DIETARY LECTINS:

BLOOD TYPES & FOOD ALLERGIES

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Published in:
Townsend Letter for Doctors
June 1991

Abstract

Dietary lectins in excess can cause 3 major physiological effects: gastrointestinal damage, Type 2 IgG immune responses, and hemagglutination. Findings include 119 lectins: 54 are panhemagglutinins; 65 are blood-type specific. Herein may lie a method for predicting food sensitivities by ABO blood type.

Introduction

Dietary lectins are protein antigens which bind to surface glycoproteins (or glycolipids) on erythrocytes or lymphocytes. (1) They function as both allergens and hemagglutinins. (2) They are found in plants and animals, and are present in small amounts in 30% of American foods, more so in a whole-grain diet. (2)

Lectins have potent in vivo effects. When consumed in excess by sensitive individuals, they can cause 3 primary physiological reactions: Lectins can cause severe intestinal damage, disrupting digestion and causing nutrient deficiencies. (3) They can provoke IgG and IgM antibodies causing Gell-Coombs Type 2 food allergies and other immune responses. (3,4) And they can bind to erythrocytes, simultaneously with immune factors, causing hemagglutination and anemia. (5) Of the 119 known dietary lectins, about half are panhemagglutinins, clumping all blood types. The remainder are blood-type specific. In general, lectins alter host resistance to infection, cause failure to thrive, and can even lead to death in experimental animals. (2)

History

Lectins have been known for a century. They were discovered in castor beans by Stillmark in 1888 (6), and in non-toxic plants (beans and lentils) in 1907. (7) By 1945 Boyd found that some lectins were blood-type specific. He reported that lima beans will only agglutinate blood type A. (6) Since that time lectins have been found in both plants and animals -- particularly in edible cereals, beans, seeds, nuts, fish and shellfish. (7) And some foods are known to have 2 or more lectins. Many species-specific lectins have also been identified. Today lectins are commonly used in laboratories to type blood, particularly type A1. (8)

Absorption

Many lectins are relatively resistant to both heating and digestion. Many have a high thermal stability (70˚ C > 30 min), and do not completely degrade with cooking. Some are also relatively resistant to stomach acid and proteolytic enzymes. (9) Thus, while some lectins are degraded and others pass through the gut, about 1% to 5% absorb into the blood stream in animals, which is considered a significant amount, sufficient to cause an immune response. (3) Furthermore, lectin absorption can be higher if eaten raw, or eaten by individuals deficient in stomach acid, proteolytic enzymes, or secretory IgA antibodies which bind lectins in the gut. (3)

In Vivo Testing

Pusztai et al report that in vivo testing of lectins has been performed on animals: rats, mice, pigs and steers. This included the feeding of high lectin diets, direct studies on ^{125}I-lectin uptake from the gut, blood assays for IgG and IgE antibodies, and dissection and examination of the intestines, liver, pancreas, spleen and thymus. Results showed severe intestinal lesions, and high titres of circulating lectin-specific antibodies, with direct relationship to the severity of the toxic symptoms. The main target tissues were the thymus and small intestine. However, lectins had relatively minor effects on the liver, pancreas, and spleen. (3)

Human Reactions

In humans lectins have been reported to cause damage, including mass food poisoning from raw or under-cooked kidney beans (10,11), and hemolytic anemia and jaundice from Mexican fava beans (in Glucose-6-Phosphate dehydrogenase deficient individuals). (12)

1. Intestinal Damage

Digestive Distress

Lectins can cause acute gastrointestinal symptoms, including nausea and vomiting. They bind to the luminal surface of absorptive enterocytes in the small intestine. This severely damages the microvilli of the enterocytes, disrupting digestion and absorption. Lectins can increase intestinal weight and cell number 60-80%, creating gas, fluid and mucus. (3) Lectins can even promote the growth of harmful bacteria in the gut. (13)

Protein Malabsorption

Lectins can disrupt protein absorption. In the gut lectins bind to enterocytes, causing lesions and inflammation, blocking the production of enterokinase, a protein enzyme. This interferes with protein breakdown and with nitrogen absorption in the gut. And it explains why animals on high lectin diets show increased fecal and urinary nitrogen loss, resulting in a negative nitrogen balance, and retardation of long-term growth. (3)

Carbohydrate Malabsorption

Lectins can also disrupt carbohydrate absorption and metabolism. Lectins can reduce intestinal glucose uptake by 50%. (10) Concanavalin A in Jack beans, Wheat Germ Agglutinin, and other lectins can even bind to insulin receptors on cells, disrupting glucose metabolism. (11) Finally, because of the high lectin content in grains, it is speculated that lectins cause inflammatory bowel (2) and celiac disease in humans. (10) In fact, Freed has found that the gliadin toxin is an isolectin of Wheat Germ Agglutinin. (10)

2. Immune Responses

Lectins can evoke a variety of immune responses, but they primarily cause Type 2 allergies. (3) To review the 4 allergy types see Table 1 and Figure 1.

Type 2 Allergies

Lectins primarily evoke IgG and IgM antibodies, causing Type 2 allergies. Pusztai's results showed high titres of circulating lectin-specific IgG antibodies (but no reaction to other foods), and a direct relationship between the severity of toxic symptoms and the antibody titre. (3) Lectins can cause: fatigue, headache, achiness, diarrhea, nausea, vomiting, irritability, and hemolytic anemia. (12)

Type 1 + 3 Allergies

Lectins can also cause Type 1 allergies involving IgE antibodies. (3) And in large quantities they can even induce histamine release from blood basophils and from mast cells without IgE intervention.(10) Lectins can also combine with complement and neutrophils to form Type 3 immune complexes. This can precipitate in the blood vessels, causing vascular lesions, resulting in thrombosis and hemorrhage.(11) Or it can circulate through the blood to the kidneys, where it lodges in the glomerular tufts causing inflammation or nephritis.(12)

Other Immune Reactions

Lectins such as Concanavalin A in jack beans can bind to T-cells and other lymphocytes triggering cell mitosis.(1) Tomato lectin agglutinates not only erythrocytes, but human lymphocytes and granulocytes.(9) Lima beans and other lectins bind to adenine and some cytokinins.(1) Lectins can alter host resistance to infection and to tumor challenge by exhausting the immune system.(2)

Table 1
The 4 Gell-Coombs Allergy Types (4,5,12)

Type 1: Reagin (IgE)

Caused when allergens react with IgE antibodies on mast cells in mucous membranes to release histamine. Immediate responses occur within 1-60 minutes. Late-phase responses occur within 12-72 hours, can take 3-4 weeks to diminish. Accounts for 10-20% of food allergies.
Immediate Symptoms: Hay fever, rhinitis, asthma, hives, eczema, and in children flushed red cheeks and hyperlinetic behavior.
Late-phase Symptoms: Migraines, neurological disorders, arthritis, bladder inflammation, gallbladder disease, heart and vascular disease.

Type 2: Lectin (or Cytotoxic)

Caused when IgG or IgM antibodies bind to lectins on red or white blood cells. Complement or K-Cells can attach, agglutinating the cell.
Delayed responses occur in 12-72 hours. Involved in 80% of food allergies.
Symptoms: Fatigue, insomnia, headache, achiness, diarrhea, nausea, vomiting. In severe cases hemolytic anemia or immune exhaustion.

Type 3: Immune Complex (IgG)

Caused when IgG antibodies form large antigen-antibody complexes. Complement and neutrophils can attach. They can deposit in tissues. Delayed responses occur within 12-72 hours. Involved in 50% of food allergies.
Symptoms: Fatigue, headache, irritability, depression, fear, hyperactivity, confusion, learning disorders, arthritis, muscle pains, liver & kidney disease, heart and vascular disease, neurological disorders and schizophrenia.

Type 4: T-Lymphocyte

Caused when macrophages interact with T-lymphocytes in tissue cells, both release inflammatory cytokines. Delayed responses occur within 24 hours. Involved in 40-50% of food allergies.
Internal Contact Symptoms: Bowel lesions, ulcers, colitis, regional ileitis, arthritis, liver and kidney disease, and neurological disorders.
External Contact Symptoms: Poison ivy, or other lesions.

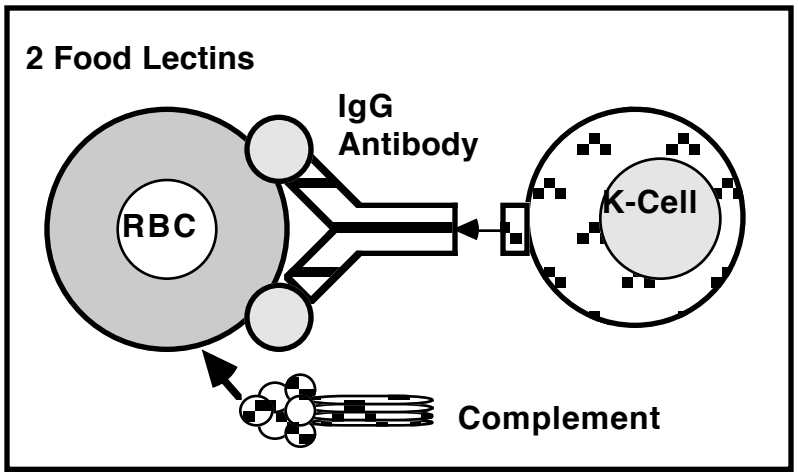

Figure 1: Gell-Coombs Type 2 Food Allergy Reaction: IgG antibodies bind to food lectins on a red blood cell. Complement protein can attach via the alternate complement pathway, lysing the cell. Or K-Cells, monocytes, or neutrophils can attach and agglutinate the cell. It is then destroyed in the liver. Note: K-Cells do not react with blood type A. (4,5)

3. Hemagglutination

Blood Types

Blood types are themselves antigens, glycoprotein (or glycolipid) molecules on the surface of red blood cells. They are part of the immune system, and as such are known to react with foreign substances, such as: antibodies, bacteria, virus, parasites, toxins, and lectins. There are some two-dozen blood groups (ABO, MN, Rh, etc.), comprising over 400 blood types. (8)

Blood Type Chemistry (8)

A = N-acetyl-D-galactosamine.

B = D-galactose.

O = L-fucose.

M = NANA or sialic acid.

N = galactose.

Agglutination

Lectins can agglutinate erythrocytes (RBC) and sometimes lymphocytes. Of the 119 dietary lectins listed here, about half are panhemagglutinins, which bind to any erythrocyte. The remainder are blood-type specific, and will bind to blood types A, B, O, AB, M or N, or subtypes A1 or A2. Later phagocytes (killer cells, monocytes, or neutrophils) may attach, agglutinating the blood cell; or complement via the alternate pathway may bind and lyse the cell.(5) It is then destroyed in the liver. This is a classic Type 2 immune response. (Figure 1.) In large numbers this can cause hemolytic anemia and jaundice.(12)

Identifying Lectins In Vitro

Blood-type specificity of lectins is determined by simple in vitro testing, similar to blood typing. Common foods are purchased from several sources; this is because different food samples may contain varying amounts of lectins. Foods are then individually blended until homogenized, filtered, and mixed with saline or NaOH to adjust pH. They are then tested against outdated human blood by mixing 1 or 2 drops of each and centrifuging for 30 minutes. (2,6)

Criteria for Lectin Selection

Tables 2 + 3 are lists of dietary lectins from the scientific literature, based on the following criteria, and grouped according to blood type reactivity.

1. All are edible food lectins or medicinal herbs.
2. All react with non-enzyme treated human blood.
3. Where only the seeds react, foods are included only if the seeds are normally eaten (ie bananas, grapes).
4. Wheat germ is included under blood type M, because blood type M is sialic acid, and sialic acid is the RBC binding site for Wheat Germ Agglutinin. (8,14)

Table 2
Blood-Type Specific Lectins

BLOOD TYPE A	(Ref)	BLOOD TYPE B		BLOOD TYPE O	
blackberries	(2)	bitter pear melon	(20)	asparagus pea	(16)
brown trout	(7)	black-eyed peas	(21)	Australian catfish	(7)
"Cornflakes"	(2)	castor beans	(7)	blackberries	(2)
escargot (Roman snail)	(7)	cocoa	(7)	boa constrictor	(7)
field beans	(15)	Coronilla	(7)	cocoa	(7)
French mushroom	(7)	(heart disease herb)		eels (47%)	(7)
(hygrophorus hypothejus)		Evonymus Europaeus	(7)	Evonymus Europaeus	
garfish	(7)	(butter dye, oil for soap)		(buter dye, soap oil)	(7)
halibut	(7)	field beans	(15)	French mushroom	(7)
hog peanut	(16)	2 French mushrooms	(7)	(amanita muscaria)	
lima beans	(7)	(hygrophorus hypothejus)		gorse	(27)
"Product 19"	(2)	(marasmius oreades)		halfmoon fish	(7)
snakes	(7)	halfmoon fish	(7)	halibut	(7)
snow white mushrooms	(2)	opayeye fish	(7)	Japanese eel	(7)
soybeans	(1)	pomegranate	(2)	lotus	(7)
soybean sprouts	(2)	salmon	(7)	opaleye fish	(7)
string beans	(2)	salmon caviar (roe)	(7)	sunflower seed	(7)
tora beans	(17)	sesame seeds	(20)		
"Total"	(2)	snakes	(7)	**BLOOD TYPE M**	
vetch (common)	(18)	soybeans	(1)	Clown's Mustard	(7)
Western painted turtle	(7)	trout caviar (roe)	(7)	(rheumatism herb)	
white croaker fish	(7)	tuna	(7)	horseshoe crab	(23)
winged bean	(19)	Western painted turtle	(7)	wheat germ	(14)

BLOOD TYPE A1		BLOOD TYPE A2		BLOOD TYPE AB	
giant butter clam	(7)	French mushroom	(7)	hyacinth bean	(7)
horse gram	(7)	(aminta muscaria)		All "A" & "B" foods	
lima beans (A1 > A2)	(22)				
				BLOOD TYPE N	
				Camel's Foot	(7)
				(Chinese pot herb)	

Table 3
Panhemagglutinin Lectins

The following lectins agglutinate all blood types.

LECTIN	Reference	LECTIN	Reference
"All Bran" cereal	(2)	Mexican mushroom (agaricus campestris)	(7)
asparagus	(24)	navy beans	(29)
banana	(15)	nutmeg	(15)
barley germ	(25)	oyster	(7)
broad beans	(1)	parsley	(7)
caraway seeds	(15)	peas	(1)
celery	(24)	peanuts	(1)
cherries	(2)	peppermint	(15)
chicory (endive)	(7)	pinto beans	(18)
coconut	(7)	potato	(32)
coconut crab	(7)	processor beans	(33)
coffee	(15)	pumpkin seeds	(34)
cucumber	(26)	radish	(7)
currants	(15)	"Raisin Bran" cereal	(2)
fava beans	(15)	rice germ	(25)
French mushroom (armarillaria mellea)	(7)	rutabaga	(24)
grapes	(2)	rye germ	(25)
hazel nuts	(15)	"Shredded Wheat"	(2)
hermit crab (75%)	(7)	"Special K" cereal	(2)
jack beans	(1)	strawberries	(15)
locust beans (black)	(28)	sweet peppers	(15)
kidney beans	(29,30)	Swiss chard	(7)
kintoki beans	(31)	tomato	(9)
lentils	(1)	triticale	(35)
lentil sprouts	(1)	walnut	(15)
lobster	(7)	wax bean	(18)
		wheat germ	(25)
		"Wheaties" cereal	(2)

Discussion

A review of the literature indicates that there are presently 119 known lectins in edible foods, 54 panhemagglutinins, and 65 lectins specific for blood types A, B, O, AB, M or N, and subtypes A1 or A2. These are present in 30% of American foods. (2)

Are Lectins Harmful?

Lectin toxicity depends on degradation and absorption. Many lectins are resistant to heating, digestion and food processing (9), allowing about 1%-5% to absorb into the blood. (3) Further, lectins are a danger when consumed in their raw state, or by persons deficient in stomach acid, proteolytic enzymes, or Secretory-IgA.

Research indicates that, when consumed in excess by sensitive individuals, lectins can cause 3 detrimental physiological effects. Lectins can cause severe intestinal damage, disrupting digestion, causing protein loss and growth retardation (3), blocking glucose uptake and insulin receptors (10,11), contributing to Celiac Disease (10), and promoting the growth of harmful bacteria. (13) They can provoke numerous immune responses, including IgG and IgM (3,4), sometimes IgE (3), and lymphocyte mitogenesis. (1) Finally, they can agglutinate erythrocytes leading to anemia, sometimes with ABO specificity. (4,12) In general, lectins can cause immune system exhaustion and failure to thrive. (2)

The irony of this is that high-lectin diets are also high-fiber and whole-grain diets, which contain more nutrients needed for better health. High-fiber diets have been associated with low incidence of bowel cancer, ischaemic heart disease, and diabetes. (10)

Can Food Sensitivities Be Predicted by Blood Type?

YES and NO. With blood-type specific lectins, hemagglutination is blood-type specific, but antibody response is not truly specific. (4,5) For example: In a sensitive type A1 person exposed to excess lima bean, the lectins and antibodies will both bind to the erythrocyte. However, in other persons, the lectins and antibodies may bind together in an immune complex. This means that the type A1 person will suffer more humoral damage, including some anemia. But other persons might be susceptible to tissue damage from immune complexes. Thus the answer is, if lectins absorb: YES. Gell-Coombs Type 2 lectin allergies and hemagglutination can be predicted by blood type in susceptible individuals. HOWEVER, this does not mean that persons with other blood types will have no immune response. Some other persons may have a Type 3 immune response, but they will have no hemagglutination.

Goals: To Prevent Lectin Toxicity

The following may be suggested to prevent lectin toxicity, while still consuming a healthy high-fiber or whole-grain diet. High lectin foods should be thoroughly cooked. Digestion can be improved with the use of proper food combinations, and digestive enzymes and hydrochloric acid supplements where needed. Blood-type specific lectins should be avoided by appropriate individuals. And panhemagglutinins should be tested for in allergy-prone individuals.

Future Research

Further research is needed to identify more dietary lectins. In addition, research is needed to identify evolutionary patterns in diet, in order to reduce the incidence of digestive distress and food allergies. We are presently conducting three epidemiological studies which match blood types to food allergies.

NOTE: Physicians and researchers may obtain simple and inexpensive blood-type testing kits from Carolina Biological Supply Co., 2700 York Road, Burlington, North Carolina 27215.

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