Spray-dried plasma in Poultry Production

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Outline

- Getting Birds off to a good start
- What is Spray-Dried Plasma (Functional Proteins)
- Plasma level in broilers
- Effect of feed processing on poultry feed containing plasma
- Stress conditions
- Conclusions

Early Growth

- Like weanling pigs, chicks are switching diets at hatch.
- Going from yolk as nutrient source of fat and lipoproteins to diet of carbohydrates and proteins
- Early growth impacts subsequent performance:
  - 1 g at 7 d = 5-10 g at 40 d.
- So… 150 vs 180 g at 7 d = 150-300 g extra at market
- $0.015-0.025 investment per bird for 150-300 g extra BW at market.

Economics: Value of 3-5 g plasma for 10 d

Impacting Gut Health

- Bacterial overgrowth is a main issue to impact gut health and performance
- Undigested nutrients to the ceca impacts bacterial overgrowth
- **Protein** is one nutrient that is an issue of being undigested contributing to bacterial overgrowth in the first 10 d

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Plasma Benefits

- Highly digestible protein
  - Reduce soybean meal in diet
- Improves ADG, F:G and survival
- Help support and maintain the immune system
  - Reduces impact of enteric and respiratory challenge
- Improved intestinal barrier function
  - Better nutrient utilization
- Better fecal score
  - Dryer litter and more fecal consistency

Functional Proteins

What are Functional Proteins?

- **Proteins**
  - Nutritional source of amino acids
- **Functional Proteins**
  - Biological actions beyond nutrition
- **Functional Proteins maintain normal gut function and support animal health**

Functional Protein Effects

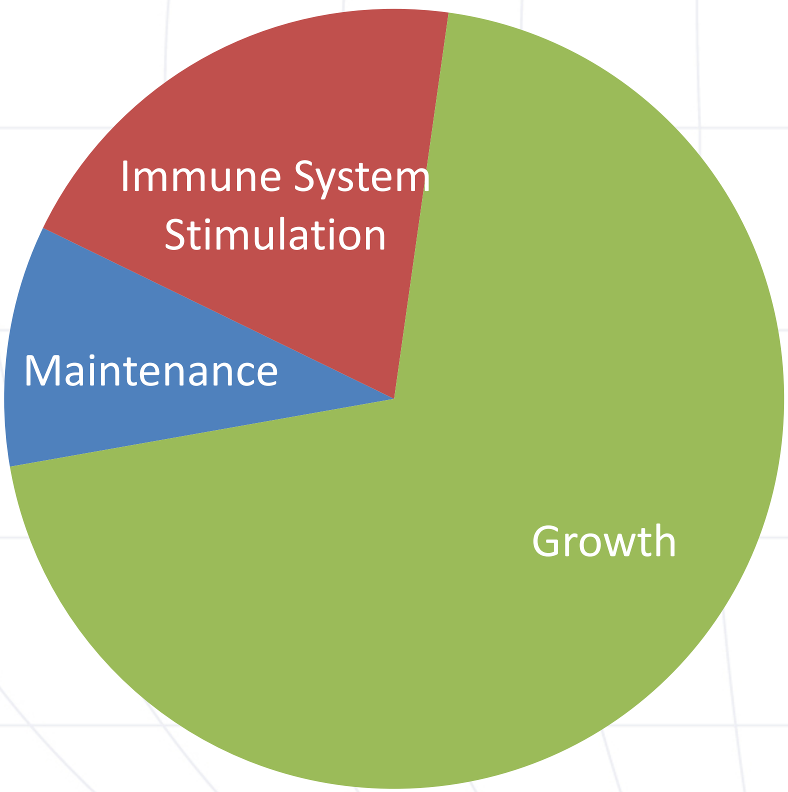
- Numerous studies document positive effects of diets containing plasma on:
  - performance
  - morbidity
  - mortality
- Effects are documented and consistent
  - 300+ published journal articles
  - Effective across multiple species
    - ruminant, poultry, aquaculture, companion animal, and swine

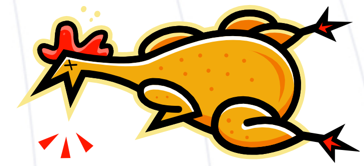




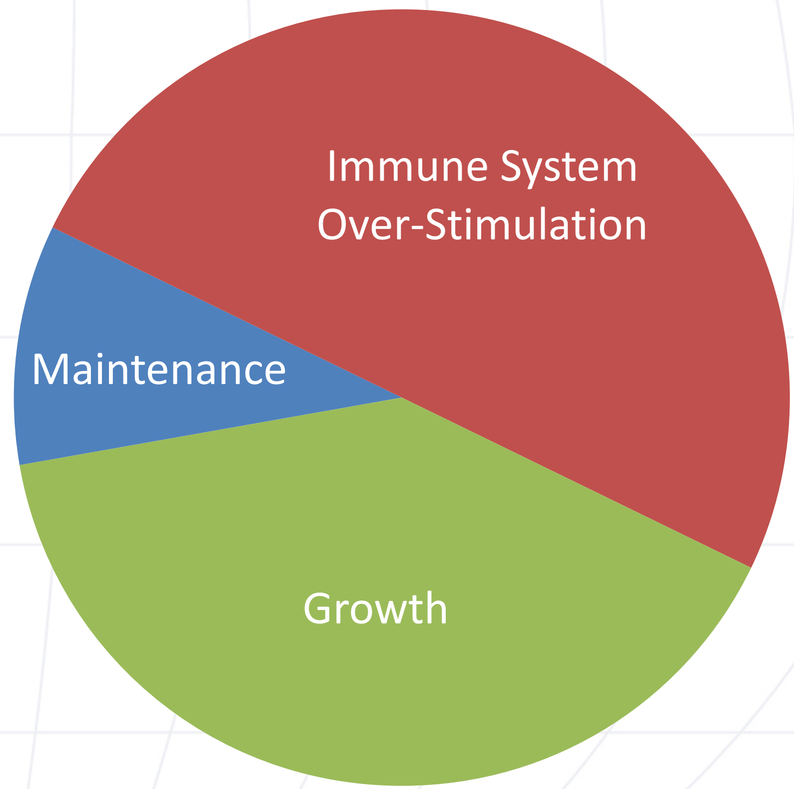
There is only so much energy & resources available for production

With Functional Proteins





Without Functional Proteins



Summary of FP Effects

- Improves digestibility
- Improves bone strength
- Improves reproduction
- Improves feed efficiency
- Speeds repair of tissues
- Reduces effects of inflammation
- Reduces diarrhea
- Reduces mortality
- Reduces treatments
- Reduces clinical respiratory symptoms

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Dietary plasma proteins, the intestinal immune system, and the barrier functions of the intestinal mucosa[1]

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ABSTRACT: The intestinal mucosa contributes to homeostasis by preventing the entrance of biological and chemical agents across the epithelium that could alter the stability of the system. This protective function is especially important at the time of weaning, when animals are exposed to infectious agents and to numerous stresses su... and diet. Diets supp... or plasma protein f... prove growth perfor... been proposed as an... review, we summariz... of action of dietary p... of intestinal inflamm... of *Staphylococcus au*... ylococcal enterotoxi... lymphoid tissue (GA... Peyer's patches and t... cytes in mesenteric l... the lamina propria ...

natural killer cell populations of the diffuse GALT. Staphyloccocal enterotoxin B significantly increased proinflammatory cytokines in Peyer's patches and mucosa. Plasma protein supplements modulated the mucosal immune response in organized and diffuse GALT, protecting GALT from possible excessive activation by the SEB challenge. These effects are accompanied by ...

Key words: gut...

INT...

Spray-dried plasm... when included in th...

[1]The authors express ... Polo, L. Russell, and E. W... regarding the preparation ... by Eureka Program Euro... APC Inc., and APC Eur... ures of this paper have ... primary authors. Presen... joint annual meeting of th... American Dairy Science ... 11, 2008.

[2]Corresponding author...

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Dietary Plasma Protein Supplements Prevent the Release of Mucosal Proinflammatory Mediators in Intestinal Inflammation in Rats[1,2]

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Abstract

Spray-dried plasma (SDP) is a complex mixture of active proteins that modulates the immune response of gut-associated lymphoid tissue. We examined whether SDP and Ig concentrate (IC) supplementation could modulate cytokine expression and inflammatory mediators in rats challenged with *Staphylococcus aureus* enterotoxin B (SEB). Wistar-Lewis rats were fed diets supplemented with SDP (8% wt:wt), IC (1.5% wt:wt), or milk proteins (control diet) from weaning (d 21) to d 34 after birth. On d 32 and 35, the rats were given SEB (0.5 mg/kg; intraperitoneal). Six hours after the second SEB dose, jejunal mucosa and Peyer's patches (PP) from the small intestine were collected. The cytokines interferon-γ (IFNγ), tumor necrosis factor-α (TNFα), interleukin (IL)-6, IL-10, transforming growth factor-β (TGFβ), and leukotrienne B_4 (LTB_4) were analyzed using commercial kits. SEB increased the release of proinflammatory mediators (IFNγ, TNFα, IL-6, and LTB_4) in PP ($P < 0.05$) and in the mucosa ($P < 0.05$). In both tissues, SDP prevented the increase in IFNγ, IL-6, and LTB_4 induced by SEB ($P < 0.05$). IC reduced the expression of TNFα and LTB_4 in PP and mucosa ($P < 0.05$). SDP supplementation increased IL-10 and mature TGFβ concentrations in intestinal mucosa from both inflamed and noninflamed rats. Both SDP and IC increased the mature:total TGFβ ratio (all $P < 0.05$). Both supplements were effective at preventing the SEB-induced increase in proinflammatory:antiinflammatory cytokine ratios in PP and mucosa and in serum. The preventive effects of plasma supplements on intestinal inflammation involve modulation of intestinal cytokines, characterized by an increased expression of antiinflammatory cytokines. J. Nutr. 140: 25–30, 2010.

Introduction

The gastrointestinal tract provides a protective interface between the luminal compartment, containing large amounts of microbes and antigens derived from food, and its internal milieu. The intestinal mucosa controls the penetration of luminal antigens and the generation of immunologic responses in the gut and dysregulation of these processes causes intestinal inflammation. Even in the absence of inflammatory stimuli, the healthy intestine is in a proinflammatory state that is characterized by the generation of proinflammatory cytokines (1).

Because the host's immune responses can be modulated by diet (2), the dietary approach offers a therapeutic potential in conditions associated with gut-barrier dysfunction and inflammatory response. Dietary supplementation with spray-dried plasma (SDP)[7] improves the intestinal homeostas... basal activation of the immune system (3,4). Furt... feed can reduce intestinal inflammation in unchall... pigs, as indicated by decreased intraepithelial lymphocytes and lamina propria cell density in the large intestine (5).

Recent information about the mechanism of action of SDP has been obtained in a rat model of mild intestinal inflammation. The model is based on the systemic administration of enterotoxin B of *Staphylococcus aureus* (SEB) (4). This activates the mucosal immune system affecting both organized and diffuse gut-associated lymphoid tissue (GALT). Plasma supplement preparations, either SDP (full SDP) or Ig concentrate (IC), can prevent SEB-induced increases in some GALT populations, such as the activated T helper cells present in Peyer's patches (PP) (4). They can also partly prevent the SEB-induced increase in paracellular flux across the epithelium, due to the reduced

[1] Supported by grant no. RDITCRD06-1-001 from the Generalitat de Catalunya, Spain.

[2] Author disclosures: A. Pérez-Bosque, L. Miró, and M. Moretó, no conflicts of interest. J. Polo is employed by APC-Europe; L. Russell, J. Campbell, and J. Crenshaw are employed by APC Inc, Ankeny. E. Weaver is employed by Proliant Health and Biologicals, Ankeny.

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[7] Abbreviations used: GALT, gut-associated lymphoid tissue; GAPDH, glyceraldehyde phosphate dehydrogenase; IC, Ig concentrate; IFNγ, interferon-γ; IL, interleukin; iNOS, inducible nitric oxide synthase; LTB_4, leukotriene B_4; PP, Peyer's patches; SDP, spray-dried plasma; SEB, *Staphylococcus aureus* enterotoxin B; TGFβ, transforming growth factor-β; TNFα, tumor necrosis factor-α.

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NS British Journal of Nutrition

Dietary plasma proteins attenuate the innate immunity response in a mouse model of acute lung injury

Mònica Maijó[1], Lluïsa Miró[1], Javier Polo[2], Joy Campbell[3], Louis Russell[3], Joe Crenshaw[3], Eric Weaver[4], Miquel Moretó[1] and Anna Pérez-Bosque[1,2]*

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(Received 14 December 2010 – Revised 10 Ma...

Abstract

We examined whether oral plasma prote... were fed diets supplemented with 8% sp... mice were challenged with intranasal lip... day 34 (and killed 6 h later for cytokine d... by twenty-sevenfold, an effect that was p... which was partly prevented by SDP. In t... SDP. In unchallenged mice, both SDP an... both SDP and IC completely prevented ... tration of cytokines (TNF-α, IL-1α, IL-6, ... and chemokines (CXCL1, CCL2, CCL3 a... both SDP and IC. For chemokines, pla... CCL2, CCL3 and CCL4 production (P<0... toxin-associated lung inflammation.

Key words: Spray-dried animal plasm...

Acute lung injury is the result of the l... inhaled or endogenous noxious agen... by the activation of nasal and bron... lymphoid tissue. Since lungs are co... large number of micro-organisms an... entry route for pathogens into the b... one of the most frequent causes of r... humans[(1)]. The inflammation cascad... innate immune system, in which neut... in the inflammatory response as they c... ment, activation and programming ... cells[(2)]. Furthermore, they generate c... attract monocytes and dendritic cells[(3)]...

Enteral nutrition has a role in the pre... of inflammatory responses in syste...

Abbreviations: BALF, bronchoalveolar lava... granulocyte-macrophage colony-stimulating ...

* Corresponding author: Dr A. Pérez-Bosqu...

Nonruminant Nutrition: Sow Nutrition and Management

281P Effects of graded levels of dietary spray-dried plasma on pregnancy rate of mated female mice under transport stress as a model for stressed sows. M. Song*[1], J. J. Lee[1], Y. Liu[1], J. A. Soares[1], T. M. Che[1], J. M. Campbell[2], J. Polo[2], S. W. Seo[3], and J. E. Pettigrew[1], [1]*University of Illinois, Urbana,* [2]*APC Inc., Ankeny, IA,* [3]*Chungnam National University, Daejeon, South Korea.*

Data from our 5 previous studies indicated that prolonged transport stress of mice immediately after mating resulted in a low pregnancy rate (average 11%), and that a high level (8%) of dietary spray-dried plasma (SDP) consistently and markedly increased the pregnancy rate (average 51%). This study was conducted to determine whether lower levels of SDP have a similar effect. Mated female mice (n = 202; 16.2 ± 1.16 g BW; C57BL/6 strain) were shipped from Bar Harbor, ME to Urbana, IL on the day the vaginal plug was found (gestation day (GD) 1), arriving at the laboratory in IL on GD 3. They were housed in individual cages and randomly assigned to dietary treatments (0, 1, 2, 4, and 8% SDP [CON, SDP1, SDP2, SDP4, and SDP8, respectively]). The diets were formulated to similar ME, CP, and AA levels without antibiotics, and fed for 2 wk. Pregnancy was determined on GD17 on the basis of BW and shape of abdomen, and was confirmed by inspection post-mortem. The pregnancy rate of mice fed the CON was low (7%). All SDP treatments increased ($P < 0.05$; Table) pregnancy rate markedly compared with the CON. Heavier mice were more likely to be pregnant ($P = 0.069$) than lighter mice, but all SDP treatments clearly improved ($P < 0.05$; Table) pregnancy rate regardless of initial BW and the interaction between initial BW and diet was not significant (Table). In conclusion, these data confirm that 8% SDP increases pregnancy rate of mated female mice under transport stress and show that even the lowest level of SDP (1% SDP) is effective.

Table 1. SDP effect on pregnancy rate of mated female mice under transport stress[1]

Item	CON	SDP1	SDP2	SDP4	SDP8	Initial BW[2]	Diet[2]	Interaction[2]
Overall, %	7 (3/42)	35 (14/40)	40 (16/40)	43 (17/40)	43 (17/40)	0.069	<0.05	0.38
Initial BW <16.5 g, %	4 (1/26)	27 (7/26)	33 (8/24)	32 (8/25)	38 (9/24)			
Initial BW ≥16.5 g, %	13 (2/16)	50 (7/14)	50 (8/16)	60 (9/15)	50 (6/16)			

[1]Data are number of pregnant/mated mice in the parentheses. Data were analyzed by chi-squared test.
[2]*P*-value for initial BW, diet, and interaction between initial BW and diet.

Key Words: mice, pregnancy rate, spray-dried plasma

282P Effects of graded levels of dietary spray-dried plasma on growth and fetal characteristics of pregnant mice as a model for sows. M. Song*[1], J. A. Soares[1], Y. Liu[1], J. J. Lee[1], T. M. Che[1], J. M. Campbell[2], J. Polo[2], S. W. Seo[3], and J. E. Pettigrew[1], [1]*University of Illinois, Urbana,* [2]*APC Inc., Ankeny, IA,* [3]*Chungnam National University, Daejeon, South Korea.*

Data from our previous study indicated that a high level (8%) of dietary spray-dried plasma (SDP) increased growth rate of pregnant mice (12%) and fetal wt (14%) compared with a control diet. This study was conducted to determine whether lower levels of SDP have similar effects. Mated female mice (n = 202; 16.2 ± 1.16 g BW; C57BL/6 strain) were shipped from Bar Harbor, ME to Urbana, IL on the day the vaginal plug was found (gestation day (GD) 1), arriving at the laboratory in IL on GD 3. They were housed in individual cages and randomly assigned to dietary treatments (0, 1, 2, 4, and 8% SDP [CON, SDP1, SDP2, SDP4, and SDP8, respectively]). The diets were formulated to similar ME, CP, and AA levels without antibiotics, and fed for 16 d. The pregnant mice (n = 67; 27.9 ± 2.06 g BW) were euthanized on GD 19 to measure growth performance of pregnant mice, number of fetuses, average fetal and placental wt, and organ wt (liver, spleen, lung, and kidneys). The SDP treatments increased ($P < 0.05$; Table) the ADG and G:F from GD 3 to 19, and number of fetuses per litter, average fetal wt, and wt of liver and spleen on GD 19, compared with the CON, but did not affect ADFI, placental wt, ratio between fetal and placental wt, and other organ wt. In conclusion, these data confirm that SDP increases growth of pregnant mice and their fetuses, and that the magnitude of response depends on the dose of SDP.

Table 1. SDP effects on pregnant mice

Item	CON	SDP1	SDP2	SDP4	SDP8	SEM	Diet[1]	L[1]	Q[1]
Pregnant mice, n	3	14	16	17	17				
ADG, g/d	0.54	0.65	0.67	0.75	0.77	0.03	<0.05	<0.05	<0.05
G:F	0.16	0.21	0.21	0.22	0.23	0.008	<0.05	<0.05	0.059
Fetuses/litter, n	5.6	5.6	6.1	7.0	7.0	0.42	<0.05	<0.05	0.38
Avg fetal wt, g	0.87	1.04	1.01	0.98	0.99	0.02	<0.05	0.28	0.069
Liver wt of BW, %	4.51	4.46	4.49	4.84	5.02	0.11	<0.05	<0.05	0.56
Spleen wt of BW, %	0.17	0.22	0.22	0.22	0.25	0.01	<0.05	<0.05	0.43

[1]*P*-value for diet and for linear (L) and quadratic (Q) effects of SDP.

Key Words: pregnant mice, fetal characteristics, spray-dried plasma

283P Feeding live *Saccharomyces cerevisiae* boulardii to sows increases immunoglobulin content in colostrum and milk. D. Guillou*[1], E. Chevaux[2], D. Rosener[2], Y. Le Treut[1], and J. Le Dividich[3], [1]*Lallemand SAS, Blagnac, France,* [2]*Lallemand Specialties Inc., Milwaukee, WI,* [3]*AV Kennedy, Breteil, France.*

The acquisition of passive immunity by the newborn piglet depends mainly on the amount of colostrum consumed and on its immunoglobulin G (IgG) content. To verify the hypothesis that sows fed the live yeast *Saccharomyces cerevisiae* boulardii CNCM I-1079 (SB) would produce more Ig in colostrum and milk, a trial including 66 Large White × Landrace sows was conducted in a commercial farm. They were housed and fed individually, and blocked by parity and body condition 3 weeks before expected parturition. A control group (C, n = 33) was fed the regular feeding program of the farm and an SB group (n = 33) was fed a supplement of 5 × 10^{10} cfu per day of SB from the start of the trial to weaning (21d). On each sow, colostrum was sampled randomly from most teats all along the udder just after birth of the first piglet, and 12 and 24h later. A sample of milk was collected after oxytocin injection on d 19 of lactation. Colostral Ig (A, G and M) and milk IgA were analyzed using a commercial ELISA kit. For colostrum data, the influence of treatment was evaluated in a mixed model of repeated measures considering the effect of sampling time, sow parity, treatment and their interactions. Milk IgA contents were compared with ANOVA including effects of parity and treatment. In the colostrum from control sows, IgG, IgA and IgM contents (mg/mL) were: 71.3, 10.5 and 5.7 respectively. In the milk, IgA from control sows was 4.9 mg/mL. Overall, feeding SB increased IgG and IgA content of colostrum by 21% ($P < 0.05$) and 18% ($P < 0.01$) respectively,

Environment Impacts the Plasma Response

- The response to plasma is greater when birds are housed in typical production settings.

Effect of Feed Processing on Poultry Feed Containing Plasma

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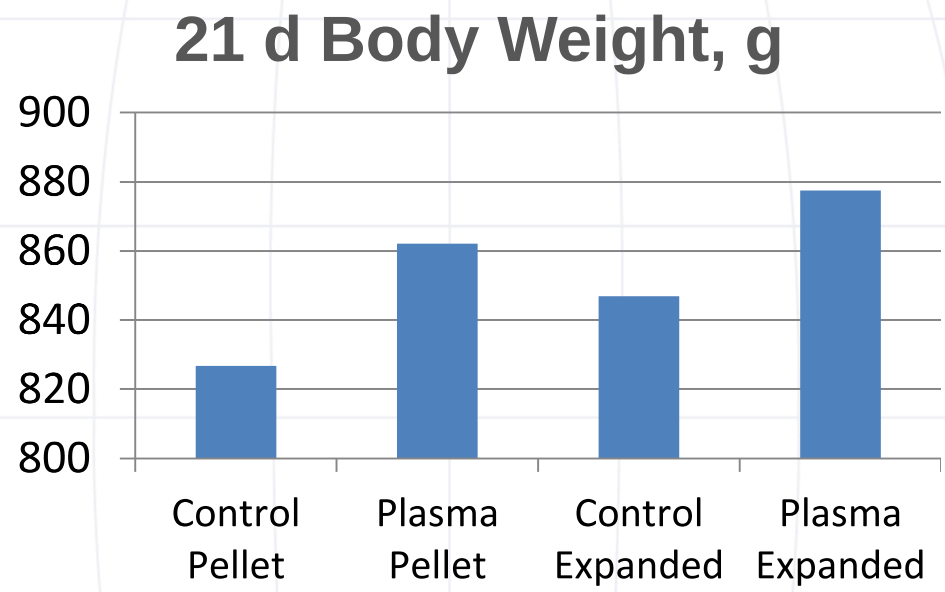
APC Functional Protein Effects During Feed Processing

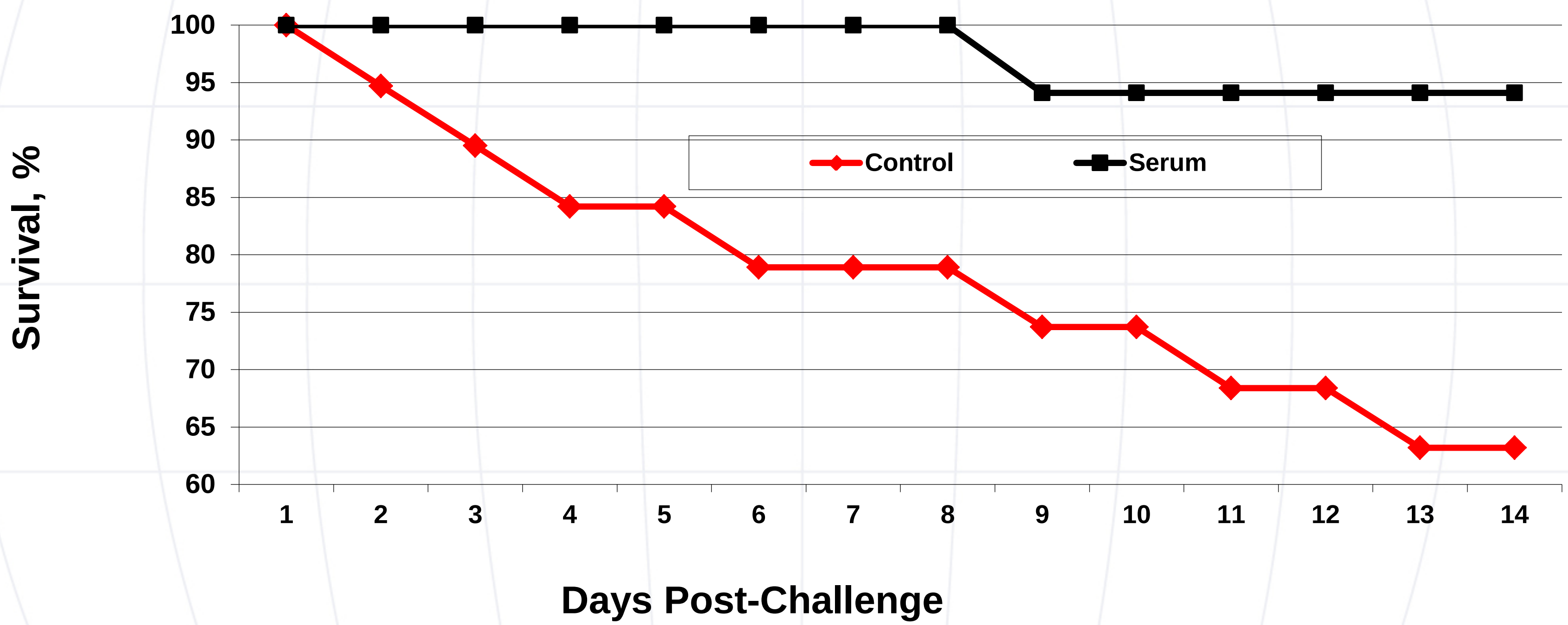


Pelleting (85ºC) or expanding conditioning temperatures of feed does not affect the plasma improvement in performance.

Campbell et al., 2006, J. Anim. Sci. 84:2501

Stress conditions

Plasma protein reduces mortality when challenged with *Pasteurella multocida*



Plasma protein improves survival during respiratory challenge

Campbell et al., 2004, J. Appl. Poult. Res. 13:388-393

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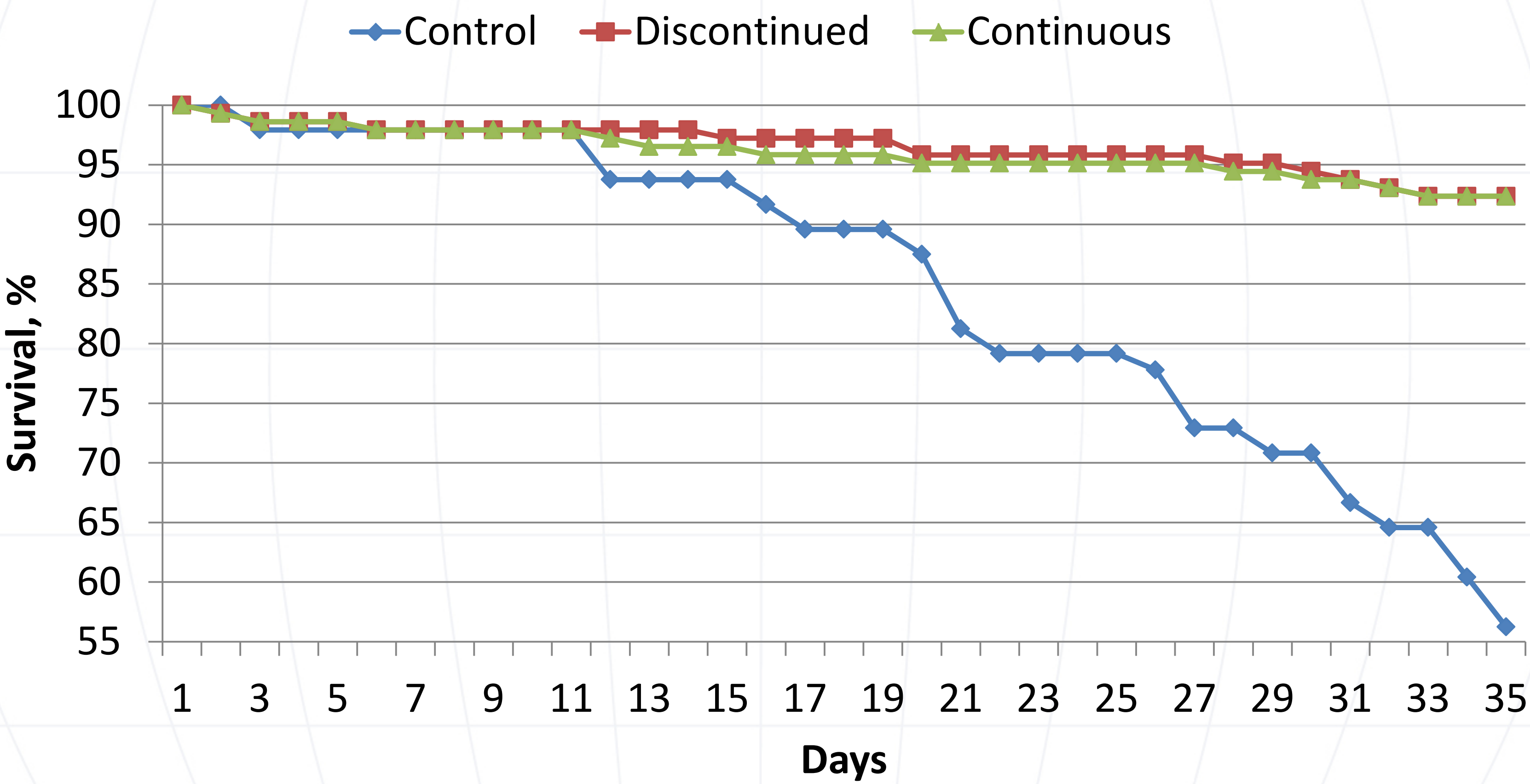
Duration of Feeding Plasma in Broiler Diets During Natural Necrotic Enteritis



Plasma improved survival during necrotic enteritis stress

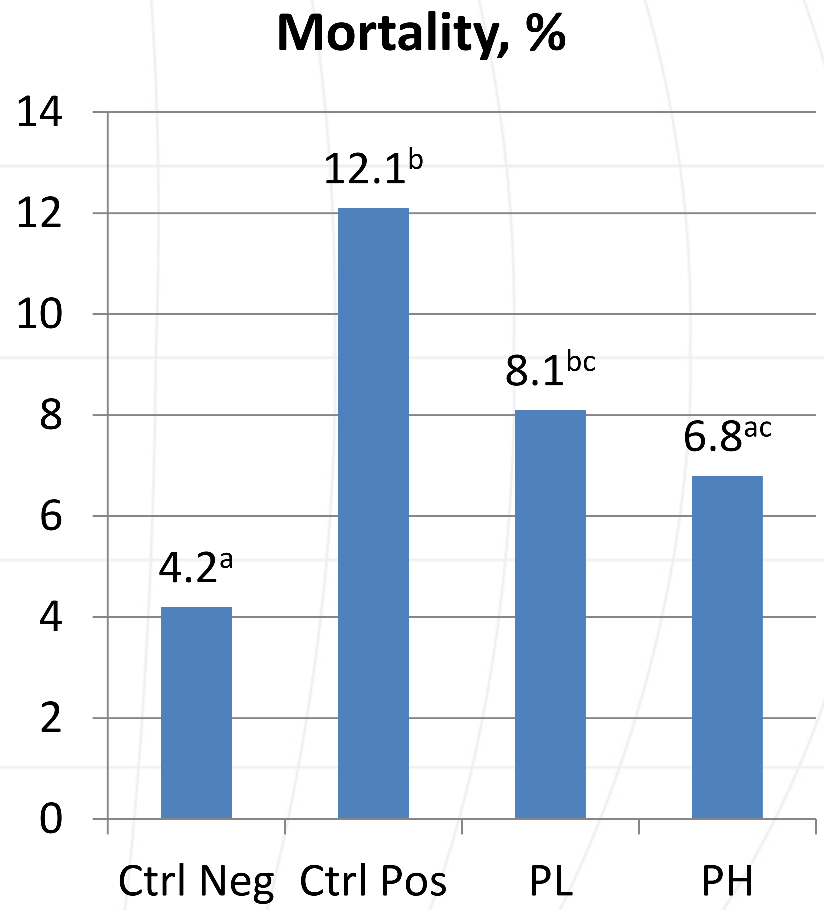
Campbell et al., 2006, J. Appl. Poult. Res. 15:584

Disease Stress Conclusions

- Strategic use of plasma proteins in feed may reduce some of the negative effects of disease stress

Impact of Stocking Density on Broiler Mortality

- Stocking density stress increased mortality
- Inclusion of plasma reduced effects of stocking density on mortality

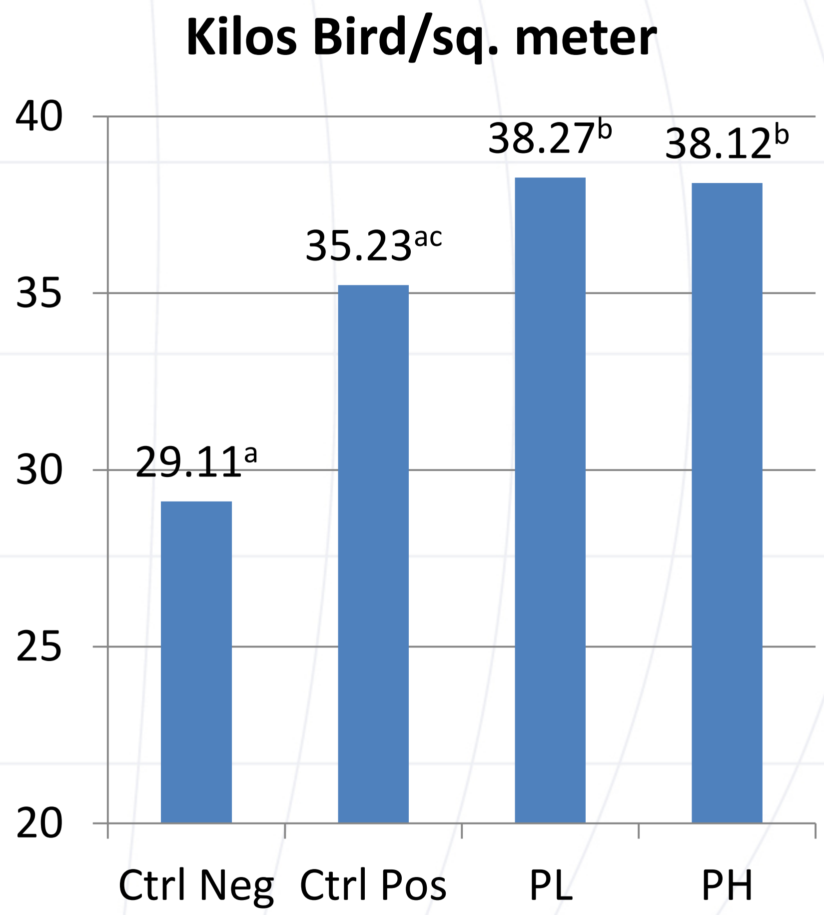


a, b, c = P < 0.05

Campbell et al., 2012, ANECA Conference, pp. 88-93

Impact of Stocking Density on Broiler Production

- Increased stocking density stress increased kilograms of broiler per square meter
- Inclusion of plasma further improved production during stocking density stress.



a, b, c = $P < 0.05$

Campbell et al., 2012, ANECA Conference, pp. 88-93

Stocking Density Conclusions

- Stocking density stress reduces broiler performance and increases mortality
- Inclusion of plasma
  - reduces negative effects of increased stocking density…
  - resulting an increased economical return and..
  - more kilogram production per square meter

Campbell et al., 2012, ANECA Conference, pp. 88-93

Recent Field Experience

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Conclusions

- Typical feed processing conditions do not affect improvements noted in performance of poultry fed plasma.
- We have recent field experiences showing profitable usage in modern commercial conditions in Europe and North America, which can be show on request
- The addition of plasma protein to broiler and turkey diets:
  - improves daily gain
  - improves feed conversion
  - increases body weight at market
  - reduces variation
  - increases breast meat yield
  - reduces mortality

Feeding Recommendations

- The response to plasma is significantly influenced by the challenge.
- Recommendation ranges for future applications: Utilize higher level when ABF or poor health
- PLEASE CONTACT APC info@apc-Europe.com to adapt inclusion levels to your feeding programs

Economics: Value of 3-5 g plasma for 10 d

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Spray Dried Plasma Products are Revolutionary

- Plasma products help supply proper nutrition to stressed animals and help healthy animals thrive.

Thank You

    

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