THE IMPACT OF FOOD RATIONS ON THE INTERMEDIATE METABOLISM OF AMINO ACIDS IN INDIVIDUALS WITH HYPERSTHENIC TYPE OF CONSTITUTION

IMPACTUL RATIILOR ALIMENTARE ASUPRA METABOLISMULUI INTERMEDIAR AL AMINOACIZILOR LA PERSOANE FIZICE CU TIP DE CONSTITUTIE HIPERSTENICA

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Summary. *The advancement of personalized nutrition systems holds significance in the future of personalized medicine. The research paper outlines the fundamental principles of sanogenic nutrition based on the hypersthenic constitution type, which serves as a criterion for individualization. When creating and computing the caloric makeup of diets for hypersthenics, special emphasis is placed on the observation that individuals with this body type have a propensity to gain weight effortlessly and encounter difficulties in shedding excess body mass. Considering the principle of food differentiation and metabolic idiosyncrasies, the hypersthenic diet should primarily comprise of nourishments that promote a decreased metabolism, rather than ones that hinder it. This entails including foods abundant in protein and limited in carbohydrates and fats. Upon analyzing the obtained findings, it can be deduced that the food ration with a protein content ranging from 20-22% is more favorable for the nitrogen metabolism process in rats of this type of constitution.*

Keywords: *metabolic algorithms, free essential amino acids, hypersthenic type, food rations.*

INTRODUCTION

Food plays a crucial role in maintaining, strengthening, and influencing health. Nutritionists primarily focus on providing the body with essential nutrients it needs to maintain normal growth and repair functions. However, they often overlook the significant role these nutrients play in the body's developmental processes, physiological systems, and overall health. Current food systems have been unable to address the health challenges faced by modern society. Balanced food systems based on scientific research are considered more advanced, they only meet the individual needs of 26% of the population. This discrepancy arises from the fact that existing food systems are designed for the average person and do not cater to the diverse needs of the majority. In recent years, researchers and practitioners have started exploring personalized elements in food sys-

tems, which hold promise for the future of personalized medicine. This individualized approach aims to tailor food systems to meet the specific needs of individuals, marking a significant shift towards personalized nutrition.

MATERIAL AND METHODS

The amino acid content was analyzed by the liquid chromatography method with the amino acid analyzer AAA339M [1]. The laboratory experiments were conducted on Vistar line white rats, specifically chosen based on their reactive body type, which is the hypersthenic type. To ascertain the constitutional type of the experimental animals the overall non-specific reactivity of their bodies was investigated. The animals' stressor reactivity was assessed using two reliable and suitable models, namely the "forced swimming" model and the "island of water" model, which provide an unbiased evaluation [2]. Four experimental groups were formed from the rats with the reactive body type, following the same principles of body mass (average weight of 242.0-242.8 g), age (4-6 months), and sex, with 4-5 individuals in each group. These groups were kept under identical conditions and provided with a similar diet. However, the key distinction was that each group received a food ration with varying caloric structures, designed according to the principles of sanogenic nutrition specific to the hypersthenic body type. The caloric structure of the food rations for the hypersthenic type can be found in table 1.

Table 1. The caloric structure of food rations for the hypersthenic type according to the experimental groups (%)

Indicator	**Experimental groups**			
	I (control)	II	III	IV
Protein, %	20	22	25	30
Fat, %	25	23	22	21
Carbohydrate, %	55	55	53	49

The duration of the experiment is 2 months. The experimental studies were performed in accordance with the protocol of the ethics committee.

REZULTS AND DISCUSSIONS

Research was conducted based on the concept and principles of nutrition in accordance with the individual's constitution. Despite the shared purpose of food, which is to satisfy hunger and promote good health, individuals with different constitutions approach it in varying ways. Furthermore, the methods and components used to achieve the ultimate goal are not always the same, and sometimes they even adopt completely opposite approaches.

When formulating and calculating the caloric composition of diets for hypersthenics, particular attention is given to the fact that individuals of this constitution type tend to gain weight easily and struggle to reduce their body mass. Taking into account the principle of food differentiation and metabolic peculiarities, the diet for hypersthenics should primarily consist of foods that support a reduced metabolism, rather than those that decrease it. This means incorporating foods with high protein content and minimal amounts of carbohydrates and fats. This method guarantees excellent well-being and peak physical fitness. If the metabolism is not sufficiently stimulated, it can result in a further decline in metabolism, weight gain, and various negative repercussions. Hypersthenic individuals possess a greater body mass compared to other constitutional types. They have larger bones and naturally, more muscle mass. Sustaining this mass necessitates a higher intake of protein and energy. A crucial measure of the nutritional value of the different caloric compositions of the diets tested on hypersthenic individuals is their impact on the amino acid intermediate metabolism. The research results are presented in table 2 in the form of free amino acids in the blood plasma of the experimental animals.

Table 2. The influence of the tested rations with different caloric structure for the hypersthenic type of constitution on the intermediate metabolism of amino acids

Plasma	I group	II group	III group	IV group
cysteine acid	1,64±0,21	4,71±1,05**	1,47±0,33	3,06±1,01**
taurin	24,59±1,21	27,82±1,03**	28,23±9,90	39,64±2,45**
aspartic acid	3,20±0,40	3,64±0,15*	6,58±1,63**	7,57±0,57**
threonine	12,19±1,11	12,94±2,09	22,82±7,19**	20,13±2,99**
serine	9,96±0,52	12,52±1,12**	20,99±7,69**	20,46±2,02**
asparagine	4,66±0,71	2,81±0,59**	3,86±0,56*	5,07±1,04
glutamic acid	10,73±2,31	5,22±1,26**	14,55±3,80	18,00±2,04**
glutamine	17,52±3,44	7,32±0,90**	9,48±2,31**	15,25±2,32
α-aminoadipinic acid	0,84±0,25	1,85±0,39**	1,89±0,56**	2,17±0,27**
proline	9,70±1,87	10,76±1,75	9,85±2,64	11,50±0,89
glycine	13,89±3,04	15,97±1,14	19,85±7,54	21,91±1,59**
alanine	19,48±2,56	28,33±3,84**	32,37±12,85*	37,12±2,69**
citruline	1,01±0,20	2,05±0,22**	2,034±0,37**	2,28±0,51**
α-aminobutyric acid	0,99±0,20	1,91±0,35**	1,97±0,32**	2,27±0,46**
valine	7,69±0,85	10,43±1,78**	11,25±2,41**	11,70±0,74**
cysteine	4,46±0,91	4,27±0,49	5,53±0,97	5,77±0,68*
methionine	1,33±0,21	1,85±0,51*	1,57±0,31	1,83±0,21**
isoleucine	3,49±0,70	5,57±1,13**	5,95±1,83*	6,40±0,76**
leucine	5,86±0,39	6,98±0,65**	9,13±3,01*	10,61±0,58**

tyrosine	4,00±0,54	4,75±0,85	4,36±1,16	3,95±0,29
phenylalanine	3,31±0,34	5,47±1,86*	5,25±1,36**	7,30±0,36**
γ-aminobutyric acid	1,01±0,13	1,07±0,24	1,01±0,22	1,58±0,22**
ornithine	2,20±0,36	3,37±0,33**	4,66±0,88**	6,59±0,40**
lysine	23,00±2,00	26,00±3,03	25,15±8,43	26,05±1,46*
histidine	2,69±0,53	3,76±0,35**	3,51±0,83	5,53, ±0,47
arginine	5,95±0,77	13,54±0,88**	8,34±1,87*	19,69±1,64**
urea	95,28±8,34	106,32±20,38	71,44±18,52*	104,34±25,46
ammonia	71,02±20,13	136,09±10,81**	154,94±19,51**	219,43±9,77**
Σ free amino acids	195,43±21,12	224,91±16,87*	261,69±77,03	313,45±19,64**
Σmetab. nitrate indices	361,74±42,19	467,37±11,40**	488,06±99,48*	637,23±49,63**
Σ non-essential amino acids	107,62±49,27	95,60±8,76	127,45±39,76	146,59±9,26**
Σ essential amino acids	81,10±31,87	86,55±8,18	92,96±26,35*	109,25±8,05**
Σ immunoactive amino acids	98,97±46,66	81,26±8,30	118,98±36,09*	127,39±8,81**
Σ glycogen amino acids	95,62±45,85	83,85±8,79	113,87±38,57*	118,88±7,84**
Σ ketogenic amino acids	43,96±17,46	48,78±6,11	49,84±15,40	54,32±2,93**
Σ proteinogenic amino acids	188,64±81,00	182,16±16,75	220,42±65,73	255,85±16,53**
Σ S-containing amino acids	32,89±12,43	38,66±2,22	36,81±10,99	50,30±3,03**
essential/non-essential	0,67±0,04	0,90±0,02**	0,73±0,04	0,74±0,03**

*p<0,01 **p<0,001

Based on the presented data, it can be concluded that the first group, which has the lowest protein content (20.0%), has a higher biological value. This is evident from the high ratio (0.67) between essential and non-essential amino acids. The protein content in the second, third, and fourth groups, which are 22.0%, 25.0%, and 30.0% respectively, had a more significant impact on the intermediate metabolism of amino acids. In comparison to the first group, the second group had a higher concentration of free amino acids in the blood plasma, except for threonine, proline, cysteine, tyrosine, and lysine. The ratio between essential and non-essential amino acids in the second group was the highest at 0.90. The third group also had a high concentration of free amino acids in comparison

to the first group, except for proline, glycine, cysteine, methionine, taurine, tyrosine, lysine, and histidine, where no significant difference was observed. The most significant difference in the concentration of free amino acids in the blood plasma ($p<0.001$) was found in the fourth group, where only asparagine, glutamine, proline, and tyrosine showed a non-significant difference.

Hence, the conducted study enabled the establishment of the fact that all the variations of the diets with different caloric compositions, which were developed and tested for individuals with a hypersthenic body type, exhibit distinct differences in their high biological value. The II and IV groups displayed the highest levels of intermediate metabolism of amino acids.

The overall concentration of immunoactive and glycogenic amino acids in the blood serum of rats in group IV exhibited a significant increase, which can be attributed to the higher protein content in their diet. The content of S-containing amino acids remained consistent in the protein retention diet at 20-25%, but it increased by 1.5 times when the protein content reached 30%.

Meanwhile, the concentrations of ketogenic and sulfur-containing amino acids showed minimal variation in diets containing 20-30% protein. Further analysis of Table 2 revealed that, across all experimental diets with a protein content of 20-30%, the levels of proline, tyrosine, ac.γ-aminobutyric acid, and lysine remained stable in the blood plasma.

Table 3. The ratios of some amino acids in the blood serum of hypersthenic rats fed different food rations

Index	**I group**	**II group**	**III group**	**IV group**
Fisher Index	2,34±0,10	2,40±0,75	2,74±0,13**	2,55±0,05**
Index C	2,52±0,39	2,97±0,88	3,31±0,41**	4,01±0,32**
Tyrosine / phenylalanine	1,21±0,04	0,93±0,24*	0,84±0,08**	0,54±0,02**
Σesentiali/Σneesentiali	0,67±0,04	0,90±0,02**	0,73±0,04	0,74±0,03**

* $p\leq0,05$ ** $p\leq0,01$

The Fisher index, which indicates the activity of liver hepatocytes, was found to be within normal limits in rats from all experimental groups. The C index, which reflects the presence of inflammatory processes in the body, was significantly increased to 4.01±0.32 in the rats of group IV, suggesting a possible accumulation of disorders in organ and system functioning in individual rats within this group. This was observed in 40% of the rats in group IV, who were on a 30% protein diet. The tyrosine/phenylalanine index, which reflects the function of the thyroid gland, was found to be 2 times lower in rats from group IV with a protein content of 30% compared to rats from groups I, II, and III. This indicates a possible impairment of the thyroid gland in rats under the conditions of ration IV, observed in 100% of the rats examined in this group. In rations containing

20-30% proteins, the ratio of essential/non-essential amino acids is greater than 0.55 to 1.0, which is considered an optimal ratio for healthy mature animals in comfortable conditions, according to data obtained by A. Nevoia [3]. The changes in the indices and blood serum of the rats in group IV suggest an accumulation of impaired functional activity of the thyroid gland and the development of inflammatory processes in the body with a protein diet of 30%, lipids 21.0%, and carbohydrates 49.0%. Interestingly, the share of the summary content of free amino acids in the total volume of nitrogen metabolism indices remains relatively constant, with 54.0% in group I, 48.1% in group II, 53.6% in group III, and 49.2% in group IV. The final product of nitrogenous metabolism is urea, which is formed under the influence of the enzymes of the ornithine cycle. The content of urea in the blood can provide some insight into the efficiency of nitrogen assimilation in the animal body [4]. This index remains quite stable in all experimental groups of rats and ensures the assimilation of food by the animals. The rise in ammonia concentration in the blood serum of the rats was found to be directly proportional to the increase in protein content in their feed, ranging from 71.02±20.13 mkm/100 ml to 219.43±9.77 mkm/100 in group IV.

Subsequently, an analysis was conducted on the range of free amino acids present in the erythrocytes of hypersthenic rats following the consumption of the four different food rations. The analysis demonstrated that the summary content of free amino acids in erythrocytes increases proportionally with the decrease in the share of proteins in the diet and is maximal in the animals of groups III and IV, veritably increased compared to the other experimental groups.

In rats from ration IV (30% of proteins, 49% of carbohydrates, 21% of lipids), the ammonia content in both serum and erythrocytes was significantly increased (3.1 times in serum and 2-5 times in erythrocytes). Nevertheless, the reversal ratio was observed in the IV rat group. As the protein content in the rat feed increased, both the urea/ammonia coefficient ratio in serum and erythrocytes decreased. This phenomenon likely indicates the adaptive functions of erythrocytes in preserving the stability of the biochemical parameters in the blood serum.

CONCLUSION

Upon analyzing the obtained findings, it can be deduced that the food ration with a protein content ranging from 20-22% is more favorable for the nitrogen metabolism process in rats of this type of constitution. In hypersthenic rats, who were sustained with a ration consisting of 16-20% protein, there is no significant difference in the total amount of free amino acids in the blood plasma. This indicates the high ability of hypersthenics to maintain a stable spectrum of free amino acids in the blood plasma, even when the protein content in the food ration varies. For rations containing 20-30% protein, the ratio of essential to non-essential amino acids in the blood serum is not less than 0.55, which is considered the optimal ratio for healthy mature animals. The antioxidant potential of the body remains stable within acceptable limits when hypersthenic rats are fed with

rations containing 20-22% proteins. This reflects the body's compensatory capabilities in hypersthenic rats. In hypersthenic rats fed with a ration consisting of 20-25% proteins, the optimal distribution coefficient of ammonium nitrogen in blood plasma and erythrocytes is 1.8, which closely aligns with the optimal value.

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