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EFFECT OF DIFFERING CALCIUM CONTENTS IN RATIONS ON SERUM CALCIUM AND INORGANIC PHOSPHORUS IN CYCLE AND EARLY PREGNANCY OF DWARF GOAT

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Abstract: Total serum calcium, inorganic phosphorus and their ratio have been studied in dwarf goat provided with varying amount of dietary calcium in their dry rations i.e. deficient, normal and supplemented in addition to routine grazing on vegetation with inadequate supply of calcium to the grazers. The significant increase in circulating calcium in calcium supplemented goats only, significant enhancement in inorganic phosphorus and decrease in calcium : phosphorus ratio in all the three groups have been observed within two week of the experiment. In prostaglandin F2α synchronized cycle calcium: phosphorus ratio increased markedly in normal ration goats at estrus although it was greater in all the groups compared to acclimation phase. The ratio elevated in calcium deficient at diestrus and it was maximum in all the three groups at early pregnancy compare to other phases.

Key words: Dwarf goat, dietary calcium, estrus cycle, serum calcium, serum phosphorus, pregnancy.

INTRODUCTION

Dietary factors affect various phases of reproduction (Rattray, 1977). The unavailability of balanced ration prior to a fertile cycle and then progressively during the cycle affects ovulation and fertilization; and both the anabolic and catabolic phases of the pregnancy (Vernon *et al.*, 1981). Calcium is one such factors, which plays vital role in the chemical balance, hormonal homeostasis and many other metabolic processes such as skeletal integrity (Adeloye and Akinsoyinu, 1984; Navch-Many and Justin, 1990), muscular contraction and relaxation, blood pressure regulation and many reproductive processes. Calcium in circulation is index of the inter-relationship of hormones like parathyroid hormone (PTH) and calcitonin (CT) (Furlanetto *et al.*, 1990).

The Ca^{2+} intake is important for preventing milk fever and there is an increased incidence of dystocia and retained placenta in cows with milk fever which reduced the first service and conception rate (Morrow *et al.*, 1980). Phosphorus concentration may not be of great significance directly, however, indirectly affect calcium regulatory mechanism. Phosphate withdrawal does not evoke an immediate response, but over several days serum phosphate concentration fall, leading to a rise in production of 1,25-dihydroxy-cholecalciferol and consequently increases in intestinal absorption of Ca^{2+}, raises serum calcium, suppresses PTH, decreases the renal clearance of phosphate and increases renal clearance of calcium (Rasmussen *et al.*, 1974).

Interdependence of Ca^{2+} and P is also well demonstrated in several works. Infusion of calcium into normal subjects have been reported to lower phosphate excretion (Chambers *et al.*, 1956; Nordin and Fraser, 1954; Chen and Neuman, 1955; Wallach

and Carter, 1961) whereas others observed enhancement in its excretion (Hiatt and Thompson, 1957; Pak, 1971; Spencer *et al.*, 1978; Greger *et al.*, 1981; Zemel and Linkswiler, 1981). A number of physiological interactions can occur when dietary levels and forms of protein, phosphorus, electrolytes and calcium are altered. Ward *et al.* (1972) concluded that supplementation of Ca^{2+} has better effect on reproductive performance of dairy cows. Supplemented minerals are most critical during the wet season when cattle are gaining weight rapidly and energy and protein supplies are adequate and the economic return on mineral supplementation is high (McDowell *et al.*, 1986). An extra calcium in diet is excreted through urine (Bailey, 1991), thus circulatory level remain within a range. Ca^{2+} and P retention was not increased by feeding these elements in excess of their estimated requirements and were reduced when Ca^{2+} and P or P alone are reduced proportionately to about 0.75 of the requirement (Zahari *et al.*, 1990).

In conventional farming, the goats form marginal lands receive reduced amount of calcium in grazing. Thus the present study was undertaken to investigate effects of dietary calcium contents on serum calcium and phosphorus in prostaglandin synchronized cycling and at early pregnant goats.

MATERIALS AND METHODS

Eighteen adult nanny goats which were not in any noticeable stage of pregnancy were selected from the herd maintained at the Bio-Saline Research Substation of Nuclear Institute for Agriculture and Biology at Lahore. These were divided into three categories of 6 goats in each group, and acclimatized for 15 days on their respective rations i.e., normal feed with 1% dicalcium phosphate (DPC), calcium deficient feed without DCP and calcium supplemented with 1% marble powder. The composition of calcium deficient base diet was cotton seed cakes 29%, wheat bran 20%, molasses 25%, rice polishing 20%, wheat straw cuttings 04%, urea 01% and common salt 01%.

The goats were given dry ration early in the morning and then allowed to graze in the fields for rest of the day and kept isolated from the males of the herd. The goats were synchronized for cycle with the injection of prostaglandin F2 (Estrumate, ICI, England). Two intramuscular injections at a concentration of 62.5μg Estrumate per goat at the spacing of 10 days were given. Estrus cycle was counted from second injection. Twenty five day after another Estrumate injection was given for the synchronization of fertile estrus and the pregnancy. Goats of all the three experimental groups were sampled for blood at a time during acclimation, synchronization and in cycle and early pregnancy.

Serum calcium level was determined with methylthymol blue method (Cheesbrough, 1981), where as serum inorganic phosphorus was estimated according to Zilversmit and Davis (1950) and Bogatzki (1938).

RESULTS

Serum calcium

The average serum Ca^{2+} level was 1.543 ± 0.165, 1.445 ± 0.181 and

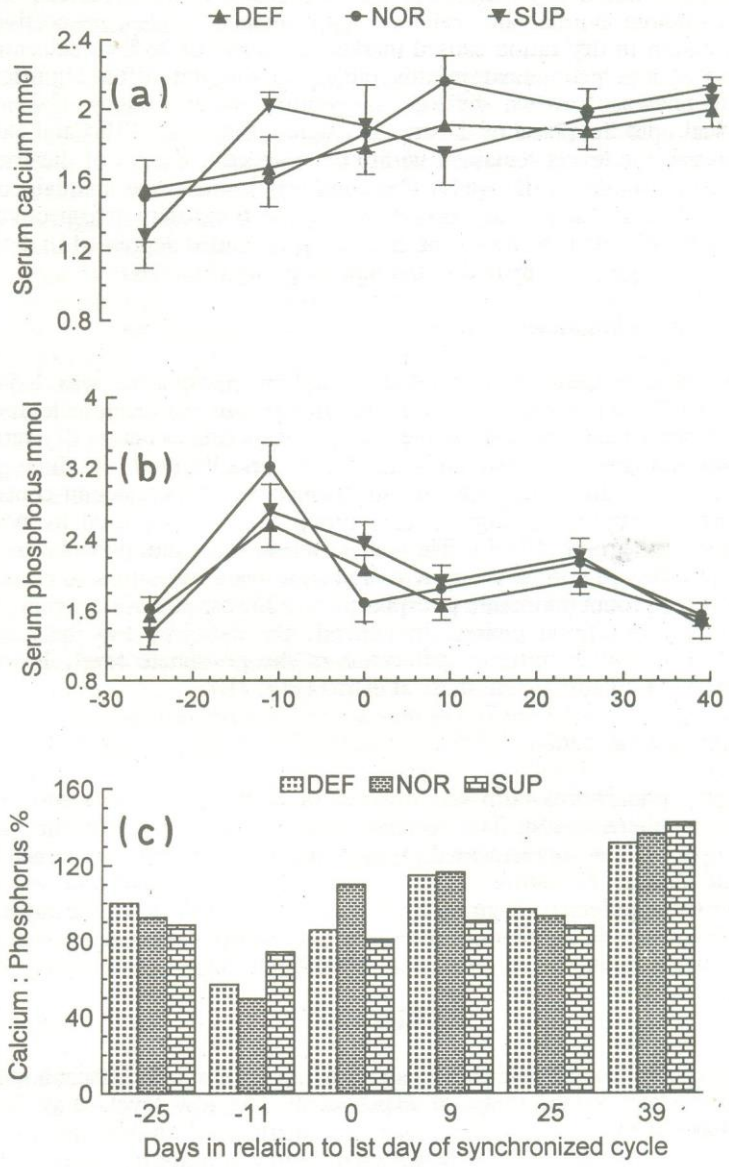

Fig. 1. Average serum calcium (a), phosphorus (b), and their ratio (c) in calcium deficient (DEF), normal (NOR) and supplemented (SUP) group during cycle and early pregnancy. Days 0, 9, 25 and 39 indicates estrus, diestrus, conception and early pregnancy respectively

1.281 ± 0.183 mmol at the onset of the experiment in the goats chosen for calcium deficient, calcium normal and calcium supplemented groups, respectively. Calcium supplementation in dry ration caused marked elevation of 76% in calcemia within two weeks and it was maintained in this range, as did not differ significantly, at the subsequent phases of estrus, diestrus, conception and pregnancy. Calcemia increases were gradual upto the phase of diestrus in calcium deficient (33%) and calcium normal (65%) groups, the levels remained within the respective ranges of diestrus calcemia at the subsequent phases of the study. Calcemia was found to be maintained in a limited range of levels at estrus, conception and early pregnancy irrespective of calcium availability in their diet, however, at diestrus, it remained depressed in deficient as well as supplemented group compared to the normal group (Fig. 1A).

Serum inorganic phosphorus

The average concentration of serum inorganic phosphorus was 1.546 ± 0.244, 1.623 ± 0.131 and 1.328 ± 0.17 mmol in calcium deficient, calcium normal and calcium supplemented group at the beginning of experiment before dry ration provision to the goats. Inorganic phosphotemia increased markedly in all the three groups within two weeks of dry ration supplementation irrespective of the calcium content in it. The increase was maximum in supplemented group (277%), followed by normal (237%) and the deficient group (191%). Thereafter, serum inorganic phosphorus was lowered markedly at estrus in normal group with non significant reductions in other groups also. In all the three groups inorganic phosphorus was lowest at early pregnancy compare to cycle and the conception phases. In general, the deficient and the supplementation group did not show significant difference in the phosphate level, however, normal group pattern was distinct from these at estrus (Fig. 1B).

Calcium phosphorus ratio

Calcium : phosphorus ratio was lowered in all the groups following two weeks of dry ration supplementation. The decrease was greater in the deficient and the normal group compare to the supplemented group. Thereafter, the ratio remained higher at the subsequent phases. At estrus it was maximum in the normal and was minimum at diestrus in the supplemented group among all the three groups. The ratio did not vary among the groups at conception and early pregnancy, however, it was maximum at early pregnancy among all the phases studied (Fig. 1C).

DISCUSSION

The goats have shown low calcemia and inorganic phosphotemia in non reproductive states at the onset of experiment. The low levels may be due to non cycling phase of the goats or these have been maintained on grazing only on the plant materials of salinity affected area which provide low availability calcium to the animals. The elevation of both circulating calcium as well as inorganic phosphate level during the acclimation phase on the dry rations with varying degree of calcium contents in general, reflect that supplementation may have been the cause of the minerals elevation. This response is certainly evident in calcium supplemented goats. In deficient and

normal groups, however, it is found that onset of cycling activity, perhaps, brings gradual increase in calcemia.

The significant lowering of calcemia in supplemented group is due to the consequent effects on parathyroid hormone (PTH) with the result of elevated serum calcium level. Aurbach *et al.*, (1985) have analyzed that rise in ionized calcium leads to suppression of PTH secretion with the consequent increased renal clearance of calcium and eventually brings low calcemia; also the suppression of PTH causes decreased clearance of phosphate thus raising the serum phosphate. To this view, the increase in inorganic phosphate in serum along the elevation in calcemia is well understsood. The response of phosphate increase is marked in normal compare to other groups. Again higher calcium concentration in normal group at estrous indicate the calcium supplementation more or less resemble to calcium deficient state in the maintenance of these minerals. Thus restoration of calcium to a normal level is more important for reproductive activity of the dwarf goat and excess dietary calcium is of no advantage in these mechanisms. Reddy and Reddy (1988) have observed that nitrogen, calcium and phosphorus balances were best with normal feeds. Because hormonal interaction of calcitonin (CT), parathyroid hormone (PTH) and vitamin D3 are most conclusive with normal proportion of calcium in diet.

The pattern of response in different cycling condition and early pregnancy resemble in all the three experimental groups of the study. It is found low calcium intake for short time apparently does not affect its production and may elevate resistance to calcium stress (Belyea *et al.*, 1976). Thus in reproductive activity in calcium deficient goats calcemia has been elevated through such mechanism.

In normal conditions elevated level of calcium mobilized by PTH reduces inorganic phosphate in circulation (Hiatt and Thompson, 1957). In hypoparathyroid subjects calcium infusion is accompained by an acute rise in serum phosphate (Eisenberg, 1965). The optimal elevation of serum calcium in cycling and early pregnancy and consistent lower phosphate, particularly at onset of pregnancy, evident from calcium : phosphorus ratio, reflect that increased PTH secretion is important at these phases.

In conclusion, restoration of normal calcium level in the diet of ruminants are necessary and extra supplementation may have adverse effects. Even in deficient state animal resist calcium deficiency through PTH mobilization.

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