

Larch arabinogalactan: A novel and multifunctional natural product

AMY FITZPATRICK ¹
 ALAN ROBERTS ²
 STEVEN WITHERLY ³

1. Natural Health Solutions
149 Gilmer Street, Kingsport, TN 37665, USA
2. Natrol, Inc.
91311 Prairie Street, Chatsworth, CA 91311, USA
3. Technical Products, Inc
23510 W. Windrose Place, Valencia, CA 91354, USA

Ingredients with broad range and diverse applicability are uncommon in the dietary supplement and food markets. However, one natural ingredient that is receiving increased attention as a clinically useful nutraceutical is Larch Arabinogalactan. A prebiotic and fermentable fiber, Larch Arabinogalactan is approved by the United States Food and Drug Administration (FDA) as a GRAS Affirmed (Generally Recognized As Safe) direct food additive. It has benefits as an immune support agent and digestive aid and may also prove beneficial as a liver protectant. Furthermore, its unique physical characteristics allow Larch Arabinogalactan to be used in a variety of food, beverage and nutraceutical applications.

coconuts) and several immune stimulating plants (e.g. *Echinacea purpurea*, *Thuja occidentalis* and Shiitake mushroom). Nature provides a uniquely high concentration of Arabinogalactan in the *Larix* genus of trees, which is used as the commercial source of Larch AG. Larch AG is a highly water-soluble prebiotic fiber that is water extracted from the lumen of cells found in the Western and Eastern Larch trees known respectively as *Larix occidentalis* and *Larix laricina*. The concentration and quality of Larch AG is not affected by seasonal variability and it is found in highest amounts in the lower portion of the tree. This natural bioactive compound is extracted from trees using a patented, eco-friendly process, which utilizes hot water and is free from solvents. There are two well recognized Larch AG products commercially available in the human nutrition marketplace, ImmunEnhancer™ and FiberAid® from Larex®, Inc. Though based upon the same natural compound, processing operations yield slightly different degrees of physical and clinical properties between the two products – see Table I for a brief overview.

DESCRIPTION

Arabinogalactan (AG) is a polysaccharide or complex sugar found in a wide range of foods (e.g. carrots, radish, maize, and

Table I – Larex ImmunEnhancer™ and FiberAid®: Physical and Clinical Differences

	ImmunEnhancer™	FiberAid®
Sensory Quality	Slight piney aroma and taste (unnoticed in capsule form)	Tasteless, odorless (ideal for beverages and foods)
Molecular Weight	~18,000-19,000 Daltons	~22,000 Daltons
Polydispersity (molecular weight spread by HPLC)	Higher, resulting in lower molecular weight	Lower, resulting in higher molecular weight
Carbohydrate, Fiber and AG Content	>85% Total Carbohydrate >80% Dietary Fiber avg. 85-87% AG	>95% Total Carbohydrate >90% Dietary Fiber avg. 93-96% AG
Clinical Indication	Greater immune potentiation at lower dosage (measured by white blood count: monocytes and lymphocytes)	More favorable gastrointestinal effects (measured by increases in beneficial microbes)
Proposed Rationale for Differences in Clinical Presentation	Lower mol. weight species may interact more efficiently with gut associated lymphoid tissue resulting in earlier and more enhanced immune response.	More uniform mol. weight may present a more consistent polysaccharide source for microflora.
Recommended Dosage	1.5 grams/day	4.5 grams/day

CHEMICAL NATURE OF ARABINOGALACTAN

Arabinogalactans are highly branched polysaccharides with molecular weights ranging from 10,000-120,000 Daltons. All Larch AG isolated from the *Larix sp.* are of the 3,6-beta-D-galactan type and consist of galactose and arabinose in a 6 to 1 ratio. Larch AG has a galactan backbone that features $\beta(1,3)$ linkages and galactose $\beta(1,6)$ and arabinose $\beta(1,6)$ and $1,3$ sugar side chains (Figure 1). In general Larch AG has a total carbohydrate content range of 85% to 95% and a total dietary fiber range of 80% to 90%. ImmunEnhancer™ and FiberAid® differ slightly in their carbohydrate and dietary fiber content – see Table I for details. Larch AG has a caloric content of 1.4 kcal/g and does not increase insulin levels. The unique chemical properties of Larch AG give it complete solubility and stability over a wide range of concentrations, pHs and temperatures.

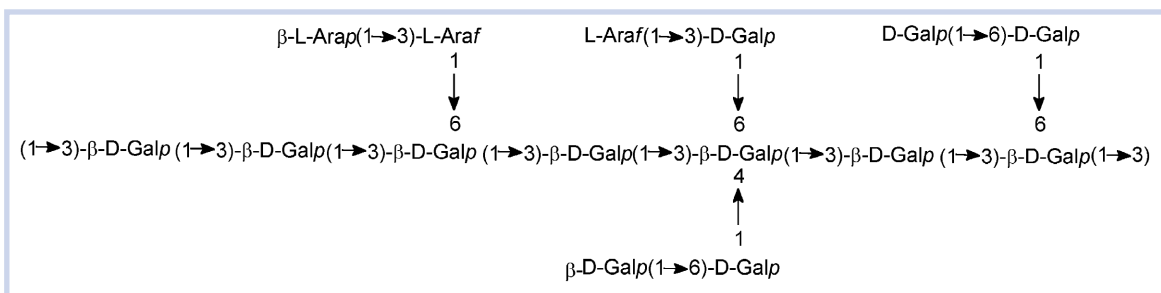


Figure 1

FOOD AND NUTRACEUTICAL APPLICATIONS

Increased demands for functional foods and nutraceuticals make it difficult for manufacturers to consistently offer products that: i) are competitive in the marketplace; ii) provide well-researched health benefits; iii) taste good; and iv) are packaged in a unique delivery system. However, the unique physical, biological and sensory characteristics of Larch AG are both multifunctional and novel making it an ideal candidate for a variety of food applications.

Beverages with Larch Arabinogalactan

Larch AG is available in two forms, a fine and an agglomerated powder with a bulk density ranging from 0.3-0.7 g/ml. The agglomerated powder is best suited for beverage applications. Larch AG is highly water-soluble, readily disperses (quick dissolution) in a hot or cold beverage within 30 seconds and remains clear in solution and does not cause turbidity or precipitate out of solution. Larch AG may be added to a beverage by up to 60% of the daily reference value (DRV) for fiber without adding any significant viscosity. In addition, Larch AG is non-reactive and heat stable (up to 250°F or 121°C), making it an ideal candidate for beverage mixes, refrigerated or shelf-stable ready to drink beverages. This fiber will also not hydrolyze at a low pH. In addition, it has a high thermal stability allowing it to be heat pasteurized or retorted. Larch AG is neutral in taste, odor and color free, with a low sensory impact; however ImmunEnhancer™ does have a slight salty note. When adding ImmunEnhancer™ to an existing formula the salt content may be reduced slightly to compensate for its natural savory nature. ImmunEnhancer™ has successfully been incorporated into thirst quenching or isotonic drinks without any change in sensory acceptability. Recommended dosage is 1.5 grams per 16 oz of the isotonic drink. Larch AG is Generally Recognized As Safe (GRAS) affirmed (GRN 000047 and 000084) and FDA approved as a food additive which allows its wide availability in many types of drinks and liquid food products.

Foods with Larch Arabinogalactan

The applications for food use are many, including the use of Larch AG as an emulsifier, humectant, processing aid, and stabilizer. Studies conducted by Larex, Inc. prove the shelf life enhancing ability of Larch AG in many types of baked goods. Larch AG retains moisture, enhances mouth feel and texture, and improves shelf life by up to ten percent. Texture is also improved in baked goods by reducing the stickiness of the dough and improvement of the external symmetry and internal grain scores. In confectionery foods, Larch AG lowers water activity and aids in flavor and oil retention. Larch Arabinogalactan also has been used to increase the stability of oils (by mixing or co-spray drying) that are often sensitive to degradation. Larch AG can be used in browning compositions for uncooked foods, in seasoning powders to improve flow and reduce hygroscopicity, and in starch-containing foods to inhibit swelling. Being a highly soluble fiber, Larch AG has a very low viscosity leaving no negative impact on mouth feel. Larch AG can be exposed to high heats

and can withstand the rigors of the extrusion process. This fiber offers many options to formulators, leaving very little sensory impact on new and existing products, while providing efficacious doses to the end consumer.

Nutraceuticals with Larch Arabinogalactan

In two-piece hardshell applications, Larch AG is easily encapsulated since it is a dense fine particle powder. The fine Larch AG powder can be formulated to fit into two 00 size capsules (750 mg/cap), yielding an efficacious dose of 1.5 grams. It has no known negative interactions with other ingredients. In tablet applications, Larch AG can act as a tablet binder yielding harder tablets that dissolve quickly with less friability or breakage. Arabinogalactan has been shown to increase tablet hardness while reducing friability. Hence, the use of Larch AG in tableting adds the extra benefit of bioactivity (immune enhancement or fiber addition) while reducing the usage of excipients.

Larch AG is also easily incorporated into sports or so-called athletic bars and meal replacements. It adds slight water binding activity, which is useful in keeping the bars moist and chewy over time. Because of the neutral sensory profile and low gas forming potential compared to other dietary fibers, a significant amount of Larch AG can be incorporated into these types of nutrition bars. Since Larch AG has been shown to have little or no effect on insulin response the use of Larch AG may be used by individuals following a low carb or Atkin's type diet.

CLINICAL APPLICATIONS

Digestive Aid

Larch AG is a prebiotic fiber, which is not digested, but is passed through into the large intestine. There it is actively fermented by friendly intestinal microflora, thereby, increasing beneficial anaerobes, such as Bifidobacteria and Lactobacillus (1-3) while decreasing Clostridia (1,3).

In addition to its prebiotic effect, Larch AG also increases short chain fatty acid (SCFA) production (4), decreases ammonia generation (1,2,4) and lowers the colon pH (4), which is thought to play a role in the protection against a variety of gastrointestinal diseases. Carbohydrate fermentation into SCFAs, especially butyrate, by intestinal microflora is now recognized as critically important to the protection of the gastrointestinal mucosa and thus large bowel function (4,5). Furthermore, high ammonia levels have been reported to be toxic to colonic epithelial cells (2).

Animal studies indicate Larch AG has the potential to support digestive health by improving intestinal microflora (3,6) and decreasing bouts of diarrhea (7,8). Furthermore, a significant increase in *Lactobacillus sp.* was observed when human subjects consumed Larch AG for a total of 6 weeks (2).

The increase in probiotic bacteria by Larch AG consumption likely plays a key role in the majority of health benefits observed in both animal and human studies. Probiotic bacteria such as *Bifidobacteria* and *Lactobacillus* favorably alter the intestinal

microflora balance, inhibit the growth of harmful bacteria, promote good digestion, support immune function, and increase resistance to infection (9,10). While clinical trials to build on and further support Larch AGs benefits on digestive health and immune function will continue, the existing data thus far suggests benefit from regular Larch AG consumption.

Immune Enhancer

Both human and animal studies have shown direct benefits of Larch AG on immune system function (3,11,12). Specifically, the low to middle molecular weight Larch AG polysaccharides have been shown to enhance the immune system response. Hauer and Anderer (13) found that Larch AG modified the immunological response in peripheral blood mononuclear cells and monocytes *in vitro*. Pretreatment with Larch AG increased levels of interferon gamma (IFN gamma), tumor necrosis factor alpha (TNF α), interleukin-1 beta (IL-1 beta), interleukin-6 (IL-6), interferon gamma (IFN gamma) and NK (natural killer) cell activity. One of the most important of these defenses is natural killer cells, which are programmed to destroy viruses and tumor cells. In general, NK cell activity is an excellent functional marker of health. Reports in the medical literature indicate decreased NK cell activity is linked to a variety of health concerns (5).

Both *in vitro* and *in vivo* data indicate that Larch AG enhances the mononuclear portion of the immune system by supporting monocyte production, one of the first lines of defense against foreign invaders (11). Although 15 and 30 grams/day of Larch AG was investigated in this study, other preliminary data suggest that a lower dosage of 1.5 and 4.5 grams/day increased circulating peripheral blood white blood cells and total monocytes (12).

Since most diets are deficient in dietary fiber, the ability to simultaneously support immune activity, while boosting fiber intake, suggests a dual advantage of this unique polysaccharide.

Liver Protection

The ability of Larch AG to lower ammonia levels has been

suggested by some researchers as a valuable tool in the management of hepatic encephalopathy, a liver condition in which high ammonia levels can cause confusion, disorientation, abnormal neurological signs, and loss of consciousness.

SAFETY

Larch AG has been approved since 1965 as a direct food additive and there have been no concerns with safety resulting from its consumption since that time. It is Generally Regarded As Safe (GRAS), FDA approved as a food additive and meets pre-1994 DSHEA requirements. Larch AG is already approved as a food additive in many foreign countries.

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