



Effect of Different Levels of Biotronic® Top Forte (Commercial blended organic acids) as a Replacement for Antibiotic Growth Promoter on the Growth Performance and Villi Morphology of Pullet Chicks (0 - 8weeks)

Agbai, K. N., Oimage, J. J., Sekoni, A. A., Afolayan, M.

Department of Animal Science, Ahmadu Bello University, PMB 1046, Zaria

Abstract

This study was conducted to evaluate the efficacy of Biotronic® Top Forte (combined organic acids and their salts with a phytochemical) as alternatives to the conventional antibiotics used as an antibiotic growth promoter. Six hundred and thirty (630) intensively managed day old pullet chicks were used for the experiment. The chicks were randomly assigned into seven treatment groups administered, 0, 100, 200, 300, 400, 500g of Biotronic® Top Forte, oxytetracycline as positive control and defined as T₁, T₂, T₃, T₄, T₅, T₆ and T₇, respectively. Growth parameters (weight gain, total feed intake, feed/gain ratio, and feed cost/kg gain) indices were measured. Collected data were subjected to one way Analysis of Variance and significant means were separated using Duncan's Multiple Range Tests at 95% probability. Results showed a significant ($p < 0.05$) influence of Biotronic® Top Forte on weight gain, feed intake, feed/gain ratio and feed cost/kg gain. The birds on 500 g inclusion had better weight gain (706.56 g), feed/gain ratio (2.34), feed cost/Kg gain (₦292.10) and villi area (22151.43 μm), villi width (169.42) when compared with 0% inclusion and oxtetracycline diets. 500 g/100kg Biotronic® Top Forte inclusion significantly lowered the cost of production than the 0% inclusion and the AGPs treatments to 16.33% in this study. It was concluded that Biotronic® Top Forte inclusion at 500 g enhanced growth performance of Pullet Chicks from 0 up to 8 weeks of age compared to other treatments.

Keywords: Performance, Organic acids, Villi, Morphology and Phytochemical

Introduction

High levels of production and efficient feed conversion are the need of the modern poultry industry, which to a certain extent could be achieved by the use of specific feed additives. Antibiotic feed additives as growth promoters have long been supplemented to poultry feed to stabilize the intestinal microbial flora, improve the general performances and prevent some specific intestinal pathology (Hassan *et al.*, 2010). However, due to the emergence of microbes resistant to antibiotics which are used to treat human and animal infections, the European Commission (EC) decided to phase out, and ultimately ban (1 January 2006), the marketing and use of antibiotics as

growth promoters in feed (European Food Safety Authority [EFSA], 2015). In other countries, such as the USA, consumer pressure is pushing the poultry industry to rear birds without antibiotics (Castanon, 2007). Antibiotics removal has led to poultry performance problems, feed conversion increases and a rise in the incidence of certain animal diseases, such as (subclinical) necrotic enteritis (Dibner and Richards, 2005). Such a situation has compelled the researchers to explore the utility of other non-therapeutic alternatives like organic acids, enzymes, probiotics, prebiotics, herbs, essential oils and immune stimulants as feed additives in poultry production. There have been a significantly increased number of

nellyhelen89@gmail.com

+23408038685777

studies focused on searching for alternatives to antibiotics with similar antimicrobial and growth-promoting effects without inducing bacterial resistance and potential side effects to animals. Organic acids (Eckel *et al.*, 1992; De Lange *et al.*, 2010), enzymes (Bedford and Cowieson, 2012), prebiotics (Gibson *et al.*, 2004), probiotics (Musa *et al.*, 2009), antimicrobial peptide (Choi *et al.*, 2013) and phytogenic compounds (Yang *et al.*, 2007; Windisch *et al.*, 2008; Randrianarivelo *et al.*, 2010; Gong *et al.*, 2014) have been widely recognized as potential alternatives to antibiotics in feed. Among these alternatives, dietary organic acids have gained greater attention because of their antimicrobial activity against pathogenic bacteria and the fact that these compounds can induce a pH reduction in the gastrointestinal tract (GIT), which can improve nutrient utilization in poultry diets (Eidelsburger *et al.*, 1992; Boling *et al.*, 2000; Partanen, 2001; Kil *et al.*, 2011). Dietary acids for poultry diets are classified as inorganic and organic acids. However, organic acids have been more often used for poultry diets. Organic acid treatments composed of individual acids and blends of several acids have been found to perform antimicrobial activities similar to those of antibiotics (Wang *et al.*, 2009).

The European Union allowed the use of organic acids and their salts in poultry production because these are generally considered safe (Adil *et al.*, 2010). As a group of chemicals, organic acids are considered to be any organic carboxylic acid of the general structure R-COOH (including fatty acids and amino acids). The short-chain acids (C1–C7) are associated with antimicrobial activity. They are either simple mono-carboxylic acids such as formic, acetic, propionic and butyric acids or carboxylic acids with the hydroxyl group such as lactic, malic, tartaric and citric acids or short-chain carboxylic acids containing

double bonds like fumaric and sorbic acids (Shahidi *et al.*, 2014). Organic acids are weak acids and are only partly dissociated. The use of organic acids has been reported to protect the young chicks by competitive exclusion (Mansoub *et al.*, 2011), enhancement of nutrient utilization, growth and feed conversion efficiency (Lückstädt and Mellor, 2011). The Biotronic® Top Forte combines selected organic acids and their salts with a phytochemical and the unique Biomin® Permeabilizing Complex fully utilizing a unique synergism in their mode of action. The Biomin® Permeabilizing Complex boosts the activity of the active ingredients (the organic acids and the phytochemical) and facilitates their entry by permeating the outer membrane of Gram-negative bacteria (Biomin, 2018). This present study reviews the effect of organic acids on general growth and cost performance of pullet chicks from 0 to 8 weeks of age.

Materials and Methods

The study was carried out at the Poultry Laying Unit, Teaching and Research Farm, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria. Day old pullet chicks were purchased from Olam Hatcheries Limited, Dutse Village, Chikun Local Government, Kilometer 25, Kaduna-Expressway, Kaduna State, Nigeria. Six hundred and thirty (630) day old pullet chicks were allocated to seven dietary treatments with 3 replicates of 30 birds each in a completely randomized design (CRD). The birds were housed in deep litter pens and managed with all necessary routine management practices. Feed and water was provided *ad libitum* for the period of the experiment. Birds were cared for according to guidelines established by the University Animal Care Committee. Seven diets were formulated as shown

below. The Biotronic® Top Forte was added as non-inclusive part of the diets.

Diet 1: (Control diet) – without Biotronic® Top Forte or oxytetracycline

Diet 2: (Control diet) + 100g of Biotronic® Top Forte /100 Kg diet

Diet 3: (Control diet) + 200g of Biotronic® Top Forte /100 Kg diet

Diet 4: (Control diet) + 300g of Biotronic® Top Forte /100 Kg diet

Diet 5: (Control diet) + 400g of Biotronic® Top Forte /100 Kg diet

Diet 6: (Control diet) + 500g of Biotronic® Top Forte /100 Kg diet

Diet 7: (Control diet) + Oxytetracycline at 0.8g/100Kg diet (as recommended by manufacturer).

Recommended dosage for Biotronic® Top Forte is 1.85 – 4.50 kg/tonne of feed. Proximate analysis of the sample of experimental diets as shown in Table 1 was done at the Biochemical Laboratory, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria according to methods described by A.O.A.C. (2005).

Growth study: Initial and final weights of birds were taken at the beginning and at the end of the study. Weight gain and feed intake were measured at the end of every 2weeks while feed/gain ratio and cost/Kg gain was computed at the end of the study. There was no mortality recorded during the experimental period.

Villi Morphology: Intestinal segment samples (approximately 2cm in length) of ileum were taken from slaughtered birds to ascertain villi morphology parameters. The morphology indices that were evaluated included; villus height (from the tip of the villus to the crypt), crypt depth (from the base of the villi to the sub mucosa), and the villus height to crypt depth as described by Zhang *et al.*; (2005). This was carried out at

the Histology Laboratory of the Department of Anatomy, Ahmadu Bello University Zaria.

Statistical Analysis

All data obtained were statistically analysed using the General Linear Model Procedure of Statistical Analysis Systems (SAS, 2002). Significant difference between treatments means were separated using Dunnett's test in the SAS package.

Experimental Model

The linear model for the experiment is:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Y_{ij} = performance of j^{th} animal fed i^{th} levels of Biotronic® Top Forte

μ = Overall mean

T_i = i^{th} effect of treatment

e_{ij} = Random Error

Results and Discussion

Table 2 shows the growth performance characteristics of pullet chicks (0-8weeks) fed Biotronic® Top Forte an organic acid (a natural growth promoter) to replace antibiotic as growth promoter. There were significant ($P < 0.05$) difference in final weight, weight gain, feed intake, feed/gain ratio and feed cost/gain. No mortality was recorded. Birds on diet containing 500g inclusion of Biotronic® Top Forte had significantly higher final weight, weight gain, better feed/gain ratio and least cost of production when compared with birds on diet containing 0 inclusion of Biotronic® Top Forte and diet containing oxytetracycline. The least performance was observed for birds fed diet containing 100g inclusion of Biotronic® Top Forte when compared with the birds fed diets containing oxytetracycline and the control. This is as a result of the organic acid (Biotronic® Top Forte) used to enhance effectiveness of nutrients and improved growth performance through establishment of low GIT pH condition by

supporting endogenous digestive enzymes, reducing undesired gut micro-organisms and exert their effects in the gut or on the gut wall cells of the bird. This is an indication that the birds effectively utilized their feed components. Acidifiers constitute an important component of modern feeding strategies without antibiotics. Organic acids are known to have strong antibacterial effects and they have been used in the protection of feed from microbial and fungal destruction (Hedayati *et al.*, 2013). This result agrees with the report of Van Immerseel *et al.*; (2006) and Naseri *et al.*; (2012), that addition of organic acids in diet can have a beneficial effect on the performance of poultry by decreasing pathogenic bacteria. Some authors such as Hebeler *et al.*; (2000); Overland *et al.*; (2000); Walsh *et al.*; (2003); Hernández *et al.*; (2006) also considered them to be a viable alternative to antibiotics in pig feeds where they already have had considerable success.

Villi Morphology of Pullet Chicks Fed Diets Containing Different Levels of Biotronic® Top Forte (0 – 8 Weeks)

Table 3 shows the result of the effect of diets containing graded Levels of Biotronic® Top Forte on villi morphology of ileum section of pullet chicks. There were significant ($P < 0.05$) differences in all parameters measured except for crypt depth. Birds on diet containing 500g Biotronic® Top Forte had significantly ($P < 0.05$) higher villi area (22151.4 μ m) and villi width (169.42mm) when compared with birds on the control diet (21218.57 μ m and 148.73mm²), diet containing oxytetracycline (5950.97 μ m and 66.67mm²) and birds on other treatments. No significant ($P > 0.05$) differences observed for crypt depth across all treatments and Villi height except for birds on diet containing oxytetracycline, having least villi height (127.07 mm).

Good intestinal health in the poultry industry is of great importance to achieve target growth rates and feed efficiency. The significant increase observed on the villi area, villi perimeter, villi height and villi width in birds on 500g inclusion of Biotronic® Top Forte may be as a result of organic acid aiding the role of the intestinal epithelium as a natural barrier against pathogenic bacteria, toxic substance that are present in the intestinal lumen and stimulate the proliferation of crypt cells, enhancing healthy tissue turn over and maintenance which brings about effective feed utilization. This agrees with the report of Iji and Tivey, (1998) who reported that organic salts reduced intestinal colonization and infectious process, thereby, decreased inflammatory process at the intestinal mucosa, this improved villus height and function of secretion, digestion and absorption of nutrients. It also agrees with the report of Kum *et al.*; (2010) and Rodríguez-Leconte *et al.*; (2012) who reported that organic acid supplementation significantly increased the villus width, height and area of the duodenum, jejunum and ileum of broiler chicks at 14 days of age. García *et al.* (2007) reported that broilers fed diets containing formic acid had the longest villi (1273 and 1250 μ m for 0.5 and 1.0% formic acid, respectively) compared with control (1088 μ m). Organic acid could be helpful in young birds for the development of the intestine.

Conclusion

It was concluded that Biotronic® Top Forte at 500g/100kg inclusion enhanced growth performance and improve profitability of pullets Chicks from 0 to 8weeks of age compared to other treatments.

References

A.O.A.C (2005). Official methods of analysis, *Association of official analytical*

chemist 17th Edition, Washington D.C, USA.

Adil, S., Tufail, B., Gulam, A. B., Masood, S. and Manzoor, R. (2010). Effect of dietary supplementation of organic acids on performance, intestinal histomorphology, and serum biochemistry of broiler chicken. *Veterinary Medicine International*. 2010:1–7. Article ID 479485.

Bedford, M.R. and Cowieson A..J. (2012). Exogenous enzymes and their effects on intestinal microbiology. *Animal Feed Science. Technology*, 173:76–85

Biomin, (2018). Biomin GmbH. Erber campus 1, 3131 Getzersdorf, Austria.

Boling, S.D., Webel, D.M., Mavromichalis, I., Parsons, C.M and Baker, D.H. (2000). The effects of citric acid on phytate phosphorus utilization in young chicks and pigs. *Journal of Animal Sciences*, 78:682–689

Castanon, J. I. (2007). History of the use of antibiotic growth promoters in European poultry feeds. *Journal of Poultry Science*. 86:2466–2471.

Choi, S.C., Ingale, S.L., Kim, J.S., Park, Y.K., Kwon, I.K. and Chae, B.J. (2013). An antimicrobial peptide-A3: Effects on growth performance, nutrient retention, intestinal and faecal microflora and intestinal morphology of broilers. *British Poultry Science*, 54:738–746. doi: 10.1080/00071668.2013.838746.

De Lange, C.F.M., Pluske J.R., Gong J. and Nyachoti C.M. (2010). Strategic use of feed ingredients and feed additives to stimulate gut health and development in young pigs. *Livestock Sciences*, 134:124–134.

Dibner, J. J. and Richards, J. D. (2005). Antibiotic growth promoters in agriculture: history and mode of action. *Journal of Poultry Science*. 84:634–643.

Eckel, B., Kirchgessner M. and Roth F.X. (1992). Influence of formic acid on daily weight gain, feed intake, feed conversion rate and digestibility. *Journal of Animal Physiology and Animal Nutrition*; 67:93–100. doi: 10.1111/j.1439-0396.1992.tb00588.x.

European Food Safety Authority) [EFSA] (2015). Scientific Opinion on the safety and efficacy of citric acid when used as a technological additive (acidity regulator) for all animal species. *EFSA Journal*, 13(2):4010.

Eidelsburger, U., Kirchgessner, M. and Roth, F. X. (1992). Influence of formic acid, calcium formate and sodium bicarbonate on pH, concentration of carbonic acids and ammonia in different segments of the gastrointestinal tract: 8 liberation. Nutritive value of organic acids in piglet rearing. *Journal of Animal Physiology*, 68:20–32.

García, V., Catalá-Gregori, P., Hernández, F., Megías, M. D. and Madrid, J. (2007). Effect of formic acid and plant extracts on growth, nutrient digestibility, intestine mucosa morphology, and meat yield of broilers. *Journal of Applied Poultry Research*. 16:555–562.

Gibson G.R., Probert H.M., Loo J.V., Rastall R.A. and Roberfroid M.B.(2004). Dietary modulation of the human colonic microbiota: Updating the concept of prebiotics. *Nutrition. Review. Revised.*, 17:259–275. doi: 10.1079/NRR200479.

Gong, J., Yin, F., Hou, Y. and Yin, Y. (2014). Chinese herbs as alternatives to antibiotics in feed for swine and poultry production: Potential and challenges in application. *Canadian Journal of Animal Sciences*, 94:223–241. doi: 10.4141/cjas2013-144.

- Hassan, H.M.A., Mohamed, M.A., Youssef, A.W. and Hassan, E.R. (2010). Effect of using organic acids to substitute antibiotic growth promoters on performance and intestinal microflora of broilers. *Asian-Australian Journal of Animal Science*. 23(10):1348– 1353.
- Hebeler, D., Kulla, S., Winkenwerder, F.J. and Amtsberg, G. (2000). Influence of a formic-acid-potassium-formate-complex on chime composition as well as on the intestinal microflora of weaned piglets. Hannover 54th *Proceedings Socety of Nutrition Physiologists*. Göttingen, Germany. March 7-9
- Hedayati, M., Manafi, M. and Vafaei, P. (2013). Effects of supplementing diets with an acidifier on performance parameters and visceral organ weights of broilers. *European Journal Zoology Resource*, 2(6):49-55.
- Hernández, F., García, V., Madrid, J., Orenge, J. and Catalá, P. (2006). Effect of formic acid on performance, digestibility, intestinal histomorphology and plasma metabolite levels of broiler chickens. *British Journal of Poultry Science*. 47:50–56.
- Iji, P. A., and Tivey, D. R. (1998). Natural and synthetic oligosaccharide in broiler chicken diet. *World's Poultry Science Journal*. 54:129–143.
- Kil, D.Y., Kwon, W.B. and Kim, B.G. (2011). Dietary acidifiers in weanling pig diets: A review *Rev Colomb Cienc Pecu*, 24:231-247.
- Kum, S., Eren, U., Onol, A. and Sandikci, M. (2010). Effects of dietary organic acid supplementation on the intestinal mucosa in broilers. *Revue de Médecine Vétérinaire*. 161:463–468.
- Lückstädt, C. and Mellor, S. (2011). The use of organic acids in animal nutrition, with special focus on dietary potassium diformate under European and Austral-Asian conditions. *Recent Advances in Animal Nutrition Australia*. 18:123–130.
- Mansoub, N.H, Karim, R., Leila, M., Mohammad, A.M.N., Seyede, L.Z. and Mehdi, M.K. (2011). Effect of different level of butyric acid glycerides on performance and serum composition of broiler chickens. *World Journal of Zoology*. 6(2):179–182.
- Musa, H.H., Wu, S.L., Zhu, C.H., Seri, H.I. and Zhu, G.Q. (2009). The potential benefits of probiotics in animal production and health. *Journal Animal Veterinary Advances*, 8:313–321.
- Naseri, K.G, Rahimi, S. and Khaki, P. (2012). Comparison of the effects of probiotic, organic acid and medicinal plant on *Campylobacter jejuni* challenged broiler chickens. *Journal of Agricultural Science and Technology*. 14:1485–1496.
- Overland, M.T., Granli, N.P., Kjos, Fjetland, Steien, S.H. and Stokstad, M. (2000). Effect of dietary formates on growth performance, carcass traits, sensory quality, intestinal microflora and stomach alterations in growing-finishing pigs. *Journal Animal Science*, 78: 1875-1884.
- Partanen, K. (2001) Organic acids-their efficacy and modes of action in pigs. In: Piva K. E, Knudsen, B. and Lindberg, J.E., (editors). *Gut environment of pigs*. Nottingham UK: Nottingham University Press; p.201-17.
- Randrianarivelo, R., Danthu P., Benoit, C., Ruez P., Raherimandimby, M., and Starter S. (2010). Novel alternative to antibiotics in shrimp hatchery: Effects of the essential oil of *Cinnamosma fragrans* on survival and bacterial concentration of *Penaeus monodon* larvae. *Journal of Applied Microbiology*, 109:642–650.

- Rodríguez-Lecompte, J.C., Yitbarek, A., Brady, J., Sharif, S., Cavanagh, M.D., Crow, G., Guenter, W., House, J.D. and Camelo-Jaimes, G. (2012). The effect of microbial nutrient interaction on the immune system of young chicks after early probiotic and organic acid administration. *Journal of Animal Science*. 90:2246–2254.
- SAS, (2002). Statistical Analysis System Institute, User's Guide. Version 9 for Windows. North Carolina, U.S.A.
- Shahidi, S., Maziar, Y. and Delaram, N.Z. (2014). Influence of dietary organic acids supplementation on reproductive performance of freshwater Angelfish (*Pterophyllum scalare*). *Global Vet*. 13:373–377.
- Van Immerseel, F., Russell, J.B., Flythe, M.D., Gantois, I., Timbermont, L., Pasmans, F., Haesebrouck, F. and Ducatelle, R. (2006). The use of organic acids to combat *Salmonella* in poultry: A mechanistic explanation of the efficacy. *Avian Pathology*. 35:182–188.
- Walsh, M., Sholly, D., Kelly, D., Cobb, M., Trapp, S., Hinson, R., Hill, B., Sutton, A., Radcliffe, S., Harmon, B., Smith, J. and Richert, B. (2003). The effects of supplementing weanling pig diets with organic and inorganic acids on growth performance and microbial shedding. Purdue University, Swine Research Report, 89–98.
- Wang, J.P., Yoo, J.S., Lee, J.H., Zhou, T.X., Jang, H.D., Kim, H.J. and Kim, I.H. (2009). Effects of phenyllactic acid on production performance, egg quality parameters, and blood characteristics in laying hens. *Journal of Applied Poultry Research*. 18:203–209.
- Windisch, W., Schedle, K., Plitzer, C. and Kroismayr, A. (2008). Use of phytogetic products as feed additives for swine and poultry. *Journal of Animal Sciences*; 86:140–148. doi: 10.2527/jas.2007-0459.
- Yang, W.Z., Benchaar, C., Ametaj, B.N., Chaves, A.V., He, M.L. and McAllister, T.A. (2007). Effect of garlic and juniper berry essential oils on ruminal fermentation and on the site and extent of digestion in lactating cows. *Journal of Dairy Sciences*, 90:5671–5678. doi: 10.3168/jds.2007-0369.
- Zhang, K.Y., Yan, F., Keen, C.A. and Waldroup, P.W. (2005). Evaluation of microencapsulated essential oils and organic acids in diets for broiler chickens. *International Journal Of Poultry Science*, 4, Pp. 612-619

Table 1: Proximate Composition of Experimental Diets for Pullet Chicks (0 – 8weeks)

Parameters	Composition (%)
Dry matter	90.16
Crude protein	21.68
Ash	7.81
Crude fibre	5.60
Ether Extract	2.40
Nitrogen free Extract	62.51

Table 2: Growth Performance of Pullet Chicks Fed Diet Containing Different Levels of Biotronic® Top Forte (0 – 8 weeks)

Parameters	Levels of Biotronic® Top Forte (g)						Oxytet	SEM
	0	100	200	300	400	500		
Initial Weight (g/bird)	39.00	39.00	39.00	39.00	39.00	39.00	39.00	0.00
Final Weight (g/bird)	697.22 ^c	697.11 ^c	716.67 ^b	725.33 ^b	730.56 ^b	745.56 ^a	700.00 ^c	5.89
Total Weight Gain (g/bird)	658.22 ^c	658.11 ^c	677.67 ^b	686.33 ^b	691.56 ^b	706.56 ^a	661.00 ^c	5.89
Total Feed intake (g/bird)	1841.22 ^a	1805.67 ^a	1784.78 ^a	1735.44 ^b	1735.44 ^b	1737.78 ^{ab}	1654.00 ^c	24.67
Feed/Gain Ratio	2.80 ^d	2.73 ^c	2.63 ^b	2.53 ^b	2.51 ^b	2.34 ^a	2.78 ^c	0.31
Feed Cost/Kg Gain	349.09 ^d	342.41 ^d	328.72 ^c	315.55 ^b	313.62 ^b	292.10 ^a	350.32 ^d	3.85
Cost of total feed intake (₦)	215.34 ^c	211.18 ^b	208.74 ^b	202.98 ^b	203.25 ^b	193.45 ^a	217.13 ^c	2.89

Oxytet: Oxtetracycline. SEM: Standard Error of Means

Table 3: Villi Morphometry of Pullet Chicks Fed Diets Containing Different Levels of Biotronic® Top Forte (0 – 8 weeks)

Parameters	Levels of Biotronic® Top Forte (g)					
	0	100	200	300	400	500
Villi Area (µm)	21218.57 ^a	16649.93 ^{ab}	1175.59 ^c	14735.54 ^b	15022.62 ^{ab}	22151.43 ^a
Villi Perimeter (µm)	704.37 ^a	548.96 ^{ab}	629.21 ^{ab}	552.56 ^{ab}	677.43 ^a	631.94 ^{ab}
Villi Height (mm ²)	290.53 ^a	223.02 ^a	243.92 ^a	222.15 ^a	288.36 ^a	237.66 ^a
Villi Width (mm ²)	148.73 ^{ab}	123.62 ^b	107.01 ^{bc}	120.47 ^b	107.01 ^{bc}	169.42 ^a
Crypt Depth (mm ²)	57.35	60.57	72.41	65.71	91.47	71.41

^{abcd} = means with different superscripts on the same row differ significantly (P<0.05), Oxytet: Oxytetracycline. SEM: Standard

Error of Means