Changes in Plasma Insulin, Thyroid Hormones, Non-Esterified Fatty Acids and Blood Glucose in Underfed Najdi Lambs

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Summary

Sixteen Najdi lambs were divided into two groups. One control group was fed on concentrate ration twice daily and the second treated one receive the half requirements of the control group (underfed group). Blood glucose, plasma insulin, T_3, T_4 and non-esterified fatty acid (NEFA) concentrations were determined during the six weeks experimental period. In the control group, the concentrations of glucose and insulin were statistically higher ($p< 0.05$) than in the underfed group. NEFA concentration was higher in the underfed group ($p< 0.05$). No statistical variations were noticed in the level of T_3 and T_4 in the two groups during the experimental period. It can be concluded that blood glucose, plasma insulin and NEFA are good indices for monitoring starvation and underfeeding in growing lambs.

Introduction

Sheep are important domestic animals in the Middle East and they are important from the social and economic point of view. They are small, easy to maintain and can tolerate extreme climatic conditions. Sheep are very suitable for increasing animal production in the Middle East. There are two ways for increasing sheep productivity. One is through improving the efficiency of reproduction and the second is through nutrition and both are interrelated [1]. For most of the year, sheep are confronted with lack of feed supplementation that leads to weight loss of up to 35% [2]. Under nutrition is a serious limiting factor in animal production [3].

During food scarcity there is interchange of metabolites such as glucose, free fatty acids, ketone bodies and amino acids to supply energy to the brain, skeletal muscles and to the erythrocytes. These processes are controlled by insulin, thyroid hormones and other hormones (4; 5).

Insulin is the main hormone concerned with regulation of carbohydrate metabolism. In particular, insulin control the level of blood glucose, glucose storage and utilization (6). Insulin is a hormone secreted by pancreatic β-cell in response to hyperglycemia (7). It plays very important role in the catabolism of glycogen, amino acids and fatty acids specially during starvation. The level of plasma insulin is proportional to the nutrient supplies. The insulin level is high in well fed animals when compared with the underfed animals (8). In lambs, under nutrition causes a sharp decrease in insulin concentration when compared with adequately fed lambs (9).

Thyroxin (T_4) and triiodothyronine (T_3) are secreted by the thyroid gland and play an important role in the metabolism of carbohydrates, proteins and lipids. The two hormones facilitate the intestinal absorption of glucose and essential amino acids (7). The relation between fasting and concentration of T_3 and T_4 is not consistent when compared with the control group (10).

The objectives of this study is to investigate some endocrinological parameters in lambs in relation to plasma concentration of insulin, T_3, T_4, NEVA and blood glucose in underfeeding circumstances.

Material and Methods

Sixteen apparently healthy Najdi lambs, aged 9 – 10 months and of an average body weight of 20 ±5 kg, were divided into two groups. Control group (C; n=8) was fed adequate ration and each animal received about 0.5 kg of the ration twice daily. The diet was formulated to supply the requirements of the Agriculture Research Council (11). While the treated group, underfed group, (T; n=8) was fed with the same diet once daily at the morning (half the requirements). The freedom of animals from internal and external parasites was checked by standard methods and insured. Water was available at *ad* libitum basis. The experiment duration was 6 weeks.

Blood sampling :

Jugular blood samples were collected from all animals on days 4, 14, 28 and 42 of the experiment into heparinized vacuotainer tubes before feeding at 08:00 AM. For glucose estimation, blood samples were collected in tubes containing sodium fluoride. Blood was centrifuged at 3000 rpm for ten minutes to obtain plasma.

Concentration of plasma insulin was determined by radio-immunoassay (RIA) as described by (12). Thyroxin (T_4) and triiodothyronine (T_3) were measured by using micro-well reader and enzyme immunoassay (EIA) technique supplied by Medix Biotech, INC (13; 14). Blood glucose was determined by glucose oxidase method using kits (bio-Merieux Laboratory Reagents and Products, France (15). NEFA in the plasma were estimated by an extraction method (Chloroform-hapten- methanol; 49:49:2) as described by (16).

Statistical analysis :

Statistical analysis of the data was executed according to (17). Means were assessed by Student t-test.

Results

As can be seen in Table 1, control lambs group showed higher concentrations of plasma insulin when compared with the underfed group. The concentrations of glucose followed the trend of insulin on day 4, 14, 28 and 42 and there was a significant difference between the two groups ($P< 0.05$). However, no significant differences were observed regarding the concentration of T_3 and T_4 in the same collection dates. There was a steady increase in the concentration of NEFA in the plasma of the underfed lambs, it was statistically higher than the control group ($P< 0.05$).

Discussion

Animals in the control group had access to a high nutritive ration (11) offered twice daily while the tested group received only one ration per day, and this will create an underfed situation has been manifested in loss of body weight. Under such circumstances blood glucose level has been reported to provide an index of

nutritional status (18; 19).. The principal circulating blood metabolites used to assess the energy status of ruminants are blood glucose and NEFA. Non-esterified fatty acids are released into the blood plasma when adipose tissue is mobilized to supply the metabolic needs of the animal during food shortage (20). In the present investigation there was a decrease in the blood glucose level in underfed animals, however, this was compensated by mobilization of fatty acids from fat depots to supply energy and this can explain the rise in plasma NEFA.

Under such conditions, the two experimental groups showed variation in plasma insulin. The underfed group showed concentration between 4.5 – 7.1 µIU/ml and that correspond to 55 – 73% of those of normally fed animals (8.1 – 9.7 µUL/ml). The difference between the amount of food offered to the two groups can explain this variation. Similar results were reported by (8; 9). Insulin concentrations obtained in this investigation go in line with the glucose concentration in the two groups and indicated reduced protein synthesis and increased catabolism of both fatty acids and amino acids (21).

Under such circumstances of nutrition one would expect that T_3 and T_4 concentrations in plasma will decrease so as to increase lipid and protein catabolism as was noticed in wild deer under food shortage (22). At the same time in the well fed (control group) one would expect an increase in T_3 and T_4 so as to increase absorption of glucose, essential amino acids and lipoproteins. In both circumstances, there was no significant variations in the level of T_3 and T_4. These results are similar to those reported by (23).

It can be concluded that in Najdi lambs, under nutrition does not influence T_3 and T_4 and they remain almost similar in fed and in the underfed animals. A better index for under nutrition are the level of glucose, insulin and non-esterified fatty acids.

References

1) Delgadillo, J. A. and Malpaux, B. (1996): Reproduction of goats in the tropics and subtropics. *Proceedings of the 6th International Conference on Goats*. Beijing, China, 785 – 793.

2) Clariget, R. P., Forsberg, M. and Rodriguez-Martinez, H. (1998): Seasonal variation in live weight, testes size. LH secretion, melatonin and thyroxin in Merino and Corriedale rams in sub-tropical climate. Acta Vet. Scand. 39: 35 – 47.

3) Lusweti, E. C. (2000): The performance of the Nguni, Afrikander and Bonsmara cattle breeds in developing areas and Southern Africa. South African J. Anim. Sci. 305: 28 – 29.

4) Vernon, R. G. (1982): Effects of growth hormone on fatty acid synthesis in sheep adipose tissue. Intern. J. Biochem. 14: 255 – 258.

5) Majdoub, L., Vermorel, M. and Ortigues-Marty, I. (2003): Intraruminal propionate supplementation modifies hind limb energy metabolism without changing the splanchnic release of glucose in growing lambs. Br. J. Nutr. 89: 39 – 50.

6) Khan, J. R. and Ludri, M. (2002): Changes in blood glucose, plasma non-esterified fatty acids and insulin in pregnant and non-pregnant goats. Trop. Anim. Health Prod. 34: 81 – 90.

7) Cunningham, J. G. (1992): Textbook of Veterinary Physiology. W. B. Saunders, London, pp 655 – 699.

8) Brockman, R. P. and Laarveld, B. (1986): Hormonal regulation of metabolism in ruminants: a review. Livestock Prod. Sci. 14: 313 – 334.

9) Cole, N. A. Purdy, C. W. and Halford, D. M. (1988): Influence of fasting and postfast diet energy level on feed intake, feed pattern and blood variables in lambs. J. Anim. Sci. 66: 798 – 805.

10) Campion, D. R., McCusker, R. H. and Buonomo, F. C. (1986): Effect of fasting neonatal piglets and blood hormones and metabolite profiles on skeletal muscle metabolism. J. Anim. Sci. 63: 1418 – 1427.

11) ARC (1980): The Nutrient Requirements for Ruminant livestock. ARC (London), Common Wealth Agriculture Bureau, Farnham Royal, UK.

12) Sano, H., Nakamura, S. and Terashima, Y. (1995): Effect of cold exposure on profiles of metabolic and endocrine responses on responses to feeding and arginine injection in sheep. J. Anim. Sci. 73: 2054 – 2062.

13) Walker, W. (1977): Introduction: An approach to immunoassay. Clin. Chem, 23: 384.

14) Willard, S. T., Neuendorf, D. A. and Randel, R. D. (1998): Voluntary feed intake, growth characteristics and serum concentrations of thyroid hormones in male and female axis fawns (Axis axis). Small Rumin. Res. 30: 19 – 27.

15) Schall, R.J.; Fraser, A.; Hansen, H.; Kern, C. and Teneso, H. (1978): A sensitive manual enzyme immunoassay for thyroxin. Clin. Chem, 24(10): 1801.

16) Trinder, P. (1961): Determination of glucose in blood using glucose oxidase with an alternative oxygen acceptor. Ann. Clin. Bioch. 6: 24-27

17) Shipe, W. F., Senyk, G. E. and Fountain, K. B. (1980): Modified copper soap solvent extraction method for measuring free fatty acids in milk. J. Dair. Sci. 63: 193 – 198.

18) Snedecor, G. W. and Cochran, W. G. 1980. *Statistical Methods.* 6th edn. Oxford, New Delhi).

19) Moran-Feher, P., Sauvant, D. B. and Rouzean, A. (1977): Parameters indicating nutritional status of goats. Zootechnica 19: 195 – 203.

20) Timothy, R. H., Oddy, H. V. and Nancarrow, C. (2004): Glucose-stimulated insulin response in pregnant sheep following acute suppression of plasma non-esterified fatty acids concentrations. Reprod. Biol. Endocrinol.2: 64 – 86.

21- Bowden, D. M. (1971): Non-esterified fatty acids and ketone bodies in blood as indicators of nutritional status in ruminants. A review. Canad. J. Anim. Sci. 51: 1 – 13.

22- Moldawer, L. L., Bistrian, B. R. and Blackburn, G. L. (1981): Factors determining the preservation of protein status during dietary protein deprivation. J. Nutr. 111: 1287 – 1292.

23- Kasser, T. R. Martin, R. J., Gahagan, J. H. (1981): Fasting plasma hormones and metabolites in feral and domestic newborn pigs. J. Anim. Sci. 53: 421 – 426.

Table 1. Concentrations of insulin, T_3, T_4, NEFA in plasma and blood glucose in control and underfed Najdi lambs

Days	4		14		28		42	
	C	T	C	T	C	T	C	T
Insulin µIU/L	8.1 ±0.8 b	4.5 ±0.4 a	9.4 ±0.8 b	5.6 ±0.6 a	8.7 ±0.6[b]	6.2 ±0.5 ab	9.7 ±0.7 b	7.1 ±0.6 ab
Glucose mg/dl	61 ±3.2 a	51 ±4.7 b	62 ±4.4 a	49 ±4.6 b	61 ±3.2 a	48 ±4.1 b	60 ±5.3 a	47 ±5.2 b
T_3 nmol/l	1.13 ±0.02 a	1.07 ±0.05 a	1.21 ±0.03 a	1.09 ±0.04 a	1.21 ±0.07 a	1.11 ±0.06 a	1.13 ±0.07 a	1.21 ±0.08 a
T_4 nmol/l	57.3 ±3.4 a	58.2 ±4.2 a	56.5 ±3.7 a	62.1 ±2.5 a	58.3 ±4.2 a	60.3 ±4.5 a	57.2 ±5.1 a	59.2 ±3.4 a
NEFA mmol/l	0.61 ±0.01[a]	0.21 ±0.03[b]	0.17 ±0.02[a]	0.25 ±0.04[b]	0.18 ±0.06[a]	0.27 ±0.01[b]	0.17 ±0.03[a]	0.28 ±0.02[b]

C= Control Najdi lambs group　　T= Underfed Najdi lambs group
Means having different subscripts are significantly different at $P<0.05$

التغيرات في اسولين البلازما، هرمونات الغدة الدرقية، الاحماض الدهنية
الغير استيريديه وجلوكوز الدم في حملان النجد الغير مغذاه

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اجريت التجربه علي 60 من حملان النجد، قسمت الي مجموعتين، الحداهما مجموعة ضابطه تغذت علي عليقه مركزة، واخري مجموعه معالجه اخذت نصف كمية العليقه المقرره للمجموعة الضابطه، وبالتحليل الاحصائي للنتائج التي امكن التوصل اليها تلاحظ ان معدل الجلوكوز والانسولين اعلي معنويا في المجموعة الضابطه، ومعدل الاحماض الدهنيه الغير استيريدية اعلي في المجموعه المعالجه، وانه ليس هناك فرق معنوي في هرمونات الغده الدرقيه بين المجموعتين، ومن هذا يستنتج ان تقدير جلوكوز الدم وانسولين البلازما والاحماض الدهنيه الغير استريديه دليلا جيدا لاظهار اثر الجوع وسوء التغذيه في الحملان الناميه.