CHAPTER 3

STUDIES ON DEVELOPING AVIAN LIVER 3. ASCORBIC ACID LEVEL IN THE LIVER AND KIDNEY OF PIGEON DURING POST-HATCHING DEVELOPMENT

Previous study, on the growth rate and changes in protein, carbohydrate, fat, nucleic acid and water contents of liver of developing pigeons (Chapter 1) has provided a significant insight into the rate of growth of liver as well as its attainment of functional maturity in relationship with the changing behavioural and feeding patterns of nestling pigeons. From this data as well as from the information obtained from the studies on acetylcholinesterase activity in the liver and serum and ionic concentrations in the liver of the developing pigeons (Chapter 2) it is concluded that the functional maturity of the liver occurs by 20th day after hatching. The present study deals with the ascorbic acid (AA) concentration in the organs like liver and kidney.

Ascorbic acid is actively synthesized in rapidly growing tissues, although this vitamin does not have any

growth promoting function. In adult tissues, the fluctuations in the concentration of AA have been reported to be associated with metabolic activities of the tissues (Gurevich, 1963; Chinoy, 1972). The AA content in the developing chick embryos has also been correlated with the metabolic turnover of the tissues (Barnett and Bourne, 1942; Rinaldini, 1960; Chinoy et al., 1974a & b). The AA is believed to play an important role in the metabolic reactions as an hydrogen ion acceptor thereby preventing many enzymes and cofactors from being rapidly reduced during oxido-reduction reactions. Apart from this, the vitamin also renders assistance to manifold functions, such as haemato-poiesis, immunity and resistance and cold stress. The most important function of AA, as Reid (1954) suggested in his review, must be the one that is connected with the inter-cellular materials i.e., in the synthesis and maturation of reticulin, collagen, bone matrix, dentine and metabolism of mucopolysaccharides.

The ascorbic acid is also known to be associated with the metabolism of carbohydrate (Banerjee and Ghosh, 1947; Banerjee and Ganguli, 1962), lipid (Rush and Kline, 1941) and protein, especially for maintaining tyrosine oxidation (Levine et al., 1941).

Since, ascorbic acid is essential for the formation of intercellular materials and structural elements as well as for metabolic activities, most of the animals have developed the abilities to synthesize it. In fact ascorbic acid is a vitamin only for few animals. Most of the birds and mammals are known to synthesize AA in their tissues (Burns, 1960; Dieter and Breitenbach, 1968; Dieter, 1969; Sebrell and Harris, 1967; Ray Chaudhari and Chatterjee, 1969; Roy and Guha, 1958). Chatterjee et al. (1957) and Roy and Guha (1958) have shown that in some species of birds synthesis of L-ascorbic acid takes place in liver, whereas in others it take place in kidney. Ray Chaudhary and Chatterjee (1969) and Chatterjee (1973) have classified the birds according to their ability to synthesize AA and found that primitive species of birds like fowl and pigeon synthesize it in kidney while in highly evolved passerines, both kidney and liver are involved. ~~in it~~. Some birds (e.g. Red-vented Bulbul) have lost the capacity to synthesize AA and hence have to depend upon dietary sources (Roy and Guha, 1958). The pigeon is capable of synthesizing ascorbic acid and hence need not depend on dietary supplements. Since the AA is necessary for connective tissue formation as well as for stabilizing the enzymes and coenzymes, the concentration of AA could be directly correlated with the growth and

functional maturity of the tissues. This contention has prompted us to undertake this study on the AA concentration in the liver, and kidney of growing young ones of the pigeon.

MATERIAL AND METHODS

The pigeon nestlings of different days of development viz., 1, 5, 10, 15, 20, 25 and 30 days after hatching, as well as adult ones from the colony maintained in the department aviary were utilized for the study. For each stage 5-10 birds were sacrificed and tissues such as liver and kidney were quickly removed and processed for the estimation of ascorbic acid. The ascorbic acid was estimated by the method of Roe and Kuether (1943) as described by Roe (1954). The values of AA is expressed as mg/100 gms of fresh tissue.

RESULTS AND DISCUSSION

The concentrations of ascorbic acid (AA) in the liver and kidney of growing pigeons are recorded in Table 1 and Fig. 1.

In the liver the AA level showed a gradual increase till it reached a peak concentration (55.67 mg/100 gm liver) on 20th day. Thereafter a decline in the level of AA (44.34 mg/100 gm liver) was noticed and this level was more

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EXPLANATION FOR FIGURE

Fig. 1. Graph showing quantitative analysis of ascorbic acid levels in the liver and kidney of pigeon during post-hatching development.

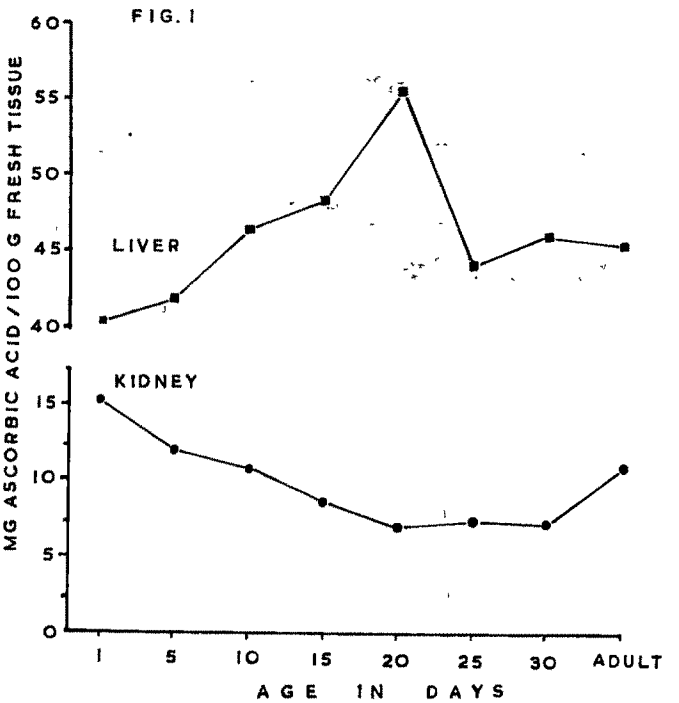
FIG. 1
MG ASCORBIC ACID / 100 G FRESH TISSUE
60
55
50
45
40
LIVER
KIDNEY
15
10
5
0
1
5
10
15
20
25
30
ADULT
AGE IN DAYS

TABLE 1

The Ascorbic acid contents of liver and kidney of pigeon during post-hatching development. Mean ± S.D.

Age in days	Ascorbic acid (mg/100 g fresh tissue)	
	Liver	Kidney
1	40.64 ± 1.20	15.49 ± 0.82
5	42.02 ± 1.01	12.66 ± 0.76
10	46.67 ± 0.08	11.08 ± 0.56
15	48.63 ± 0.09	8.99 ± 0.73
20	55.67 ± 1.24	7.26 ± 0.74
25	44.34 ± 2.12	7.75 ± 0.81
30	46.33 ± 1.05	7.62 ± 0.85
Adult	45.58 ± 0.96	11.33 ± 1.04
*Significant at the level	$p < 0.001$	$p < 0.001$

*p values refer to differences between 1 day and 20 day stages. The Student's 't' test was used to analyze differences in means.

or less maintained all throughout the rest of the development as well as in the adult. The peak level of AA in the liver on 20th day coincided with the maximum growth rate as well as high degree of metabolic activity of the liver (Chapter 1). From the amount of deposition of metabolites and the liver weight-body weight ratio, (Chapter 1) it was reasoned that the 20th day liver has more or less attained ~~the~~ functional maturity. Rinaldini (1960) also suggests that the highest AA content, in the early stages of prenatal development of the chick, corresponds to the maximum specific growth rate.

Since AA is essential for development of structural complements (Reid, 1954) it could be concluded that at 20th day, the laying of the intercellular substances is at a feverish pitch demanding higher concentration of ascorbic acid. However, 20th day liver also shows increased metabolic activities in terms of deposition of higher concentration of metabolites (Chapter 1) and increased activities of certain enzymes (Chapter 2). The elevated lipid synthesis and deposition is the most significant manifestation observed in the liver on 20th day. The increased metabolic activities especially those concerned with lipids might be requiring the presence of higher concentration of AA. The role of AA in electron transport

has been stressed by many workers (Chinoy, 1969a) who have also shown that the tissues showing higher lipid metabolism maintain increased AA level. The concentration of AA in the liver was also observed to ~~become~~ increased during hyperlipogenesis in the migratory birds (Pilo, 1967).

Although the increase in the AA content in the liver of 20 days old pigeon could be correlated to the maximum growth rate and metabolic activities of the liver, it is difficult to explain how this increase is brought about. Since, it has been reported that in pigeon, the site where AA synthesis takes place is the kidney (Ray Choudhari and Chatterjee, 1969) it is probable that hepatic AA comes from the kidney. However, in the kidney the AA level did not show any parallel fluctuations (Table 1). Perhaps the major part of hepatic AA comes from dietary source. If this contention rings true, then the fall in the AA content of the liver observed on 25th day might be due to the decreased food availability as the young ones cease to be nestlings soon after 20th day and are forced to go about by themselves for food procurement. The maximum growth rate and the attainment of functional maturity and optimum liver mass by 20th day is then a must for the pigeon young ones as they are forced to lead an independent life thereafter.

Thus it could be concluded that the rate of growth and the time of attainment of functional maturity of any organ are closely related to the duration of nestling period.