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EFFECT OF EXTENDED COLOSTRUM FEEDING ON THE PLASMA PROFILE OF INSULIN, THYROID HORMONES AND BLOOD GLUCOSE OF CROSSBRED PRE-RUMINANT CALVES

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Abstract : In the present study, the effect of extended colostrum feeding on certain physiological and endocrinological parameters of pre-ruminant crossbred calves from birth to one month of age was investigated. Estimation of blood glucose level, plasma concentration of anabolic hormones as thyroid hormones and insulin were performed and compared with control calves (G-I) which were fed with colostrum for the first three days of age and thereafter with the whole milk, till 30 days of age. There was steady increase in the blood glucose level (BGL) from birth to one month of age in both groups of calves, with the rise being slightly higher in the calves of G-II group, which is attributed to the action of glucagon by gluconeogenesis especially in the neonates. Intake and absorption of increased amounts of dietary proteins and amino acids in colostrum stimulated a significant increase in the plasma insulin concentration in G-II calves compared to G-I calves, over and above the accelerated tissue development of pancreas. Fluctuating levels of thyroid hormones in plasma of calves of both the groups suggested that the concentration of thyroid hormones were not influenced either by extended colostrum or whole milk feeding in calves, but rather followed a diurnal rhythm.

Key words : colostrum extended feeding blood glucose level insulin thyroid hormones calves

INTRODUCTION

Bovine colostrum is the first lacteal secretion which is fortified with nutrients and bioactive factors such as insulin like growth factors and hormones like insulin and prolactin as pointed out by (1). Components of colostrum influence immune status, metabolism, and endocrine systems in newborn animals (2). Nutrition during neonatal period can have influence later on in life. It is estimated that cows produce about 40% extra colostrum than required for their own calves. Since colostrum is unfit for sale, it is often encountered that this protein-rich nutritious food is wasted or

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under utilised in farm and field conditions. Hence this extra colostrum can be preserved and used as a protein rich feed to pre-ruminant calves for 30 days of age. The maximum use of available colostrum in calf feeding programme should be adopted to provide better growth rate and health status of calves (3). According to (4), colostrum intake allows the establishment of an anabolic state of metabolism. Therefore, the present study was taken up in order to evaluate and correlate the effects of enhanced colostrum feeding on the blood glucose level (BGL) and release of anabolic hormones as insulin and thyroid hormones in pre-ruminant calves.

MATERIALS AND METHODS

Colostrum collection and Animals

Around 700 kg of colostrum was collected from the healthy crossbred cows of University Livestock Farm, College of Veterinary & Animal Sciences, Mannuthy, starting ahead of the period of study and preserved in air tight sterile bottles at –20°C. Twelve numbers of clinically healthy calves of either sex were selected and divided into two groups, group I (control) and group II (experimental) with equal number of both sexes.

Experimental treatments

Calves of group I (G-I) and II (G-II) were fed fresh colostrum (1/10th of the body weight) in feeding pail twice daily for the first three days. Thereafter, calves of group I were fed with whole milk (1/10th of bodyweight) twice daily as under standard farm managemental conditions for 30 days of age, whereas thawed colostrum was fed (1/10th of body weight) to the calves of group II till 30 days of age. Calf starter (@100 g/day/calf) from 14 days of age and water *(ad libitum)* were provided to all the calves.

Collection of blood and plasma separation

From all animals of Group I and II, blood samples were collected with anticoagulant by jugular *venepuncture,* immediately after birth (within 10 min; before first colostrum feeding) and repeated on day 1 *(18 hours after birth),* 6, 12, 18, 24 and 30 and plasma was separated.

Estimation of blood glucose

Blood glucose level (BGL) was estimated by glucose oxidase-peroxidase method (GOD-POD method), as suggested by (5) using Ecoline® kit (M/S E. Merck (India) Limited, Mumbai).

Hormonal assay – Insulin and thyroid hormones

The plasma concentrations of insulin and thyroid hormones viz thyroxine (T_4) and triiodothyronine (T_3) were estimated using radioimmunoassay using kits of Diasorin, Saluggia, Italy and Minnesota, USA respectively and calculated the T_4: T_3 ratio.

Statistical analysis

All the data were statistically analysed (6). All values are presented as mean±s.d. Comparisons between two independent sets of data was performed with unpaired Student's t test. The criterion for significance was set at $P<0.05$. Inter and intra assay coefficients of variation while determining the above mentioned parameters were found to be less than 10 percent.

RESULTS

1. Blood glucose level (BGL)

Tables I and II and Fig. 1 shows blood glucose levels of the two groups of calves. In the control animals of G-I group, BGL increased steadily from the lowest value (102.001±15.99 mg/dl) observed immediately after birth (zero day) and reached a peak value of (137.33±38.35 mg/dl) on 30th day of age. The experimental calves of G-II group

TABLE I: Effect of continued feeding of colostrum and milk on blood glucose level, plasma concentration of insulin and thyroid hormones and T_4 : T_3 ratio of pre-ruminant crossbred calves for a period of 30 days, Mean±SD (n=6 per group).

Age in Days	*Glucose (mg/dl)*		*Insulin (μU/ml)*		*Thyroxine (T_4) (ng/ml)*		*Triiodothyronine (T_3)(ng/ml)*		*T_4 : T_3 ratio*	
	GpI	*GpII*	*GpI*	*GpII*	*GpI*	*GpII*	*GpI*	*GpII*	*GpI*	*GpII*
0	102.00± ^{x}15.99^{abcde}	111.17± ^{x}15.48^{abcde}	11.17± ^{x}2.89^{adef}	13.79± ^{x}3.77^{ab}	64.79± ^{x}19.66^{acdefg}	69.09± ^{x}9.999^{a}	2.58± ^{x}0.18^{a}	2.30± ^{x}0.11^{ab}	25.04± ^{x}7.86^{acd}	30.21± ^{x}5.19^{cfjno}
1	119.17± ^{x}11.70^{chlors}	118.83± ^{x}16.77^{afghij}	24.01± ^{x}3.50^{j}	28.51± ^{x}2.90^{f}	69.12± ^{x}9.65^{aab}	71.79± ^{x}10.68^{a}	2.47± ^{x}0.21^{a}	2.48± ^{x}0.20^{a}	23.95± ^{x}3.93^{ab}	29.20± ^{x}5.20^{aefghi}
6	119.00± ^{x}4.86^{glcopq}	12.50± ^{x}26.21^{bfklmn}	23.65± ^{x}2.73^{j}	24.17± ^{x}4.24^{bef}	55.84± ^{x}11.64^{bch}	49.60± ^{x}2.28	1.52± ^{x}0.17^{b}	1.62± ^{x}0.23^{bcd}	37.52± ^{x}10.51^{ehij}	31.06± ^{x}4.48^{bgknpr}
12	114.83± ^{x}35.81^{afghij}	129.00± ^{x}18.99^{cgkopq}	13.73± ^{x}3.80^{cfhi}	18.43± ^{y}2.90^{c}	45.60± ^{x}3.44^{di}	44.67± ^{x}2.51	0.99± ^{x}0.17^{egh}	1.54± ^{y}0.20^{gh}	47.07± ^{x}8.35^{jlm}	29.40± ^{y}3.67^{bejklm}
18	115.33± ^{x}36.35^{bfklmn}	136.67± ^{x}22.27^{dhlors}	13.60± ^{x}4.26^{begi}	11.44± ^{x}1.89^{a}	44.45± ^{x}2.17^{ehijk}	41.31± ^{x}2.91	1.11± ^{x}0.23^{dfh}	1.81± ^{x}0.26^{fh}	41.35± ^{x}8.13^{gikm}	37.67± ^{x}7.79^{imqr}
24	125.33± ^{x}23.84^{dimprt}	140.67± ^{x}24.15^{imprt}	10.06± ^{x}1.88^{abc}	15.98± ^{y}2.43^{bcd}	40.37± ^{x}3.01^{gkl}	40.24± ^{x}2.19^{b}	1.16± ^{x}0.41^{bcfg}	1.24± ^{x}0.21^{defg}	39.49± ^{x}17.18^{bdfhkl}	33.01± ^{x}4.65^{hlopr}
30	137.33± ^{x}38.35^{ejnqst}	140.50± ^{x}23.24^{ejnqst}	13.20± ^{x}2.59^{dgh}	24.04± ^{y}2.84^{e}	41.27± ^{x}3.37^{fgl}	43.09± ^{x}1.75	1.22± ^{x}0.22^{cde}	1.54± ^{y}0.21^{ce}	^{x}35.09± 8.94^{cefg}	^{x}28.29± 2.90^{abcd}

Mean±Standard Deviations (between periods) in columns bearing same superscripts (a,b,c,d,e....t) for each parameter are homogenous.

Mean±Standard Deviations (between groups) in rows bearing same superscripts (x,y) for each parameter differ significantly ($P<0.05$).

TABLE II: Effect of continued feeding of colostrum and milk on blood glucose, plasma insulin, plasma thyroid hormones and T_4 : T_3 ratio of pre-ruminant crossbred calves for a period of 30 days, Mean±SD (n=6 per group).

Sampling period	*Glucose (mg/dl)*		*Insulin (μU/ml)*		*Thyroxine (T_4) (ng/ml)*		*Triiodothyronine (T_3)(ng/ml)*		*T_4 : T_3 ratio*	
	GpI	*GpII*	*GpI*	*GpII*	*GpI*	*GpII*	*GpI*	*GpII*	*GpI*	*GpII*
Before the start of the experiment (0d)	102.00± 15.99^{a}	111.17± 15.48^{a}	11.17± 2.89^{a}	13.79± 3.77^{a}	64.79± 19.66^{a}	69.09± 9.99^{a}	2.58± 0.18^{a}	2.30± 0.11^{a}	25.04± 7.86^{a}	30.21± 5.19^{a}
18h after the start of the experiment (0d)	119.17± 11.70^{a}	118.83± 16.77^{a}	24.01± 3.50^{b}	28.51± 2.90^{b}	69.12± 9.65^{a}	71.79± 10.68^{a}	2.47± 0.21^{a}	2.48± 0.20^{a}	23.95± 3.93^{ab}	29.20± 5.20^{a}
At the end of the experiment (30d)	137.33± 38.35^{a}	140.50± 23.24^{a}	13.20± 2.59^{a}	24.04± 2.84^{b}	41.27± 3.37^{b}	43.09± 1.75^{b}	1.22± 0.22^{b}	1.54± 0.21^{b}	35.09± 8.94^{ac}	28.29± 2.90^{a}

Mean±Standard Deviations (between periods) in columns bearing different superscripts for each parameter differ significantly ($P<0.05$).

followed a similar trend with least value (111.17±15.48 mg/dl) recorded soon after birth (zero day) and the peak value (140.67±24.15 mg/dl) on 24th day of age and maintained almost the same level. There was no significant difference in the BGL of the two groups at any of the period of study (Tables I, II and Fig. 1).

2. Plasma Insulin concentration

Plasma insulin concentration of G-I and G-II calves are presented in Tables I and II and Fig. 1. Plasma concentration of insulin in the control animals of G-I group exhibited a fluctuating trend with the highest value (24.01±3.5 µU/ml) recorded at 18 h after birth (first day) and the lowest value (10.06±1.88 µU/ml) on 24th day of age, corresponding to the increase in blood glucose level. Experimental calves of G-II, which were fed colostrum for 30 days of age also showed a similar fluctuating trend with the lowest value recorded (13.79±3.77 µU/ml) soon after birth and the peak value (28.51±2.90 µU/ml) obtained 18 h after birth (first day) which further got reduced and then increased to a value of 24.04±2.84 µU/ml by the end of the experiment.

While analysing values from zero to 30 days of age of the two groups, it was observed that the values recorded for calves of G-I group on 12th day (13.73±3.80 µU/ml). 24th day (10.06±1.88 µU/ml) and 30th day of age (13.20±2.59 µU/ml) were significantly ($P<0.05$) lower than the corresponding values of G-II calves during

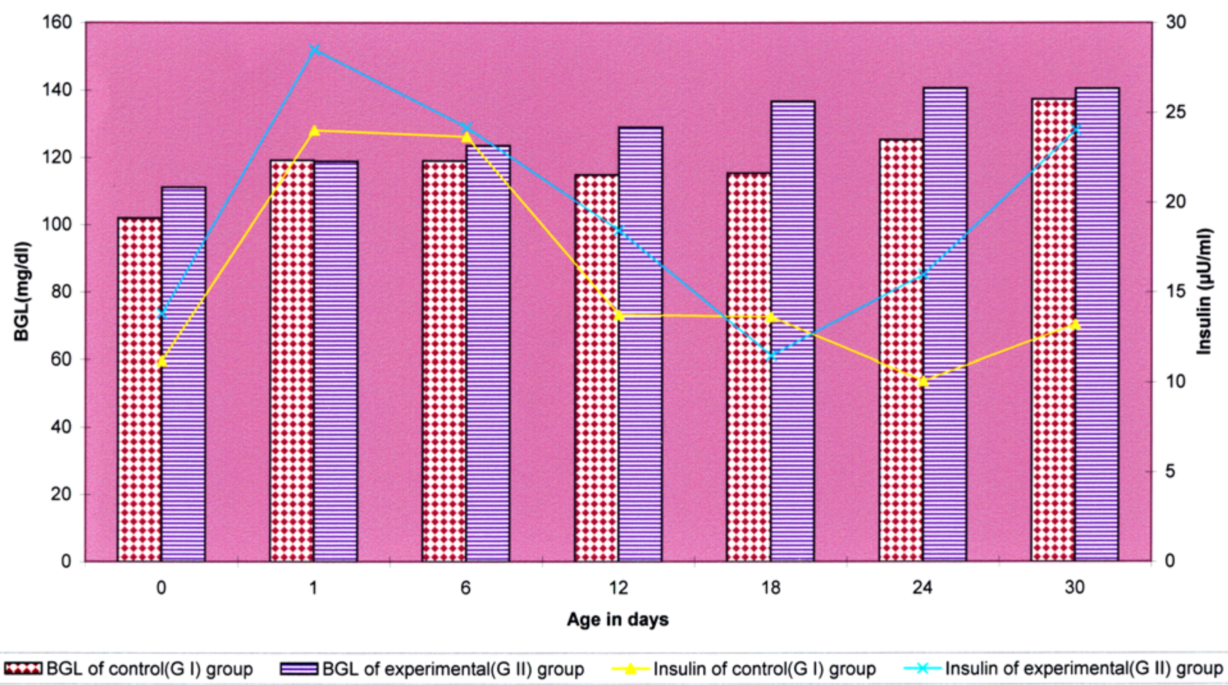

Fig. 1: Effect of continued feeding of colostrum and milk on blood glucose and plasma insulin of pre-ruminant crossbred calves for a period of 30 days.
Bar graph comparing blood glucose levels (BGL) and plasma insulin of group I and II calves during the experimental period of 30 days (n=6 per group); with Age in days plotted in the X-axis.

the same period. The corresponding values were 18.43±2.90 μU/ml, 15.98±2.43 μU/ml and 24.04±2.84 μU/ml respectively (Table-I). Calves of both control (G-I) and experimental (G-II) groups had significantly ($P<0.05$) highest values (24.01±3.50 μU/ml and 28.51±2.90 μU/ml respectively) on the first day (18 h after birth) than the values recorded soon after birth (11.17±2.89 μU/ml and 13.79±3.77 μU/ml respectively) vide Tables I and II and Fig. 1.

3. Plasma concentration of Thyroid hormone

a. Thyroxine (T_4)

Plasma concentration of thyroxine (T_4) of the control animals of group G-I declined steadily from the highest value (69.12±9.65 ng/ml) recorded 18 h after birth (first day) to the lowest value (40.37±3.01 ng/ml) on 24th day of age. The calves of experimental group (G-II) also followed a similar trend with the peak value (71.79±10.68 ng/ml) 18h after birth (first day) and the lowest value (40.24±2.19 ng/ml) on 24th day of age (Table-I and Fig. 2). On comparing the serum T_4 concentrations of both groups, there was no significant variation between them (Table-I and Fig. 2).

In the control animals of G-I, the plasma concentration of T_4 (41.27±3.37 ng/ml) was observed on 30th day of age was significantly ($P<0.05$) lower than the value (64.79±19.66 ng/ml) recorded immediately after birth (zero day) as well as the value (69.12±9.65 ng/ml) observed 18h after birth (first day). The

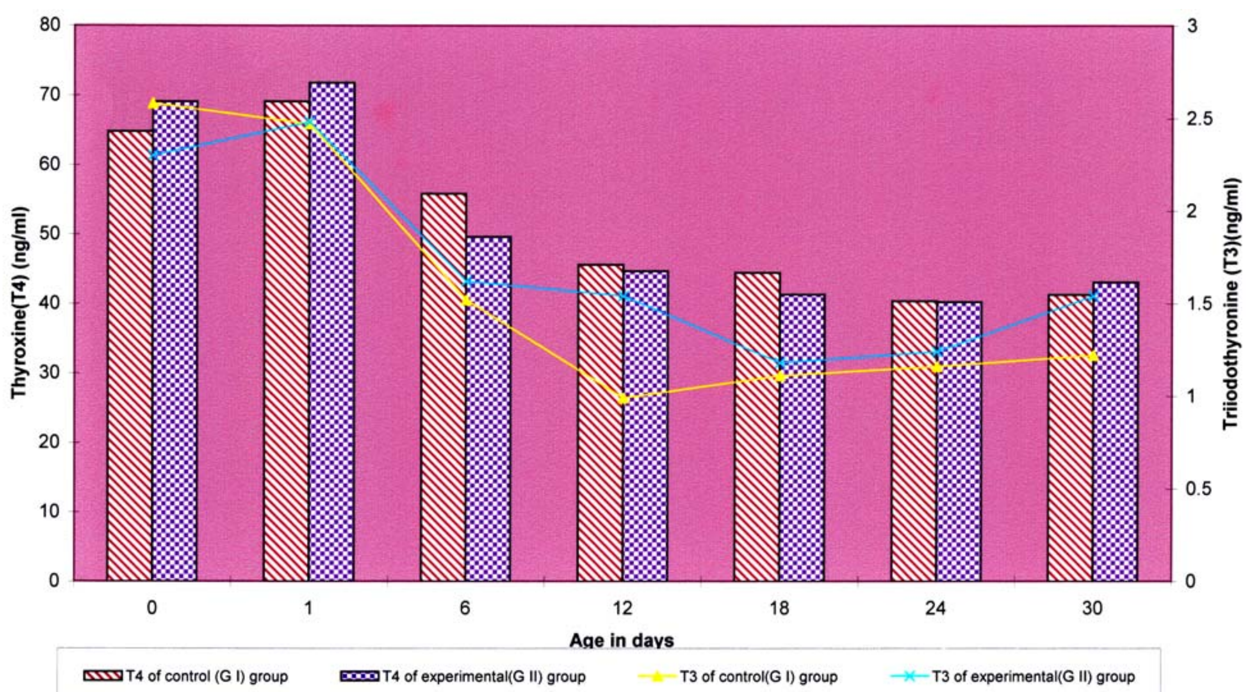

Fig. 2: Effect of continued feeding of colostrum and milk on plasma thyroxine and triiodothyronine concentrations of pre-ruminant crossbred calves for a period of 30 days.
Bar graph comparing plasma T_3 and T_4 of group I and II calves during the experimental period of 30 days (n=6 per group); with Age in days plotted in the X-axis.

experimental calves of group-II also showed significant ($P<0.05$) variations in the concentrations of T_4 recorded immediately after birth (69.09±9.99 ng/ml) and the value at first day of age by 18 h after birth (71.79±10.68 ng/ml) when compared to the value (43.09±1.75 ng/ml), observed on 30th day of age (Table II and Fig. 2).

b. Triiodothyronine (T_3)

Plasma T_3 concentration in the control group of animals of G-I showed a fluctuating trend with the peak value (2.58±0.18 ng/ml) recorded soon after birth and the value declined to the lowest value (0.99±0.17 ng/ml) on 12th day of age, which further increased till the end of the experiment. The experimental calves of G-II showed a similar fluctuating trend with the highest value (2.30±0.11 ng/ml) recorded immediately after birth (zero day) and the lowest value (1.18±0.26 ng/ml) on 18th day of age (Table I and Fig. 2).

While analyzing the values from zero to 30 days of age of the two groups, it was observed that the values obtained on 12th day (0.99±0.17 ng/ml) and 30th day of age (1.22±0.22 ng/ml) for the calves of G-I were significantly ($P<0.05$) lower than the corresponding values of G-II calves. The values of G-II calves on 12th day and 30th day were 1.54±0.20 ng/ml and 1.54±0.21 ng/ml respectively (Table I and Fig. 2).

G-I and G-II animals showed a significant ($P<0.05$) variation in the plasma T_3 concentration when the value (1.22±0.22 ng/ml) of the G-I calves recorded on 30th day of age was compared with the value (2.58±0.18 ng/ml) recorded soon after birth (zero day) and the value (2.47±0.21 ng/ml) obtained 18 h after birth (first day). The animals of G-II group had significant ($P<0.05$) variations in the level of T_3 at different days after birth, with the lowest value observed on 30th day of age (1.54±0.21 ng/ml) compared to both zero day (2.30±0.11 ng/ml) and first day, observed 18 h after birth (2.48±0.20 ng/ml) vide Table II.

c. T_4 : T_3 ratio

In the control animals of G-I group, T_4: T_3 ratio showed a fluctuating trend starting with the lowest value (23.95±3.93) recorded 18h after birth (first day) which increased to the peak level (47.07±8.35) on 12th day of age and further declined by the 30th day of age. The experimental calves of G-II group showed a peak value (37.67±7.79) on 18th day of age and lowest value (28.29±2.90) recorded on 30th day of age (Table I and Fig. 2).

On comparing T_4: T_3 ratio between the two groups, there was significant ($P<0.05$) variation between the values of the two groups recorded, especially on 12th day of age and the values of calves of G-I and G-II were 47.07±8.35 and 29.40±3.67 respectively (Table I and Fig. 2).

In the calves of G-I group, the values of T_4: T_3 ratio recorded at the end of the experiment (30th day of age) was significantly ($P<0.05$) higher (35.09±8.94) than the value (23.95±3.93) obtained on 18h after birth (first day of age). Whereas in the animals of G-II, none of the three values showed any significant variation (Table II).

DISCUSSION

1. Blood glucose level (BGL)

In our study we reported a transient rise in BGL in both groups of calves, immediately after birth, which later continued till one month of age, which can be attributed to the adrenal response to the stressors of birth and the postnatal environment (7, 8). Increase in BGL, could also be due to the action of glucagon by gluconeogenesis especially in the neonates which were under extended colostrum intake (9). Moreover, the stimulation of small intestinal lactase activity by ingested colostrum and the consequent lactose digestion and absorption of glucose and galactose enhanced BGL in neonatal calves (9, 10)}. We have observed that glucose concentrations at birth were low, and increased after feed intake, as pointed out in other studies on colostrum - fed calves (1, 11, 12, 13). Enhanced feeding intensity in G-II than in G-I did not influence plasma glucose concentrations, indicating that glucose homeostasis was maintained irrespective of the feeding schedule.

2. Plasma Insulin concentration

We observed a greater insulin response in colostrum fed calves, since plasma insulin concentrations depend on amounts of ingested colostrum (11). The enhanced insulin secretion due to greater nutritional intake, (14) would be utilised for protein anabolism and triglyceride synthesis (15). Accelerated pancreatic development could also be attributed, as a possible cause for elevated plasma insulin concentration observed after birth in calves fed colostrum intensively (16). Over and above these, factors such as feeding density, energy intake, protein intake and gastrointestinal hormones possibly contributed to modify insulin secretion in colostrum fed calves (12).

Thus, colostrum feeding is found to have a pronounced effect on glucose metabolism and insulin release in calves (17) more so, in case of insulin, during the first month of life (18,19).

3. Plasma concentration of Thyroid hormones

Thyroxine (T_4) and Triiodothyronine (T_3) & T_4: T_3 ratio

In the present study, a fluctuating trend in the levels of plasma thyroid hormones is obvious, since they were neither influenced by feeding different amounts of colostrum or by delaying colostrum feeding nor fasting (4).

In conclusion, it is clearly evident from the present study that feeding nutrient rich colostrum for extended periods after birth in pre-ruminant calves, proved to be an excellent source of nutrients which help to increase the concentration of hormones as insulin to a significantly higher level. Insulin, being an anabolic hormone, in turn would be utilised for protein anabolism and triglyceride synthesis, thus augmenting growth rate and body weight gain in calves. Since the age of sexual maturity in bovines is closely linked with body weight, and the delay in age of puberty and age of conception in heifers is now a major problem in our country, feeding of colostrum for extended periods can be judiciously and effectively utilised to bring down the age of sexual maturity thus making dairy farming a more lucrative profession. Moreover, excess colostrum that is usually wasted in large dairy farms could be hygienically collected and economically preserved and fed to the calves. The study also helped to confirm that the plasma thyroid hormones were not found to be influenced by time or amount of colostrum or milk fed, but followed a typical diurnal rhythm.

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