

Mode of action and effect of a natural citrus extract on growth performances in piglets

Alexia LEPONT¹, Alexandre BUDAN¹, Sébastien LE²

¹Nor-Feed Sud, Beaucouzé, France

²Agrocampus Ouest, Applied Mathematics Laboratory, Rennes, France

Introduction

Nor-Spice AB Powder is a premixture of feed additive formulated from lemon extract, a natural product- botanically defined additive (European Union Register of Feed Additives, 2014). A feed additive registration dossier for lemon extract has been received by EFSA on 23/09/2010. Nor-Spice AB Powder is a citrus concentrate containing a set of well characterized phytochemical compounds: citroflavonoids, pectic oligosaccharides, organic acid, limonene and citrus essential oil.

Considering its natural composition, Nor-Spice AB Powder may be used in organic farming according to the regulations (CE) n°834/2007 and (CE) n°889/2008.

Nor-Spice AB has been formulated to be a natural growth promoter during specific periods such as weaning, when animals gut microbiota are subject to changes (Rasmussen and Siemsen, 1998; Chicoteau *et al*, 2001; Aurensan, 2012; Lamballais, 2013).

Material and methods

In order to measure the effect of Nor-Spice AB Powder on growth performances at this critical period, ten trials were conducted on more than 2000 post-weaning piglets in Denmark, the United Kingdom, Canada and Switzerland, in varied conditions and their results evaluated via a comprehensive statistical analysis. Nine trials were conducted in commercial farms, and one trial has been done as part of a thesis at the Royal Danish Veterinary and Agricultural University. Of these ten trials, three involve a positive control with the addition of a synthetic growth promoter in the control group.

The piglets were homogeneously divided into a control group and a trial group according to their live weight and their gender. The difference of the average start weights of the animals in each group did not, as far as possible, exceed 2%, and each pen consisted of an equivalent number of each gilts and castrates.

Piglets were fed *ad libitum* with a commercial feed formulated according to good manufacturing practice and had free access to fresh water. Nor-Spice AB Powder (Nor-Feed Sud, France) was added to trial groups during a given period following the product direction of use, typically 250 grams per ton of complete feed. Detail of each trial is presented in Table 1.

The piglets were weighed together in each pen, at the start and at the end of each trial. Feed intake was calculated by weighing of the feed refusal once a week. Number, date and weight of dead piglets were registered, as well as medications used.

Average daily gain (ADG) and feed conversion rates (FCR) were compared by two-way unbalanced variance analysis (ANOVA), using firstly a Fisher test in order to demonstrate the global effect of treatment factor, and secondly a Student test, as a test of significance of coefficient.

Table 1 : details of the trial conditions

Trials	Location	Duration (days)	Number of animals	Average weight, start (Kg)	Positive control
1	Denmark, commercial farm	14	55 piglets in each group	8.1	-
2	Denmark, commercial farm	13	63 piglets in each group	7.6	-

3	Denmark, Royal Danish Veterinary and Agricultural University.	49	86 piglets in each group	6.9	-
4	United Kingdom, commercial farm	42	60 piglets in each group	8.4	-
5	Denmark, commercial farm	28	35 piglets in each group	5.3	-
6	Denmark, commercial farm	21	35 piglets in each group	6.7	-
7	Denmark, commercial farm	21	30 piglets in each group	7.9	-
8	Switzerland, commercial farm	90	30 piglets in each group	9.8	50 ppm Olaquinox
9	United Kingdom, commercial farm	63	60 piglets in each group	7.1	50 ppm Avilamycin
10	Canada, commercial farm	49	612 piglets in control group, 607 piglets in trial group	5.6	Aureomycin

Results

The results are presented in Table 2.

Except for trial 2, all trials, taken individually, show positive results of Nor-Spice AB Powder on ADG parameters, compared to negative or positive control. In the same way, all trials except trials 3 and 9 show individually improvement of FCR with Nor-Spice AB Powder added to the feed.

We observe a positive effect of Nor-Spice AB Powder with ADG and FCR improvement for trials 8, 9 and 10 (except for trial 9 with no change of FCR between both groups as previously described), *i.e.* trials which involved a synthetic growth promoter as a positive control, with average results for these three trials comparable to the average results of all trials (10.9% average ADG improvement, and 6.3% average FCR improvement for trials 8-10).

The ADG average improvement calculation for these ten trials show a 10.9 % improvement of trial groups compared to control groups, with a statistical significance at $p < 0.001$, for both Fisher and Student tests.

The FCR average improvement calculation for these ten trials show a 7.1 % improvement of trial groups compared to control groups, with a statistical significance at $p < 0.01$, for both Fisher and Student tests.

Table 2 : trial results

Trials	Control ADG (g/animal/d)	Trial ADG (g/animal/d)	ADG improvement/ Control group	Control FCR	Trial FCR	FCR improvement/ Control group
1	158	190	20,3%	1,37	1,11	-19%
2	178	170	-4,8%	1,16	1,06	-8,6%
3	314	337	7,3%	1,85	1,85	0%
4	407	500	22,9%	1,56	1,49	-4,5%
5	161	173,5	7,8%	1,95	1,94	-0,5%
6	194	216	11,4%	1,4	1,25	-11,0%
7	275	305	10,9%	1,45	1,32	-8,6%
8	408	474	16,2%	1,51	1,39	-7,9%
9	412	468	13,6%	1,46	1,46	0%
10	431	444	3%	1,37	1,22	-10,9%
Average			10,9 % ***			-7,1 % **

*** $p < 0.001$

** $p < 0.01$

Discussion

Nor Spice AB Powder had therefore a positive effect on piglet's growth performances. These results confirm conclusions from different reviews on growth promoter alternatives (Vondruskova *et al*, 2010; Piro, 2007; Wenk, 2002) in which plant extracts have been demonstrated as efficient natural alternatives to the use of growth promoters, especially antibiotics. The importance of selection and standardization of plant extracts has been highlighted by Budzinski *et al.*, 2000; Oetting *et al.*, 2006.

Furthermore, we observe comparable ADG and FCR average improvement with Nor-Spice AB Powder added to the feed compared to negative control or positive control (synthetic growth promoters such as ionophores), but we have no explanation of these similar results.

This growth promoter effect may be explained by a prebiotic action supporting the growth of certain beneficial micro-organisms of the digestive track (*e.g.* lactic acid bacteria), combined to a gut flora control, resulting in the depression of the population of other micro-organisms (gram negative bacteria), including potential or opportunistic pathogens.

This complementary mode of action is illustrated with *in vitro* work (comparative growth of selected micro-organisms, Tours University, 2000; Nor-Feed Sud, 2012) and *in vivo* experiments (characterization of the ileal microflora of the pigs using a DNA probe technique by a T-RLFP analysis, Berg, 2001).

Nor-Spice AB Powder naturally contains citroflavonoids, pectic oligosaccharides, organic acids, limonene and citrus essential oil. Flavonoids from citrus have been well described in the literature to have antimicrobial effect (Pistelli and Giorgi, 2012; Cushnie and Lamb, 2005; Pretorius, 2003; Benavente-Garcia, 1997). A dietary prebiotic has been defined as a selectively fermented ingredient that results in specific changes in the composition and/or activity of the gastrointestinal microbiota, thus conferring benefit(s) upon host health (Gibson *et al*, 2010). Pectic oligosaccharides (POS) are complex fragments coming from degradation of pectin (Agnan Marie Michel Combo *et al*, 2011). These molecules have prebiotic properties that have been recently described and studied by various author (Gullon *et al*, 2013; Manderson *et al*, 2005; Hotchkiss *et al*, 2003; Olano-Martin *et al*, 2002). Other beneficial effects induced by POS include the inhibition of pathogenic bacteria (Olano-Martin *et al*, 2003) and the prevention of the adhesion of microorganisms (Hotchkiss *et al*, 2003; Guggenbichler *et al*, 1997).

Thus, the phytochemicals contained in Nor-Spice AB might act synergistically to enhance the gut flora balance, which result in improved performances during periods associated with severe stress for piglets.

Conclusion

Nor-Spice AB Powder has shown a technical interest illustrated by a positive effect on growth performances for post-weaning piglets in varied conditions. The economic interest should now be evaluated according to these zootechnical results, and by analysis of the Nor-Spice AB Powder price and dosage compared with the feed economy in relation to the actualized cost of feed.

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Corresponding author

Alexia LEPONT
Nor-Feed Sud
3 rue Amedeo Avogadro
49070 BEAUCOUZE, FRANCE
e-Mail : alexia.lepont@nor-feedsud.fr