The use of short and medium chain fatty acids as an alternative to antibiotic growth promoters in broilers infected with malabsorption syndrome

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In an experiment with 624 malabsorption syndrome infected (MAS-infected) Ross-308 male broiler chickens the effect of a mixture of short and medium chain fatty acids on performance of animals was studied. Animals were housed at day-old in one room with 48 pens. Infection was spread out by two seeder birds per pen, infected at day 0 and removed at day 14. The experiment included 3 treatments of 16 replicates each. Treatment 1 was the control group. In treatments 2 and 3, 0.20%, 0.15% and 0.10% of medium chain fatty acids (MCFA, treatment 2) or a mixture of short (SCFA) and MCFA (Selacid Green Growth Poultry, Selko, treatment 3) were included in the starter, grower and finisher diets, respectively. Antibiotic growth promoters were not included in any of the feeds. Data were subjected to analysis of variance. At 14 days of age, the addition of short and medium chain fatty acids resulted in significantly higher average daily gain of birds compared to the control and MCFA groups. At 42 d, the addition of the mixture gave numerical higher broiler growth than the others treatments. The results of the experiment showed that the mixture of short and MCFA may present beneficial effects when animal health is impaired.

Keywords: short chain fatty acids; medium chain fatty acids; malabsorption syndrome; broilers

Introduction

Since the European ban of the antibiotic growth promoters (AGP) in January 2006, many potential alternatives have been described. Some of them refer to pre- and probiotics (Kocher, 2006), herbs and botanicals (Wenk, 2006), bacteriophages (Huff et al., 2006) or acidifiers (Diebold and Eidelsburger, 2006). Short (SCFA) and medium chain fatty acids (MCFA) affect parameters that are also affected by the banned AGP. Short and medium chain fatty acids have been reported to have antibacterial properties (Santomá et al., 2006), with their effect more pronounced in acid-intolerant bacteria (Thompson and Hinton, 1997). Mathis et al. (2005) showed that a combination of organic acids and MCFA is able to strongly reduce clinical effects of artificially induced Necrotic Enteritis in broilers.

Most of the positive effects of the alternatives are shown when the health status of the animal is impaired and hence, the intestinal integrity is compromised. However, in experimental conditions animals are normally grown in a healthy environment where the microflora is well balanced. For this reason, when the effectiveness of the different alternatives wants to be tested, animals have to be stressed in one or another way. There are some challenge models that favour the bacterial proliferation and allow researchers to test the alternatives. One of those models is the malabsorption syndrome model (MAS), consisting on infecting the animals at day 0 by giving 0.5 ml of a MAS homogenate (Den Hartog et al., 2005).

An experiment was carried out to determine the effect of MCFA (C6 - C12) alone or in combination with SCFA (C1 - C4) on broiler chicken performance under MAS conditions.

Materials and methods

A total of 624 Ross-308 male broiler chickens were allocated at day-old in one room with 48 floor pens (13 animals per pen) and infected with MAS. Each pen had a floor area of 0.8 m^2, wood shavings being used as bedding material. Feed was provided *ad libitum* by one feeder per pen and water by two nipple drinkers per pen.

Birds were infected with MAS by giving 2 birds per pen 0.5 ml of a MAS homogenate at 0 days of age. This homogenate was obtained from the intestines of an earlier flock that was infected with MAS. Before infection, the homogenate was thawed and mixed 50/50 with a phosphate buffer solution. The 2 birds infected the other birds. In order to facilitate this, plastic foil was put on top of the wood shavings to promote the pecking of the excreta. The 2 seeder birds were removed at 14 days of age after weighing. Weight was also determined at 0, 21 and 42 days of age. Feed intake was recorded for the period of days 0 to 14, 14 to 21 and 21 to 42 and mortality was recorded daily, along with the body weight of dead birds, to correct feed conversion ratio (FCR) for mortality.

The experiment included three different treatments with 16 replicates per treatment. Treatment 1 (control group) did not contain any antibiotic growth promoter nor alternative. In treatment 2 and 3, 0.20%, 0.15% and 0.10% of MCFA (treatment 2) or a mixture of SCFA and MCFA (Selacid Green Growth Poultry, Selko, treatment 3) were included in the starter, grower and finisher diets, respectively. The starter diet contained diclazuril as the coccidiostat whilst monensin was added to the grower diet. The starter and the grower diets were offered as 2 and 3 mm pellets, respectively. The composition of the basal diets is given in *Table 1*.

Birds were vaccinated at 0 days of age against Marek and Infectious Bronchitis and at 20 days of age against Infectious Bursal Disease. A standard temperature schedule was applied, which started at 30 °C at 0 days of age and that was gradually decreased to 20 °C at 28 days of age. Light was continuously provided during the first 3 days of age and thereafter, a light schedule of 20L:4D was applied.

Data were subjected to analysis of variance (general linear models procedure of SAS, 1997). The statistical model included treatment as factor. Significant differences between treatments were detected by a least significant differences procedure. Differences between treatments were considered significant at $P \leq 0.05$.

Results and discussion

Results of the current experiment are summarised in *Figures 1* and *2*. Significant differences among treatments were detected during the period 0 to 14 days of age but not during the whole period (from 0 to 42 days of age). In the MAS model most of the results may be expected during the starting period, when the animals are being infected by the seeders and suffering from the syndrome. Afterwards, compensatory growth may occur and differences tend to be diluted (Den Hartog et al., 2005). Then, the lack of consistency of the results during the trial might be explained by the challenge model used.

As compared to the control group the inclusion of the mixture of SCFA and MCFA resulted in a significant 7.5% higher live weight at 14 days and a non-significant 3.3% higher live weight at 42 days. Feed intake tended ($P = 0.06$) to be increased for the period 0-14 days of age (7% increase) while not affected for the total period. The use of MCFA alone showed intermediate results, with a non-significant increase of 1.8% and 2.2% in live weight at 14 and at 42 days of age, respectively. Feed intake during the period 0-14 days resulted similar to the control group but similar to the mixture of SCFA and MCFA during the whole period (0 to 42 days of age). Den Hartog et al. (2005) suggested a synergetic effect between SCFA and MCFA; the MCFA may act disrupting the cell wall membrane of the microorganisms and helping the SCFA to enter into the cytoplasm where they act. These results, tend to confirm the synergetic effect.

As conclusion, the results of the experiment showed that the mixture of SCFA and MCFA may present beneficial effects when animal health is impaired.

Table 1 Ingredient and calculated nutrient composition (g/kg) of the basal experimental broiler starter and grower-finisher diets

Feedstuffs, g/kg	Starter feed	Grower and finisher feed
Corn	223.8	50.00
Wheat	350.2	610.3
Soybeans	100.0	100.0
Soybean meal, 44 % cp	250.3	165.0
Soya oil	31.97	33.89
Sodium chloride	2.44	1.67
Sodium bicarbonate	2.68	3.10
Calcium carbonate	11.48	10.85
Monocalcium phosphate	16.56	13.41
L-lysine HCl	2.04	2.75
DL-methionine	2.34	2.03
L-threonine	0.18	0.44
Premix, vitamins and trace elements	5.00	5.00
Avizyme 1300	1.00	1.00
Calculated contents, g/kg		
$AME_{broilers}$, MJ/kg	11.71	12.13
Moisture	101.09	91.23
Ash	66.01	59.38
Crude protein	222.0	210.0
Crude fat	68.96	67.46
Crude fibre	33.44	32.07
Digestible lysine	11.00	10.19
Digestible methionine	5.110	4.663
Digestible methionine+cystine	8.152	7.754
Digestible threonine	6.652	6.200
digestible tryptophan	2.258	2.161
Calcium	9.001	7.999
Available phosphorus	4.501	3.899
Sodium	1.798	1.601
Potassium	9.199	7.851
Choride	2.298	2.000

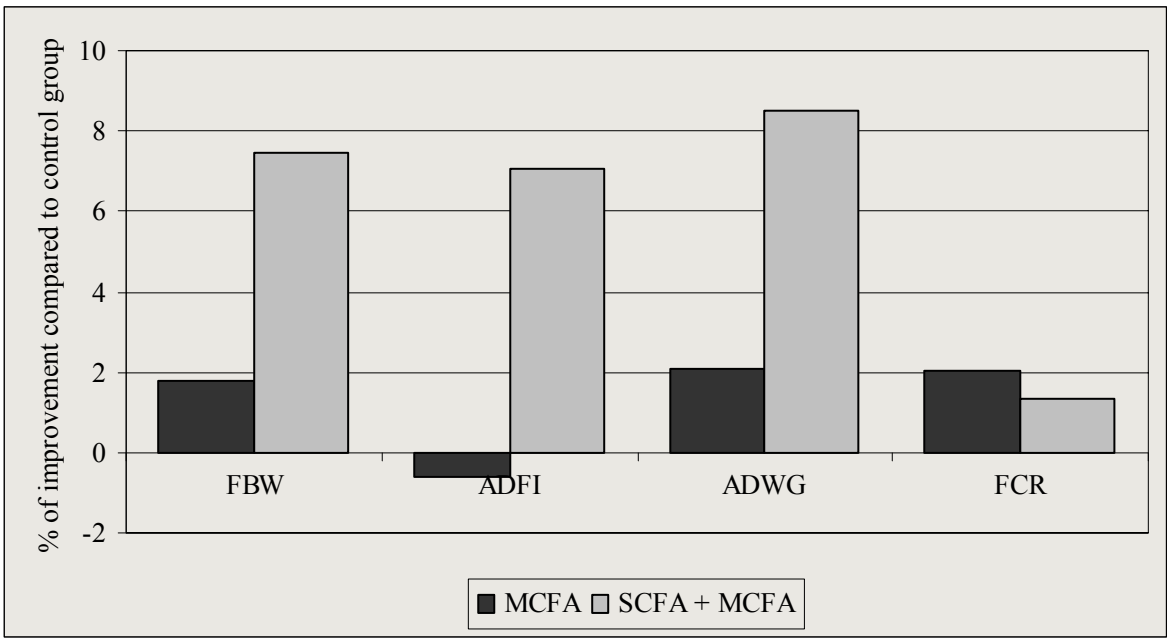

Figure 1 Percentage of difference respect the control group in technical results of MAS-infected birds fed diets with MCFA alone or in combination with SCFA during the starter period (0 to 14 days of age). FBW, final body weight; ADFI, average daily feed intake; ADWG, average daily weight gain; FCR, feed conversion rate.

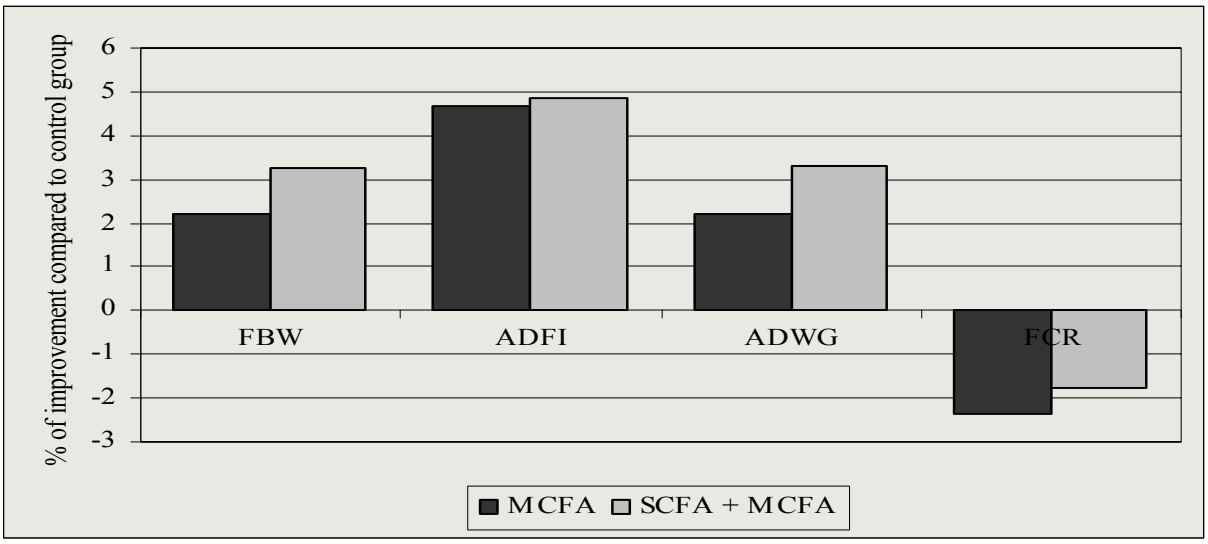

Figure 2 Percentage of difference respect the control group in technical results of MAS-infected birds fed diets with MCFA alone or in combination with SCFA during the whole period (0 to 42 days of age). FBW, final body weight; ADFI, average daily feed intake; ADWG, average daily weight gain; FCR, feed conversion rate.

References

DEN HARTOG, L. A., GUTIÉRREZ DEL ÁLAMO, A., DOORENBOS, J. and FLORES, A. (2005) The effect of natural alternatives for anti-microbial growth promoters in broiler diets. Proceedings of the 15th European Symposium on Poultry Nutrition, Balatonfüred, Hungary.
Proc. Eur. Symp. on Poultry Nutrition, Budapest

DIEBOLD, G. and EIDELSBURGER, U. (2006) Acidification of diets as an alternative to antibiotic growth promoters, in: *Antimicrobial growth promoters, where do we go from here?* (D. Barug, J. de Jong, A.K. Kies and M.W.A Verstegen eds), pp311-324, Wageningen: Wageningen Academic Publishers.

HUFF, W.E., HUFF, G.R., RATH, N.C., BALOG, J.M. and DONOGHUE, A.M. (2006) Bacteriophage: a safe and natural alternative to AGPs, in: *Antimicrobial growth promoters, where do we go from here?* (D. Barug, J. de Jong, A.K. Kies and M.W.A Verstegen eds), pp341-358, Wageningen: Wageningen Academic Publishers.

KOCHER, A. (2006) Interfacing gut health and nutrition: the use of dietary pre- and probiotics to maximise growth performance in pigs and poultry, in: *Antimicrobial growth promoters, where do we go from here?* (D. Barug, J. de Jong, A.K. Kies and M.W.A Verstegen eds), pp289-305, Wageningen: Wageningen Academic Publishers.

MATHIS, G.F., VAN DAM, J.T.P., CORUJO FERNÁNDEZ, A. AND HOFACRE,, C.L. (2005) Effect of an organic acids and medium-chain fatty acids containing product in feed on the course of artificial Necrotic Enteritis infection in broiler chickens. WPSA 15th European Symposium on Poultry Nutrition, Hungary 25-29 September.

SANTOMA, G., PEREZ DE AYALA, P. AND GUTIERREZ DEL ALAMO, A. (2006) Producción de broilers sin antibióticos promotores del crecimiento. Conocimientos actuales. Proceedings 53rd Spanish Scientific Symposium on Poultry, Barcelona, Spain.

SAS Institute (1997). SAS/STAT User´s Guide, Version 6.12, SAS Institute Inc., Cary, North Carolina.

THOMPSON, J.L. and HINTON, M. (1997) Antibacterial activity of formic and propionic acids in the diet of hens on Salmonellas in the crop. *British Poultry Science* **38:** 59-65.

WENK, C. (2006) Are herbs, botanicals and other related substances adequate replacements for antimicrobial growth promoters?, in: *Antimicrobial growth promoters, where do we go from here?* (D. Barug, J. de Jong, A.K. Kies and M.W.A Verstegen eds), pp329-339, Wageningen: Wageningen Academic Publishers.