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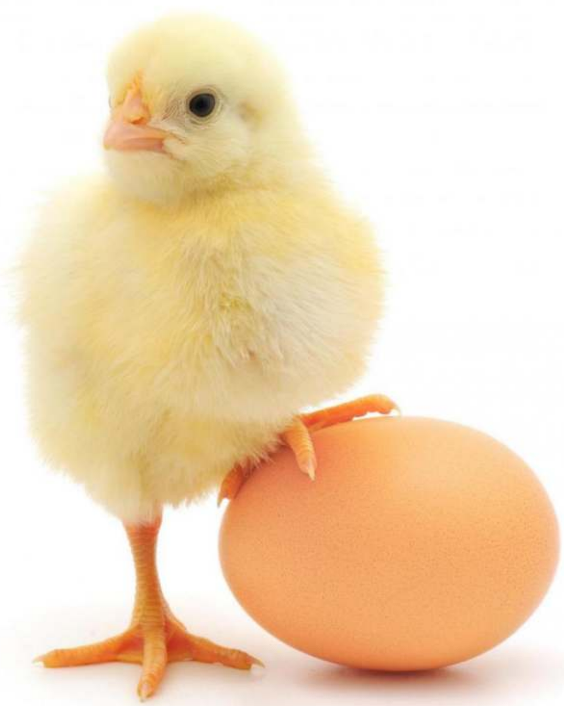

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Research Article
Effect of Addition of Selenium from Different Feedstuffs on Feed Digestibility, Growth Performance, Carcass Percentage and Meat Selenium of Broiler Chickens

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Abstract
Background and Objective: A study was conducted to determine the effect of diet supplemented with selenium (Se) from different sources on feed digestibility, growth performance, carcass percentage and meat selenium of broilers. **Materials and Methods:** A total of 200 day-old broiler chicks were used in this study. The broiler chicks were placed into five brooder cages for 7 days prior to allocate them into 20 pens. Each pen was equipped with a drinker and feeder. The basal diets (T-1) were supplemented with high Se feedstuffs: Se commercial feed additive (Sel-plex; T-2), tuna fish meal (T-3), *Moringa oleifera* seeds meal (T-4) and snail meal (*Melania testudinaria*, T-5), Diets and water were provided *ad libitum*. A completely randomized design with five treatments and four replications was used. Data were with analysis of variance. Differences among treatments were tested for significance by Tukey Test. **Results:** The study indicated that treatments produced significant effects on body weight gain and feed intake, Se intake, dry matter digestible intake, Se digestibility, carcass percentage and breast meat Se. Selenium intake, digestible Se intake and carcass percentage were higher in T1, T3, T4 and T5. Addition of Se in the diets in the forms of Sel-plex and snail meal significantly increased body weight gain, Se digestibility and breast meat Se. Feed intake and dry matter digestible intake were only affected by Sel-plex supplementation. **Conclusion:** Diets containing Se from either Sel-plex or snail meal produced heavier birds, higher in Se digestibility and Se meat than those of birds fed the control diet.

Key words: Broiler chickens, feed digestibility, growth performance, selenium, snail meal

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The effect of selenium on human health has long been recognized by a number of researchers[1,2]. McCartney[3] stated that selenium deficiency in humans might weaken the immune system and raise susceptibility to various diseases, such as cancer, stroke, heart disease, premature aging, cataracts, influenza, diabetes and a weakened immune system. In poultry, several diseases have been reported due to insufficient selenium in the diet. Muscular dystrophy, mortality, poor growth[4], myopathies of the gizzard and heart[5] were some examples of the diseases found in poultry when the birds was offered a low selenium diet.

Studies on eggs produced by a system of "free range" where the animals gain extensive access to more varied feedstuffs and eggs produced by wild birds, were reportedly to be rich in selenium[6]. Modern farms have changed the rearing of poultry with all feeds provided by the farmers. In this system, the birds do not have an access to select feedstuffs with an adequate selenium concentration. This indicates that modern farm, to some extent, fails to meet some tracer minerals need, either for growth or health status. This is because the purpose of the modern farm system is more focused on the aspect of increasing animal production, rather than improving reproduction, immunity and health status of the animals.

Recommendation on selenium requirement for broiler chickens has been reviewed by NRC[7] . Broiler chickens needed 0.15 ppm selenium both in the starter and grower diets[7]. However, the recommendation was based on the research that was done long time ago from late 1950 to early 1970[4,5]. During the period of early study on selenium, body weight of broiler chickens was relatively smaller. Accordingly, formulating diets based on the NRC recommendation of Se requirement might not be valid for the current strain of broiler. A higher selenium requirement for the present strain of broiler chickens is needed to meet the requirements of growth, health, reproduction and immunity. Since a lot of feedstuffs used for broiler chicken diets contain low amount of selenium, particularly feedstuffs present in the tropical region, finding out local feedstuffs with high concentration of selenium is important to enrich data base of selenium-rich feedstuffs. A study to determine the effect of selenium from different feedstuffs on feed digestibility, growth performance, carcass percentage and meat selenium of broiler chickens was carried out.

MATERIAL AND METHODS

Feedstuffs and analysis of selenium: Four feedstuffs has been selected to be used in this study due to their potential in selenium content. The feedstuffs were *Moringa oleifera* seeds, Tuna fish meal and snail (*Melania testudinaria*) meal along with commercial selenium (Sel-plex). These feedstuffs were purchased from local market. Analysis of selenium was done by using Atomic Absorption Spectrometry as described by Almeida *et al.*[8].

Animals and diets: A total of 200 day old unsexed broiler chicks were used as the experimental animals. The birds were distributed into 5 brooder cages for 7 days. At day 3, the broiler chicks were vaccinated against New Castle diseases. After 7 days brooding, the broiler chicks were placed into 20 pens. Each pen were equipped with a plastic drinker and feeder. The surroundings of the pens were routinely cleaned and the plastic drinkers were kept clean during the experimental period. The basal diets (Table 1) were formulated using UFFF software[9]. The basal diets were supplemented with high selenium feedstuffs : snail meal (*Melania testudinaria*), tuna fish meal, *Moringa oleifer*a seeds meal and commercial selenium (sel-plex). Diets and water were available at all times. The experimental diets (Table 2) were offered throughout the study.

The additions of 0.1 ppm selenium in the forms of sel plex, tuna meal, snail meal, *Moringa oleifera* seeds meal in the diets were equivalent to the addition of 0.02, 3.67, 5.45 and 5.95% in the diet respectively. The supplementation of the diets with the feed supplements in such amount led to the change in protein content in each experimental diets (Table 2).

Table 1: Basal diet and nutrients composition

Feed ingredients	Starter diet (%)	Grower diet (%)
Full fat soybean meal	24.90	23.80
Corn	56.20	59.10
Fish meal	13.00	11.00
Rice bran	3.38	4.00
Dicalcium phosphate	1.50	1.50
Salt	0.20	0.20
Methionine	0.15	1.50
Lysine	0.05	0.05
Premix	0.20	0.20
Crude protein	22.30	21.00
Crude fibre	3.50	3.60
Metabolizable Energy (MJ kg^{-1})	3167.00	3176.00
Lysine	1.34	1.23
Methionine+cysteine	0.93	0.89
Selenium (ppm)	0.33	0.29
Calcium	1.21	0.94
Phosphorus	0.81	0.64

Table 2: Experimental diets

Treatments	Addition of feedstuffs (%)		Protein of the diets(%)	
	Starter	Grower	Starter	Grower
T-1, Basal	0.00	0.00	22.3	21.0
T-2, Basal+0.1 ppm Se (SP)	0.02	0.02	22.3	21.0
T-3, Basal+0.1 ppm Se (TM)	3.67	3.67	24.0	22.7
T-4, Basal+0.1 ppm Se (SM)	5.45	5.45	22.9	21.7
T-5, Basal+0.1 ppm Se (MOM)	5.95	5.95	21.1	21.0

SP: Sel plex, TM: Tuna meal, SM: Snail meal and MOM: *Moringa oleifera* meal

Table 3: Selenium and protein contents of feedstuffs used in this study

Feedstuffs	Protein content (%)	Selenium content (ppm)
Sel Plex (selenium commercial)	20.8	381.00
Tuna fish meal	68.7	1.75
Snail meal	33.0	0.84
Moringa oleifera seed meal	21.0	0.69

Table 4: Body weight gain, feed intake and FCR of broiler fed diets containing selenium

Treatments	Weight gain (g)	Feed intake (g)	Selenium intake (g)	FCR
Control	858.00[b]	1311.00[b]	347.000[b]	1.53
Control+sel plex	1033.00[a]	1476.00[a]	399.000[a]	1.47
Control+tuna fish meal	963.00[ab]	1407.00[ab]	387.000[a]	1.46
Control+snail meal	1039.00[a]	1437.00[ab]	395.000[a]	1.38
Control+MOSM meal	953.00[ab]	1423.00[ab]	398.000[a]	1.53
P value	0.02	0.05	0.005	0.12
SEM	20.7	18.90	5.650	0.02

MOSM: *Moringa olievera* seed meal

Parameters measurements: On day 28, the birds were finally weighed and feed intake was recorded on the basis of 4 weeks. Five birds from each experimental unit were randomly selected and fasted for 12 h. The birds were then individually weighed, prior to slaughtering by cervical dislocation. The broiler chickens were slaughtered and dressed by removing the feather and skin. Carcass measurement was done by using the concept of Jensen[10]. On day 29, the other two birds from each pen were transfered into metabolic cages for one week for digestibility study. During the study, faeces was collected for three days and any foreign materials were discarded. The faecal discharges were weighed and then oven dried.

Data and statistical analysis: A completely randomized design with five treatment diets and four replicate cages of ten birds each was adopted in this study. Data were subjected to analysis of variance using Minitab 16 statistical package. Differences among treatments found in the analysis of variance were further tested for significance by Tukey Test[11].

RESULTS AND DISCUSSION

Four selenium sources, such as: sel-plex as commercial selenium feed supplement, tuna fish meal, snail meal and *Moringa oleifera* seeds meal were used in this study. The selenium content of these feedstuffs can be seen in Table 3. It seems that the selenium content in the feedstuffs linearly correlated with the protein content of the feedstuffs. This might be due to the fact that organic selenium found in the feedstuffs was in the form of protein, such as seleno-methionine or seleno-cysteine[12].

Data on body weight gain, feed intake and feed conversion ratio of broiler chickens kept for 4 weeks can be seen in Table 4. There were significant effects ($p<0.05$) of treatment on body weight gain and feed intake. However, effect of treatment on feed conversion ratio was not statistically different ($p>0.05$). The birds fed the control diet were smaller and consumed less feed than those of birds fed the diet supplemented with 0.1 ppm selenium either from snail meal or from sel-plex (Table 4).

Growth performance: Supplementation of the diet with organic selenium to increase growth performance of birds has been reported by a number of researchers[1,2]. Edens[2] found that there was an increase in body weight gain of broiler chickens when the diet was supplemented with organic Se (sel-plex) as a high selenium feed additive. These current findings indicated the same trend. Addition of 0.1 ppm of organic selenium in the form of sel-plex increased body weight gain by about 160 g in the present study when the broiler chickens were kept for 4 weeks.

It is hard to rationalize this improvement due to the fact that not all the diets supplemented with 0.1 ppm selenium could enhace broiler chicken performance. The addition of 0.1 ppm selenium in the form of Tuna fish and *Moringa Oleifera* seeds meal could not increase bird performance significantly. However, the addition of 0.1 ppm selenium in the form of snail meal produced better body weight gain than those of birds fed the control diet and the body weight gain, even, overtook the body weight gain of birds fed the diet supplemented with the commercial selenium (Sel-plex). Since the significant improvements in body weight gain were only found in birds fed Sel-plex diet and snail meal-containing diet, it can be speculated here that the main contributor for the improvement was selenium addition rather than protein supplementation. This speculation was based on the fact that the increased 2% protein in the diet due to addition of 0.1 ppm selenium in the form of tuna fish meal did not increase body weight gain. However, the supplementation of the diet with 0.1 ppm selenium from Sel-plex, without any increase in protein diet, produced a significant improvement of body weight gain, compared with the birds fed the control basal diet.

The increased body weight gain of broiler chickens fed the Selplex-containing diet might be associated with feed intake and selenium digestibility. The current findings indicate that the birds fed the Selplex diet consume more feed (1476 vs 1311 g) than the control birds. Selenium digestibility might also play a role in increased body weight gain of birds fed the sel-plex diet. According to Briens *et al*.[13] an increased body weight gain from 827-837 g on day 23 was found when selenium digestibility increased from 24-49%. Therefore, the birds fed the snail meal-containing diets were also heavier than the control birds, partly due to an increase in selenium digestibility and accumulative effects of relatively increased feed intake and digestible dry matter intake.

Although, a significant increase in feed intake was only found when the birds fed the diet supplemented with selenium in the form of Sel-plex, the additions of selenium from other feedstuffs (tuna fish meal-supplemented diet, snail meal diets and *Moringa oleifera* diet) did not significantly enhance feed intake. The increased feed intake of birds fed the sel-plex diet was nothing to do with dry matter digestibility as all treated diets had insignificant difference in feed digestibility. The heavier body weight found in the Sel-plex-fed birds than those chickens fed the control diet might contribute the difference in feed intake. It has been well believed that heavier birds consumed more feed than lighter birds. Since feed intake of birds fed the Selenium-supplemented diets was higher, particularly in Sel-plex diet, increasing selenium concentration in the diets enhanced selenium intake. The increased selenium intake was in the range between 12 and 15%. Feed conversion ratio was not affected by treatments. This fact indicated that increased feed intake led to an enhance in body weight gain, especially Sel-plex-supplemented diet.

Feed digestibility: Data on dry matter digestibility, digestible dry matter intake, selenium digestibility and digestible selenium intake are presented in Table 5. Treatments produced significant effect on digestible dry matter intake, selenium digestibility and digestible selenium intake. Early Study on dry matter digestibility conducted by Edens[2] indicated that Selplex supplementation in the diet increased dry matter digestibility of the diets fed to broiler chickens. Nuijten *et al*.[14] conducted an experiment on growing pigs to determine the effect of selenium supplementation on dry matter digestibility. The authors also found that dry matter digestibility of the diets increased from 74.4-82.4%. However, our current findings indicated on the contrary. There was no increase in dry matter digestibility when the diets were added 0.1 ppm selenium from different selenium-rich feedstuffs. Two possible reasons can be raised to elaborate the different findings. First, the quality of the control diet used in the current study might be better than the diet used by Nuijten *et al*.[14] (74 vs 81%). Accordingly, addition of selenium in the diets did not affect much the digestibility of the diets. Second, the addition of selenium at the level 0.1 ppm might be too low to increase dry matter digestibility as Nutijen *et al*.[14] added 0.24 ppm to significantly increased digestibility.

Table 5: Dry matter and selenium digestibilities of the diets supplemented with 0.1 ppm Selenium

Treatments	DMD(%)	DDMI (g)	Se digestibility (%)	Dig. Se Intake (g)
Control	80.90	1061.000^{b}	77.700^{b}	270.00^{b}
Control+sel plex	84.70	1250.000^{a}	82.300^{a}	328.00^{a}
Control+tuna fish meal	83.60	1176.000^{ab}	81.300^{ab}	324.00^{a}
Control+snail meal	84.60	1216.000^{ab}	83.900^{a}	316.00^{a}
Control+MOSM	83.30	1184.000^{ab}	80.100^{b}	323.00^{a}
p-value	0.57	0.028	0.002	0.00
SEM	1.77	37.200	0.890	5.64

DMD: Dry matter digestibility, DDMI: Digestible dry matter intake, Se: Selenium, Dig: Digestibility

Table 6: Carcass percentage and selenium content in breast meat of broiler fed diets supplemented with 0.1 ppm selenium

Treatments	Breast meat selenium (ppm)	Carcass (%)	Breast muscle (%)
Control	955.000[b]	71.600[b]	22.10[a]
Control+sel plex	1184.000[a]	74.100[a]	22.80[a]
Control+tuna fish meal	1064.000[ab]	73.900[a]	22.60[a]
Control+snail meal	1151.000[a]	74.100[a]	22.60[a]
Control+*Moringa oleifera* meal	1032.000[ab]	73.800[a]	22.70[a]
p-value	0.003	0.005	0.99
SEM	35.400	0.200	0.38

Selenium digestibility increased when the birds were fed the Sel plex-supplemented diet and the snail meal-supplemented diet. However, addition of 0.1 ppm selenium in the Tuna fish meal diet-and the *Moringa oleifera* diet could not produce better digestibility than the control diet. It can be said that source of selenium might determine the availability of this mineral for poultry. Interestingly, it is not like protein where animal protein is better quality than plant protein, selenium from animal were not guaranteed to be better than selenium from plant and yeast. It was the fact that yeast-derived selenium (Sel plex) had the same quality as selenium from snail meal, in terms of improving selenium meat, even in promoting growth. The increase in selenium meat found in the diets containing Sel plex and snail meal might be associated with selenium digestibility. It is clear from the data that when selenium digestibility of the diets containing Sel plex and snail meal increased, meat selenium was also improved. These findings are in accordance with the findings of Briens *et al.*[13] who reported that when the digestibility of selenium increased from 24-49%, breast muscle selenium concentration increased from 0.33-1.21 ppm.

Carcass percentage: Data on breast meat selenium, carcass and breast muscle percentage in Table 6. Breast meat selenium and carcass percentage were affected by treatments. In a previous study, Djorjevic *et al.*[15] conducted an experiment on the effect of organic selenium supplementation on slaughter traits of broiler chickens, found that addition 0.3 ppm organic selenium did not significantly increase carcass mass[15]. However these current findings indicated that carcass percentage increased as the birds were fed the selenium-supplemented diets from different kind of feedstuffs. The different findings between these two studies might be related to the source of selenium used. These current findings used selenium-rich feedstuffs while Djordjevic *et al.*[15] used organic selenium. An increased carcass percentage in the current study was much related to body weight of broiler chickens. However breast percentage of birds was not affected by the treatments.

Meat selenium in the muscle of broiler was much dependant upon selenium intake and selenium digestibility. All the selenium present in the meat must be from the selenium in the feed and the amount of digested selenium. A study of Briens *et al.*[13] indicated that addition of 0.3 ppm selenium increased selenium in muscles. Although all the birds fed the 0.1 ppm extra selenium in the diets had more selenium intake, birds fed the sel-plex and snail mail-supplemented diets had more selenium in breast muscle than the control birds. While the addition of 0.1 ppm selenium in the form of tuna fish meal and moringa oleifera could not increase breast meat selenium of broiler chickens. Data on selenium digestibility could elaborate these findings as there was a strong connection between selenium in the breast muscle and selenium digestibility.

CONCLUSION

Diets containing Se from either Sel-plex or snail meal produced heavier birds, higher feed intake, higher selenium digestibility and higher concentration of breast muscle selenium than those of birds fed the control diet. Birds fed the Selenium-supplemented diets had higher selenium digestible intake and higher carcass percentage. Feed conversion ratio was not affected by treatments.

SIGNIFICANCE STATEMENT

The present study discovered non-conventional feedstuffs, as a source of selenium, abundantly available in South East Asian countries, particularly in Indonesia. Snail (*Melania testudinaria*) meal could be used to improve broiler performance, carcass percentage and increase breast meat selenium and thus could replace commercial organic selenium (sel plex) in the diet.

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REFERENCES

1. Surai, P.F., 2006. Selenium in Nutrition and Health. Nottingham University Press, Nottingham, UK.
2. Edens, F.W., 2001. Involvement of Sel-Plex in Physiological Stability and Performance of Broiler Chickens. In: Science and Technology in the Feed Industry, Lyons, T.P. and K.A. Jacques (Eds.). Nottingham University Press, Nottingham, UK., pp: 349-376.
3. McCartney, E., 2005. Living Longer, Happier, Healthier? Selenium Supplementation of Human Foods-The Need to Move Forward. In: Nutritional Biotechnology in the Feed and Food Industry: Proceedings of Alltech's 21st Annual Symposium, Kentucky, USA., Jacques, K.A. and T.P. Lyons (Eds.)., Notingham University Press, UK., pp: 121-131.
4. Nesheim, M.C. and M.L. Scott, 1958. Studies on the nutritive effects of selenium for chicks. J. Nutr., 65: 601-618.
5. Walter, E.D. and L.S. Jensen, 1963. Effectiveness of selenium and noneffectiveness of sulfur amino acids in preventing muscular dystrophy in the Turkey poult. J. Nutr., 80: 327-331.
6. Pappas, A.C., R.M. McDevitt, P.F. Surai, T. Acamovic and N.H. Sparks, 2004. The effects of selenium and PUFA supplementation in the diet of young broiler breeders on the incorporation of selenium in the egg and in the tissues of the day old broiler chick. Br. Poult. Sci., 45: S26-S27.
7. NRC., 1994. Nutrient Requirements of Poultry. 9th Edn., National Academy Press, Washington, DC., USA.
8. Almeida, I.M.C., M.T. Oliva-Teles, J. Santos, C. Delerue-Matos and M.B.P.P. Oliveira, 2015. Total selenium content of commercial food supplements: Label accuracy evaluation. Austin J. Nutr. Food Sci., Vol. 3, No. 4.
9. Pesti, G.M., B.R. Miller and R. Chambers, 1986. User Friendly feed Formulation Program (UFFF) version 1.11-256 k. Department of Poultry Science and Agricultural Economics. The University of Georgia Atlanta.
10. Jensen, J.F., 1981. Method of Dissection of Broiler Meat Carcass and Description of Parts. Printed at Popwoths Pendagron Press, Papworth Everad, Denmark.
11. Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics. McGraw Hill, New York.
12. Power, R., 2005. A Toxicological Comparison of Selenium Sources: Does Enhanced Bioavailability Imply Increased Safety Concerns? In: Nutritional Biotechnology in the Feed and Food Industries: Proceedings of Alltech's 21st Annual Symposium, Lyons, T.P. and K.A. Jacques (Eds.)., Nottingham University Press, UK., pp: 135-146.
13. Briens, M., Y. Mercier, F. Rouffineau, V. Vacchina and P.A. Geraert, 2013. Comparative study of a new organic selenium source *v.* seleno-yeast and mineral selenium sources on muscle selenium enrichment and selenium digestibility in broiler chickens. Br. J. Nutr., 110: 617-624.
14. Nuijten, W.G.M., P.C.H. Morel and R.W. Purchas, 2010. Effect of lipid type, selenium and vitamin E on total tract nutrient digestibility in growing pigs. Proc. N. Z. Soc. Anim. Prod., 70: 266-268.
15. Djordjevic, S., I. Omerovic, N. Stolic and B. Milosevic, 2016. Effect of organic selenium in broiler diet on slaughter traits and plasma lipids. IOSR J. Agric. Vet. Sci., 9: 71-73.