"IN VITRO" DIGESTION OF PROTEINS OF SOME KINDS OF FOOD RAW MATERIALS AND THEIR MIXTURES

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Results of investigations discussed in the given report gave possibility to receive important information concerning the effective protein digestion under the action of acid and alcaline proteases of human alimentary canal. A method easily reproducible in technological laboratories was used. Mean experimental indices corresponded to 4-time repeats of tests are summarized in tables 1 and 2. As demonstrated in tables, proteins of all dry raw material have considerably high level of digestion including:

- prehydrated form of product in comparison with non - hydrated protein;
- hydrated protein of the product by dispersing of its particles in the initial phase of the process in comparison with simply hydrated product;
- thermoprocessed protein of primary product in hydrated form in comparison with non - thermoprocessed protein.

The thermal processing was carried out by thermostating 150 g of dry protein preparation with hydration water correlation 1:4. The temperature was kept on the level of 72°±1°C for 15 min., just

the period of time necessary for obtaining similar temperature in the geometric centre of the sample.

If estimating the effectiveness of six-hour summary pepsin - trypsin digest of proteins contained in all types of raw material in often-used relative units of "mg of tyrosine/g of protein" and simultaneously in generally accepted units of "mcg of tyrosine/g of dry matter" (tab. 1), you may make wrong conclusion that the protein of sodium caseinate has the highest level of digestion whereas the bone protein isolate has the minimal level. Contrariwise, if to take into account that the quantity of tyrosin separated in the course of digest, that characterized the effectiveness of protein proteolysis under action of digestive enzymes, depends not only on the effectiveness of peptide bonds under action of pepsine or trypsine, but on the quantity of tyrosine residua in the polypeptide chain, and to attribute the very digestion expressed in mg of tyrosine/g of protein to mass quota of tyrosine in that protein, then it would appear to be quite easy to obtain the index of pepsine - trypsine digest of the protein in percent to tyrosine contained (tab. 1, right column). Analysis of the digestion shows that the protein in composition of Polyporus fungus micellial mass occurs to be the most sensitive to the action of enzymes contained in the alimentary canal. The second place is occupied by bone protein isolate and cotton protein isolate and then soya protein isolate follows. Sodium caseinate and diafiltration concentrate of the milk protein are the most resistant to the pepsin-trypsine digest. At first it seems to be in contradiction with generally accepted opinion that milk proteins are characterized by high digestion. As a matter of fact results assumed as a basis were obtained in practice for native proteins,

in particular for caseine isolated from the milk in "mild" laboratory conditions. It is appeared to be that commercial technologies lead to substantial change of overmolecular protein structures of tested powdered milk - protein preparations. As a result summary contact surface of disperse protein phase with buffer liquid in the digest process and pepsine or trypsine macromolecules contained descends substantially after the hydration of powdered protein preparations, even after forced dispersing in the aqueuns dispersion medium, in comparison with contact aurface characteristic to native milk proteins. In that case the summary effectiveness of protein digestion occurred to be considerably lower (even without change of proteolitic attacking ability of individual peptide bonds in polypeptide chains of protein macromolecules because of limited "access" of proteolytic enzymes to inner zones of overmolecular protein structures).

Analysis of data (tab. 2) obtained for natural animal raw material biologically supplied with water shows that non-thermoprocessed blood proteins of the cattle have the highest level of digestion (percent to initial tyrosine) and blood plasma protein - minimal level. Maximum level of digestion is characteristic first of all to thermoprocessed pork muscle protein (close on 92%), then - to the protein of thermoprocessed trimmed beef, and at last - to the protein of prefermented thermoprocessed meat trimmings. Minimum level of digestion is characteristic to the thermoprocessed plasma. The next stage of investigation concerns the study of protein digestion in vitro for binary and triple systems. The purpose of the study is to accumulate enough statistic material in order to confirm the very assumption of the probability to carry cut

estimation of the digestion of summary protein contained in multicomponent mixtures.

In tab. 3 some indices obtained in the course of experiment and concerned the digvestion of binary systems proteins are shown. It is important to note that, when changing the correlation of components from 0.9:0.1 to 0.7:0.3. the summary pepsine-trypsine digestion expressed in mg of tyrosine/g of protein descends from 11.62 to 8.63 while the digestion expressed in percent to the initial tyrosine increases from 39.22 to 49.04. Such a situation may be explained by an advancing fall of the mass quota of tyrosine in the summary protein. From the analysis of the table follows that if the correlation between binary system components changes, then it appears that digestion levels of summary proteins in a binary system are regularly limited (in terms of experimental error) under the influence of low or high level of protein digestion of different components. Hence the following formula for estimating pepsine-trypsine digestion of the summary protein contained in multicomponent system is worked out taking into account the digestion of proteins in separate components:

$$\pi_{\Sigma} = \frac{\sum_{i=1}^{n} \chi_i \cdot P_i \cdot \pi_i}{\sum_{i=1}^{n} \chi_i P_i}, \qquad (1)$$

where

π_{Σ} is pepsin-trypsin digestion of summary protein in multicomponent system, mg of tyrosin/g of protein;

χ_i is mass quota of a component in the system, unit quota;

P_i is mass quota of protein in the component, %;

π_i is digestion of protein in i - component, mg of tyrosine/g of protein.

To determine the digestion in percent to the initial tyrosine, we divide the formula (1) on the equation allowed to calculate mass quota of tyrosine in the summary protein of multicomponent system:

$$\rho_\Sigma = 10\frac{\pi_\Sigma}{T_\Sigma} = 10\frac{\sum_{i=1}^{n}\chi_i P_i \pi_i}{\sum_{i=1}^{n}\chi_i P_i} = 10\frac{\sum_{i=1}^{n}\chi_i P_i \pi_i}{\sum_{i=1}^{n}\chi_i P_i T_i}, \quad (2)$$

where

ρ_Σ is digestion of summary protein in multicomponent system, in percent to initial tyrosine;

T_Σ is mass quota of tyrosine in summary protein, g/100 g of protein;

T_i is mass quota of tyrosine in component of i - component, g/100 g of protein;

10 is coefficient of proportionality, g of protein · g%/mg·100g of protein.

To check up the adequancy of given formulas, we determined experimentally pepsin-trypsin digestion of two types of three-component systems by different correlations among components. Experimental and rated indices characteristic to three-component system digest are summarized in table 4. Analysis of these indices showed that it is possible to influence upon the digest of the

summary protein if changing correlation among components contained in the system analyzed. It becomes clear that in case of five different versions of the correlation among components of the system (shown in this table) the pepsine-trypsine digestion of its summary protein is within the limits from 21.28 mg of tyrosine/g of protein (by correlation of components equal to 0.07:0.42:0.51) to 25.98 mg of tyrosine/g of protein by correlation of components equal to 0.5:0.1:0.4). Calculated indices of the pepsine-trypsine digestion (mg of tyrosine/g of protein) obtained by means of the computer on the basis of formula (1) show that maximum relative deviation of calculated indices from indices determinated experimentally (percent to tyrosine) does not exceed 5.77%. Comparison of actually determined digestion (percent to tyrosine) with calculated indices of known parameter (but now on the basis of formula (2) - shows that in this case the relative deviation of calculated indices from factually determined also appear to be quite acceptable for designing calculations and does not exceed 5.33%.

Formulae proposed are quite acceptable for calculating digestion level of the summary protein which should presumably contain in new food products made on the basis of different components composed in one complex system.

Table 1. Digestion of Protein-containing raw material

Table 2. Digestion of proteins contained in animal raw material

Table 3. Digestion of proteins of binary system

Table 4. Digestion of protein in three-component system