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Puberty and ejaculate characteristics of native toms subjected to increasing photoperiods

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Abstract

The study was carried out to determine the effect of photoperiod (PTP) on age and body weight at first ejaculation and on first and overall ejaculate characteristics of pubertal native toms. Thirty healthy grower native toms, 28 weeks old, were used for the study. The birds were assigned to one of 5 photoperiods or treatments (T): control or 12L:12D (T1), 14L:10D (T2), 16L:8D (T3), 18L:6D (T4) and 20L:4D (T5). Data included age and body weight at first ejaculation (AFE and BFE, respectively), first and subsequent ejaculate volumes (EV), sperm concentration (SPC), sperm motility (SPM), percent live sperm (LSP), dead sperm (DSP), normal sperm (NSP) and abnormal sperm (ASP). Analysis for effect of PTP on AFE and BFE and on first ejaculate characteristics involved initial body weight as a covariate. AFE for toms in 20L:4D was 36.95±0.43 wk compared to 41.59±0.46 wk for the control ($P<0.05$). BFE and weight gain up to first ejaculation did not vary with PTP. First ejaculate characteristics were affected by PTP except LSP, NSP and ASP. Effect of PTP on overall ejaculate characteristics was however, significant ($P<0.05$) for all traits with PTP 18L:6D and 20L:4D having the highest overall EV, SPC, LSP, SPM and NSP but least ASP and DSP. Significant ($P<0.05$) correlations existed between PTP, AFE and BFE and some semen quality traits in the first and overall ejaculates of the toms. It was concluded that photoperiod significantly affected the age at first ejaculation as well as first and subsequent ejaculate characteristics of native toms.

Keywords: First ejaculate; photoperiod, puberty; semen characteristics; native tom

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Introduction

The changes in the reproductive performance of a novice tom over the reproductive cycle have been divided into five major stages or phases (Bacon et al., 2000). These include 1. Age of puberty (onset of sperm production or age of first semen ejaculation), 2. Phase of reproductive increase (when the rate of sperm production increases to its maximum), 3. Phase of sexual maturity (when a male first attains maximum sperm production and maximum sperm production attains longest duration), 4. Phase of reproductive decrease (when sperm production progressively declines) and 5. Phase of reproductive failure (when sperm production ceases). When breeder males and females are reared separately, hatching-egg production proceeds by artificial insemination using semen from breeder toms. For this, maximum utilization of breeder toms becomes very critical. To exploit each breeding male maximally, all appropriate phases of the reproductive cycle must be optimised. For an elite tom, this would imply earliest age at puberty, a rapid rise to reproductive increase, sustained high semen production during sexual maturity, a slow rate or absence of reproductive decline and a late onset or absence of reproductive failure (Bacon et al., 2000).

The effect of lighting (photoschedule) on the reproductive performance of exotic poultry breeds have been widely studied (Noirault et al., 2006a&b; Tyler and Gous, 2009) but such information is lacking in the indigenous breeds. Once puberty is attained, egg production in photosensitive females, and sperm

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production in photosensitive males ensues under appropriate photoschedule (Eitan and Soller, 2001). There is also ample evidence of juvenile and adult photorefractoriness in male and female chickens (Lewis et al., 2004; Lewis and Gous, 2006; Tyler and Gous, 2008; Floyd and Tyler, 2011) and in female turkeys (Proudman, 1998; Floyd and Tyler, 2011) but not in male turkeys (Proudman and Siopes, 2005). Thus photosensitivity in poultry species could be species specific (Noirault et al., 2006a) and have genetic components (Eitan and Sollers, 2001; Tyler and Gous, 2009). Such genetic variation is manifested by differences in photosensitivity between and within breeds and by changes in photosensitivity following intense selection for rapid growth (e.g., in broilers) and for increased egg production (e.g., in layer chickens). It has also been shown that dwarf broilers tolerate higher photothresholds compared to layers (Eitan et al., 1998; Eitan and Sollers, 2001).

Photoschedules can be intermittent (asynchronous or synchronous) (Siopes, 1983; Bacon et al., 1994) or continuous and of long or short duration (Bacon et al., 2000). Intermittent lighting (asynchronous or synchronous) as well as continuous lighting schedules were shown to support normal semen production in turkeys. Short photoperiods (short days) have a photophase duration of less than the critical day length for the species and this is the shortest duration of photoperiod required to stimulate an increase in plasma LH in the photosensitive bird or to bring about a change in its reproductive phase (Floyd and Tyler, 2011). Long photoperiods (long days) have a duration of photophase that is greater than the saturation day length for the species and this is the shortest duration of photoperiod required to stimulate maximum LH release in the photosensitive bird (Bacon et al., 2000) or the photoperiod above which no further advance in sexual maturity is observed (Floyd and Tyler, 2011). Critical day length of between 11 and 11.5 h per 24 h during winter and greater than 14 h during summer was reported for domestic turkey by Siopes (1994). Photostimulation affects both the rate and amplitude of reproductive hormone secretion (Bacon et al., 2000), weight and rate of testes development (Noirault et al., 2006a&b; Tyler and Gous, 2009), rate of spermatogenesis (Noirault et al., 2006a), age at puberty and sexual maturity (Eitan and Soller, 2001), volume of ejaculate and other semen characteristics (Eitan and Soller, 2001; Noirault et al., 2006b). Exposure to photostimulation of 14 h L:10 h D (after rearing in short day of 8 h L:16 h D) was reported to induce precocious semen production in turkeys (Etches et al., 1993). Earlier, Siopes et al. (1983) had reported photoperiod induced increased testes weight at 22 wk of age with longer photoperiods associated with larger testes. Cecil and Bakst (1991) also reported early semen production following exposure to 14 h L:10 h D from 1 wk of age. The present study was aimed at evaluating the effect of various continuous photoschedules on the age and body weight at first ejaculation and on first and subsequent ejaculate characteristics of domestic male turkeys.

Materials and Methods

The study was carried out at the Poultry Research Section and the Biochemical Laboratory of the Department of Animal Science, University of Nigeria, Nsukka. A total of 30 healthy grower male turkeys, 28 weeks of age (WOA) were used for the study which lasted for 16 weeks. The birds were weighed to obtain their initial body weight (IBW) at the commencement of the experiment and then randomly assigned to 5 treatments (T) made up of different hours of light:Dark periods (L:D) in a Completely Randomized design (CRD). These were: control or 12L:12D (T1), 14L:10D (T2), 16L:8D (T3), 18L:6D (T4) and 20L:4D (T5) in a completely randomised design (CRD). Five light tight rooms were used for the experiment. Light was provided by means of incandescent bulbs at an intensity of 30 Laux and regulated by an automated light control device with Monostable 555 timer. The turkey males were maintained on breeder diet 2850 kcal/kg metablizable energy and 18% CP at 200g/bird/day. Water was provided *ad libitum*. Routine medication and other management practices were kept optimal to ensure optimal health.

Semen collection and evaluation

Semen was collected using the dorso-abdominal massage technique. The toms were trained to yield semen for two weeks (28-30 weeks of age) before the commencement of the study. Thereafter, twice per week trials for semen yield was made on birds belonging to each treatment between 06:00 to 09:00 hrs on the day of trial. First and subsequent ejaculations from each treatment were evaluated for volume (EV), sperm motility (SPM), sperm concentration (SPC), percent live spermatozoa (LSP), percent dead spermatozoa (DSP), percent normal spermatozoa (NSP), and percent abnormal spermatozoa (ASP) using standard techniques. To determine these parameters, collected semen was transferred into a 37^0C water bath immediately after collection. Volume of ejaculate (VEJ) was obtained by reading from calibrated collection tubes. Sperm progressive motility (PGM) was assessed immediately after semen collection using a light microscope with a warm stage attachment at x 400 magnification, and the percentage of motile spermatozoa was estimated by visual appraisal (Suriyasomboon et al., 2005). Sperm concentration (SPC, no. × 10^6/ml) was determined using a haemocytometer count while percentage live, dead, and abnormal spermatozoa (LSP, DSP, and ASP, respectively) were determined by examination under oil-immersion phase contrast microscope (× 1000)

(Suriyasomboon et al., 2005) after differential staining using eosin-negrosin stain. The age (wk) and body weight (kg) at first ejaculation of each tom in a treatment was recorded.

Data analysis

Two separate analyses were performed. Data on AFE, BFE, and first ejaculate characteristics were subjected to analysis of variance (ANOVA) using the GLM of Genstat computer software (Genstat Discovery edition 3, 2009). For this analysis, photoperiod was the fixed effect while initial body weight (IBW) was included as a covariate to correct for effect of differences in body weight at onset of the experiment. The second analysis involved data on overall ejaculate characteristics of the experimental toms for the experimental period. Significant effects in the two analyses were separated using Fisher's least significant difference (Fisher's LSD) option in Genstat.

Results

The effects of photoperiod on age and growth parameters at first ejaculation of pubertal toms are presented in Table 1. AFE differed significantly (P<0.05) between PTP while BFE and BWG were not significantly affected. Toms belonging to 20L:4D PTP ejaculated at the youngest age of 36.95±0.43 wk while toms in 12L:12D and 14L:10D PTPs ejaculated at the oldest ages of 41.56±0.46 and 40.57±0.44 wks, respectively. AFE was not significantly different among 14L:10D, 16L:8D and 18L:6D PTPs however, toms subjected to 16L:8D and 18L:6D photoperiods ejaculated at younger ages than those in 12L:12D photoperiod.

Table 2 presents the effect of photoperiod on first ejaculate characteristics of the experimental toms. Volume of ejaculate (EV), SPM and DSP were significantly (P<0.05) influenced by PTP while SPC tended to be significantly influenced (P<0.077). EV was similar for PTP 12L:12D, 14L:10D and 18L:6D and these had the highest values of EV. Toms subjected to PTP 16L:8D and 20L:4D had similar but lowest EVs (0.16±0.02 and 0.12±0.02 ml, respectively). For SPC, toms in PTP 12L:12D produced semen with the least SPC ($14.49\pm0.70\times10^6$) although this was only marginally significantly (P<0.077) different from that of other PTP. Other PTPs were similar in SPC which showed an increasing trend with increase in PTP. Sperm motility (SPM) was similarly least (P<0.05) in the semen of toms in PTP 12L:12D followed by those of 14L:10D (76.23±1.24 and 85.74±1.19%, respectively). SPM was similar for toms in the other PTPs (range, 90.52±1.37-91.49±1.15%). Percent dead sperm (DSP) followed no particular trend with PTP but was least (P<0.05) at 3.33±1.49% in semen of toms subjected to PTP 20L:4D compared to other PTPs.

The effects of photoperiod (PTP) on the overall ejaculate characteristics of toms are presented in table 3. There were highly significant (P<0.00) PTP effects on all semen traits studied. Semen from toms exposed to 18L:6D and 20L:4D had the highest EV of 0.26±0.01 and 0.25±0.0 ml, respectively while ejaculates of toms belonging to 12L:12D PTP had the least EV of 0.19±0.00 ml. However, ejaculates from toms subjected to 12L:12D, 14L:10D and 16L:8D did not differ in EV.

Fig. 1 presents the trend in semen traits with age of toms for the various PTPs (age × photoperiod interaction effect). Volume of ejaculate (EV) of toms in 20L:4D and 18L:6D PTP (panel A) increased progressively from onset of semen production to its mean peak yield of 0.3 ml between 40 and 42 weeks of age (WOA) before a gradual decline with age of toms. The same trend was observed for photoperiod 16L:8D but at a lower level of semen volume. For PTP 12L:12D and 14L:10D, semen volume was lower but more stable over the age periods. There was an increasing trend in SPC with age in semen of toms in PTP 20L:4D and 18L:6D (panel B). For the rest of the PTP, SPC did not vary much with age from its value at onset of semen production and there was no clear trend with increasing age of toms. Panel C shows that LSP was quite erratic across age periods for all PTP especially 20L:4D. Percent live sperm (LSP) decreased sharply in PTP 12L:12D from 89% at onset of semen production to about 80% over two age periods (42 and 43 WOA) before showing an upward trend. Age did not significantly alter SPM within PTPs (panel D). Thus SPM remained high and stable across age periods irrespective of PTP.

The correlation matrix for PTP, AFE, BFE and first ejaculate characteristics are presented in Table 4. PTP was significantly (P<0.05) positively correlated with BFE (r=0.690), SPM (r=0.847), SPC (r=0.802) and LSP (r=0.810) but significantly (P<0.05) negatively correlated with AFE (r=-0.911), ASP (r=-0.792) and DSP (r=-0.725). BFE was significantly (P<0.05) negatively correlated with AFE (r= -0.676) and EV (r= -0.684) but insignificantly correlated with other semen traits. AFE was significantly (P<0.05) positively correlated with ASP and DSP (r=0.779 and 0.778, respectively) but significantly negatively correlated with SPM, SPC and LSP (r=-0.696, -0.740 and -0.843, respectively). EV was insignificantly correlated with all semen traits considered while SPM was significantly (P<0.05) correlated with only SPC (r=0.800) and ASP (r=-0.759). The relationship between SPC and LSP was positive and significant (r=0.762, P<0.05) but negative for ASP and DSP (r=-0.779 and -0.741, respectively, P<0.05). NSP and ASP were expectedly negatively correlated (r=-0.685, P<0.05). A similar result was obtained between ASP and LSP (r=-0.927) and between LSP and DSP (r=-0.918) while ASP and DSP were significantly (P<0.05) positively correlated (r=0.792).

Table 1: Age and body weight at first ejaculation (Mean ± SE) of native toms on different photoperiods

	Photoperiod (hr)					
Parameter	12L:12D	14L:10D	16L:8D	18L:6D	20L:4D	P value
AFE (wk)	41.56±0.46^{a}	40.57±0.44^{ab}	39.86±0.51^{b}	39.54±0.43^{b}	36.95±0.43^{c}	0.012
BFE (kg)	4.30±0.13	4.13±0.12	4.60±0.14	4.45±0.12	4.62±0.12	0.226
BWG (kg)	0.62±0.13	0.45±0.12	0.92±0.14	0.77±0.12	0.94±0.12	0.226

^{a,b,c} Means on the same row with different superscripts are significantly (P<0.05) different. AFE: age at first ejaculation; BFE: body weight at first ejaculation, BWG: body weight gain up to AFE

Table 2: First ejaculate characteristics of native toms (Mean ± SE) on different photoperiods

	Photoperiod (hr)					
Parameter	12L:12D	14L:10D	16L:8D	18L:6D	20L:4D	P value
EV (ml)	0.20±0.13^{a}	0.23±0.02^{a}	0.16±0.02^{b}	0.19±0.02^{a}	0.12±0.02^{b}	0.053
SPC (× 10^{6}/ml)	14.49±0.70^{b}	16.94±0.67^{a}	16.76±0.77^{ab}	16.94±0.64^{a}	18.70±0.66^{a}	0.077
SPM (%)	76.23±1.24^{c}	85.74±1.19^{b}	90.52±1.37^{a}	91.49±1.15^{a}	91.01±1.17^{a}	0.004
LSP (%)	85.12±2.81	86.63±2.68	86.07±3.10	92.14±2.60	95.42±2.64	0.156
NSP (%)	92.47±2.19	92.97±2.09	94.86±2.41	93.97±2.02	95.61±2.06	0.874
ASP (%)	5.02±1.02	6.06±0.97	4.22±1,12	3.10±0.94	1.47±0.96	0.136
DSP (%)	11.69±1.57^{a}	14.20±1.51^{a}	16.34±1.75^{a}	11.82±1.47^{a}	3.33±1.49^{b}	0.018

^{a,b,c}Means on the same row with different superscripts are significantly (P<0.05) different. EV: ejaculate volume, SPC: sperm concentration, SPM: sperm motility, LSP: live spermatozoa, NSP: normal spermatozoa, ASP: abnormal spermatozoa, DSP: dead spermatozoa.

Table 3: Overall ejaculate characteristics of native toms (Mean ± SE) on different photoperiods

	Photoperiod (hr)					
Parameter	12L : 12D	14L:10D	16L:8D	18L:6D	20L:4D	P value
EV (ml)	0.19±0.00^{c}	0.21±0.01^{bc}	0.21±0.01^{bc}	0.26±0.01^{a}	0.25±0.02^{ab}	0.00
SPC (× 10^{6}/ml)	14 66±0.44^{c}	17.26±0.79^{bc}	17.53±0.60^{bc}	20.05±1.08^{ab}	21.10±1.03^{a}	0.00
SPM (%)	75.43±0.44^{d}	83.00±1.44^{c}	87.60±1.32^{b}	91.36±0.36^{a}	92.69±0.38^{a}	0.00
LSP (%)	82.68±1.55^{d}	86.11±0.81^{c}	89.23±1.04^{b}	93.00±0.61^{a}	94.42±0.42^{a}	0.00
NSP (%)	90.25±1.30^{c}	90.72±1.06^{c}	93.30±0.73^{b}	96.43±0.59^{a}	96.89±0.47^{a}	0.00
ASP (%)	8.50±1.35^{a}	7.28±0.88^{ab}	6.45±0.79^{b}	3.34±0.38^{c}	1.89±0.26^{c}	0.00
DSP (%)	16.18±1.33^{a}	13.22±1.09^{b}	11.65±0.80^{b}	8.18±0.89^{c}	4.95±0.62^{d}	0.00

a, b, c, d: means on the same row with different superscripts are significantly (P 0.00) different. EV: ejaculate volume, SPC: sperm concentration, SPM: sperm motility, LSP: live spermatozoa, NSP: normal spermatozoa, ASP: abnormal spermatozoa, DSP: dead spermatozoa.

Table 5 is the correlation matrix for photoperiod (PTP), body weight at first ejaculation (BFE), age at first ejaculation (AFE) and overall ejaculate characteristics of the experimental toms. The table shows enhanced relationship among the variables compared to the situation for the first ejaculate. Photoperiod (PTP) was significantly (P<0.05) positively correlated with all semen traits and BFE except AFE, ASP and DSP which were significantly (P<0.05) negatively correlated with PTP (r=-0.395, -0.764 and -0.817, respectively). Body weight at first ejaculation (BFE) was insignificantly correlated with all traits measured except EV (r=-0.845, P<0.05) while AFE was significantly (P<0.05) correlated with SPM (r=-0.382), NSP (r=-0.289) and ASP (r=0.510). Volume of ejaculate (EV) was significantly (P<0.05) positively correlated with SPM, SPC, NSP and LSP (r=0.498, 0.455, 0.483 and 0.457, respectively) but negatively correlated with ASP and DSP (r=-0.408 and -0.451, respectively). SPM, SPC, NSP, and LSP were significantly (P<0.05) positively correlated with each other while SPM was significantly (P<0.05) negatively correlated with ASP and DSP, respectively. The relationship between SPC and ASP and SPC and DSP was negative and significant (r=-0.324 and -0.568, respectively, P<0.05). For NSP, significant (P<0.05) correlation was obtained with ASP (r=-0.615), LSP (r=0.622) and DSP (r=-0.547). ASP and LSP were negatively correlated (r=-0.589, P<0.05). DSP was positively correlated with ASP (r=0.620, P<0.05) and negatively correlated with LSP as expected (r=-0.853, P<0.05).

Discussion

The significant effect of PTP on AFE (Table 1) indicates that PTP affected age of onset of puberty, semen production and sexual maturity in the experimental toms. The earlier onset of ejaculation observed for PTPs longer than natural day length (12L:12D) agrees with reports of similar studies in turkeys and other poultry species and could be attributed to enhanced nutrition (Kastelic, 2013). Kastelic (2013) reported that increased nutrition before 30 WOA increased leutinizing hormone pulse frequency, hastened puberty, and increased testicular size in bulls. Yang et al. (1998) reported that male domestic turkeys

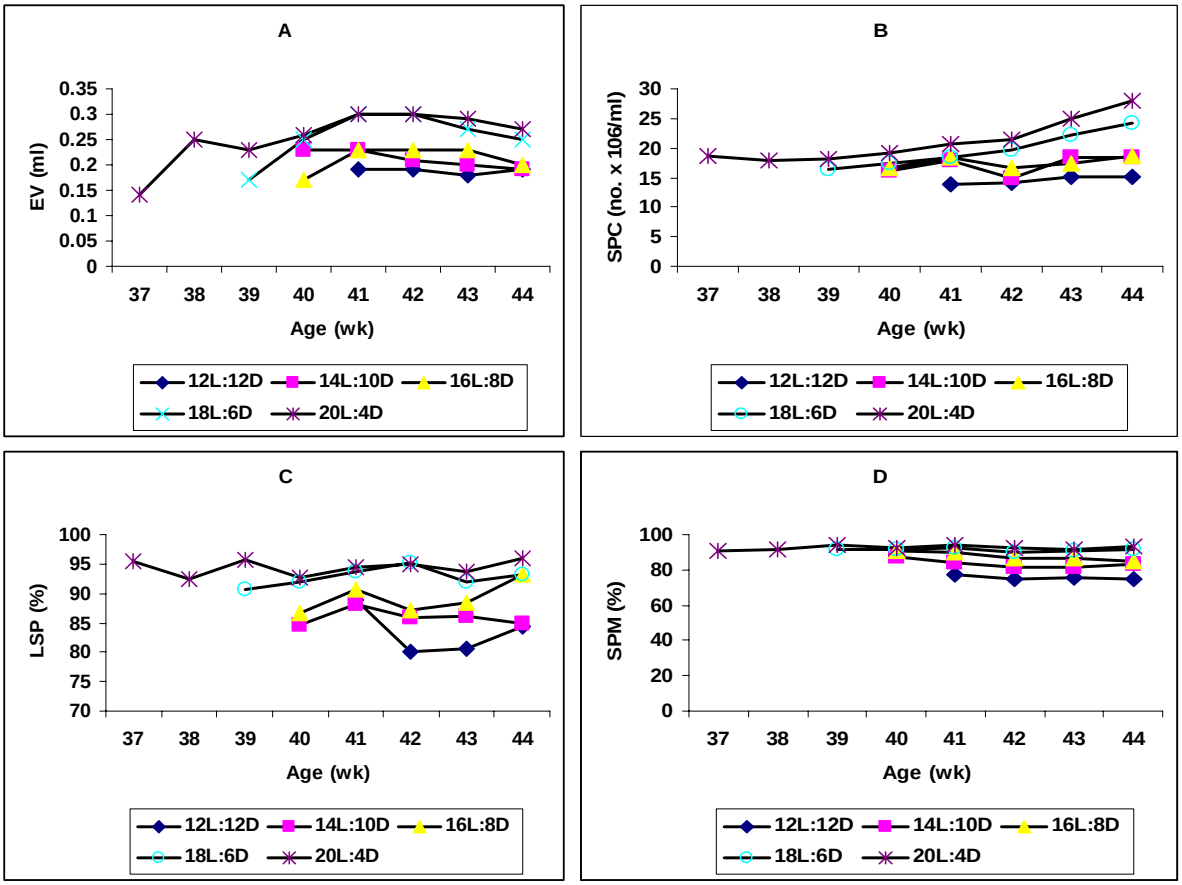

Fig. 1: Effect of age × photoperiod on Volume of ejaculate (EV, panel A), sperm concentration (SPC, panel B), Percent live spermatozoa (LSP, panel C), and percent sperm motility (SPM, panel D) of native turkey toms.

subjected to 16 h L:8 h D attained puberty and sexual maturity several weeks earlier than those in 6 h L:18 h D.

The authors also reported significantly higher levels of plasma LH, testosterone (T) and thyroxin (T_4) in toms belonging to 16 h L:8 h D compared to those of 6 h L:18 h D. Bacon et al. (2000) reported positive correlation between high rate and amplitude of luteinizing hormone (LH) and T secretion and early puberty (25 WOA) in male turkeys subjected to long day PTP (14 h L:10 h D) compared to above 29 WOA for their counterparts in short day PTP (10 h L:14 h D). Also El-Badry et al. (2009) reported significantly higher seminal total protein, albumin, aspertate transaminase (AST), alanine transaminase (ALT), testis weight and T concentration in drakes subjected to 24 h L and 18 h L:6 h D compared to those in 6 h L:18 h D and natural day light (12 h L:12 h D). However, Floyd and Tyler (2011) did not observe significant photostimulation effect on age at first semen production in broiler breeders subjected to a range of PTPs (9.0 to 18.0 h L) at 20 WOA. This result was attributed to high individual variation in this variable probably due to lack of prior selection for semen quality or due to differential attainment of sexual maturity among birds in the same treatment at the age of photostimulation. Body weight and body weight gain up to the age at first ejaculation were not significantly affected by photostimulation probably because the threshold body weight for puberty/sexual maturity had been attained by the toms at the age (28 WOA) they were photostimulated. In traditional turkey hatching-egg production, male turkey breeders are photostimulated at about 27 to 29 WOA, 3 wk prior to the stimulation of female breeders (Bacon et al., 2000). Noirault et al. (2006b) also reported insignificant effect of photoperiod on body weights of male turkeys.

Volume of first ejaculate was least in PTP 20L:4D (Table 2) probably on account of the high stimulatory effect of this PTP and hence the very young age at first ejaculation in this group. It could also be that this photoperiod had a depressive effect on semen yield since the immediate preceding photoschedule (16L:8D) had significantly higher ejaculate volume. Proudfoot (1981) reported insignificant effect of photoperiod on semen volume in meat type chickens which was attributed to photorefractoriness-a phenomenon common in male broiler breeders (Lewis et al., 2003; Tyler and Gous, 2009; Tyler and Gous, 2011). Significant effect of PTP on SPC, SPM and DSP indicated that PTP affected sperm

Table 4: Correlation matrix for photoperiod (PTP), age at first ejaculation, body weight at first ejaculation and first ejaculate characteristics of native toms

	BFE	AFE	EV	SPM	SPC	NSP	ASP	LSP	DSP
PTP (L:D)	0.690*	-0.911**	-0.376	0.847**	0.802**	0.499	-0.792**	0.810**	-0.725*
BFE (kg)		-0.676*	-0.684*	0.579	0.344	0.568	-0.480	0.559	-0.445
AFE (wk)			0.583	-0.696*	-0.740*	-0.448	0.779**	-0.843**	0.778*
EV (ml)				-0.098	-0.130	-0.019	0.105	-0.355	0.306
SPM (%)					0.800**	0.572	-0.759*	0.607	-0.447
SPC (x10^6/ml)						0.256	-0.779**	0.762*	-0.741*
NSP (%)							-0.685*	0.519	-0.355
ASP (%)								-0.927**	0.792**
LSP (%)									-0.918**

**P<0.01; *P<0.05; PTP: photoperiod; BFE: body weight at first ejaculation; AFE: age at first ejaculation; EV: ejaculate volume; SPM: spermatozoa motility; SPC: sperm concentration; NSP: normal spermatozoa; ASP: abnormal spermatozoa; LSP: live spermatozoa

Table 5: Correlation matrix for photoperiod (PTP), age at first ejaculation, body weight at first ejaculation and overall ejaculate characteristics of native toms

	BFE	AFE	EV	SPM	SPC	NSP	ASP	LSP	DSP
PTP (L:D)	0.690*	-0.395**	0.488**	0.879**	0.584**	0.736**	-0.764**	0.851**	-0.817**
BFE (kg)		0.611	-0.845**	0.557	0.399	0.337	-0.566	0.349	-0.403
AFE (wk)			0.146	-0.382**	0.241	-0.289*	0.510**	-0.264	0.319
EV (ml)				0.498**	0.455**	0.483**	-0.408**	0.457**	-0.451**
SPM (%)					0.570**	0.647**	-0.726**	0.775**	-0.735**
SPC (x10^6/ml)						0.389**	-0.324**	0.613**	-0.568**
NSP (%)							-0.615**	0.622**	-0.547**
ASP (%)								-0.589**	0.620**
LSP (%)									-0.853**

**P<0.01; *P<0.05; PTP: photoperiod; BFE: body weight at first ejaculation; AFE: age at first ejaculation; EV: ejaculate volume; SPM: spermatozoa motility; SPC: sperm concentration; NSP: normal spermatozoa; ASP: abnormal spermatozoa; LSP: live spermatozoa

production and quality. Toms in 14L:10D and above had the highest SPC and SPM showing that the reproductive potentials of toms in these photoschedules were enhanced. Significant positive effect of long PTP (14L:10D) on testicular development and sperm output of turkeys was reported by Noirault et al. (2006a&b). Noirault et al. (2006b) reported that toms in the long photoschedule had higher testicular weight and weekly semen output compared to those in strictly short photoperiod (7L:17D) or moderately short photoperiod (10.5L:13.5D). The significantly lower DSP observed in photoperiod 20L:4D indicate that early spermatogenesis (sperm production) and sexual maturity enhances semen viability (Noirault et al., 2006b).

Photoschedules of 16L:8D and above generally maintained the best semen qualities over the experimental period (Table 3) compared to shorter photoschedules showing that these photoperiods were above the critical day length for the toms used in the present study. There is dearth of information on the photoresponse curve for exotic and indigenous male turkey breeders (Bacon et al., 2000) but the critical day length for exotic domestic turkey hen was reported to be 11 to 14 h (Bacon et al., 2000). Our results also indicate that photostimulation had a sustained positive effect on the parameters measured.

The effect of age within photoperiod (interaction effect of age × photoperiod) on EV, SPC, LSP and SPM (Fig. 1) was insignificant but provided insight into the trend of sperm quality with age for various photoschedules. The highest volume of ejaculate attained by the toms was 0.3 ml (PTP 18L:6D, panel A) which suggests that 0.3 ml could be the upper threshold of semen volume for the toms in the present study. The increasing trend observed in SPC with age in PTP 18L:6D and above (panel B) shows that SPC is highly correlated with age at high photoschedules and that under this condition there is greater latitude for genetic improvement of SPC than for the other semen traits. Bacon et al. (2000) reported that male turkeys exposed to long-day lighting (16L:8D) at an early age maintained higher levels of semen production throughout the reproductive period compared to those given short-day photoperiod. The effect of increasing age is however detrimental to SPC, SPM, viability and morphology in broiler breeder rooster semen as reported by Tabatabaei et al. (2010) hence the present report suggests that manipulation of photoperiod could be used to modify the effect of age on semen production and semen quality in male turkey (Bacon et al., 2000).

The significantly negative correlation between PTP and AFE, ASP and DSP and positive correlation between PTP and SPM, SPC and LSP (Table 4) indicate that selection for increased sensitivity to PTP prior to sexual maturity would reduce the former traits and improve the

later ones. Age at first ejaculation (AFE) was negatively correlated with SPM, SPC, NSP and LSP showing that reduced AFE would enhance sperm quality. Therefore, factors which delay sexual maturity will most likely decrease the quality of the first ejaculate. Tabatabaei et al. (2010) stated that age has an adverse effect on the reproductive success of birds. The authors reported significantly lower SPC, SPM and sperm viability and higher morphological defects with increasing age in broiler breeder rooster semen. The negative relationship between BFE and AFE means that increased early growth rate would enhance sexual maturity and hence reduce the AFE. The non significant relationship between BFE and all first ejaculate quality traits shows that the body weight of the toms at first ejaculation had no direct effect on the first ejaculate characteristics. It could be that initial semen production (spermatogenesis) ensues at an earlier critical body weight such that the quality of first semen output (first ejaculation) was not related to body weight at first ejaculation (BFE). The positive correlation between SPC, LSP and SPM shows that increasing sperm density (SPC) would yield higher numbers of live and motile sperm. The negative correlation between the positive semen qualities (SPM, SPC, NSP and LSP) and the negative semen qualities (ASP and DSP) was expected and shows that factors which enhance sperm quality would reduce the later traits.

The positive and highly significant correlation between photoperiod (PTP) and the semen quality traits namely SPM, SPC, NSP and LSP over the entire experimental period (Table 5) show that increasing photoschedule from the critical day length will lead to improvement in the sperm quality traits although this would be within certain limits (Noirault et al., 2006b) depending on the saturation day length of the breed of turkey (Siopes, 1994). Noirault et al. (2006b) inferred the existence of a threshold of photosensitivity in male turkeys for photoperiods longer than 9.5L:14.5D, but shorter than or equal to 10.5L:13.5D. The results of the present study however suggest a higher upper threshold of 18L:6D which may be related to the breed of turkey and/or the study environment. Thus selecting for increased sensitivity to photoperiod could enhance sperm production and quality. PTP was negatively correlated with AFE but positively correlated with BFE which means that increased sensitivity to PTP early in the growth phase would enhance growth (higher BFE) and reduce the age at sexual maturity (reduced AFE). All the positive semen quality traits (SPC, NSP, LSP and SPM) were significantly positively correlated indicating that improvement in one trait would lead to correlated positive response in the others. The negative correlation between the positive semen quality traits and the negative quality traits means that improving the positive traits will reduce the negative quality traits. These results agree with reports of similar studies in birds and other species (Noirault et al., 2006a, b; El-Badry et al., 2009; Moghaddam et al., 2012; Pourseif and Moghaddam, 2012).

Conclusion

The results provide strong evidence that local turkey toms exhibit photosensitivity. Thus photostimulation affect the age at first ejaculation as well as first and subsequent ejaculate characteristics of native toms. Also selection for increased photosensitivity in native toms could lead to correlated improvement in age at sexual maturity and semen quality.

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