

The study was conducted at the Outeniqua Research Farm (33°58′38′ S and 22°25′16′′ E; altitude 210 m above sea level) near George, South Africa. The area has a temperate climate with a long-term (45 years) mean annual precipitation of 732 mm, received throughout the year (ARC-ISCW, 2011). During the study period the total precipitation was 277.4 mm and the mean daily maximum- and mean daily minimum temperatures were 19.9 °C and 9.3 °C, respectively. The paddock where the study was conducted consisted of 8.55 ha of permanent irrigated kikuyu (*Pennisetum clandestinum*) and annual ryegrass (*Lolium multiflorum* var. *italicum*) pasture. The soil properties of this paddock are described in detail by Swanepoel et al. (2013). The study was performed from the 12th of August 2011 to the 1st of November 2011 with a 60 d data collecting period.

2.2. Pasture performance management

The pastures were managed as an irrigated pasture under a no-tillage regime, according to the recommended guidelines for kikuyu-ryegrass (Botha, 2003). The pasture consisted predominantly of ryegrass during the study period, since kikuyu is