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Toxicity of Raw Kidney-Beans

In feeding experiments with diets containing raw or autoclaved kidney-beans (*Phaseolus vulgaris*) we found that they are toxic for rats, producing rapid loss of weight and even death after a short time. As KLOSE and coworkers[1] reported recently on a fraction from Lima beans that retarded the growth of rats, we want to present some of our findings.

Each experimental group consisted of 2 male and 2 female Sprague Dawley rats, individually housed in screen-bottomed cages. Food and water were given *ad libitum*. The diets were made to contain 12% protein (about 40% of beans) with the given amount of dried

Table I

Weight changes and food consumption of rats fed with diets containing black kidney beans

Group No.	Diet	Body weight change/day /animal	Food consumption/ day/ animal
1	Raw beans	—5·1 g	1·1 g
2	Autoclaved beans	—1·3 g	5·6 g
3	Cooked beans	+2·3 g	7·7 g
4	Alcohol extracted beans . .	—1·7 g	4·7 g
5	Raw beans + 20% casitone	—1·5 g	6·0 g
6	Raw beans + 20% casein .	+0·2 g	5·2 g

[1] A. A. KLOSE, J. D. GREAVES, and H. L. FEVOLD, Science *108*, 88 (1948).

Table II

Comparison between highest dilution of bean-extracts capable of agglutination of washed red blood cells and growth of rats fed a soy meal-corn ration containing 20% of the same raw beans

Bean sample	Highest dilution agglut.:		Growth/ day/ animal
	Rat blood cells	Horse blood cells	
47—166 (black) . . .	1:150	1:5000	0·10
Orlandilla (black) . .	1:800	1:22000	0·17
Controls			3·5

and ground-beans; moreover, the following ingredients were added:– salts 44%, NaCl 1%, *l*-methionine 0·3%, cotton seed oil containing 0·5% of oleum percomorphum 4%, sucrose 20%, 10 crystallized B-vitamins as indicated earlier[1] and corn starch to make up to 100%. In addition, 3 drops of liver extract were given 3 times weekly by dropper. Additions to the diet were made at the expense of corn starch. In the experiments reported in Table II, a soy meal-corn ration[1] to which 20% of raw kidney-beans had bean added at the expense of the whole ration, was used.

Groups 1–3, presented in Table I, are typical for the pronounced difference of weight changes between animals receiving raw, autoclaved (10 minutes at 115°C), or cooked beans. Similar results were obtained with 7 samples including black, white, and red kidney-beans. Animals kept on the raw bean diet died within less than 10 days. Group 4 shows that alcohol extraction (8 hours) did not remove the toxic principle. The results from groups 5 and 6 demonstrate that even 20% of a tryptic casein digest (Casitone "Difco") did not prevent completely the loss of weight, and that casein was somewhat more active. This and the very severe growth retardation produced by raw beans make it improbable that proteolytic enzyme inhibition is the explanation for the toxic effect. No hydrocyanic acid or alcaloids could be detected by routine analytical methods.

[1] W. G. JAFFÉ and C. A. ELVEHJEM, J. Biol. Chem. *169*, 287 (1947).

Hemagglutinins but no toxins have been reported by several authors to occur in beans[1]. All samples used in the present study had agglutinating activity, but preliminary experiments did not reveal evidence for a quantitative correlation between the hemagglutinating and growth-retarding properties (Table II).

None of the following legumes showed growth-retarding effects comparable to those observed with kidney-beans:– *Phaseolus aureus, Phaseolus angularis, Vigna sinensis, Pisum sativum, Cajanus indicus, Cicer arientium, Lens esculenta, Glycina soja.*

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Zusammenfassung

Ratten, die mit ca. 40% trockene, gemahlene, rohe Bohnen (*Phaseolus vulgaris*) enthaltenden Diäten ernährt wurden, verloren sehr schnell Gewicht und starben nach weniger als 10 Tagen. Autoklavierte Bohnen verursachten geringeren Gewichtsverlust und gekochte erlaubten normales Wachstum. Alkoholextraktion, Casein oder tryptisch verdautes Casein konnten den toxischen Effekt nicht völlig neutralisieren. Es konnte keine quantitative Beziehung zwischen Bohnenagglutininen und Wachstumsdepression gefunden werden.

[1] O. WIENHAUS, Biochem. Z. *18*, 288 (1909).