

Improved Nutrient Utilization from Wheat Subjected to Autoclaving and Freezing

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ABSTRACT

The nutritional availability of wheat which had been subjected to autoclaving and freezing, respectively, was compared to that of raw wheat. Nutritional availability was estimated in terms of the metabolizable energy content of the wheat for chicks. Autoclaving for 60 min. at 15 lb. pressure or freezing for 5 days at -4°C . significantly increased the metabolizable energy values of the wheat samples under test.

Evidence that the nutritive value of wheat can be improved by certain treatments is contradictory. Beaudoin *et al.* (1) demonstrated that the biological value of the protein of whole wheat was improved when the wheat was cooked in boiling water as in the preparation of shredded wheat. Other investigators (2,3,4) have reported that the nutritive value of wheat is unaffected by mild cooking. Willingham *et al.* (5) found that autoclaving of wheat improved its nutritive value for the chick. Water-soaking reportedly improves the nutritive value of wheat for poultry (6,7). Steaming of wheat has been shown (8,9) to improve its nutritive value for weanling rats. Pelletting of wheat milling by-products (10) reportedly improves metabolizable energy (ME) values for the chick but has no consistent effect on the ME value of whole wheat (11,12).

The present study was conducted to determine whether the ME value of wheat for the chick can be improved by autoclaving or by freezing.

MATERIALS AND METHODS

Determination of Metabolizable Energy

White Leghorn cockerel chicks, 3 weeks of age in experiment 1 and 2 weeks of age in experiments 2 and 3, were used in the determination of metabolizable energy. The basal diet¹ was fed during the pre-experimental period. The samples of wheat under test were substituted in the basal diet at a level of 25%. The birds were distributed into lots of six chicks each. Each experimental diet was fed to triplicate lots. Three lots of chicks were fed the basal diet during the experimental period in each experiment. Chicks were fed the experimental diets for 1 day to accustom them to the diets. Feed intake was measured and excreta were collected during the following 3-day period.

The samples of excreta were freeze-dried and ground for analysis. Combustible energy was determined on the diets and excreta from each lot of birds by oxygen bomb calorimetry. Nitrogen was determined by the Kjeldahl method. The ME values of the diets were corrected for the nitrogen retention of the birds as suggested by Hill and Anderson (13).

¹Basal diet (%): ground wheat, 29.2; ground yellow corn, 37.8; soybean meal (48% protein), 15.0; herring meal (72% protein), 10.0; dried distillers' solubles, 3.0; dehydrated cereal grass, 2.0; bonemeal, 1.5; limestone, 1.0; iodized salt, 0.5; and manganese sulfate, 242 mg.; riboflavin, 3.6 mg.; zinc bacitracin, 9.68 mg.; vitamin A, 4,400 I.U.; and vitamin D-3, 440 I.C.U. per kg.

Description of Wheat Samples and Their Treatment

Experiment 1, Wheat No. 1: 15.4% protein, untreated, ground; autoclaved for 60 min. at 15 lb. pressure, fan-dried at room temperature, ground; soaked in water overnight, autoclaved for 60 min. at 15 lb. pressure, fan-dried at room temperature, ground; frozen for 5 days at -4°C ., thawed, ground.

Experiment 2, Wheat No. 1: untreated and treated as in experiment 1.

Wheat No. 2: 12.1% protein, untreated, ground; autoclaved for 60 min. at 15 lb. pressure, fan-dried at room temperature, ground; soaked in water overnight, autoclaved for 60 min. at 15 lb. pressure, fan-dried at room temperature, ground; frozen for 5 days at -4°C ., thawed, ground.

Experiment 3, Wheat No. 1: Untreated, ground; autoclaved for 60 min. at 15 lb. pressure, fan-dried at room temperature, ground; autoclaved for 90 min. at 15 lb. pressure, fan-dried at room temperature, ground; autoclaved for 120 min. at 15 lb. pressure, fan-dried at room temperature, ground.

RESULTS AND DISCUSSION

The ME values of the samples of wheat before and after different treatments are given in Table I. The statistical significance of differences in average values reported are based on the variation among the replicate values obtained.

Autoclaving for 60 min. at 15 lb. pressure significantly increased the ME value of the wheat in all three experiments. Soaking of the wheat in water

TABLE I. METABOLIZABLE ENERGY (ME) VALUES OF WHEAT SUBJECTED TO DIFFERENT TREATMENTS*

	ME calories per g.	± Sample std. dev.
Experiment 1		
Wheat 1		
untreated	3,328	± 14
autoclaved 60 min.	3,395*	± 23
water-soaked, autoclaved 60 min.	3,428*	± 25
frozen 5 days	3,390*	± 15
Experiment 2		
Wheat 1		
untreated	3,337	± 13
autoclaved 60 min.	3,408**	± 13
water-soaked, autoclaved 60 min.	3,402**	± 16
frozen 5 days	3,393**	± 19
Wheat 2		
untreated	3,321	± 14
autoclaved 60 min.	3,399**	± 20
water-soaked, autoclaved 60 min.	3,404**	± 16
frozen 5 days	3,388**	± 16
Experiment 3		
Wheat 1		
untreated	3,370	± 8
autoclaved 60 min.	3,475**	± 13
autoclaved 90 min.	3,319**	± 16
autoclaved 120 min.	3,324*	± 8

*Significantly different from the respective untreated controls within each experiment at 5% level of significance; and **at 1% level of significance.

prior to autoclaving did not enhance the effect of autoclaving. Prolonging the duration of the autoclaving to 90 or 120 min. (experiment 3) resulted in a decrease in the ME value of the wheat to a level significantly below that of the untreated sample. It is apparent, therefore, that the conditions under which the ME value of wheat may be improved by autoclaving are quite critical if a deterioration rather than an improvement in nutritive value is not to be incurred. Reactions during overheating (such as from the Maillard reaction) which bind nutrients in enzyme-resistant complexes can be expected to reduce ME value. The cause of the initial increase in ME value when wheat is autoclaved has not been determined. A heat-labile antitryptic factor has been demonstrated in wheat germ (14) and in wheat flour (15,16). It is not known whether some samples of wheat may contain enough of this factor to interfere with digestion when fed to poultry. Hutchinson et al. (9) have suggested that heat-treatment of wheat may improve its digestibility by destroying the capacity of the wheat protein to form gluten.

Freezing of wheat for 5 days at -4°C . in experiments 1 and 2 significantly increased the ME value of the samples so treated. The reason for the increase is not understood. The physical character of some component of the grain may be altered as a result of mechanical stress during ice formation in such a way as to facilitate digestion.

The results reported here indicate that the nutrient potential of wheat may not be fully realized when wheat is fed in the raw state. Since autoclaving and freezing both increase the ME value of wheat it seems probable that some physical characteristic of raw wheat is responsible for limiting the biological availability of a nutrient component.

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