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EFFECTS OF DIETARY LIPID SOURCES ON THE SEMEN QUALITY OF HY-LINE SILVER-BROWN COCKERELS

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ABSTRACT

A study was conducted to evaluate the effects of dietary lipid sources on the reproductive performances of Hy-line Silver-Brown cockerels. Five different lipid sources namely fish oil, sunflower oil, high oleic acid sunflower oil, tallow and an equal (50:50) proportion of linseed and fish oil (representing the control diet), were used in formulating five *iso-energetic* and *isonitrogenous* diets (30g/kg inclusion level). The experimental cockerels (n = 10/treatment) were randomly allocated to the 5 experimental diets at 32 weeks of age, and measurements were taken from week 35 to 46 of age. The parameters recorded were: feed intake, body weight, semen volume, sperm concentration, sperm motility and sperm viability. Semen ejaculation rate was also calculated for the cockerels from which semen was collected. While a lower (P<0.05) feed intake (78.75g/bird/day), body weight (2499g), sperm motility (48.1%) and ejaculation rate (79.2%) was recorded in the cockerels fed a fish oil supplemented diet during this period, a higher (P<0.05) semen volume (0.42mL) was recorded in the tallow fed cockerels. Results indicate dietary fatty acid supplementation from the various sources to have distinct effects on certain semen quality (semen volume, sperm output, sperm motility) and reproductive (ejaculation rate) parameters in the cockerels tested.

Keywords: male breeders, fatty acids, diets, fertility, cockerels.

INTRODUCTION

Dietary manipulation by fatty acids has been suggested as a method of enhancing cockerel semen quality due to the strong relationship that exists between nutrition and overall flock fertility (Hudson & Wilson, 2003). Lipids are known to be constituents of avian semen and are also involved in the sperm biological activities. Dietary lipid or fatty acid sources have then been thought to affect cockerel sperm composition and functionality in different ways (Bongalhardo *et al.*, 2009), even when deposited proportionately in the sperm (Kelso *et al*., 1997; Cerolini *et al.*, 2003).

The omega-6 (n-6) type of fatty acids (e.g. docosatetraenoic acid; DTA) have been shown to be the most prevalent in cockerel sperm (Cerolini *et al.*, 1997b), as opposed to the omega-3 (n-3) type of fatty acids that are predominant in bull sperm (Kelso *et al.*, 1997). However, unsaturated fatty acids readily undergo oxidation at the carbon atoms adjacent to the double bond to form hydroperoxidase (McDonald *et al.*, 2011). Therefore, despite reports that long chain n-3 fatty acids (e.g. docosahaexanoic acid; DHA) incorporated in fish oil improve sperm progressive motility in cockerels (Cerolini *et al.*, 2006), its susceptibility to peroxidation is a concern (Ollero & Alvarez, 2003).

Although positive results in terms of improved sperm motility following the supplementation of n-3 and n-6 in diets with varying levels of Vitamin E have been reported (Cerolini *et al.*, 2006), the effectiveness of antioxidants could be compromised by a high (30°C) ambient temperature (Njobeh *et al*., 2006). Isolated studies that encompass all categories of fatty acids are rare. So for example, polyunsaturated lipid sources were tested by Cerolini *et al.* (2006) where similar results were reported in the semen parameters of cockerels fed n-3 and n-6 rich diets (at a 1% lipid inclusion level), except regarding sperm progressive motility. Furthermore, Zanini *et al.* (2003) reported improved sperm motility in 30 week old cockerels fed an omega-9 (n-9) rich diet, in an experiment that included mono-unsaturated and polyunsaturated lipid sources only. The poultry breeder is thus confronted with a range of lipid choices from studies conducted on limited categories of available dietary lipid sources. The subjective nature of the general semen quality assessment methods employed by many researchers makes a single study of all the categories of fatty acids (saturated, mono-unsaturated and polyunsaturated) thus imperative.

The aim of the present study was therefore to evaluate the effect of a fish oil (n-3), sunflower oil (n-6), high oleic sunflower oil (n-9), tallow (saturated fatty acid), and a control diet (n-3) consisting equal proportions (50:50) of linseed and fish oil, on the semen quality of cockerels.

MATERIALS AND METHODS

Experimental animals, housing and diet: This study was conducted at the poultry research facility on the Paradys experimental farm of the University of the Free State, situated 20 km south of Bloemfontein, South Africa. Guidelines regarding animal care and welfare were followed as stipulated and approved by the Animal Ethics Committee of the University of the Free State (Experiment No. 19/2011). Seventeen week old Hy-Line Silver-Brown cockerels (n = 70) were purchased from a commercial pullet producer. On arrival, birds were individually housed in cages (1600 cm^2) and a standard layer grower mash fed from arrival (week 17 of age), until the onset of the experimental dietary treatments (week 32 of age). From 22 weeks of age, all cockerels were trained for semen collection according to the "massage" technique (Cole & Cupps, 1977). The 20 least sensitive cockerels with the lowest ejaculation frequency were removed from the population of 70 cockerels at week 32 of age.

Experimental design: At 32 weeks of age, 50 cockerels (n = 10 per treatment) were randomly assigned to one of the following five *iso-energetic* (12.4 MJ AME/kg DM) and *isonitrogenous* (170 g CP/kg DM) dietary treatments. The (i) control diet (a blend of 50% fish and 50% linseed oil); (ii) pure fish oil (n-3); (iii) sunflower oil (n-6); (iv) high oleic acid sunflower oil (n-9) and (v) tallow (SFA). Birds had free access to water, while the supply of feed was limited to 110g/bird/day to prevent obesity of cockerels and to decrease the possibility of kidney urolithiasis (Hy-Line, 2012). A photoperiod schedule of 16 hours light and 8 hours darkness (16L:8D) was provided constantly throughout the study period (32 to 46 weeks of age). The fatty acid methyl esters (FAME) of the experimental dietary treatments were determined by extracting the fat content thereof (King *et al*., 2012). Fatty acids were expressed as the relative percentage of individual fatty acids for the total fatty acids present in the lipid sample.

Semen evaluation: After an adaptation period of 3 weeks to the experimental diets, semen collection and sperm analyses commenced at the onset of week 35 of age. This was conducted once a week on individual cockerel basis, for a period of 12 weeks, until the end of 46 weeks of age. During this time, individual feed consumption was recorded weekly and used for the calculation of average daily feed intake (g/bird/day), while birds were individually weighed every four weeks to monitor their body weight. Semen was collected in 5mL transparent graduated tubes (least graduation of 0.5mL), maintained in a preheated (41°C) warm water flask and the semen individually analysed within 30 minutes of collection. Immediately after collection, the semen volume was visually appraised directly from the graduated collection tube. Cockerels that failed to ejaculate or produced semen contaminated with faeces/uric acid were noted. The ejaculation rate (percentage) was calculated as the number of males collected divided by the number of males within a treatment group in that given collection period. Parameters such as sperm motility, concentration and viability were determined according to methods of Anderson (2001) and Lukaszewicz *et al*. (2008). Sperm motility was analysed on a warm microscope slide (x 400 magnification), by assessing a 10µL semen and Beltsvile Poultry Semen Extender (BPSE) mixture (1:10) and classifying 100 sperm cells as either motile or non-motile. Sperm were counted with the aid of haemocytometer (dilution at 1:200 of distilled water) from which the sperm concentration was then determined. Two hundred (2 x 100) individual sperm cells were viewed per slide for morphology assessment using the eosin-nigrosin stain method. The sperm output for each cockerel was calculated as the product of semen volume (mL) and sperm concentration (10^9/mL) (Anderson, 2001; Cerolini *et al*., 2006).

Statistical analyses: Semen parameters were statistically analysed using a fully randomized one-way ANOVA design (SAS, 2010), while the parameter means were compared using the least significant difference (LSD) test at a significance level of $P \leq 0.05$, according to the Duncan Multiple Range test. Pearson's correlation coefficients were calculated for certain related semen parameters at significance levels of $P \leq 0.05$, $P \leq 0.01$ and $P \leq 0.001$, based on the variability associated with the type of variable.

RESULTS AND DISCUSSION

The inclusion of the respective dietary lipid sources resulted in the prevalence of the specific fatty acids in the dietary treatments - thereby producing distinct characteristics in lipid saturation and relative fatty acids concentrations (%) of the diets (Table 1).

The prevalence of individual fatty acids, as well as the total saturated, mono-unsaturated, polyunsaturated, n-6, and n-3 fatty acids, and their specific ratios in the experimental diets are summarised in Table 1. Significant differences ($P<0.0001$) were recorded for both the total concentration and ratios of fatty acids between the dietary treatments. The control diet recorded the highest concentration (21.42%) of total n-3 fatty acids, and had the second highest concentration of total PUFA's (51.77%). The fish oil (n-3) treatment as expected, recorded the highest ($P<0.001$) concentration of long chain n-3 derivatives, such as eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA), and docosahexanoic acid (DHA) (8.17, 0.66 and 2.57%, respectively). In addition, the fish oil (n-3) diet contained a high proportion of saturated fatty acids. It was in this

diet that the highest (P<0.0001) concentration of myristic acid (5.22%) and palmitic acid (similar to tallow) were recorded. Consequently, fish oil (n-3) diet was rated second highest in total saturated fats (28.17%), as well as in n-3 (12.53%) concentration. This can partially be explained by the fact that although fish oil is a polyunsaturated n-3 source, it remains a lipid source of animal (fish) origin. Furthermore, it was evident that the sunflower (n-6) treatment recorded the highest total n-6 concentrations (55.27%). The n-6:n-3 and n-6:n-9 ratios were also significantly (P<0.0001) higher (65.99 and 1.91 respectively) in the sunflower treatment, compared to the other treatments. The high oleic acid sunflower (n-9) treatment had the highest concentration of total mono-unsaturated fatty acids (MUFA) (55.90%) and UFA (although not statistically different from the sunflower (n-6) treatment). This resulted in the highest proportion of n-9: n-3 (72.41:1) being recorded in the high oleic acid (n-9) sunflower treatment. Moreover, the tallow treatment only resulted in the highest total SFA (40.74%), with subsequent lowest UFA (59.26%) and PUFA (25.00%) concentrations.

Table 1 The mean effects of dietary lipid sources on the fatty acid methyl esters (FAME) of the experimental diets fed to the cockerels

FAME (%)	Control	Fish oil (n - 3)	Sunflower oil (n-6)	HO Sunflower oil (n-9)	Tallow (SFA)	Probability level (P)
Dietary fat (%)	5.08	5.23	5.17	5.18	5.17	0.5122
Saturated fatty acids						
C14:0 Myristic acid	2.39^{b}	5.22^{a}	0.06^{c}	ND	2.01^{b}	<0.0001
C16:0 Palmitic acid	13.03^{b}	18.18^{a}	9.14^{c}	7.56^{c}	19.99^{a}	<0.0001
C18:0 Stearic acid	3.36^{b}	3.47^{b}	4.56^{b}	4.47^{b}	17.11^{a}	<0.0001
Mono-unsaturated fatty acids (n-9)						
C16:1 Palmitoleic acid	2.81^{b}	5.96^{a}	0.08^{d}	0.07^{d}	1.39^{c}	<0.0001
C18:1 Oleic acid	23.18^{d}	21.32^{d}	27.82^{c}	54.86^{a}	30.24^{b}	<0.0001
C18:1 Vaccenic acid	1.63^{b}	2.54^{a}	0.66^{d}	0.74^{cd}	0.95^{c}	<0.0001
Polyunsaturated fatty acids (n-6)						
C18:2 Linoleic acid	29.96^{b}	27.09^{c}	55.27^{a}	29.87^{c}	24.04^{d}	<0.0001
C20:2 Eicosadienoic acid	0.04^{b}	0.08^{a}	ND	ND	ND	<0.0001
C20:4 Arachidonic acid	0.20^{b}	0.39^{a}	ND	ND	ND	<0.0001
C22:4 Docosatetraenoic	0.41	0.66	ND	ND	ND	<0.0001
Polyunsaturated fatty acids (n-3)						
C18:3 α-linolenic acid	15.38^{a}	1.13^{b}	0.84^{b}	0.78^{b}	0.95^{b}	<0.0001
C20:5 Eicosapentaenoic acid	4.26^{b}	8.17^{a}	ND	ND	ND	0.0002
C22:5 Docosapentaenoic acid	0.41^{ab}	0.66^{a}	ND	ND	ND	0.0021
C22:6 Docosahexanoic acid	1.38^{ab}	2.57^{a}	ND	ND	ND	0.0008
Total fatty acids (%)						
∑SFA[1]	19.74^{c}	28.17^{b}	14.97^{d}	13.45^{d}	40.74^{a}	<0.0001
∑UFA[2]	80.26^{b}	71.83^{c}	85.02^{a}	86.55^{a}	59.26^{d}	<0.0001
∑MUFA[3]	28.49^{d}	31.55^{bc}	28.91^{cd}	55.90^{a}	34.27^{b}	<0.0001
∑PUFA[4]	51.77^{a}	40.28^{b}	56.11^{a}	30.65^{c}	25.00^{c}	<0.0001
∑n-6	30.35^{c}	27.75^{c}	55.27^{a}	29.87^{b}	24.04^{d}	<0.0001
∑n-3	21.42^{a}	12.53^{b}	0.84^{c}	0.78^{c}	0.95^{c}	<0.0001
Fatty acid ratios						
n-6:n-3	1.44^{d}	2.49^{d}	65.99^{a}	38.67^{b}	25.35^{c}	<0.0001
n-6:n-9	1.07^{b}	0.88^{c}	1.91^{a}	0.53^{e}	0.70^{d}	<0.0001
n-9:n-3	1.35^{c}	2.88^{c}	34.54^{b}	72.41^{a}	36.17^{b}	<0.0001

^{a,b,c,d} Row means with different superscripts differ significantly at P<0.05; ND = not detected; [1]Saturated fatty acid; [2]Unsaturated fatty acid; [3]Mono-unsaturated fatty acid, [4]Polyunsaturated fatty acid.

The performance of cockerels in the present study was affected by the dietary lipid sources, as set out in Table 2. Firstly, the lower (P<0.05) feed intake of the fish oil (n-3) fed cockerels, compared to the cockerels in the other dietary treatments indicated a possible lower acceptability and subsequent intake of this particular diet. The present feed intake could not be compared with previous dietary experiments focussing on semen quality and fertility in poultry - as the feed intake of the experimental cockerels/toms was not reported (Surai *et al*., 2000; Hudson & Wilson, 2003; Zanini *et al*., 2003; Blesbois *et al*., 2004; Cerolini *et al*., 2006). The high concentration of long chain fatty acids, such as EPA and DHA in the 3% fish oil diet (as shown in Table 1), makes this treatment to be susceptible to oxidation (Ollero & Alvarez, 2003), particularly under the current temperature conditions. Njobeh *et al.* (2006) reported that a high ambient temperature (30°C) caused increased free fatty acid and elevated peroxide values, even in the presence of antioxidants. Although ambient temperature was not part of the study objectives, daily records showed the mean maximum temperature to be relatively high (29°C). One of the main disadvantages in consuming oxidized feed, has been reported to be the disruption of biological cellular activities (Shermer & Calabotta, 1985). This was observed in the general performance of the fish oil (n-3) fed cockerels of the present study. It is not surprising the disparity regarding feed intake between the 3% fish oil group, compared to the cockerels fed the control diet (1.5% fish oil and 1.5% linseed oil), as well as that of the cockerels whose diet comprised other categories of fat sources, was reflected in a lower body weight of the cockerels in the fish oil group (Engberg *et al.*, 1996). Research has revealed that dietary fatty acids are proportionately deposited in the sperm cell (Kelso *et al.*, 1997; Cerolini *et al.*, 2003), thus influencing the sperm quality of the cockerels (Cerolini *et al.*, 2006; Bongalhardo *et al.*, 2009).

An important observation in the present study was the positive effect of the saturated fatty acids on the semen volume of the cockerels (Table 2). So for example, the tallow - a saturated fatty acid (SFA) treatment, resulted in a higher (P<0.05) semen volume (0.42mL) than for cockerels whose dietary lipids were composed of unsaturated fatty acids of n-3, n-6 and n-9 origin. The similar semen volume recorded for cockerels fed the polyunsaturated lipids being in agreement with the findings of Cerolini *et al.* (2006). To the contrary, the fish oil (n-3) fed cockerels recorded a lower (although not significant) semen volume, when compared to cockerels maintained on the other unsaturated fatty acid diets. The trend in semen volume recorded for the fish oil (n-3) treatment and the cockerels in the other unsaturated fat diets in the present study (Table 2), was similar to the 0.34mL and 0.35mL reported by Cerolini *et al.* (2006) for 22 to 54 week old broiler breeders fed n-3 and n-6 diets, respectively. The present results also show similar tendencies to the study of Surai *et al.* (2000) on 26 week old Ross broiler breeder cockerels – where a semen volume of 0.44mL was recorded for maize oil (18:2n-6) and arasco oil (20:4n-6 and 18:1n-9) fed cockerels, but a relatively lower semen volume (0.43mL) for tuna oil (22:6n-3) fed cockerels. The slight variation in the semen volume between the fish/tuna oil diet and the other unsaturated fatty acid diets in the present study and other research may have been due to the relatively higher concentration and activity of the long chain fatty acids eicosopentaenoic acid (EPA) and docosahexanoic (DHA), in the sperm cells of cockerels fed these fish oil diets. Terano *et al.* (1996) reported that in the bid to prevent arteriosclerosis, EPA and DHA helped in regulating the proliferation of the smooth muscle cells - by inhibiting DNA synthesis and replication. Thus suppressing the progression of the synthesis phases in the cell cycle. Contrary, the tendency of saturated fatty acids to hasten muscle cell proliferation has been reported. Studies by Terano *et al.* (1996) and Sudheendran *et al*. (2010) revealed that while fish and vegetable oils attenuated or retarded smooth cell proliferation, highly saturated lipid sources enhanced coronary smooth muscle cell proliferation. Hence the low and the high semen volumes recorded in the fish oil and the tallow fed cockerels respectively, may be related to the characteristic effects of these lipid sources.

The sperm concentration did not differ (P>0.05) between the dietary treatment groups. The data in the present study is more in agreement with Surai *et al.* (2000) and Bongalhardo *et al*. (2009) than Cerolini *et al.* (2006), who reported significant differences in the sperm concentration between dietary n-3 and n-6 fed cockerels.

In the current study, lower (P<0.05) sperm motility was evident in the cockerels that consumed the diet containing 3% fish oil (n-3). This is a symptom of the negative effect of dietary lipid oxidation on the sperm cell. Sperm motility has been reported to be negatively affected by the free oxygen radicals, particularly those emanating from exogenous sources (Jones & Mann, 1977). Conversely, the high sperm motility recorded in the present study for high oleic sunflower (n-9) fed cockerels, is in agreement with the improved sperm motility reported by Zanini *et al.* (2003) in cockerels fed a diet supplemented with canola oil (n-9). This was attributed to the characteristic ability of omega-9 to enhance cellular membrane fluidity. The sperm motility of cockerels fed a tallow (SFA) diet was also among the highest ranked and statistically comparable to the values recorded in the control and the high oleic acid sunflower (n-9) fed cockerels. Although, semen was not separated into its constituents in the present study, the uncharacteristically high semen volume of the tallow fed cockerels indicate a high seminal plasma fraction. This could be an advantage, as seminal plasma has the

capacity to protect the avian sperm from lipid peroxidation. Surai (1998a) demonstrated that the seminal plasma of cockerels to be able to inhibit spontaneous lipid peroxidation in a concentration dependent manner - although the blood plasma had the opposite effect. Previous research indicated that the superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px) activity in semen plasma is deployed as a free radical trapping mechanism (Surai *et al*., 1998). In the present study, the 3% fish oil (n-3) supplemented cockerels recorded the lowest sperm viability, although not statistically different (P=0.1549) from the other treatments.

Stress has been reported to have a profound impact on the endocrine system, particularly the disruption of the hypothalamus-pituitary system and the anti-oxidant capacity of the brain tissue (Surai, 1998b). In addition to the poor performance and inferior semen quality of cockerels fed the fish oil (n-3) treatment, a negative effect was further encountered in the ejaculation rate (79%) of the cockerels in this group. Thus, these cockerels either failed to ejaculate or produced contaminated semen in 25 out of the 120 successive weekly abdominal massages. Ejaculation rates in the present study were higher than the 74.6% and 73.2% reported by Hudson and Wilson (2003) for menhaden (fish) oil and poultry fat fed cockerels in a fertility test. Generally, the ejaculation rate could serve partly as an indicator of cockerels' welfare (absence of stress). In a natural flock, stressful cockerels have been implicated in poor reproductive performance (Shabalina, 1984).

Correlations (Table 3) between certain sperm parameters in the present study are in agreement with those recorded by Cerolini *et al*. (1997a). Similar with the current trial, it has been reported that the high correlation of total sperm output with the semen volume and sperm concentration was not diet induced (lipid sources being maize oil, fish oil and flaxeed oil). Therefore, due to the formula used in the calculation of semen output, factors affecting any of the indices (semen volume and sperm concentration) will have an impact on the sperm output. The tallow thus had a higher capacity than the other lipid sources to boost the sperm output of the cockerels, as a result of the characteristic positive effect of this lipid source on the semen volume of cockerels. Semen volume showed a more pronounced correlation with sperm output, compared to the sperm concentration in all the dietary treatments. However, where semen volume was only correlated with sperm concentration in a pre-trial diet of Bongalhardo *et al.* (2009), these parameters recorded significant correlations in all (contrary to the two n-3 treatments in the present study). Correlations between sperm viability and motility are also contradictory to that of Bongalhardo *et al.* (2009). Sperm viability (percentage live sperm) was only significantly (P<0.01) correlated (r=0.28) to sperm motility in the sunflower (n-6) treatment group. The sperm viability data determined in this correlation was only for that of the live sperm. It was also observed that during the sperm analyses in the present study, the sperm motility was high in certain samples in which a high proportion of sperm abnormalities was later recorded. Further, the results of the present study regarding the absence of a significant correlation between sperm viability and sperm concentration is in agreement with the report of Cerolini *et al*. (1997a).

Table 2. The effects (LSM ± S.E.M) of dietary lipid sources on the performance and semen quality characteristics of cockerels at 35 to 46 weeks of age

Parameter Probability level (*P*)	Control	Fish oil (n-3)	Sunflower oil (n-6)	*HO Sunflower oil (n-9)	Tallow	(SFA)
Average daily feed intake (g/bird/d)	$81.36^{a} \pm 0.76$	$78.75^{b} \pm 0.59$	$81.53^{a} \pm 0.72$	$83.06^{a} \pm 1.02$	$81.49^{a} \pm 0.87$	0.0007
Body weight (g)	$2567^{a} \pm 17.4$	$2499^{b} \pm 17.3$	$2594^{a} \pm 30.3$	$2623^{a} \pm 16.4$	$2607^{a} \pm 27.4$	0.0005
Semen volume (mL)	$0.36^{b} \pm 0.015$	$0.35^{b} \pm 0.019$	$0.36^{b} \pm 0.016$	$0.36^{b} \pm 0.015$	$0.42^{a} \pm 0.020$	0.0061
Sperm concentration(10^9 /mL)	3.33 ± 0.09	3.47 ± 0.09	3.53 ± 0.08	3.42 ± 0.08	3.42 ± 0.08	0.5759
Total sperm output (10^9)	$1.20^{b} \pm 0.06$	$1.20^{b} \pm 0.07$	$1.29^{b} \pm 0.07$	$1.25^{b} \pm 0.06$	$1.48^{a} \pm 0.09$	0.0091
Sperm motility (%)	$54.8^{a} \pm 2.14$	$48.1^{b} \pm 2.10$	$50.0^{ab} \pm 2.26$	$53.7^{a} \pm 2.03$	$55.1^{a} \pm 2.10$	0.0365
Live sperm (%)	93.4 ± 0.49	91.7 ± 0.64	93.6 ± 0.45	92.6 ± 0.64	92.9 ± 0.45	0.2307
[1]Viable sperm (%)	86.3 ± 0.76	84.5 ± 1.09	87.5 ± 0.57	85.2 ± 0.79	86.1 ± 0.65	0.1549
[1]Sperm abnormalities (%)	7.07 ± 0.40	7.17 ± 0.52	6.13 ± 0.28	7.38 ± 0.33	6.85 ± 0.32	0.1463
Ejaculation rate (%)	$87.5^{a} \pm 0.03$	$79.2^{b} \pm 0.04$	$88.3^{a} \pm 0.03$	$94.2^{a} \pm 0.02$	$94.2^{a} \pm 0.02$	0.0008

*High oleic acid

[a,b] Row means with different superscripts differ significantly at P<0.05.

[1] Calculated as a percentage (%) of the total sperm count

Table 3. Correlations between semen parameters of cockerels (35 – 46 wks of age) fed different dietary fatty acids.

Semen volume	Sperm output	Semen volume	Sperm viability
Control (n-3)	0.87***	--	--
Fish oil (n-3)	0.87***	--	--
Sunflower (n-6)	0.90***	--	--
High oleic (n-9)	0.91***	--	--
Tallow	0.93***	--	--
Sperm concentration		--	--
Control	0.58*	0.17	0.10
Fish oil (n-3)	0.46**	0.04	0.12
Sunflower (n-6)	0.64**	0.30**	0.15
High oleic (n-9)	0.61**	0.28**	-0.05
Tallow	0.55**	0.24*	0.13
Sperm motility			
Control	0.14	0.25*	-0.18
Fish oil (n-3)	0.18	0.22*	-0.04
Sunflower (n-6)	0.07	0.07	0.28**
High oleic (n-9)	0.17	0.28**	0.17
Tallow	0.11	-0.07	0.07

* $P<0.05$, ** $P<0.01$, *** $P<0.001$.

Conclusion: From current findings, it is evident that dietary lipids have distinct effects on certain parameters normally used in evaluating the sperm quality of cockerels. Notable parameters affected were the semen volume and the sperm motility. The possible contribution of tallow as a saturated lipid source on sperm output of cockerels, warrants further studies in an attempt to clarify the actions thereof. Also, the 3% pure fish oil diet was the only diet with a marked negative effect on both the semen quality and performance of the cockerels tested. However, this should not be a deterrent to the poultry breeders as an equal proportion (1.5%) of fish oil and linseed oil could be effective.

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