ELSEVIER

Animal Reproduction Science 106 (2008) 48–64

ANIMAL REPRODUCTION SCIENCE

www.elsevier.com/locate/anireprosci

# Correlation of nitric oxide (NO) activity and gonadal function in Japanese quail, *Coturnix coturnix japonica* following temporal phase relation of serotonergic and dopaminergic oscillations

Pankaj Kumar, Chandra Mohini Chaturvedi *

*Department of Zoology, Banaras Hindu University, Varanasi 221005, UP, India*

Received 1 December 2006; received in revised form 7 March 2007; accepted 23 March 2007
Available online 4 April 2007

## Abstract

Nitric oxide (NO), a highly reactive and short-lived radical, is considered to be an important trigger molecule for several physiological mechanisms including gonadotrophin releasing hormone (GnRH) secretion in mammals, although there is no such information in avian literature. On the other hand, specific temporal phase relation of circadian neural (serotonergic and dopaminergic) oscillations is reported to modulate reproductive activity in many avian species including Japanese quail. The present study was undertaken to investigate the correlation of NO activity and gonadal function of Japanese quail. In experiment I, the effect of serotonin and dopamine precursors, (5-hydroxytryptophan (5-HTP) and L-dihydroxyphenyalanine (L-DOPA) respectively; 5 mg per 100 g body weight) administered at intervals of 8 or 12 h over a period of 13 days, was studied on reproductive responses and NO activity. Measurements of body weight, cloacal gland size, testosterone concentration, spermatogenesis, nitrite–nitrate concentration in plasma, hypothalamus and testes, and NADPH-diaphorase (NADPH-d) activity in testes were made on the 2nd, 3rd, 6th and 11th days of treatment and 2nd and 30th day post-treatment. In experiment II, quail were divided into five groups including the control. One experimental group received 13 daily injections of 5-HTP and L-DOPA at intervals of 8 h along with 0.1 ml of normal saline administered orally (8-hr + Veh), while another group of 8-hr quail received NO donor (sodium nitroprusside (SNP), 5 mg per 100 g body weight) orally (8-hr + SNP). The third experimental group received 5-HTP and L-DOPA at intervals of 12 h along with normal saline (12-hr + Veh), while the fourth group of quail along with 5-HTP and L-DOPA at intervals of 12 h also received the NOS inhibitor (*N*-nitro-L-arginine methyl ester, L-NAME, 25 μg per 100 g body weight) intraperitoneally (12-hr + L-NAME) for 13 days. This experiment was terminated after 21 days of the treatment.

* Corresponding author. Tel.: +91 542 2368323; fax: +91 542 2368323.
*E-mail address:* cmcbhu@yahoo.com (C.M. Chaturvedi).

0378-4320/$ – see front matter 
doi:10.1016/j.anireprosci.2007.03.025

Results indicate that 5-HTP and L-DOPA administered 8 h apart (8-hr) suppressed but if given 12 h apart (12-hr) stimulated the reproductive system and NO activity compared to the control. These effects were apparent on the 6th day of injections and were maintained 30 days following the termination of the treatment. A significant decrease in nitrite and nitrate concentration and NADPH-d activity in reproductively inhibited 8-hr group and an increase in reproductively stimulated 12-hr quail was also evident. In contrast, these activities were stimulated in 8-hr + SNP quail and were suppressed in 12-hr + L-NAME group quail. It is concluded that activity of the reproductive system and NO activity waxes and wanes simultaneously in Japanese quail. Moreover, experimental modulation of gonadal activity (following changes in the phase relation of serotonergic and dopaminergic activity) or NO activity (following the administration of NO modulator or inhibitor) affects each other maintaining a parallel relation between the two systems. Further, it is interesting to note that the gonado-stimulatory effect of SNP overpowers the gonado-inhibitory effects of the 8-hr time interval and inhibitory effects of L-NAME mask the stimulatory effects of 12-hr temporal relation of 5-HTP and L-DOPA administration. These findings strongly suggest that reproductive effects may be induced via changes in NO activity, however the exact mechanism by which NO drives gonadal axis needs to be ascertained.


*Keywords:* Nitric oxide; Nitrite and nitrate; NADPH-d; 5-HTP; L-DOPA; Testosterone; Reproduction; Japanese quail

## 1. Introduction

Maintenance of body homeostasis is the function of complex interactions between two major central processing information systems, namely the neuroendocrine and the autonomic nervous systems. An intricate network, comprising a rich bidirectional connectivity between these systems, enables the central nervous system to generate complex patterns of autonomic/neuroendocrine outputs required for the maintenance of proper homeostasis and physiological functions (Palkovits, 1999). Furthermore, besides neuron-to-neuron interactions, flow of information within these circuits occurs through complex vascular–neuro-glial interactions, which also contribute to their ability to adapt in response to changes in the activity of peripheral inputs/signals (Miyata and Hatton, 2002; Paton et al., 2002).

Many studies have focused on the regulation of seasonal avian reproduction involving exogenous (photoperiodic) and/or endogenous (thyroid or pineal control) mechanisms (Thapliyal, 1969; Nicholls et al., 1988; Goldsmith et al., 1989; Underwood et al., 2001; Dawson and Thapliyal, 2002). It has been also suggested that the temporal phase relation of circadian neural oscillations is the basis of reproductive seasonality (Miller and Meier, 1983a; Chaturvedi and Bhatt, 1990; Chaturvedi and Prasad, 1991; Chaturvedi et al., 1991, 2006). Experimental studies indicate that daily injections of L-DOPA (L-dihydroxyphenyalanine, dopamine precursor) given 12 h after 5-HTP (5-hydroxytryptophan, serotonin precursor) administration (12-hr relation) established a gonado-stimulatory condition but when these injections were given 8 h apart (8-hr relation), breeding activity and gonadal growth were suppressed in the white throated sparrow, *Zonotrichia albicolis*; house sparrow, *Passer domsticus*; red headed bunting, *Emberiza bruniceps*; Indian Weaver bird, *Ploceus philippinus*; spotted munia, *Lonchura punctulata*; Lal munia, *Estrilda amandava*; Japanese quail, *Coturnix coturnix japonica*. All other time schedules/relations (0, 4, 16 and 20 h) were found to be ineffective (Miller and Meier, 1983a,b; Chaturvedi and Bhatt, 1990; Chaturvedi and Prasad, 1991; Chaturvedi et al., 1991, 1997, 2006; Bhatt and Chaturvedi, 1992; Phillips and Chaturvedi, 1992, 1995; Prasad and Chaturvedi, 1992).