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IMMUNOGLUBULIN CONCENTRATION IN COLOSTRUM AND BLOOD SERUM IN REFERENCE WITH GROWTH AND VITALITY OF FRIESIAN CALVES

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SUMMARY

This study was carried out at Sakha Experimental Station, Animal Production Research Institute, Ministry of Agriculture. The objective of this study was to clarify the relationship between colostrum intake and its immunoglobulins (Igs) with calves blood Igs as passive immunity against early calf diseases.

Thirty eight Friesian calves (20 males and 18 females) and their dams were used in this study. The blood samples were taken from the dams before and after parturition. The colostrum and milk samples were obtained on days 1, 2, 3, 6, 14, 30, 60 and at weaning time (15 wks). Blood samples from the calves were collected on the same periods. The live body weight was recorded weekly and any health disorders were also recorded.

Concentrations of Igs in colostrum decreased sharply from first day to second day post-partum (84.3 ± 5.9 and 25.2± 2.8 mg/ml, respectively). The calves blood serum Igs showed the highest concentration with the first three days of age (2.12 ± 0.10 turbidity unit TU) then it showed a gradual decline thenafter till weaning (1.43 ± 0.1 Tu). The significant correlation coefficients of colostral Igs with daily gains were in the first week of calf's life (1st day= 0.17 and 2-3 days= 0.19).

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In conclusion, colostrum must be suckled as soon as possible after parturition and in sufficient amounts to provide the calves with efficient passive immunity by Igs.

Keywords: Friesian calves, colostrum, blood serum and imunoglobulin

Calves, lids, lambs, foals and pigs are born without antibodies and with only traces of gammaglobulin in their blood. The reason for this lack of immunity, compared to the other species; i.e. guinea pigs, rabbits and monkeys, have not been conclusively proven (Smith et al. 1964). Cruywagen (1990) found that calf's plasma IgG concentration before colostrum ingestion (0 h) was negligible (0.27-0.39 mg/ml). Since newborn calves have innate low resistance to disease, transfer of immunoglobulins (Igs) by suckling colostrum is of particular importance.

Gammaglobulins are concentrated in the udder of the cow prior to parturition,and highly concentrated into colostrum (Butler, 1974 and Pellerin et al. 1990). The newborn calf gains passive immunity by absorbing these gammaglobulins from the colostrum. This ability to absorb whole proteins; however, is limited to the first calf's 24 to 30 hr of life (Smith et al. 1964). The transfer of macromolecules (i,e colostrum proteins) from the intestine to blood declines at a progressively increased rate after 12 h of age with mean closure time at approximately 24 h (Bush and Staley, 1980).

The present work aimed at quantifying the relationship between Ig intake in colostrum and blood Ig concentration in calves under controlled colostrum intake in relation with the calf vitality and growth.

MATERIALS AND METHODS

1. Experimental Animals:

Twenty males and 18 females of Holestein-Friesian calves were used throughout the period from Oct. 1987 to May 1988. They were raised at Sakha Experimental Station, Kafr El- Sheikh Governorate, Animal Production Research Institute, Ministry of Agriculture.

2. Experimental Procedures:

2.1. Management.

Cows were individually fed according to the farm routine recommended by the Ministry of Agriculture of Egypt, fulfilling their nutritional requirements. Concentrates were offered twice daily (07.00 and 15.00). Roughages were available all the day.

Cows were moved to individual lose-stall, well bedded with rice straw one week befor parturition. Parturition was left to occur with minimal interference, attraction was executed when necessary. Calf weight was recorded at birth then at weekly basis till weaning (15 weeks).

Calves were allowed to suckle their dams freely on the first day after parturition (initail colostrum intake) followed by another suckle of the same dam after 12 hours. Calves were separated from their dams on the second day. Colostrum was obtained from dams by hand milking and each calf fed its own dam's colostrum at a rate of 10 % of the calf body weight, using a nipple and nursing bottle, till the end of the 7 th week. Then this amount was reduced by 1 % of the calf body weight weekly up to weaning at the 15 th week of age. Both green fodder and concentrates (calf meal recommended by the Ministry of Agriculture) were offered to the calf after the 3 rd week of age. Then, calves were classified into two groups according to their weight. The incidence of diarrhea and general health of the calves were reported.

2.2. Sample Collection.

2.2.1. Colostrum and milk samples.

Samples of 25 ml colostrum were obtained from each udder quarter of individual cows, 30 min. after parturition (1st day) and throughly mixed together. On the 2nd and 3rd days, colostrum was obtained from each cow by hand milking. A sample of 25 ml was retained for chemical analysis, while the remainder was used for feeding the same cow calf. Samples of each cow milk were also taken prior to bucket suckling on days 6, 14, 30, 60 and at weaning. All samples were stored at - 20 °C for chemical analysis. Colostrum and milk samples were assayed for total immunoglobulins by a colostrometer (Fleenor and Stott, 1980).

2.2.2. Blood samples.

Daily blood samples were collected individually from the dam at morning (08.00) on days of expected parturition. The samples taken on parturition day, 30 minutes after it's occurrence, followed by samples from both cow and calf on days 3, 6, 14, 30, 60 and weaning (15 wks) were used for determination of immunoglobulin concentration.

Ten ml blood sample was taken from the external jugular vein of each cow and calf at the same time was allowed to clot for separation of clear blood serum by centrifugation at 300 rpm for 20 minutes. The serum was transferred to sterilized dry tubes by syphoning. All samples were stored at $-20^{\circ}c$ for analysis. Serum immunoglobulins were determined by the Sodium Sulphite Turbidity Test (S.S.T.T.) as described by Stone and Gitter (1969).

Statistical analysis of data was carried out according to Snedecor (1973).

RESULTS AND DISCUSSION

1. Immunoglobulin in Colostrum and Blood.

1.1. Immunoglobulin in dam blood serum.

Average immunoglobulin concentrations in maternal blood serum were found to be appreciably higher than that attained in calves blood (Fig. 1) which is consistent with Smith et al. (1967) and Bush et al. (1971).

1.2. Immunoglobulin in colostrum and milk.

Concentration of immunoglobulins (Igs) in colostrum decreased Sharply from the first day to the second day post-partum (84.3 ± 5.9 and 25.2 ± 2.8 mg/ml respectively) (Table 1 and Fig 2). At the 3rd day post-partum, the average concentration was 15.7 ± 1.2 mg/ml. Of considerable interest was the great individual difference in colostrum Ig immediately after parturition with a rang of 14.16 - 161.89 mg/ml. On the 2nd and 3rd days, the range was 1.42 - 93.12 and 1.42 - 39.63 mg/ml. respectively. From the 6th day upto weaning Ig concentration in the milk was almost stable around 6.6-7.3 mg/ ml (Fig 2). Cruywgen (1990) found that colostral IgG concentration was 32-40 mg/ml in the pooled and mixed colostrum from the three milkings postpartum.

Stott et al., (1981) reported that colostral IgG concentration of first milking from 12 cows varied between 26 and 170 mg/ml). Brandon et al., (1971) and Butler (1974) reported that, during the last two weeks pre-partum, there is an accumulation of Igs in the udder. These accumulated pools of Igs decreased exponentially until the rate of removal of these components in milk balanced their rate of active transportation from the blood to the mammary gland alveolar cells, which is greatest shortly before parturition and decreases to the normal level during the first few days after calving (Brandon et al. 1971).

Table 1. Means and standard errors of total immunoglobulins in colostrum and milk fed to the calves.

Age of calves (day)	Total immuoglobulins concentration(mg/ml) Male	Female	Overall
1	89.0±7.9	78.4±8.8	84.3±5.9
2	23.0±2.6	29.9±5.9	25.2±2.8
3	17.1±1.5	14.2±2.0	15.7±1.2
6	6.8±0.2	6.9±0.3	6.8±0.2
14	7.3±0.3	6.5±0.2	6.9±0.2
30	7.2±0.3	7.4±0.3	7.3±0.2
60	6.5±0.0	6.8±0.2	6.6±0.1
90-120	7.4±0.4	7.1±0.3	7.3±0.2

It is frequently assumed that allowing calves free access to their dams, will result in the early ingestion of colostrum and efficient absorption of colostral Igs (klause et al. 1969; Mcguire et al. 1976 and Brignole and stott, 1980). Even so, 20 to 30% of the calves left with their dams to suckle are agammaglobulinemic or hypogammaglobulinemic (Klause et al. 1969 and Selman et al. 1970). This may be due to the calf's inability to absorb Ig from ingested colostrum (Fey, 1971 and Gay, 1971). Other investigations, showed evidence that calves fed Known amounts of colostrum at an early age after birth absorb Ig (Penhale et al. 1973 and Stott et al. 1979).

The calf ability to absorb Igs decreases rapidly from the tim of birth, thus early assisted suckling is necessary to achieve high serum concentrations of absorbed Igs before cessation of absorption of such macromolecules from the gut to blood of the neonate.

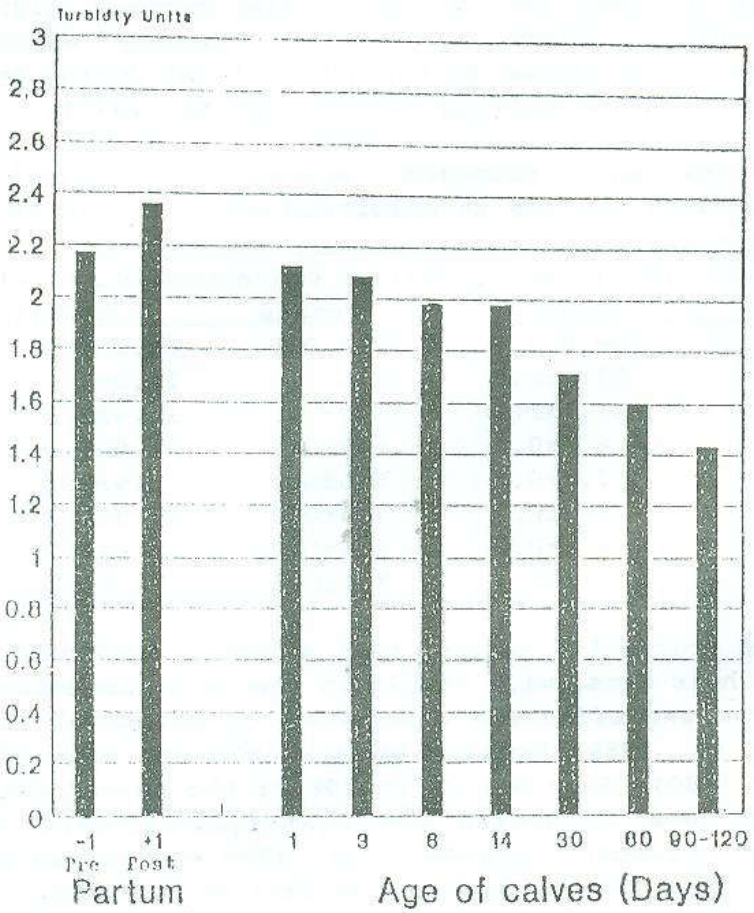

Fig. 1: Concentration of Igs in blood serum of calves and their dams.

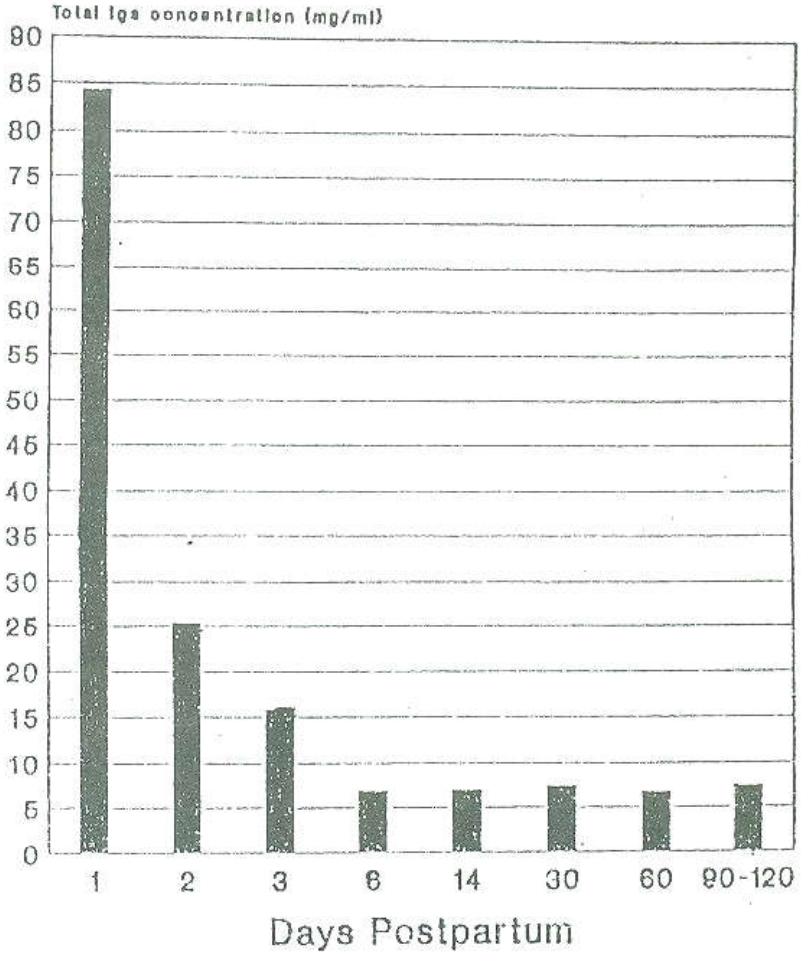

Fig. 2: Average concentration of Igs in colstrum and milk of dams.

The calves which are delayed in suckling to 12 hrs post-partum, have the increasing risk of closure occuring before any or a limited amount of colostrum Igs is absorbed which, undoubtedly, results in hypogammaglobulinemia (Kruse, 1969 and Selman et al. 1971).

Since the ability to absorb colostral Ig declines with age until it ceases at approximately 1 day post-partum (Penhale et al. 1973 and Stott et al. 1979), the practice of feeding calves additional colostrum at that time (1 day post-partum) to increase Ig concentration in serum is of questionable value.

1.3. Immunoglobulins in calf blood serum.

After Suckling colostrum (the first 3 days), the calves serum Igs showed the highest concentration within the first 3 days of age with a gradual decline with age progress till weaning (Table 2 and Fig.1). This was strongly agreed with the findings of Kruse (1970 a,b), Bush et al., (1971); El-Molla (1972); Penhale et al., (1973) and Stott et al.,(1979). The overall average Igs concentration in blood serum of calves (males and females) was 2.12 ± 0.10 turbidity unit after suckling mother colostrum freely on the first day postpartum which decreased to 1.43 ± 0.06 turbidity unit at weaning, this is close to that found by Kruse (1970a).

Table 2: Mean and standard errors of total immunoglobulins in calves serum.

Age of calves (day)	Total immunoglobulins concentration (Turbidity unit)*		
	Male	Female	Overall
1	2.10±0.15	2.14±0.15	2.12±0.10
3	2.03±0.12	2.13±0.10	2.08±0.08
6	2.04±0.09	1.90±0.10	1.98±0.07
14	1.97±0.06	1.99±0.06	1.98±0.04
30	1.66±0.09	1.77±0.08	1.71±0.06
60	1.53±0.09	1.69±0.09	1.60±0.06
90-120	1.38±0.08	1.50±0.08	1.43±0.06

* Turbidity Units:based on Sodum Sulfite prescipitation test.

2. Growth and vitality of calves till weaning.

Average birth weights of male and female Friesian calves suckled mother colostrum freely and immediately after birth (32.5 ± 1.3 and 30.6 ± 0.9 kg respectively) are showen in Table 3 and Fig. 3. Superiority of male calves, having heavier weights than females was maintained throughout the whole experimental period. Similar results have been reported by Roy (1970) and Afifi and Soliman (1971) on Friesian calves.

Average relative body weight gains (Table 3) was 0.85 % in the first week of age which dropped to 0.60 % in the second week. The highly nutritious value of colostrum is expected to have some contribution in this higher rate of growth in the first week. Male calves gained more weight than females (Table 3 & Fig. 3). This gradual increase in growth rate during the first 15 weeks of the calves age appears indicative of more vigorous and healthy calves which is in agreement with Muller et al. (1973). The highest average daily gain of the body weight was recorded at the time of weaning (105 days) for males and females (1.11 and 1.29 kg/day respectively). The correlation coefficients of Igs with daily gains were 0.17 ($P< 0.05$) and 0.19 ($P< 0.01$) in the first day and in first 3 days of age, respectively, which were coincident with the period of colostral suckling. All the calves subjected to the colostral feeding system in this experiment were healthy and with high vitality which reflect the efficiency of the amount of colostrum given. No signs of health disorders were recorded during the period of the study. Kruse (1970a) and Meyer and Steinbach (1965) found that all the calves that died in their experiments had received less than 80 gm of Igs.

A number of studies have indicated a relationship between low concentrations of serum Igs and calf morbidity and mortality (MacEwan et al., 1970; MoGuire et al., 1976 and Penhale et al., 1973). They postulated that surviving calves had in their serum mean concentraton of 75 mg/ml Ig G, 0.8 mg/ml Ig M and 0.2 mg/ml Ig A. However, noone showed that concentration above those gave the calf more immune protection (Penhale et al., 1973).It was estimated that 45 % of Ig ingested immediately after birth and 12 hrs was absorbed prior to 24 hrs (Bush et al., 1971). Approximately 68 % of the variation in blood serum Ig in calves at 24 hrs

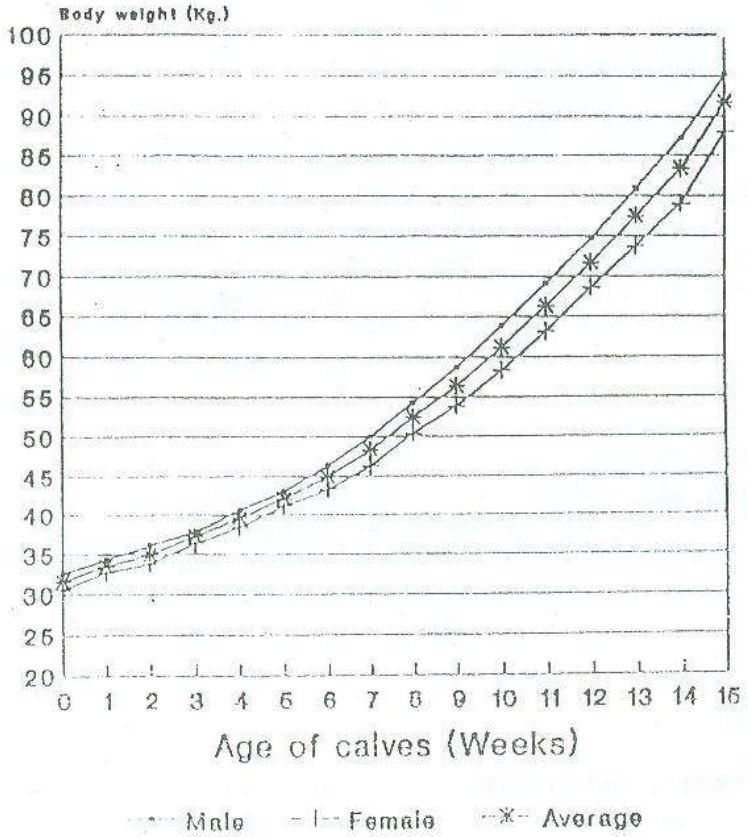

Fig. 3: Body weight in Friesian calves throughout the experimental period.

could be attributed to differences in Ig consumed per unit of weight.

Table 3. Body weight and daily gain in Friesian calves throughout the experimental period

Age week	Body Wight (Kg)			Daily Gain (Kg)			Aver.Relative Body Gain
	Male	Female	Average	Male	Female	Average	
0	32.5±1.3	30.6±0.9	31.6±0.8	-	-	-	-
1	34.3±1.1	32.7±0.9	33.5±0.7	0.26	0.30	0.27	0.85
2	36.0±1.2	33.8±0.9	34.9±0.8	0.24	0.16	0.20	0.60
3	37.8±1.4	36.3±1.0	37.2±0.9	0.26	0.36	0.30	0.86
4	40.6±1.4	38.3±1.0	39.6±0.9	0.40	0.29	0.36	0.97
5	43.0±1.3	41.1±1.0	42.1±0.8	0.34	0.40	0.36	0.91
6	46.3±1.0	43.2±1.1	44.9±0.9	0.47	0.30	0.40	0.95
7	50.0±1.6	46.3±1.2	48.3±1.1	0.53	0.44	0.49	1.09
8	54.2±1.7	50.4±1.3	52.4±1.1	0.60	0.59	0.59	1.22
9	58.7±1.7	53.8±1.2	56.4±1.2	0.64	0.51	0.57	1.09
10	63.8±2.0	58.3±1.2	61.2±1.2	0.73	0.63	0.69	1.22
11	69.1±2.0	63.1±1.3	66.3±1.3	0.76	0.69	0.71	1.16
12	74.6±2.1	68.6±1.4	71.7±1.4	0.79	0.79	0.79	1.19
13	80.9±2.3	73.8±1.4	77.5±1.5	0.90	0.74	0.83	1.16
14	87.3±2.6	79.1±1.6	83.4±1.7	0.91	0.76	0.84	1.08
15	95.1±2.2	88.1±1.0	91.8±1.4	1.11	1.29	1.21	1.45

In conclusion, colostrum must be suckled as soon as possible after parturition and in sufficient amounts to provide the calves with efficient passive immunity by Igs.

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REFERENCES

Afifi, Y.A. and A.M. Soliman, 1971. Source of variation in birth weight and weaning weight of Friesian calves. Agric. Res Rev., (Egypt), 49:1.

Brandon, M.R., D.L. Waston and A.K. Lascelles, 1971. The mechanism of transfer of immunoglobulines into mammary secretion of cows. Aust. J. Exp. Biol. Med. Sci., 49:613.

Brignole, T.J. and G.H. Stott, 1980. Effect of sucking followed by bottle-feeding colostrum on immunoglobulin absorption and calf survival. J. Diary Sci., 63:451.

Bush, L.J., M.A.Aguilera, G.D.Adams and E.W. Jones,1971. Absorption of colostral immunoglobulins by new born dairy calves. J. Dairy Sci., 54:1547.

Bush, L.J. and T.E. Staley, 1980. Absorption of colostral immunoglobulins in new born calves. J. Dairy Sci., 63:672.

Butler, J.E. 1974. Immunoglobulins of mammary secretion. "Cited by Larson. B.L; H.L. Heary and J.E. Devery, 1980. Immunoglobulin production and transport by the mammary gland. J. Dairy Sci., 63:665.

Cruywagen C.W., 1990. Effect of curd forming of colostrum on absorption of immunoglobulin G in new born calves. J. Dairy Sci., 73:3287.

El-Molla, A.A., 1972. Electrophoretic studies on sera and milk of buffalo dams with particular referance to suckling colostrum and milk. Ph.D., Fac. Vet. Med. Cairo Univ.

Fey, H., 1971. Immunology of the new-born calf: Its relation to colisepticemia. Annals of the New York Academy of science, 176:49 (cited by Petrie, L., 1984. Maximising the absorption of colostral immunoglobulines in the new-born dairy calf, Vet. Record, 114:157).

Fleenor, W.A. and G.H. Stott, 1980. Hydrometer test for estimation of immunoglobulin concenteration in bovine colostrum. J. Dairy Sci., 63: 973.

Gay, C.C., 1971. Problems of immunozation in control of Escherichia Coli infection. Ann. New york Acad. Sci., 176:336.

Klause, G.G.B., A. Bennett and E.W. Jones, 1969. A quantitative study of the transfer of colostral immunoglobulins to the new-born calf. Immunology, 16: 293.

Kruse, V., 1969. Ph.D. Thesis (cobenhagin). (Cited by Selman,I.E., E.W. Fisher and A.D. McEWAN, 1971). The serum immunoglobulin concentrations of new-born dairy heifer calves: A farm survey, Vet. Record., 88: 460.

Kruse, V., 1970a. Absorption of immunoglobulin from colostrum in new-born calves. Anim. Pord.,12:627.

Kruse, V., 1970b. Yield of colostrum and immunoglobulin in cattle at the first milking after parturition. Anim. Prod.12:619

McEwan, A.D., E.W. Fisher and I.E. Selman, 1970. An estimation of the efficiency of the absorption of immunogobulins from colostrum by new-born calves. Res. Vet. Sci., 11:239.

McGuire,T.C., N.E.Pfeiffer, J.M.Weiket and R.C. Bartsch, 1976. Failure of clostral immunoglobulin transfer in calves dying from infections disease. J. Vet. Med. Assoc., 169:713.

Meyer, H. and G. Steinbach, 1965. The time and amount of the first colostrum recieved by calves. Mh. Vet. Med., 20:84.

Muller, H.D., M.J. Owens., G.L. Beardsley, and D.J. Schingoethe, 1973. Colostrum and whole milk feeding from birth to four weeks. J. Dairy Sci., 58:683.

Pellerin, J.L., S. Lefeure and G. Bodin, 1990. Humoral immunity during pregancy in the ewe and its transmission to the lamb. Revue-de-Medecine-Veterinaire, 141:6,469.

Penhale. W.J.; E.F. Logan. I.E. Selman. E. Fisher. and A.D. McEwan, 1973. Observation on the absorption of colostral immunoglobulins by neonatal calf and their significance in colibacillosis. Ann. Res. Vet. 4:223.

Roy, J.H.B., 1970. "The calf". Management and feeding. London,Iiffe Books Ltd.

Selman, I.E., A.D. McEwan and E.W. Fisher, 1970. Serum immunoglobulin concentrations of calf with their dams for the first two days of life. J. Com. Pathol., 80:419.

Selman, I.E.; A.D. McEwan and E.W. Fisher, 1971. Studies on dailry heifer calves allowed to suckle their dams at fixed times post-partum. Res. Vet. Sci., 12:1.

Sender, G., M. Glabowna, M. Lukaszewicz and L. Bassalik-Chabielska, 1989. Effect of environmental factors on the levels of immunoglobulins in cow milk. Dairy Sci. Abst.1990. 052-0260.

Smith, V.R., R.E. Reed and E.S. Erwin, 1964. Relation of physiological age to intestinal permiability in bovine. J. Dairy Sci., 47:923.

Smith, H.W., J.A. Oneil and Simmons, 1967. The immunoglobulin content of the serum of calves in England. Vet. Record, 80:664.

Snedecor, G.W. 1973. "Statistical Methods". The Iowa State Univ. Press, U.S.A.

Stone, S.S. and M. Gitter, 1969. The validity of sodium sulphite test for detecting immunogolobulins in calf sera. Brit. Vet. J., 125:68.

Stott, G.H.,D.B. Marx, B.E.Menefee and G.T. Nightengale, 1979. Colostral immunoglobulin transfer in calves. 3- Amount of absorption. J. Dairy Sci., 62:1902.

Stott, G.H., W.A. fleenor and W.C. Kleese, 1981. Colostral immunoglobulin concentration in two fraction of first milking postpartum and five additional milkings. J. Dairy Sci., 64:459.

تأثير الإميونوجلوبيولين على نمو وحيوية عجول الفريزيان

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اجريت هذه الدراسة بمحطة بحوث الانتاج الحيوانى بسخا - كفر الشيخ التابعة لمعهد بحوث الانتاج الحيوانى -مركز البحوث الزراعية المصرية وذلك بهدف استبيان العلاقة بين جلوبيولينات المناعة الموجودة فى السرسوب والتى تنتقل الى العجول اثناء الرضاعة وجلوبيولينات المناعة فى دم العجول كعامل للمناعة المكتسبة ضد الأمراض التى تتعرض لها العجول فى بداية حياتها .

تمت الدراسة على ٢٠ عجل ، ١٨ عجلة فريزيان . اخذت عينات دم من الامهات قبل الولادة مباشرة وفى اليوم التالى للولادة . تم تحليل عينات من سرسوب كل ام على حدة فى اليوم الاول والثانى والثالث ، ثم عينات لبن عند اليوم ٦ ، ١٤ ، ٣٠ ، ٦٠ وعند الفطام (١٥ اسبوع) . كما تم تحليل عينات من دم العجول عند نفس الفترات كذلك وزن العجول والعجلات عند هذه الفترات.

وجد ان معامل الارتباط معنوى بين اميونوجلوبيولين فى كل من السرسوب والدم وبلغ اعلى معدل له عند الاسبوع الاول من عمر العجول ، كما وجد ان معامل الإرتباط بين كمية الاميونوجلوبيولين ووزن العجل عند عمر يوم ٠,١٧ (معنوى عند ٠,٠٥) وعند ٢ -٣ يوم ٠,١٩ (معنوى عند ٠,٠١) . ووجد أيضا ان مستوى الاميونوجلوبيولين فى دم الأمهات اعلى منه فى دم العجول والعجلات (٢,٢٦ مقابل ١,٨٤ وحدة عكارة على التوالى) .

إنخفض مستوى الاميونوجلوبيولين فى السرسوب انخفاضا حادا من قيمته فى اليوم الاول من الولادة ٨٤,٣ ملليجرام/ملليتر الى ٢٥,٢ ملليجرام/ملليتر فى اليوم الثانى ويظل تركيزه فى اللبن ثابت من اليوم السادس وحتى الفطام بمدى ٦,٦ - ٧,٣ ملليجرام/ملليتر.

كان اعلى تركيز للإميونوجلوبيولين فى سيرم دم العجول بعد رضاعة السرسوب مباشرة فى اليوم الاول (٢,١٢ وحدة عكارة) وتناقص تدريجيا بتقدم العمر حتى وصل الى ١,٤٣ وحدة عكارة عند الفطام .

تنصح الدراسة بالاهتمام الشديد برضاعة العجول للسرسوب بعد الولادة مباشرة حيث ان معدل إمتصاص الامعاء للسرسوب يكون أعلى ما يمكن ثم يتناقص تدريجيا عقب الـ ٣٠ ساعة الاولى من الولادة .