Jpn. J. Vet. Res., **35**, 73–78 (1987)

RELATIONSHIP BETWEEN SERUM TOTAL CHOLESTEROL LEVEL AND THE NUMBER OF TRANSFERABLE EMBRYOS IN RELATION TO MILK YIELD IN SUPEROVULATED COWS

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(Accepted for publication March 6, 1987)

Superovulation was induced in 254 Holstein cows with gonadotropins between days 9 and 14 of the estrous cycle. Dry and milking cows which produced less than 30kg/day were classified into two groups, one having a total cholesterol (T-CHO) level of less than 130mg/dl, and the other having a level of 130mg/dl and over. In milking cows which produced 30kg and over, the grouping level was 170mg/dl.

In dry and milking cows which produced less than 30 kg/day, the percentages of cows which produced more than 3 transferable embryos were 28.2% (22/78) of the cows that had less than 130mg/dl of T-CHO, and 52.5% (21/40) of those that had 130mg/dl and over ($P<0.01$). In the milking cows which produced 30kg/day and over, the percentages were 36.4% (4/11) and 69.2% (18/26) in those which had T-CHO levels of less than 170mg/dl and of 170mg/dl and over, respectively. However, in dry and milking cows which received APG (bovine anterior pituitary extracts) as an ovulation stimulating preparation, the results were different from those obtained from the cows which had not received the extracts.

The present results indicate that milk yield should be considered when T-CHO level is used as a preselection criterion for good ovarian response in Holstein cows.

Key words: Superovulated cows, milk yield, total cholesterol, ovarian response

INTRODUCTION

In the previous report[6,8] it was found that the number of transferable embryos obtained was significantly higher in cows with a serum total cholesterol (T-CHO) level of 130mg/dl and over as compared to those with a T-CHO level of less than 130mg/dl. However, in heifers, the level was 90mg/dl. The T-CHO level of cattle is affected by

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several factors such as parturition, stage of lactation, milk yield and occurrence of diseases.[2,4,7] Milk yield and stage of lactation had the greatest effect on the T-CHO level.[7] This means that cows with a high milk yield have an increasing T-CHO level. The difference in the T-CHO level between heifers and cows was probably due to the fact that the heifers were not yet engaged in milk production.

It was also thought that in order to preselect cows for good ovarian response, different level of T-CHO should be used as a parameter for cows with different milk yield.

In the present study, the relationship between serum T-CHO level and the number of transferable embryos was investigated in relation to milk yield in cows.

MATERIALS AND METHODS

Two hundred fifty-four Holstein cows in their 1st to 9th calving were used as donors at a commercial farm from 1982 to 1986. Their milk yield was between 0 and 60kg/day.

Superovulation was induced by administering 2,000–4,000 IU of PMSG (Teikoku-Zoki Co.) or 35–60mg of FSH (Denka Co.) between days 9 and 14 of the estrous cycle. PG (Prostaglandin $F_{2\alpha}$, The Upjohn Co.) was given intramuscularly to induce luteolysis 2 days after the superovulation treatment. The amount of PG used was 10 to 15mg twice a day. Donors were inseminated artificially 2 or 3 times with frozen semen at 12-hour intervals following observation of estrus. APG (bovine anterior pituitary extracts, Teikoku-Zoki Co.) as ovulation stimulating preparation was injected at the time of artificial insemination in some animals. Embryos were recovered 6 to 8 days after estrus by a non-surgical method.

Serum T-CHO within 10 days before superovulation treatment was analyzed spectrophotometrically by an enzyme method.[1] Daily milk yield on the day of superovulation treatment was recorded.

Cows were divided according to their T-CHO level and milk yield: a) $<$130mg/dl and 130mg/dl$\leqq$for dry and milking cows which produced less than 30kg/day, and b) $<$170mg/dl and 170mg/dl$\leqq$for milking cows which produced 30kg/day and over.

The χ^2-test was performed to compare the percentage of animals which had over 3 transferable embryos between different T-CHO groups in relation to daily milk yield.

RESULTS

The percentages of dry and milking cows which had over 3 transferable embryos were 28.2% (22/78) in cows which had a T-CHO level of less than 130mg/dl, and 52.5% (21/40) in cows which had a level of 130mg/dl and over (Table 1). The percentages were significantly different between cows which had a T-CHO level of less than 130mg/dl and those whose level was 130mg/dl and over ($P<0.01$). However, the perecentages were not significantly different in dry and milking cows

which produced less than 30 kg/day and had received APG : 35.9% (14/39) and 47.8% (11/23), respectively.

In milking cows which produced 30kg/day and over, the perecentages of the cows which produced over 3 transferable embryos were 36.4% (4/11) in cows which had less than 170mg/dl, and 69.2% (18/26) in cows which had 170mg/dl and over (Table 2). In milking cows which produced 30 kg/day and over and had received APG, the percentages were 21.4% (3/14) and 52.2% (12/23), respectively. Although there was no significant difference between the two groups, the percentage of cows which had less than 170mg/dl was lower than that of those which had 170mg/dl and over.

TABLE 1 Percentages of cows which had over 3 transferable embryos in relation to total cholesterol level and whether APG was used or not in dry and milking cows which produced less than 30 kg/day

Ovulation stimulating preparation	T-CHO(mg/dl)	
	< 130	130 ≦
No treatment	28.2%[a] (22 / 78)	52.5%[b] (21 / 40)
APG	35.9% (14 / 39)	47.8% (11 / 23)
Total	30.8%[a] (36 / 117)	50.8%[b] (32 / 63)

a, b ; $p<0.01$

TABLE 2 Percentages of cows which had over 3 transferable embryos in relation to total cholesterol level and whether APG was used or not in milking cows which produced 30 kg/day and over.

Ovulation stimulating preparation	T-CHO(mg/dl)	
	< 170	170 ≦
No treatment	36.4% (4 / 11)	69.2% (18 / 26)
APG	21.4% (3 / 14)	52.2% (12 / 23)
Total	28.0%[a] (7 / 25)	61.2%[b] (30 / 49)

a, b ; $p<0.01$

DISCUSSION

In normal lactating cows, the serum T-CHO level reaches a peak at about 110 days after calving, and thereafter the level changes according to their milk yield.[7] The change of T-CHO level in relation to lactation stage and milk yield is reportedly related to the metabolism of lipoproteins.[10,12] RAPHAEL et al.[12] demonstrated that 50% of the increase in lipids of serum which occurred during the lacatation cycle was associated with the increase of alpha LDL (low density lipoprotein). PUPPIONE[10] suggested that the elevation of alpha lipoproteins during lactation may be the result of increased VLDL (very low density lipoprotein) metabolism by the mammary gland to synthesize milk fat. To compensate for the decrease in size as the triglyceride-rich lipoprotein undergoes a loss of core lipid (triglyceride), portions of the surface components such as apoprotein C and polar lipids (cholesterol, phospholipid) are shed and then taken up by HDL (high density lipoprotein). Therefore, increased VLDL for milk fat production in lactating cows may also lead to increased production of HDL in the liver. VLDL catabolism should thus be more accelerated in higher yield milking cows. This might explain the difference in the T-CHO level between cows which had different milk yields.

It was reported that cows which had suffered from disease within 1 week after calving and showed severe symptoms such as pain, fever and anorexia had a lowerd T-CHO level until 10 weeks after calving.[4] Cows which showed clinical symptoms 1 month before and 1 month after the day of blood collection, or had subclinical mastitis on the day of blood collection, had a significantly lower T-CHO level.[7] Thus lowerd T-CHO level may indicate a metabolic disorder or illness.

Extrahepatic lipoprotein lipase, which is present in epithelial cells, cleaves fatty acids and glycerides from the triglycerides of VLDL and enables them to be taken up by the tissues for storage, energy utilization or milk fat production.[10] It was thought that when lacating cows suffer from a disease such as mastitis, extrahepatic lipoprotein lipase cannot be activated and the triglycerides of VLDL cannot be used for milk fat production. This condition leads to decreased production of alpha LDL and HDL from the liver, which is a reservoir of apoprotein, cholesterol ester and phospholipid of VLDL, followed by a decreased T-CHO level.

Lowerd ovarian response to hormonal treatment in the cows which had a lowerd T-CHO level could be related to their metabolism. However, the mechanism by which the ovarian response to hormonal treatment was affected by metabolic condition is not known. Another suggestion was that persistent disease as a stress affects the endocrine system.[11] It was thought that some kind of metabolic disorder or illness disturbed the endocrine system of the animals, which resulted in decrease in the population of growing follicles in the ovaries. Another report showed that the occurrence of disease before and after calving delayed the initiation of ovarian activities as

detected by changes in progesterone levels, as compared to normal cows.[5]

The use of ovulation stimulating preparations was reported by several researchers,[3,9,13,14] but the effectiveness of these remains unclear. In the present study, APG seemed to be effective in milking cows which produced less than 30kg/day and had less than 130mg/dl of T-CHO. However, further studies are needed to validate this suggestion.

Some evidence also suggests that cows which do not have a normal cholesterol level in relation to their milk yield are unhealthy and do not show good ovarian response to hormonal treatment as compared to cows which have a normal cholesterol level.

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