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Effect of Parenteral Administration of Vitamin A in Late Pregnant Cows on Vitamin A Status of Neonatal Calves

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Abstract**—**To evaluate the effect of intramuscular administration of vitamin A in pregnant dairy cows during late stages of pregnancy, on vitamin A status of neonatal calves, a total of 30 cows were randomly selected and divided into three groups; two treatment groups and one control group. Single intramuscular injection of 2000000 IU vitamin A; was carried in 10 dairy cows at 7 months of pregnancy (group 1). In second group of treated animals (10 cows) the injection was performed in 8 months of pregnancy (group 2). Ten pregnant dairy cows were received saline injection as placebo and selected as control group. Blood samples were collected from experimental dairy cows at 7 and 8 months of pregnancy as well as their newborn calves' pre and after colostrum intake. There was no significant difference between vitamin A and β-carotene concentration of dairy cows of three groups in two last months of pregnancy ($P > 0.05$). Vitamin A concentration of calves of two treatment groups before and after receiving of colostrum were significantly higher than that in control group ($P < 0.05$). There was no significant difference between serum concentrations of vitamin A in calves of two treated groups ($P > 0.05$). β-Carotene concentration of serum samples of dairy cows and neonatal calves of three groups were not significantly different as compared with together. From results of the present study it can be concluded that single injection of vitamin A during at 7 or 8 month of pregnancy can significantly increase level of vitamin A in their colostrum and neonatal calves.

Keywords**—**Dry cow, Beta-carotene, Newborn calves, Vitamin A.

I. Introduction

VITAMIN is the general term for a variety of substances including retinol, retinal, retinoic acid, retinyl esters as well as provitamin A carotenoid such as β-carotene. Retinol and its derivatives are only found in animal tissues whereas β-carotene is principally found in plants [1]. Vitamin A is a fat soluble nutrient which is involved in numerous essential life processes. It has an important role in vision, reproduction, immunity, cell differentiation and growth and development [2]. More specifically, it is of utmost importance to allow successful gestation and proper offspring development [3]. Vitamin A is also essential for the development and good functioning of the immune system. Among ruminants, only bovines accumulate high concentrations of carotenoids, mainly β-carotene, possibly due to lower Vitamin A synthesis efficiencies in enterocytes. Vitamin A deficiency may induce fetal resorption, stillbirth and malformation [3]. Cattles do not ingest vitamin A naturally but produce it from provitamins contained mostly in green food. β -carotene, converted mostly in the mucosa of small intestine to vitamin A, appears to be the most efficient provitamin [4], or have absorbed insufficient colostral immunoglobulins, thus rendering them highly susceptible [5]. Primary vitamin A deficiency is of major economic importance in groups of young animals on pasture or fed diets deficient in the vitamin or its precursor. It especially occurs in beef cattle and sheep on dry range pasture during periods of drought. Secondary vitamin A deficiency may occur in case of chronic diseases of liver or intestine, presence of highly chlorinated naphthalene in diet, low phosphate diets, high environmental temperature, increased amount of nitrate in the feed, and continued ingestion of mineral oil. The addition of vitamin A supplements to diet may not always be sufficient to prevent deficiency. Carotene and vitamin A are readily oxidized, particularly in the presence of unsaturated fatty acids. Heat, light, and mineral mixes are known to increase the rate of destruction of vitamin A supplement in commercial rations. In one study, 47- 92% of the vitamin A in several mineral supplements was destroyed after 1 week of exposure to the trace minerals, high relative humidity, sunlight and warm temperature [6]. Supplementation of vitamin A to feed may not always be sufficient to prevent its deficiency in cows and their newborn calves, because destruction of carotene and vitamin A in commercial rations is a very common occurrence. The present study has been conducted to evaluate the effect of parenteral administration of vitamin A in pregnant dairy cows at two different times before parturition on serum β-carotene and vitamin A concentration of their newborn calves.

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II. Materials And Methods

To determine the effect of parenteral administration of vitamin A in late pregnancy in dairy cows on serum vitamin A concentration of new born calves a total of 30 Holstein-Friesian dairy cows in advanced pregnancy with an average body weight of 550± 30 kg and three to six parity were randomly selected from an industrial dairy farm. Selected pregnant dairy cows were randomly allocated to three main groups, group 1, group 2 and control group. Animals of the first group (group 1) were administered with vitamin A intramuscularly at 210 days of pregnancy, as soon as they transferred to far off stall. Dairy cows in second group (group 2) were received single injection of vitamin A when they moved to close up, almost a month prior to expected calving date. Animals in control group received normal saline injection as placebo at 7th and 8th month of pregnancy and did not inject with any vitamins during pregnancy. The total amount of vitamin A, which has been injected to animals in group 1 and 2, consisted of 2,000,000 IU vitamin A as palmitate per dose. These animals received their daily diet as total mixed ration (TMR). Jugular blood samples were taken from dairy cows two times before parturition, first collection was carried out at 7 month of pregnancy in the far off stall and second one was occurred at 8 month of pregnancy when they entered the close up stall.

Calves born from experimental dairy cows were weighed at birth, separated from the dams and housed in individual pens. Each calf received fresh colostrum from their dam equal to 6-10 percent of their live body weight in the first 6 hours of life and again 2 kg after 12 hours of birth. During next two days each calf was nourished with dam's colostrum and milk. Blood samples (15 ml) were collected via jugular puncture into nonheparinized evacuated tubes from newborn calves prior to the colostrum feeding and later on, two days after birth. The concentration of vitamin A and β- carotene in sera of dairy cows and new- born calves were measured according to [7].

Mean values of vitamin A and β-carotene were analysed by using Student's t-test, and a value of $P< 0.05$ was considered to be significant.

III. Results

The mean values of neonatal calves' body weight at birth in experimental groups were shown in Table I. Statistical analysis did not show any significant difference between mean body weights of newborn calves in three groups ($P> 0.05$). Table II shows the mean values of vitamin A and β- carotene concentrations in experimental cattle of three groups in last two months of pregnancy. Serum vitamin A and β- carotene concentrations of dairy cows of control groups during 7 and 8 month of pregnancy did not significantly different as compared with cows in injected groups (group 1 and 2) ($P> 0.05$). Mean values of serum vitamin A and β- carotene for dairy cows in group 1 during two last months of pregnancy were also not significantly different as compared with those in cows in group 2. Table III shows the mean serum concentration of vitamin A in newborn calves of three mentioned groups prior and 2 days after colostrum feeding. The serum vitamin A concentration of calves in control group prior to colostrum feeding (35.5± 14.5 µg/dl) was significantly lower than those in calves of group 1 (90.6± 30.1 µg/dl) and group 2 (93.1± 39.2 µg/dl) ($P< 0.05$). The corresponding average vitamin A values two days after birth were 62.5± 22.0 µg/dl for calves of control group, 120.3± 32.8 µg/dl for calves of group 1 and 118.3± 42.2 µg/dl for calves of group 2. Statistical analysis for mean values showed a significant increase in vitamin A concentration in sera of calves of treatment groups two days after birth as compared with that in control groups ($P< 0.05$). Serum vitamin A concentration of calves in group 1 before receiving colostrum and two days after birth was not significantly different with serum vitamin A concentration of calves in group 2 for the mentioned times. The β-carotene levels in sera of calves in the present study are shown in Table IV. Statistical analysis did not show any significant difference between serum β-carotene concentrations of calves in three different groups

TABLE I
Body Weight (kg) at Birth in Calves of Three Different Groups (Mean± SE)

Group	Body weight
Control	42.6± 2.3
Group 1	45.4± 1.7
Group 2	43.5± 2.2

TABLE II
Mean Values of Vitamin A (µg/dl) and B- Carotene (µg/dl) Concentration in Serum of Dairy Cows of Three Different Groups during Last Two Month of Pregnancy (Mean± SE)

	Seven month of pregnancy		Eight month of pregnancy	
	Vitamin A	β- carotene	Vitamin A	β- carotene
Control	53.7± 34.0	74.8± 11.9	132.3± 27.2	88.3± 11.0
Group 1	51.1± 21.0	90.2± 17.9	120.8± 35.6	86.6± 41.2
Group 2	61.5± 22.5	88.4± 16.3	114.3± 28.5	84.3± 21.7

TABLE III
Mean Values of Vitamin A (µg/dl) Concentration in Serum of Neonatal Calves of Three Different Groups Prior and After Colostrum Feeding (Mean± SE).

	Before colostrum feeding	Two days after colostrum feeding
Control	35.5± 14.5	62.5± 22.0
Group 1	90.6± 30.1[a]	120.3± 32.8[b]
Group 2	93.1± 39.2[a]	118.3± 42.2[b]

[a,b] Significantly different ($P< 0.05$)

TABLE IV
Mean Values of B-carotene (µg/dl) Concentration in Serum of Neonatal Calves of Three Different Groups Prior and After Colostrum Feeding (Mean± SE).

	Before colostrum feeding	Two days after colostrum feeding
Control	4.2 ± 1.8	5.5± 1.5
Group 1	9.7± 11.5	8.1± 3.2
Group 2	6.4± 3.1	10.1± 4.0

IV. Discussion

Newborn calves have low levels and stores of vitamin A and carotene which is due to considerably limited permeability of syndesmochorial placenta for these substances. It has been showed that colostrum is the only source of vitamin A and carotene in early postnatal period of calf life. The amount of vitamin A and carotene of colostrum is influenced by the diet, season, breed and by individual differences. Researchers found in the first colostrum in winter season 1170 international units (IU) of vitamin A/100 mI (dL), in summer season 1890 IU/dL. Similar data were also reported by some researchers, although others obtained lower vitamin A concentration [1]. A significant rise in vitamin A level in colostrum appeared after several weeks of administration of 70 000 IU of vitamin A (per day and cow). During the last weeks of pregnancy, a significant decrease in plasma vitamin A levels occurs, this being probably due to the utilization of vitamin by dam organism in order to ensure an abundant intake of this substance of vital importance to a calf [5].

In most animal species under normal conditions the vitamin A level in blood plasma is about 30 μg/dL. Generally, plasma vitamin A concentration below 10 μg /dL are regarded as being very low, 10-19 μg /dL as low and the range of 20-50 μg /dL as reasonable [8].

With regard to the results shown in Table III in the present study, it can be observed that the mean serum concentration of vitamin A in dairy cows of three groups in seven month of pregnancy is in normal range and in accordance with normal reference values reported for cattle [8]. But as it shown in Table III, there is a significant increase in the mean serum concentration of vitamin A in experimental dairy cows at eight month of pregnancy which is the result of administration of vitamin A as supplement in their daily feed, and parenteral administration in cows of two groups (group1 and 2). However, the intramuscular injection of vitamin A in pregnant dairy cows of group 1 and 2, which is carried out in seven and eight month of pregnancy respectively, did not significantly increased the vitamin A levels of sera of these groups as compared with dairy cows in the control group ($P > 0.05$).

Plasma carotene levels vary largely with the diet. In cattle, levels of 150 μg/dL are optimum, and in the absence of supplementary vitamin A in the ration, clinical signs will appear when the levels fall to 9 μg/dL [5]. As it is shown in Table IV, the serum β- carotene concentration of dairy cows of three different groups in two last months of pregnancy was significantly lower than optimum level defined for cattle, which is due to type of ration and not using greens in their daily feed.

In normal calves after colostral nutrition the vitamin A concentration in liver is 10-50 μg /l g of tissue, in blood plasma over 25 μg /dL [4]. It has been found that the vitamin A concentration does not drop below 25 μg /dL in blood plasma, assuming that its reserve is sufficiently high.

The effect of prepartum supplementation of 1 million IU of vitamin A in the forms of ester, alcohol, and dehydrated alfalfa leaf meal on the health and performance of the young calf was studied by researchers. They found that plasma carotene levels in calves from dams fed the alcohol form of vitamin A during the experimental period were significantly higher than calves from dams in the other dietary groupings. Also, calves from dams receiving the ester form of vitamin A had significantly higher plasma carotene than calves from dams fed alfalfa leaf meal. Plasma of calves from cows fed vitamin A as either ester or alcohol was significantly higher in vitamin A than that of calves from the basal dams or those fed alfalfa leaf meal. Greater liveweight increases were observed in calves from dams fed either form of vitamin A than in calves from dams fed the basal ration alone or with alfalfa leaf meal. There were no statistical differences in feed consumption. Incidence of scours was significantly lower in calves from dams fed either form of vitamin A than that observed in calves from control dams. Calves from dams fed alfalfa leaf meal had fewer cases of scours than calves from control dams [2].

Plasma vitamin A status in calves fed colostrum from cows that were supplemented with vitamin A during late pregnancy were studied. The supplementation of vitamin A in cows during late gestation (dry period) increased cow plasma retinol concentrations, the retinol content of first colostrum, and the plasma vitamin A status of calves during their first month of life. Plasma and colostrum retinol concentrations were higher in vitamin A supplemented cows than in non-supplemented cows. In calves that were for 5 days fed colostrum (milk) from vitamin A-supplemented cows and then mature milk, plasma retinol concentrations were higher from 14 to 30 days after birth than in calves that were fed colostrum (milk) from cows that were not vitamin A supplemented.

The mean values of serum vitamin A and β- carotene concentration of newborn calves before and two days after colostrum feeding in the present study showed in Tables III and IV. As it appeared in Table III, the serum level of vitamin A in calves of three different groups prior receiving colostrum is high, which is due to administration of vitamin A in daily feed of their dam. The serum vitamin A concentration of calves of group 1 and 2 was significantly higher than those in control group ($P < 0.05$). Parenteral administration of vitamin A in dairy cows, which previously received it in their daily feed, during last two months of pregnancy significantly increased the serum vitamin A level of newborn calves at birth and before colostrum intake. Results of the present study showed that serum vitamin A concentration of calves in group 1 and 2 two days after colostrum feeding were significantly higher as compared with that in control group ($P < 0.01$).

Average β-carotene level of calves of three different groups in the present study was shown in Table IV. As it can be seen, the β- carotene concentration in sera of calves of control group (4.2 ± 1.8) was not significantly different from those that in group 1 (9.7± 11.5) and group 2 (6.4± 3.1). Determination of β- carotene concentration in serum samples of calves after taking colostrum in the present study showed that there is no recognizable increase in β-carotene, and the difference between three different groups was not statistically significant. Since the dairy cows in the present study did not receive any green roughage during the period of study the β-carotene concentration of dairy cows and their calves were too low and lower than normal values reported for cattle [5].

Prepartum supplementation of vitamin A increased body weight of newborn calves at birth. Scientists reported that supplementation of 1 million IU vitamin A daily for 30 days prior to the calculated date of parturition to dams ration did not significantly increase calves liveweight [2]. Intramuscular administration of vitamins A, D3 and E (consisting of 2500000 IU vitamin A as palmitate, 2500000 IU vitamin D3 and 1000 IU vitamin E as DL- α tocopherol acetate) two times with 15 days' interval in pregnant buffaloes during last two months of pregnancy did not increased the body weight of calves at birth. But calves born from treated buffaloes had higher body weight gain during days after birth than those not treated [5].

As it is shown in Table III, the live bodyweight of newborn calves in the present study was not significantly different between three groups and administration of vitamin A to pregnant dairy dams either at 7 or 8 months of pregnancy could not significantly increased the bodyweight of newborn calves at birth. The increasing effect of prepartum supplementation of vitamin A in daily feed on body weight of newborn calves at birth is shown by [3]; however, in some other studies there was not significant increase in body weight of calves at birth in supplemented as compared to no supplemented dams [2]. In the present study the pregnant dairy cows of three groups received the vitamin A in their daily feed during dry period which is different with another study which cows in control group did not supplemented with dietary vitamin A.

From the results of the present study it can be concluded that single injection of vitamin A at 7 or 8 month of pregnancy in dairy cows, significantly increases serum vitamin A concentration of their neonatal calves immediately after birth before colostrum intake and also after colostrum intake. This increasing effect may support colostrum deprived calf and maintain calf needs for this vitamin in their early life.

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