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Dept. of Animal Production,
Faculty of Agriculture, Assiut University

INFLUENCE OF NIACIN SUPPLEMENTATION ON PHYSIOLOGICAL PERFORMANCE OF SUCKLING FRIESIAN CALVES DURING WINTER SEASON

(With 5 Tables and 1 Figure)

By

*H.A. DAGHASH; M.M. AZAB * and A.H.ETMAN **

*: Dept. of Animal Production, Faculty of Agriculture, El-Azhar University.

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تاثير أضافة النياسين على الاداء الفسيولوجى لعجول الفريزيان الرضيعة اثناء فصل الشتاء

حسن دغش ، محمد عوض اللة ، أحمد عتمان

أستخدم ١٠ عجول فريزيان رضيعة عند عمر ١٩ يوم لدراسة تأثير أضافة النياسين لمدة ٩٠ يوم (فترة الرضاعة) على المظهر الانتاجى، معدل التنفس، درجة حرارة الجسم و الجلد وايضا بعض مكونات الدم. بدأت اضافة النياسين عند وزن ٣٩ كجم و استمرت حتى وزن ١٢٠ كجم. تم تقسيم الحيوانات الى مجموعتين متساويتين. غذيت المجموعة الاولى (المجموعة الضابطة) بدون اضافة النياسين بينما المجموعة الثانية (المجموعة المعاملة) غذيت على ١٠ مليجرام نياسين/كجم وزن حي. تم ايواء الحيوانات داخل الحظيرة (شبة مفتوحة) وذلك خلال أشهر ديسمبر، يناير و فبراير (فترة التجربة). تم أختبار كل مجموعة بالنسبة لمعدلات النمو، معدل التنفس، درجة حرارة المستقيم ، الجلد و ايضاً بعض مكونات الدم. أوضحت النتائج ان المجموعة المضاف اليها نياسين زاد فيها متوسط وزن الجسم بنسبة ١١% ($p<0.05$) ومعدل الزيادة اليومية بنسبة ١٧% ($p<0.01$) مقارنة بالمجموعة الضابطة (الكنترول) مما ترتب علية التبكير في الفطام . كان معدل التنفس و درجة حرارة المستقيم و الجلد أعلى في الساعة ٢ ظهراً مقارنة بالساعة ٨ صباحاً و في المجموعة المعاملة مقارنة بالكنترول و ذلك في كل من الفترتين السابقتين. العجول المعطاة نياسين ارتفع فيها تركيز سيرم البروتين الكلى والجلوبيولين الكلى ومشتقاته (الفا، بيتا، جاما). لوحظ ايضا زيادة

نسبة الجلوبيولين الكلى بنسبة ٤٥ % (P<0.02) بينما زاد مستوى جاما -جلوبيولين بنسبة ٦٧% (p<0.01) وانخفض تركيز الإلبيومين (p<0.01) في سيرم العجول المعاملة . تناول النياسين ادى الى زيادة في تركيز جلوكوز السيرم بنسبة ٢٢%(p<0.01) ، الكوليسترول الكلى بنسبة ١٨% (p<0.05)، وثلاثى الجليسريدات بنسبة ٤٠% (p<0.01) ، وانزيمات ترانسفيريز (اسبرتات ، الآنين ترانسفيليز) بنسبة ١٦% (p<0.02) و٢٢% (P<0.01) على التوالى بينما انخفض تركيز الكرياتينين بنسبة ٢٤% (p<0.01). لم يختلف معنويا تركيز كل من سيرم الكالسيوم ، الفسفور الغير عضوى ، اليوريا نيتروجين والبليروبين الكلى بين المجموعتين. أوضحت الدراسة مدى أهمية أمداد عجول الفريزيان الرضيعة بالنياسين خلال فصل الشتاء البارد. أضافة النياسين أدت إلى زيادة في معدل التمثيل الغذائي و ايضا زيادة في نسبة الجلوكوز في سيرم الدم و كان هذا مرتبطا بالتاثير الايجابى على كل من معدل النمو ودرجة حرارة الجسم و معدل التنفس.

SUMMARY

The effect of niacin supplementation at two levels: 0.0 (control) and 10 mg/Kg body weight on growth performance, respiration rate, rectal and skin temperatures as well as some blood constituents were studied. A total of 10 suckling Friesian calves, 19±0.34 day's age were used. The addition of niacin started at 39 Kg body weight and lasted till 120 Kg body weight. Animals were divided into two equal groups and housed indoors (semi-open shed) during the period from December to February. Each group was examined for growth performance, respiration rate, rectal and skin temperatures as well as some blood constituents. A treatment by period interaction was detected for body weight ($P<0.05$) and average daily gain ($P<0.01$). However, for the 90-day period, niacin suckling calves (NC) were 11 % more body weight and gained 17 % faster than control suckling calves (C) . Respiration rate and rectal temperature were higher at 14:00 h than at 8:00 h and in-group (NC) than in-group (C) at either period. Calves fed niacin had significantly higher concentrations of serum total protein, total globulin and its fractions (alpha, beta and gamma). It was not surprised to notice that serum total globulin concentration was 45% ($P<0.02$) greater while gamma–globulin elevated by 67% ($P<0.01$) in niacin-fed calves. Also treated calves had lower concentration of serum albumin ($p<0.01$). Fed niacin (group, NC) increased concentrations of serum glucose by 22% ($P<0.01$), total cholesterol by 18% (P<0.05), triglycerides by 40% (P<0.01) and transferase enzymes (aspartic transferase, and alanine transferase) by 16% (P<0.02) and 22% (P<0.01), respectively while creatinine concentration decreased by 24 % (P<0.01). Concentrations of serum calcium, inorganic phosphorus, urea-nitrogen and total bilirubin did not differ between groups. The results cleared that the benefits of niacin supplementation to suckling Friesian calves were achieved under cool winter temperature. Fed niacin succeeded in improving growth performance and increasing the supply of energy enough to support thermostability in cold stressed calves.

Key words: *Niacin, Suckling Friesian calves, Growth, Blood metabolites Clod stress*

INTRODUCTION

Niacin, or nicotinic acid, is required for the synthesis of nicotinamide adenine dinucleotide (NAD) and NAD phosphate, two coenzymes essential for metabolism of proteins, carbohydrates and lipids (White, 1982 and Henderson, 1983) and to its roles as a Coenzyme in energy metabolism (Moore, 1984). The young animals, preruminant calf, require niacin. Adding niacin to milk replacers is recommended at a level of 2.6 ppm to prevent niacin deficiency (NRC, 1989).

Synthesis of niacin in the rumen of cattle has been demonstrated and may be under metabolic control i.e. more niacin is synthesized when small amounts are provided in the ration (Porter, 1961). Niacin is a B vitamin synthesized by rumen microbes (Zimmerman et al., 1992). The inclusion of niacin in ruminant diet may affect ruminal fermentation and performance of ruminants (Campbell et al., 1994). Mechanisms postulated previously for the beneficial effects of niacin have included increase in microbial protein synthesis and propionate production in the rumen (Riddell et al., 1980), protozoal numbers (Erickson et al., 1990) and cellulose digestion (Horner et al., 1988).

Because cold exposure intefers with the availability of nutrients for animal production, feed is directed toward providing substrates for use in thermogenesis rather than growth (Scotte et al., 1993) which lead to reduced growth performance (Young, 1985). For this reason, adding niacin to suckling Friesian calves, exposed to cool stress, may cause increasing in live weight gain and improving feed efficiency of early weaned calves which lead to earlier weaning age. This positive feature resulted from the role of niacin in elevating protozoal numbers and increasing microbial protein synthesis.

Niacin supplementation for suckling Friesian calves was not examined for growth performance and serum metabolites under cool stress conditions. Therefore, the objectives of this trial were undertaken to evaluate the effects of supplemental niacin on growth and thermo-physiological responses of suckling Friesian calves under cool weather temperature. Effects on various blood serum constituents were also examined.

MATERIALS and METHODS

This trial was started during the cold months of winter (December to February) in the experimental Farm of the Department of Animal Production, Faculty of Agriculture, El-Azhar University to examine the influences of supplemented 10 mg niacin/Kg BW on growth and some blood serum metabolites of suckling Friesian calves. In addition, the thermal physiological responses were also examined.

Animal management:

Ten suckling Friesian calves were utilized in this study. Average age of calves at the start of the trial was 19±0.34 day and average BW was 39.35±1.70 kg. Suckling calves were divided into two groups of five animals each. The control group (C) was fed on basal diet while the second group (NC) was supplemented with 10-mg niacin/kg BW. This level was almost similar to those reported by Siponz et al. (1993). The experimental dose of niacin was dissolved in 15 ml of water and drenched individually to suckling calves of the respective treatment group. Animals were housed indoors (semi-open shed) and were allowed to suckle while rearer was offered at 28 days of age. Composition of ration fed (rearer) was determined according to (AOAC, 1990). All experimental animals received ad libitum concentrate mixture consisting of 50% corn, 15% cottonseed meal, 25% soybean meal and 10% crushed barely. Chemical analysis showed that the concentrate mixture contained 9.84% moisture, 15.60% crude protein, 2.72 % either extract, 7.99% crude fiber, 57.37% nitrogen free extract and 6.48% ash. All animals were kept under the same managerial and hygienic conditions.

Animal performance:

Body weights were recorded (after an overnight fast) every fortnight throughout the experiment, to estimate the exact quantity of niacin which will be added according to live body weight. Average daily gain was calculated.

Thermo physiological assessments:

Respiration rate (RR, breath/min) was determined by counting the flank movements for 1 min. It was carried out for all suckling claves at 8:00 h and 14:00 h every once a week till 90 days. Rectal (RT, °C) and skin temperatures (ST,°C) were measured using clinical thermometer and digital telethermometer. Maximum and minimum air temperature (AT,°C) and relative humidity (RT,%) are presented in Table (1) while AT and RH at 8:00 h and at 14:00 h are shown Table (2).

Table 1: Maximum and minimum of air temperatures (AT, °C) and relative humidity (RT, %) during the experimental period

Month	AT		RH	
	Max	Min	Max.	Min.
Dec.	23.6 ± 0.55	3.6± 0.39	90.8±0.54	50.4±1.05
Jan.	20.2 ±0.69	3.1± 0.38	93.7±1.46	42.5±1.51
Feb.	19.8± 0.62	1.7± 0.16	89.3±1.30	37.7±1.29

Table 2: Average air temperature and relative humidity in the morning (8:00h) and in the afternoon (14:00h) during 90 days of the experimental period.

Month	AT		RH	
	08:00	14:00	08:00	14:00
Dec.	15.3	21.8	71.6	85.2
Jan.	12.1	18.6	82.4	61.2
Feb.	11.5	16.5	80.2	72.6

Blood sampling and methods:

Blood samples were obtained biweekly from the jugular venipuncture at 9:00 h before feeding. The fresh serum was then separated by centrifugation at 3OOO rpm for 15 min., decanted into clean dry glass vials and stored at -20°C until analysis. Serum total protein, albumin, glucose, triglycerides, aspartate and alanine transferase enzymes (AST and ALT, respectively) were determined using Scalvo (Italy). Calcium, inorganic phosphors, urea-nitrogen and total bilirubin were estimated using kits supplied from Biocon (Germany). Kits from Diamond (Egypt) were used in determination of serum creatinine. Serum total globulin concentration was determined by difference between serum total protein and serum albumin. The serum protein fractions were electrophoresed according to the procedure mentioned in Helena Laboratories Publications (1984).

Data were analyzed by analysis of variance (ANOVA) procedures of the Statistical Analysis System (SAS, 1987).

RESULTS and DISCUSSION

Growth performance: Niacin supplementation to suckling Friesian calves during cold weather improved growth rate ($P<0.05$) and gain ($P<0.01$) than when compared with the unsupplemented calves (Table 3 and Fig. 1). These findings are in agreement with those of Piva et al. (1975). They reported that a ration supplemented with 400-ppm niacin improved feed efficiency and weight gain in beef cattle. Moreover, Flachowsky et al. (1993) found that average live weight gain of growing bulls increased when niacin was supplemented. They added that about 2/3 of live weight gain were attributed to rumen and intermediately effects of niacin while the other 1/3 to increased feed intake. In dairy cattle, Falchowsky et al. (1991) observed that cows lost 11 kg without niacin and gained 10 kg body weight when 6 g niacin was added daily. The tendency of niacin supplementation to improve body weight and average daily gain could be due to increased protozoal numbers (Dennis et al., 1982), microbial protein synthesis and crude protein digestibility (Horner et al. 1988).

In this respect, niacin addition could improve body weight and daily gain of the treated calves by increasing rumen microbial activity, increased propionic acid production at the expense of acetate and improved utilization of absorbed amino acids (Sipocz et al. 19). Propionate is used more efficiently than acetate by ruminants, possibly by reducing heat increment (Blaxtey and Wainman, 1964), sparing amino acids used normally for gluconeogenesis (Reilly and Ford, 1971) and stimulating body protein synthesis (Eskeland et al., 1974).

Table 3: The influence of niacin supplementation on growth of suckling Friesian calves (Mean±SE)

Item	Control (C)	Treatment(NC)	± SEM
No of animals	5	5	
Initial BW (Kg)	39.25	39.50	1.70
Final BW (Kg)	108^{d}	120^{c}	4.63
Daily gain (g/d)	763^{b}	894^{a}	15.89

Means in the same row with the same superscript are not significantly different.
^{a},^{b} (P<0.01) & ^{c},^{d} (P<0.05).

A major reason for the consistent improvement in growth performance that occurs with added niacin may be related to the role of niacin in carbohydrate and lipids metabolism (Dufva et al., 1984) and to its roles as a coenzyme in energy metabolism (Moore, 1984). The improvement in weight gain by adding niacin may be attributed to the improvement in the intermediary metabolism, leading to improve the ruminal digestion and the utilization of the absorbed nutrients (Dorean and Ottou, 1996).

Some physiological responses: Thermo respiratory responses are shown in Table 4. Respiration rate (RR), rectal (RT) and skin (ST) temperatures were greater (P<0.01) in the afternoon (14:00 h) than in the morning (8:00 h) in both groups. Niacin supplementation resulted in a significant increase in RR (p<0.01) and RT (P<0.05). The overall means of RR (breaths/min) were 19.90 and 21.50 at 8:00 h and 24.98 and 26.87 at 14:00 h for control and niacin treated-calves, respectively. The corresponding values for RT (°C) were 38.43 and 38.62 at 8:00 h and 38.81 and 39.09 at 14:00 h for control and niacin treated- calves, respectively. ST (°C) tended to increased (P>0.10) due to niacin. The increase of blood flow to skin is the main cause of high skin temperature in niacin-fed calves. These results suggested that animals housed under cool winter temperatures modify the rate of heat exchange by vasomotor control of blood flow to superficial tissues.

In this field, there is a lack of data dealing with thermal physiological responses (RR, RT and ST) in case of adding niacin to suckling Friesian calves in cold weather under Upper Egypt conditions. In the present study, raising RR and RT in niacin treated-calves could be explained on the basis that niacin supplementation contributed to the increase of heat production and basal metabolic rate due to its roles as a coenzymes (Moore, 1984) in energy and lipids metabolism (Muller et al., 1986) and stimulation of protein synthesis by rumen microorganisms (Shields et al., 1983). It is clear from the present study that adding niacin to suckling Friesian calves raised plasma glucose by about 22% which led to the supply of readily energy substrate to support thermostability in cold stressed calves and increase the ability of glucose to maintain rectal temperature (Stanko et al., 1992). Increasing both RR and RT in niacin-fed calves may lead to keep body temperature very closely from thermoneuteral zone.

Blood serum metabolites: Results in Table 5 indicate that serum total protein concentrations increased ($p<0.05$) by added niacin. Such increase was mainly due to the increase in total globulin concentration rather than albumin (Table 5). In respect to, the significant increase of serum total protein in niacin-treated calves than in control, such increase may be attributed to the good effect of niacin in preventing diseases which usually lead to a great loss of body proteins. Bonomi et al. (1994) found that nicotinic acid (niacin), irrespective of dose, had a positive effect on the health status of cows, decreasing the most frequency reported diseases by 50 to 70%. Another explanation is that addition of niacin to the ration increase microbial protein synthesis (Dennis et al., 1982 and Riddell et al., 1981) and crude protein digestibility (Horner et al., 1988) which possibly increase total protein concentration in serum of niacin-treated calves.

It is not surprised to notice that concentrations of total globulin increased significantly ($p<0.02$) in treated calves. Both alpha and beta globulin concentrations were raised significantly ($P<0.02$). Also, gamma globulin concentration was increased ($P<0.01$) by about 67% in serum of niacin-treated calves compared with untreated ones. For this reason niacin supplementation had a positive effect on the health status of animals (Bonomi et al., 1994) due to the elevation of gamma globulin fraction that considered one of the most important items that responsible for immune system in the body.

Concentration of serum glucose was significantly higher ($P<0.01$) for suckling calves supplementedwith niacin than unsupplemented ones (Table 5). Increasing serum glucose concentration associated with niacin supplementation is in agreement with the reported by DI Costanzo et al. (1997) who found that plasma glucose concentrations in cows fed diets supplemented with niacin were significantly higher than those fed control diet. Previous reports of Thornton and Schultz (1980) indicated that administration of 6.5 to 17 g/d of niacin to goats elevated blood glucose and insulin. This increase might be an indication of greater gluconeogenic activity promoted by the partial lipogenic suppression elicited by niacin at the cellular level as reported by Ruegsegger and Schultz (1986).

In this field, alter serum glucose concentration in niacin-fed calves could be explained by the previous findings of Riddell and Bartley (1980) that niacin feeding increase propionate production in the rumen. Much of propionate produced in the rumen is absorbed and transformed to glucose in the liver. Higher levels of glucose are then released into the peripheral circulation. Bergman (1983) reported that propionate is a potent glycogenic compound and can account for about two-thirds of total glucose produced in large amount of concentrates.

In the present study, concentration of total cholesterol in serum of niacin-treated calves was increased ($P<0.05$) by about 18% (Table 5). The higher values of total cholesterol concentration in treated group in comparison with untreated ones (83.84 Vs 70.73 mg/dl) may be due to the important of ether extract digestibility by niacin supplementation which caused an increase in lipids intake. Another explanation to raising total cholesterol concentration may be attributed to the greater absorbability of dietary energy and its availability for anabolism and synthesis process. Stufflebeam et al. (1969) reported that lower energy intake by beef heifers resulted in a lower serum cholesterol level.

The increase in triglyceride concentration in niacin- treated suckling calves ($P<0.01$) compared with control ones could be due to increased glucose availability in niacin-treated calves (Table 5). Glucose is essential for triglycerides synthesis because it forms alpha glycerophosphate which is the specific precursor of glycerol with which fatty acids are esterified for triglycerides formation (Bergman, 1983). In addition glucose furnishes NADPH which is required as a reducing agent in the synthesis of long chain fatty acids. In general, the increase in plasma levels of both glucose and triglycerides in the present study (Table 5) indicate that niacin-treated suckling calves were in better condition compared with control calves.

Feeding niacin resulted in insignificant differences in plasma contents of calcium and inorganic phosphorus (Table 5) indicating the niacin supplementation had no effect on bone metabolism and mineralization.

Serum urea-nitrogen concentration was not significantly affected by fed niacin (Table 5). Horton (1992) also found in growing lambs that supplemented niacin (661 mg/Kg diet) did not affect plasma urea-nitrogen.

Serum total bilirubin concentration tended to decrease insignificantly by about 8% in niacin-fed calves (Table 5). Decreased serum bilirubin in treated calves might results from improved nutritional status (final body weight and average daily gain) of these calves (Table 3). Earlier studies suggest a reciprocal relationship between serum total bilirubin and nutritional status. Hallford and Galyean (1982) reported greater serum bilirubin in ewe lambs ($P<0.10$) and mature ewes ($P<0.05$) at parturition than before breeding. In human, Blommer et al. (1971) reported that fasting was associated with hyperbilirubinemia, which was attributed mainly to decreased hepatic removal endogenously produced serum bilirubin.

Niacin supplementaion decreased ($P<0.01$) serum creatinine concentration in treated calves compared with untreated ones (Table 5). Most creatinine originates from non-enzymatic conversion of creatine that stores energy in muscle as phosphocreatine. Protein catabolism may affect size of the creatine pool and, thus, the daily production of creatinine (Finco, 1980). Stimulation of body protein synthesis in niacin-fed calves could be the reason for decreasing serum creatinine in these animals (Table 5).

Table 4: The influence of niacin supplementation on respiration rate (r.p.m.), rectal and skin temperatures (°C) at 8:00 h and 14:00 h in suckling Friesian calves (Mean±SE).

Time	RR (r.p.m)				RT (°C)				ST (°C)			
	C	NC	±SEM	Sig	C	NC	±SEM	Sig	C	NC	±SEM	Sig
8.00 h	19.90	21.50	0.25	**	38.43	38.62	0.02	*	37.01	37.15	0.03	NS
14.00 h	24.98	26.87	0.25	**	38.81	39.09	0.02	*	37.47	37.56	0.03	NS
±SE	0.25	0.25			0.02	0.02			0.03	0.03		
Sig	**	**			**	**			**	**		

** $P<0.01$ & * $P<0.05$

Table 5. The influence of niacin supplementation on some blood constituents in suckling Friesian calves (Mean±SE)

Item	Treatments		
	Control (C)	Niacin (NC)	±SEM
Total protein (g/dl)	6.31^{d}	7.48^{c}	0.27
Albumin (g/dl)	3.33^{a}	2.75^{b}	0.12
Total globulin (g/dl)	2.98^{d}	4.73^{c}	0.29
Alpha globulin (g/dl)	0.71^{d}	1.04^{c}	0.08
Beta globulin (g/dl)	0.51^{d}	0.75^{c}	0.05
Gamma globulin (g/dl)	1.76$_{b}$	2.94^{a}	0.17
Glucose (mg/dl)	62.27^{b}	76.06^{a}	1.10
Total cholesterol(mg/dl)	70.73^{f}	83.84^{e}	1.80
Triglycerides (mg/dl)	40.74^{b}	56.91^{a}	1.44
Calcium (mg/dl)	8.74	9.64	0.13
Inorganic phosphorus (mg/dl)	4.56	5.01	0.65
Urea-N (mg/dl)	27.15	28.21	1.19
Total bilirubin (mg/dl)	0.37	0.34	0.03
Creatinine (mg/dl)	1.09^{a}	0.88^{b}	0.02
AST (U/L)	42.10^{c}	48.68^{d}	1.41
ALT (U/L)	13.90^{b}	16.96^{a}	0.31

Means in the same row with the same superscript are not significantly different.
^{a,b} ($P<0.01$) & ^{c,d} ($P<0.02$) & ^{e,f} ($P<0.05$).

Calves fed niaicn had higher serum transferases AST (aspartic transferase) and ALT (alanine transferase) concentrations than those fed control diet (Table 5). Serum AST and ALT increased by about 16%

(P<0.02) and 22% (P<0.01), respectively due to fed niacin, thus suggesting increased synthesis of these enzymes in response to an increased need for glyconeogenesis. AST and ALT enzymes are very important in glucose synthesis from noncarbohydrate metabolism sources (Harper et al., 1977).

In conclusion, added niacin to suckling Friesian calves under cold winter environment success in improving nutritional and physiological status that was reflected by increasing both final body weight and immune system. Also, niacin supplementation increased glucose concentration by about 22% in treated calves, which can be used as a metabolic substance for heat production to support thermostability in cold stressed calves. In regard to the elevation in RR and RT in niacin-fed calves, further investigation may be suggested.

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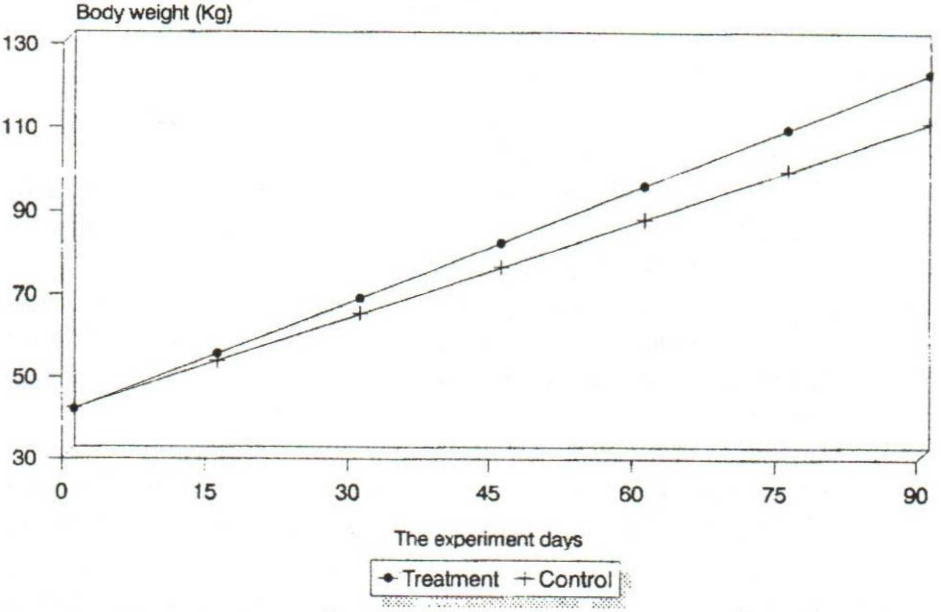

Fig. 1: Growth rate of suckling Friesian calves as affected by niacin supplementation during the experimental period.