Activity of tRNA and aminoacyl-tRNA synthetases of rabbit liver under myocardial ischemia in different seasons of the year

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The activities of tRNA and aminoacyl-tRNA synthetases (AA-tRNA synthetases) in postribosomal supernatants from normal (control) rabbit liver and 6, 12 and 24 h after experimental myocardial ischemia (EMI) in autumn (September and October) and in winter (December and January) have been compared. The results showed that acceptor activity of total tRNA for glutamic acid, glycine and leucine under 6 h EMI in autumn was higher by 21–29%, under 12 h EMI by 22–31% and under 24 h EMI by 37–56% than in winter. No differences were observed in acceptor activity of tRNA between normal groups of both seasons. The results of a study of AA-tRNA synthetase activities showed that the specific activity of glutamyl-, glycyl- and leucyl-tRNA synthetases in liver under 6 and 12 h EMI in autumn was higher by 16–36% than in winter. Only leucyl-tRNA synthetase activity under 24 h EMI was higher by 22% in autumn than in winter. No seasonal differences in the activity of glutamyl- and glycyl-tRNA synthetases under 24 h EMI and in the activity of all AA-tRNA synthetases of normal groups were observed. A decrease of tRNA acceptor activity under EMI in both seasons correlated with an increase of the corresponding AA-tRNA synthetase activity, which may be part of the compensatory mechanism of the cell to keep the normal range of protein synthesis under extreme conditions.

Key words: tRNA, aminoacyl-tRNA synthetases, protein biosynthesis, rabbit liver, seasons, myocardial ischemia

INTRODUCTION

Aminoacyl-tRNA formation is a key step in protein biosynthesis. This reaction is catalyzed with remarkable accuracy by the AA-tRNA synthetases, a family of 20 evolutionary conserved enzymes [1] that catalyze the covalent attachment of an amino acid to its cognate transfer RNA [2, 3]. It is known that under myocardial ischemia protein biosynthesis is altered in heart [4, 5] and other organs, particularly in liver [6, 7].

Our previous studies have shown that acceptor activity of rabbit liver tRNA for glutamic acid, glycine and leucine decreased after 6, 12, 24 h EMI, and reached the control level within 72 h, while the activities of glycyl-, leucyl- and glutamyl-tRNA synthetases of liver extracts were on the increase at the same time [8, 9]. It is known that the intensity of protein biosynthesis depends on the seasons of the year [10–13], seasonal differences have been shown in gene expression [14], acceptor activity of total tRNA [15] and changes in the ultrastructure of hepatocytes [13].

The objective of this study was to examine the acceptor activities of tRNA for glutamic acid, glycine and leucine and the activities of the corresponding AA-tRNA synthetases of normal rabbit liver and 6, 12 and 24 h after EMI in different seasons of the year.

MATERIALS AND METHODS

Male rabbits were used. Acute myocardial ischemia was induced by occlusion of the left anterior descending coronary artery according to [16].

AA-tRNA synthetases and tRNA were isolated from normal (control) rabbit liver and 6, 12 and 24 h

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after EMI. These periods were chosen, because essential alterations in protein synthesis and level [17] as well as in the activity of rabbit liver tRNA, AA-tRNA synthetases and ribosomes were observed [9, 18, 17].

Total tRNA was isolated from rabbit liver by phenol deproteinization and further chromatography on DEAE-cellulose column according to [19] with subsequent deacylation as described earlier [20]. Isolation of total AA-tRNA synthetases and determination of its concentration were performed as in [21].

The acceptor activity of total tRNA for particular ^{14}C-labelled amino acids was determined as described in [22]. Activity of AA-tRNA synthetases was measured by the initial rate of tRNA aminoacylation. The composition of standard reaction mixture and the procedure were reported in [9].

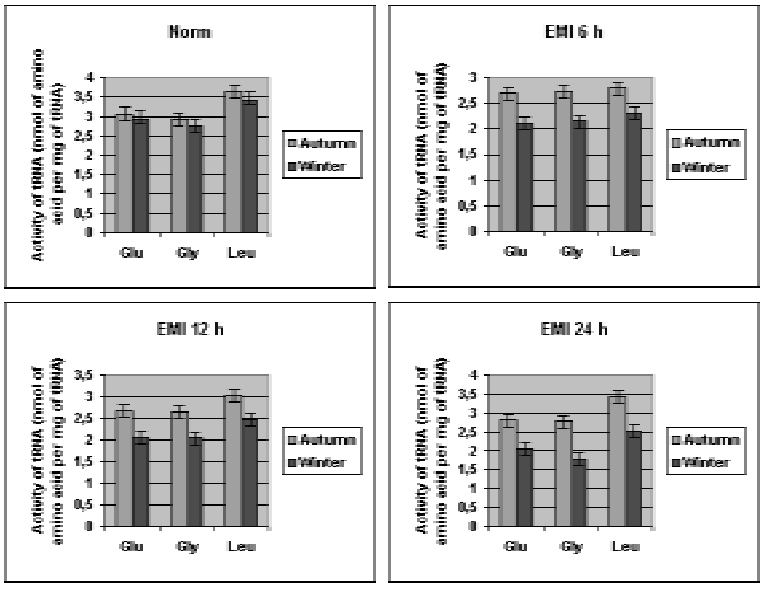

Fig. 1. Acceptor activities of specific tRNA of rabbit liver in norm and under 6, 12 and 24 h EMI in autumn and winter

RESULTS AND DISCUSSION

The activities of tRNA and AA-tRNA synthetases of normal rabbit liver and under 6, 12 and 24 h EMI in autumn (September and October) and in winter (December and January) were compared. The results showed that acceptor activity of total tRNA for glutamic acid, glycine and leucine under 6 h EMI in autumn was higher by 21–29%, under 12 h EMI by 22–31%, and under 24 h EMI by 37–56% than in winter (Fig. 1). No differences were observed in acceptor activity of tRNA between normal groups of both seasons.

As reported earlier [9, 22], decrease of acceptor activity of tRNA under EMI is associated with formation of inactive molecules due to conformational changes of some molecules of tRNA and is not related with a loss of terminal CCA nucleotide triplet of the acceptor steam of these molecules.

In winter, acceptor activity of tRNA for glutamic acid, glycine and leucine under 6, 12 and 24 h EMI decreased by 22–39% as compared to norm. In autumn, a statistically significant decrease (by 17–23%) was determined only for leucine under 6 and 12 h EMI as compared with norm. No differences were observed for glutamic acid and glycine in all EMI periods and for leucine under 24 h EMI in autumn as compared to control. Alterations of the acceptor activity of tRNA under EMI in different seasons may be associated with appearance of inactive tRNA conformers, as was shown for some tRNA under EMI [8, 22], and with alterations in activity of total tRNA methyltransferases, which can cause differences in the step of methylation of some tRNA nucleotides, as described for total methyltransferase activity under 12 h EMI [23].

Results of the study of AA-tRNA synthetase activity of rabbit liver postribosomal supernatant showed that the specific activity of glutamyl-, glycyl- and leucyl-tRNA synthetases under 6 and 12 h EMI in autumn was higher by 16–36% than in winter (Fig. 2). Only leucyl-tRNA synthetase activity under 24 h EMI was

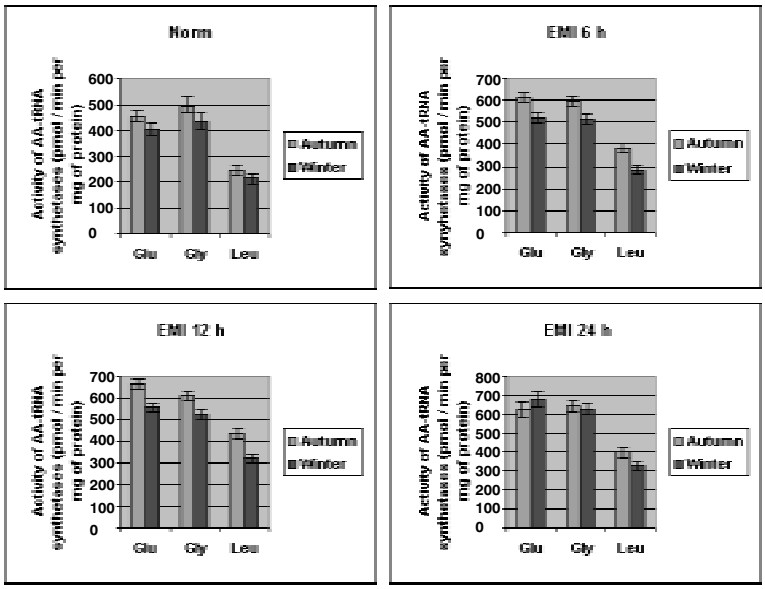

Fig. 2. Activities of specific aminoacyl-tRNA synthetases of rabbit liver in norm and under 6, 12 and 24 h EMI in autumn and winter

higher by 22% in autumn than in winter. No seasonal differences in the activity of glutamyl- and glycyl-tRNA synthetases under 24 h EMI and in of all AA-tRNA synthetases of normal groups were observed.

In winter, the activity of glutamyl-, glycyl- and leucyl-tRNA synthetases under 6, 12 and 24 h EMI increased by 19–69% and in autumn – by 21–79% as compared to control. Differences of the AA-tRNA synthetase activities in rabbit liver postribosomal supernatant under EMI in different seasons may be associated with an increasing activity of inorganic pyrophosphatase which regulates AA-tRNA synthetase activity by cleavage of inorganic pyrophosphate, as shown earlier for 12 h EMI [23], and with alterations in the distribution of AA-tRNA synthetase activity between high molecular complexes and fractions of lower molecular complexes and free enzymes as reported under EMI [6] and other conditions [24]. A lower decrease in acceptor activity of tRNA and a higher increase of AA-tRNA synthetase activity under 6 and 12 h EMI in autumn than in winter may be related to alterations in the action of some hormones, excretion of which depends on the natural light period of the day and on differences in the feeding of laboratory animals in different seasons as have been noted for other subjects [12, 25, 26]. The decrease of acceptor activity of tRNA under EMI in both seasons studied correlates with the increase of the corresponding AA-tRNA synthetase activity, which may be part of the compensatory mechanism of the cell to keep protein synthesis in a normal range under extreme conditions.

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MIOKARDO IŠEMIJOS POVEIKIS TRIUŠIŲ KEPENŲ TRNR IR AMINOACIL-TRNR SINTETAZIŲ AKTYVUMUI SKIRTINGU METŲ LAIKU

S a n t r a u k a

Palygintas tRNR ir aminoacil-tRNR sintetazių (AA-tRNR sintetazių) aktyvumas poribosominiame supernatante, išskirtame iš triušių kepenų esant normai (kontrolė) ir praėjus 6, 12 ir 24 val. po eksperimentinės miokardo išemijos (EMI) rudenį (rugsėjo–spalio mėnesį) ir žiemą (gruodžio–sausio mėnesį). Nustatyta, kad rudenį po 6 val. EMI tRNR gebėjimas akceptuoti glutamo rūgštį, gliciną ir leuciną yra 21–29%, po 12 val. – 22–31%, o po 24 val. – 37–56% didesnis negu žiemą. Kontrolinių grupių triušių kepenų tRNR akceptinio aktyvumo skirtumų skirtingu metų laiku nerasta. AA-tRNR sintetazių aktyvumo tyrimai parodė, kad glutamil-, glicil- ir leucil-tRNR sintetazių aktyvumas po 6 ir 12 val. EMI rudenį yra 16–36% didesnis negu žiemą. Praėjus 24 val. po EMI sukėlimo tik leucil-tRNR sintetazės aktyvumas rudenį yra 22% didesnis negu žiemą. Glutamil- ir glicil-tRNR sintetazių aktyvumas po 24 val. EMI skirtingu metų laiku buvo vienodas. Nustatyta, kad kontrolinių triušių kepenų AA-tRNR sintetazių aktyvumas rudenį ir žiemą nesiskyrė. Ir rudenį, ir žiemą kai kurių tRNR akceptinio aktyvumo sumažėjimas EMI metu koreliuoja su specifinių AA-tRNR sintetazių aktyvumo padidėjimu. Manoma, kad AA-tRNA sintetazių aktyvumas padidėja kaip kompensacinis atsakas sumažėjus tRNR akceptiniam aktyvumui EMI metu tiek rudenį, tiek žiemą.