



Effects of Selenium and Zinc on Biochemical Constituents and Quality of Indigenous Turkey Semen

Norah Nonye Ogbu

Department of Animal Science,
University of Nigeria, Nsukka,
Enugu State, Nigeria

Cosmas Chikezie Ogbu

Department of Animal Health and Production, College
of Veterinary Medicine, Michael Okpara University of
Agriculture, Umudike, Abia State, Nigeria
Email ID : coschi07@yahoo.com

S. O. C. Ugwu

Department of Animal Science,
University of Nigeria, Nsukka,
Enugu State, Nigeria

Abstract – The objective of the study was to evaluate the effects of organic selenium (Sel-yeast) and zinc (as ZnO) on the biochemical constituents and quality of indigenous turkey semen. Thirty-six (18 weeks old) local toms were used for the study. The birds were randomly assigned to nine treatments (T) of four birds each: T₁ or control (no supplementation), T₂ (0.2mg Se), T₃ (0.3mg Se), T₄ (110mg Zn), T₅ (120mg Zn), T₆ (0.2mg Se + 110mg Zn), T₇ (0.3mg Se + 110mg Zn), T₈ (0.2mg Se + 120mg Zn), and T₉ (0.3mg Se + 120mg Zn) per kg of feed. They were fed the experimental diets for 12 weeks prior to semen collection. Semen was collected and analysed twice a week for eight weeks starting at 30 weeks of age. Data recorded included semen volume (SV), progressive motility (PM), percent normal (NS), abnormal (AS), live (LS), and dead (DS) sperm, sperm concentration (SC), total sperm in ejaculate (TSE), fructose (FC), sodium (Na), and potassium (K) concentrations. Toms supplemented with Se and Zn had significantly better semen quality and biochemical constituents than the control group. Selenium and Zn supplemented groups had equivalent semen trait values except SV, LS, FC, Na, and K which were higher in the 120mg Zn group than in the 0.2mg Se group. The combination of either 0.2 or 0.3mg Se with 120mg Zn was better than combination with 110mg Zn in improving semen traits. Also the combination of Se and Zn was superior to sole Se or Zn in improving semen traits. Significant ($P < 0.05$) positive correlations existed between SV, PM, SC, LS, NS, TSE, FC, Na, and K and these traits correlated negatively with AS and DS. It was concluded that 0.3mg Se + 120mg Zn was the best to improve the quality and biochemical constituents of indigenous turkey semen.

Keywords – Biochemical Constituents, Indigenous Turkey, Mineral Supplementation, Semen Quality.

I. INTRODUCTION

Turkey production has assumed global importance as alternative source of poultry meat [1]-[2]. Turkeys are effective protein sources because of their high capacity to convert feed to meat [3]. Turkey meat is the leanest among other domestic avian species; it is rich in protein, vitamins, and minerals and is low in cholesterol [4].

According to [5], local turkeys are about 1.05million in Nigeria, being the lowest when compared with other poultry species. Turkey production in Nigeria is therefore low and this has been linked to low fertility as a result of poor quality semen. Oxidative stress (OS) has been reported to be the chief factor that adversely affects the viability of spermatozoa, leading to poor quality semen, and low fertility in turkeys [6]-[7]. Oxidative stress is the result of imbalance between the generation of reactive oxygen species (ROS) and the scavenging activities of

antioxidants in the body [8]. This imbalance can lead to sperm damage, spermatozoa deformity, and eventually male infertility [9]. Moreover, the membranes of spermatids and mature spermatozoa are known to be rich in polyunsaturated fatty acids which generate ROS [10]. For turkeys to give maximum contribution to animal protein supply, it is important to understand and improve their reproductive potentials. The reproductive potential of turkeys can be enhanced by dietary supplementation with substances that can reduce oxidative stress in semen. Such substances include trace minerals like selenium and zinc [11]-[12].

Selenium has anti-oxidative properties through its involvement in the active site of the enzyme glutathione peroxidase which serves as the first line of defense against oxidative stress [13]. It protects testicular spermatozoa from toxic free radicals [14], leading to increased spermatozoa concentration, motility and fertilizing capacity [15]. Zinc exhibits anti-oxidative activities, scavenges reactive oxygen species from cells [12] and protects spermatozoa genetic materials (RNA and DNA chromatin) important for successful fertilization [16]. We speculate that the combination of selenium and zinc will greatly enhance semen quality and the fertilizing capacity of indigenous turkey semen and thus enhance their reproductive potentials. The present study was therefore designed to evaluate the effects of varying dietary levels of organic selenium (Sel-yeast) and zinc (as zinc oxide) on turkey semen quality and biochemical constituents.

II. MATERIALS AND METHODS

Location of Study, Birds and Management

The experiment was carried out at the Poultry Research Unit of the Department of Animal Science, University of Nigeria Nsukka. A total of thirty six growing local toms of 18 weeks of age were used for the study. The toms were held in floor pens bedded with wood shavings and were allowed natural light for 12hr/day. They were allowed to acclimatize for two weeks on commercial growers mash and water supplied *ad libitum*. The study was approved by the University of Nigeria Ethical Committee on the use of animals for biomedical studies.

Experimental Design and Ration Formulation

At the end of the period of acclimatization, the toms were assigned to nine (9) experimental groups in a completely randomized design with four birds per treatment and two birds per replicate. Two experimental rations (growers mash and layers mash) were formulated,

using conventional feed ingredients, to contain 19.0% CP and 3003kcal/kg ME and 17.0% CP and 2900kcal/kg ME, respectively. The proximate composition of the feeds was analysed according to [17] (Table I). Selenium (Se) and zinc (Zn) were incorporated in the diets after formulation. Feed and clean water were supplied to the birds *ad libitum* during the experimental period. The birds were fed the experimental diets for 12 weeks prior to semen collection and for eight weeks during semen collection and analysis. The study lasted for a total of 20 weeks. The experimental groups were as below.

T₁: 0.0mg Zn+0.0mg Se; T₂: 0.0mg Zn+0.2mg Se;
 T₃: 0.0mg Zn+0.3mg Se; T₄: 110.0mg Zn+0.0mg Se
 T₅: 120.0mg Zn+0.0mg Se; T₆: 110.0mg Zn+0.2mg Se
 T₇: 110.0mg Zn+0.3mg Se; T₈: 120.0mg Zn+0.2mg Se
 T₉: 120.0mg Zn+0.3mg Se

Table I. Percent and proximate composition of experimental diets

Ingredients	Compositions (%)	
	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 compositions		
Crude protein (%)	19	17.6
Energy (kcal/kg)	3003	2900

Semen Collection and Evaluation

The toms were trained for semen collection for two weeks. Semen was collected two times a week for eight (8) weeks starting from thirty (30) weeks of age by the abdominal massage technique [18]. Collected semen was analysed for volume (SV), progressive motility (PM), sperm concentration (SC), percent live (LS) and dead (DS) spermatozoa, percent normal (NS) and abnormal (AS) spermatozoa and for biochemical constituents (Fructose, FC; Sodium, Na; and Potassium, K concentrations).

Statistical Analysis

Data collected were subjected to Multivariate Analysis of Variance (MANOVA) in Completely Randomized Design using the General Linear Model of the statistical Package for Social Sciences (SPSS). Significant means were separated using the Duncan's New Multiple Range Test in SPSS.

III. RESULTS AND DISCUSSION

Semen quality and biochemical constituents varied significantly ($P < 0.05$) between levels of selenium (Table II) with toms in the control group having the least values for all the semen traits studied except dead (DS) and

abnormal (AS) spermatozoa which were highest in this group. Toms fed 0.20 and 0.30mg Se had equivalent values for semen traits except sperm concentration (SC) which was highest in toms fed 0.30mg Se (5.90×10^9 /ml). The range of values obtained in the present study for semen volume (0.21 to 0.34ml) are in agreement with the findings of [19]-[21] who reported semen volume in toms to be within the range of 0.25-0.50ml. Reference [22] and [23] also reported a range of 0.3-0.5ml in toms fed selenium supplementation. The values of PM, LS and NS recorded in the present study agreed with the findings of [22], [24], and [25]. Reference [22] reported 85% motile spermatozoa in a group of toms fed 0.3mgSe/kg. Reference [15] and [26] observed decreased spermatozoa motility in semen of toms without Se supplementation while [27] recorded 70-80% live normal sperm, which was consistent with the results obtained in the present study.

Table II. Effect of Selenium on semen quality and biochemical constituents

Treatments	Parameters			
	control	0.2mg Se	0.3mg Se	SEM
SV (ml)	0.21 ^a	0.33 ^b	0.34 ^b	0.01
PM (%)	65.42 ^a	76.33 ^b	79.42 ^b	1.63
SC ($\times 10^9$)	4.37 ^a	5.40 ^b	5.90 ^c	0.16
LS (%)	73.38 ^a	81.67 ^b	83.79 ^b	1.01
DS (%)	26.63 ^a	18.25 ^b	16.21 ^b	1.03
NS (%)	70.79 ^a	82.79 ^b	83.75 ^b	1.17
AS (%)	29.21 ^a	17.21 ^b	16.25 ^b	1.17
TSE ($\times 10^9$)	1.26 ^a	1.90 ^{ab}	2.20 ^b	0.10
FC (mg/dl)	0.58 ^a	1.14 ^b	1.17 ^b	0.01
Na (mg/dl)	2.28 ^a	3.08 ^b	3.55 ^b	0.01
K (mg/dl)	0.56 ^a	0.74 ^b	0.93 ^b	0.10

a, b, c row means with different superscripts are significantly different ($P < 0.05$). SV—semen volume; PM—progressive motility; SC—sperm concentration; LS—live sperm; DS—dead sperm; NS—normal sperm; AS—abnormal sperm; TSE—total sperm in ejaculate.

The significantly higher spermatozoa concentrations (SC) in toms fed Se agrees with the findings of [24], [28], and [22] while improved TSE is supported by [22] who reported a TSE of 2.0×10^9 /ml which was similar to our result. Studies on fructose concentration of turkey semen are scarce in literature but the values obtained in the present study are lower than those of [29] – [31] in turkeys, cocks and cockerels, respectively. These workers reported a range of 3.0 to 4.0 mg/100ml of fructose in seminal plasma. The range of 2.28 to 3.55mg/100ml for sodium and 0.56 to 0.93 mg/100ml for potassium observed in the present study were quite higher than the 0.31mg/100ml and 0.34mg/100ml for sodium and potassium, respectively reported by [32]. These differences could be as a result of differences in breed of turkey, age and nutrition all of which influence mineral content of semen. The improved semen quality and biochemical constituents in the present study may be as a result of the antioxidant and mineral homeostatic properties of selenium as reported by numerous studies [13], [22] and [33].

Dietary supplementation with Zn significantly ($P < 0.05$) affected all the semen characteristics studied (Table III). Semen volume (SV), PM, SC, LS, NS, and TSE as well as FC, Na, and K were least ($P < 0.05$) in toms without Zn supplementation. Toms fed 110 and 120mg Zn had similar values of the above semen traits except SV, LS, FC, and FC which were higher in toms fed 120mg Zn. As was observed for Se, toms that did not receive Zn supplementation had the worst semen quality with highest values of dead (DS) and abnormal (AS) sperm cells. These results agree with those of [34] and [16]. Reference [34] reported highest volume of semen in toms that received 120mg Zn while [16] attributed the increased semen volume to the stimulatory effect of zinc on testosterone production. The authors also reported highest percentage motile spermatozoa, sperm concentration and percentage normal sperm in toms fed supplemental zinc.

Table III. Effect of sole Zinc supplementation on semen quality and biochemical constituents

Trait	Control	110mg Zn	120mg Zn	SEM
SV (ml)	0.21 ^a	0.29 ^b	0.38 ^c	0.01
PM (%)	65.42 ^a	74.96 ^b	78.46 ^b	1.63
SC ($\times 10^9$)	4.37 ^a	5.43 ^b	5.67 ^b	0.16
LS (%)	73.38 ^a	82.13 ^b	86.88 ^c	1.01
DS (%)	26.63 ^a	17.04 ^b	13.13 ^c	1.03
NS (%)	70.79 ^a	81.21 ^b	83.96 ^b	1.17
AS (%)	29.21 ^a	18.79 ^b	16.04 ^b	1.17
TSE ($\times 10^9$)	1.26 ^a	1.65 ^a	2.03 ^b	0.10
FC (mg/dl)	0.58 ^a	1.44 ^b	2.29 ^c	0.05
Na (mg/dl)	2.28 ^a	4.38 ^b	4.98 ^b	0.03
K (mg/dl)	0.56 ^a	0.93 ^b	0.93 ^b	0.01

a, b, c row means with different superscripts are significantly different ($P < 0.05$).

Reference [12] reported that Zn supplementation showed positive correlation with normal sperm morphology. The enhanced semen quality in toms fed zinc has been attributed to the antioxidant properties of zinc which was found to reduce lipid peroxidation, and decrease free radical production in testicular tissues by acting as a co-factor for Cu-Zn superoxide dismutase [35]. These results indicate that dietary supplementation of zinc can be an effective means to reduce oxidative damage of sperm cells [36]. Our observations are supported by the findings of [16] and [37] who reported that dietary Zn supplementation increased sperm concentration in turkeys due to increased testosterone production. The fructose concentrations obtained in the present study was lower than the 3.0mg/100ml recorded by [29] in turkeys, 4.0 mg/100ml recorded by [30] in cocks and [31] in cockerels. The range of 2.28 to 4.98mg/100ml sodium and 0.56 to 0.93mg/100ml potassium observed in the present study were higher than the values of 0.31mg/100ml and 0.34mg/100ml, respectively reported by [32]. These variations relate to differences in breed, age, nutrition and method of analysis.

The comparative effects of sole selenium and zinc supplementation on semen quality and biochemical constituents are presented in Table IV. Turkey toms that received 0.2mg Se were similar in SV, LS, and DS to

those that received 110mg Zn. A similar result was observed between the groups fed 0.3mg Se and 120mg Zn. Thus the performances of toms that received 110mg and 120 mg Zn in these traits did not surpass those of their counterparts fed 0.2 and 0.3mg Se, respectively. The experimental groups did not also differ significantly in PM, SC, NS, AS, and TSE. The FC of semen of toms that received 120mg Zn surpassed those of toms that received Se while the K content of semen of this group surpassed that of toms that received 0.2mg Se but not that of those that received 0.3mg Se. Semen sodium (Na) concentration differed significantly across groups with toms fed 120mg Zn having the highest semen Na content compared to those fed Se. The predominant similarity in semen traits of toms fed Se and Zn at the different dose levels show that Zn and Se have similar potentiating effects on sperm quality probably due to their common protective effects against oxidative damage to cells [38]-[40].

Table IV. Comparative effects of sole selenium and zinc on semen quality and biochemical constituents

Trait	0.2mg Se	0.3mg Se	110mg Zn	120mg Zn
SV	0.29 \pm 0.02 ^a	0.36 \pm 0.02 ^b	0.33 \pm 0.02 ^{ab}	0.38 \pm 0.03 ^b
PM	79.42 \pm 2.20	78.46 \pm 2.07	79.54 \pm 2.55	74.96 \pm 2.67
SC	5.84 \pm 0.15	5.90 \pm 0.20	5.43 \pm 0.16	5.67 \pm 0.23
LS	86.88 \pm 1.10 ^a	82.13 \pm 1.46 ^b	87.83 \pm 1.63 ^a	81.67 \pm 1.56 ^b
DS	13.13 \pm 1.10 ^a	17.04 \pm 1.47 ^{ab}	12.17 \pm 1.63 ^a	18.25 \pm 1.58 ^b
NS	83.96 \pm 1.52	84.17 \pm 1.45	83.75 \pm 1.93	81.21 \pm 1.77
AS	16.04 \pm 1.52	15.92 \pm 1.43	16.25 \pm 1.93	18.79 \pm 1.77
TSE	2.03 \pm 0.17	2.28 \pm 0.32	2.20 \pm 0.11	1.90 \pm 0.00
FC	1.14 \pm 0.00 ^a	1.17 \pm 0.00 ^a	1.44 \pm 0.27 ^a	2.29 \pm 0.00 ^b
Na	3.04 \pm 0.04 ^a	3.58 \pm 0.03 ^b	4.42 \pm 0.09 ^c	4.62 \pm 0.02 ^d
K	0.75 \pm 0.01 ^a	0.92 \pm 0.02 ^b	0.94 \pm 0.01 ^b	0.92 \pm 0.01 ^b

a, b, c: row means with different superscripts are significantly differently different ($p < 0.05$). Se – selenium; Zn – zinc; SV – semen volume; PM – progressive motility; SC – sperm concentration ($\times 10^9$ /ml); LS – live sperm; DS – dead sperm; NS – normal sperm; AS – abnormal sperm; TSE – total sperm in ejaculate (no. $\times 10^9$ /ml), FC - fructose (mg/dl), K - potassium (mg/dl), Na – sodium (mg/dl).

The comparative effects of combined Se and Zn showed significant ($P < 0.05$) differences in semen biochemical constituents and semen quality traits except in semen volume (SV) which was similar among the treatment groups (Table V). Toms fed 0.2mg Se + 110mg Zn, 0.2mg Se + 120mg Zn, and 0.3mg Se + 120mg Zn had similar and higher values of PM, SC, LS, NS, and TSE and lower values of DS, and AS compared to those fed 0.3mg Se + 110mg Zn. Overall, 0.2mg Se + 120mg Zn, and 0.3mg Se + 120mg Zn gave the best semen quality and reduced percent dead, and abnormal sperm cells to the lowest values. The results suggest that combining Selenium and Zn at the levels indicated could be an effective means to enhance semen quality probably via reduced oxidative damage by reactive oxygen species on spermatozoa [36]. These results are in agreement with the report of [13]. Reference [41] also reported that reduction in percent abnormal sperm can be achieved by feed supplementation with Se and Zn. Semen biochemical (FC, K, and Na) values were least in toms fed 0.2mg Se + 110mg Zn but highest in those fed 0.3mg Se + 120mg Zn. Generally, the combination of selenium with the higher level of Zn

produced the highest values of FC, K, and Na. The improved biochemical constituents of semen of toms fed 0.2mg Se+120mg Zn and 0.3mg Se+120mg Zn diets reflect the positive synergistic effects of Se and Zn on semen quality. Reference [16] reported increased fructose concentration in toms attributed to the stimulatory effect of zinc on testosterone production and enhanced testicular growth. It had been reported that the fructose content of fresh semen depends upon the secretory functions of the accessory reproductive glands which is influenced directly by the activities of the male sex hormone [42].

Table V. Comparative effects of combined selenium and zinc on semen quality and biochemical constituents

Trait	Levels of Se + ZnO			
	0.2mgSe+ 110mgZn	0.2mg Se+ 120mg Zn	0.3mg Se+ 110mg Zn	0.3mg Se+ 120mg Zn
SV	0.35 ± 0.02	0.37 ± 0.02	0.33 ± 0.01	0.34 ± 0.02
PM	83.79 ± 2.44 ^a	85.42 ± 1.73 ^a	76.33 ± 1.83 ^b	87.67 ± 1.81 ^a
SC	5.90 ± 0.22 ^{ab}	6.40 ± 0.14 ^{bc}	5.40 ± 0.16 ^a	6.67 ± 0.09 ^c
LS	88.38 ± 1.43 ^a	89.79 ± 1.06 ^a	83.79 ± 1.53 ^b	91.17 ± 0.95 ^a
DS	11.63 ± 1.43 ^a	10.21 ± 1.06 ^a	16.21 ± 1.53 ^b	8.83 ± 0.95 ^a
NS	85.83 ± 1.86 ^{ab}	90.38 ± 1.19 ^b	82.79 ± 1.59 ^a	87.79 ± 1.43 ^{ab}
AS	14.17 ± 1.86 ^a	9.63 ± 1.19 ^b	17.21 ± 1.59 ^a	12.21 ± 1.43 ^a
TSE	2.33 ± 0.42 ^{ab}	3.21 ± 0.12 ^c	1.65 ± 0.00 ^a	2.72 ± 0.00 ^{bc}
FC	2.86 ± 0.01 ^a	4.02 ± 0.02 ^b	3.43 ± 0.00 ^c	4.57 ± 0.00 ^d
K	0.94 ± 0.01 ^a	2.63 ± 0.03 ^b	1.84 ± 0.01 ^c	2.80 ± 0.02 ^d
Na	4.64 ± 0.01 ^a	5.57 ± 0.03 ^b	5.11 ± 0.02 ^c	6.16 ± 0.01 ^d

a, b, c: row means with different superscripts are significantly different ($p < 0.05$). Se – selenium; Zn – zinc; SV – semen volume; PM – progressive motility; SC – sperm concentration ($\times 10^9/\text{ml}$); LS – live sperm; DS – dead sperm; NS – normal sperm; AS – abnormal sperm; TSE – total sperm in ejaculate (no. $\times 10^9/\text{ml}$), FC - fructose (mg/dl), K - potassium (mg/dl), Na – sodium (mg/dl).

The comparative effects of sole selenium supplementation and combined selenium and zinc supplementation on semen quality traits and biochemical constituents are presented in fig. 1.

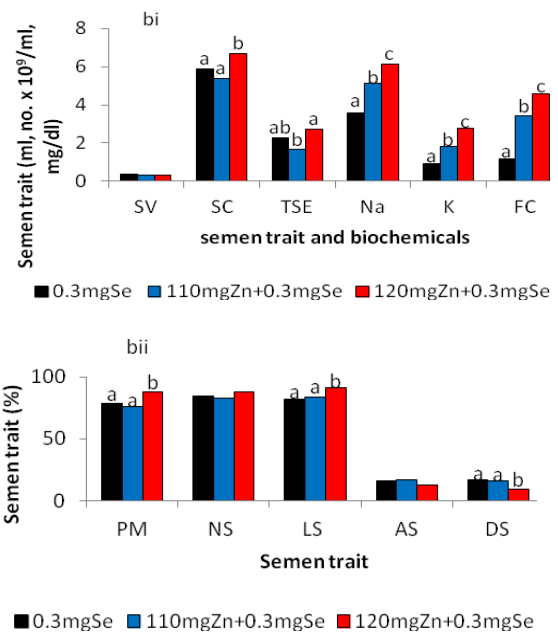
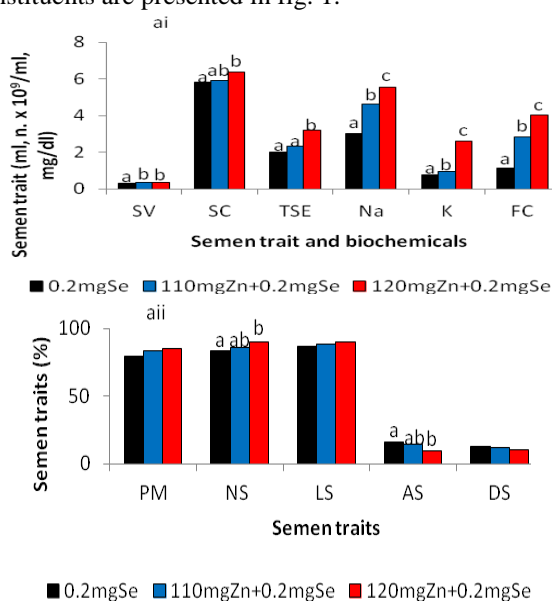


Fig. 1. Comparative effects of Se and Se + Zn supplementation on turkey semen traits and biochemical constituents (a: 0.2mg Se; b: 0.3mg Se)

There were significant ($p < 0.05$) differences in semen traits and semen biochemical constituents of toms fed 0.2mgSe/kg sole or combined with Zn (Fig. 1a). Significant differences were observed in SV, SC, TSE, Na, K, and FC (Fig. 1ai) and in NS, and AS but not in PM, LS, and DS (Fig. 1aii). Toms fed Se combined with Zn had the highest values for SV, SC, TSE, Na, K, FC, and NS but least value of AS compared to those fed sole (0.2mg Se). For the groups fed 0.3mg Se with or without Zn (Fig. 1b), significant differences were observed in SC, TSE, Na, K, and FC, but not in SV (Fig. 1bi) and in PM, LS, and DS but not in NS and AS (Fig. 1bii). Toms fed 0.3mgSe + 110mg Zn had similar values of SC, PM, LS, and DS with those fed 0.3mg Se alone. But these values were lower than those of toms fed 0.3mg Se + 120mg Zn. Toms fed 0.3mg Se sole had the least values of semen Na, K, and FC content.

The comparative effect of supplementation with sole zinc or zinc combined with selenium is presented in Fig. 2. There were no significant differences in SV, SC, and TSE (Fig. 2ai) and in NS (Fig. 2aai) but semen Na, K, and FC content (Fig. 2ai) and PM, LS, AS, and DS (Fig. 2aai) differed significantly ($p < 0.05$) between groups. Toms fed only 110mg Zn had the lowest values of semen Na, and FC while K content was similar between this group and those fed 110mg Zn + 0.2mg Se. These groups also had equivalent values of PM, and LS while the lowest values for these variables were observed in toms fed 110mg Zn + 0.3mg Se. Percent AS, and DS was highest in toms fed 110mg Zn + 0.3mg Se compared to those fed 110mg Zn + 0.2mg Se but similar to those of toms fed 110mg Zn alone. For toms fed 120mg Zn sole or combined with Se (Fig. 2b), significant differences were observed in SC, TSE, Na, K, and FC but not in SV (Fig. 2bi) and in PM, NS, LS, AS, and DS (Fig. 2bii). The combination of zinc with

selenium led to higher sperm PM, NS, LS, SC, and TSE as well as higher Na, K, and FC content of semen compared to sole zinc supplementation.

The observed significantly improved semen quality and biochemical constituents on supplementation with selenium and zinc could result from the synergistic interaction between selenium and zinc. Reference [39] reported that selenium compounds catalyze thiol/disulfide interchange reactions, which mobilizes redox-inert zinc from binding sites, and reduces protein disulfides, thereby generating binding sites for zinc in proteins. Reference [38] had reported that zinc potentiates the oxido-reductive potentials of selenium and that zinc release from metallothioneins by selenium is a significant aspect of the therapeutic antioxidant action of selenium compounds.

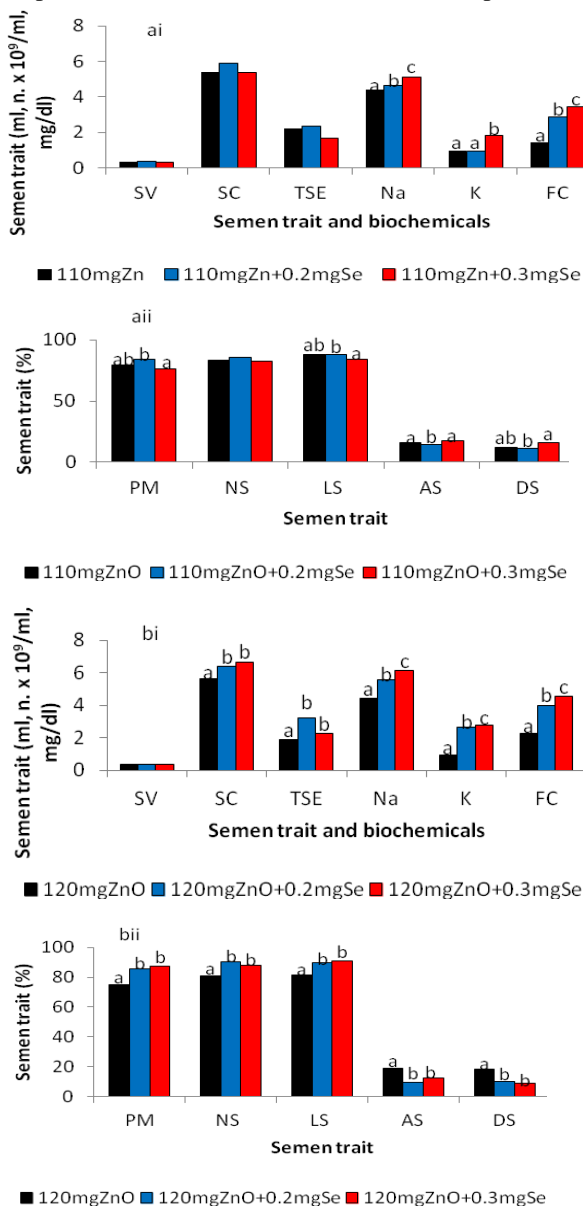


Fig. 2. Comparative effects of Zn and Zn + Se supplementation on turkey semen traits and biochemical constituents (a: 110mg Zn; b: 120mg Zn)

The correlation coefficients between semen quality traits and semen biochemical constituents are shown in Table VI. Generally, the normal semen quality traits (SV, PM, NS, LS, SC, and TSE) were positively correlated with one another but negatively correlated with the abnormal semen quality traits such as abnormal (AS) and dead (DS) spermatozoa which were in turn positively correlated. The normal semen quality traits were also generally positively correlated with the semen biochemical constituents. Thus significant positive correlations existed between LS, and FC, K, and Na ($r = 0.47, 0.50, \text{ and } 0.51$, respectively), NS, and FC, K, and Na ($r = 0.72, 0.76, \text{ and } 0.65$, respectively), TSE, and FC, K, and Na ($r = 0.60, 0.60, \text{ and } 0.65$, respectively) as well as between PM and K ($r = 0.54, P < 0.05$). A similar result was obtained between FC, and K, and Na ($r = 0.91, 0.94$, respectively), as well as between Na and K ($r = 0.85$). Conversely, DS and Na, and DS and K were significantly negatively correlated ($r = -0.51, \text{ and } -0.50$, respectively, $P < 0.05$). Similarly significantly ($P < 0.05$) negative correlation also existed between AS, and FC, K, and Na ($r = -0.72, -0.76, \text{ and } -0.65$, respectively). Sperm motility was positively but non-significantly related with FC, and Na concentrations of semen.

The positive correlation between the normal semen quality traits and the negative correlation between these and the abnormal semen quality parameters indicate that factors that will improve any of the normal semen quality traits will as well improve the others but limit the abnormal semen traits. The observed significantly positive correlation between normal semen traits and the biochemical constituents indicate that semen quality of toms could be improved by enhancing their energy and mineral nutrition. These results are in line with the findings of [43] who reported that fructose was positively correlated with semen volume, motility, normal morphology and sperm concentration. Our results also agree with those of [44]-[46] who reported positive and significant correlations between normal semen quality traits and negative correlations between these traits and the abnormal semen qualities.

IV. CONCLUSION

The results of the present study showed that supplementing selenium (Se) and zinc in the diets of turkey toms improved semen quality and that Se in combination with 120mg Zn gave the best semen quality traits. The combination of Se and Zn could therefore, be used to improve the fertility of native turkey toms.

Table VI. Correlation coefficients among semen quality traits of turkey toms fed or not sole and combined Se and Zn

Trait	SV	PM	NS	AS	LS	DS	SC	TSE	FC	Na
P M	0.42**									
N S	0.54**	0.73**								
AS	-0.54**	-0.72**	-1.00**							
LS	0.37**	0.65**	0.67**	-0.67**						
DS	-0.38**	-0.65**	-0.68**	0.68**	-0.99**					
SC	0.31**	0.29**	0.27**	-0.27**	0.39**	-0.38**				
TSE	0.37	0.44*	0.55**	-0.55**	0.63**	-0.63**	0.32			
FC	0.23	0.38	0.72**	-0.72**	0.47**	-0.47	0.23	0.60**		
Na	0.27	0.31	0.65**	-0.65**	0.51*	-0.51*	0.35	0.65**	0.94**	
K	0.29	0.54*	0.76**	-0.76**	0.50*	-0.50*	0.37	0.60**	0.91**	0.85**

*P<0.05; **P<0.01. SV=Semen volume, PM=Progressive motility, NS=Normal sperm, AS=Abnormal sperm, LS= Live sperm, DS=Dead sperm, SC=Sperm concentration, TSE=Total sperm in ejaculate, FC=Fructose concentration, Na=Sodium, K=Potassium.

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