Animal, page 1 of 6 © The Animal Consortium 2015
doi:10.1017/S1751731115002189

The effects of a novel synthetic emulsifier product on growth performance of chickens for fattening and weaned piglets

V. Bontempo†, M. Comi and X. R. Jiang†

Department of Health, Animal Science and Food Safety, Università degli Studi di Milano, via Celoria 10, 20133 Milan, Italy

(Received 30 October 2014; Accepted 7 October 2015)

Two experiments were conducted to evaluate the effects of a novel synthetic emulsifier product (AVI-MUL TOP) on the growth performance of chickens for fattening and weaned piglets. The emulsifier product consists of 50% vegetal bi-distillated oleic acid emulsified with 50% glyceryl polyethyleneglycol ricinoleate. In experiment 1, 480 1-day-old female Cobb500 chickens for fattening were assigned to two treatments: (1) a control diet (CTR); and (2) the control diet + the emulsifier (AMT, 1 g/kg from day 0 to day 10, 0.75 g/kg from day 10 to day 20 and 0.5 g/kg from day 20 to day 34 of the trial). AMT supplementation increased BW on days 20 and 34 (P < 0.01). Dietary AMT increased the average daily gain and average daily feed intake (ADFI) from day 10 to day 20, from day 20 to day 34 and from day 0 to day 34 (P < 0.01). A reduced feed conversion ratio was observed in the AMT group from day 10 to day 20 (P < 0.01). In experiment 2, 96 Stambo HBI × Dalland piglets were weaned at 24 days and assigned to two treatments (the basal diet without the product (CTR) or with 2 g/kg emulsifier from day 0 to day 14 and 1.5 g/kg from day 14 to day 42 (AMT)). There was an increase in the ADFI associated with AMT supplementation from day 14 to day 42 (P = 0.04). These results indicated that supplementation with the synthetic emulsifier may significantly improve the growth performance of chickens for fattening and numerically improve that of weaned piglets.

Keywords: chickens for fattening, emulsifier, growth performance, weaned piglets

Implications

This study determined whether a novel synthetic emulsifier product, consisting of vegetal bi-distillated oleic acid and glyceryl polyethyleneglycol ricinoleate, could have beneficial effects on the growth performance of chickens for fattening and weaned piglets. The current observations may be of significant value to commercial feed manufacturers and farmers as they may give rise to important savings in the industry.

Introduction

Low hepatic bile acid synthesis may result in poor lipid digestion in weaned piglets (Lewis *et al*., 2000), and inefficient digestion and absorption of fat also occurs in young chickens, possibly due to a low level of natural endogenous lipase production (Al-Marzooqi and Leeson, 1999). These observations have generated considerable interest in and research on the use of emulsifiers to improve the utilisation of fats in young chicks (Al-Marzooqi and Leeson, 1999) and post-weaning piglets (Jones *et al*., 1992). Lecithin, an emulsifier, has been reported to depress free fatty acid absorption, probably by increasing the size of bile salt micelles, which diffuse more slowly through the luminal water interface, retarding the delivery of free fatty acids to the absorptive cell surface (Saunders and Sillery, 1976). Compared with lecithin, glyceryl polyethyleneglycol ricinoleate is more hydrophilic and dissolves free fatty acids, which are largely insoluble in bile salt micelles alone (Dierick and Decuypere, 2004). Roy *et al*. (2010) reported that supplementation of exogenous emulsifiers in diets containing moderate quantities of added vegetable fats may substantially improve broiler performance. In addition, emulsification of fat (as in sow milk) may improve the growth performance of weaned pigs fed supplemental fat (Xing *et al*., 2004).

To the best of our knowledge, the use of emulsifiers in association with vegetable oils in animal feed has not yet been thoroughly investigated, even though the interest in using exogenous emulsifiers has increased in the last several decades. Experiments were therefore conducted with the aim of assessing the effect of a novel synthetic emulsifier product (AVI-MUL TOP), consisting of vegetal bi-distillated oleic acid and glyceryl polyethyleneglycol ricinoleate, on the growth performance of chickens for fattening and weaned piglets.

† E-mails: valentino.bontempo@unimi.it; xianrenjiang@126.com

Material and methods

The experimental protocol was reviewed and approved by the Animal Care and Use Committee of the University of Milan. Both experiments were performed at the facility for Animal Production Research and Teaching Centre of the Polo Veterinario, Università degli Studi di Milano (Lodi, Italy).

The emulsifier product (AVI-MUL TOP; SEVECOM S.P.A., Milan, Italy), consisting of 50% vegetal bi-distillated oleic acid emulsified with 50% ethoxylated castor oil E484, which belongs to the glyceryl polyethyleneglycol ricinoleate family (Community Register of Feed Additives – EU Reg. No. 1831/2003), was mixed with other ingredients before the pelleting process. The animal fat consisted of 50% poultry fat and 50% lard and vegetable oils (soybean oil) were used in experiment 1, whereas only vegetable oils (soybean oil and coconut oil) were used in experiment 2. The experimental diets were produced by Veronesi Verona S.P.A., Verona, Italy.

Experiment 1

In experiment 1, 480 female Cobb500 chickens for fattening (44.46 ± 0.96 g) were obtained from a local hatchery at 1 day of age and allocated to 48 pens with 10 birds in each pen, measuring 1.25 × 1.00 m. All of the chickens were vaccinated against Marek's disease, Newcastle disease and infectious bronchitis via coarse spraying at hatching. The 48 pens were randomly assigned to two treatments, consisting of a non-supplemented basal diet (CTR) and the basal diet supplemented with the emulsifier (AMT, 1 g/kg inclusion rate from day 0 to day 10, 0.75 g/kg from day 10 to day 20 and 0.5 g/kg from day 20 to day 34 of the trial). The diets (Table 1) were formulated to meet the nutrient requirements defined by the National Research Council (NRC) (1994). The diet during the starter and grower periods was provided in crumble form, and the diet during the finisher period was provided as pellets. The birds were housed in an environmentally controlled room in separate floor pens with white wood shavings as bedding, under a photoperiod of 24 h of light from day 0 to day 7 and 23 h light : 1 h dark from day 7 to day 34. Room temperature was maintained at 35°C from day 1 to day 3 and was then decreased by 2.5°C/week, to a final temperature of 24°C at day 34. Feed and water were provided for *ad libitum* consumption. The animals were checked twice daily and any dead animals were removed, weighed and recorded. All birds were individually weighed on days 0, 10, 20 and 34 of age. The average daily gain

Table 1 *Ingredients and calculated analysis of the basal diet for chickens for fattening (as-fed basis)*

	Starter (0 to 10 days)		Grower (10 to 20 days)		Finisher (20 to 34 days)	
	CTR	AMT	CTR	AMT	CTR	AMT
Ingredients (%)						
Maize	45.17	45.17	37.31	37.31	30.28	30.28
Soybean meal (49% CP)	32.50	32.50	25.00	25.00	25.50	25.50
Wheat	15.00	15.00	15.00	15.00	20.00	20.00
Sorghum	0	0	10.00	10.00	15.00	15.00
Soybean full fat	0	0	5.00	5.00	0	0
Soybean oil	3.00	3.00	0	0	0	0
Poultry fat and lard	0	0	4.00	4.00	6.00	6.00
Sodium chloride	0.40	0.40	0.35	0.35	0.25	0.25
Calcium carbonate	1.20	1.20	1.00	1.00	0.95	0.95
Dicalcium phosphate (18%)	1.50	1.50	1.2	1.2	1.00	1.00
DL-Methionine	0.34	0.34	0.30	0.30	0.25	0.25
L-Threonine	0.11	0.11	0.09	0.09	0.04	0.04
L-Lysine HCl	0.28	0.28	0.25	0.25	0.23	0.23
Premix[1]	0.50	0.50	0.50	0.50	0.50	0.50
EM[2]	0	0.10	0	0.075	0	0.05
Calculated composition						
ME (MJ/kg)	12.77	12.77	13.19	13.19	13.65	13.65
CP (%)	21.80	21.80	20.20	20.20	19.00	19.00
Crude fat (%)	5.20	5.20	6.70	6.70	8.20	8.20
Calcium (%)	0.92	0.92	0.80	0.80	0.70	0.70
Phosphorous (%)	0.65	0.65	0.60	0.60	0.54	0.54
Analysed composition						
CP (%)	21.50	21.87	20.70	20.10	19.42	19.34
Crude fat (%)	5.16	5.86	6.49	6.58	7.69	7.47

CTR = basal diet without supplementation; AMT = CTR + EM; EM = emulsifier; ME = metabolisable energy.
[1]Provided the following per kilogram of diet: vitamin A, 11 250 IU; vitamin D_3, 5000 IU; vitamin E, 60 mg; $MnSO_4 \cdot 1H_2O$, 308 mg; $ZnSO_4 \cdot 1H_2O$, 246 mg; $FeSO_4 \cdot 1H_2O$, 136 mg; $CuSO_4 \cdot 5H_2O$, 39 mg; KI, 2.4 mg; Na_2SeO_3, 657 μg; 6-phytase EC 3.1.3.26, 750 FTU; endo-1, 4-β-xylanase EC 3.2.1.8, 2250 U.
[2]AMT group: 1 g/kg during day 0 to day 10, 0.75 g/kg during day 10 to day 20, 0.5 g/kg during day 20 to day 34.

(ADG), average daily feed intake (ADFI) and feed conversion ratio (FCR) values were calculated for each pen. At days 20 and 34, the gait score of each bird was characterised according to a three-point gait-scoring system: 0 = no impairment of walking ability; 1 = obvious impairment, but still ambulatory; 2 = severe impairment and inability to walk without great difficulty. At 34 days of age, one bird exhibiting the average BW for the pen was chosen and marked to measure the carcass yield. Following a 12-h overnight fast, all of the chickens were sent to a commercial slaughter house and stunned in water bath (125 Hz AC, 80 mA/birds, 5 s) before killing via exsanguination. The dressing percentage was calculated by dividing the eviscerated weight by the live weight. Breast muscle was removed and weighed, and the breast muscle yield was calculated as the percentage of eviscerated weight.

Experiment 2

In total, 96 crossbred weaned barrow piglets (Stambo HBI × Dalland, 24 days old, 8.04 ± 1.32 BW) were selected for a 42-day experiment from a commercial swine herd. All of the piglets were vaccinated for *Mycoplasma hyopneumoniae* at 2 days of age. The piglets were randomly allotted to two dietary treatments according to their initial BW (12 replicates of four piglets each per treatment). The experimental unit was defined as one pen. The two dietary treatments consisted of two different diets: (1) control (CTR), basal diet; and (2) AMT, basal diet + emulsifier (2 g/kg from day 0 to day 14 and 1.5 g/kg from day 14 to day 42 of the trial). All of the diets were provided in pellet form and were formulated to meet the recommended requirements of the NRC (2012) for a feeding programme (Table 2). The piglets were housed in one environmentally regulated room with a slatted plastic floor (4 piglets/pen, 1.20 × 1.00 m). Each pen was equipped with a one-sided self-feeder and a nipple waterer to allow the pigs *ad libitum* access to feed and water throughout the experimental period. The temperature of the pig barn was set between 26°C and 28°C, with a 12-h light : dark cycle. All of the piglets were individually weighed on days 0, 14, 28 and 42 of the trial. The ADG, ADFI and FCR values were calculated for each pen.

Statistical analysis

The data from both experiments were analysed in accordance with the GLM Procedure of SAS version 9.2 (SAS Institute Inc., Cary, NC, USA). The pen was used as the experimental unit for the growth performance of the chickens and piglets, whereas the individual chicken was considered to be the experimental unit for the carcass yield of chickens. The gait score data were analysed using the MIXED procedure for repeated measurements, and the pen represented the experimental unit. Treatment differences were assessed via the least squares means with the Tukey adjustment. Treatment effects were considered significant at $P \leqslant 0.05$, whereas a trend for a treatment effect was noted for $P \leqslant 0.10$.

Results

The effects of the AMT on the BW, ADG, ADFI and FCR of chickens for fattening are shown in Table 3. There was no detectable effect of the diet on BW from day 0 to day 10 ($P > 0.05$). AMT supplementation increased BW compared with the CTR group on day 20 and day 34 ($P < 0.01$). An increased ADG was observed in the AMT chickens in comparison with the CTR birds from day 10 to day 20, from day 20 to day 34 and from day 0 to day 34 ($P < 0.01$). Compared with the CTR group, dietary AMT supplementation increased the ADFI from day 10 to day 20, from day 20 to day 34 and from day 0 to day 34 ($P < 0.01$). In addition, AMT supplementation tended to increase the ADFI from day 0 to day 10 compared with the CTR diet ($P = 0.09$). A reduced FCR was observed in the AMT group compared with the CTR group from day 10 to day 20, whereas the AMT chickens exhibited a higher FCR than the CTR birds from day 0 to day 10 and from day 20 to day 34 ($P < 0.01$). AMT supplementation significantly increased the percentages of dressing and breast muscle ($P < 0.01$, $P < 0.01$, respectively). The gait scores of the AMT chickens were lower than those of the CTR birds on day 20 and day 34 ($P < 0.01$; Table 4). A significant interaction between the diet and age was observed ($P < 0.01$), which was due to the decreased values recorded from day 20 to day 34 in the CTR group ($P < 0.01$), whereas there was no change in the AMT group.

The effects of AMT supplementation on the growth performance of weaned piglets are shown in Table 5. The AMT piglets presented a higher ADFI compared with the CTR group from day 28 to day 42 ($P = 0.04$). In addition, AMT supplementation tended to increase the ADFI from day 0 to day 42 ($P = 0.098$) and numerically increased the ADG from day 28 to day 42 ($P = 0.11$). The addition of AMT to diet also promoted greater mean BW on day 42 (30.40 kg), although in this case, the difference compared with the CTR group (28.98 kg) was not significant ($P = 0.29$).

Discussion

This experiment was performed with the aim of evaluating the effect of a synthetic emulsifier, consisting of vegetal bi-distillated oleic acid emulsified with glyceryl polyethyleneglycol ricinoleate, on the growth performance of chickens for fattening and weaned piglets. The results showed that the addition of emulsifier to the feed significantly increased the ADG and ADFI of chickens for fattening and tended to increase the ADFI of weaned piglets during the entire experimental period, which is in agreement with the findings of previous studies (Xing *et al*., 2004; Roy *et al*., 2010; Price *et al*., 2013). The increased growth and feed intake may be due to certain effects of the dietary emulsifier on pellet quality and fat digestibility (Jones *et al*., 1992; Roy *et al*., 2010).

It is well known that emulsifiers can reduce the surface tension of water and increase the penetration and improve the distribution of water in press meal (van der Heijden and

Table 2 *Ingredient and calculated analysis of the basal diet for weaned piglets (as-fed basis)*

	Prestarter (0 to 14 days)		Starter (14 to 42 days)	
	CTR	AMT	CTR	AMT
Ingredients (%)				
Maize	14.00	14.00	15.00	15.00
Barley	16.28	16.28	16.39	16.39
Wheat	15.00	15.00	12.00	12.00
Rolled barley	10.00	10.00	6.00	6.00
Soybean meal (49% CP)	7.00	7.00	10.00	10.00
Whey	8.00	8.00	6.00	6.00
Wheat bran	4.00	4.00	6.00	6.00
Corn flakes	8.00	8.00	6.00	6.00
Corn gluten meal	3.00	3.00	3.00	3.00
Soy protein concentrate	4.00	4.00	3.00	3.00
Rice flour	0	0	4.00	4.00
Soybean oil	1.50	1.50	2.50	2.50
Coconut oil	1.50	1.50	1.50	1.50
Beet pulp	4.00	4.00	4.00	4.00
Sugar cane molasses	0	0	1.00	1.00
Sodium chloride	0.25	0.25	0.30	0.30
Calcium carbonate	0.60	0.60	0.65	0.65
Dicalcium phosphate (18%)	0.65	0.65	0.50	0.50
Citric acid	0.50	0.50	0.50	0.50
DL-Methionine	0.24	0.24	0.20	0.20
L-Tryptophan	0.06	0.06	0.04	0.04
L-Threonine	0.20	0.20	0.22	0.22
L-Lysine HCl	0.72	0.72	0.70	0.70
Premix[1]	0.50	0.50	0.50	0.50
EM[2]	0	0.20	–	0.15
Calculated composition				
ME (MJ/kg)	13.40	13.40	13.65	13.65
CP (%)	16.60	16.60	17.20	17.20
Crude fat (%)	4.50	4.50	5.50	5.50
Calcium (%)	0.55	0.55	0.55	0.55
Phosphorus (%)	0.50	0.50	0.48	0.48
Copper (mg/kg)	140	140	140	140
Analysed composition				
CP (%)	17.50	17.26	18.60	18.05
Crude fat (%)	4.30	4.03	5.53	5.56

CTR = basal diet without supplementation; AMT = CTR + EM; EM = emulsifier; ME = metabolisable energy.
[1]Provided the following per kilogram of diet: vitamin A, 20 000 IU; vitamin D_3, 2000 IU; vitamin E, 100 mg; $MnSO_4 \cdot 1H_2O$, 154 mg; $ZnSO_4 \cdot 1H_2O$, 356 mg; $FeSO_4 \cdot 1H_2O$, 425 mg; $CuSO_4 \cdot 5H_2O$, 628 mg; KI, 3.1 mg; Na_2SeO_3, 657 μg; 6-phytase EC 3.1.3.26, 1500 FTU; endo-1, 4-β-xylanase EC 3.2.1.8, 1220 U; endo-1, 3(4)-β-glucanase EC 3.2.1.6, 125 U; citric acid, 5000 mg.
[2]AMT group: 2 g/kg during day 0 to day 14, 1.5 g/kg during day 14 to day 42.

de Haan, 2010). In the current study, the AMT product was mixed with feed compounds before pelleting process, which may increase humidity, reduce pellet press energy consumption and improve pellet quality by modulating the moisture content during the pelleting process and, consequently, improve feed intake and performance of animals. Lecithin, as an emulsifier, has been reported to enhance the apparent digestibility of unsaturated fatty acids in lard (Soares and Lopez-Bote, 2002). Dierick and Decuypere (2004) reported that the addition of an emulsifier improved the digestibility of major nutrients, which may reduce the viscosity of the digestive contents and increase the transit of the digesta as well as feed intake (Lázaro *et al*., 2004). In this study, the incorporation of vegetal bi-distillated oleic acid and glyceryl polyethyleneglycol ricinoleate may have also improved the growth performance of animals via the emulsification of supplemental fatty acids (Xing *et al*., 2004). However, there was no significant influence of AMT supplementation on the ADFI during the first phase in the chickens and piglets, possibly due to the insufficient digestion and absorption of fat in young animals (Dierick and Decuypere, 2004).

In experiment 1, a high incidence of tibial dyschondroplasia, an abnormality of the growth cartilage that occurs in chickens, was observed in the CTR chickens on day 20 and day 34, which may have been due to the rapid growth rate

Table 3 *Effect of emulsifier (EM) supplementation on growth performance of chickens for fattening*

Items	CTR	AMT	SEM	*P* value
Number of pens	24	24		
BW (g)				
day 0	44.3	44.6	0.2	0.37
day 10	306	303	1	0.20
day 20	728	855	6	<0.01
day 34	1792	2101	17	<0.01
ADG (g/day)				
day 0 to day 10	26.2	25.8	0.2	0.16
day 10 to day 20	42.2	55.2	0.6	<0.01
day 20 to day 34	76.0	89.0	1.0	<0.01
day 0 to day 34	51.4	60.5	0.5	<0.01
ADFI (g/day)				
day 0 to day 10	34.3	34.9	0.2	0.09
day 10 to day 20	67.8	79.3	0.6	<0.01
day 20 to day 34	119.7	144.2	1.2	<0.01
day 0 to day 34	79.3	93.0	0.6	<0.01
FCR (feed/gain)				
day 0 to day 10	1.31	1.35	0.01	<0.01
day 10 to day 20	1.61	1.44	0.01	<0.01
day 20 to day 34	1.58	1.62	0.01	<0.01
day 0 to day 34	1.54	1.54	0.01	0.52
Mortality (%)	0.83	0.83	0.58	–
Carcass yield at day 35 (%)[1]				
Dressing	68.44	71.18	0.29	<0.01
Breast muscle	28.84	31.92	0.48	<0.01

CTR = basal diet without supplementation; AMT = CTR + EM (1 g/kg during day 0 to day 10, 0.75 g/kg during day 10 to day 20 and 0.5 g/kg during day 20 to day 34); ADG = average daily gain; ADFI = average daily feed intake; FCR = feed conversion ratio.
[1]The dressing percentage was calculated by dividing the eviscerated weight by the live weight and breast muscle yield was calculated as the percentage of eviscerated weight.

Table 4 *Effect of emulsifier (EM) supplementation on gait score[1] of chickens for fattening*

				P value		
	CTR	AMT	Pooled SEM	Diet	Age	Interaction
day 20	0.588[A]	0.004[C]	0.027	<0.01	<0.01	<0.01
day 34	0.139[B]	0.004[C]				

CTR = basal diet without supplementation; AMT = CTR + EM (1 g/kg during day 0 to day 10, 0.75 g/kg during day 10 to day 20 and 0.5 g/kg during day 20 to day 34).
[A,B,C]Values within the same column or row with different superscripts differ significantly at $P < 0.01$.
[1]Gait scores were recorded using a three-point scoring system: 0 = none; 1 = obvious impairment; 2 = severe impairment.

(Kestin *et al*., 1999) and the broiler strain used (Dinev *et al*., 2012). Leg problems are of serious consequence for welfare as lame birds have difficulty reaching diet and water (Mc Geown *et al*., 1999), and seriously lame birds may lose weight (Kestin *et al*., 1999). However, the growth of the CTR chickens in our study was normal compared with the reference value (Cobb Vantress, 2013; weight on day 34, 1792 *v*. 1829 g). Interestingly, our results indicated that there was no incidence of poor gait in the AMT group during the entire experimental trial, which may due to the possible improvements in the pellet quality and nutrients digestibility of birds by AMT supplementation. However, the present data are insufficient to demonstrate that the lack of leg weakness in the AMT chickens was due to emulsifier supplementation, more research should be conducted to identify the effect of emulsifier on nutrients absorption and determine whether it would influence the incidence of leg weakness. In addition, increased feed intake was observed in the weaned piglets during the last period in experiment 2, which may suggest that the synthetic emulsifier can positively affect growth performance for both chickens and piglets by increasing feed intake. However, the effect of the emulsifier on the growth of piglets was weaker than on chickens, possibly due to the high copper intake of the piglets. The piglets' diets contained 140 mg/kg copper, which is close to the maximum authorised level for weaned piglets (175 mg/kg) according to the EU (European Commission, 2003) and could affect the gut flora (Højberg *et al*., 2005), the metabolism of bile acids (Deol *et al*., 1992) and eventually interfere with the effect of the emulsifier. It has been reported that the dietary fat level may influence the apparent fat digestibility (Lauridsen *et al*., 2007). In this study, the fat intake of piglets was lower than chickens, which may also influence the effect of the emulsifier. The digestive system of swine is monogastric that is

Table 5 *Effect of emulsifier (EM) supplementation on growth performance of weaned piglets*

	CTR	AMT	SEM	*P* value
Number of pens	12	12		
BW (kg)				
day 0	8.03	8.05	0.39	0.98
day 14	11.66	11.96	0.53	0.70
day 28	19.17	19.87	0.76	0.52
day 42	28.98	30.40	0.91	0.29
ADG (g/day)				
day 0 to day 14	259	279	14	0.34
day 14 to day 28	536	567	20	0.31
day 28 to day 42	701	752	21	0.11
day 0 to day 42	499	532	15	0.14
ADFI (g/day)				
day 0 to day 14	358	388	21	0.32
day 14 to day 28	770	829	34	0.23
day 28 to day 42	1131	1264	43	0.04
day 0 to day 42	753	827	30	0.098
FCR (feed/gain)				
day 0 to day 14	1.38	1.39	0.03	0.88
day 14 to day 28	1.44	1.46	0.02	0.26
day 28 to day 42	1.63	1.68	0.04	0.40
day 0 to day 42	1.51	1.55	0.02	0.23
Mortality (%)	0	0	–	–

CTR = basal diet without supplementation; AMT = CTR + EM (2 g/kg during day 0 to day 14, 1.5 g/kg during day 14 to day 42); ADG = average daily gain; ADFI = average daily feed intake; FCR = feed conversion ratio.

different from the avian digestive system found in poultry. Jones *et al.* (1992) concluded that addition of emulsifiers increased digestibility of nutrients but had minimal effect on growth performance in weanling pigs. In addition, the CTR chickens had better FCR than the AMT birds during the finishing phase, possibly due to the improved feed efficiency during compensatory growth when the tibias of the CTR chickens were recovering from day 20 to day 34 (Zubaira and Leeson, 1996). Scheele (1997) noted that the growth of the pectoral muscles primarily occurs during the late stages of developmental growth in fast-growing birds. In the present study, an increased slaughter yield was also observed in the treated group, suggesting that the relatively rapid growth of the AMT-fed chickens in the grower and finisher phases may have contributed to the comparable increases in carcass and breast muscle yields. The increased growth performance recorded in the present work was probably supported by digestive and physiological mechanisms/processes (Dierick and Decuypere, 2004; Roy *et al.*, 2010); however, these processes were not considered in our experiments. Future studies are in progress to specifically assess the possible improvement of digestibility and fat utilisation.

In conclusion, the current observations indicated that the supplementation of a novel synthetic emulsifier consisting of vegetal bi-distillated oleic acid and glyceryl polyethyleneglycol ricinoleate has the potential to significantly improve the growth performance of chickens for fattening, although only numerical improvements were noted in the growth performance of weaned piglets under supplementation with the synthetic emulsifier product.

Acknowledgements

This work was funded by SEVECOM S.P.A., Milan, Italy. The authors gratefully acknowledge Dr Roberto Bombardieri, and Dr Roberto Zaupa and Paolo Chignola (Veronesi Group) for kind support and technical assistance.

References

Al-Marzooqi W and Leeson S 1999. Evaluation of dietary supplements of lipase, detergent, and crude porcine pancreas on fat utilization by young broiler chicks. Poultry Science 78, 1561–1566.

Cobb Vantress 2013. Cobb500 broiler performance and nutrition supplement. Retrieved January 24, 2014, from http://cobb-vantress.com/docs/default-source/cobb-500-guides/cobb500-broiler-performance-nutrition-supplement-(english).pdf.

Deol HS, Howell JM, Dorling PR and Symonds HW 1992. The effect of copper and heliotrope on the composition of bile in sheep. Research in Veterinary Science 53, 324–330.

Dierick N and Decuypere J 2004. Influence of lipase and/or emulsifier addition on the ileal and faecal nutrient digestibility in growing pigs fed diets containing 4% animal fat. Journal of the Science of Food and Agriculture 84, 1443–1450.

Dinev I, Denev SA and Edens FW 2012. Comparative clinical and morphological studies on the incidence of tibial dyschondroplasia as a cause of lameness in three commercial lines of broiler chickens. The Journal of Applied Poultry Research 21, 637–644.

European Commission 2003. Opinion of the Scientific Committee for Animal Nutrition on the Use of Copper in Feedingstuffs. In Health & Consumer Protection Directorate General, Directorate C – Scientific Opinions, C2 Management of Scientific Committees, pp. 1–47. Scientific Co-operation and Networks, Brussels, Belgium.

Højberg O, Canibe N, Poulsen HD, Hedemann MS and Jensen BB 2005. Influence of dietary zinc oxide and copper sulfate on the gastrointestinal ecosystem in newly weaned piglets. Applied and Environmental Microbiology 71, 2267–2277.

Jones DB, Hancock JD, Harmon DL and Walker CE 1992. Effects of exogenous emulsifiers and fat sources on nutrient digestibility, serum lipids, and growth performance in weanling pigs. Journal of Animal Science 70, 3473–3482.

Kestin SC, Su G and Sørensen P 1999. Different commercial broiler crosses have different susceptibilities to leg weakness. Poultry Science 78, 1085–1090.

Lauridsen C, Bruun Christensen T, Halekoh U and Krogh Jensen S 2007. Alternative fat sources to animal fat for pigs. Lipid Technology 19, 156–159.

Lázaro R, Latorre MA, Medel P, Gracia M and Mateos GG 2004. Feeding regimen and enzyme supplementation to rye-based diets for broilers. Poultry Science 83, 152–160.

Lewis DS, Oren S, Wang X, Moyer ML, Beitz DC, Knight TJ and Mott GE 2000. Developmental changes in cholesterol 7alpha- and 27-hydroxylases in the piglet. Journal of Animal Science 78, 943–951.

Mc Geown D, Danbury TC, Waterman-Pearson AE and Kestin SC 1999. Effect of carprofen on lameness in broiler chickens. Veterinary Record 144, 668–671.

National Research Council (NRC) 1994. Nutrient requirements of poultry, 9th revised edition National Academies Press, Washington, DC, USA.

National Research Council (NRC) 2012. Nutrient requirements of swine, 11th revised edition. National Academies Press, Washington, DC, USA.

Price KL, Lin X, van Heugten E, Odle R, Willis G and Odle J 2013. Diet physical form, fatty acid chain length, and emulsification alter fat utilization and growth of newly weaned pigs. Journal of Animal Science 91, 783–792.

Roy A, Haldar S, Mondal S and Ghosh TK 2010. Effects of supplemental exogenous emulsifier on performance, nutrient metabolism, and serum lipid profile in broiler chickens. Veterinary Medicine International 2010, 1–9.

Saunders DR and Sillery J 1976. Lecithin inhibits fatty acid and bile salt absorption from rat small intestine in vivo. Lipids 11, 830–832.

Scheele C 1997. Pathological changes in metabolism of poultry related to increasing production levels. Veterinary Quarterly 19, 127–130.

Soares M and Lopez-Bote CJ 2002. Effects of dietary lecithin and fat unsaturation on nutrient utilisation in weaned piglets. Animal Feed Science and Technology 95, 169–177.

Van der Heijden M and de Haan D 2010. Optimising moisture while maintaining feed quality. All About Feed 1, 29–31.

Xing JJ, van Heugten E, Lit DF, Touchette KJ, Coalson JA, Odgaard RL and Odle J 2004. Effects of emulsification, fat encapsulation, and pelleting on weanling pig performance and nutrient digestibility. Journal of Animal Science 82, 2601–2609.

Zubair AK and Leeson S 1996. Compensatory growth in the broiler chicken: a review. World's Poultry Science Journal 52, 189–201.