

Table 5. Immunomodulatory Polysaccharide Products: Composition and Structure

Source	Category	Features	MW	Monosaccharide composition	Reference
<i>Agaricus subrufescens</i> (<i>A. blazei</i>)	Extract	β -1,6-D-glucan	10,000	NA	[66]
<i>Agaricus subrufescens</i> (fruit body)	Extract	α -1,6- and α -1,4 glucans with β -1,6-glucopyranosyl backbone (629.2 mcg/mg polysaccharides, 43.5 mcg/mg protein)	170,000	glucose	[24]
		α -1,4 glucans & β -1,6 glucans with β -1,3 side branches; α -1,6 glucans; β -1,6; 1-3 glucans, β -1,4 glucans; β -1,3 glucans; β -1,6; α -1,3 glucans; riboglucans, galactoglucomannans, β -1,2; β -1,3 glucomannans	NA	glucose, mannose, galactose, ribose	[25,117,118]
<i>Agaricus subrufescens</i> (mycelia)	Extract (ATOM)	β -1,6-D-glucan, protein complex, 5% protein	100,000-1,000,000	glucose, mannose, galactose, ribose	[93]
<i>Aloe barbadensis</i> (leaf gel)	Whole tissue	Dry weight: 10% polysaccharides; acemannan, aloemannan, aloeride, pectic acid, galactans, arabinans, glucomannans	average 2,000,000	mannose, glucose, galactose, arabinose, xylose, rhamnose	[119,120]
	Extract (aloemannan)	neutral partially acetylated glucomannan, mainly β -1, 4-	>200,000	mannose, glucose	[121]
	Extract (aloeride)	NA	4,000,000-7,000,000	37 % glucose, 23.9% galactose, 19.5% mannose, 10.3% arabinose	[122]
	Extract (acemannan)	β -1,4 acetylated mannan	80,000	mannose	[123]
<i>Aloe barbadensis</i> , (leaf gel), <i>Larix</i> sp. (bark), <i>Anogeissus latifolia</i> (bark), <i>Astragalus gummifer</i> (stem), <i>Oryza sativa</i> (seed), <i>glucosamine</i>	Extracts (Ambrotose® powder)	β -1,4 acetylated mannan, arabinogalactans, polysaccharide gums, rice starch, 5.4% protein	57.3 % \geq 950,000; 26.4 % <950,000 and \geq 80,000 ; 16.3% \leq 10,000	mannose, galactose, arabinose, glucose, galacturonic acid, rhamnose, xylose, fructose, fucose, glucosamine, galacturonic acid	(unpublished data, Mannatech Incorporated)

<i>Aloe barbadensis</i> (leaf gel), <i>Larix</i> sp. (bark), <i>Undaria pinnatifida</i> (frond), <i>Anogeissus latifolia</i> (bark), <i>Astragalus gummifer</i> (stem), <i>Oryza sativa</i> (seed), <i>glucosamine</i>	Extracts (Advanced Ambrotose® powder)	β -1,4 acetylated mannan, arabinogalactans, polysaccharide gums, fucoidans, rice starch, 6% protein, 1% fatty acids	13% = 1,686,667; 46% = 960,000 30 % <950,000 and \geq 70,000; 11 % \leq 10,000		
<i>Avena</i> spp. (seed endosperm)	Extract	β -1,3;1,4 particulate (1-3 μ) glucans	1,100,000	glucose	[43]
<i>Avena</i> spp. (seed)	Extract	β -1,4,1,3 particulate glucans (linear chains of β -D-glycopyranosyl units; 70% β 1-4 linked)	2,000,000	NA	[41,124]
<i>Buplerum falcatum</i> (root)	Extract (bupleuran 2IIc)	6 linked galactosyl chains with terminal glucuronic acid substituted to β -galactosyl chains	NA	galactose, glucuronic acid, rhamnose	[35]
Citrus spp. (fruit)	Extract	α -1,4-linked partially esterified D-anhydrogalacturonic acid units interrupted periodically with 1,2-rhamnose	70,000-100,000	galactose, galacturonic acid, arabinose, glucose, xylose, rhamnose	[125]
<i>Cladosiphon okamuranus</i> (frond)	Extract	α -1,3-fucopyranose sulfate	56,000	fucose:glucuronic acid (6.1:1.0)	[126]
<i>Cordyceps sinensis</i> (mycelia)	Extract	β -1,3-D-glucan with 1,6-branched chains	NA	NA	[127]
<i>Cyamopsis tetragonolobus</i> (seed)	Extract (guar gum)	Main chain of β -1,4-mannopyranosyl units with α -galactopyranosyl units	220,000	mannose, galactose	[36,128]
	Extract (partially-hydrolyzed guar gum)	NA	20,000	mannose, galactose	[50]
<i>Flammulina velutipes</i>	Extract	NA	NA	glucose, mannose, galactose	[117]
<i>Flammulina velutipes</i> (fruit body)	Extract	β -1,3 glucan	NA	glucose	[129]
<i>Ganoderma lucidum</i>	Whole tissue	Linear β -1,3-glucans with varying degrees of D-glucopyranosyl branching, β -glucan/protein complexes, heteropolysaccharides	400,000-1,000,000	glucose, galactose, mannose, xylose, uronic acid	[130]
	Extract	NA	7,000-9,000	NA	[67]
<i>Ganoderma lucidum</i> (fruit body)	Extract	NA	7,000-9,000	NA	

		β -linked heteroglycan peptide	513,000	Fructose, galactose, glucose, rhamnose, xylose (3.167:0.556:6.89:0.549:3.61)	[15]
<i>Ganoderma tsugae</i>	Extract	55.6% carbohydrates (12.5% polysaccharides); 12% triterpenes, 1.7% sodium, 0.28% protein, 0% lipid	NA	NA	[53]
<i>Ginkgo biloba</i> (seed)	Extract	89.7% polysaccharides	NA	glucose, fructose, galactose, rhamnose	[131]
<i>Grifola frondosa</i>	Whole tissue	β -1,3; 1, 6-glucans, α -glucans, mannoxyloglucans, xyloglucans, mannogalactofucans	NA	glucose, fucose, xylose, mannose, galactose	[117]
<i>Grifola frondosa</i> (fruit body)	Extract (D fraction)	β -1,6-glucan with β -1,3 branches, 30% protein	NA	glucose	[132]
	Extract (X fraction)	β -1,6-D-glucan with α -1,4 branches, 35% protein	550,000-558,000	glucose	
<i>Hordeum</i> spp. (seed)	Extract	β -1,3; 1,4-and β -1,3;1,6-D-glucans	45,000-404,000	glucose	[75]
		Primarily linear β -1,3;1,4- glucans	NA	glucose	[124]
<i>Laminaria</i> spp. (frond)	Extract (laminarin)	β -1,3;1-6 glucan	7,700	glucose	[29]
		β -1,3 glucan with some β -1,6 branches and a small amount of protein	4,500-5,500	glucose	[44]
	Extract	Fucoidan	NA	NA	[133]
<i>Larix occidentalis</i> (bark)	Extract	β -1,3;1,6-D-galactans with arabinofuranosyl and arabinopyranosyl side chains	19,000-40,000	galactose:arabinose (6:1), uronic acid	[128,134]
<i>Lentinula edodes</i>	Extract (SME)	β -1,3-glucans (4-5%), α -1,4-glucan (8-10%), protein (11-14%)	NA	glucose	[80]
	Extract	β -glucan	1,000	glucose	[27]
	Whole tissue	Linear β -1,3-glucans, β -1,4;1,6-glucans, heterogalactan	NA	glucose, galactose, mannose, fucose, xylose	[135]
	Extract (lentinan)	β -1,3-glucan with 2 β -1,6 glucopyranoside branchings for every 5 β -1,3-glucopyranoside linear linkages	500,000	glucose	[136]
<i>Lentinula edodes</i> (fruit body)	Extract (lentinan)	Neutral β -1,3-D glucan with two β -1,6 glucoside branches for every five β -1,3 units	400,000-800,000	glucose	[137]
<i>Lentinula edodes</i>	Extract (KS-2)	Peptide units and mannan connected by α -glycosidic bonds	60,000-90,000	mannose, glucose	
<i>Lentinula edodes</i> (mycelia or fruit body)	Extract	Triple helical β -1,3-D glucan with β -1,6 glucoside branches	1,000,000	glucose	[3]

<i>Lentinula edodes</i> (mycelia)	Extract (LEM)	44% sugars, 24.6% protein	~1,000,000	xylose, arabinose, glucose, galactose, mannose, fructose	[3]
	Extract (PG101)	72.4% polysaccharides, 26.2% protein, 1.4% hexosamine	NA	55.6% glucose, 25.9% galactose, 18.5% mannose	[138]
<i>Lycium barbarum</i>	Whole tissue	α -1,4;1,6-D-glucans, lentinan, β -1,3;1,6 heteroglucans, heterogalactans, heteromannans, xyloglucans	NA	glucose, galactose, mannose, xylose	[139]
<i>Lycium barbarum</i> (fruit body)	Extract (LBP _{3p})	88.36% sugars, 7.63% protein	157,000	galactose, glucose, rhamnose, arabinose, mannose, xylose (molar ratio of 1:2.12:1.25:1.10:1.95:1.76)	[91]
<i>Panax quinquefolium</i> (root)	Extract	Poly-furanosyl-pyranosyl saccharides	NA	arabinose, galactose, rhamnose, galacturonic acid, glucuronic acid	[33]
		NA	NA	glucose, mannose, xylose	[140]
	Extract (Cold-FX [®])	90% poly-furanosyl-pyranosyl-saccharides	NA	furanose	[20]
<i>Phellinus linteus</i> (fruit body)	Extract	α - and β -linked 1,3 acidic proteoglycan with 1,6 branches	150,000	glucose, mannose, arabinose, xylose	[141]
<i>Phellinus linteus</i> (mycelia)	Extract	83.2% polysaccharide (4.4% β -glucan), 6.4% protein, 0.1% fat	NA	glucose	[142]
<i>Pholiota nameko</i> (fruit body)	Extract (PNPS-1)	NA	114,000	mannose, glucose, galactose, arabinose, xylose (molar ratio of 1:8.4:13.6:29.6:6.2)	[55]
<i>Pleurotus ostreatus</i> (mycelia)	Extract	β -1,3;1,6-D-glucans	316,260	glucose	[143]
<i>Saccharomyces cerevisiae</i>	Extract (WGP)	Particulate β -1,3;1,6-D-glucan	NA	glucose	[144]
	Extract	β -glucans with β -1,6 branches with a β -1,3 regions	NA	glucose	[124]
	Extract (SBG)	soluble β -1,3-D-glucan with β -1,3 side chains attached with β -1,6 linkages	20,000	glucose	[145]
<i>Sclerotinia sclerotiorum</i> (mycelia)	Extract (SSG)	β -1,3-D-glucan, <1% protein (>98% polysaccharide)	NA	glucose	[83]
<i>Sclerotium rofsii</i>	Extract (scleroglucan)	β -1,3;1,6 glucan	1,000,000	glucose	[29]

<i>Trametes versicolor</i> (fruit body)	Extract (PSP)	α -1,4, β -1,3 glucans, 10% peptides	100,000	glucose, arabinose, mannose, rhamnose	[146]
<i>Trametes versicolor</i> (mycelia)	Extract (PSK)	β -1,4;1,3;1,6-D-glucans, protein	94,000	glucose (74.6%), mannose (15.5%), xylose (4.8%), galactose (2.7%), fucose (2.4%)	[137,147]
<i>Undaria pinnatifida</i> (sporophyll)	Extract	Galactofucan sulfate	9,000	fucose:galactose 1.0:1.1	[148]
		Galactofucan sulfate	63,000	fucose:galactose:gluc- uronic acid (1.0:1.0:0.04)	[149]
		β -1,3-galactofucan sulphate	38,000	fucose, galactose	[150]
Unidentified source	Extract (modified citrus pectin)	NA	10,000	galactose, rhamnose, uronic acid	[125]
	Extract (highly methoxylated pectin)	NA	200,000	NA	[36]