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Abstract

Full Text

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HEATS OF COMBUSTION OF WHEAT GLIADIN DURING ITS THERMAL DENATURATION

(Presented by Academician A. I. Oparin on 13 II 1963)

In our previous works ([1], [2]) it was shown that thermal denaturation of proteins isolated from wheat grain by the method described there affects their heat of combustion. This change in the heat of combustion may be interpreted as an indication of a change in the bond energies of fragments in the molecules of these proteins, caused by a change in their internal structure. In the present work we give the results of determinations of the heat of combustion of gliadin isolated from wheat grain that had previously been heated to specified temperatures (heating time—one hour), i.e., gliadin denatured by heat in the grain (*in vivo*). The results obtained in this case (Table 1) show that the heat of combustion of gliadin subjected to heating is practically constant, which may serve as grounds for considering that the protein in the grain is to a significant degree protected from thermal denaturation.

Table 1

Heat of combustion of gliadin denatured by heating (cal. per gram)

Temp., °C	Heating of gliadin preparations (denaturation *in vitro*)	Heating of grain (denaturation *in vivo*)	Heating of the gliadin and sucrose complex
–	5986.3 ± 3.3	5986.4 ± 3.4	5852.5 ± 0.9
35	5911.3 ± 5.0	–	–
50	5777.2 ± 3.2	5991.6 ± 7.2	5855.4 ± 1.3
60	–	5996.8 ± 13.8	5757.9 ± 2.0
70	5809.3 ± 1.6	5989.8 ± 6.5	5786.5 ± 0.3
80	–	–	5791.1 ± 13.1
90	–	–	5897.3 ± 20.4

Indeed, determination of the nitrogen of the alcohol-soluble protein fraction of the same wheat samples showed that, with increasing temperature of grain

heating, only an insignificant decrease in the solubility of gliadin occurs (Table 2). At a wheat-heating temperature of 70°, the loss of gliadin solubility amounts to only 7.6% of its initial content. Under the usually employed regime of thermal drying with heating of the grain to 50°, the loss of gliadin solubility, i.e., its denaturation, does not exceed 3.8%.

Table 2

Content of the alcohol-soluble protein fraction (in % nitrogen)

Samples	Nitrogen content, %	Loss of gliadin solubility, % of initial
Initial	0.79	–
40°	0.77	2.54
50°	0.76	3.80
60°	0.75	5.07
70°	0.73	7.60

From studies on protein denaturation it is known that cysteine and hydroxylamine protect protein from thermal denaturation ([3], [4]), from denaturation by ionization ([4]) and by X-rays ([5], [6]). Vitamin B_2 accelerates, while vitamin C slows, the denaturation of human albumin and casein occurring under the action of ultraviolet irradiation ([7], [8]). The presence of sugar slows the denaturation of urea proteins ([9]), and a mixture of 75% sugar with certain amino acids protects the latter from changes arising in them upon heating (10 min, 160°) ([10]).

The presence in the grain of a considerable quantity of soluble sugars ([11]) served as the basis for carrying out the following experiment. To an alcoholic solution of gliadin extracted from wheat grain, there was added

10% sucrose, after which the gliadin was dried in a lyophilic apparatus and then subjected to denaturation at various temperatures (one hour). The heat of combustion of the resulting gliadin + sucrose complex was determined. The results of these determinations are given in Table 1, from which it is evident that the heat of combustion of this complex upon heating to 60° is practically constant. This may serve as a basis for the assertion that the presence of sucrose protects gliadin from thermal denaturation.

Knowing the heat of combustion of gliadin (5986.3 cal/g) and the heat of combustion of sucrose (3969.1 cal/g), one can calculate the heat of combustion of the gliadin + sucrose complex ($5986.3 \cdot 0.9 + 3969.1 \cdot 0.1 = 5784.6$ cal/g), and from this judge the magnitude of the binding energy of gliadin with sucrose (5852.5–5784.6 = 67.9 cal/g).

Thus, on the basis of the data obtained, the following conclusions may be drawn:

1) Gliadin forms an energetically bound complex with sucrose.

2) The presence of soluble carbohydrates, including sucrose, in wheat grain protects the gliadin present in it to a considerable extent from thermal denaturation.

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CITED LITERATURE

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Note: Figure translations are in progress. See original paper for figures.