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AMINO ACID COMPOSITION OF FRUIT IN THE MANUFACTURE OF SEDIMENTATION-STABILIZED DISPERSED PRODUCTS

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*Information is given on the total amino acid composition and the free amino acids of pears (*Pyrus communis *L.), squashes (* Cucurbita pepo *L.), grapefruits (*Citrus paradisi *L.) and apples* (Malus sylvestris *Mill.). It has been established that during the dispersion of the fruits in the manufacture of sedimentation-stabilized products that the total qualitative and quantitative amino acid compositions scarcely change but the concentration of free amino acids rises by 14.5—45.1% on the total amount of free amino acids in the initial material. The causes of the rise in the level of free amino acids are discussed.*

Among the indices of the nutritional and biological value of fruits the dominating role is that of the amino acid composition. In view of this, we have investigated the most promising species and varieties of edible fruit crops — both those used the fresh state and those employed for the preparation of sedimentation-stabilized dispersed products.

The general characteristics of the amino acid compositions of the fruits and their biological value are given in Table 1.

It follows from Table 1 that the highest amounts of total and free amino acids were present in grapefruits, and the lowest in pears. Analysis of the biological value of the protein compounds showed that the main amino acid limiting their biological value was leucine for squashes and apples and for the total amino acids of grapefruits; the sulfur-containing amino acids methionine and cystine for pears, and threonine for the free amino acids of grapefruits.

The amino acid compositions of the species and varieties of fruits investigated are given in Table 2. It must be mentioned that the proportion of free amino acids of the total concentrations of free and bound amino acids in the materials concerned ranged from 42.8% for apples to 50.7% for grapefruits. This index is comparable with those that have been found for sea buckthorn berries, figs, peaches, and apricots [1—3]. Among the total amino acids, aspartic and glutamic acids predominated for the fruits of all species, and this tendency also applied to the free amino acids of the fruits of all the species with the exception of pears. There were high concentrations of lysine in squashes, pears, and grapefruits, of threonine in pears, and of phenylalanine and valine in pears and grapefruits. It is important to state that the fruits investigated contained all the essential amino acids, with low values of the score for leucine and the sulfur-containing amino acids methionine and cystine.

In previous investigations [4, 5] we found the mean fruit particle sizes that were suitable for obtaining sedimentation-stabilized dispersed products from raw materials with different chemical compositions. In this connection, information on the qualitative and quantitative characteristics of the amino acids of the fruits are given for two types of dispersed composition of the species of raw materials studied (Table 3).

It follows from Table 3 that the process of dispersing plant raw material has practically no influence on the total concentration of amino acids. The scores for all the essential amino acids and, in particular, for those limiting the biological values of the nitrogen complexes of the fruits also remained unchanged. After dispersion the amount of free amino acids rises by 14.5 - 45.1 % on the initial level for the fruits of all species.

The scores for the free amino acids with respect to the limiting amino acids rose with an increase in the degree of dispersity by from 4.2% for squashes to 11.6% for pears. It must be emphasized that in relation to the initial amount of free amino acids for each species of fruit the process of dispersion led to an increase in the index by 30.0 and 45.1% for pears and apples, respectively.

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TABLE 1. General Characteristics of the Amino Acid Compositions of Fruits

Index	Grapefruits	Pears	Squashes	Apples
Total amount of amino acids, 10^{-3}%	633	438	616	528
Score for limiting amino acids, %	30.1 (Leu)	52.14 (Met+Cys)	33.6 (Leu)	49.1 (Leu)
Total free amino acids, 10^{-3}%	321	207	303	226
Score for limiting amino acids, %	13.2 (Tre)	29.2 (Met+Cys)	23.1 (Leu)	26.8 (Leu)

TABLE 2. Amino Acid Compositions of Fruits, 10^{-3} %

Amino acid	Grapefruits		Pears		Squashes		Apples	
	Amino acids							
	total	free	total	free	total	free	total	free
Lys	36	23	27	12	47	17	24	15
His	13	6	8	4	12	8	14	8
Arg	58	31	24	10	14	7	12	5
Asp	102	54	131	49	270	128	154	51
Thr	13	4	24	11	19	10	18	8
Ser	21	10	19	8	23	11	25	13
Glu	89	38	34	14	63	32	96	39
Pro	31	18	8	5	21	11	33	13
Gly	76	30	11	7	20	9	14	8
Ala	49	31	19	7	31	15	29	11
Val	35	18	23	14	17	10	19	9
Ile	26	12	22	16	14	8	16	7
Leu	16	9	23	12	16	11	22	12
Tyr	16	9	14	8	11	6	15	8
Phe	26	14	34	21	15	8	14	9
Trp	5	3	8	4	8	5	9	3
Met	14	8	5	3	6	3	7	4
Cys	7	3	4	2	6	4	7	3

A study of the compositions of the free amino acids for the dispersed fruits (Table 4) showed that the proportion of free amino acids in the grapefruits had increased from 50.7% on the total amount of amino acids in the initial material to 68.7%, in pears from 47.3% to 61.4%, in squashes from 49.2 to 64.6%, and in apples from 42.8% to 62.1%, respectively. The different results for the increases in the levels of free amino acids can probably be explained in the following way. During the dispersion process mechanodestruction of the high-molecular-mass biopolymers of protein nature takes place. This is in harmony with the literature [6]. In view of the same degrees of comminution of the different species of fruits one should expect similar values of the changes in the index. However, the range of changes — from 14.1% for pears to 19.3% for apples — permits us to assert that endogenous enzymatic proteolytic processes take place.

The hypothesis expressed has been confirmed by the setting up of experiments to demonstrate endogenous proteolytic activity of the species of fruits investigated, which gave results similar to those that we have described for vegetables [7, 8]. This made it possible to establish the presence of an intracellular protease complex of enzymes and to arrange the fruits in order of increasing proteolytic activity in the following way: pears—squashes—grapefruits—apples.

TABLE 3. Dynamics of the Change in Amino Acids on the Dispersion of Fruits, %

Object of investigation	Total amount of amino acids	Score of total amino acids (on the limiting amino acid)	Free amino acids (on their initial concentration in the raw material)	Score of free amino acids (on the limiting amino acid)
Grapefruits				
fresh	100.0	30.1*	100.0	13.2***
after comminution to a particle size of 700 μm	100.0	30.1*	115.5	16.4***
200—300 μm	99.3	30.1*	135.5	23.0***
Pears				
fresh	100.0	52.4**	100.0	29.2**
after comminution to a particle size of 700 μm	99.7	52.4**	114.5	35.0**
200—300 μm	99.8	52.3**	130.0	40.8**
Squashes				
fresh	100.0	33.6*	100.0	23.1*
after comminution to a particle size of 700 μm	100.1	33.6*	115.8	25.2*
200—300 μm	99.6	33.6*	131.4	27.3*
Apples				
fresh	100.0	49.1*	100.0	26.8*
after comminution to a particle size of 700 μm	99.7	49.0*	119.0	31.2
200—300 μm	99.9	49.0*	145.1	33.5*

*Limiting acid Leu
**Met+Cys.
***Thr.

TABLE 4. Compositions of the Free Amino Acids of the Dispersed Fruits, 10^{-3}%

Amino acid	Grapefruits		Pears		Squashes		Apples	
	Particle size, μm							
	700	200-300	700	200-300	700	200-300	700	200-300
Lys	26	29	15	16	24	31	17	18
His	7	9	4	6	9	11	9	11
Arg	38	46	12	14	8	9	7	9
Asp	60	72	56	63	143	154	59	66
Thr	5	7	13	15	11	13	10	14
Ser	12	16	10	12	17	18	16	19
Glu	47	62	15	18	34	43	43	58
Pro	19	24	6	6	13	14	16	22
Gly	33	42	7	9	11	13	10	12
Ala	34	38	9	12	17	19	18	21
Val	21	27	16	17	12	13	11	13
Ile	15	18	17	19	9	10	8	11
Leu	11	13	13	16	12	13	14	15
Tyr	10	13	9	11	7	9	9	11
Phe	17	21	24	26	10	12	10	11
Trp	3	4	5	5	6	7	4	6
Met	9	10	4	4	4	4	5	6
Cys	4	4	2	3	4	5	3	5

Thus, empirical investigations permit the conclusion that the species of fruit considered contain 18 amino acids, including eight essential for the mature organism. During dispersion the total concentration of amino acids scarcely changes, while the level of free amino acids rises by 14.1—19.3%, depending on the species and features of the enzymatic composition of the fruits. The mechanical and enzymic degradation of the protein biopolymers increases the digestibility of the product and improves its organoleptic properties, while the accumulation of ionogenic amino acids leads to a increase in the charge of the particles, which, in its turn, affects the aggregative stability of the finished product.

EXPERIMENTAL

We investigated pears (*Pyrus communis* L.) of the variety Bere [Beurré] zimnyaya Michurina, squashes (*Cucurbita pepo* L.) of the variety Aromatnaya, apples (*Malus sylvestris* Mill) of the variety Dzhonatan [Jonathan] growing in the Odessa region, and grapefruits (*Citrus paradisi* L.) of the variety Marsh Bessemyannyi (*March seedless* L.) imported, 1996—1997 crop.

Amino acid compositions were determined on a KLA-ZV amino acid analyzer by the method of Moore et al. [9]. Free amino acids were extracted from 50 g of plant tissue with 80% ethyl alcohol, and the extract was evaporated in vacuum at 40°C. The residue was extracted with water for 15 min, and was purified on a column of the sulfophenolic cation-exchange resin KU-1. The solution under investigation was passed through prepared columns (15 g of cation-exchange resin washed with 50 cm^3 of 10%HCl and 600 cm^3 of distilled water). The amino acids were eluted from the column with 50 cm^3 of 10% HCl and 600 cm^3 of distilled water, the eluates were evaporated (at 40°C), and the residue was dissolved in citrate buffer (pH 2.2) and deposited on the column of the amino acid analyzer.

Total amino acids were determined in accordance with the recommendations of [9]. The freeing of the hydrolysate from sugars and other impurities and the following operations, also, were carried out as in the determination of the free amino acids.

In the determination of total amino acids, the quantitative identification of tryptophan was achieved by alkaline hydrolysis using the method of Drese and Reit [10]. The tryptophan in the alkaline hydrolysates was determined as described by A. E. Ermakov and N. P. Yarosh [12].

Amino acid scores were calculated in accordance with handbook recommendations [11], the total amount of protein substances being found by the Kjeldahl method [12], while endogenous proteolysis was determined from the accumulation of the nonprotein nitrogen of the free amino acids found by Lowry's method [12].

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