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REPLACEMENT OF INORGANIC SELENIUM BY ORGANIC IN THE GROWTH BROILER CHICKENS PERFORMANCE

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ABSTRACT

The study evaluated the effects of substituting inorganic selenium with organic selenium on broiler chicken's growth performance. We used 972 male Ross broiler chickens that were randomly distributed in 36 pens with 27 birds each. The birds were fed an *ad libitum* (at one's pleasure) corn-soybean diet from one to 43 days of age. The treatments consisted of two main groups, the whole or fractional inorganic sodium selenium (IS) treatments and the organic selenium (OS) produced by Sel-Plex®. Treatment 1 (T1) 0.3 ppm IS; treatment 2 (T2) 0.2 ppm IS + 0,1 ppm OS; treatment 3 (T3) 0.1 ppm IS + 0.2 ppm OS; and treatment 4 (T4) 0.3 ppm OS. At 43 days of age, the broiler body weights were: (T1) 2978 g; (T2) 2981 g; (T3) 3005 g, and (T4) 2981 g while the feed conversion Table were: (T1) 1,888:1; (T2) 1,850:1; (T3) 1,839:1; and (T4) 1,825:1. The total mortality rate were: (T1) 12.75%; (T2) 12.35%; (T3) 10.32% and (T4) 8.86%. The values of the productive efficiency index recorded were: (T1) 322; (T2) 329; (T3) 341 and (T4) 347. The results indicated that the replacement of inorganic selenium for organic did not maximize broiler performance at 43 days of age.

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INTRODUCTION

The assimilation of essential trace minerals in the diet of all animals is necessary for the maintenance of health, growth and many biochemical and physiological processes (Scott *et al*., 1982). The path in which the minerals are meTabolized depends on whether the source is organic or inorganic. Inorganic minerals need to be solubilized in an ionic form to be consequently absorbed. The ionic form is electrically charged and can interact with others nutrients in the diet (minerals, proteins and carbohydrates) creating a product that cannot be absorbed by animals. Also, some inorganic minerals may be converted into complex molecules that cannot be processed by the majority of animals (Rutz *et al*., 2004). Although there is a possible decrease in the efficiency of using inorganic elements, they are still widely used in animal diets. Therefore to compensate for the possible unavailability of nutrients caused by the inorganic side reactions, vast quantities of inorganic elements are sometimes being used.

Large quantities of inorganic elements result in an excessive unnecessary supplementation which can cause negative effects to the environment (Close, 1998). Before reaching the site of absorption (enterocyte membrane), the ingested mineral water must pass a preliminary aqueous layer and then a mucosal layer with an intense negative charge. Although the enterocyte membrane is quite thin, the mineral must first travel through two layers that correspond to an order of magnitude thicker than the actual surface area for absorption. With inorganic minerals there is an immediate threat of hydroxyl-polymerization, a process that increases the pH in the small intestine. The process occurs mainly in the aqueous fluid layer, and leads to the formation of large insoluble metal hydroxides that prevent absorption (Lyons, 2004; Power, 2004).The mucous layer being negatively charged acts as an additional barrier against the passage of inorganic metal ions and likewise serves as a protective mechanism against toxic elements such as aluminum (Al^{3+}). Due to this layer having an intense negative charge, the metal cation binding strength can be described as follows: $M^{+3} > M^{+2} > M^{+1}$, wherein M represents a metal ion (Power, 2004). With the load reduction in metal ions, the inorganic metal ions that avoided hydroxyl-polymerization may cross the layer, but at a very slow speed. The supplementation of organic minerals solves these problems by avoiding the risk of hydroxyl-polymerization, and accelerating the passage rate of the metal ion to the negatively charged mucous layer because organic minerals are electrically neutral (Lyons, 2004; Power, 2004). Thereby organic minerals, such as selenium, can be an ideal alternative to improve the nutritional reserves and the performance of birds.

Although there is an increasing amount of information demonstrating the superiority of organic selenium as mineral source for animals, sodium selenite is still the main source of selenium in animal feeds. This trend is conflicting because sodium selenite is proven to have a pro-oxidant action that creates unneeded oxidative stress to the organism's cells (Spallholz, 1997). In contrast, the organic selenium increases antioxidant protection of the cells through combination of its non-toxicity, higher rate of intestinal absorption, and higher sTability and retention in tissues and organs (Ashmead & Zunino, 1992). Sel-Plex® provides selenium to birds through the process of retention and distribution of selenium amino acids in body proteins, which increases reserves in tissues. The organic selenium (Sel-Plex®, Alltech Inc., Nicholasville, KY) was subjected to extensive testing in conjunction with the Food and Drug Administration (FDA) of the United States and received approval for inclusion in diets of broilers in 2000 (Food and Drug Administration, 2000). The organic selenium is produced by incorporation of selenium to a selected strain of *Saccharomyces cerevisiae* for a modified fermentation process. The predominant form of selenium in Sel-Plex® is selenomethionine. The form selenomethionine is similar to the organic selenium found in plants and grains, resulting a greater bioavailability compared to inorganic sources of selenium (Kelly & Power, 1995). The objective of this study was to evaluate the performance of broilers using diets containing high levels of organic selenium in the form of Sel-Plex® that was total or partial replacement for inorganic selenium in the form of sodium selenite.

MATERIAL AND METHODS

The experiment was conducted at the Experimental Aviary known as *Unidade Especial de Avicultura* (UEA) in the Agro-technical Department of *Visconde da Graça* (CAVG) in the *Universidade Federal de Pelotas* (UFPEL). This University is located in the Pelotas city of Rio Grande do Sul State, Brazil. The research was conducted in 43 days from May 23 to July 04^{th}, 2003. The shed used in the experiment has dimensions of 12 m wide by 20 m long with a ceiling height of 2.5 m, built with a double sheet metal and insulating material between them. This shed is internally divided into four lines of pits with nine boxes per row, a total of 36 boxes, each having the size of 2 m wide and 2 m long and 1.5 m in height. The floor was concrete and modulated screens divided the boxes. A gate gave the birds access to the hall where their respective treatments were located. The shed ventilation system was maintained using two extractors that were driven by two thermostats set to operate when internal temperature reached 23°C. Extractors were located in the middle of the sidewalls at a height of 2 m above the floor. Furthermore, the exit gas and hot air departed through adjusTable apertures located longitudinally on both sides of the exhaust and air intake for adjusTable openings on each side of the shed.

All boxes received wood shavings bed of about 8 to 10 cm thick and contained the feeders and water fountains. During the first five days,of age a paper covering was placed over the wood shavings to allow the chicks to access the feed, and to prevent fragments to be absorbed by the bed. Each box contained pan feeders, a semi-automatic tube feeder, and an automatic pendulum cooler. The tray type feeders were used during the first five days of the birds, while the semi-automatic tube feeders and automatic bell drinkers were used within one to 43 days. Feed and water were provided ad libitum throughout the experimental period. The heating system consists of cylinders with gas hoods of 45 kilograms. The ambient temperature was initially set to 30° C, according to the breeder manual recommendation (Agross, 2001). After housing the birds, the temperature was controlled by regulating the gas outlet and height of the hood based on the behavior of the chicks and distribution in relation to the heat source. At 21 days of age, the birds were kept at room temperature. A material named "eucatex" prevented leakage and crowding of chicks, and facilitated access to their feeders, water cooler, and their heat source for up to 10 days old.

Diets composed of corn and soybean meal were isonitrogenous and isocaloric supplemented with organic selenium, whose composition is shown in Table 1. The core composition in Table 2 was used in the final stage with no antibiotic, coccidiostatic and growth promoter. The levels and sources of selenium were added to the core as the treatments prescribed. The mixture of diets were made in a pan mixer with a capacity of up to 100 kg, and a mixing time of 15 minutes per beat. The diets were packed in polyethylene bags, which was identified according to the treatments, and then stored inside the poultry facilities. The adopted food program used the four stages of creation, with mash diet and according to the age of the birds (Tab.1). We used 972 male broiler chicks, the AgRoss line 308, and at day one of age they were vaccinated against Marek's disease and Cavg produced in the hatchery. The birds were individually weighed using a digital scale accurate to centigrams. They were then randomly assigned to experimental units in the ratio of 27 birds per pen, at a density of 6.75 birds per m^2. Eight day old birds were then weighed using a digital scale with a precision of 2 g. The experiment consisted of four treatments (T1, T2, T3, T4), which represent increasing levels of organic selenium supplementation (OS) in the form of Sel-Plex® in full or partial replacement of inorganic selenium (IS) in the form of sodium selenite. The treatments were: (T1) 0.3 ppm IS; (T2) 0.2 ppm IS + 0.1 ppm OS; (T3) 0.1 ppm IS + 0.2 ppm OS; (T4) 0.3 ppm OS. The experiment was laid out in a completely randomized design with four treatments and nine replication. Each replication consisted of 27 birds .There were a total of 36 experimental units (boxes) and 243 birds for each treatment. Data were statistically analyzed by analysis of variance with the procedure of General Linear Models SOC (1997), considering a 5% probability of error. Mortality data were transformed using the arc sine square root method (Steel and Torrie, 1980). Feed intake (FI), body weight (BW), weight gain (WG), feed conversion (CA) and mortality were calculated periodically, at 8, 15, 22, 29, 36, and after 43 days of age. The productive efficiency index (CI) was calculated using the following formula: [viability (%) x body weight (kg) / age (days) x CA] x 100.

RESULTS AND DISCUSSION

Feed intake, although not presenting statistical differences, indicated that birds fed with organic selenium supplementation diets (T2, T3 and T4) consumed a smaller amount of feed at the end of the test, according to Table 3. Similar observations were reported by Moreira *et al*. (2001), Deniz *et al*. (2005), Payne & Southern (2005) regarding feed intake of birds fed with feeds with organic selenium. However, the study by Choct *et al*. (2004) which compared the supplementation of 0.25 ppm selenium in the form of Sel-Plex® (sodium selenite) showed a significant reduction ($P<0,05$) feed intake of birds fed the Sel-Plex®. Body weight, although not statistically different, proved that the birds supplemented with T3 had predominance in this variable the eighth day by the end of the experiment (Table 3). Similar results were also reported by Deniz *et al*. (2005) and Payne & Southern (2005).

On the other hand, Edens *et al*. (2003) reported that similar study conducted in Mexico, India and Thailand with diets containing Sel-Plex® produced significant increases ($P<0,05$) in body weight of 198 g, 59 g and 50 g, respectively, compared to sodium selenite. Analysis of weight gain showed no statistical differences among the treatments, which suggest that from start to finish the birds supplemented with T3 have superior performance (Tab. 3). Similar results were found by Choct *et al*. (2004), Deniz *et al*. (2005) and Payne & Southern (2005). In constrast, Moreira *et al*. (2001) testing different levels and sources of selenium, concluded that there was significant difference ($P<0,05$). Birds from the T4 (0.3 ppm only in the form of Sel-Plex®) numerically showed the best feed. However, this effect was not statistically significant (Tab. 3).

Table 1. Feed composition of the experimental diets

Ingredients (%)	Prestater 1 to 8 days	Starter 9 to 22 days	Grower 23 to 36 days	Finisher 37 to 43 days
Corn	58,02	61,47	60,72	63,92
Soybean meal	35,60	32,30	31,80	28,90
Oyster flour	0,10	0,10	0,20	–
Iodized salt	0,68	0,43	0,38	0,38
Refined soybean oil	1,60	1,70	2,90	2,80
Starter Premix	4,00	4,00	–	–
Grower Premix	–	–	4,00	–
Finisher Premix	–	–	–	4,00
Total	100,00	100,00	00,00	100,00

Calculated Composition:

ME (kcal/kg)	2950	3050	3100	3150
CP (%)	21,24	20,00	19,72	18,62
Fiber (%)	3,50	3,36	3,31	3,19
Total phosphorus (%)	0,68	0,67	0,63	0,60
Available phosphorus (%)	0,46	0,45	0,42	0,41
Calcium (%)	1,00	1,00	0,96	0,96
Lysine (%)	1,26	1,19	1,05	1,05
Methionine (%)	0,52	0,51	0,44	0,44
Methionine+Cystine (%)	0,88	0,85	0,77	0,77

Table 2. Core Composition (amount per Kg product)

Nutrient	Stater	Grower	Finisher
Calcium (g)	210	200	200
Phosphorus (g)	85,7	77	77
Manganese (mg)	2500	2500	2500
Zinc (mg)	1500	1500	1500
Iron (mg)	1250	1250	1250
Copper (mg)	250	250	250
Iodine (mg)	15	15	15
Vitamin A (UI)	250 000	180 000	180 000
Vitamin D3 (UI)	50 000	40 000	40 000
Vitamin E (mg)	275	375	325
Vitamin K3 (mg)	42,5	35	35
Vitamin B1 (mg)	45	45	45
Vitamin B2 (mg)	150	125	125
Vitamin B6 (mg)	62,5	75	75
Vitamin B12 (mcg)	300	300	300
Niacin (mg)	1000	975	875
Folic acid (mg)	27	19	19
Pantothenic acid (mg)	400	300	300
Choline (g)	12,5	7,5	7,5
Biotin (mg)	2	–	–
Methionine (g)	45	51	51

Table 3 – Broiler performance fed with diets containing the replacement of inorganic selenium by organic selenium, after 43 days of age

Treatments	FI (g)	BW (g)	GW (g)	FCR	Mortality (%)	IEP
T1*	5537	2978	2933	1,888	12,75	322
T2**	5432	2981	2936	1,850	12,35	329
T3***	5444	3005	2960	1,839	10,32	341
T4****	5361	2981	2936	1,825	8,86	347
Prob>F	0,34	0,77	0,78	0,23	0,38	0,36
CV (%)	3,68	2,04	2,08	3,57	28,94	9,63

*T1) 0,3 ppm IS; **T2) 0,2 ppm IS + 0,1 ppm OS; ***T3) 0,1 ppm IS + 0,2 ppm OS; ****T4) 0,3 ppm OS

Conversely, Deniz *et al*. (2005) studied in Turkey the effect of supplementation of 0.3 ppm selenium in the form of Sel-Plex® or sodium selenite on the performance of broilers and concluded that the feed conversion improved significantly ($P <0.05$) in birds supplemented with Sel-Plex®. The high mortality rate (Tab. 3) although not statistically different across all treatments occurred largely due to sudden death as a result of excessive weight of the poultry. The Agross (2001) indicated a body weight of 2.6 kg at 43 days of age, but the birds in the present experiment had a body weight of about 3 kg. Similar studies conducted in broiler chickens in the United States (Edens, 2001), and in Thailand and India (Edens *et al*., 2003), comparing organic selenium supplementation (Sel-Plex®) and inorganic (sodium selenite), also showed no significant differences in mortality of birds. In contrast, a survey conducted in Mexico (Edens *et al*., 2003), comparing the supplementation of 0.3 ppm Sel-Plex® or sodium selenite showed a significant reduction ($P <0.05$) in mortality of birds fed with diets containing Sel-Plex®. The productive efficiency index (Tab. 3) at 43 days of age indicated that broilers fed with 0.3 ppm SO (T4), was 25 points higher than broiler who consumed 0.3 ppm SI (T1), but the difference was not statistically significant.

Conclusion

The replacement of inorganic selenium with organic selenium did not show significant differences in maximizing broiler performance at 43 days of age based from the conditions in which this experiment was developed.

REFERENCES

Agross. 2001. Manual de Manejo de Frangos. Agroceres Ross – Melhoramento Genético de Aves S. A.

Ashmead, H. D. and Zunino, H. 1992. Factors which affect the intestinal absorption of minerals. In: The Roles of Amino Acid Chelates in Animal Nutrition. (H. D. Ashmead, ed.). Park Ridge: Noyes Publication, p. 21-46.

Choct , M., Naylor, A.J. and Reinke, N. 2004. Selenium supplementation affects broiler growth performance, meat yield and feather coverage. British Poultry Science, v. 45, p. 677-683.

Close, W. H. 1998. The role of trace mineral proteinates in pig nutrition. In: Biotechnology in the Feed Industry. Proceedings of Alltech's 14th Annual Symposium (T. P. Lyons and K. A. Jacques, eds). Nottingham University Press, Nottingham, UK, p. 469-484.

Deniz, G. *et al*. 2005. Efeito da fonte de selênio sobre o desempenho e perdas por gotejamento em frangos de corte.

In: Biotecnologia Nutricional na Indústria de Alimentação Animal. 2º Simpósio Brasileiro da Indústria de Alimentação Animal, Curitiba, PR, Resumos, p.55.

Edens, F. W. 2001. Involvement of Sel-Plex in physiologicals Tability and performance of broiler chickens. In: Science and

Technology in the Feed Industry. Proceedings of Alltech's 17th Annual Symposium (T. P. Lyons and K. A. Jacques, eds). Nottingham University Press, Nottingham, UK, p. 349-376.

Edens, F.W., Gowdy, K.M. and Sefton, A.E. 2003. Resultados de campo obtidos com frangos de corte suplementados com selênio (Sel-Plex®). In: Em Contato com a Natureza. Aplicações Práticas de Tecnologias Naturais. 13ª Ronda Latino Americana da Alltech. Curitiba, PR, p.11-16.

FDA. 2000. Food additive permitted in feed and drinking water for animals: Selenium yeast. Federal Register. U. S. Food and Drug Administration, Washington, D. C., v. 65, p. 35823-35824.

Kelly, M. P., Power, R. F. 1995. Fractionation and identification of the major selenium compounds in selenized yeast. Journal of Dairy Science, v. 78, p. 237. (Suppl.1).

Lyons, T. P. 2004. Re-imagining the feed industry: Focus on price, perception and policy. In: Nutritional Biotechnology in the Feed and Food Industries. Proceedings of Alltech's 20th Annual Symposium (T. P. Lyons and K. A. Jacques, eds). Nottingham University Press, Nottingham, UK, p. 1-10.

Moreira, J., Santos, C. D., Abreu, C. M. P., Bertechini, A. G., Oliveira, D. F. and Cardoso, M. G. 2001. Efeito de fonte e níveis de selênio na atividade enzimática da glutationa peroxidase e no desempenho de frangos de corte. Ciência e Agrotecnologia, Lavras: v. 25, p. 661–666.

Payne, R. L. and Southern, L. L. 2005. Comparison of inorganic and organic selenium sources for broilers. Poultry Science, v. 84, p. 898-902.

Power, R. F. 2004. Por que os oligoelementos apresentam melhor biodisponibilidade? Feeding Times, v. 9, p. 4-7.

Rutz F., Anciuti M.A., Rech J.L. and Rossi P. 2004. Impacto dos minerais orgânicos sobre o desempenho animal. In: Biotecnologia Nutricional na Indústria de Alimentação Animal. Anais do Simpósio Brasileiro Alltech (A. Malaguido e F. Rutz, eds). Curitiba, PR, p. 74-82.

Scott, M.L. ; Nesheim, M.C. ; Young, R.J. 1982. Nutrition of the chicken. 3rd ed. Ithaca: M. L. Scott & Associates.

SOC – Software Científico. 1997. Ambiente Software NTIA. Embrapa – Tecnologia em Informática para Agricultura. Manual do Usuário – Ferramental Estatístico. Versão 4.2.2, Campinas, SP, 1997.

Spallholz, J. E. 1997. Free radical generation by selenium compounds and their pro-oxidant toxicity. Biomedical and Environmental Sciences, v. 10, p. 260-270.

Steel, R. G. D., Torrie, J. H. 1980. Principles and procedures of statistics: A biochemical approach. 2nd ed. New York: McGraw-Hill.

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