MEDWIN PUBLISHERS
Committed to create value for Researchers

Open Access Journal of Veterinary Science & Research
ISSN: 2474-9222

Somatotropic Axis Associated Growth Governance in Livestock

Afsal A[1,2] and Sejian V[1]*

[1]ICAR-National Institute of Animal Nutrition and Physiology, Adugodi, Hosur Road, Bangalore-560030, India

[2]Academy of Climate Change Education and Research, Kerala Agricultural University, Vellanikkara, Thrissur, Kerala, India

Opinion

Volume 3 Issue 1

Received Date: March 05, 2018

Published Date: March 13, 2018

Corresponding author: Veerasamy Sejian, ICAR-National Institute of Animal Nutrition and Physiology, Adugodi, Hosur Road, Bangalore-560030, India, Tel: +91-9483314383; E-mail: drsejian@gmail.com

Background

The animal productions are the outcome of integration between nutrient intake and multiple interactions between the neuro-endocrine systems. Further, the effect of genetic and the various environmental factors associated with changing climate scenario are known to negatively influence animal production. Growth was considered to be the primary productive response that gets compromised when then animals are subjected to environmental stresses. Somatotropic axis was considered the central regulator of growth performance in animals. Therefore, understanding the hidden intricacies of how somatotropic axis affects growth and the associated pathways may pave way for identification of animals with superior growth potential.

Somatotropic Axis and its Components

The somatotropic axis mainly consists of growth hormone (GH), insulin-like growth factors (IGF-I and II), their associated target organs and receptors. Further, it plays pivotal role in the control of metabolism and regulation of various physiological process in animals [1,2]. Apart from the components of somatotropic axis, other hormones like insulin, leptin, glucocorticoids and thyroid hormones are also involved in controlling the growth mechanism by moderating GH and IGF-I production and action. The somatotropic axis plays a pivotal role in coordinating the associated endocrine system and the interactions with various other hormonal regulators for maintaining the growth homeostasis. This indicates the complexity in the interaction between the neuro-endocrine regulators to maintain growth performance in livestock.

Significance of Somatotropic Axis

The hypothalamic–pituitary–somatotropic axis which includes the secretion of growth hormone (GH; somatotropin) from somatotrophs, specialized cells present in the anterior pituitary, and represents the leading factor for the apical "growth regulator and support the subsequent stimulation of insulin-like growth factor 1 (IGF-1) produced from liver. Other hypothalamic–pituitary hormones such as growth hormone-releasing hormone (GHRH; somatocrinins), growth hormone-inhibiting hormone (GHIH; somatostatin), and ghrelin (GHS) are also involved in the control of GH secretion from the pituitary gland [3]. Thus the GH activity is regulated at multiple levels. The secretion of GH from pituitary gland has been regulated by the interplay of two hypothalamic neuropeptides GHRH and somatostatin which stimulates and inhibits the GH secretion respectively. The pattern of GH secretion is an important determinant of growth rate and productivity in the animal. Also, GH activity can be regulated at the level of the GHR, with malnutrition in particular associated with a state of GH resistance. The IGF system contains two factors termed IGF I and II. The IGF I is correlated with postnatal growth and metabolism which is regulated by GH. Although structurally similar to insulin, IGFI differs with respect to its place of origin and mode of action. The IGF-1 is primarily produced from liver as an endocrine hormone as well as in other tissues in a paracrine fashion. After birth, IGF-I circulated to blood at a level of high concentrations mostly by hepatic production. Apart from these regulators, few insulin like growth factor binding proteins (IGFBP) have also been identified. These IGFBPs play a major role in transporting IGFs in the circulation to the target tissues and modulation of IGFs action by controlling their access to specific receptors. The production and action of GH and IGF1 mainly depends on the nutritional status of the animal [4,5]. The nutritional status of an animal can be identified through modulation of tissue sensitivity to GH. Hence, nutrition could be considered as a primary factor in determining growth and the regulation of the somatotropic axis in the postnatal ruminant animals

Nutritional Status and Somatotropic Axis

The nutritional stress affects the somatotrophic axis related gene expression and endocrine regulation in farm animals. Nutritional status plays a major role in regulating the levels of GH, IGF-I, and their respective binding proteins and receptors. The reduced feed intake can also affect the plasma GH concentrations and ultimately result in the reduced metabolic clearance rate of GH. Further, the metabolic clearance of GH was also regulated by the GH associated feedback mechanisms as well as the altered properties of GHRs. Also, both moderate and severe food restrictions finally result in a decrease of plasma IGF-I concentrations. Dietary protein supply seems to be the limiting factor for maximal stimulation of IGF-I plasma concentrations. Nutritional restriction and post-partum negative energy balance generally result in a decrease in the concentration of both circulating IGF-I and IGFBP-3 which is due to lower hepatic synthesis. Further leptin hormone also was found to play a significant role in controlling the growth performance of the animals. The reduced leptin concentration in feed restricted animals could be activate the appetite center in the hypothalamus and stimulate feed intake and initiate adaptive mechanisms by synthesizing glucocorticoid production to favor hepatic gluconeogenesis and also decrease thyroid activity to maintain the homeostasis in animals [4].

Somatotropic Axis Associated Biological Markers for Growth Potential

Ghrelin is known to be important in the control of GH secretion and feeding behavior. Moreover, the nutritional status of an animal is at stake, the level of ghrelin increases, and it has an orexigenic effect in stimulating the appetite center to increase the GH concentration [6]. Furthermore, the increased ghrelin concentration also was found to be associated with the upregulation of GH gene. Nutritional stress also influences the GH expression in the pituitary and GHR gene expression in the liver. The IGF-1 hormone level is an indicator of nutritional status in many species and the nutrient restriction was associated with a marked decline of circulating IGF-1 in livestock [7]. It has anabolic effects which ultimately mediate the changes in growth and metabolism under different nutritional status. From the above facts it is evident that ghrelin, GH and IGF-1 may serve as ideal indicators of nutritional status in farm animals.

Blood leptin levels also respond to changes in nutritional status in livestock. Leptin has multiple roles in regulating physiological and behavioral responses of the animal. Also, it plays a pivotal role in control of body growth and adaptation. Leptin serves as a unique nutritional cue to reflect the status of growth axis [8]. The high leptin levels were observed to inhibit the feed intake through binding to specific receptor in the hypothalamus. Also, the respiration rate and rectal temperature are identified as physiological markers for assessing the nutritional status in animals. T3 (Triiodothyronine), T4 (Thyroxine) and cortisol are the metabolic and stress relieving hormones which are produced from the thyroid and adrenal gland respectively. These endocrine variables also may directly reflect the nutritional status of the animals indicating that these variables also could serve as markers for nutritional stress. Finally, few cellular markers such heat shock protein 70 (HSP70) and HSP90 also were established to be upregulated during nutritional stress [9]. Therefore, these genetic traits also could be considered reliable molecular markers for nutritional stress in livestock.

Way Forward

Somatotropic axis was established to be the primary control centre for regulating growth performance in livestock. There are several endocrine product from this axis which plays vital role in governing the growth mechanisms. Several endocrine and genetic variables such as GH, IGF-1, ghrelin, leptin, T3, T4, HSP70 and HSP90 were established to be the biological markers for depicting the growth status of the animals [9,10]. Although sufficient information available in establishing the roles of these variables in regulating the growth, still there are unidentified pathways associated with growth axis. Further, the interrelationship among these endocrine and genetic variables in governing the growth mechanisms in farm animals has not been elucidated. Advanced biotechnological tools such as functional genomics, microarray technology, whole transcriptome analysis, whole genome association studies and next generation sequencing technology offers huge scope for establishing these hidden intricacies and various pathways associated with growth axis. This suggests the significance of future research efforts in elucidating these unidentified mechanisms in farm animals. This may pave way for identification other important biological markers which in coordination with the already established markers could serve to identify animals with superior growth efficiency through marker assisted selection.

References

1. Padgett DA, Glaser R (2003) How stress influences the immune response. Trends in immunology 24(8): 444-448.
2. Keogh K, Waters SM, Kelly AK, Wylie AR, Kenny DA (2015) Effect of feed restriction and subsequent re-alimentation on hormones and genes of the somatotropic axis in cattle. Physiological genomics 47(7): 264-273.
3. Renaville R, Hammadi M, Portetelle D (2002) Role of the somatotropic axis in the mammalian metabolism. Domestic animal endocrinology 23(1-2): 351-360.
4. Bagath M, Sejian V, Archana SS, Manjunathareddy GB, Parthipan S, et al. (2016) Effect of dietary intake on somatotrophic axis–related gene expression and endocrine profile in Osmanabadi goats. Journal of Veterinary Behavior: Clinical Applications and Research 13: 72-79.
5. Steyn FJ, Tolle V, Chen C, Epelbaum J (2016) Neuroendocrine regulation of growth hormone secretion. Comprehensive Physiology 6: 687-735.
6. Phomvisith O, Takahashi H, Mai HT, Shiotsuka Y, Matsubara A, et al. (2017) Effects of nutritional status on hormone concentrations of the somatotropin axis and metabolites in plasma and colostrum of Japanese Black cows. Animal Science Journal 88(4): 643-652.
7. Sejian V, Bahadur S, Naqvi SM (2014) Effect of nutritional restriction on growth, adaptation physiology and estrous responses in Malpura ewes. Animal Biology 64(2): 189-205.
8. Delavaud C, Bocquier F, Chilliard Y, Keisler DH, Gertler A, (2000) Plasma leptin determination in ruminants: effect of nutritional status and body fatness on plasma leptin concentration assessed by a specific RIA in sheep. Journal of Endocrinology 165(2): 519-526.
9. Sejian V, Bagath M, Parthipan S, Manjunathareddy BG, Selvaraju S, et al. (2015) Effect of different diet level on the physiological adaptability, biochemical and endocrine responses and relative hepatic HSP70 and HSP90 genes expression in Osmanabadi kids. J Agric Sci Technol A 5: 755-769.
10. Wathes DC (2012) Mechanisms linking metabolic status and disease with reproductive outcome in the dairy cow. Reproduction in domestic animals 47(s4): 304-312.