CHAPTER 8

ARGINASE AND PREMIGRATORY ADAPTIVE CHANGES IN THE LIVER AND KIDNEY OF MIGRATORY STARLING (*STURNUS ROSEUS*) AND WAGTAIL (*MOTACILLA ALBA*)

Arginine is one of the glucogenic amino acids. Hydrolysis of arginine catalyzed by arginase is the first step in a chain of reactions leading to conversion of arginine into intermediate product which can enter into TCA cycle. In mammals, liver arginase is an important component of ornithine-urea cycle. In birds, all the enzymes of ornithine-urea cycle are not present in any tissue of their body *i.e.* ornithine-urea cycle is incomplete in birds (Boorman and Lewis, 1971). However, the presence of arginase has been reported in the liver of several avian species (Brown, 1966). Tamir and Ratner (1963) reported that arginase is moderately active in the liver and highly active in the kidney of chickens. Dietary and hormonal manipulations are known to modify the intensity of arginase activity in the tissues of birds (O'Dell *et al.*, 1965; Grazi *et al.*, 1972). Inspite of considerable work so far done on this enzyme in birds, its metabolic significance is not yet fully

understood. Perhaps with this fact in mind, Tamir and Ratner (1963) considered it to be a vestigeal enzyme in birds.

The migratory birds, Rosy Pastor and Wagtail exhibit different feeding habits during their premigratory period. In the Rosy Pastor, dietary carbohydrates support premigratory hyperlipogenesis. The Wagtail due to its habit of feeding on protein and lipid rich diet is confronted with a supply of amino acids in excess. In this birds, dietary carbohydrates would be insufficient to meet with the demand for hyperlipogenesis during premigratory period. Consequently, the glucogenic amino acids can contribute their carbon chains by channeling ~~it~~ them into pathways of carbohydrate and lipid metabolism.

The objective of the present study on arginase activity in the liver and kidney of the two migratory birds with varying food preferences, was to understand its possible involvement in the intermediary metabolism with special emphasis on its role in premigratory adaptations.

MATERIALS AND METHODS

Rosy Pastors and Wagtails were shot and brought to the laboratory immediately. Liver and kidney were

excised, blotted free of blood and homogenized in cold distilled water.

Tissue homogenates were used for assaying the arginase activity employing the method described by Brown (1966). Enzyme activity was terminated by adding of 2ml of 87% acetic acid. Urea formed as a result of enzymatic hydrolysis was estimated using xanthydrol reagent as described by Greenberg (1955). Protein content of the homogenate was estimated employing the method of Lowry et al. (1951). Enzyme activity is expressed as μ mole of urea released/mg protein/30 minutes.

RESULTS

Data presented in Table 1 and Fig. 1 show that the liver arginase activity in Rosy Pastor was quite low while that in Wagtail was relatively higher. Arginase activity in the kidney of both the birds was observed to be higher than that observed in their respective liver. During the premigratory period, significant reduction in the level of the arginase activity in the liver (Fig. 1) and kidney (Fig. 2) of Rosy Pastor was noticed, while that in the liver and kidney of Wagtail increased.

TABEL 1

Arginase activity in the liver and kidney of Wagtail and Rosy Pastor. Expressed as μ Mole urea released/mg protein/30 min. Mean value ± S.D.

Month	Wagtail		Rosy Pastor	
	Liver	Kidney	Liver	Kidney
October	---	---	9.00 ±0.34	76.79 ± 3.41
November	90.58 ±21.06	435.71 ±90.29	---	---
December	101.44 ± 4.59	501.67 ±84.32	---	---
January	78.72 ± 4.10	548.49 ±76.60	---	---
February	120.32 ±10.00	591.06 ±58.79	---	---
March	125.61* ±12.81	758.18* ±55.21	---	---
April	---	---	2.88* ±0.36	55.97* ±4.62
*Significant at the level	P<0.05	P<0.05	P<0.005	P<0.05

*P values refer to differences between post and premigratory periods. The Student's 't' test was used to analyze differences in means.

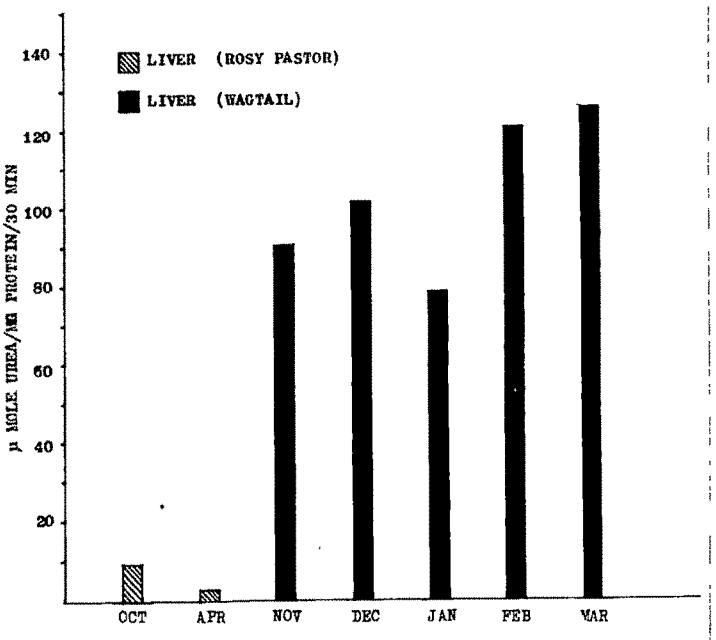

FIG. 1 LEVELS OF ARGINASE ACTIVITY IN THE LIVER OF ROSY PASTOR AND WAGTAIL. ENZYME ACTIVITY IS EXPRESSED AS μ MOLE UREA FORMED/MG PROTEIN/30 MINUTES.

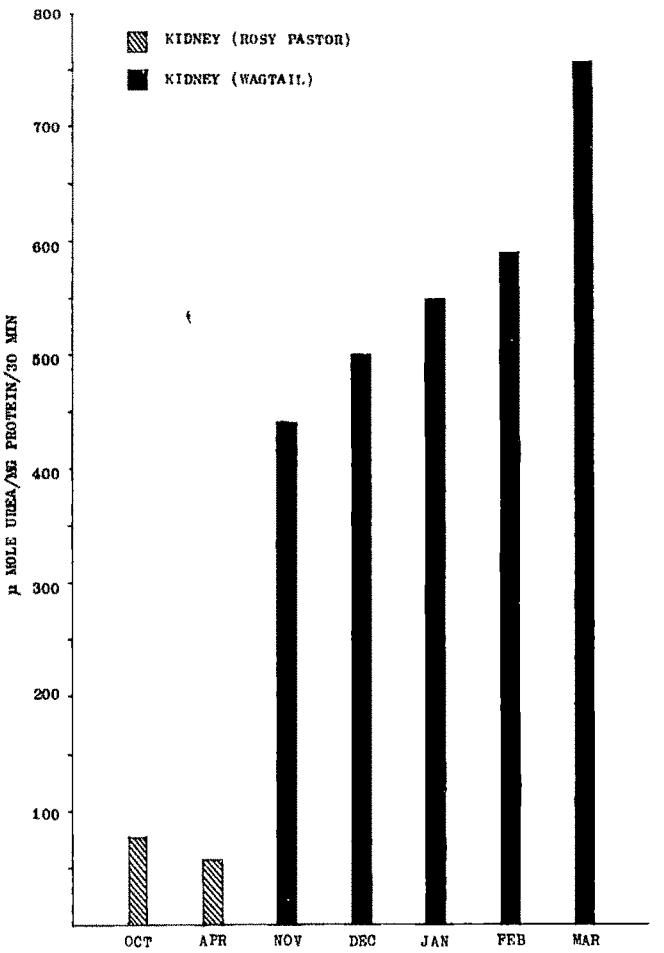

FIG. 2 LEVELS OF ARGINASE ACTIVITY IN THE KIDNEY OF ROSY PASTOR AND WAGTAIL. ENZYME ACTIVITY IS EXPRESSED AS μ MOLE UREA FORMED/MG PROTEIN/30 MINUTES.

DISCUSSION

Liver and kidney of both the migratory birds studied revealed the presence of arginase activity. With kidney having higher level of the enzyme than that in their respective liver. These findings are in agreement with the reports of Smith and Lewis (1963) and Tamir and Ratner (1963) who have also shown that kidney of fowl has higher arginase activity than its liver.

Arginase activity in the liver and kidney of Wagtail was significantly higher than the same in the respective organs of the Rosy Pastor. Such a difference in the enzyme activity in the tissues of these migratory birds may be due to the difference in the nature of the food they consume. Higher level of arginase activity in the tissues of Wagtail can be correlated with its protein rich diet. Present findings are in accordance with those of Bauerova and Sorm (1956) who concluded that the arginase activity in bird liver homogenate depends on the protein content of its diet.

In view of the fact that Ornithine cycle is incomplete in birds (Boorman and Lewis, 1971), the exogenous arginine available through diet will be the

substrate for arginase in the tissues where it is present. This arginine can be metabolized through several pathways, viz., (1) Its involvement in the synthesis of protein and creatine and (2) the formation of ornithine and urea under the action of arginase. Since arginine is an essential amino acid for birds, high arginase activity would waste arginine made available to them. But the very high arginase activity in the liver and kidney of Wagtails feeding on protein rich diet are suggestive of the fact that in these birds, high arginase activity would not simply waste arginine but by hydrolysing excess of arginine, it can provide ornithine. And this ornithine can be catabolized to glutamate, which in turn can be converted to oC-Ketoglutaric acid. This keto acid entering into TCA cycle can contribute later in production of acetyl Co A, which in turn can be utilized for lipid synthesis, and the urea liberated during arginine hydrolysis can be excreted. Thus, it is possible to envisage that the arginase in the liver of Wagtail might be participating in the production of intermediate products which can be either utilized for energy production or converted into carbohydrate and/or lipid which may get stored. The increase in the arginase activity in the liver of Wagtail observed during premigratory

period can be correlated with hyperphagia and the resultant protein influx that mainfest during this period.

Since the arginase activity in the kidney of Wagtail was also found to be very high, it could be assumed that the rate of utilization of arginine for gluconeogenesis in kidney could be quite high. This assumption finds support in the work of Evans and Scholz (1973) who have reported increased gluconeogenesis in the liver and kidney of chick fed on high fat, high protein, carbohydrate-free diet.

Low arginase activity noticed in the liver and kidney of Rosy Pastors as compared to that in Wagtails can be explained on the basis of the fact that the former unlike Wagtail receive large amount of carbohydrate and less protein through its diet. Besides, during premigratory period, the arginase activity in the liver and kidney of Rosy Pastors was found to be further reduced. This is only to be expected, as they consume large amount of carbohydrate rich diet (fruits) during this period and with a lesser protein intake, the need for high activity of arginase does not arise. It is also significant to note that both arginase and ornithine-δ-transaminase are present in avian liver and show response to condition that

stimulates gluconeogensis (Vecchio and Kalman, 1968).

Finally, on the basis of the present findings, it could be safely suggested that differential activity of arginase in the liver and kidney of Wagtail and Rosy Pastor is a part of the adaptive mechanisms in response to the diet, especially so during their premigratory phase.