PLASMA AND EGG POWDER AS SUSTAINABLE ALTERNATIVES TO ZnO

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Zinc Oxide (ZnO) time is running out. Rational use of antibiotics and growth promoters moves the focus from pharmacology to functional ingredients. Spray dried plasma and egg powder are successfully used as excellent nutritional ingredients, preventing post-weaning diarrhea, improving the immune status of piglets and maintaining productive parameters in the absence of antibiotics and ZnO.

Zinc Oxide is a compound widely known to be an effective tool to prevent post-weaning diarrhea, mainly in piglets. Its mechanism of action is not fully known, but we can highlight beneficial effects on the balance of the intestinal flora (microbiome), bactericidal effect on E. Coli, stimulation of Ghrelin secretion and reducing intestinal permeability, among others. The use of this product has been very extensive in time, finding studies of its use since the 80s.

There is no homogenization regarding the effective doses, but 85 mg of zinc oxide / kg of live weight are proposed per day for 14 days post-weaning (equivalent to 3.1 kg of veterinary drug / Tm of feed or equivalent at 2500 g of Zinc / Tm of feed).

After so many years of use, in 2015 the EMEA revealed an environmental risk, when studying a referral procedure. Zn accumulated in the environment, representing a real problem for some of the member states as showed in Figure1, where red dots represent Zn concentrations over than 103 mg/kg.

Consequently, in 2016 France and the Netherlands force the Agency to review all available data and evaluate the risk / benefit of using ZnO-containing products for oral administration. In March 2017, the EMA finalized its review of risk and efficacy in food

Figure 1. Zn soil contamination. Image based on publication from Christos Noulas et al. 2018

production animals. Its verdict is unfavorable, that is, the environmental risk exceeds the pharmacological benefit, and there are also no effective measures to manage or eliminate the environmental accumulation of Zn. In addition to the environmental risk, there was the risk of co-selection of antimicrobial resistance, although it was not quantifiable.

Despite finding a multitude of formulations already approved on the market, the revocation of the marketing licenses of all of them is recommended (up to 80 marketing licenses coexisted in 2015 throughout Europe). Resolution, on June 26th 2017, set June 26th 2022 as the deadline for the use of prophylactic ZnO, while valid alternatives to the use of ZnO were found and the appropriate measures were taken to cushion the transition. Despite the above, its use as a nutritional ingredient is still authorized, since Zn is a mineral necessary for the correct functioning of enzymatic processes, immune system, contributes to the stability of cell membranes, and even intervenes in the transcription of polynucleotides.

In the absence of just over a year for the implementation of the ban, and in conjunction with the global framework of disuse and responsible consumption of antibiotics, several alternatives are postulated as ideal substitutes for ZnO.

THE ERA OF FUNCTIONAL INGREDIENTS

The appearance of post-weaning diarrhea is a multifactorial process, which can be approached from several fronts. It appears due to stress processes, which occur with inflammation and oxidative lesions. The alteration of the intestinal flora is also a key factor, so in addition to reducing stress at this stage, we must adjust the nutrients (protein, fiber, sugars, fats, ...) and their digestibility so that the excess or lack of them do not generate dysbiosis. Some antinutritive factors and toxins can damage the mucosa, making it easier for opportunistic microorganisms to attack. And we cannot forget the presence of pathogenic bacteria, such as E. Coli, which can cause severe damage to the intestinal mucosa and trigger inflammatory processes that will decrease the growth and animal welfare.

All these needs make one type of product stand out from all the others. Functional products capable of providing not only nutrients in a balanced way, but also bioactive molecules capable of, for example, neutralizing pathogenic microorganisms or accelerating the maturation of the intestine of young animals. In this line, we find both plasma and egg powder, whose effectiveness has been demonstrated on many occasions, mainly in early weaned animals and with special effectiveness in unhygienic environments and with highly challenging conditions. These beneficial effects are the result of many factors, highlighting its high content in IgG in the case of plasma, and IgY in the case of eggs, since both types of immunoglobulins decrease the binding of pathogens and toxins to the intestinal mucosa. Plasma and egg also provide bioactive molecules such as growth factors and cytokines, with the ability to accelerate the maturation of the intestine in recently weaned animals. Another benefit is the lack of antinutritional factors.

FAMILIAR PRODUCTS, NEW ALTERNATIVES

There are multiple studies that have demonstrated the efficacy and high value of plasma and egg powder as a functional ingredient, as evidenced by the meta-analysis carried out by Remus et al in 2013, or the study carried out by Harmon et al. published in 2000.

Table 1.
Adapted table extracted from Ocusu et al. en el 2003

	Spray dried plasma + Egg yolk	Egg yolk	ZnO	AB
ADG (g/day)				
Week 1	137,9	100,1	129,0	128,2
Week 2	189,1	149,6	188,6	170,6
G:F (g/g)				
Week 1	186,7	146,9	173,0	184,1
Week 2	276,0	136,5	264,9	255,1

Focusing on the use of spray dried plasma (SDP) and spray dried egg (SDE) as an effective alternative to replace ZnO and to participate in the reduction and rational use of antibiotics, we found very clarifying studies. For example in the study carried out by Ocusu et al. in 2003, different diets with the same protein content and equivalent nutritional contribution were compared in a challenge against enterotoxigenic Escherichia coli (K88) in 90 weaned piglets of 10 days old, varying in the addition of ZnO, antibiotics, plasma, egg powder and other functional ingredients. The results showed that the addition of SDP and egg yolk resulted in a higher average daily gain compared to the rest of the diets, and even higher than the diets with inclusion of ZnO and antibiotics, as shown by the results transcribed in Table 1.

On this basis, we can support the assertion of the suitability of plasma to replace ZnO with subsequent studies, such as the one carried out by the VEOS Group, in collaboration with Zootechnical Center, KU Leuven, Lovenjoel (W. Merckx, S. Massart, ID Kalmar 2015). In this study, 280 pigs were fed spray dried plasma powder (SDP) in the starter and pre-start diets and the performance of the piglets was studied during the entire weaning period in conditions of absence of ZnO and the prophylactic use of antibiotics. The results showed that SDP clearly reduced post-weaning diarrhea and improved initial technical performances.

Although weaning occurred in the current trials without the prophylactic use of antibiotics, post-weaning infectious diarrhea was also not observed, as described in the table 2, called "Iso-nitrogenous, partial replacement of soybean meal with spray-dried plasma (SDP) at a dose of 3% SDP during a two-week pre-starter phase on piglet post-weaning performance in absence of prophylactic use of antibiotics (Trial 1; N = 8 pens of 10 piglets each)."

The spray dried egg powder (SDE) has also been the object of study, finding equally promising results. In another study carried out in Brazil (2006 Vilar da Silva et al.), use of SDE in the diet of pre-starter hens was studied, facing diets that contained either antimicrobial (coccidiostats) and / or growth promoters, or well SDE. The results showed that SDE is an effective substitute for antimicrobial and growth promoters, which, added to its high nutritional value, results in a highly valuable ingredient. The results of the productive parameters in the different diets are summarized in table 3:

Table 2.
Extracted from W. Merckx et al. 2015

2 wk pre-starter phase	-	SDP	Control
LWd0	(kg)	5.1	5.1
Weight dip	(%pigs)	3.8	7.5
SRd0-13*	(%pigs)	97.5	92.5
SLWd13	(kg)	6.1	6.1
NLWd13	(kg)	6.0	5.6
ADFI	(g/d)	191a	150b
ADG	(g/d)	70	45
GFR	(kg/kg)	0.37	0.27

a,b different superscripts within a row indicate a significant difference at p < 0,001.
**One additional control piglet died at day 1 and was excluded from all data.*
LW, live weight; SR, survival rate; SLW, survivor LW; NLW, net LW (SLW x SR x 0,01); ADFI, average daily feed intake; ADG, average daily gain; GFR, gain to feed ratio

Table 3.
Adapted from 2006 Vilar da Silva et al.

	Body Weight g	Weight Gain g	Mortality %	Feed conversion kg/kg
R1 = +ANTIM	63,54	29,10	0,83	2,308
R2 = -ANTIM	63,06	21,91	0,83	2,381
R3 = -ANTIM+SDE	62,52	27,53	0,83	2,362

R1: Diet one, with antimicrobials
R2: Diet two, without antimicrobials. We can consider it as control diet
R3: without antimicrobials and with SDE

Table 4.
Adapted from Song et al. 2012

	Control (-AB,-ZnO,-SDP,-SDE)	+AB,+ZnO, +SDP,+SDE	-AB,-ZnO, +SDP, +SDE
ADG (g)	50	124	120
F:G	0,35	0,67	0,55

ADG: Average daily gain
F:G: feed/weight gain ratio
-AB,-ZnO,-SDP,-SDE: diet formulated without antibiotics (Carbadox) & ZnO, without spray dried plasma and without spray dried egg)
+AB,+ZnO,+SDP,+SDE: diet formulated with antibiotics (Carbadox) & ZnO, spray dried plasma and spray dried egg
-AB,-ZnO,+SDP,+SDE: diet formulated without antibiotics (Carbadox) & ZnO and with spray dried plasma and spray dried egg

As we can see, the results do not differ greatly between diets 1 and 3, but we do find a difference in weight gain with diet 2, which we can consider as control diet.

Once the suitability of SDP and SDE had been verified as effective substitutes for antibiotics, and as the last reference to highlight, we want to mention a study published by Song et al. 2012, where various diets were tested, in the absence and presence of ZnO and with equivalent diets at a nutritional level. The results showed that both the inclusion of SDP and SDE resulted in a similar average daily gain in the diets that included ZnO and Carbadox and those that did not include them, in the so-called phase I (first week after weaning), as results in table 4.

A NUTRITIOUS, SUSTAINABLE AND EFFECTIVE SOLUTION

As a conclusion, we can say that both plasma and egg powder can be used as a sustainable alternative to ZnO with similar positive effects on growth performance and health. These positive effects can be explained by the high nutritional value of plasma and egg powder and thanks to the bioactive components they contain, mainly immunoglobulins IgG (in plasma) and immunoglobulins IgY (in egg), which have a direct influence on pathogenic microorganisms, on the immune function and on the gut maturation and protection. In addition, the excellent nutritional composition of plasma and egg powder and their high digestibility make the use of their nutrients extremely valuable. As the undigested part is minimal, it prevents harmful bacterial proliferation inside the gut.

References available upon request carlos.ucero@veos.es

About Carlos Ucero, MVetMed

Carlos graduated from the Complutense University of Madrid with a degree in Veterinary Medicine. Later he completed his education with postgraduate studies in Innovation Management and also in Business Management and Marketing.

With more than 20 years experience in the animal health and welfare sector, he is now involved in business development and R&D management at the VEOS Group as Technical Sales Manager ACTIPRO, a brand dedicated to animal nutrition.