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Editor: Dr Stephen Collett, Associate Professor
Co-Editor: Dr Pedro Villegas, Professor
Department of Population Health

Phone (706) 542-1904

Fax (706) 542-5630

e-mail: Ashley Moody at armoody@uga.edu

Probiotics – do the organisms need to be alive?

Adriana A Pedroso and Margie D Lee

*Poultry Diagnostic and Research Center
University of Georgia, Athens, Georgia, USA*

With all the recent publicity being given to the complications associated with Salmonella contamination of the human food chain; methods of control are once again in the limelight. Competitive exclusion has for a long time being an important part of gut health management. In this issue, Adriana Pedroso and Margie Lee address the issue of live vs inactivated probiotic preparations.

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Broiler Live Production Cost	Average Company
Feed Cost/ton w/o color (\$)	231.21
Feed cost /lb meat (c)	21.48
Days to 4.6 lbs	42
Chick cost / lb (c)	4.73
Vac-Med cost/lb (c)	0.05
WB & ½ parts condemn. Cost/lb	0.15
% mortality	4.24
Sq.Ft. @ placement	0.82
Lbs/sq. ft.	7.09
Downtime (days)	13

Data for week ending July 30th 2010

Synopsis

Probiotics are currently offered to animals as intact, living cells that are preserved by a freeze-drying (lyophilization) process, in some instances after removing metabolites from the cell suspension. But some studies are revealing that dead bacterial cells and their metabolites can offer beneficial effects to animals. These bio-active compounds, some of which have antimicrobial or signaling activity, could regulate gut health and enhancing the immune system.

Probiotics: a wide range of fractionated components

Probiotics are defined as nonpathogenic microorganisms which can exert a positive effect on the host. The mechanisms of action that have been described include *adhesion* to the intestinal-lumen interface; *competition* with pathogens for nutrients, receptor binding, and colonization; enhancement of mucosal *barrier function*; promoting of innate and adaptive *immune responses*; elaboration of *bacteriocins*; and modulation of *cell kinetics* via alterations in the proliferation/apoptosis ratio (Prisciandaro, Geier et al. 2009). The beneficial effects of administering living cells as probiotics are widely described.

A common guideline for probiotic is that the organisms should be alive when administered to produce a beneficial outcome (FAO 2002). Determining the viability of probiotic strains and their persistence within the gastrointestinal system has been object of considerable research (Shah 2000; Lourens-Hattingh and Viljoen 2001; Kailasapathy 2002; Lahtinen, Ouwehand et al. 2006; Jia, Shigwedha et al. 2010; Vanhee, Goeme et al. 2010). However, some researchers have reported benefits from administration of inactivated or killed organism (Higgins, Higgins et al. 2008). Among the claimed properties of beneficial bacteria, is their potential to act as a physical barrier against pathogens by competing for attachment sites. To accomplish this action, they do not have to be viable because attachment is mediated by specific structures present on the bacterial surface. In addition, direct contact between the probiotic and pathogenic bacteria is not necessary for occurrence of a protective effect (Lazar, Miyazaki et al. 2009). Preparations of fractionated dead cells and various cellular components have been demonstrated to produce a range of biological responses (Adams 2010).

Soluble Factors

During growth the bacterial cell's environment is enriched with substances excreted by the growing, or dying, bacterial cell. When a probiotic is produced, these bioactive compounds include communication molecules, antimicrobials, bacteriocins, bacterial surface molecules, and other metabolic products in the supernatant. During the probiotic manufacture, the soluble factors may be eliminated during the lyophilization process because of the production cost (Cole 2008). However, the soluble factors can produce favorable effects when administrated to animals.

The best characterized microbial soluble products are antibiotics that are used as therapeutics. However, soluble probiotic metabolites and structural molecules can interfere with the first step of cell adherence and colonization (Lazar, Miyazaki et al. 2009). *Lactobacillus* and *Lactococcus* cultures are known to be a rich source of bacteriocins (Avonts, Van Uytven et al. 2004; Schaefer, Auchtung et al. 2010). Culture solutions from acid lactic bacteria have been shown to inhibit *Helicobacter pylori*, *Salmonella*, and a wide variety of bacteria (Bernet, Brassart et al. 1994; Lin, Lin et al. 2009). Also bacterial communication molecules have been described that induce a response in host cells (Hong, Duc et al. 2005) that could protect intestinal cells from injury (Tao, Drabik et al. 2006).

Dead cells

Probiotics which contain a high proportion of dead cells are generally considered undesirable (Lacroix and Yildirim 2007; Weinbreck, Bodnar et al. 2010), but products based on dead cells or cell fractions have been demonstrated to be effective (Kataria, Li et al. 2009). For example killed *Lactobacillus* have been shown to inhibit adherence of gastrointestinal pathogens to epithelial cells (Coconnier, Bernet et al. 1993).

The biological response to dead probiotic cells is similar to an oral immunization response from a killed vaccine (Adams 2010). Dead cells can stimulate the immune system (Kanasugi, Hasegawa et al. 1997). Killed *Enterococcus faecalis* cells have been shown to stimulate the bone marrow (Hasegawa, Kanasugi et al. 1996) and orally administered cell wall preparations stimulate the gut immune system (Sakai, Tsukahara et al. 2006). Live and heat treated *Lactobacillus rhamnosus* have been shown to be effective in reducing the inflammatory response in the gastrointestinal tissue (Li, Russell et al. 2009). Similarly, heat killed *Bifidobacterium* was effective against ulcerative colitis (Imaoka, Shima et al. 2008).

Biological products based on dead cells might be simple to produce and commercialize. They would be relatively easy to standardize and would have a long shelf life (Adams 2010). Products based on dead cells could be produced from many species of organisms considered to be beneficial, even mixed cultures. In live cultures, only well-characterized, non-pathogenic species can be used.

Conclusion

The use of probiotic products, as dead cells, cellular fractions or soluble fractions is attractive. The absence of microorganisms in the final product could be a good strategy to simplify commercialization. And the use of probiotic bioactive products could avoid probiotic outbreaks which are rare but recognized (Cassone, Serra et al. 2003; Boyle, Robins-Browne et al. 2006).

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Excerpts from the latest USDA National Agricultural Statistics Service (NASS) “Broiler Hatchery,” “Chicken and Eggs” and “Turkey Hatchery” Report and Economic Research Service (ERS) “Livestock, Dairy and Poultry Situation Outlook”

Chickens and Eggs

Released September 21, 2010, by NASS, Agricultural Statistics Board, USDA

August Egg Production Up 2 Percent

U.S. egg production totaled 7.74 billion during August 2010, up 2 percent from last year. Production included 6.64 billion table eggs, and 1.10 billion hatching eggs, of which 1.02 billion were broiler-type and 73 million were egg-type. The total number of layers during August 2010 averaged 339 million, up 2 percent from last year. August egg production per 100 layers was 2,283 eggs, unchanged from August 2009.

All layers in the U.S. on September 1, 2010 totaled 340 million, up 2 percent from last year. The 340 million layers consisted of 283 million layers producing table or market type eggs, 53.6 million layers producing broiler-type hatching eggs, and 3.00 million layers producing egg-type hatching eggs. Rate of lay per day on September 1, 2010, averaged 74.1 eggs per 100 layers, up slightly from September 1, 2009.

Egg-Type Chicks Hatched Down 2 Percent

Egg-type chicks hatched during August 2010 totaled 37.0 million, down 2 percent from a year ago. Eggs in incubators totaled 37.5 million on September 1, 2010, up 2 percent from a year ago. Domestic placements of egg-type pullet chicks for future hatchery supply flocks by leading breeders totaled 265 thousand during August 2010, down 9 percent from May 2009.

Broiler-Type Chicks Hatched Up 2 Percent

Broiler-type chicks hatched during August 2010 totaled 799 million, up 2 percent from August 2009. Eggs in incubators totaled 639 million on September 1, 2010, up 3 percent from a year earlier. Leading breeders placed 7.31 million broiler-type pullet chicks for future domestic hatchery supply flocks during August 2010, up 2 percent from August 2009.

Broiler Hatchery

Released September 22, 2010, by NASS, Agricultural Statistics Board, USDA

Broiler-Type Eggs Set In 19 Selected States Up 2 Percent

Commercial hatcheries in the 19-State weekly program set 198 million eggs in incubators during the week ending Sep-

tember 18, 2010. This was up 5 percent from the eggs set the corresponding week a year earlier. Average hatchability for chicks hatched during the week was 84 percent. Average hatchability is calculated by dividing chicks hatched during the week by eggs set three weeks earlier.

Broiler Chicks Placed Up 2 Percent

Broiler growers in the 19-State weekly program placed 169 million chicks for meat production during the week ending September 18, 2010. Placements were up 2 percent from the comparable week a year earlier. Cumulative placements from January 3, 2010 through September 18, 2010 were 6.30 billion, up 1 percent from the same period a year earlier.

Turkey Hatchery

Released September 15, 2010, by the NASS, Agricultural Statistics Board, USDA

Eggs in Incubators on September 1 Up Slightly from Last Year

Turkey eggs in incubators on September 1, 2010, in the United States totaled 26.4 million, up slightly from September 1, 2009. Eggs in incubators were down 5 percent from the August 1, 2010 total of 27.9 million eggs. Regional changes from the previous year were: East North Central down 1 percent, West North Central up 2 percent, North and South Atlantic up 5 percent, and South Central and West down 18 percent.

Poults Hatched During August Down 2 Percent from Last Year

Turkey poults hatched during August 2010, in the United States totaled 22.9 million, down 2 percent from August 2009. Poults hatched were down 13 percent from the July 2010 total of 26.2 million poults. Regional changes from the previous year were: East North Central up 2 percent, West North Central up 5 percent, North and South Atlantic down 3 percent, and South Central and West down 23 percent.

Net Poults Placed During August Up Slightly from Last Year

The 22.7 million net poults placed during August 2010 in the United States were up slightly from the number placed during the same month a year earlier. Net placements were down 13 percent from the July 2010 total of 26.0 million.

Current Month Charts

Broiler Performance Data Live Production Cost	Region					Average Company
	SW	Midwest	Southeast	Mid-Atlantic	S-Central	
Feed Cost/ton w/o color (\$)	228.36	217.96	236.84	233.67	230.14	231.21
Feed cost /lb meat (c)	21.50	20.41	21.41	22.27	21.70	21.48
Days to 4.6 lbs	43	41	41	41	42	42
Chick cost / lb (c)	4.53	4.72	5.07	4.32	4.60	4.73
Vac-Med cost/lb (c)	0.07	0.03	0.06	0.05	0.02	0.05
WB & ½ parts condemn. Cost/lb	0.15	0.18	0.11	0.15	0.13	0.15
% mortality	4.46	6.10	4.19	4.13	3.74	4.24
Sq.Ft. @ placement	0.80	0.81	0.83	0.86	0.82	0.82
Lbs/sq. ft.	7.30	7.14	6.59	7.37	7.33	7.09
Downtime (days)	12	10	14	15	13	13

Broiler Whole Bird Condemnation	Region					Average Company
	SW	Midwest	Southeast	Mid-Atlantic	S-Central	
% Septox	0.127	0.180	0.067	0.106	0.071	0.108
% Airsac	0.044	0.047	0.029	0.040	0.028	0.037
% I.P.	0.008	0.009	0.003	0.040	0.015	0.017
% Leukosis	0.000	0.001	0.000	0.001	0.001	0.001
% Bruises	0.002	0.001	0.003	0.002	0.002	0.002
% Other	0.006	0.003	0.013	0.015	0.005	0.009
% Total	0.188	0.241	0.115	0.205	0.122	0.174
% ½ parts condemns	0.239	0.347	0.214	0.236	0.288	0.262

Data for week ending Jul 30th 2010

Previous Month Charts

Broiler Performance Data Live Production Cost	Region					Average Company
	SW	Midwest	Southeast	Mid-Atlantic	S-Central	
Feed Cost/ton w/o color (\$)	227.23	216.33	234.93	232.56	228.56	229.80
Feed cost /lb meat (c)	21.06	19.80	20.99	22.05	21.42	21.17
Days to 4.6 lbs	43	41	41	40	42	41
Chick cost / lb (c)	4.56	4.60	5.01	4.35	4.61	4.70
Vac-Med cost/lb (c)	0.07	0.03	0.06	0.07	0.02	0.06
WB & ½ parts condemn. Cost/lb	0.14	0.16	0.11	0.16	0.12	0.14
% mortality	3.61	4.02	3.67	4.37	3.69	3.85
Sq.Ft. @ placement	0.80	0.80	0.83	0.92	0.82	0.83
Lbs/sq. ft.	7.42	7.23	6.60	7.18	7.32	7.10
Downtime (days)	13	10	15	15	13	13

Broiler Whole Bird Condemnation	Region					Average Company
	SW	Midwest	Southeast	Mid-Atlantic	S-Central	
% Septox	0.116	0.171	0.063	0.110	0.073	0.106
% Airsac	0.040	0.036	0.030	0.043	0.025	0.038
% I.P.	0.007	0.009	0.003	0.040	0.018	0.019
% Leukosis	0.000	0.001	0.000	0.002	0.001	0.001
% Bruises	0.003	0.001	0.003	0.002	0.002	0.002
% Other	0.005	0.003	0.010	0.017	0.005	0.009
% Total	0.171	0.219	0.109	0.213	0.122	0.174
% ½ parts condemns	0.229	0.295	0.209	0.259	0.281	0.261

Data for week ending Jul 16th 2010

Meetings, Seminars and Conventions

2010
October

October 4-6, 2010. 45th National Meeting on Poultry Health and Processing. Clarion Resort Fountainbleau Hotel Ocean City, Maryland. For more information contact: Bill Satterfield, Phone: (302) 856-9037, Email: satterfield@dpichicken.com

October 17-20, 2010: The 5th International Workshop on the Molecular Pathogenesis of Marek's Disease Virus. 1st Symposium on Avian Herpesvirus. For more information and registration: <http://www.georgiacenter.uga.edu/conferences/2010/Oct/17/avian.phtml>

2010
November

November 5, 2010: The North Carolina Poultry Health 2010 Meeting. The meeting will be held at the Raleigh Convention Center in Raleigh, NC. Sponsored by Lohmann Animal Health. Registration and general information is available at <http://ncveterinaryconference.com/>. If unable to register online please contact Michael Martin at (919) 513-6330.

November 11-17, 2010: United States Animal Health Association 2010 Annual Meeting. This meeting will be held at the Minneapolis Hilton Hotel in Minneapolis, Minnesota. For more information please go to <http://www.usaha.org/meetings/>.

2011
January

January, 2011 Southern Conference on Avian Diseases (SCAD) The meeting will be held together with Southern Poultry Science Society at the International Scientific Forum in Atlanta GA. Registration is on line at <http://www.internationalpoultryexposition.com/ipsf/>

January 24-25, 2011: The International Poultry Scientific Forum. The Forum will be held at the Georgia World Congress Center, Atlanta, GA. Registration is online at www.ipe11.org. Last call for abstracts is October 6, 2010. For more information please contact Bob Buresh (bobburesh@gmail.com) or Barbara Jenkins (bjenkins@poultryegg.org).

2011
March

March 21-23, 2011: 60th Western Poultry Disease Conference. The conference will be at the Holiday Inn Capitol Plaza in Sacramento, CA. General information and title submission is online at <http://conferences.ucdavis.edu/wpdc>. Please contact Rich Chin (rpchin@ucdavis.edu) for additional information.

2011
July

July 16-19, 2011: American Veterinary Medical Association 2011 Annual Convnetion. This year it will be held in St. Louis, Missouri. For more information please go to <http://www.avma.org/convention/news/default.asp>.

2011
September

August 14-18, 2011. XVII Congress & Exhibition of the World Veterinary Poultry Association
Cancun, Mexico. More info: www.congressmexico.com



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