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EFFECT OF FOOD RESTRICTION ON THE TURNOVER RATE OF LIVER AND MUSCLE PROTEINS IN RATS

M. Akmal Khan

The effect of food restriction on the turnover rate of mixed proteins of liver and muscle in rats was studied. The rats were given an injection of L-Methionine-S35 and killed after 1, 10, 20 and 31 days. The results indicated that all time-intervals the radioactivity in the liver was greater in the restricted rats than the rats fed ad-libitum; conversely the activity in the muscle was less in the restricted than in ad-libitum group. It was suggested that food restriction in the present study caused a decrease in the activity of insulin with an increase in that of cortisol, resulting in a low radioactivity in the muscle and high in the liver.

INTRODUCTION

When a single dose of a labelled amino acid is given to rat, the distribution of the label between various organs and tissues of the body depends upon the dietary state of the animal. Waterlow (1959) found, three days after the injection of DL-(S^{35}) methionine to normal rats, that 75 per cent of the radioactivity recovered was in the carcass and 25 per cent in the internal organs. In rats on low protein diet the radioactivity recovered from the viscera was nearly 50 per cent.

Many workers have shown in experiments using labelled amino acids that in animals on a low protein diet liver protein was more highly labelled than in controls on a normal diet (Solomon and Tarver, 1952; Bendicenti and Coworker, 1959; Gaetani *et al.*, 1961; Muramatsu *et al.*, 1963).

Schrein and Kazassis (1960) found no effect on the rate of incorporation of lysine into protein of any of tissues when the energy intake of the rats was reduced by 50 per cent. Groups on fat free diet and on very low carbohydrate intake showed similar results.

The present study was planned to measure the turnover rate of liver and muscle proteins by injecting a dose of L-Methionine-S^{35} to adult rats fed diets low in protein and inadequate in calories.

MATERIALS AND METHODS

Forty two mature adult male rats, 6-7 months old were divided randomly into seven groups of six rats each. All the rats were fed ad-libitum an experi-

* Department of Nutrition, University of Agriculture, Lyallpur.

mental diet containing corn oil 5 per cent, vitamin mixture 2 per cent, mineral mixture 4 per cent, casein to provide 5 per cent protein and maize starch to 100 per cent. All the rats were given an intraperitoneal injection of L-Methionine-S^{35} (2 uc/100 gm body weight) a day before the start of restriction. One group was killed a day after an injection of L-Methionine-S^{35} for liver and muscle analysis. Ad-libitum and restricted (70 per cent of the normal food intake) diets were randomly assigned to six group in such a way that three groups received food ad-libitum and three groups were fed a restricted diet, killed after 10, 20 and 31 days. Liver and a piece of gastrocnemius muscle were prepared for radioactive counting (Khan, 1972). About 1 gram samples of liver and muscle in duplicate were used for nitrogen determination by Kjeldahl method. The data were subjected to statistical analysis by using Mann Whitney U test (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

The radioactivity of liver and muscle expressed as d.p.m. per mg tissue, per mg N or per total liver of rats fed ad-libitum or restricted diets and killed 1, 10, 20 and 31 days after an injection of L-methionine-S^{35} is given in Table 1. There was a high incorporation of labelled methio-nine into liver and low in the muscle indicating rapid turnover rate in the liver and slow in the muscle. The average activity (d.p.m. per mg tissue) in the liver and muscle was 91.6 and 17.5 respectively.

TABLE 1. *Radioactivity in Liver and Muscle of Rats after an Injection of L-Methionine-S^{35} (Mean Values)*

Dietary Treatment	Days after injection	Liver d.p.m.* per mg	Liver d.p.m.* per mg N	Liver d.p.m.* per Total	Muscle d.p.m. per mg	Muscle d.p.m. per mg N
Ad-libitum	1	91.6	2700.0	1545.0	17.5	500.0
Ad-libitum	10	33.4	1289.0	564.0	18.4	508.0
Restricted		44.7	1358.0	551.0	16.5	435.0
Ad-libitum	20	20.0	740.0	359.0	20.5	501.0
Restricted		27.6	763.0	346.0	18.5	469.0
Ad-libitum	31	14.4	481.0	228.0	22.7	535.0
Restricted		18.7	534.0	254.0	20.3	520.0

* d.p.m. (disintegration per minute)

After 10 days the average radioactivity (d.p.m. per mg tissue) in the liver of restricted and ad-libitum fed rats was 44.7 and 33.4 respectively and the difference was significant ($P < .048$). The activity per mg N was higher in the restricted groups than ad-libitum fed rats, but the difference was not significant. This could be due to the difference in the chemical composition of livers of both the groups. There was no difference in total activity of livers of both the groups. Less activity in the muscle of the restricted group was found as compared to group fed ad-libitum.

After 20 days, the livers of the restricted group were significantly ($P < .032$) more highly labelled than the ad-libitum fed group. The average activities (d.p.m. per mg tissue) of restricted Vs ad-libitum fed were 27.6 Vs 20.0. Similar results obtained in case of muscle as were found after 10 days on restriction.

The radioactivity in livers of both the groups was reduced after 31 days. The average activity in restricted and ad-libitum fed group was 18.7 and 14.4 and it was significantly ($P < .008$) different. No difference in the activity of muscle of both the groups was observed.

The results of the present study indicate that at all times intervals the radioactivity in the liver was greater in the restricted rats than the rats fed ad-libitum; conversely, the activity in the muscle was less in the restricted than in the ad-libitum group. These results are in agreement with Waterlow (1959) who suggested that in the protein depleted animal there is a concentration of protein synthesis in the internal organ, at the expense of muscle and skin.

The results of the present study may be explained in terms of the action of insulin and cortisol, which in some respect have reciprocal action on protein metabolism. It is well known that in vitro insulin both promotes the entry of amino acids into muscle cell (Manchester and Young, 1958) and increases their uptake into muscle proteins (Castles *et al.*, 1965). The effects are not found with liver slices (Wagle, 1963).

Cortisone, on the other hand, appears to promote protein synthesis in the liver, while causing a negative nitrogen balance in the body as a whole, so that nitrogen is gained by the liver at the expense of peripheral tissues such as muscle (Munro, 1964 and Korner, 1960). There is evidence that plasma cortisol levels in malnourished children were higher than normal (Alleyne and Young, 1966). It seems possible that food restriction in the present study caused a decrease in the activity of insulin with an increase in that of cortisol, resulting in a low radioactivity in the muscle and high in the liver.

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