Effect of organic selenium and zinc supplementation on fertility and hatchability of turkey eggs

[1]Ogbu, N. N., [2]Ogbu,* C. C. and [3]Ugwu, S. O. C.
[1]Department of Animal Breeding and Physiology, College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.
[2]Department of Animal Health and Production, College of Veterinary Medicine, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.
[3]Department of Animal Science,
University of Nigeria, Nsukka, Enugu State, Nigeria.
*corresponding author email: coschi07@yahoo.com

Abstract

The study was carried out to evaluate the effects of organic selenium (Se-yeast, 0.20mg Se) and zinc (as zinc oxide) on fertility and hatchability of indigenous turkey eggs. Eighteen toms and twenty seven hens aged eighteen weeks were used for the study. The toms were randomly assigned to nine experimental treatments with two birds per treatment: 0mg Se + 0mg Zn/kg (T_1 or control), 0.2mg Se (T_2), 0.3mg Se (T_3), 110mg Zn (T_4), 120mg Zn (T_5), 0.2mg Se + 110mg Zn (T_6), 0.3mg Se + 110mg Zn (T_7), 0.2mg Se + 120mg Zn (T_8), 0.3mg Se + 120mg Zn/kg (T_9) in a completely randomized design. At 32 weeks of age, semen was collected twice a week from toms in each treatment and used to inseminate hens belonging to the treatment. A total of 100 eggs in four batches were incubated from each treatment group and these were used to evaluate fertility, hatchability, and embryonic mortality. Supplementation of the diet of turkey toms with 0.3mg Se or 120mg Zn/kg of feed produced sperm which gave higher percentage fertility and hatchability and lower embryonic death in inseminated turkey hens compared to the control and those supplemented with 0.20mg Se or 110mg Zn/kg. Also the combination of Se and Zn improved fertility, hatchability, and embryonic viability than sole Se or Zn supplementation. Overall, supplementation with 0.3mg Se + 110mg Zn or 0.3mg Se + 120mg Zn/kg was found best to improve fertility, hatchability and embryonic viability in inseminated turkey hens.

Keywords: Turkey, selenium, zinc, semen, egg, fertility, hatchability

Introduction

Turkey production is an aspect of the poultry industry especially in the developed world where it plays a significant role in the supply of animal protein. Indigenous turkey production has not fulfilled a similar role in the tropics due to poor egg production, low fertility and hatchability (Ozcelik *et al.,* 2009). The fertility level in a flock depends on a number of factors which include the health and nutritional status of the breeders, egg and semen quality. Apart from genetic improvement, fertility and hatchability could be improved in indigenous turkeys through improved nutrition and management.

Trace mineral nutrition has been shown to impact growth and reproductive traits such as fertility and hatchability. Selenium is involved in the regulation of growth, development, spermatogenesis and embryonic viability (Papazyan *et al.,* 2006; Attia *et al.,* 2010). Avian spermatozoa contain high levels of polyunsaturated fatty acids (PUFAs) responsible for the specific spermatozoan membrane properties such as fluidity, and flexibility. This high content of PUFAs however, predisposes sperm cells to

high lipid peroxidation such that the antioxidant defense system is a key element of maintaining semen quality (Papazyan *et al.,* 2006). Selenium in the form of gluthathione peroxidase (Se-GSH-Px) and thioredoxin reductase is responsible for the detoxification of hydroperoxide (LOOH) radicals released in the process of detoxification of lipid peroxides (Papazyan *et al.,* 2006). Selenium supplementation therefore enhances the antioxidant defenses of chicken semen (Surai *et al.,* 1998) and spermatozoa integrity. Christensen *et al.* (2005) reported that fertility and embryo survival are functions of good sperm quality and the ability of sperm to bind to the ovum, hydrolyze the perivitelline layer, and penetrate the layer to initiate physiological events leading to fertilization and embryo development. Zinc is essential for spermatogenesis, sperm maturation in the epididymis, ovulation in females, fertilization, and embryo development (Glogowski *et al.,* 2004; Mahmood and Al-Daraji, 2011). It is important for capacitation, acrosome reaction, and in the maintenance of low metabolic rate during storage in the male reproductive system. Zinc is involved in the regulation of sperm motility, protection of sperm against oxidative damage, regulation of sperm chromatin condensation, and inhibition of transcription. It maintains sperm motility and prevents premature proacrosin activation during oviductal storage (Glogowski *et al.,* 2004). Siudzinska and Lukaszewicz (2008) reported lower spermatozoa abnormalities in zinc supplemented groups which led to higher fertility. Balch (2007) and Mahmood and Al-Daraji (2011) reported that Zn helps to protect the structure of DNA chromatin in the sperm nucleus which aids successful fertilization. The reproductive capacity of indigenous turkeys needs to be enhanced to maximize turkey breeding and production in Nigeria. In the present study, we evaluated the effects of dietary supplementation of selenium and zinc on the fertilizing capacity of local turkey semen and the hatchability of turkey eggs.

Materials and methods

Location of study and experimental design

The experiment was carried out at the Poultry Research Unit of the Department of Animal Science, University of Nigeria Nsukka. A total of 45 growing local turkeys consisting of 18 toms and 27 hens at 18 weeks of age were used for the study. The toms were randomly assigned to nine experimental treatments with two birds per treatment (Table 1). Two basal diets namely growers mash (19% CP, 3003Kcal ME/kg), and layers mash (17.6% CP, 2900Kcal ME/kg) were compounded for the study (Table 2). Selenium (Se) and zinc (Zn) were incorporated in the experimental diet and fed to the toms while the hens were fed unsupplemented layers mash. Feed and water were supplied to the birds *ad libitum*. The study lasted for 12 weeks.

Semen collection, insemination of hens and hatching of eggs

Toms were trained for semen collection for two weeks. Semen was collected from toms belonging to each treatment twice a week starting from 30 weeks of age using the manual massage technique by Burrows and Quinn (1937). Three hens were assigned to each group of toms for artificial insemination and hens were inseminated after one month in lay. Insemination was done twice a week between 16.00 and 18.00h using 0.025mL of pooled fresh semen per dose. Eggs were collected daily after five days of initial insemination between 30-35, 40-45, 50-55, and 60-65 weeks of age. Collected eggs were stored at room temperature and incubated within

seven days of collection. A total of 900 eggs (100/treatment, 25/batch) were set in the incubator for evaluation of fertility and hatchability. Fertile eggs were determined by candling at the 14th day of incubation. Eggs that did not hatch were broken to confirm fertility status while late embryonic deaths were recorded as dead in shell. Fertility was calculated as a percentage of total eggs set while hatchability was calculated as percentage of total and fertile eggs that hatched into live poults.

Proximate composition of experimental diet and statistical analysis

The experimental diet (growers mash) were analyzed for proximate composition by the methods of AOAC (1999). Data collected was subjected to multivariate analysis of variance in completely randomized design using the General Linear Model of the Statistical Package for Social Sciences (SPSS, 2007). Significant means were separated using the Duncan's New Multiple Range Test in SPSS (Duncan, 1955).

Results and discussion

Table 1 contains the experimental groups while Table 2 presents the percentage and proximate composition of the experimental diet (growers mash).

Table 1: supplementation of selenium (se) and zinc (Zn) in experimental diets for turkeys

Experimental group (T)		
0.0mg Se + 0.0mg Zn (T_1)	0.0mg Se + 110.0mg Zn (T_4)	0.3mg Se + 110.0mg Zn (T_7)
0.2mg Se + 0.0mg Zn (T_2)	0.0mg Se + 120.0mg Zn (T_5)	0.2mg Se + 120.0mg Zn (T_8)
0.3mg Se + 0.0mg Zn (T_3)	0.2mg Se + 110.0mg Zn (T_6)	0.3mg Se + 120.0mg Zn (T_9)

T_1: control; all supplementation is per kg basal diet.

Table 2: Percentage and proximate composition of experimental diets for turkeys

	Growers mash	Layers mash
Maize	49.00	48.00
Wheat offal	13.00	14.00
Soybean cake	8.00	14.00
Palm kernel cake	13.00	12.00
Groundnut cake	10.00	3.00
Fish meal	2.00	2.00
Bone meal	4.00	2.00
Limestone	-	4.00
Methionine	0.25	0.25
Lysine	0.25	0.25
Vitamin premix	0.25	0.25
Common salt	0.25	0.25
Total	100	100
Calculated composition		
Crude protein (%)	19.00	17.60
Energy (kcal/kg)	3003.00	2900.00
Proximate composition		
Crude protein (%)	17.90	
CHO (%)	52.14	
Fibre (%)	12.66	
Fat (%)	4.64	
Ash (%)	9.39	
Moisture (%)	3.28	

Hens inseminated with semen from toms fed supplemental Se had higher percent fertile eggs compared to the control (Table 3).

Table 3: Effect of sole Se supplementation on fertility and hatchability traits of turkey eggs

Variable	Control	0.20mg Se	0.30mg Se	SEM
Fertility (%)	64.67^{c}	76.33^{b}	88.00^{a}	1.02
Dead fertile egg (%)	17.92^{a}	10.51^{b}	9.12^{b}	1.13
Dead set eggs (%)	11.67^{a}	8.00^{b}	8.00^{b}	0.94
Hatched fertile eggs (%)	81.53^{b}	89.49^{a}	90.88^{a}	1.08
Hatched set eggs (%)	52.67^{c}	68.33^{b}	80.00^{a}	0.95

abc: means on the same row with different superscripts are significantly different ($p<0.05$).

Fertility was also dose related as eggs from hens belonging to toms fed 0.30mg Se/kg were more fertile than those from hens inseminated with semen from toms fed 0.20mg Se/kg (88.00 vs 76.33%). The percentages of dead fertile eggs and dead eggs based on set eggs were not statistically different between doses of Se but were significantly ($p<0.05$) lower in the group fed supplemented diets compared to the control (10.51 and 9.12 vs 17.92% and 8.00 and 8.00 vs 11.67%, respectively). Hatchability of fertile eggs did not differ statistically between the supplemented groups but was higher in these groups compared to the control. Hatchability of incubated eggs was highest for eggs fertilized by semen of toms fed diet supplemented with 0.30mg Se/kg followed by those of toms supplemented with 0.20mg Se/kg and lowest in those of the control group. The higher fertility, and hatchability values and lower percent dead eggs observed in eggs of hens inseminated with semen of toms belonging to the supplemented groups indicated that Se supplementation in the diet of the toms enhanced semen quality, fertility, hatchability and embryo viability and that the control diet was probably deficient in this trace mineral. Selenium is proven to participate in the regulation of major physiological functions in humans and animals including growth, development, spermatogenesis and embryonic viability (Papazyan *et al.,* 2006; Attia *et al.,* 2010). The beneficial effects of selenium on performance of poultry species have been widely reported. Avian spermatozoa contain high levels of polyunsaturated fatty acids (PUFAs) responsible for the specific membrane properties-fluidity, flexibility, semi-permeability, etc of sperm cells. This high content of PUFAs however, predisposes sperm cells to high lipid peroxidation such that the antioxidant defense system is a key element of maintaining semen quality (Papazyan *et al.,* 2006). Selenium in the form of gluthathione peroxidase (Se-GSH-Px) and thioredoxin reductase is responsible for the detoxification of lipid hydroperoxide (LOOH) produced by the reaction of vitamin E with peroxyl radicals released in the process of detoxification of lipid peroxides (Papazyan *et al.,* 2006). Selenium supplementation therefore enhances the antioxidant defenses of chicken semen (Surai *et al.,* 1998) hence enhancing spermatozoa integrity. Christensen *et al.* (2005) reported that fertility and embryo survival are functions of good sperm quality and the ability of sperm to bind to the ovum, hydrolyse the perivitelline layer, and penetrate the layer to initiate physiological events leading to fertilization and embryo development. Sperm quality therefore determines fertility and hence hatchability. Reduced embryo livability coincidental with declines in fertility has been reported previously (Christensen and Fairchild, 1999). Both the form and level of Se in the diet influence the effect of the mineral on reproductive

parameters (Leeson *et al.,* 2008; Attia *et al.,* 2010; El-Slamony *et al.,* 2015). Edens (2002) reported high percent normal spermatozoa in cockerels fed 0.48mg Se/kg compared to those fed 0.28mg Se/kg. The form of Se (Se-yeast) employed in the present study has been reported to be more effectively metabolized and therefore has greater bioavailability than inorganic Se (Edens, 2002; Leeson *et al.,* 2008; Attia *et al.,* 2010) and this may have been partly responsible for the improvement in fertility, hatchability and embryo viability observed in the treated groups.

The effects of zinc supplementation of toms on fertility and hatchability of turkey eggs showed a dose related response in all the traits measured (Table 4). Dietary zinc supplementation enhanced fertility and hatchability and reduced embryonic mortality. Fertility and hatchability was highest in eggs of hens belonging to toms supplemented with 120mg Zn/kg followed by those of toms fed 110mg Zn/kg but lowest in those of unsupplemented control diet. In addition, percent dead eggs was significantly ($p<0.05$) highest in eggs of hens belonging to toms in the control group followed by those of toms fed 110mg Zn/kg and lowest in those of toms fed 120mg Zn/kg.

Table 4: Effect of zinc (Zn) supplementation on fertility and hatchability traits of turkey eggs

Variable	Control	110mg Zn	120mg Zn	SEM
Fertility (%)	64.67^{c}	69.00^{b}	84.67^{a}	1.02
Dead fertile eggs (%)	17.92^{a}	11.89^{b}	4.68^{c}	1.13
Dead set eggs (%)	11.67^{a}	8.33^{b}	4.00^{c}	0.94
Hatched fertile eggs (%)	81.53^{c}	88.11^{b}	95.32^{a}	1.08
Hatched set eggs (%)	52.67^{c}	60.67^{b}	80.67^{a}	0.95

abc: means on the same row with different superscripts are significantly different ($p<0.05$).

These results indicated that the basal diet (control) was deficient in zinc and that zinc supplementation has enhancing effect on sperm viability and fertilizing ability which translated to higher egg fertility and hatchability. Zinc is essential for spermatogenesis, sperm maturation in the epididymis, ovulation in females, fertilization, and embryo development (Glogowski *et al.,* 2004; Mahmood and Al-Daraji, 2011). It is important for capacitation, acrosome reaction, and in the maintainance of low metabolic rate during storage in the male reproductive system. Zinc is involved in the regulation of sperm motility, protection of sperm against oxidative damage, regulation of sperm chromatin condensation, and inhibition of transcription. It maintains sperm motility and prevents premature proacrosin activation during oviductal storage (Glogowski *et al.,* 2004). Siudzinska and Lukaszewicz (2008) reported lower spermatozoa abnormalities in zinc supplemented groups which led to higher fertilizing ability of the spermatozoa. Balch (2007) and Mahmood and Al-Daraji (2011) reported that Zn helps to protect the structure of DNA chromatin in the sperm nucleus which aids successful fertilization. The inclusion levels of zinc in the present study were within the range of levels reported to enhance sperm quality, fertility and hatchability in chickens and turkeys. Jankowski *et al*. (2001) and Glogowski *et al*. (2004) reported that inclusion level of 120mg ZnO/kg diet of turkeys resulted in the best fertilizing ability of semen, highest hatchability, and lowest early and late embryonic mortality. Glogowski *et al*.

(2004) therefore recommended optimal zinc level in diets for optimal reproductive performance in turkey-toms as 150mg/kg or a supplementation of 120mg/kg diet.

Supplementation of toms with 0.30mg Se/kg produced higher fertility of 88.00% as against the 84.67 and 69.00% by toms fed 120 and 110mg Zn/kg, respectively while toms fed 0.2mg Se/kg produced semen that gave higher fertility than toms fed 110mg Zn/kg (76.33 vs 69.00%) but lower to that due to 120mg Zn/kg supplementation (76.33 vs 84.67%) (Table 5).

Table 5: E ffects of sole sel enium (Se) and zinc supplementation on fertility and hatching parameters of turkey eggs

Variable	0.20mg Se	110mg Zn	0.30mg Se	120mg Zn	SEM
Fertility (%)	76.33^{c}	69.00^{d}	88.00^{a}	84.67^{b}	1.02
Dead fertile egg (%)	10.51^{a}	11.89^{a}	9.12^{a}	4.68^{b}	1.13
Dead egg (%)	8.00^{a}	8.33^{a}	8.00^{a}	4.00^{b}	0.94
Hatched fertile eggs (%)	89.49^{c}	88.11^{c}	90.88^{b}	95.32^{a}	1.08
Hatched set eggs (%)	68.33^{b}	60.67^{c}	80.00^{a}	80.67^{a}	0.95

abc: means on the same row with different superscripts are significantly different ($p<0.05$).

Percent dead eggs was lowest in eggs from hens belonging to toms fed 120mg/kg zinc compared to those of 0.30 and 0.20mg Se/kg. Hatchability of fertile eggs was highest in eggs of hens inseminated with semen from toms fed 120mg Zn/kg followed by those of 0.30mg Se/kg while this trait did not differ significantly between 0.20mg Se/kg and 110mg Zn/kg. Hatchability of set eggs was the same for eggs of hens belonging to toms fed 0.30mg Se/kg and 120mg Zn/kg but higher compared to those of 0.2mgSe/kg and 110mg Zn/kg which differed significantly (68.33% for 0.20mg Se/kg vs 60.67% for 110mg Zn/kg). Thus at the lower level of supplementation (0.20mg Se/kg and 110mg Zn/kg), Se had stronger effect on fertility than zinc oxide. This result could be attributed to an enhanced antioxidative effect of Se due to synergistic interaction with other dietary nutrients such as vitamin E reported to function in tandem with Se in the scavenging of reactive lipid hydroperoxides in semen thereby enhancing sperm viability and subsequently fertility and hatchability (Papazyan *et al.,* 2006). Similar synergistic relationship between vitamin E and zinc has not been established. Stanley et al. (2012) found no difference in egg production between hens fed sole Se and zinc but fertility was lower in the zinc supplemented group compared to those fed Se which agrees with the findings of the present study. On the other hand, El-Slamony *et al.* (2015) found no significant difference in fertility and hatchability of eggs of hens fed sole Se or zinc. The lowest percent dead eggs observed at the highest dose of zinc compared to the groups fed Se could mean that this level of zinc supplementation was sufficient to meet the requirements of the birds for zinc and hence had stronger positive effect on sperm viability. The need of zinc for sperm include maintainance of membrane stability, slowing metabolic reaction during storage, and inactivation of the enzyme acrosome (Glogowski *et al.,* 2001) thus limiting acrosome reaction during sperm storage in vivo. Zinc deficiency is associated with impaired spermatogenesis, embryo development and mortality (Durmus *et al.,* 2004; Mahmood and Al-Daraji, 2011).

Eggs of hens inseminated with semen from toms fed 0.30mg Se + 120mg Zn/kg diet were more fertile than those of other

treatments followed by those of toms fed 0.20mg Se + 120mg Zn, 0.30mg Se + 110mg Zn and 0.20mg Se + 110mg Zn/kg but lowest in the control (93.33 vs 90.00, 88.67 and 88.33 vs 64.67%) (Table 6).

Table 6: Effects of combinations of selenium (Se) and zinc (Zn) on fertility and hatchability parameters of turkey eggs

Variable	Control	0.20mg Se + 110mg ZnO	0.30mg Se + 110mg ZnO	0.20mg Se + 120mg ZnO	0.30mg Se + 120mg ZnO	SEM
Fertility (%)	64.67^{c}	88.33^{b}	88.67^{b}	90.00^{b}	93.33^{a}	1.02
Dead fertile eggs (%)	17.92^{a}	9.07^{b}	4.74^{c}	8.90^{b}	4.55^{c}	1.13
Dead set eggs (%)	11.67^{a}	8.00^{b}	4.33^{c}	8.00^{b}	4.33^{c}	0.94
Hatched fertile eggs (%)	81.53^{a}	90.94^{b}	95.26^{a}	91.10^{b}	95.45^{a}	1.08
Hatched set eggs (%)	52.67^{d}	80.33^{c}	84.33^{b}	82.00^{bc}	89.00^{a}	0.95

abc: means on the same row with different superscripts are significantly different ($p<0.05$).

Percent dead eggs were highest in eggs laid by hens mated to toms in the control group and lowest in eggs of hens mated to toms fed 0.30mg Se + 110mg Zn/kg and 0.30mg Se + 120mg Zn/kg. Hatchability of fertile eggs was similar between 0.30mg Se + 110mg Zn/kg and 0.30mg Se + 120mg Zn/kg groups (95.45 and 95.26%, respectively) but these were higher compared to those of 0.20mg Se + 110mg Zn/kg and 0.20mg Se + 120mg Zn/kg groups which were also similar but higher than that of the control (91.10 and 90.94% vs 81.53%, respectively). Hatchability of set eggs was highest in eggs of hens mated to toms fed 0.30mg Se + 120mg Zn/kg and lowest in those of the control (52.67%). The highest fertility and hatchability values and lowest embryo mortality observed in eggs of turkey-hens inseminated with semen of toms fed 0.30mgSe + 120mgZn/kg indicate that this level of combination of Se and Zn benefited fertility, hatchability and embryo viability more than the other treatments and the control diet. Reports on the effect of Se + Zn on fertilizing ability of semen are scarce; however the combined effect of Se and zinc on reproductive performance of hens has been reported by a number of studies. For instance Stanley *et al.* (2012) reported non-significant 6% and 3% increase in egg production and hatchability of fertile eggs, respectively and significantly lower early and late embryonic mortality in eggs of hens fed Se + Zn compared to the control. In a study that compared the effects of dietary seleno-methionine and zinc glycine on hormonal, productive, reproductive, and physiological parameters of laying hens, El-Slamony *et al.* (2015) found the highest fertility and hatchability in eggs of hens fed a combination of the highest doses of seleno-metionine and zinc glycine (0.30mgSel-plex + 125mgZn-glycine). The effects of sole Se and Se + Zn supplementation on fertility and hatchability are shown in Table 7.

Table 7: Comparative effect of sole Se and Se + Zn on fertility and hatching parameters of turkey eggs

Variable	**0.20mg Se**	**0.20mg Se +110mg Zn**	**0.20mg Se +120mg Zn**	**0.30mg Se**	**0.30mg Se +110mg Zn**	**0.30mg Se +120mg Zn**	**SEM**
Fertility (%)	76.33^{c}	88.33^{b}	90.00^{a}	88.00^{b}	88.67^{b}	93.33^{a}	1.02
Dead fertile egg (%)	10.51	9.07	8.90	9.12^{a}	4.74^{b}	4.55^{b}	1.13
Dead set egg (%)	8.00	8.00	8.00	8.00^{a}	4.33^{b}	4.33^{b}	0.94
Hatched fertile eggs (%)	89.49	90.93	91.10	90.88^{b}	95.26^{a}	95.45^{a}	1.08
Hatched set eggs (%)	68.33^{b}	80.33^{a}	82.00^{a}	80.00^{c}	84.33^{b}	89.00^{a}	0.95

abc: means on the same row with different superscripts are significantly different ($p<0.05$).

The table showed that supplementation with 0.20mgSe + 120mgZn/kg gave the highest fertility value of 90.00% followed by supplementation with 0.20mgSe + 110mgZn/kg (88.33%) and these were significantly higher than the value observed in the group fed sole 0.20mgSe/kg. Hatchability of fertile eggs and embryo mortality did not differ statistically between these groups but hatchability of set eggs was least in the group fed sole Se at 0.20mg/kg. For toms fed 0.30mgSe/kg, fertility and hatchability of set eggs were highest in eggs of hens mated to toms fed 0.30mgSe + 120mgZn/kg followed by those of 0.30mgSe + 110mgZn/kg. These groups also had the least embryonic mortality. Hens mated to toms fed 0.30mgSe alone produced eggs with the least values of fertility, and hatchability and the highest values of percent dead eggs. Generally, for each level of Se supplementation, the combination of Se with zinc enhanced fertility and hatchability and decreased embryonic death more than sole Se supplementation and these effects were more with the highest dose of zinc. These results are in disagreement with El-Slamony *et al.* (2015) who reported statistically similar values for fertility, and hatchability for sole selenium and combined Se and Zn supplementation in laying Golden Montazah chickens.

Semen of toms fed 110mgZn/kg diet alone produced the least values of fertility, and hatchability and highest percent dead eggs (Table 8).

Table 8: Comparative effect of sole Zn and Zn + Se on fertility and hatching parameters of turkey eggs

Variable	110mg Zn	0.20mg Se +110mg Zn	0.30mg Se +110mg Zn	120mg Zn	0.20mg Se +120mg Zn	0.30mg Se +120mg Zn	SEM
Fertility (%)	69.00^{b}	88.33^{a}	88.67^{a}	84.67^{c}	90.00^{b}	93.33^{a}	1.02
Dead fertile egg (%)	11.89^{a}	9.07^{a}	4.74^{b}	4.68^{b}	8.90^{a}	4.55^{b}	1.13
Dead set eggs (%)	8.33^{a}	8.00^{a}	4.33^{b}	4.00^{b}	8.00^{a}	4.33^{b}	0.94
Hatched fertile eggs (%)	88.11^{b}	90.93^{b}	95.26^{a}	95.32^{a}	91.10^{b}	95.45^{a}	1.08
Hatched set eggs (%)	60.67^{c}	80.33^{b}	84.33^{a}	80.67^{b}	82.00^{b}	89.00^{a}	0.95

abc: means on the same row with different superscripts are significantly different ($p<0.05$)

A similar trend was observed in the groups fed 120mg/kg zinc oxide. Toms fed 120mgZn/kg diet alone produced semen with the least fertility and hatchability values compared to those fed a combination of zinc and selenium. Percent dead eggs was highest in the group fed 0.20mg Se + 120mg Zn/kg compared to those fed 120mgZn/kg sole and 120mgZn + 0.30mg Se/kg which were similar. The observed significantly improved fertility, hatchability and embryo viability on supplementation with combined selenium and zinc (Tables 7 and 8) could result from improved spermatozoa viability and fertilizing ability probably sequel to improved antioxidant properties of selenium and zinc resulting from the synergistic interaction between these elements (Jacob *et al.,* 1999; Holger *et al.,* 2004). Holger *et al.* (2004) reported that selenium generates binding sites for zinc in proteins in vivo and that zinc release from metallothioneins by selenium is a significant aspect of the therapeutic antioxidant action of selenium compounds. On the other hand zinc is reputed to potentiate the oxido-reductive potentials of selenium (Jacob *et al.,* 1999). Ogbu *et al.* (2016) had reported improved semen quality and biochemical constituents in toms fed combinations of Se and zinc compared to those fed sole Se or zinc in diet.

Conclusion

Dietary supplementation with Zn and Se for

toms improved the fertility and hatchability traits of turkey eggs. Also the combined effects of Se + Zn were largely better than sole Se or Zn supplementation. Thus, combination of selenium and zinc can be used as an efficient tool for improving the reproductive potentials of turkeys.

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