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STARVATION INDUCES DEHYDRATION OF CELLS

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Starvation of different duration is frequently recommended as a treatment for weight reduction purposes [1,2], or it can be either a result of psychological disturbances [3] or the outcome of severe diseases [4,5]. The pathophysiology and consequences of starvation are widely discussed in current literature and the changes in starved organism are explained mainly by the lack of protein supply.

The aim of the present study has been to investigate the cell volume changes after starvation of different duration and its role in adaptation or intolerance to starvation.

The hydration state is an adaptive reaction of the cell to environmental changes [6]. Cell volume changes can modulate the cell functional activity by changing the surface of the cell membrane, resulting in changes of the number of active units of receptors – increase in swelling and decrease in shrinkage, when a part of the functional active receptors goes into reserve; their function can be restored in case of recovery of [7] the cellular hydration initial state. Cell membrane packing in cell shrinkage process thus leads to the decrease of chemosensitivity [8] and functional activity [9]. The protein [10] and glycogen [11] synthesis in the cell and other important metabolic processes [6] are controlled by cell volume changes. Cellular hydration state is an important determinant of protein turnover; the increase in cellular hydration acts as an anabolic-proliferative signal, whereas the cell shrinkage is catabolic and antiproliferative [12]. The information about the hydration state of different tissues can help to understand the whole network of metabolic processes, established in different periods of starvation and the time for onset of disadaptation for every certain tissue.

Material and Methods

White male rats with average weight of 150g were used for the experiments. The animals were fasted for 2,3 and 4 days. The hydration of different tissues was measured immediately after decapitation.; after weighing the tissue sam-

ples of starved and fed (control) rats were dried in a thermostatically controlled oven at 105° C for 24 hrs, reweighed and the hydration index was calculated as (wet weight − dry weight)/dry weight and expressed as water content g/g dry w..The mean values, standard deviations and statistical probability by Student's test was calculated and the figures made with the help of computer program Sigma Plot.

Results and Discussion

The dehydration of all tissues of rats, expressed in various intensities, was studied, which was growing in most of the tissues till the 4th day (see the figure). After 2 days' starvation (48hrs) the hydration of brain decreased to 4.3%, of liver − to 5,3 %, spleen tissue − to 4.1%, while the hydration of heart was not changed.

The animals starved for 3 days drank water in a greater amount than the controls, but the decrease of hydration of tissues was more expressed, the internal organs showed an extraordinary low turgor at first sight. The decrease of hydration of brain was 5,1%, liver − 15,7%, spleen − 6,4%, and a tendency of decrease of heart tissue hydration state was noticed.

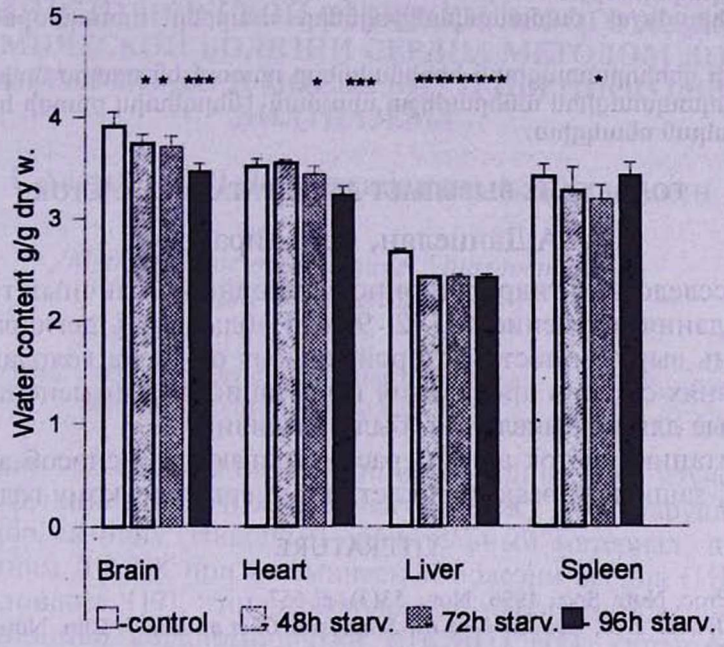
The most interesting were the data obtained after 4 days of starvation, when the decrease of brain hydration was severe (11,2%), for the first time a marked decrease of heart tissue was detected − for 6,4%, a "restoration" of spleen and liver tissue hydration was observed. The restoration of hydration levels could be the sign of decompensatory hyperhydration of cells, initiated after 96 hrs of starvation, as in most of the cases the rats didn't survive after a longer duration of starvation. As it can be seen from the results the heart tissue has the best volume regulating capacities, as it is the last being involved in the process. Spleen is the first to show hyperhydration, maybe because of preventing the hyperhydration of blood as a result of shifting water from other organs.

The decreased sensitivity of different tissues to catecholamines and thyroxin, observed during starvation, was explained by the authors as a result of decrease of a number of receptors because of protein starvation [13,14]. Of great interest is the fact that the sensitivity of tissues of starved rats to insulin is decreased because of the reduction of the relative number of receptors [15], a fact which can be explained also by the results of our experiments; dehydration of cells leads to the packing of the cell membrane and thus a part of active protein molecules are stored as a reserve, and can be reactivated after restoration of the initial volume of the cell.

There are interesting data about starvation induced multiresistance to hazardous influences in *Enterococcus faecalis* [16] and mutagen induced mutations decline during starvation in *Escherichia* coli [17] which also could be explained by shrinkage induced decrease in sensitivity.

Insulin is shown to promote protein synthesis during feeding [18], which corresponds to the theory of hydration state regulating the cellular metabolism,

as the protein synthesis promotion of insulin is considered to be secondary to its swelling inducing action [6] on the cell. The data about Na-K pump activity, activation of peroxide formation processes [19], protein synthesis decrease during starvation [20,21] and many other data in current literature could also be explained by the theory of the role of cell volume in metabolic control and can be explained by the dehydration mechanism of pathophysiological changes in starvation.



The changes in metabolism, induced by starvation and explained as a result of protein deficiency induced decrease of the number of receptors, we explain by the decrease of amount of receptors because of shrinking of the cells and the decrease of mean surface of cell membrane, resulting in the decrease of the amount of functioning (active) receptor units. This process could be developed by the cell for establishing an economical metabolism in conditions of energy starvation and thus protecting cells from various hazardous influences. This fact may be useful in some conditions, where a short period of starvation may have beneficial results.

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ՍՈՎԱՀԱՐՈՒԹՅՈՒՆԸ ԲԵՐՈՒՄ Է ԲՋԻՋՆԵՐԻ ԾԱՎԱԼԻ ՓՈՔՐԱՑՄԱՆԸ

Ա.Ա.Դանիելյան, Ս.Ն.Հայրապետյան

Հետազոտվել է 48ժ, 72ժ, 96ժ սովահարությունից հետո սպիտակ արու առնետների տարբեր հյուսվածքներում դիտվող հիդրատացիոն փոփոխությունները: Սովահարության տևողությունից կախված դիտվել են տարբեր հյուսվածքների տարբեր աստիճանի հիդրատացիոն փոփոխություններ: Բացահայտվել է, որ հիդրատացիոն փոփոխությունների արտահայտվածության աստիճանի ու դրսևորման համար անհրաժեշտ ժամանակամիջոցները տարբեր հյուսվածքների համար տարբեր են:

Բջիջների դեհիդրատացիան հեղինակները դիտում են որպես սովահարության ժամանակ աղապտացիոն անհրաժեշտ պայման՝ էներգետիկ քաղցի հանդեպ բջջի պաշտպանական ռեակցիա:

ГОЛОДАНИЕ ВЫЗЫВАЕТ ДЕГИДРАТАЦИЮ КЛЕТОК

А.А.Даниелян, С.Н.Айрапетян

Было исследовано гидратационное состояние различных тканей крыс после голодания в течение 48, 72, 96 *ч.* Наблюдалась дегидратация тканей, степень выраженности которой зависит от срока голодания. В различных тканях степень проявления гидратационных изменений и сроки, необходимые для их выявлений, были различны.

Дегидратацию клеток авторы рассматривают как способ адаптации к голоданию, защитной реакцией клетки к энергетическому голоду.

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