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The dietary fatty acids and their effects on reproductive performance of ruminants

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ABSTRACT

In this review article, the effect of dietary fat and fatty acids on reproductive performance of ruminants has been discussed. Fat supplementation affects several organs involved in reproduction such as hypothalamus, anterior pituitary, ovary and uterus. Dietary inclusion of fat could improve reproductive performance either through energy supply or the impact on reproduction procedures. The efficacies of dietary fat on reproduction depend on fatty acid types especially polyunsaturated fatty acids. Dietary supplementation of fats and fatty acids has caused an improvement in cell membrane fluidity, an increase in follicle numbers and diameter, an improvement in oocyte and embryo quality as well as an increase in hormone secretion including estrogen, progesterone and growth factor. Furthermore, inclusion of fat could increase gene expression involved in reproduction. In general, the results indicated that dietary fat could lead to improved in reproductive performance of ruminants.

Key words: Fatty acids, Reproductive, Ruminants

INTRODUCTION

An improvement in reproductive performance has been one of the important economical parameters. As, delay in pregnancy resulted in noticeable economical loss in lactating dairy cow industry. It seems one of the strategies to enhance reproduction efficiency is inclusion of nutrients such as fats especially essential fatty acids [18]. Essential fatty acids content of ruminants is less available than in those of non ruminants due to microbial biohydrogenation of fatty acids in rumen [10]. Thereby, dietary fat supplementation might improve reproduction [21]. Ferguson et al. (1990) found a 2.2 increase in pregnancy rate in the first of artificial insemination of dairy cows fed on fat [5]. In addition, dietary inclusion of n-3 fatty acids was shown to improve embryo survival and pregnancy of dairy cows [13]. In addition to the effect of fatty acids on cell membrane fluidity and biophysical properties, they resulted in improved follicle [29], oocyte [30] and embryo [23] development and increased gene expression involved in reproduction occurrences [12]. Additionally, fatty acids and cholesterol are substrates to synthesis reproduction hormones including estrogen, progesterone and prostaglandin altering ovary and uterus performance that affects pregnancy rate (7 and 28).

Reproductive hormones

Dietary supplementation of fat can affect ovary steroidogenesis increasing follicular concentration of steroidal [14]. Robinson et al. (2002) found higher steroidal concentration in plasma of cows fed linolenic acid than control group [17]. Also, Moallem et al. (1999) observed that supplementation of high unsaturated fatty acids increased follicular steroidal concentration when compared to cows fed low unsaturated fatty acids [14]. Fats can improve reproductive performance through affecting progesterone metabolism, because it produced by corpus luteum is essential to keep pregnancy. In addition, progesterone concentration was increased in cows supplemented with fat such as cotton seed or fatty acids [22]. This increase might result from either a reduction in progesterone clearance of plasma [8] or an increase in production of bigger corpus luteum [25]. However, Bilby et al. (2006) showed that progesterone concentration was not influenced by feeding diets containing MUFA and PUFA [3]. Furthermore, long fatty acids in particular arachidonic acid (AA) and eicosapentaenoic acid (EPA) are precursors for eicosanoids such as prostaglandins [4]. However, linolenic acid inhibited prostaglandin synthesis by inhibiting cyclooxygenase enzyme [7]. Thereby, it prevents corpus luteum regression on ovary essential for pregnancy [21].

Follicle growth and development

One of the mechanisms of dietary fat on an improvement of reproduction procedure is its impact on follicle growth. The number and size of ovulatory follicles determine future success of ovulatory rate and oocyst survival [1]. A 23% increase of dominant follicle in cows supplemented with dietary inclusion of fat was reported by Staples and Thatcher (2005) [21]. Furthermore, n-3 and n-6 polyunsaturated fatty acids have remarkable influences on the numbers of follicle in ovary of ewes [30]. Dietary addition of polyunsaturated fatty acids increased the number of follicles with medium size [24]. Similarly, Robinson et al. (2002) indicated that an increase in the number of medium sized follicles (5-10 mm) was obtained in cows supplemented with n-3 and n-6 fatty acids as compared to those added control cows [17]. In addition, they noted that cows fed high n-6 diets had higher dominant follicles diameter than those received control and high n-3 diets. Fat supplementation can affect follicular growth dynamic in cows through 1.5 to 5 mm follicle numbers [26]. However, inclusion of high n-3 diets had no effect on the follicle number [3 and 16] and diameter [3 and15] in cows when compared to those supplemented with rich n-6 diets.

Luteal performance

Supplementation of high fat diets increased corpus luteum long life through progesterone production [27] improving reproduction. Staples and Thatcher (2005) suggested that an increase in progesterone concentration might be as a result of higher corpus luteum size resulting from higher dominant follicles in cows fed fat supplementation [19]. Garcia-Bojalil et al. (1998) indicated that high linoleic acid diets had higher corpus luteum than those received control diet [9].

Oocyte quality and maturity

Embryo quality and competence depends on fatty acids composition [18]. Zeron et al. (2002) stated that supplementation polyunsaturated fatty acids from fish oil resulted in an increase in high quality oocyte number, a better oocyte membrane stability and an increase in long polyunsaturated fatty acids content of plasma and cumulus cells when compared to ewes fed control diet affecting oocyte quality and maturity [30]. However, some studies have found that feeding high n-6 diets can inhibit oocyte development through avoiding of meiosis resumption at the germinal vesicle stage [11].

Embryo quality and survival

Fouladi-Nashta et al. (2007) exhibited that dairy cows supplemented with 200 and 800 g/d calcium salt of fatty acids palm oil had higher conversion of oocytes to blastocyst as compared to control cows, but fertility rate and the number of embryo was not altered [6]. Moreover, Thangavelu et al. (2007) showed that embryo development was elevated in cows fed on polyunsaturated fatty acids than saturated fatty acids [23].

Growth factor

Insulin like growth factor is one of the known growth stimuli for follicular development [20]. HDL concentration might be responsible for IGF-I production in granulose cells due to its effect on mitogenic stimulation [2]. Robinson et al. (2002) found an increase of IGF-I concentration in follicle of cows supplemented with soybean oil than control [17].

CONCLUSION

Dietary supplementation especially polyunsaturated fatty acids could affect reproductive performance either through influence on peripheral hormone circulation involved in reproduction or effect on follicle and oocyst number or quality involved in embryo survival.

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