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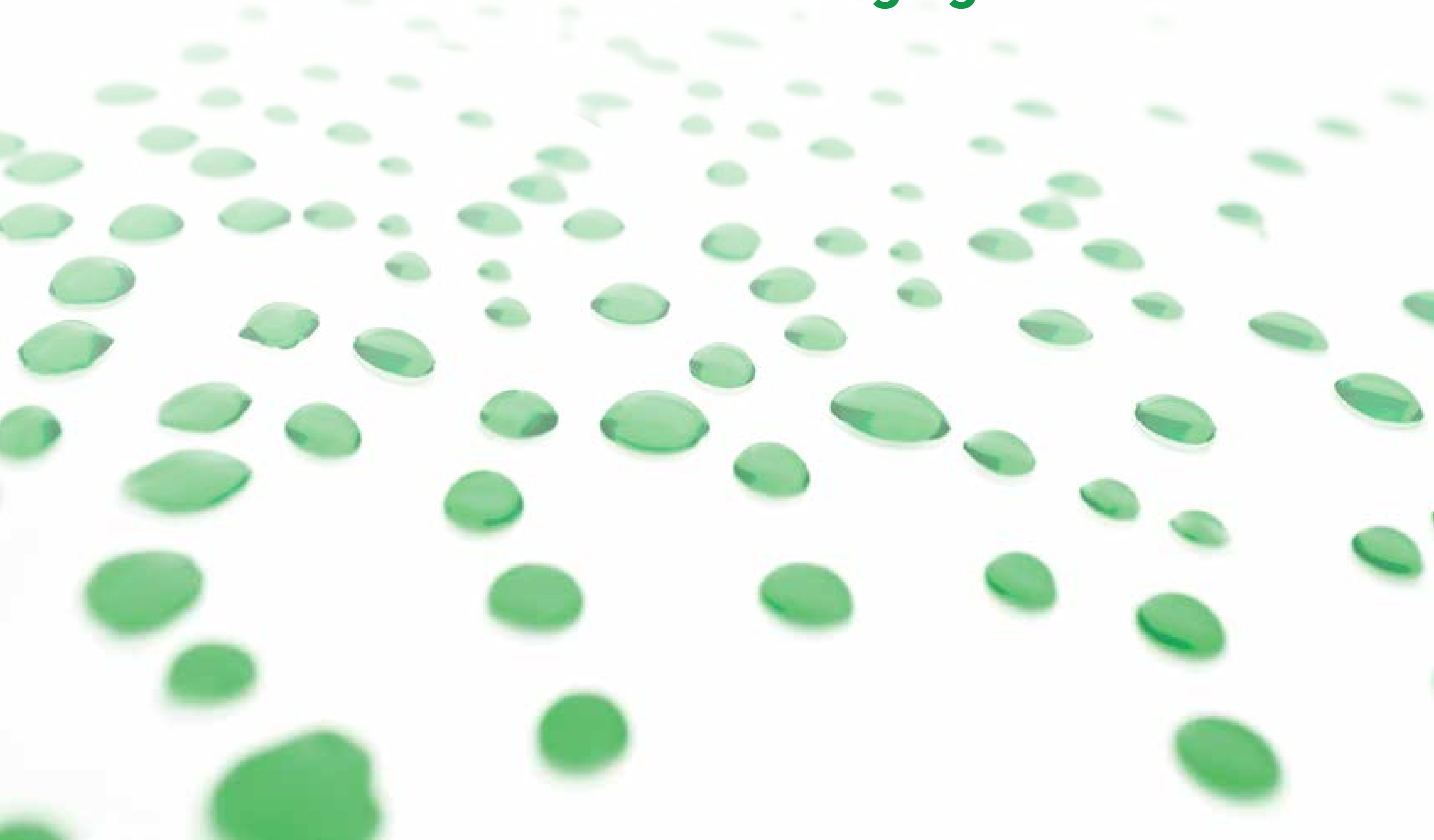
Gel-Pac®

The Ideal Gel Delivery System



Edible gel concentrate for delivering vaccines and oral additives using poultry hatchery tap water

EXECUTIVE SUMMARY

Contemporary poultry production is accelerating on a path toward heightened bird health and food safety with less reliance on antimicrobial additives. Reducing antimicrobial usage for poultry health requires alternate strategies for disease prevention. Importantly, preventive vaccines and gut-protection measures administered at hatch are providing early self-defense, shielding baby poultry before they exit the hatchery.

The fastest growing style of administering alternative treatments is via edible gel droplets used as a vehicle to carry a variety of vaccines and additives. Gel-Pac®[1] is a concentrated gelling additive in powdered form that is conveniently added to hatchery tap water. Unlike aerosol sprays, hydrated Gel-Pac carries combinations of vaccines and probiotics in edible soft-gel beadlets, sprayed for the birds to easily see and abruptly consume. The easy-to-eat gel is an ideal solution; a perfect carrier to deliver additives, singly or in combination, precisely where they are needed to protect birds before they arrive at the growing house. The resulting protection can be targeted for the gut, which is obviously the goal of coccidiosis vaccine, *Salmonella* vaccine, and competitive exclusion probiotic bacteria. Beyond the benefits of these enteric safeguards, Gel-Pac is also used to apply respiratory infectious bronchitis (IB) and Newcastle disease (ND) vaccines combined with other vaccines in the same single gel application. Multiple sprayings of individual additives are not necessary. The stabilized gel insulates sensitive respiratory vaccines from the threats of decay by minerals in tap-water or well-water, chlorine, other vaccine preservatives, pH, and osmotic pressure. Gel-Pac, mixed and sprayed in hatchery water, allows more effective and efficient vaccine and probiotic combinations than have previously been possible.

EVOLUTION OF GEL APPLICATION

Using antibiotics, oral vaccines, or competitive exclusion bacteria in water or feed after birds enter growing houses is a staple practice. Obtaining earlier protection by day-of-hatch dosing of oral additives in hatcheries proved more difficult. Jenkins *et al.,* (2012) demonstrated coccidiosis vaccine given to day-old chicks via gel beads delivered more vaccine to the gut, and protected the chickens more thoroughly and uniformly, than vaccine delivered in traditional aerosol spray (Table 1). Although the results demonstrated the experimental technique's potential, the researchers found their method of heating, forming, and cooling the gel to prepare vaccine-laden beadlets was impractical. It became imperative to develop a conveniently prepared and applied edible gel for successful hatchery use. The resulting Gel-Pac stable emulsion is an easy-to-spray and easy-to-consume soft gel, containing no animal proteins.

Table 1
Gel beads increase coccidiosis vaccine intake and increase application uniformity

Application	OPG (x1000)	CV%
Gel Beads	3687*	3.0
Aerosol Spray	63	13.0
Oral Gavage	2154	4.7

*Coccidiosis vaccine administered at day 1 and oocysts collected between days 5-8. Gel beadlets increased the number of *Eimeria* vaccine oocysts excreted per gram of feces (OPG) (* $p<.05$) and reduced the coefficient of variation (CV) of oocysts in individual fecal samples, compared to aerosol spray (Jenkins *et al*., 2012).

[1] Gel-Pac® is a registered trademark of Animal Science Products, Inc., Nacogdoches, Texas, USA.

NEW GENERATION GEL-PAC APPLICATION FOR COCCIDIOSIS VACCINE

Degussem *et al*. (2016), recognized that soft, sprayable Gel-Pac is an ideal solution for early hatchery coccidiosis vaccine application, permitting direct consumption of concentrated vaccine. They compared coccidiosis vaccine sprayed on day-old hatchlings in Gel-Pac to another common method, which is spraying in water on feed for day-old chicks. The researchers assessed the oocyst excretion (cycling) pattern in feces from broilers under battery conditions and measured the immune protection against a challenge with *Eimeria* species isolated from broiler chickens in the field.

It became imperative to develop a conveniently prepared and applied edible gel for successful hatchery use. Gel-Pac is the ideal solution...

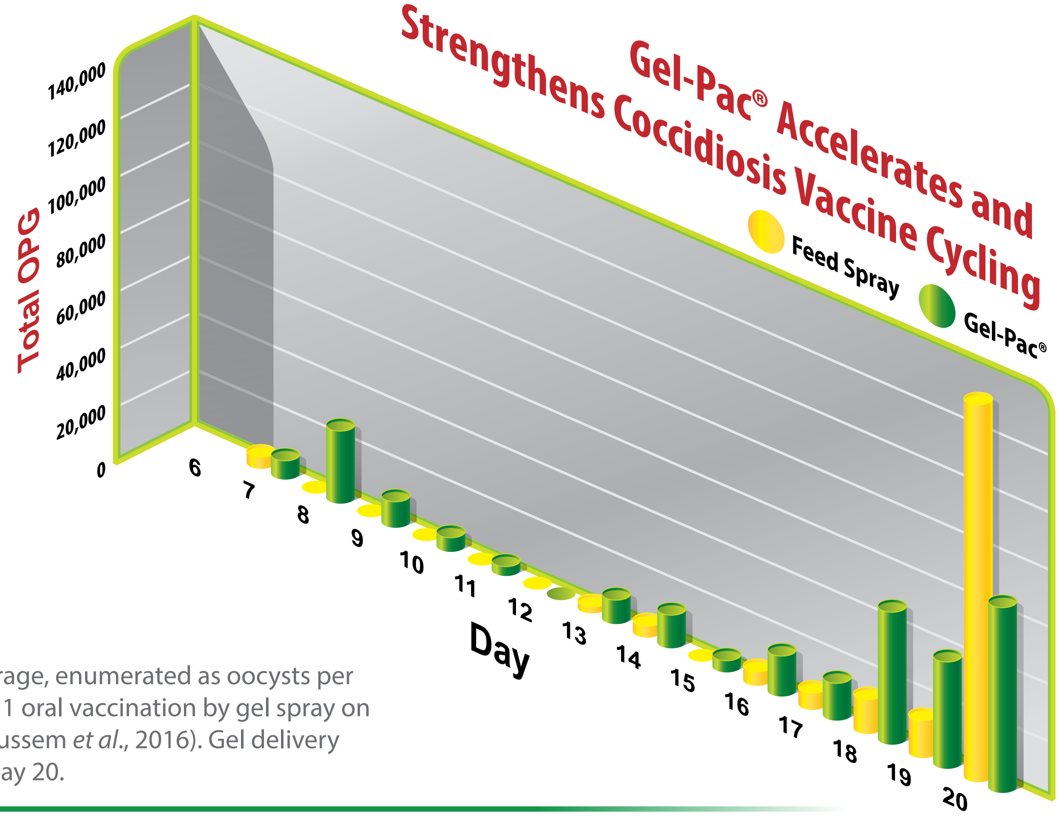


Figure 1: Coccidiosis vaccine coverage, enumerated as oocysts per gram of feces (OPG), following day 1 oral vaccination by gel spray on chicks or water spray on feed (Degussem *et al*., 2016). Gel delivery increased OPG on all days except day 20.

After oral administration on day 1, excreted vaccine oocysts were first detected in fecal samples on day 7. The number of oocysts per gram of feces (OPG) excreted in the first cycling wave from days 7-11 was greater for those vaccinated via gel than via feed (Figure 1). That pattern of amplified early vaccine coverage persisted, with the vaccine OPG from gel exceeding that of feed on all days except day 20. In addition to Gel-Pac generating more abundant early vaccine cycling, spraying the vaccine in gel improved the uniformity of the dose, gel vaccine oocysts in fecal samples being more uniform than the vaccine sprayed on feed. This was evident in a greater proportion of gel-spray fecal samples being positive for vaccine oocysts (Figure 2) and, compounding this effect, each positive sample was also more densely populated than those from chicks vaccinated by sprayed feed (Figure 3).

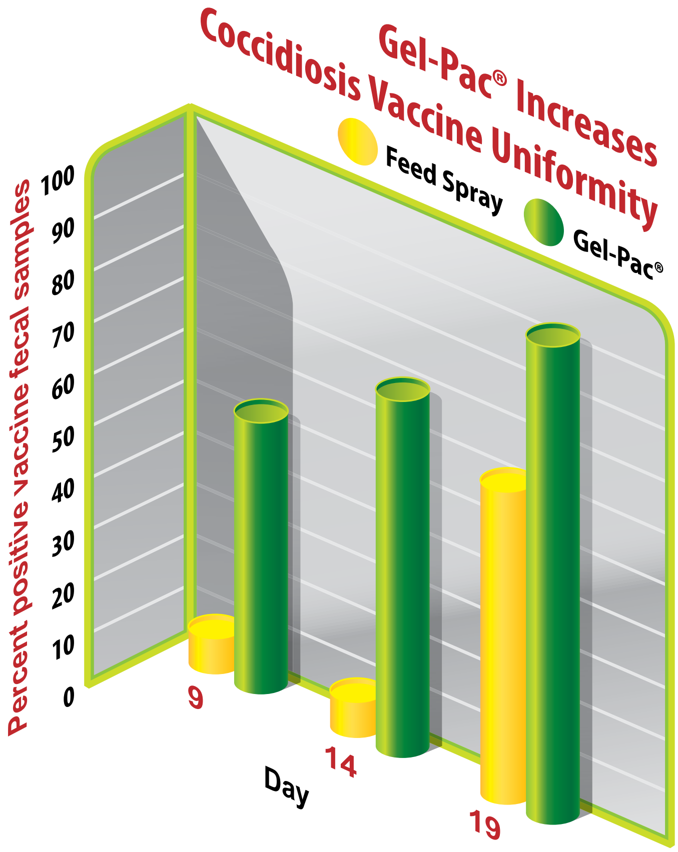


Figure 2: Gel spray increased the percent of individual fecal samples (n=15 samples/group/day) found positive for *Eimeria* vaccine oocysts (Degussem *et al*., 2016).

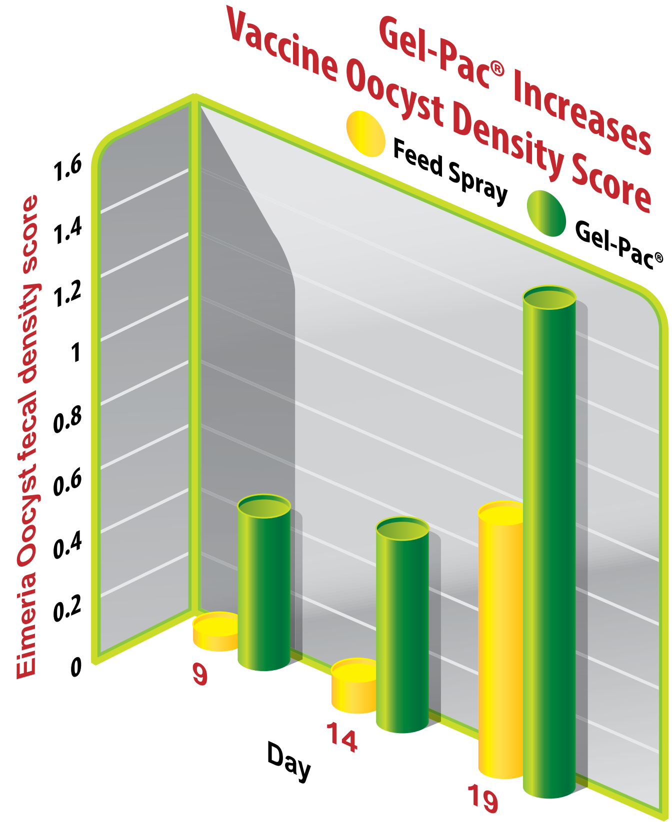


Figure 3: Fecal samples found positive for *Eimeria* vaccine oocysts were more densely populated in chicks vaccinated by gel versus feed spray. Average score of individual fecal samples (15 samples/group/day) graded for density of *Eimeria* oocysts. Microscopic oocyst density score: 0 = none present, 1 = some present, 2 = present in all fields, 3 = full of oocysts (Degussem *et al*., 2016).

The experimental coccidiosis challenge infection was most harmful to non-protected control birds. Intestinal lesions assessed 7 days following the challenge appropriately reflected the extent of the infection, with non-vaccinates having more total lesions than either vaccine treatment. The comparable moderation in lesion scores for feed spray was not significant, versus unvaccinated birds. Gel spray, in contrast, did protect birds significantly better ($p<0.05$) (Table 2). The reduced lesions arising from the vaccine delivered in Gel-Pac was linked to fewer infectious challenge organisms present in feces, the field strain organisms having been cleared more completely (Table 3).

Intuitively, coccidiosis vaccination techniques that facilitate the most direct consumption of vaccine are also the most protective and vaccinating earlier will accelerate that protection. Vaccine administered in Gel-Pac yielded greater early vaccine oocyst cycling, and the greater vaccine oocyst numbers were also more uniform among the gel-vaccinated chicks. The improved vaccination did result in better protection against the challenge by field organisms. More pronounced protection was evident among gel-vaccinates, having far fewer residual infectious challenge organisms passing in feces and commensurately less severe lesions.

Table 2
Mean *Eimeria* associated intestinal lesion scores (ILS) 7 days after challenge

Group	ILS
Non-challenged control	1.29[a]
Non-vaccinated, challenged	3.71[c]
Feed vaccinated, challenged	3.37[bc]
Gel vaccinated, challenged	2.86[b]

Eimeria associated ILS of chickens undergoing vaccination treatments on day of hatch and challenged on day 19 with *Eimeria* field isolates. Chickens vaccinated by Gel-Pac had significantly less lesions than non-vaccinated chickens, and numerically fewer compared to chickens vaccinated by feed spray. Values with different superscripts differ ($p<.05$) (Degussem *et al.*, 2016).

Table 3
Mean *Eimeria* challenge organism oocysts per gram of feces (OPG) 7 days following challenge

Group	OPG
Non-challenged control	0
Non-vaccinated, challenged	313,421
Feed vaccinated, challenged	85,991
Gel vaccinated, challenged	38,189

Eimeria challenge organism OPG from chickens undergoing vaccination treatments on day of hatch and challenged on day 19 with *Eimeria* field isolates. Chickens vaccinated by gel spray had fewer infectious organisms remaining than non-vaccinated chickens or those vaccinated by feed spray (Degussem *et al.*, 2016).

RESPIRATORY VACCINE COMPATIBILITY

Gel-Pac also helps hatcheries streamline IB and ND vaccinations, whether given independently or in a single-spray combination with coccidiosis vaccine. Increasing the number of vaccines sprayed in hatcheries also increases the amount of water diluent used, making convenient tap water more attractive as the gel diluent than distilled water. In adopting hatchery tap water as the diluent, it is imperative to insure the stability of the respiratory virus vaccines under potentially stressful water conditions.

Both ND vaccine and IB vaccine function well when consumed orally, and they are frequently administered in drinking water at later stages of production. The vaccines give strong mucosal respiratory protection when ingested (Luginbuhl *et al.*, 1955). The characteristic of stimulating respiratory protection through gut exposure also makes it possible to dose IB and ND vaccine with edible Gel-Pac in hatchery tap water. Preserving the vaccines in tap water conditions that vary around the world is important. Gel-Pac preserves a live vaccine's activity using protective stabilizers to guard the vaccines from threats in the water caused by oxidizers, inappropriate pH, and poor mineral balance. Focusing on oxidizers, there are three risks to be alert to:

- First, naturally occurring inorganic minerals in water, iron for example, damage the hair-like surface proteins of the vaccine, rendering it unable to generate specific antibodies for effective immunity against infectious field strains
- Second, some organic compounds like nitrate in natural water sources can oxidize vaccine and inactivate it
- Third, some elements that are added to improve water cleanliness will ruin a live vaccine. Chlorine, peroxide and ozone are among these

Hatcheries wishing to avoid complications from chlorine in tap water threatening ND and IB vaccines often suspend and spray vaccines in distilled water while under constant agitation. Demonstrating that Gel-Pac reliably protects sensitive respiratory vaccines is a critical step toward confidently and conveniently combining them in gel prepared with tap water and containing other active biologicals, even cocci vaccine.

To establish that Gel-Pac can rescue respiratory vaccines and guard them against oxidation in water supplies, researchers at Lasher Associates (Davis, 2015) measured the potency of live commercial ND and IB vaccines delivered via edible Gel-Pac prepared with tap water. Commercial, live lyophilized ND and IB vaccines were introduced into distilled (DI) water as input control, non-stabilized chlorinated water, and the same chlorinated water stabilized by Gel-Pac. Vaccine titers were measured using the same method USDA requires of vaccine manufacturers in Title 9, Code of Federal Regulations §113.329.

The titer of the ND vaccine input at time 0 was $10^{5.6}$ EID_{50}/ml. The ND vaccine exposed to ordinary chlorinated water for 30 minutes fell to $10^{3.9}$ EID_{50}/ml (98% reduction), and after 60 minutes decayed further to $10^{3.0}$ EID_{50}/ml (>99% reduced). In comparison, using Gel-Pac to stabilize a suspension of the same water source sustained the original vaccine potency, with titers at 30 and 60 minutes holding at $10^{5.7}$ and $10^{5.6}$ EID_{50}/ml, respectively (Figure 4).

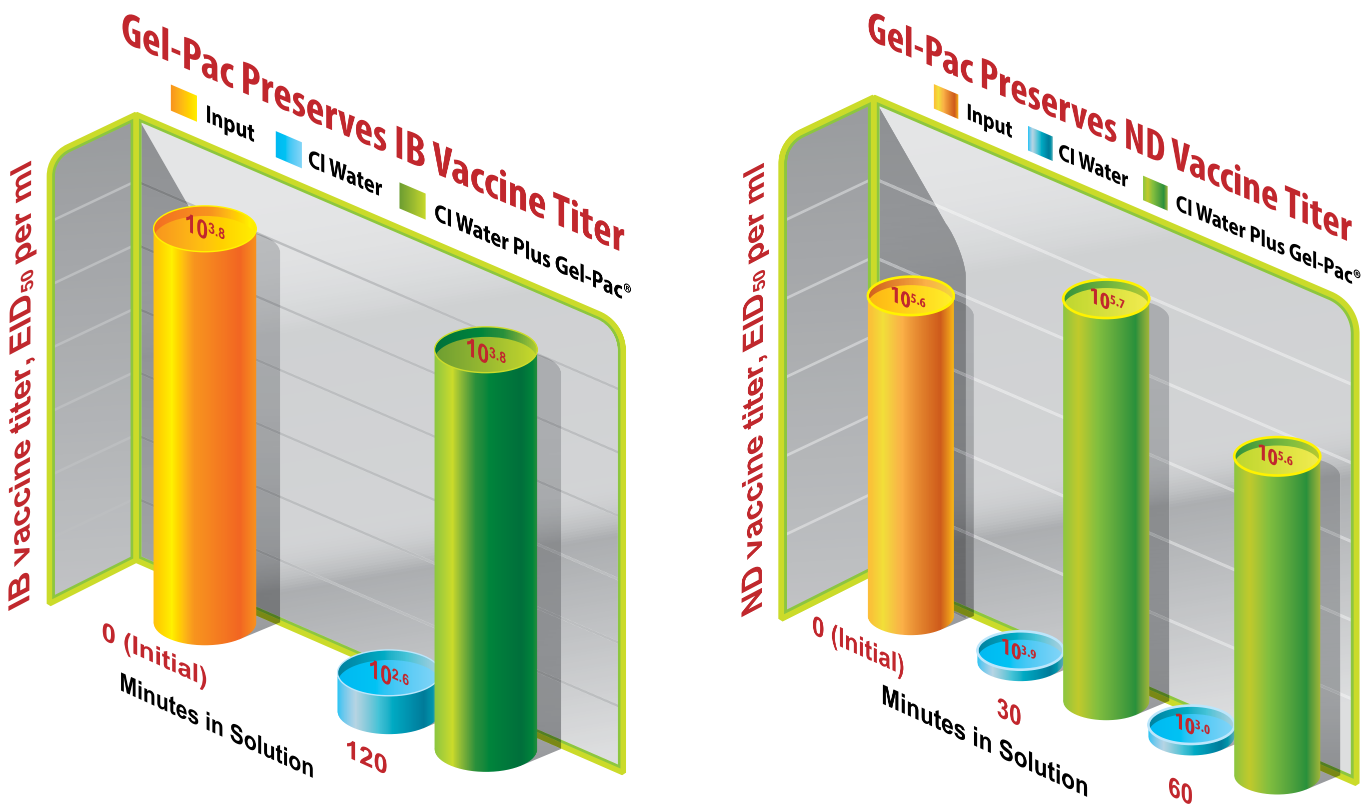
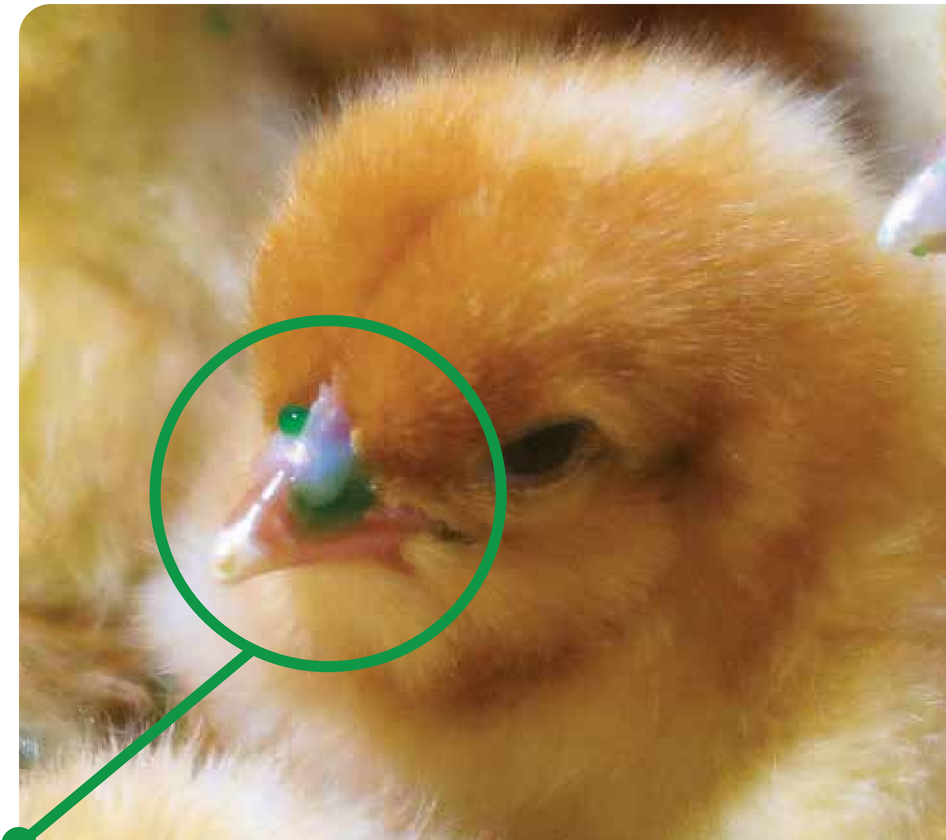


Figure 4: Rescue effect of a stabilized Gel-Pac suspension protecting ND vaccine (right panel) and IB vaccine (left panel) in oxidizing conditions (Lasher Associates. Davis, 2015).



Respiratory and enteric vaccines in Gel-Pac deliver abundant antigen to mucosal tissues. The gel pictured in accompanying images was initially consumed, excess becoming evident from nares, oropharynx cavities, and digestive tract tissues upon dissection.

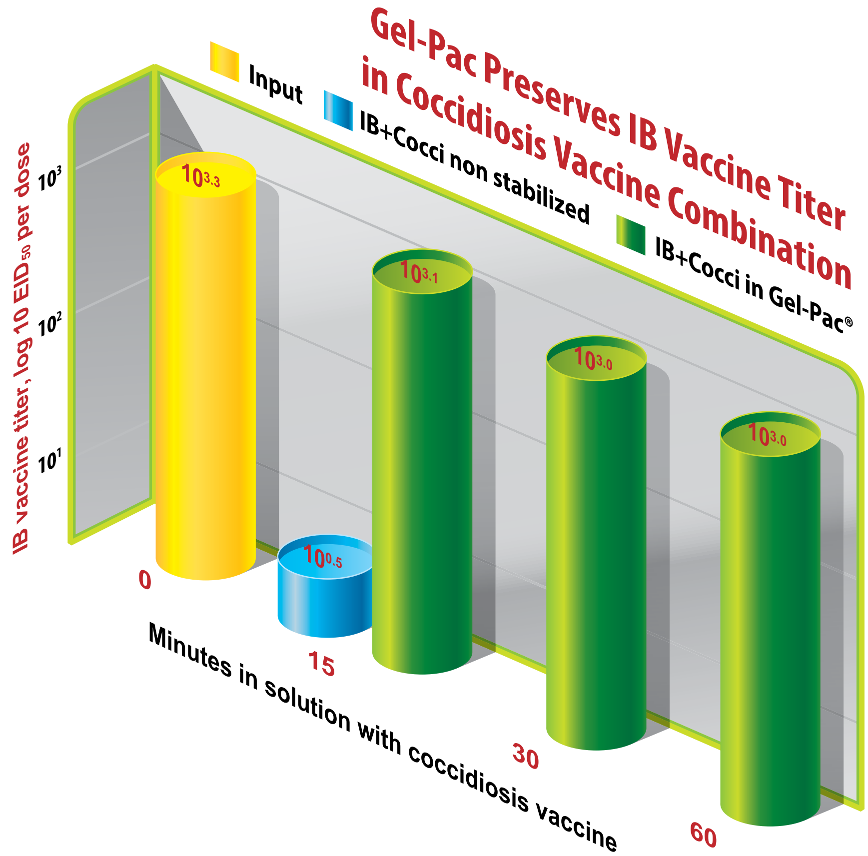
It is a dominant practice among coccidiosis vaccine manufacturers to include powerful preservatives; these preservatives are lethal to other biologicals, including ND/IB vaccines, unless the ND and IB are specially insulated...

Paralleling the results obtained with ND vaccine, Gel-Pac fully preserved IB vaccine against inactivation by the chlorinated water diluent, sustaining the initial vaccine titers and preventing the decay observed in the negative control. The titers of the IB vaccine input in water alone at initial time 0 was $10^{3.8}$ EID_{50}/ml. In chlorinated water (non-stabilized), the final 120 minute titer reduced to $10^{2.6}$ EID_{50}/ml (>90% reduced). In contrast, Gel-Pac rescued the vaccine in chlorinated water, fully preserving it at $10^{3.8}$ EID_{50}/ml at 120 minutes.

ENABLING EFFICIENT COMBINATIONS - SINGLE APPLICATIONS OF IB OR ND PLUS COCCIDIOSIS VACCINE

Historically, hatcheries vaccinating against ND and IB by aerosol could not combine those vaccines with coccidiosis vaccine. Consequently, hatcheries prepared and maintained 2 separate spray solutions and aerosolizing systems, 1 for respiratory vaccine and the other for coccidiosis vaccine. The reason for separating respiratory vaccines from coccidiosis vaccine is due to cocci vaccine preservatives. It is a dominant practice among coccidiosis vaccine manufacturers to include powerful preservatives; these preservatives are lethal to other biologicals, including ND/IB vaccines, unless the ND and IB are specially insulated. This protective insulation is inherent to Gel-Pac, shielding live vaccines and opening the door to more vaccine combinations.

Figure 5: IB vaccine titer preservation and persistence in coccidiosis vaccine stabilized with Gel-Pac, and immediate inactivation by non-stabilized coccidiosis vaccine (Lasher Associates. Davis, 2016).



To measure the stability of IB vaccine combined with cocci vaccine, Lasher Associates (Davis, 2016) measured residual IB vaccine titers in liquid cocci vaccine suspensions, after combining both commercial vaccines at the label concentrations for hatchery spray.

An IB vaccine in distilled water alone was titered immediately to quantify the starting potency as a positive control. Two other IB-plus-cocci vaccine combinations were prepared, 1 in distilled water (not stabilized) and 1 in the same water stabilized with Gel-Pac. Both were titered after 15 minutes to compare short-term stability, and the Gel-Pac suspension was titered again after 30 and 60 minutes to assess the persistence of IB potency through a typical time in suspension with the cocci vaccine (Figure 5).

As expected from previous titrations with combined vaccines, exposure to the coccidiosis vaccine alone decimated the IB vaccine even before the earliest sample was titered. Within fewer than 15 minutes, the non-stabilized IB vaccine was significantly degraded by the cocci vaccine, stabilizing the IB with Gel-Pac prevented any inactivation.

The non-stabilized IB titer dropped from the initial $10^{3.3}$ EID_{50}/0.2ml dose to $10^{0.5}$ EID_{50} per dose (>99% decay) in solution with cocci vaccine at 15 minutes. At the same 15 minute time point, Gel-Pac protected the IB vaccine from this inactivation by cocci vaccine, preserving the titer at $10^{3.1}$ EID_{50} per dose and further extending the protection beyond the end of 60 minutes, longer than typically required for birds to consume vaccine in gel drops.

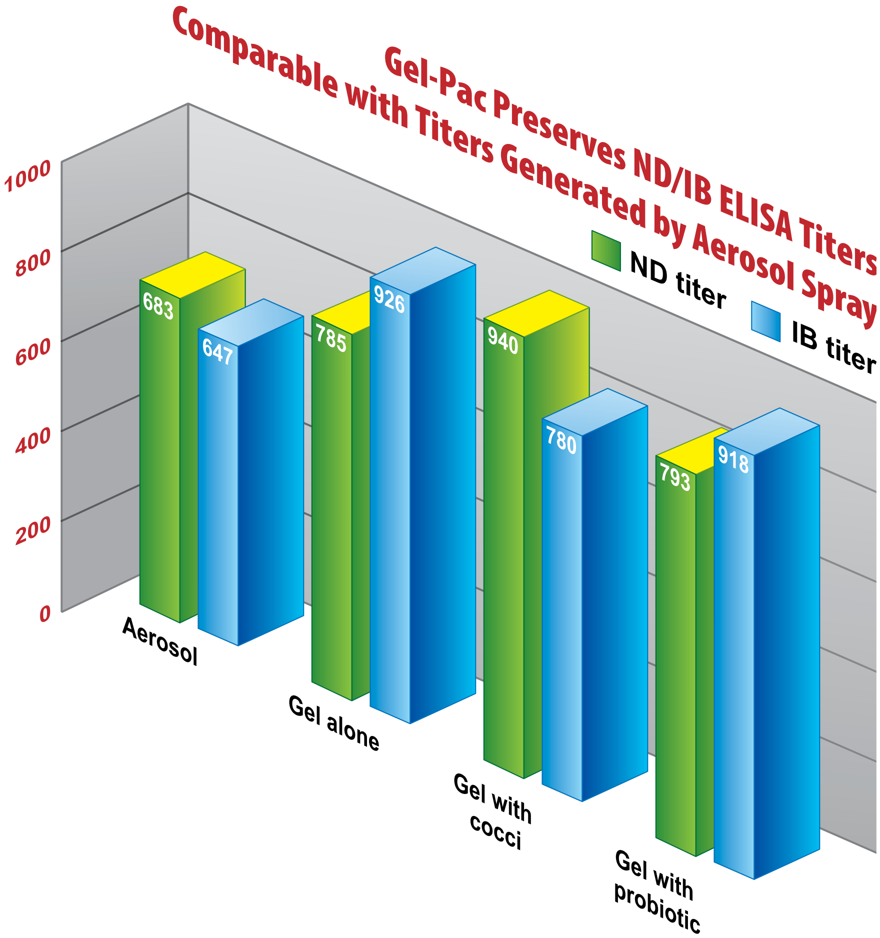


Figure 6: Mean ND and IB vaccine ELISA antibody titers in chickens at 42 days of age after a single commercial vaccination at hatch. Treatments are ND/IB vaccine in aerosol spray as control, ND/IB in Gel-Pac alone, ND/IB stabilized in Gel-Pac with coccidiosis vaccine, and ND/IB stabilized in Gel-Pac with probiotic (Izard, 2020).

SEROLOGICAL ND/IB UPTAKE CONFIRMATION

Subsequent to the respiratory vaccine embryo titrations, *in vivo* uptake studies using ND and IB vaccines dosed in Gel-Pac were performed to confirm the vaccines generated protective immunity (Izard, 2020). After combining ND/IB vaccine with coccidiosis vaccine or live probiotic bacteria and dosing to chickens at hatch, abundant ELISA vaccine antibodies were expressed in chickens housed in isolators at 42 days of age (Figure 6).

The 4 gel treatments, administered at hatch, comprised ND/IB in aerosol spray as control, ND/IB plus coccidiosis vaccine in gel, ND/IB plus probiotic in gel, and ND/IB in gel alone. The magnitudes of the titers are indicative solely of an initial vaccination at hatch, persisting for 42 days, as the chickens did not receive subsequent ND/IB booster vaccine. The only subsequent vaccination was for Gumboro at day 11 via eye drop. ND/IB titers for all gel treatments were at least as great as the aerosol spray control, confirming there was no interference from either the gel application or the other oral additives. The lack of interference gives positive confirmation that the hatchery's more efficient single gel application of multiple additives delivers stable and abundant respiratory vaccine. The work established that Gel-Pac preserves ND/IB vaccine when the vaccines are consumed in the edible gel simultaneously carrying the gut-protective treatments. It does so while addressing the integrator's desire to improve gut health via coccidiosis vaccine and competitive exclusion probiotic. The newfound freedom to combine multiple live biologicals in a single gel spray is streamlining hatchery operations.

IMPROVING *SALMONELLA* VACCINE DELIVERY, INCLUDING ADMINISTRATION WITH COCCIDIOSIS VACCINE

In addition to improving gut health through coccidiosis vaccines and probiotics, a principal method of reducing salmonellosis in poultry and the vertical transmission of *Salmonella* to poultry products for humans includes administering a live *Salmonella* vaccine beginning at 1 day of age in the hatchery. The naïve poultry gut is fertile ground for the *Salmonella* vaccine to seed itself and occupy the gut to defend the young bird. The vaccine locally immunizes young poultry on the mucosal surface, and initiates cell-mediated systemic immunity for internal organs. These defenses protect the gut tissue and the internal organs from pathogens that are sure to come after the chick or poult arrives at the farm.

Safely combining the 2 vaccines in 1 solution offers hatcheries the potential to efficiently vaccinate with 1 Gel bead application...

Until the development of Gel-Pac, *Salmonella* vaccines were not recommended to be dosed with coccidiosis vaccines. The rationale is the same as that pertaining to ND/IB vaccine, the prevailing characteristic among coccidiosis vaccines to contain powerful preservatives makes them lethal to other biologicals, including *Salmonella* vaccine, unless properly stabilized. Gel-Pac is engineered to protect fragile biologicals from antagonistic coccidiosis vaccine. Gel-Pac has been observed to reduce oxidation attributed to commercial coccidiosis vaccines preserved with potassium dichromate or chloramine, and it stabilizes IB vaccine and probiotic bacteria against inactivation by chlorine, iron and nitrate (Izard, 2016).

Operators can now use Gel-Pac to deliver consumable *Salmonella* vaccine in the hatchery and combine it with coccidiosis vaccine. Gel-Pac insulates *Salmonella* vaccine, preventing inactivation by additives in coccidiosis vaccines, in a single application of stabilized gel beadlets. To assess Gel-Pac's protective effect toward an

attenuated live *Salmonella* vaccine, researchers prepared 3 vaccine solutions and measured the *Salmonella* vaccine titer retention in each solution throughout 6 hours (Aehle, 2017). The vaccine solutions were:

- *Salmonella* Vaccine (10^8 CFU/ml) in water, as control
- *Salmonella* vaccine (10^8 CFU/ml) plus coccidiosis vaccine (100 doses/ml) in water, as a non-stabilized solution
- *Salmonella* vaccine (10^8 CFU/ml) plus coccidiosis vaccine (100 doses/ml) in water stabilized with Gel-Pac (25g/l), as a gel-stabilized solution

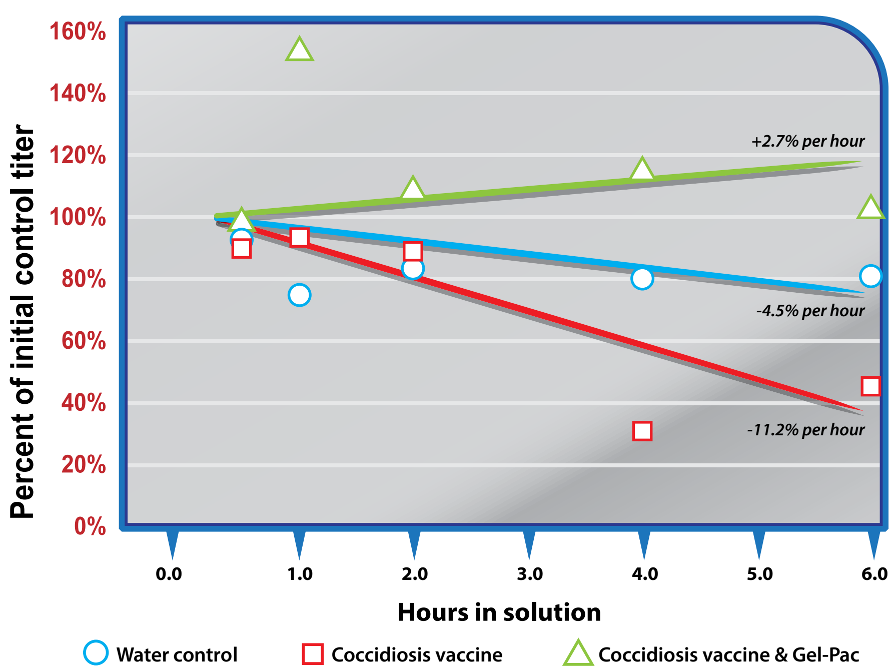
There were no significant differences in vaccine concentrations among the treatments at the initial and 30 minute applications. After 1 hour in solution, the gel-stabilized vaccine maintained greater concentrations than both the control ($p<0.01$) and non-stabilized vaccine ($p<0.05$), the gel-stabilized vaccine being $10^{8.42}$ CFU/ml, control vaccine $10^{8.11}$ CFU/ml, and non-stabilized vaccine $10^{8.19}$ CFU/ml (Figure 7).

The significant decay of non-stabilized vaccine continued throughout the 6 hours of sampling. Stabilized gel maintained $10^{8.23}$ CFU/ml, significantly more than non-stabilized vaccine at $10^{7.86}$ CFU/ml ($p<0.01$). Control vaccine titer was intermediate at $10^{8.08}$ CFU/ml. The respective 6 hour concentrations for gel-stabilized, control, and non-stabilized vaccine were 102%, 80%, and 44%, expressed as percentages of the initial control titer. Throughout the entire study, the *Salmonella* vaccine in the non-stabilized application decayed markedly, leading to significantly reduced final titer, compared to the gel-stabilized solution. There was no apparent *Salmonella* vaccine titer loss in the gel-stabilized vaccine solution.

The significant deterioration experienced by the *Salmonella* vaccine in the presence of coccidiosis vaccine was completely prevented by Gel-Pac's stabilizing properties. Safely combining the 2 vaccines in 1 solution offers hatcheries the potential to efficiently vaccinate with 1 Gel bead application. Furthermore, the edible gel droplets facilitate chicks or poults receiving the vaccine directly targeted to the gut, where both vaccines must inhabit before beginning their protective work.

Figure 7: Concentration of *Salmonella* vaccine as a percent of initial control titer ($10^{8.22}$ CFU/ml) after being held in solutions of water as control, water with coccidiosis vaccine (100 doses/ml), and water with coccidiosis vaccine (100 doses/ml) stabilized with Gel-Pac (25g/l). Mean of 3 replicates per time point (Aehle, 2017).

Live *Salmonella* Vaccine Survival in Water Alone, Non-stabilized Coccidiosis Vaccine Solution, and Coccidiosis Vaccine Solution Stabilized with Gel-Pac®.



ALTERNATIVE ANTI-*SALMONELLA* ADDITIVES DELIVERED IN GEL-PAC

Competitive exclusion probiotic bacteria delivered in Gel-Pac at hatch have also been documented protecting poultry against *Salmonella* infection, although the means of protection differs from *Salmonella* vaccination.

Gel-Pac is a logically appropriate way to help beneficial bacteria colonize the gut at hatch, before the young bird leaves the hatchery and becomes exposed to environmental bacteria. One means of testing the defense afforded by protective bacteria cultures delivered in Gel-Pac is to challenge the young birds after they have consumed the beneficial probiotic bacteria in the gel. Researchers employed a challenge model to test this gut protectivity (Sclivagnotis Siotkas, 2018). One treatment of hatchling chickens was fed Gel-Pac carrying competitive exclusion bacteria, while the control group was not protected. Both groups were held for 2 days before challenging them orally with >10^3 *Salmonella*. On day 5 post challenge, the chicks were assessed for infection by counting *Salmonella* in their cecal contents. The competitive exclusion bacteria consumed in Gel-Pac fully reduced the infective *Salmonella*, with Gel-Pac protected chicks having 4.6 log fewer infective *Salmonella* per gram of cecal contents (>99.99% reduction) (Figure 8).

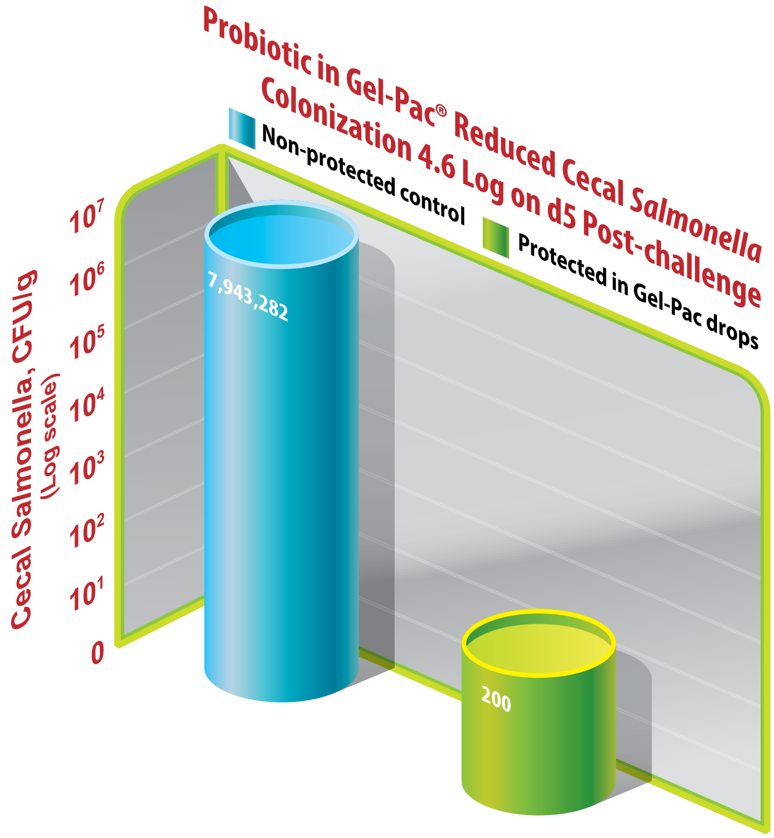


Figure 8: Competitive exclusion cultures delivered in Gel-Pac at hatch protected chicks from a day 2 infective dose (>10^3 CFU) of *Salmonella*, with a -4.6 log (-99.99%) reduction compared to unprotected control chicks (Sclivagnotis Siotkas, 2018).

APPLICATIONS

Poultry hatcheries can feel the amplifying pressure; it comes from their accelerated day-1 role in protecting the life-long health of the flock and their responsibility to keep the hatchery operating efficiently. Using distilled water to spray respiratory vaccines started as a means of avoiding problems with the uncertainty of local water conditions. Adding a similar but separate aerosol coccidiosis vaccine spray in the hatchery was a way to gain earlier coccidiosis protection, albeit less effective than directly consuming the vaccine. The increasing number of vaccinations given in the hatchery has naturally inspired veterinarians to look for ways to combine them into single applications. Now other orally active ingredients including probiotics have entered the mix. Liquid sprays containing these ingredients are not ideal because oral additives do not function as an inhaled respiratory antigen would; these orally active components perform best when directly consumed.

The knowledge that respiratory vaccine antigens confer immune protection whether they are inhaled or consumed makes it possible to combine IB or ND vaccines in a convenient edible gel that also carries other oral additives. Preparing the gel spray with local tap water can be an ideal solution, provided the gel can protect sensitive vaccines from selected elements that may be present in the water or from components of the other additives being delivered in combination. Gel-Pac's new generation stabilizers reshape the future for hatchery vaccination by making cocci vaccines completely compatible with live virus vaccines, bacterial vaccines and probiotic bacteria. The live vaccines and bacteria are free from the threats posed by oxidizers, pH variations and electrolyte imbalance.

Edible gel droplet applicators, either retrofitted from existing aerosol sprayers or newly installed, are placed in-line at the hatchery. Early experimenters proved the concept of gel application with droplets prepared by sequential heating, forming and cooling. Modern Gel-Pac requires little preparation. The hatchery homogenizes the cool-water soluble gel powder with approximately 97% hatchery tap water, then the vaccine and other additives are uniformly mixed in for spraying on hatchlings. The stabilized gel suspension does not require constant agitation as aerosol liquids do.

To ensure Gel-Pac suspensions could deliver uniform doses of coccidiosis vaccine without the constant stirring recommended for aerosol liquid sprays, researchers measured the positional stability of coccidiosis vaccine oocysts in a Gel-Pac suspension, with no additional stirring (Cargill, 2014). A typical concentration of 4,000 vaccine doses per liter was dispersed in a finished gel spray. The gel was produced in the same proportions as hatcheries use by homogenizing the Gel-Pac powder with water at the rate of 25 grams per

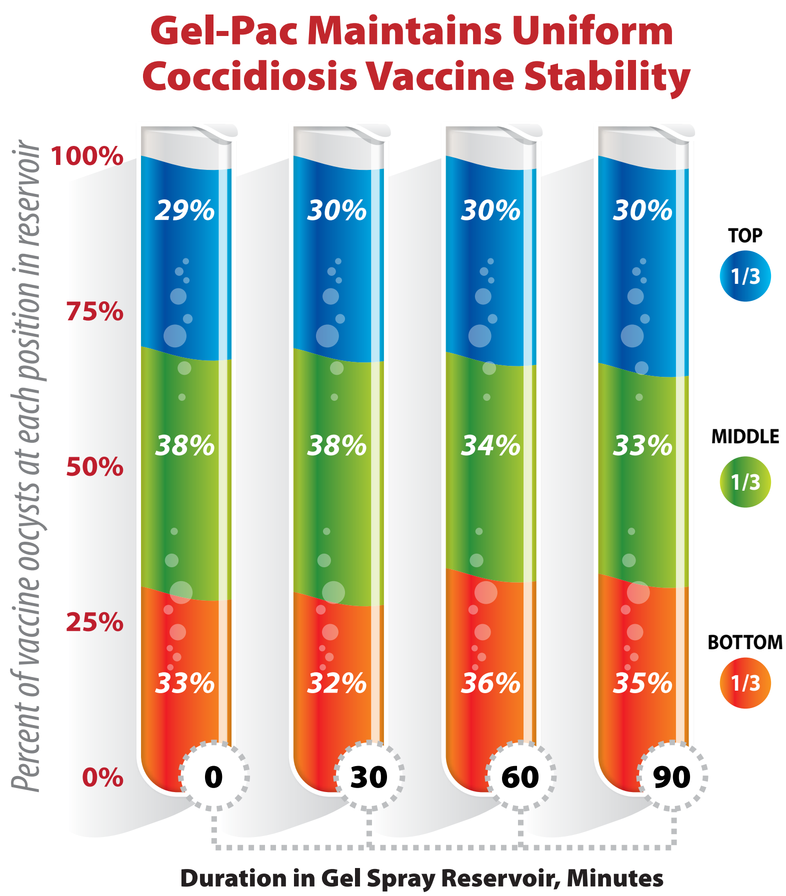


Figure 9: Percent of coccidiosis vaccine oocysts pipetted from the top third, mid third, and bottom third of a spray reservoir and counted (Cargill, 2014). Vaccine oocysts maintained relative positional stability throughout the 90 minute sampling, with approximately 33% remaining at each sampling position with no stirring imposed.

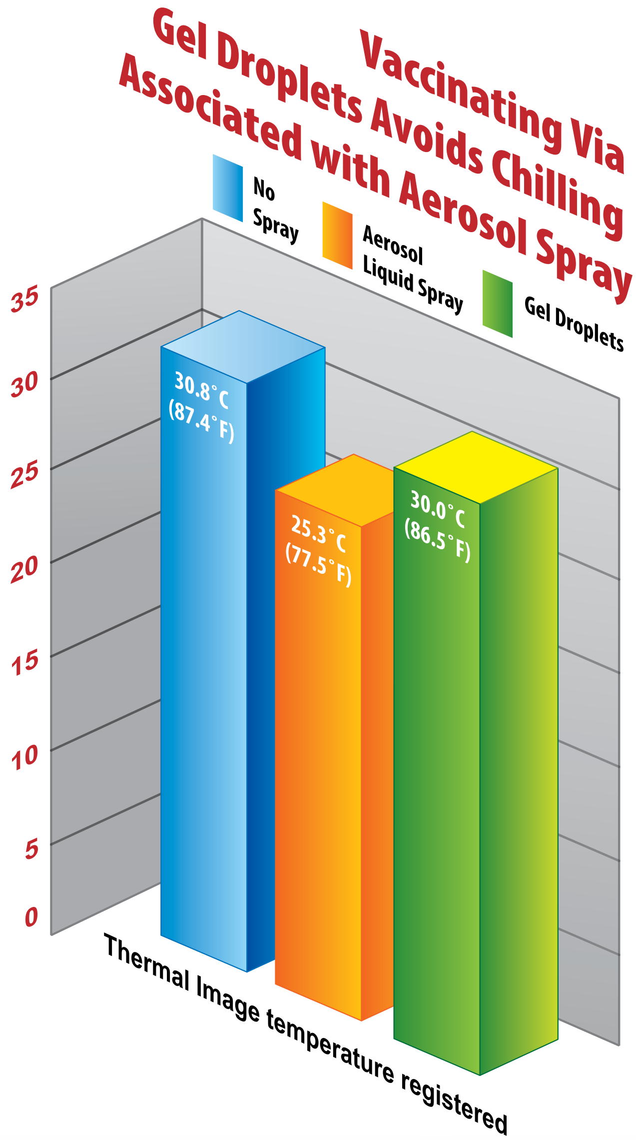
The increasing number of vaccinations given in the hatchery has naturally inspired veterinarians to look for ways to combine them...

liter with a commercial blender, then stirring in the vaccine. These solutions were stirred uniformly at the start of the experiment and then left undisturbed for the 90 minute testing period, except for the removal of the samples. At each time interval, samples from the top, middle and bottom of the solutions were taken for counting vaccine oocysts.

The oocyst counts revealed a firm pattern of positional stability in the Gel-Pac solution throughout the study (Figure 9). The results confirm Gel-Pac can be an ideal solution to protect the positional stability or uniformity of a spray vaccine, allaying the risks and fears of non-uniform distribution in the delivery system.

Beyond the time and labor savings of multiple additives in a single gel application, reducing the number of aerosol sprays is desirable because each successive pass through a vaccine mist wets the birds, increasing the vulnerability to chilling imposed by evaporative cooling. Gel-Pac addresses this concern. Gel droplets rest on top of the feathers instead of soaking to the skin. Thermal imaging was used to contrast the temperature of chicks subjected to no spray as control, aerosol liquid spray, and gel droplets (Figure 10). Thermal images of unsprayed control chicks registered 30.8°C (87.4°F), those sprayed with aerosolized water were chilled to 25.3°C (77.5°F), contrasted to chicks vaccinated via gel maintaining 30.0°C (86.0°F), (Holloway Jones, 2014).

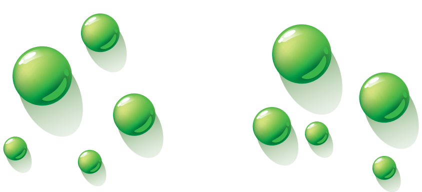
Chicks naturally preen the large, stabilized gel drops and thereby pick up the vaccine in concentrated form, where it can directly generate immunity. Hatchlings eat the gel droplets within a few minutes, giving the



vaccines and oral additives direct access to the gut before the bird leaves the hatchery. Protection begins before the bird arrives at the farm.

Gel-Pac powdered gel concentrate lets hatcheries efficiently prepare their own gel sprays from local tap water, then add and combine any variety of orally active products in a single application. Novel delivery systems for poultry health and nutrition products are opening doors, providing innovative and flexible management solutions for the food industry. Gel-Pac provides the means for veterinarians and nutritionists to capitalize on these new technologies, impacting life-long bird wellbeing and performance by applying the earliest possible intervention on the day of hatch.

Figure 10: Average temperature of thermally imaged chicks in hatchery boxes after being subjected to no spray, spray vaccination by aerosol liquid, and vaccination via gel droplets (Holloway Jones, 2014). Gel spray avoided the evaporative cooling effect imposed by aerosol spray.



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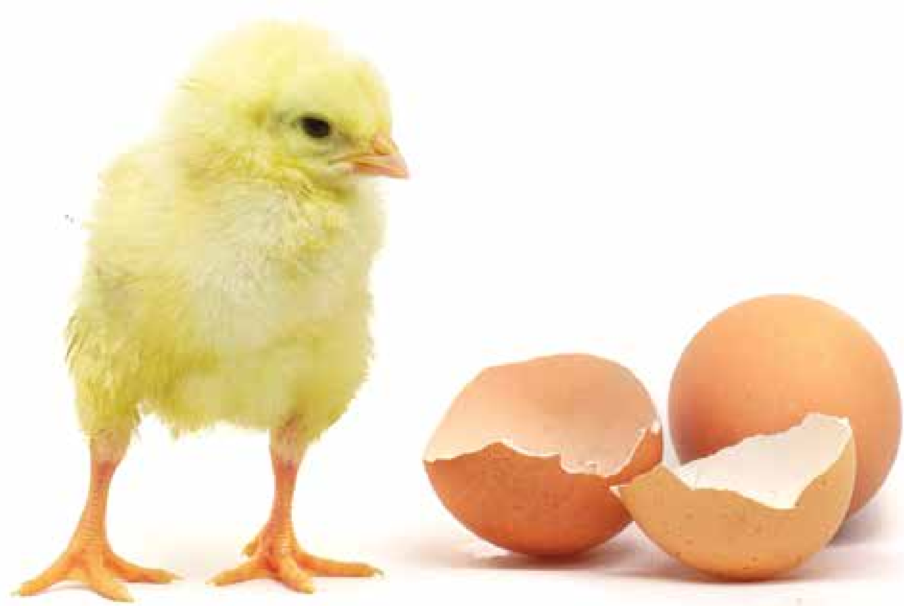


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