PROSTATE GLAND ENZYMEOLOGY OF SEXUALLY "QUIESCENT" AND "ACTIVE" TAPHOZOUS MELANOPOGON MELANOPOGON TEMMICK (MICROCHILOPTERA: MAMMALIA)

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ABSTRACT

Histochemical studies on the site and pattern of distribution of monoamine oxidase (MAO), lactate dehydrogenase (LDH) and β-galactosidase in the prostate gland of sexually "quiescent" and "active" Taphozous melanopogon melanopogon Temmick revealed identical activity of MAO and LDH, but the pattern of distribution of β-galactosidase varied in the aforesaid reproductive states.

It is suggested that uniform presence of MAO facilitates catabolism of the biogenic amines, thus circumventing its deleterious actions on the gland. Positive LDH activity during the two reproductive states signifies the importance of lactate metabolism in the gland. This may be important for the integrity of the gland and its basal metabolic activity.

The varying β-galactosidase activity in the prostate gland during phases of sexual "activity" and "quiescence" may represent differential rates of hydrolysis and hence utilization of carbohydrates. The weak activity of this enzyme during reproductive arrest may be due to decline in the rate of utilization of carbohydrates.

INTRODUCTION

MAMMALIAN prostate gland contributes a variety of substrates, enzymes, and electrolytes to the semen. These secretions not only add to the volume of the seminal fluid, but also serve as vehicle for the transport of spermatozoa. The latter depend for their sustenance, viability and motility on the biochemicals present in the semen. Many biochemicals have been shown to be prostate specific. These secretory activities are reflected in the histoarchitecture and fine structure of the gland.

Histochemical studies on the site and distribution of anabolic and catabolic enzymes in the prostate glands of mammals are deficient and except for our earlier reports, further information on the prostate gland enzymology of Chiroptera is not available. We report here histochemical assessment of the site and distribution of monoamine oxidase (MAO), lactate dehydrogenase (LDH), and β-galactosidase in the prostate gland of sexually "quiescent" and "active" Taphozous melanopogon melanopogon Temmick.

MATERIALS AND METHODS

Males of T. m. melanopogon were netted locally throughout the year. They were maintained in batches of 2-3 each in steel cages with wire nettings. They had access to sugared water ad libitum. A total of 17 males was used. The approach to dissection of the animal and the recovery of tissues were described earlier.

Fresh unfixed frozen sections of prostate gland of sexually "quiescent" and "active" lats were cut at 10 μM for histochemical localisation of MAO and LDH. For the demonstration of β-galactosidase, the tissues were fixed in chilled 10% neutral formalin and sectioned on a cold microtome.

The sections were processed for the histochemical localisation of the aforesaid enzyme species as follows:

(a) MAO: Activity was demonstrated according to the method of Gleener et al. using tryptamine hydrochloride (Fluka) as substrate. The sections were incubated for 15 min at 37°C. Presence of blue dihydroformazan granules indicated the cellular sites of MAO activity. Sections incubated in a substrate-free medium served as control.

(b) LDH: Activity was demonstrated by the method of Hess et al. Sections were fixed briefly (2 min) in formalin vapor. They were incubated in the appropriate substrate solution containing nitroblue tetrazolium and nicotinamide adenine dinucleotide (NAD) for 15 min at 37°C and fixed in 10% neutral formalin. Blue formazan deposits indicated LDH activity. Suitable controls (sections incubated in substrate-free medium) were run simultaneously.

(c) β-galactosidase: Activity was determined in the sections according to the method of Rutenburg et al., using 6-bromo-2-naphthyl-β-D-galactopyranoside as substrate. Controls were incubated and processed identically but in a substrate-deficient medium.

Enzyme activity in the histologic constituents of the prostate gland was visually appraised and scored as described earlier.
RESULTS AND DISCUSSION

The unpaired prostate gland of *T. m. melanopogon* is of the alveolo-glandular type and is composed of tightly packed acini lined by a single layer of secretory cells. The latter exhibited hypertrophy during sexually “active” state and underwent involutory changes as the animals entered a phase of sexual “quiescence”. The acini were separated by a single strand of smooth muscles. The prostatic urethra was traversed by several ductules which elaborated their secretions into it.

Intense activity of MAO and LDH was histochromically localised in the acini and in the pseudo-stratified transitional epithelium of the prostatic urethra. The prostatic fluid in the urethra also exhibited positive enzyme reaction. Secretion droplets in the luminal fluid of the acini also manifested positive staining reaction for MAO and LDH. No significant differences in the pattern of distribution of these enzymes were noticed in the sexually “quiescent” and active phase; although the histology and general appearance of the gland were different (Plate I and II).

Positive MAO activity in the prostate gland of bat suggests that synthesis and elaboration of this enzyme occurs in this organ. This may endow to the prostate the ability to catabolise biogenic amines that might otherwise detrimentally affect the male gamete, as well as challenge the integrity of the organ and its metabolic activity. This finding is in consonance with our earlier study on an allied species *Taphozous longimanus*. Perhaps, no other tangible information exists in the literature on MAO activity in the prostate gland of any other mammalian species.

LDH is a key glycolytic enzyme involved in carbohydrate metabolism. It catalyses the interconversion of lactate ⇌ pyruvate by simultaneous oxidation and reduction of the coenzyme NAD. The positive activity of this enzyme in the prostate gland of sexually “quiescent” and “active” bats is a clear histochemical proof for the importance of lactates in the metabolic processes of this gland. Although no histochemical localisation of this enzyme seems to have been attempted in any mammalian species, LDH has been biochemically estimated in the seminal fluid*. Changes in the pattern of LDH isoenzymes have been related to certain pathologies in the prostate, e.g., prostatic cancer and hyperplasia†.

In sexually “active” bats, β-galactosidase was intensely localised in the prostatic acini, smooth muscles, connective tissue and histological constituents of the prostatic urethra. However, mild activity of this enzyme was discerned in the prostate gland components of sexually “active” bats (Plate III). The presence of β-galactosidase suggests its role in the carbohydrate degradation. Relatively less activity of this enzyme in the sexually “quiescent” bats may be due to the fact that the enzyme is lysosomal and that some sort of compartmentation or the presence of endogenous

![Plate I](image1.jpg) MAO activity during sexually “active” (Figs. 1–2) and “quiescent” phase (Figs. 3–4), × 100.

![Plate II](image2.jpg) LDH profile of sexually “active” (Figs. 1–2) and “quiescent” bats, × 100.

![Plate III](image3.jpg) β-galactosidase pattern in sexually “active” (Figs. 1–2) and “quiescent” (Figs. 3–4) bats, × 100.
inhibitor might be preventing enzyme-substrate interaction.

β-galactosidase is an heterogeneous enzyme which has been implicated in the hydrolysis of gangliosides and lipids. It is reported to consist of two types of isoenzymes—'neutral' galactosidase and 'acid' galactosidase. Results of several biochemical studies indicate that this enzyme is either wholly or partly lysosomal in origin. The occurrence of β-galactosidase in the prostate gland of bats seems to indicate the considerable abilities of the secretory epithelium to metabolise a wide array of substrates. This is borne out by the fact that the chemical composition of the seminal fluid is so complex. Obviously, such elaborations are crucial for the integrity and functional competence of the male gamete.

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SECOND CONGRESS OF FAOB AND GOLDEN JUBILEE MEETING OF SOCIETY OF BIOLOGICAL CHEMISTS (INDIA)

On the occasion of the Second Congress of Federation of Asian and Oceanian Biochemists (FAOB) and the Golden Jubilee Meeting of the Society of Biological Chemists (India), about 1,400 delegates from all parts of India and from countries as distant as Australia, Japan, United States and Italy gathered together at the Indian Institute of Science, Bangalore, from December 14 to 18, 1980. FAOB, consisting of biochemists from India, Japan, Australia, Pakistan, Bangladesh, Taiwan, Malaysia, Korea, Philippines, Singapore, Thailand, Hawaii, Hong Kong, Indonesia and New Zealand had its first Congress in Nagoya, Japan, in 1977 and the third Congress is scheduled to be held in Bangkok, Thailand, in 1983. The Society of Biological Chemists (India) was founded in 1921 with its headquarters at the Indian Institute of Science, Bangalore, and has 1,300 members from all over India.

The topics discussed at the meeting ranged from diseases like leprosy and cancer to control of fertility, environmental pollution and plant productivity. There was also a symposium on the impact of biosciences on society and a panel discussion on perspectives in biochemical education. Besides these applied aspects, there were symposia on frontiers in biochemistry like genetic engineering and structure and function of biopolymers.

The meeting consisted of five Golden Jubilee Lectures and one FAOB Lecture, symposia in six areas in biological chemistry, and free papers presented as posters. The six areas in which symposia were conducted were (1) biochemical effects of environmental pollution, (2) biochemistry of developing brain, (3) transfer of genetic information: principles and practice, (4) photosynthesis and plant productivity, (5) structure and function of biopolymers, biomembranes and cell surfaces and (6) biochemical and immunological approach to disease and reproduction.

Some of the highlights of the topics discussed were as follows. Dr. B. D. Sanwal from Canada spoke on the control of cyclic nucleotide phosphodiesterases which existed in multiple forms, one of these forms being regulated by a phosphorylation-dephosphorylation mechanism at the fine level. Mechanisms which led to the enhancement of the degradation of cyclic AMP were probably as important in the regulation of cyclic AMP levels as the oft-studied hormonal
mechanisms. Dr. J. R. Tata described studies on the activation by the hormone estrogen of vitellin genes through the application of recombinant DNA technology; the amplification of DNA coding for vitellin by cloning had allowed a more rigorous quantitation of transcription of vitellin gene in the presence or absence of estrogen.

Dr. K. Yagi from Nagoya, Japan, described the effects of the oxidation of fats and oils by light, air, etc., on degenerative diseases like atherosclerosis and retinopathy. He discussed the prevention and treatment of these disorders. Dr. A. N. Radhakrishnan from Hyderabad described how proteins were broken down into peptides in the intestines and absorbed, and how malfunctioning of this process occurred in many subjects in India. Dr. T. Kada from Mishima, Japan, explained how vegetables such as spinach, cabbage, etc., destroyed the mutagenic compounds produced when certain foods were heated. Dr. H. K. M. Yusuf from Bangladesh described how malnutrition impaired the development of the brain of young children. In mice rehabilitation for one month subsequent to malnutrition during the first 30 days of life results in the brain recovering from the impairment, but not later than 30 days. Dr. Yu. S. Nasyrov from Dushanbe, U.S.S.R., showed how mutation of the genes of carbon dioxide fixing enzymes in plants led to better photosynthesis. Dr. V. Sasisekharan from Bangalore described a new structure of DNA, the hereditary material, which he and his group had discovered. Dr. G. P. Talwar from Delhi and Dr. C. V. Bapat of Bombay spoke about the prospects of producing vaccines against leprosy and Dr. R. F. Anders from Melbourne, Australia, described how vaccines against malaria could be produced by using the recently discovered hydridoma technology. Dr. T. M. Jacob of Bangalore described experiments which showed that RNA-binding antibodies could be used as anticancer agents. Dr. A. L. Lehninger from U.S.A. discussed the stoichiometric relationships in mitochondrial electron transport and phosphorylation.

A number of scientists discussed the various methods for controlling fertility in humans. Dr. P. R. Adiga from Bangalore showed that a protein carrying vitamins like riboflavin was necessary for foetal survival, and a vaccine directed against this protein prevented conception. Dr. O. P. Bahl from New York and Dr. Thanawala from London described experiments to show that a vaccine against the female hormone, human chorionic gonadotropin, produced complete fertility control.

Quite a number of papers, both under symposia and free papers, were contributed by workers from the Indian Institute of Science, Bangalore. Apart from those mentioned above, Dr. N. Appaji Rao, who gave the Sreenivasaya Memorial Lecture, spoke on the form and function of regulatory enzymes. His results highlighted the regulation of mung bean nucleotide pyrophosphatase by association-dissociation of the enzyme in the presence of adenine nucleotides and other regulatory molecules. Dr. P. S. Sastry described a new cholesterol ester synthetase in developing rat brain. Dr. K. P. Gopinathan described the chromosome structure of the transducing mycobacteriophage 13 which was isolated in 1972 by Sundar Raj and Ramakrishnan; the phage DNA had large single-stranded ends amounting to one-third the size of the total genome and showed different levels of supercoiling. Dr. P. Balaram discussed the effects of peptide chain length and charge on channel formation taking alamethicin as a model. Dr. V. S. R. Rao described theoretical studies on the binding specificities of \( \beta \)-lactam antibiotics to transpeptidases and penicillinases. Dr. Paul Vithayathil discussed the structural degeneration processes of ribonuclease A.

In all, the Conference proved a stimulating one both for veteran scientists and students alike. The scientific sessions were interspersed in the evenings with light entertainment, so that scientists could come to the scientific sessions next morning with receptive minds.

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