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The Influence of Dietary Iodine and Enviromental Temperature on the Activity of Mitochondria in Liver and Kidney

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Introduction

It has often been suggested that the increased metabolic rate of animals acclimatized to cold environments is related to increased thyroid activity (COTTLE et al. 1956, 1960). The turnover and utilization of the thyroid hormone are greater in animals exposed to cold than in animals treated with TSH (BORIS CATZ et al. 1953). Iodine in a diet is an element that occupies a unique position in thyroid regulation. Diets with a low content of iodine induce increased function and size (goiter) of the thyroid gland. Diets with a high content of iodine have been reported by WOLFF (1969) to cause goiter in some animals but not in all species. The calorigenic action of thyroid hormones in homeothermic adult vertebrates is exerted on many tissues e. g. skeletal muscle, liver, and kidney. Thyroid hormone stimulates ATP-ase activity and increases ATP utilization (FARAMARZ 1971).

Many effects of thyroxin have been found on cell-free tissue preparations and on isolated enzyme systems. TATA et al. (1963) reported that administration of thyroid hormone produces an increase in number, size and oxidative phosphorylative capacity of mitochondria of mammalian skeletal muscles. Some form of direct action of thyroid hormone on mitochondria or mitochondrial permeability has been indicated by swelling and contraction (TAPLEY et al. 1955; LEHNINGER et al. 1959). It has been reported that administration of large doses of thyroxin or direct addition in vitro leads to uncoupling of oxidative phosphorylation in liver mitochondria (MARTIUS et al. 1951). Its relationship to the physiological effect of thyroxin is not clear. The environment also has effect on mitochondrial activity. Mitochondrial loose coupling observed in brown adipose tissue excised from guinea pigs exposed to a cold environment was not an all or none response, but a phenomenon of gradual onset (ANDERSEN et al. 1970). PEDERSEN et al. (1972) found that in brown adipose tissue P/O ratio → (= ADP/O ratio) and RCR (= respiratory control ratio) decreased in proportion to the time of cold exposure to animals.

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Since mitochondria are the major site of oxidative processes in the cell, interaction with mitochondria or mitochondrial enzyme is often an important feature of investigation. An experiment was carried out to determine whether the activity of mitochondria can be influenced by changing the iodine level in the diet or the environmental temperature.

Materials and methods

Adult male rabbits were used in this experiment. Each rabbit had its own stainless steel cage. The experiment consisted of a 2 weeks pre-experimental period followed by a 4 weeks experimental period. In the pre-experimental period the rabbits were divided into three groups, weighed and selected to distribute a mean weight for each group. The three groups of rabbits were fed the following diets (Table 1): group I

Table 1

The composition of diet in the three groups of rabbit

Group No.	I (basal diet)	II	III
Share of feed	%	%	%
Casein	19	19	19
Glucose	58	58	58
Cellulose	13	13	13
Maize Oil	4	4	4
Vitamin Mixture	1	1	1
Mineral Mixture	5	5	5
Potassium Iodide (KI)	0	5 ppm I_2	0
Propyl-thiouracil (PTU)	0	0	0.05

The vitamin mixture has the following composition: One kilogram of diet has: Vitamin A 18,000 I.U., vitamin D_3 6,000 I.U., α-tocopherol 220 mg, choline chloride 2 gm, inositol 2 gm, ascorbic acid 2 gm, niacin 200 mg, thiamine hydrochloride 22 mg, pyridoxine hydrochloride 22 mg, riboflavin 22 mg, capantothanate 40 mg, folic acid 10 mg, biotin 0.6 mg, vitamin B_{12} 0.04 mg.

The mineral mixture has the following composition: One kilogram of mineral mixture has: Calcium carbonate ($CaCO_3$) 120.80 gm, pentacalcium hydroxidtriphosphate ($Ca_5[PO_4]_3OH$) 462 gm, Magnesium carbonate ($MgCO_3$) 35.2 gm, magnesium sulphate ($MgSO_4$) 38.2 gm, Potassium chloride (KCl) 124.7 gm, Potassium carbonate (K_2CO_3) 111.08 gm, Sodium chloride (NaCl) 100 gm, Iron(III)nitrate ($Fe[NO_3]_3 9H_2O$) 15.3 gm, copper sulphate ($CuSO_4$) 0.078 gm, Manganese sulphate 0.20 gm, Sodium fluoride (NaF) 0.51 gm, Zine sulphate ($ZnSO_4 7H_2O$) 1.0 gm.

without iodine (basal diet), group II with 5 ppm iodine (iodine diet) and group III with 0.05 % propyl-thiouracil (PTU diet). Before start of the experimental period, all animals from the pre-experimental period were kept at normal environmental conditions (temperatures at approximately 20° C) for adaptation. The different diets were given ad libitum in a powdered form and the animals had access to deionized water.

Before start of the experimental period, the rabbits in each group were divided into three sub-groups and then transferred to rooms with temperatures of 6°, 20°

and 34° C, respectively. Under these conditions all rabbits were fed the same diet as given in the pre-experimental period. Body weight was measured at the beginning of the experimental period and at an interval of one week. After 18 days (adjustment) from the beginning of the experiment, records of food consumption for a period of 12 days were kept.

At the end of the experimental period, the rabbits were slaughtered by stunning and decapitation. The liver and kidney were quickly removed and chilled in iced buffer.

Kidney and liver mitochondria were isolated from homogenates in 0.3 M sucrose (0.30 M sucrose, 0.001 M EGTA, 0.05 M trisma base, 1 % B.S.A.). All work was carried out at app. 2° C. The kidney capsule was removed by gentle squeezing, and the medullary portion was removed and discarded. Both liver and kidney cortex were washed three times in cold buffer solution. The small pieces of the tissue were homogenized in a Potter-Elvehjem homogenizer. The tissue suspension was centrifuged for 5 minutes at 480 × G (approx. 1500 rpm) in the high speed centrifuge (Model MSE high speed 18). The supernatant was decanted and centrifuged for 10 minutes at 7710 × G (approx. 9000 rpm), whereafter the mitochondrial pellet was ready for dilution and suspended in a suitable amount of buffer (mitochondria from 5 gm. of tissue in 2 ml of buffer solution).

Respiratory control index and phosphorylation were assayed polarographically (Digital Acid-Base Analyzer PHM 72 equipped with a PO_2-Module Type PHA 932) at 25° C in mitochondria isolated from the rabbits. Buffer solution used for measurements of oxygen consumption (3.8 ml) contained 2000 µl 0.6 M sucrose, 200 µl 0.06 M tris-phosphate, 40 µl 1.0 M trisbuffer, 1500 µl redistilled water. The reaction medium contained 3.8 ml buffer solution, 100 µl mitochondria, 100 µl 0.8 M succinate or 100 µl 0.8 M α-ketoglutarate solution for determination of the respiratory control ratio (RCR) and oxidative phosphorylation (P/O), addition of 10 µl of 0.05 M ADP were made.

The data from the effect of diets and environmental conditions were analyzed statistically by using the student t-test, and the difference between groups of animals at varying conditions were tested by using independent comparisons with a single degree of freedom. If a P-value is less than 0.05 the difference is considered significant.

Results

Effect of various diets and different conditions on growth and food consumption

As shown in Table 2, the average daily food intake of basal and PTU diets, were less for rabbits kept at high environmental temperature (34° C) than that of animals kept at normal temperatures (20° C) viz. 13 and 15 %, respectively. In the group of rabbits fed the iodine diet, the values of food intake at 34° C compared with the values at 20° C, were not significantly different. The data presented in Table 2 also show that rabbits fed the iodine diet and kept at a temperature of 34° C ate 27 and 19 % more than animals fed basal and PTU diets, respectively. The effect on food intake for rabbits kept at an environmental temperature of 6° C increased slightly, when fed a basal high iodine diet, but decreased 16 % for rabbits fed the PTU diet

Table 2

Effect of different diets and different conditions on food consumption and growth in rabbits during the experimental period

Diet	Daily food consumption (g/kg)			Increase in body weight during the last 4 weeks (% of initial body weight)		
	6° C	20° C	34° C	6° C	20° C	34° C
Basal diet	29.51 ± 3.49	26.16 ± 2.16	22.84 ± 2.23	18.31	10.13	1.02
PTU diet	23.90 ± 2.12	28.75 ± 1.21	24.36 ± 2.40	14.01	24.45	2.08
High I_2diet	29.12 ± 1.22	27.91 ± 0.76	28.99 ± 1.28	15.70	9.80	18.27

as compared to the values of animals kept at a room temperature of 20° C. As predicted in Figure 1, body weight gain was markedly depressed at 34° C in basal and PTU diets, but rabbits fed the iodine diet had an increase in weight by 18 % over the initial body weight during an experimental period of 4 weeks (Table 2). Thus the effect on body weight of a high iodine diet increased when exposed to high temperature. All rabbits in groups I, II and III kept at temperatures of 6° and 20° C, respectively, had an increase in body weight in the experimental period (Table 2, Figure 1).

Effect of different diets and different conditions on phosphorylation during α-ketoglutarate oxidation in kidney and liver mitochondria

Kidney mitochondria

Data in Table 3a indicate that when α-ketoglutarate is used as a substrate, the P/O ratio (= ADP/O ratio) is higher in mitochondria from the group fed the iodine

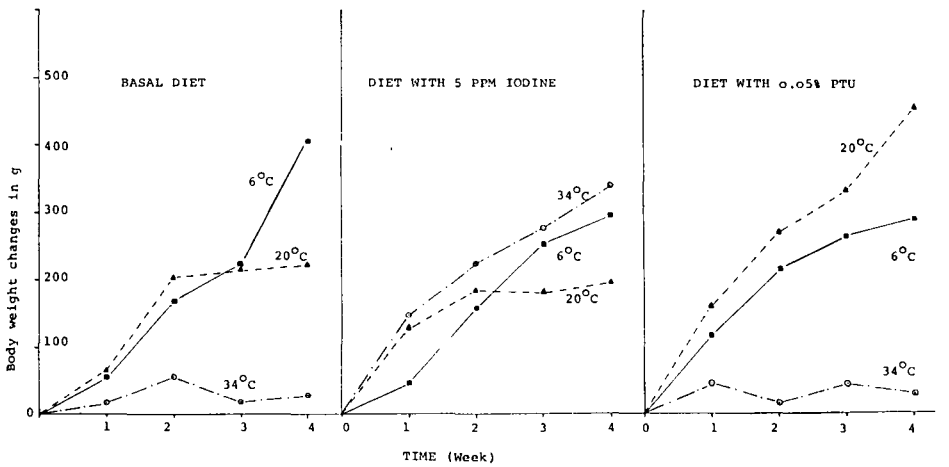

Fig. 1. Affect of different diets and environmental temperature on weight gain in male rabbits

diet than in the groups on the basal and PTU diets. This apparently holds true for all climatic conditions, although there are no significant differences between the

Table 3a

Oxidative phosphorylation (ADP : O ± SEM) by kidney mitochondria from rabbits receiving different diets under various environmental temperatures [1]

	Basal diet (4) 6° C	Diet + I_2 (4) 6° C	Diet + PTU (3) 6° C	Basal diet (4) 20° C	Diet + I_2 (5) 20° C	Diet + PTU (6) 20° C	Basal diet (3) 34° C	Diet + I_2 (4) 34° C	Diet + PTU (4) 34° C
Basal diet (4) 6° C	1.61 ± 0.12 1.34 ± 0.04	P < 0.01			P < 0.001			P < 0.025	
Diet + I_2 (4) 6° C	P < 0.025	2.35 ± 0.13 1.66 ± 0.08	P < 0.01	P < 0.025		P < 0.05	P < 0.025		
Diet + PTU (3) 6° C		P < 0.025	1.66 ± 0.06 1.27 ± 0.06		P < 0.001			P < 0.025	
Basal diet (4) 20° C				1.81 ± 0.10 1.47 ± 0.14	P < 0.025				
Diet + I_2 (5) 20° C	P < 0.001		P < 0.001		2.25 ± 0.06 1.76 ± 0.12	P < 0.025	P < 0.005		P < 0.05
Diet + PTU (6) 20° C					P < 0.05	1.79 ± 0.14 1.50 ± 0.10			
Basal diet (3) 34° C					P < 0.005		1.69 ± 0.11 1.31 ± 0.12	P < 0.05	
Diet + I_2 (4) 34° C	P < 0.025		P < 0.05					2.05 ± 0.08 1.72 ± 0.11	
Diet + PTU (4) 34° C					P < 0.001			P < 0.05	1.98 ± 0.09 1.44 ± 0.04

[1] In parenthesis the number of animals. On the diagonal is shown the mean ADP : O ± SEM. In the squares is seen the significance of differences between groups. Above diagonal results from the use of α-ketoglutarate and below succinate as substrate for the mitochondria. Empty squares correspond to insignificant difference.

Table 3b

Oxidative phosphorylation (ADP : O ± SEM) by liver mitochondria from rabbits receiving different diets under various environmental temperatures [1]

	Basal diet (4) 6° C	Diet + I_2 (4) 6° C	Diet + PTU (3) 6° C	Basal diet (4) 20° C	Diet + I_2 (5) 20° C	Diet + PTU (6) 20° C	Basal diet (3) 34° C	Diet + I_2 (4) 34° C	Diet + PTU (4) 34° C
Basal diet (4) 6° C	2.06 ± 0.11 1.51 ± 0.05	P < 0.025	P < 0.05				P < 0.025		
Diet + I_2 (4) 6° C		1.57 ± 0.08 1.42 ± 0.08		P < 0.005	P < 0.01		P < 0.001	P < 0.001	
Diet + PTU (3) 6° C			1.59 ± 0.11 1.46 ± 0.05	P < 0.01	P < 0.025		P < 0.005	P < 0.005	
Basal diet (4) 20° C	P < 0.025	P < 0.025	P < 0.05	2.31 ± 0.10 1.85 ± 0.09					
Diet + I_2 (5) 20° C					2.37 ± 0.18 1.67 ± 0.09				
Diet + PTU (6) 20° C				P < 0.05		2.07 ± 0.19 1.52 ± 0.09			
Basal diet (3) 34° C	P < 0.01	P < 0.025	P < 0.01				2.61 ± 0.11 1.94 ± 0.10		
Diet + I_2 (4) 34° C	P < 0.025	P < 0.025	P < 0.025					2.35 ± 0.09 1.75 ± 0.06	P < 0.05
Diet + PTU (4) 34° C							P < 0.05		1.97 ± 0.19 1.63 ± 0.07

[1] In parenthesis the number of animals. On the diagonal is shown the mean ADP : O ± SEM. In the squares is seen the significance of difference between groups. Above diagonal results from the use of α-ketoglutarate and below succinate as substrate for the mitochondria. Empty squares correspond to insignificant differences.

iodine diet and the PTU diet at 34° C. There is a slight decrease in the P/O ratio in animals fed basal and PTU diets at 6° C, as compared with 20° and 34° C.

Respiratory control ratio from kidney mitochondria using α-ketoglutarate as a substrate showed (Table 4 a) a significant decline in animals fed the basal diet at 6° C. No significant differences were found in the RCR values for animals fed the diet rich in iodine and the PTU diet and this applied to all climatic conditions.

Liver mitochondria

The figures in Table 3 b indicate that at low environmental temperatures the P/O ratio of liver mitochondria using α-ketoglutarate as a substrate was significantly decreased for animals fed the basal diet ($P < 0.025$) and the iodine diet ($P < 0.01$). The P/O ratio in animals fed the PTU diet at 6° C also declined as compared with environmental temperatures of 20° and 34° C, but there were no significant differences.

There is no significant difference in the P/O ratio of groups at varying climatic conditions.

The data in Table 4 b indicate that the RCR value of liver mitochondria using α-ketoglutarate as a substrate declines significantly in the mitochondria of the group fed the iodine diet ($P < 0.05$) and the basal diet at 6° C as compared to 20° and 34° C. There is no significant difference in the RCR value for the group fed the PTU diet under varying environmental conditions.

Effect of various diets and different conditions on phosphorylation during succinate oxidation in kidney and liver mitochondria

Kidney mitochondria

As shown in Table 3 a the activity of mitochondria expressed by the P/O ratio with succinate as the substrate is higher in the group of rabbits fed the iodine diet than in those fed basal and PTU diets. The difference was most pronounced at 6° C. The different climatic conditions had no influence upon P/O ratios.

There is no significant difference in RCR values of mitochondria from kidneys of different groups using succinate as the substrate (Table 4 a).

Liver mitochondria

From Table 3 b it will be seen that animals on the basal diet had a significantly lower P/O ratio at 6° C, than at 20° C and 34° C. Animals on the iodine diet did not show any significant differences between 6° C and 20° C but the P/O ratio at 34° C is significantly higher than at 6° C.

There is no significant difference in the P/O ratios of groups kept at various climatic conditions. Animals fed the iodine and PTU diets at both 20° C and 34° C showed significantly decreased P/O ratios as compared with the groups on the basal diet.

The RCR values of liver mitochondria with succinate as the substrate are shown in Table 4 b. The RCR values for animals on the basal diet at 6° C are significantly lower than RCR values for animals on the basal diet at 20° or 34° C. The same

tendency is found among groups on the iodine diet, but as for animals on the PTU diet these differences are not significant.

Table 4a

Respiratory control ratio (RCR) by kidney mitochondria from rabbits receiving different diets under various environmental temperatures [1]

	Basal diet (4) 6° C	Diet + I_2 (4) 6° C	Diet + PTU (3) 6° C	Basal diet (4) 20° C	Diet + I_2 (5) 20° C	Diet + PTU (6) 20° C	Basal diet (3) 34° C	Diet + I_2 (4) 34° C	Diet + PTU (4) 34° C
Basal diet (4) 6° C	1.36 ± 0.09 1.81 ± 0.08				P < 0.05		P < 0.05	P < 0.05	P < 0.025
Diet + I_2 (4) 6° C		1.65 ± 0.16 1.92 ± 0.12							
Diet + PTU (3) 6° C			1.59 ± 0.06 1.82 ± 0.11						
Basal diet (4) 20° C				1.66 ± 0.13 1.92 ± 0.16					
Diet + I_2 (5) 20° C					1.63 ± 0.05 1.90 ± 0.02				
Diet + PTU (6) 20° C						1.62 ± 0.12 1.97 ± 0.10			
Basal diet (3) 34° C							1.73 ± 0.09 1.88 ± 0.13		
Diet + I_2 (4) 34° C								1.67 ± 0.07 1.92 ± 0.14	
Diet + PTU (4) 34° C									1.88 ± 0.10 2.07 ± 0.09

[1] In parenthesis the number of animals. On the diagonal is shown the mean RCR ± SEM. In the squares is seen the significance of differences between groups. Above diagonal results from the use of α-ketoglutarate and below succinate for the mitochondria. Empty squares correspond to insignificant differences.

Table 4b

Respratory control ratio (RCR) by liver mitochondria from rabbits receiving different diets under various environmental temperatures [1]

	Basal diet (4) 6° C	Diet + I_2 (4) 6° C	Diet + PTU (3) 6° C	Basal diet (4) 20° C	Diet + I_2 (5) 20° C	Diet + PTU (6) 20° C	Basal diet (3) 34° C	Diet + I_2 (4) 34° C	Diet + PTU (4) 34° C
Basal diet (4) 6° C	1.25 ± 0.09 1.73 ± 0.05				P < 0.025	P < 0.025			
Diet + I_2 (4) 6° C		1.35 ± 0.06 1.74 ± 0.21			P < 0.05	P < 0.025			
Diet + PTU (3) 6° C			1.57 ± 0.16 2.09 ± 0.17						
Basal diet (4) 20° C				1.67 ± 0.17 2.40 ± 0.21					
Diet + I_2 (5) 20° C					1.73 ± 0.13 2.07 ± 0.12				
Diet + PTU (6) 20° C						1.59 ± 0.05 1.98 ± 0.15			
Basal diet (3) 34° C							1.44 ± 0.13 2.18 ± 0.12		
Diet + I_2 (4) 34° C								1.56 ± 0.11 1.97 ± 0.06	
Diet + PTU (4) 34° C									1.61 ± 0.18 2.40 ± 0.22

[1] In parenthesis the number of animals. On the diagonal is shown the mean RCR ± SEM. In the squares is seen the significance of differences between groups. Above diagonal results from the use of α-ketoglutarate and below succinate as substrate for the mitochondria. Empty squares correspond to insignificant differences.

Discussion

That some species of small mammals native to hot climates have a depressed metabolic rate was observed by many investigators (RISING 1969; CASSUTO et al. 1966, 1970, RAY et al. 1968). In the present investigation similar result was observed, the rabbits fed the basal and PTU diets at an environmental temperature of 34° C for 4 weeks indicate metabolic response by a marked reduction in feed intake and body weight, as compared with animals fed the same diets at normal temperatures (Table 2). But this did not apply to the group of rabbits fed the iodine diet. From the observations on daily food consumption and weekly body weight gain (Figure 1) of animals fed the iodine diet at 34° C, it can be concluded that the metabolic activity increased. Inorganic iodine in the body is taken up by the thyroid gland and thyroid activity appears to be related to the total amount of iodine in the gland. Thyroid function is affected by the level of food intake (COTTLE 1960). YOUSEF et al. (1968) suggested that the voluntary feed restriction seen in heat acclimatized animals may be a factor leading to the decreased thyroid activity. In the present experimental design where the animals were fed ad libitum, it may thus be assumed that the high content of iodine in the diet is causing the increased thyroid activity. The stimulation of growth in rabbits fed the high iodine diet indicates that there is no toxic effect. As the metabolic rate is elevated in hyperthyroidism loss of weight and general weakness are often observed (RUCH and PATTON 1973; CASSUTO 1970), but these signs were not observed in the present experiment.

There was a decreased food consumption in rabbits fed the PTU diet at low environmental temperatures. This observation is similar to the results of HSIEH et al. (1957) who observed a reduction in caloric intake of thyroid-ectomized rats living in a cold environment in spite of an increased output of heat. These results indicate that there may be an interrelationship between an elevated metabolic activity and an increase in the thyroid activity at 6° C in rabbits fed basal and iodine diets.

The metabolic changes evoked by the thyroid hormone are associated with the electron transport system, reaction in tricarboxylic acid cycle, and the enzyme system. Results obtained in the present study revealed that both the P/O ratio and the RCR value of liver mitochondria using succinate as the substrate — decreased in the group of rabbits fed the basal and iodine diets, at the temperatures of 6° C but were not significantly different in the group fed the PTU diet. Succinate as substrate to kidney mitochondria for the three groups of animals at 6° C tended to give a decreased P/O ratio while the RCR value was not altered. These results indicate that the activity of succinic dehydrogenase significantly increased in animals exposed to cold, particularly in the liver mitochondria of rabbits fed the basal and high iodine diets at 6° C. TATA (1963) proposed that mitochondrial respiration and phosphorylation and their degree of coupling may vary in relation to the thyroid activity. In the present experiment the group of animals fed the 0.05 % PTU diet did not show any differences in either liver or kidney mitochondria at different conditions. JANSKY (1966) has reviewed the literature on organ thermogenesis and has put forward the hypothesis that total cytochrome oxidase activity of individual organs might be used to estimate maximal O_2 consumption. From that statement the present experiment may indicate that liver mitochondria have a more important role than kidney mitochondria in the acclimatisation to cold environments.

The experiment on kidney mitochondria using α-ketoglutarate as a substrate showed that both the P/O ratio and the RCR value from animals fed basal and PTU diets at 6° C fell slightly as compared with animals fed the same rations at 20° and 34° C. In rabbits at 6° C on basal and iodine diets a significant decrease in P/O ratios and RCR values were observed in liver mitochondria using α-ketoglutarate as a substrate. In the group of rabbits fed the PTU diet the P/O ratio also declined but not significantly. These results indicate that the dehydrogenase activity involved in the oxidation of α-ketoglutarate, which is localized in the outer membrane of the mitochondria, seem to be affected by different temperatures and diets as compared with succinic dehydrogenase which is localized in the matrix. The kidney mitochondria are sensitive to a lesser degree than liver mitochondria. On the other hand, kidney mitochondria do not contract or swell like liver mitochondria, and the biological action of increasing thyroid hormone production during exposure to cold may involve more subtle effects on the fine structure of liver mitochondria. TAPLEY (1955) reported that mitochondria isolated from hyperthyroid rats swell more readily and those from hypothyroid rats swell less readily than those from normal animals. The present results indicate that both P/O and RCR values do not show significant changes in the group of rabbits fed the PTU diet. At the high environmental temperature (34° C), it was found that both P/O ratios and RCR values using succinate and α-ketoglutarate as substrates were not significantly different as compared with normal temperatures (20° C).

CASSUTO et al. (1970) states that administration of 3, 5, 3'triiodothyronine increases respiration of liver mitochondria in control groups (57 % increase) and in heat acclimatized animals (132 % increase), resulting in a similar enzyme activity of the two groups. The result of the present experiment in the group of animals fed the high iodine diet at 34° C verifies that statement.

Summary

It was found that both effect of temperatures and diets influence metabolic changes in rabbits. In animals fed basal and PTU diets (propyl-thiouracil diets) at 34° C for 4 weeks the metabolic response showed a marked reduction in feed intake and body weight, compared with animals fed at normal temperatures. In the animals fed the iodine diet, there was an increase in daily food consumption and weekly body weight gain at 34° C. This indicates a rise in metabolic activity in this case. Studying the activity of kidney mitochondria of the three groups of animals using succinate as a substrate revealed that the P/O ratio tends to decrease in animals kept at 6° C while the RCR value was not altered by changing conditions or produced by the different diets. At the temperature of 6° C both the P/O ratios and the RCR values of liver mitochondria using succinate as a substrate decreased in the group of rabbits fed the basal and iodine diets, but were not significantly different in the group fed the PTU diet.

In the experiment on kidney mitochondrial activity using α-ketoglutarate as a substrate it was found that both the P/O ratios and the RCR values from animals fed basal and PTU diets at 6° C decreased slightly as compared with animals fed at 20° C and 34° C. In liver mitochondria, using α-ketoglutarate as a substrate a

significant decrease in the P/O ratio and the RCR value was found for both rabbits fed the basal and the iodine diets at 6° C. In the group of rabbits fed the PTU diet, the P/O ratio also decreased but the fall was not significant.

These results suggested that the activity of succinate dehydrogenase in liver mitochondria increases in animals fed basal and iodine diets at 6° C. The enzyme dehydrogenase involved in oxidation of α-ketoglutarate which is localized in the outer membrane of mitochondria seems to be affected by different temperatures and diets as compared with succinate dehydrogenase localized in the matrix. The kidney mitochondria activity is less sensitive than that of liver mitochondria.

Mitochondrial respiration and phosphorylation due to the tightness of their coupling may respond differently depending on the degree of thyroid activity.

Zusammenfassung

Der Einfluß von Jod und Umgebungstemperatur auf die Aktivität von Leber- und Nierenmitochondrien

Es wurde in Versuchen mit Kaninchen gefunden, daß sowohl die Umwelttemperatur wie auch das Futter den Stoffwechsel der Tiere beeinflussen. Tiere, die ein Basal- und PTU-Futter (Propylthiouracilum-Futter) vier Wochen hindurch bei 34° C erhielten, zeigten eine stark verminderte Futteraufnahme und ein niedrigeres Körpergewicht verglichen mit Tieren, die bei normalen Temperaturen gefüttert wurden. Die Tiere, die ein Futter mit hohem Jodgehalt bekamen, zeigten eine Steigerung in der täglichen Futteraufnahme und ein wöchentlich zunehmendes Körpergewicht bei 34° C. Dieses deutet auf eine erhöhte Stoffwechselaktivität in diesem Falle. Eine Untersuchung der Aktivität der Nierenmitochondrien der drei Tiergruppen unter Anwendung von Succinat als Substrat offenbarte, daß das P/O-Verhältnis eine fallende Tendenz aufweist bei Tieren, die bei 6° C gehalten wurden, während die RCR-Werte weder durch wechselnde Umweltverhältnisse noch durch verschiedene Futtermittel beeinflußt wurden. Bei einer Temperatur von 6° C zeigten die Lebermitochondrien bei Anwendung von Succinat als Substrat sowohl eine Herabsetzung von dem P/O-Verhältnis wie den RCR-Werten bei Kaninchen, die ein Basalfutter und ein jodreiches Futter bekommen hatten. Die Unterschiede waren jedoch nicht signifikant in der Gruppe, die ein PTU-Futter bekommen hatte.

In der Untersuchung der Nierenmitochondrien-Aktivität, wo α-Ketoglutarat als Substrat benutzt wurde, wurde festgestellt, daß sowohl das P/O-Verhältnis wie die RCR-Werte eine kleine Verminderung aufwiesen bei den Tieren, die Basal- und PTU-Futter bei 6° C bekommen hatten verglichen mit Tieren, die bei 20° C und 34° C gefüttert worden waren. In den Lebermitochondrien wurden, bei Anwendung von α-Ketoglutarat als Substrat, signifikant verminderte P/O-Verhältnisse wie RCR Werte gefunden sowohl bei den Kaninchen, die ein Basalfutter wie bei denen, die ein jodreiches Futter bei 6° C bekommen hatten. Bei der Gruppe Kaninchen, die 0,05 % PTU im Futter bekommen hatte, zeigte das P/O-Verhältnis ebenfalls einen Abfall. Dieser war jedoch nicht signifikant.

Diese Ergebnisse lassen vermuten, daß das Niveau der oxidativen Enzymaktivität, die Succindehydrogenase in den Lebermitochondrien von Tieren, die ein Basal- und jodreiches Futter bei 6° C bekommen, erhöht. Das Enzym Dehydrogenase, das bei

der Oxydation von α-Ketoglutarat beteiligt ist und das in der äußeren Membran der Mitochondrien lokalisiert ist, läßt sich scheinbar beeinflussen durch verschiedene Temperaturen und Fütterungen, verglichen mit der Succindehydrogenase, die in der Matrix lokalisiert ist. Die Aktivität der Nierenmitochondrien läßt sich weniger beeinflussen als die der Lebermitochondrien.

Die Respiration und Phosphorylierung der Mitochondrien verursacht durch die Dichte ihrer Kupplung kann unterschiedlich reagieren abhängig von dem Grade der Schilddrüsen-Aktivität.

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