CADMIUM INDUCED ALTERATIONS IN THE INTESTINAL ABSORPTION OF GLUCOSE AND FRUCTOSE IN A FRESHWATER CAT FISH, HETEROPNEUSTES FOSSILIS

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Abstract. The effect of four concentrations (1.0, 0.1, 0.01, and 0.001 mM) of Cd on the rate of absorption of two sugars, glucose and fructose by the intestine of the fresh water cat fish, Heteropneustes fossilis has been studied after 1 h at 23 °C. Intestinal glucose and fructose transport was also assessed in fish exposed to a sublethal concentration (0.0023 mM) of Cd in the ambient water for 15 and 30 days. Control fish showed no marked difference in the rates of absorption of glucose and fructose. All four concentrations of Cd decreased the rate of transport of glucose and fructose significantly. Among the two sugars, decrease in the rate of transport of fructose was more marked than glucose. In fish exposed to Cd in the ambient water, reduction of glucose and fructose absorption was greater after 30 days of exposure than after 15 days.

1. Introduction

Active transport is one of the processes by which nutrients enter cells. Both aminoacid and sugar transport are dependent on the presence of Na⁺ in the mucosal medium (Csaky, 1965; Schultz and Zalusky, 1965; Read, 1967). Crane et al. (1965) studied the active transport of glucose in the small intestine of a hamster and stated that the process is Na dependent. The in vivo intestinal absorption of sugar in the toad fish, Opsanus tau was studied by Farmanfarmaian (1972). Heavy metals can enter the digestive system of fish through ingestion of food chain organisms (Lorenz, 1979) and can produce structural and functional disturbances. The present study has been undertaken to examine if Cd can produce any alteration in the rate of absorption of two sugars, glucose and fructose by the intestine of a freshwater cat fish, Heteropneustes fossilis, under two experimental conditions.

In the first experiment, different concentrations of Cd mixed with the nutrient solution were instilled in the intestinal sacs and the rate of absorption was determined. The second experiment was conducted to assess if alterations are produced in the rate of intestinal absorption of nutrients in fish exposed to a sublethal concentration of Cd by bath for 15 and 30 days.

2. Material and Methods

Living specimens of Heteropneustes fossilis were collected from local freshwater sources and were maintained in laboratory glass aquaria. Prior to experimentation, fish were allowed to acclimate to laboratory conditions for a week. During this period they were
not fed so as to clear off the alimentary canal from any food material. The water characteristics were pH 7.4; temperature, 20 ± 3 °C; hardness, 160 ppm (as CaCO₃); alkalinity, 87 ppm (as CaCO₃) and dissolved oxygen concentration of 7.5 ppm. Intestinal sacs were prepared according to the method of Musacchia (1967). The fish were placed on a dissecting board and cotton plugs soaked in water were placed in the mouth, gills and over the skin of the fish in order to keep the surface moist. A midline abdominal incision was made in order to expose the viscera. The intestine was cut at the pyloric-duodenal junction and in front of the rectum. Into the duodenal end of the intestine, a syringe-tube attachment was inserted and the intestinal contents were flushed out with KRB solution. A ligature was applied to the rectal end of the intestine and another loose ligature was held in position towards the duodenal end, to be tied after filling of the intestinal sacs with the appropriate solutions. Four concentrations of Cd (1.0, 0.1, 0.01, and 0.001 mM) containing 40 mM of glucose or 40 mM of fructose were prepared in Kreb’s-Ringer-bicarbonate (KRB) solution. The intestines were separately filled with each concentration of Cd solution. In control fish nutrient KRB solution without Cd was used. The luminal fluids of both control and experimental fish were collected after 1 h at 23 °C. The concentration of glucose and fructose in the recovered solutions was determined according to the colorimetric method of Park and Johnson (1963). The dry weight of the intestines was recorded by dehydrating the tissue in an oven at 100 °C until the weight became constant.

In another experiment, 120 fish were divided into four equal groups. The first group was exposed under static conditions to a sublethal concentration (0.0023 mM) of Cd for 15 days and the second group for 30 days. The third and fourth groups served as controls for the first and second groups respectively. Water in the aquaria was renewed after every 24 h, and Cd solution was added to bring the concentration of Cd to the requisite level. No mortalities occurred in any of the Cd exposed and control groups of fish. On the 16th and 31st days, the rate of intestinal absorption was determined in both control and Cd exposed fish by instilling glucose and fructose in KRB solution separately as described above. The Student’s ‘t’ test described by Fisher (1950) was employed to calculate the significance of difference between control and experimental means.

3. Results

The results of experiments in which Cd was added directly to the contents of intestinal sacs and fish exposed to 0.0023 mM of Cd for 15 and 30 days are summarized in Tables I and II. Control fish showed no marked difference in the rates of absorption of glucose and fructose. All four concentrations of Cd decreased the rate of transport of glucose and fructose significantly by the intestine of Heteropneustes fossilis. Increase in the concentration of Cd in the instilled medium decreased the rate of absorption to a greater extent. Among the two sugars, decrease in the rate of intestinal transport of fructose was greater than that of glucose. The decrease in the rate of absorption was more marked between 0.01 and 0.001 mM of Cd in both cases. The decrease in the rate