STUDIES ON RAW AND HEATED WHEAT GERM FOR YOUNG CHICKS[1]

F. ATTIA AND R. D. CREEK

ABSTRACT

The nutritive values of raw and autoclaved wheat germ were compared using the chick as an experimental animal. Raw wheat germ was found to depress growth and fat utilization, and also to induce pancreatic hypertrophy. A hemagglutinin factor was detected in raw wheat germ. All detrimental properties noted could be destroyed by autoclaving.

Recent reports from this station have indicated that raw wheat germ contains a thermolabile inhibitor and/or toxin which depresses chick growth and blocks proper utilization of dietary fat (1). Parrish and Bolt (2) confirmed the growth depression and increased fecal fat; however, they stated that the poor growth resulted from reduced consumption of feed when the raw germ formed a paste on the chicks' beaks, and that the increase of fecal fat was the result of the birds' cleaning their beaks on wire floors and thus dropping feed fat directly into the feces. We encountered the adhesive effect with some samples of wheat germ, but believe that we controlled this problem by use of ultrahigh fat diets which did not form paste when mixed with saliva.

The purpose of the studies reported here was to critically re-examine previous work in view of the criticisms of Parrish and Bolt (2), and to make inquiries into other aspects of the problem.

Materials and Methods

White Plymouth Rock male chicks were used in these experiments. They were reared in batteries with standard management procedures. The basal diets used are given in Table I. Chicks were placed on experimental diet at one day of age.

The wheat germ used was from soft red winter wheat. Samples to be heat-treated were autoclaved for 45 min. at 121°C. unless otherwise specified. They were dried at 50°C. under forced air.

In order to circumvent the criticisms of Parrish and Bolt (2) feces were collected in the following manner: the feeders were removed, the chicks' beaks were immediately wiped clean with a cloth, and then feces were collected on clean aluminum foil from each pen for 6 hr. on four successive days. Thus, any possibility of introducing food fat

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TABLE I

COMPOSITION OF RATIONS USED IN EXPERIMENTS 1, 2, AND 3

INGREDIENTS	EXPERIMENT 1		EXPERIMENTS 2 AND 3	
	Raw	Autoclaved	Raw	Autoclaved
Raw wheat germ	33.48	....	38.48	....
Autoclaved wheat germ	....	33.48	....	38.48
Corn oil, crude	10.00	10.00	10.00	10.00
Hyd. animal and vegetable fat	10.00	10.00	10.00	10.00
Isolated soybean protein[a]	10.00	10.00	10.00	10.00
Fish meal, menhaden	5.00	5.00	5.00	5.00
Casein	15.00	15.00	15.00	15.00
Gelatin	5.00	5.00	4.00	4.00
Methionine hydroxy analogue	0.22	0.22	0.22	0.22
Vitamin mix[b]	5.00	5.00	1.00	1.00
Mineral mix[c]	6.00	6.00	6.00	6.00
Chromic oxide	0.30	0.30	0.30	0.30

[a] C-1 Assay protein, Archer-Daniels-Midland Co., Minneapolis, Minn.

[b] Micronutrient premix, blended on cerelose, supplies the following as mg./100 g. of diet: folic acid, 0.12; menadione sodium bisulfite, 0.50; pyridoxine HCl, 1.00; Ca pantothenate, 4.00; riboflavin, 2.00; ascorbic acid, 2.00; inositol, 100.00; choline chloride, 37.50; niacin, 10.00; biotin, 0.04; and thiamine HCl, 2.00. In addition the following were supplied per 100 g.: vitamin E, 3.08 I.U.; vitamin D_3, 187.5 I.C.U.; vitamin A, 1300; vitamin B_{12}, 9 mcg.; ethoxyquin, 12.5 mg.; and erythromycin thiocyanate, 1.77 mg.

[c] Mineral mix supplied the following in mgs./100 g. of diet: $CaCO_3$, 750; $Ca_3(PO_4)_2$, 2,300; K_2PHO_4, 800; $MgSO_4 \cdot 7H_2O$, 500; NaCl iodized, 600; $FeSO_4$, 12.4; $CuSO_4 \cdot 5H_2O$, 2; $MnSO_4 \cdot H_2O$, 31; $CoSO_4$, 0.2; H_3BO_3, 1; $Na_2MoO_4 \cdot 2H_2O$, 1; NaBr, 2; $ZnSO_4$, 22.2; KCl, 200; $NaSeO_3 \cdot 10H_2O$, 0.4; cerelose, 800.

directly into the feces was eliminated. Fecal fat was determined by the method of Renner and Hill (3). Chromic oxide determinations were made using the procedure of Bolin *et al.* (4).

The hemagglutination test of Liener and Hill (5) was used to test the wheat germ for the presence of this factor. The hemagglutinin solution was made by adding 100 ml. of 0.9% saline to 10 g. of wheat germ meal. Red blood cells from rabbits or chickens were used. With chicken blood 1% sodium chloride solution was used instead of the 0.9% solution used with rabbit blood. The red blood cells were treated with papain as this makes the test more sensitive. The oxalate mixture of Heller and Paul (6) was used as an anticoagulant.

Studies on pancreatic size were made in Trials 1 and 3. Five chicks per pen (25 per treatment) were selected randomly and decapitated, and fresh pancreatic weight taken.

Results

Trials 1, 2, and 3 were conducted to study the effect of raw wheat germ on growth rate at 2 and 3 weeks of age, to get more precise information about the effect of raw wheat germ on absorption of fat, and to study the effect on the size of the pancreas. The results are given in Table II and indicate that raw wheat germ depresses growth, interferes with utilization of fat, and causes pancreatic hypertrophy.

TABLE II

THE EFFECT OF RAW AND AUTOCLAVED WHEAT GERM ON GROWTH, PANCREAS SIZE, FAT ABSORPTION, AND FEED RETENTION

Feeding Trial No.[a]	Wheat Germ Treatment	Body Weight		Pancreas Size		Consumed Fat Excreted[b]	
		2 Weeks	3 Weeks	2 Weeks	3 Weeks	2 Weeks	3 Weeks
		g.	g.	mg./100 g.		%	%
1	Raw	215	...	462	...	33.30	....
	Autoclaved	236**	...	413*	...	13.56	....
2	Raw	174	...	...	...	....	24.03
	Autoclaved	201**	...	...	...	....	12.60
3	Raw	146	283	...	343	....	26.50
	Autoclaved	205**	364**	...	264**	....	11.60

[a] Five replicates of 20 chicks per pen were used in trial 1, and 5 replicates of 15 chicks per pen were used in trials 2 and 3.
[b] Adjusted by use of chromic oxide as an indicator.

Close observation of the chicks revealed no evidence of beak pasting. Calculations reveal that more fat is excreted than is contained in the germ; thus the raw germ blocks absorption of added dietary fat and the problem is not simply one of the availability of fat from the germ itself. Nesheim *et al.* (7) have reported similar results with raw soybeans.

Definite hemagglutinin activity was noted. With rabbit blood 2,500 hemagglutinin units per g. of wheat germ were noted. With chick blood this value increased to 5,000 units. Soyin and ricin, toxic proteins found in the soybean and castor bean, respectively, both have hemagglutinin properties; thus the hemagglutinin properties of raw wheat germ may be related to the presence of a toxic protein.

Discussion

The results from feeding raw wheat germ parallel those from raw soybean in every respect tested – growth, pancreatic hypertrophy, and fat absorption. Raw soybean contains a hemagglutinin and an antitrypsin factor, both of which contribute to its deleterious effects. A hemagglutinin has been demonstrated in wheat germ in this research. Shymala (8) and Learmonth and Wood (9) reported a trypsin inhibitor in wheat flour. An antiproteolytic factor has been detected in raw wheat germ by Creek and Vasaitis (10); thus, the results of feeding raw wheat germ are consistent with other findings, particularly when compared to results with the raw soybean.

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