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QTI™ ANIMAL HEALTH & NUTRITION

Meta-Analysis of Five Performance Comparisons of Broilers Fed Basal vs Basal + ImmunoWall® (IMW50®) Diets and Estimated Economic Returns

Introduction

IMW50®, marketed in North America, also known as ImmunoWall® internationally, is a yeast cell wall extract taken from autolyzed whole yeast cells (*Saccharomyces cerevisiae*) derived from molasses ethanol fermentation in Brazil (ICC Brazil). Quality Technology International (QTI), Inc. distributes IMW50® for use as a feed additive in animal agriculture (for example, for poultry, swine, calves, and aquaculture species) in North America. The purpose of this report is to present results of a statistical meta-analysis of 5 performance comparisons (3 trials) in which broilers were fed either basal diets or basal diets supplemented with IMW50® and to give estimates of economic returns using the European Poultry Efficiency Factor (EPEF) and a simple spreadsheet model to give cost:benefit ratio and return on investment (ROI).

Yeast Mannan Oligosaccharide and Beta-Glucans

Recovering and recycling live yeast cells from one batch to another during molasses ethanol (alcohol) production, as well as the relatively high temperature (95o F), low pH (2.5-4.0), and high alcohol (11%) conditions during processing, results in mature yeast cells with thick cell walls and abundant quantities of beta-glucans (30% minimum, mostly 1,3-beta linked backbone with a small numbers of 1,6-beta linked side chains; Bohn and BeMIller, 1995) and mannan oligosaccharide (17% minimum; MOS). These cell walls are nearly indigestible compared to some other types which are at least moderately digestible. The fat content of cell walls from these hardy, mature yeast cells is about 2.7% compared to about 4% fat in cell walls from some other strains of yeast and processes. IMW50® has ~31.3% protein, 5% moisture, 3.5% ash, and 0.72% crude fiber based on typical results from analyses.

Mannan Oligosaccharide (Mannans)

Typically, the largest part of the yeast cell wall carbohydrates in IMW50® are β-glucans (30% minimum), mainly β-1,3 glucans with lesser components being β-1,6 glucans, chitin, and mannoproteins. The β-1,6 glucans assure a linkage among various components. The proportion of 1,3 and 1,6 beta-glucans, 70:30%, remains relatively constant for yeasts grown on alcoholic fermentation substrates. The mannoproteins form a layer on the external surface of the yeast. Mannoproteins with a structural role contain approximately 90% mannose and 5-10% protein (Ballou and Raschke, 1974). The ~31.3% protein in IMW50® comes from mannoproteins as well as protein in residual cytoplasm. Mannose molecules linked in sequence form mannan oligosaccharide (MOS) which becomes part of the protective coat of yeast cells. The MOS component in feeds can agglutinate and strongly attach to pathogenic bacteria

Figure 1

Photo and color diagram of intact *Saccharomyces cerevisiae* yeast cell wall.

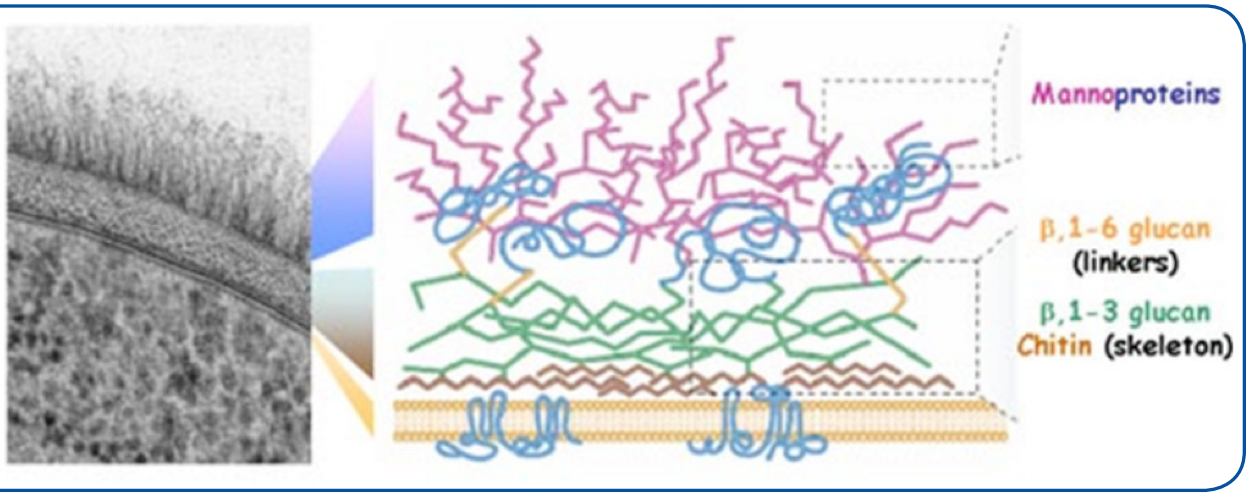
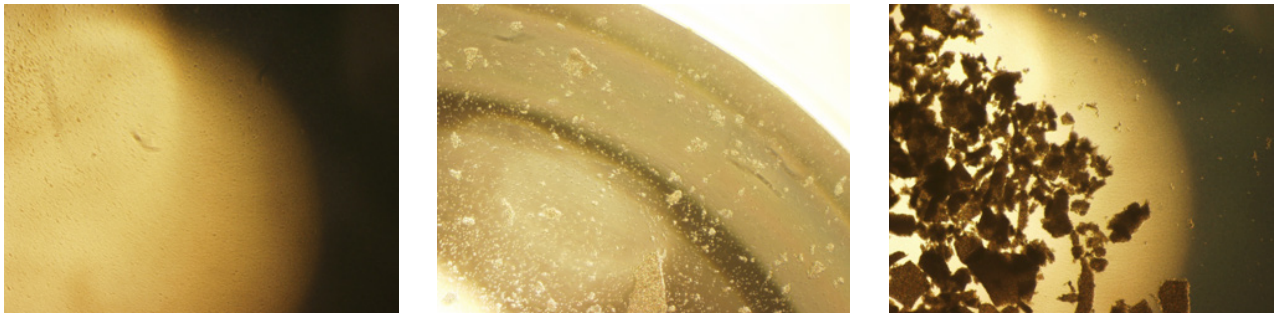


Figure 2

Left to right in Phosphate Buffered Saline (PBS): *Salmonella dublin*, yeast cell wall extract, and agglutination of *Salmonella dublin* and yeast cell wall extract (Lohrmann, 2012).



(for example, certain enterotoxic strains of *E. coli* and *Salmonella*) seeking to bind to similar sites on the intestinal mucosa cells. The bound pathogenic bacteria and yeast cell wall material passes out of the intestinal tract. This promotes gut health, live performance, and food safety.

The initial interest in using MOS to protect gastrointestinal health originated from work done in the late 1980s. At that time researchers looked at the ability of mannose, the pure version of the complex sugar in MOS, to inhibit salmonella infections. Different studies showed that salmonella can bind via type-1-fimbriae (finger-like projections, with mannose-seeking lectins) to mannose on the gut wall, colonize, and produce toxins. It was found that the binding to mannose reduced the risk of pathogen colonizing the intestinal tract. Different forms of mannose-type sugars interact differently with type-1-fimbriae. The form present in the cell wall of *Saccharomyces cerevisiae* (α-1,6 backbone with α-1,2 and α-1,3 branched mannans) is particularly effective at binding pathogens such as entotoxic strains of *E. coli* and *salmonella* (Mannan Oligosaccharide; Mannan; Wikipedia). This process is also called adsorption. A mixture of pathogens and MOS in water results in agglutination (for example, *in vitro*) which is a way to test different sources of mannan oligosaccharides for their pathogen binding ability.

Yeast cell walls containing mannose (in mannan oligosaccharide) exhibit a high degree of antigenicity which positively affects the immune system by stimulating the liver to secrete mannose-binding protein. This protein subsequently binds to the capsule of bacteria and triggers the immune response via the complement system. Complement earmarks foreign invaders (antigens) for phagocytic cell destruction.

Beta (β)-Glucans

Dietary yeast beta-glucans interact with intestinal mucosa to induce immune responses that help prevent or reduce infection without inflammatory cytokine (fever) production. Beta-glucans stimulate phagocytosis which is the cytotoxic activity in macrophages, increase antigen presentation activity which helps direct the adaptive immune response, and other biological activities. Beta-glucans alert and prime the immune system enabling faster, better, smarter, and more extended immune responses. Beta-glucans provide protective effects against bacteria, viruses, parasites, and fungi, and can serve as a vaccine adjuvant for more potent responses. With beta 1,3/1,6 glucans overstimulation of the immune system is not observed, but the macrophages stay in an alert or ready mode until the presence of "non-self" entities such as viruses, bacteria, fungi, cancer, parasites, etc. are detected, at which time the macrophages are activated and become the first line of defense against any invader."

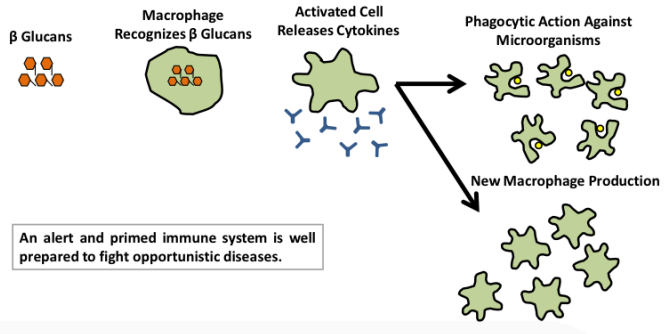


Figure 3

How beta-glucans (for example, beta-1, 3 glucan particles ~1-2 µm) work to boost immune readiness.

Some authors claim that the β-1,3/1,6-glucan derived from yeast Saccharomyces cerevisiae produce the highest biological effects. Branched or linear (1,4)-glucans have limited activity and β-glucans with a 1,3-configuration with additional branching at the position C-6 of the 1,3 linked D-glucose residues have the highest immunostimulating activity (Vetvicka, 2001; Freimund et al., 2003). Beta-glucans are among the most effective natural stimulants of the innate immune system and when in contact with phagocytic cells, which recognize β-1-3 and β-1-6 linkages, these phagocytes are stimulated to produce a variety of cytokines. Cytokines trigger a "chain reaction" inducing a higher immune status in poultry and swine, making them better able to fight against opportunistic pathogens.

Meta-Analysis and Economic Returns

Several comparisons (treatments) in published or unpublished trials were considered for this meta-analysis and based on the criteria (age, IMW inclusion rate, BW, FCR, and MORT % in pen trials with replication on litter), only 5 comparisons from 3 trials were acceptable. These trials gave very reliable and consistent data which resulted in significant differences between Control (CON) and ImmunoWall® (IMW®; IMW), in favor of IMW for 42-day body weight and 0-42 day feed conversion ratio and EPEF. Mortality % were not significantly different; however, mortality is known to be a more highly variable parameter, so more replication (data points) would be needed to accurately assess the benefits of IMW on livability. The inclusion rate from IMW ranged from 0.025 to 0.10% of the diet with an overall average of 0.055% for the 5 comparisons. This is equivalent to 1.1 lb/U.S. ton or 0.55 kg/MT. Three of the comparisons were done with 0.05% IMW (1 lb/U.S. ton or 0.5 kg/MT).

Table 1

Meta-analysis of 5 performance comparisons (3 trials) with broilers fed diets with or without ImmunoWall® (IMW50®) and European Poultry Efficiency Factor (0-42 days)

Reference	IMW, %	Body Wt, lb		Feed Conversion		Mortality %		EPEF	
		CON	IMW	CON	IMW	CON	IMW	CON	IMW
VDRC, 2012 (Virginia)	0.025	4.976	5.218	1.927	1.880	1.75	0.00	274.0	299.8
VDRC, 2012 (Virginia)	0.05	4.976	5.205	1.927	1.804	1.75	1.00	274.0	308.5
VDRC, 2012 (Virginia)	0.10	4.976	5.313	1.927	1.812	1.75	1.00	274.0	313.5
SPR, 2016 (Georgia)	0.05	4.875	4.945	1.804	1.777	7.60	8.00	268.7	276.5
USP, 2017 (Brazil)	0.05	5.827	5.873	1.735	1.704	0.59	2.97	360.6	361.2
Average	**0.055**	**5.126**b	**5.311**a	**1.864**a	**1.795**b	**2.688**	**2.594**	**290.2**b	**311.9**a
Difference			0.185		-0.069		-0.094		21.7
Difference from CON, %			3.61%		-3.70%		-3.50%		7.48%
P value Paired t-test (n = 5)			**0.024**		**0.030**		0.901		**0.045**

Notes: These trials were all with Cobb broilers (3 Virginia trials with straight-run and SPR and USP trials with males only). European Poultry Efficiency Factor (EPEF) is calculated as: [(BW, kg x Livability, %)/(FCR x Days)] x 100. It is an index of performance and profitability.

Estimated economic returns for a complex placing 1 million chicks/week are given in Table 1 using the 5-comparison live performance results from the meta-analysis, feed cost of $262.91 per ton (PIP Newsletter, 6-23-2018, University of Georgia Vet School), and assumed live production cost of $0.3877 per lb. The IMW50® price of $1.50 extra per ton of feed is also assumed and may be more or less as prices are subject to change over time. Cost:benefit ratio of 9.63:1 and ROI of 8.63:1 (with cost of additive removed; "pure profit") were estimated based on these assumptions. This will help broiler integrators know what to expect with regard to production and profitability from IMW50® supplementation.

Based on 5 Comparisons (3 Pen Trials)	Negative Control	ImmunoWall 0.055% Avg	
Chicks Placed Weekly	1,000,000	1,000,000	
Body Weight, lb	5.121	5.311	
Livability, %	97.312	97.406	42.00 Days
FCR	1.864	1.795	
Total Liveweight, lb	4,983,348	5,173,233	
Feed Cost, $/ton	262.91	264.41	$1.50
Total Feed, lb	9,288,960	9,285,953	Assumed
Total Feed Expense, $	1,221,080	1,227,649	cost for this
Chicken Live Value, $/lb	0.3877	0.3877	example.
Total Live Value, $	1,932,044	2,005,662	
Net: Live Value - Feed, $	710,964	778,013	
Difference from Control, $	0	67,049	
Total Cost of Additive, $	0	6,964	
"Benefit:Cost Ratio"	0	**9.63**	:1
Difference: Control - Additive, $		60,085	
"Return on Investment" (ROI)		**8.63**	:1

Return on investment is equivalent to subtracting 1 representing 1x cost of additive from Benefit:Cost. So it is "pure profit" for each additive dollar spent.

IMW50® (sold internationally as IMMUNOWALL®) is a registered trademark of ICC, San Paolo, Brazil.

REFERENCES

Araújo, L. Francelino. 2017. Desempheho e reposta imune de frangos de corte suplementados com immunowall, Hilyses e oleo essencial. USP Pirassununga, Brazil. Final report of contract research sponsored by ICC Brazil. 12 pp.

Ballou, C. E., and W. C. Raschke. 1974. Polymorphism of the somatic antigen of yeast. Science 184(4133):127-134.

Bohn J. A., and J. N. BeMiller. 1995. (1→3)-β-Glucans as biological response modifiers: a review of structure-functional activity relationships. Carbohyd. Polym. 28: 3-14.

Bonato, M. A., J. Schleifer, G. D. Santos, B. S. Lumpkins, and G. F. Mathis. 2016. Performance of broilers fed diets supplemented with yeast mannan oligosaccharide and/or nucleotides from different sources. In: Proc. Int. Poult. Sci. Forum, Atlanta, GA, p. 56 (Abstr.).

Freimund S., M. Sauter, O. Kapelli, and H. Dutler. 2003. A new nondegrading isolation process for 1,3-β-glucan of high purity from baker's yeast Saccharomyces cerevisiae. Carbohyd. Polym. 54:159-171.

Kath, F., and W.-M. Kulicke. 1999. Mild enzymatic isolation of mannan and glucan from yeast Saccharomyces cerevisiae. Molecular Mater. Eng. 268(1):59-68.

Lohrmann, T. L.. 2012. The ability of three enteric pathogens to trigger agglutination of QMOS yeast cell wall product. QTI, Inc. Technical Report, 3 January, 3 pp.

Sims, M. D. 2012. Virginia Diversified Research Corp., Harrisonburg, VA, 2012-007. Final report of contract research sponsored by QTI and Calpis.

Vetvicka, V. 2001. β-Glucans as imunomodulators. J. Amer. Nutraceutical Assoc. 3:31-34.

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