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Effects of Age on the Physical Semen Characteristics of Arbor Acres Broilers under Sudan Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background and objectives: The objective of this study was to investigate the effect of age on semen characteristics of arbor acres cocks reared in Sudan.
Materials and Methods: One day old ten male broiler chicks were randomly selected and reared in cages. Temperature was adjusted at 25C° and photostimulation program of arbor acres breeder was applied. They were fed pre-starter ration in the first week, starter ration in 2-5 weeks , growing ration in 6-18 weeks, pre-production ration 19-23 weeks and production ration 24- 42 weeks of age . Semen samples were weekly collected from the 22nd week up to 42th .Semen samples were evaluated for color, volume (SV), sperm mass motility (MM), percent of individual motility percent (IMP), live sperm (LSP), concentration (SC) and abnormal sperm percent (ASP).
Results: Out of the 230 samples obtained ,197 (85.65%) were creamy and 27 (11.74%) were white milky in consistency, the other 6 (2.61%) samples were turbid and watery. The mean values

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obtained for SV (0.29±0.02 ml), MM (2.25±0.63) in the 26th week of age were significantly higher compared to the initial collection values (0.24±0.12/ml), (1.75±0.54) respectively where they tended to decrease gradually with advanced age . However, at the 30th weeks of age the values obtained for IMP (81.62±9.36), LSP (87.70±4.15) and SC (3.21±1.62) were higher, compared to the initial values and decreased with advanced age thereafter. The values obtained for ASP in the 22nd week of age were significantly higher (9.63±4.26) compared to the following values up to the end of the experiment where a general pattern of reduction was observed.

Conclusions: It is concluded that semen characteristics of Arbor Acres cocks reared in Sudan are within the normal range and are adversely affected by advanced age.

Keywords: Arbor Acres; coks; semen characteristics; age.

1. INTRODUUCTION

Poultry industry became one of the important economical revolutions in the developing countries as they play an important role in producing animal protein most effectively within the shortest possible time [1]. The performance of exotic breeds of poultry under Sudan conditions was covered by many authors [2-5].

Reproduction in male poultry is characterized by age at sexual maturity, fertility and sperm storage in female reproductive tract [6]. Age at sexual maturity means the age at which the reproductive system is completely developed, it is considered as an important factor that determines cocks´ performance [7]. Physical characteristics associated with reproductively mature male are wattle size and color as well as body size in addition to semen production and evaluation [8]. Previous studies on the, effect of age on semen quality and fertility of cocks (*Gallus domesticus*) in the tropic and temperate zones have been carried out by many investigators [5,9-13].

Semen quality parameters vary with the age of the male, leading to a progressive decline in fertility [14]. A significant decrease in the percent of normal sperm with increasing age was reported in Iranian indigenous broiler breeder chicken [15]. A decrease in sperm mass motility (3.17±0.08)and increases in the percentage of dead (15.44±0.23)and abnormal sperms (5.62±0.16) of White Leghorn older cocks reared in Sudan was reported [5]. In Nigerian local chicken roosters, of normal feather and naked neck breeds there was a remarkable increase (44.16%) in semen volume between 28 and 36 weeks of age and a reduction (24.67%) at 40 weeks of age [14]. However, aging was associated with a corresponding significant decrease in sperm concentration but with an increase in total sperm count/ejaculate up to 36 weeks of age. Sperm concentration was highest at 28 weeks of age with a decreased of up to by 40 weeks of age .Neither the breed nor the age of cocks influenced the sperm motility. Although, there appeared to be in sperm morphology, proportion of live and dead sperm and sperm viability as the roosters aged, there were no evidences that the breed and age of roosters influenced these sperm quality traits [14].

Arbor Acres were originally a family farm, started by an Italian immigrant Frank Saglio who purchased a Glastonbury, Connecticut farm in 1917. Since then the industry of Arbor acres had grown to become the world's largest broiler breeding company, with customers in over 70 countries. Arbor Acres was divested in 2000, eventually acquired by Avigen [16].

A lot of studies covered Arbor Acres reproductive performance [17-20]. In Sudan, under the prevailing environmental conditions, the performance of the exotic commercial broiler breeds in different farms worths study to evaluate their adaptive capabilities . This work was designed to study ,for the first time , the effect of age on semen quality of Arbor Acres broiler breeder cocks as one of the exotic breeds.

2. MATERIALS AND METHODS

Study Area: This Work was conducted from May 2015 to August 2016 at private poultry farm in Khartoum State, (Eastern Nile Locality), Sudan.

Animals: Ten male chicks of one day old of Arbor Acres broiler breed weighed 42 ± 2.94 gm were randomly selected for this study.

Management and Housing: The chicks were reared on floor pen and maintained under uniform conditions of housing (cages), of an

intensive production system, made of galvanized iron with dimension of 55 cm.length,55 cm. height and 35 c. width. Temperature was adjusted at 25Ć, humidity 50-65%, wind velocity 1.5-2.5 m/hr. At 21^{1st} week the cocks were transferred into individual cages up to the end of the experiment.

Lighting: To achieve good uniformity in sexual maturity and optimal reproductive performance by proper photo stimulation applied to Arbor Acres (day length and light intensity), Arbor Acres breeder′s guide was applied [21] (Table. 1).

Feeding: Chicks were fed according to the breeder's guide [21]. The feeding started with pre-starter diet (0-1 week), 100 gm/chicks,14 gm/day, (Table 2) .Followed by starter diet (2-5 weeks), growing diet (6-18 weeks), pre-production diet (19-23 weeks) and production diet (24- 64 weeks)(Table 3).

Semen collection and Evaluation: Semen was collected using abdominal massage method and then evaluated [22-23] Semen collection started at the 22nd, the date when first semen samples were obtained and ended at 42thweek.

2.1 Statistical Analysis

The data were subjected to analysis of variance (ANOVA) using the General linear Model (GLM). Data collected were treated and analyzed statistically using SPSS Package [24]. Physical and morphological results of semen were represented as mean±S.D.

Table 1. Lighting program of Arbor Acres during the experiment

Age		Hours of Light	Light Intensity
Weeks	**Days**		
1	1	23	80-100 lux in brooding area
	2	23	10-20 lux in house
	3	19	
	4	16	
	5	14	
	6	12	30-60 lux in brooding area
	7	11	10-20 in house
	8	10	
	9	9	
20	10-146	8	10-20 lux
21	147	12	30-60 lux target
22	154	12	
23	161	13	
24	168	13	
25	175	14	
26	182	14	
27	189	15	

Table 2. Composition of the Pre-starter Diet (age/ 0-1week)

Ingredients	Amounts
ME(Kcal/Kg)	3200
Crude Protein(Analyzed Dumas)	22.00%
Crude Fat	7.00%
Crude Fiber	3.00%
Sodium	0.19%
Lysin	1.30%
Methionine	0.55%
Meth.+Cyst.	0.95%
Calcium	0.95%
Total Phosphorus	0.65%

**Koudijs Prestarter – Galldus*

Table 3. Composition and Nutrient Intake of Starter, Grower, Pre-Breeder and Breeder Diets given to Arbor Acres cocks broiler breeder during the Rearing and Production period

Age / Ingredient/(Kg)	Starter 2-5weeks	Grower 6-18 weeks	Pre-Breeder 19-23 week	Breeder 24-64 week
Sorghum	0	0	550	650
Yellow Corn	506	560	0	0
Liquid Oil	2	10	2	0
Dry Oil	0	0	0	2
Pea nut meal	230	101	28	105
Wheat Bran	190	260	340	133
Concentrates	50	50	50	25
Lime Stone	8	8	21	77
DCP	4	3	1	1
Lysine	2.5	1	1	1
Methionine	1.5	1	1	1
Na CL	1	1	1	1
Premix[A]	2	2	1	2
Additives[B]	2	2	2	1

[A] *Premix :Multivitamins.*
[B] *Additives: Toxin Binder, Phytase and Flavomycin.*

3. RESULTS

3.1 Semen Color

Fig. 1 shows the color of all the 230 semen samples. The majority of the samples, 197(85.65%) were white creamy(W.C) 27(11.74%) were white milky (W.M.), 4 (1.73%) were white turbid(W.T.) and 2(0.87%) white watery(W.W) .The samples of white creamy color were highly significantly (p≤0.01) different compared to the other samples.

3.2 Semen Volume

The obtained values for semen samples volumes´ throughout the experimental period are presented in Fig. 2. In week 26th, the mean value of semen volume was significantly (p≤0.05) higher compared to other values. This increase was followed by a gradual decrease until week 38th (0.21±0.012).At week 42 there was a slight increase in semen volume.

3.3 Sperm Mass Motility (MM,0-5)

Fig. 3 shows the values obtained for mass motility of sperms through the experiment. The value of M.M. was significantly (p≤0.05) higher in week 26th compared to other ages, this was followed by a gradual decrease up to the end of the experiment.

3.4 Sperm Individual Motility (IMP,%)

Values obtained for IM is presented in Fig. 4. A gradual increase in IMP value was observed from week 26th up to week 30th where it was significantly (p≤0.05) higher compared to other ages. This was followed by a gradual decrease with advanced age up to the 42 week.

3.5 Sperms Concentration (SC)

Throughout the experimental period, values obtained for SC showed fluctuations Fig. 5. In week 26th, values obtained for SC was lower compared to other weeks, however, in week 30th SC showed higher values but it did not show any significant level.

3.6 Live Sperms percent (LSP,%)

Fig. 6 shows the values obtained for LSP .The value of LSP increased gradually from the first collection up to week 30 th where it was significantly (p≤0.05) higher compared to other ages. After then a fluctuation in LSP was observed.

3.7 Abnormal Sperms Percent (ASP,%).

The ASP values obtained during the experimental period are presented in Fig. 7. The ASP was significantly (p≤0.05) higher in the first

collection at 22^{end} weeks of age then it drastically decreased in the 26th weeks of age followed by a gradual increase up to week 38.

4. DISCUSSION

In this study, Arbor Acres cocks were able to produce semen at 22nd week of age. This indicates that Arbor Acres cocks were able to adapt and withstand the prevailing environmental conditions in Sudan and reach their recorded age of sexual maturity [25]. In Arbor Acres cocks, after 15 weeks of age testicular growth is accelerated and at 20 weeks of age, before light stimulation and under a constant rearing day length of 8hr, the weight of tests increased from 0.5gm to 2gm [25]. Further growth of testes occurred after three weeks of light stimulation, which stimulates hormones production commences sexual maturity and sperm production. Photostimulation after 20 and 22 weeks of age increased testicular weight and

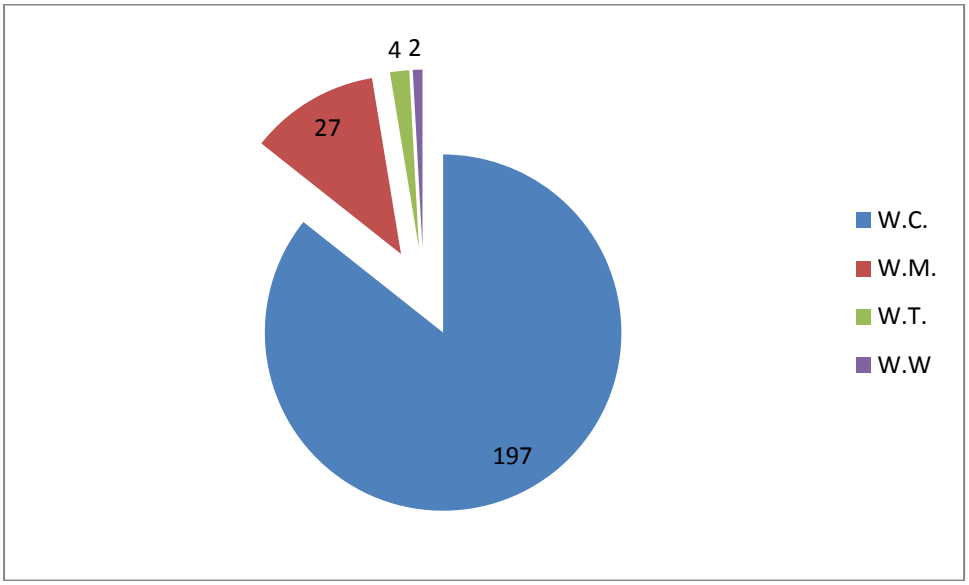

Fig. 1. Semen color

Results of semen characteristics are presented as mean±SD.

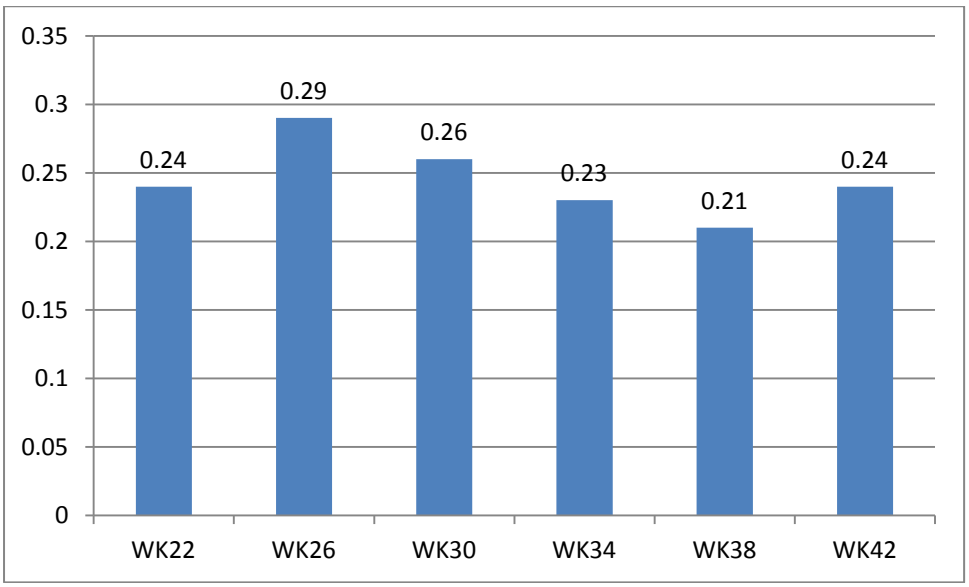

Fig. 2. Semen Volume, SV, (ml)

hormone production [26]. At the 23rd week of age, testes weight ranged from 12-22/gm, which is associated with the complete development of the reproductive system [25] body composition and occurrence of sexual maturity [27]. This indicates their age of sexual maturity and the complete development of their reproductive system under the prevailing environmental condition in Sudan. Close to the current findings and under tropical conditions, 41% of naked neck and 85% dwarf breed of male chicken produced semen at 20 weeks of age [12] as well as rooster of the same age [13]. This finding disagrees with what was reported in Nigerian breed cockerel which reached sexual maturity at 14 weeks of age [28] and in Norfa chicken where the age of sexual maturity was 13 weeks [23]. This difference could be related to breed and environmental conditions.

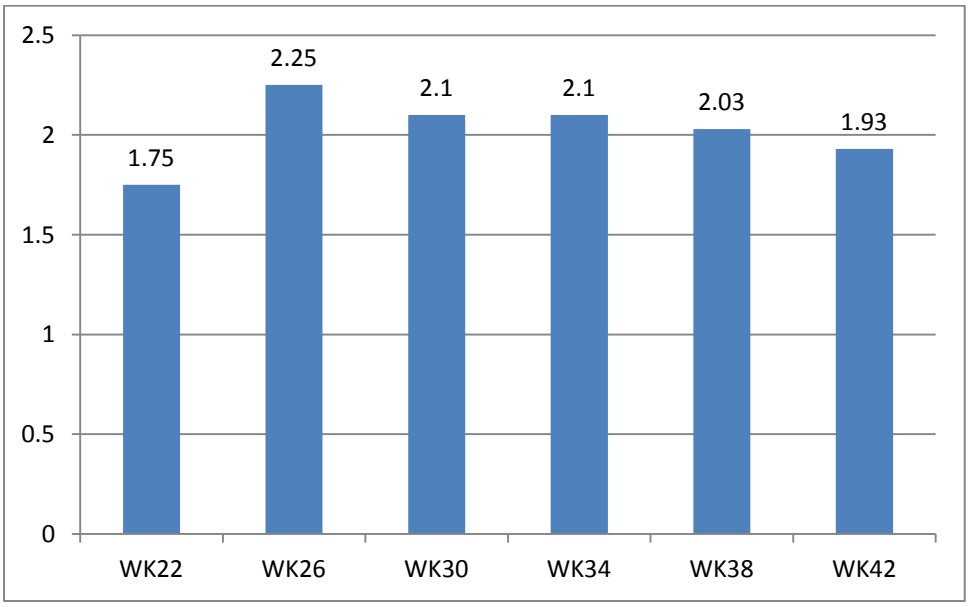

Fig. 3. Sperm Mass Motility (MM)

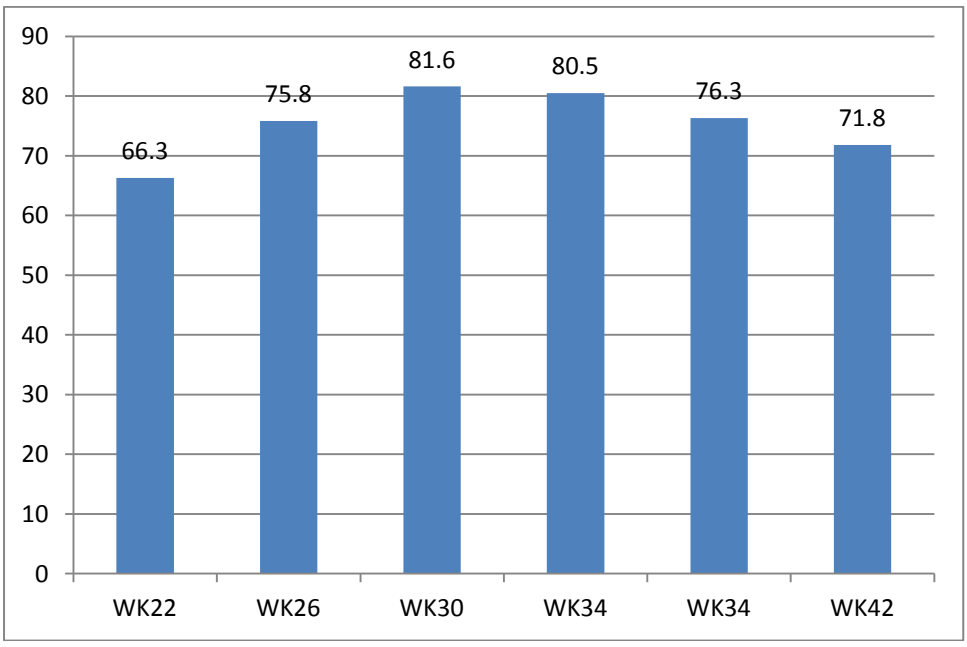

Fig. 4. Sperms Individual Motility (IMP,%)

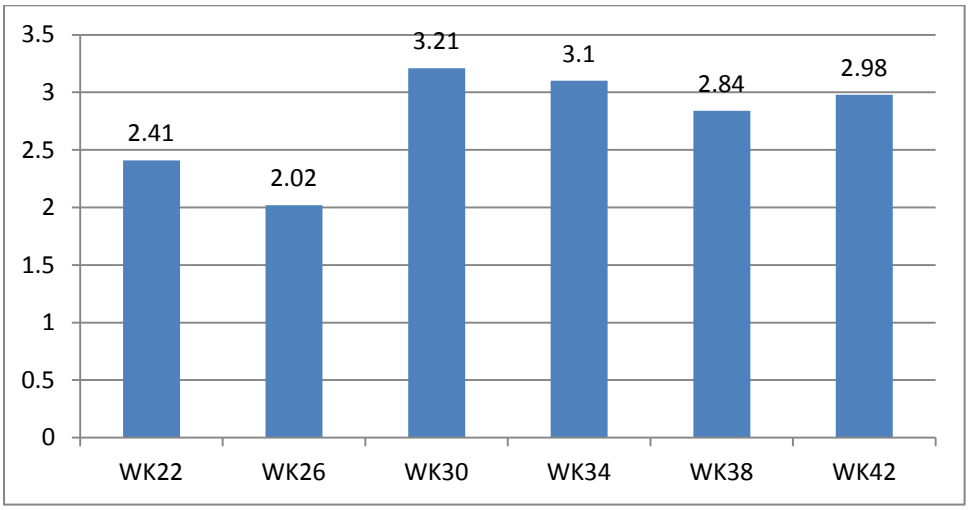

Fig. 5. Sperms Concentration (NO*10^7)

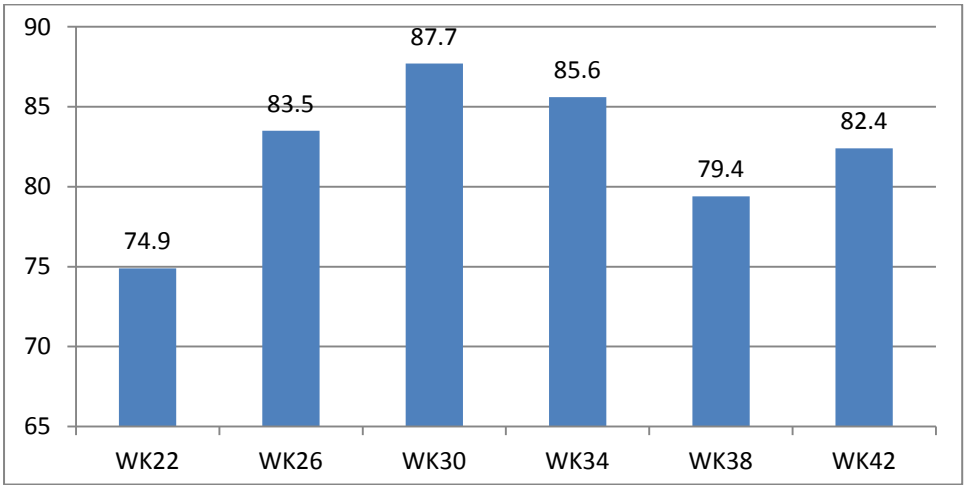

Fig. 6. Live Sperms, (LSP,%)

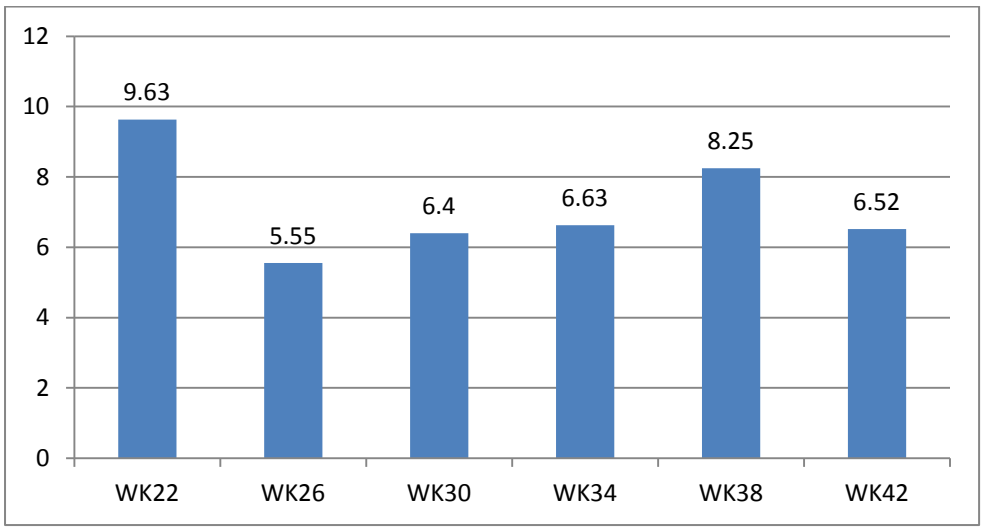

Fig. 7. Abnormal Sperms (ASP,%)

However, no breed effect on semen characteristics was reported [29] Similarly, no breed influence on semen characteristic were found in three indigenous Nigerian cocks [30]. Contrarily, authors indicated that, semen characteristics are affected by breed of male bird [31].

The color of semen is generally an indicator of the density of the ejaculate. The semen of the domestic fowl varies from a dense opaque suspension to a watery fluid [32]. The majority of samples obtained,197(85.65%) were white creamy and 27(11.74%) samples were white milky which indicates that about more than 97% of arbor acres breed cocks used in this study reached the suitable testicular activity and size under the prevailing condition in Sudan associated with sperm concentration values for samples obtained which ranged from (2.02± 1.03) to (3.21± 1.62).Semen colour is affected by breed of cock , White leghorn and Oraka breeds had an intermediate colour between opaque and creamy-white , while the Brahma had opaque colour [33]. The small amount of turbid samples obtained from 4(1.73%) cocks could be related to infection in the reproductive tract. The variation in semen colour could be partly due the presence of blood, feces or pus contamination, or may also be due to semen density that showed the variations of semen appearance [34]. The watery two samples which represented (0.87%) could be associated with an in active testicular tissues.

Many authors indicated that fertility indices of broiler breeders are reduced with increased age [35-36].

In the present study the mean values of SV was (0.24 ml ± 0.02 ml) at 22 week of age. This finding was in the same range of (0.22 ml ± 0.02 ml) that was obtained in white leghorn cocks under Sudan conditions [5]. A lower semen volume at 23 week of age was reported and was attributed to the starting of semen collection at 20 weeks of age [13]. The significant increase in semen volume (0.29±0.012 ml) observed in the 26^{th} week of age, could be related to the increased amount of hormones production and testicular size. Peak values of testicular weight and semen production in arbor acres during the 25^{th} and the 30^{th} week of age were reported [25] Similarly, an increase of SV in Nigerian local cocks during 28^{th} and 36^{th} weeks of age was reported [14]. The gradual decrease in SV up to 42 week of age could be associated with advanced age and lowered fertility. After 30-35 weeks of age in arbor acres there is a natural reduction in testes weight and sperm production and declined fertility [25]. A decrease in SV of White Leghorn chicken with advancing age was foud [37]. Similar low values of SV were reported with aged(40weeks) normal feather and naked neck Nigerian local chicken [14]. In this study at 42 week of age, SV of arbor acres returned to the initial value of volume obtained . Similarly, authors reported SV of (0.24±0.15ml) in Kampung rooster breed of older age [38]. This could also be related to possible fluctuations in semen volume. Similar fluctuation in semen volume was reported [39]. However, increases in semen volume with advanced age were reported [12,13,5]. On the other hand, no significant effects of age on semen volume were reported in Thai native cocks [40].

Sperm mass motility (MM) score (2.25 ±0.63) reported in this study was significantly ($p \leq 0.05$) higher at the 26^{th} week of age. This increase in MM was attributed to the increased weight of testes. Peaks in testicular weight and semen production in arbor acres during the 25^{th} and the 30^{th} week of age were reported [25]. This could be associated with the increase in live sperm percent (83.5-±9.9) and decrease in the value of sperm abnormalities percent(5.55±2.01) reported in this study, compared to the initial values at week 22^{nd} . The gradual decrease in sperm motility could be related to increased age and lower production of sperms [25]. Similarly, a lower value in sperm MM in older white leghorn cocks under Sudan conditions, compared to younger one, was obtaied[5]. On the other hand, no significant effects of age on sperm mass motility were reported in Thai native cocks [40].

The gradual increase in the values of IMP from the initial collection in week 22^{end} (66.38±1.10) up to week 30 (81.62±9.36) of age could be related to the increased testicular weight and activity [25] and the concomitant increase in sperm production, concentration (3.21±1.62), live sperm percent (87.70±4.15) and IMP (6.40±2.39). This agrees with what was previously reported in Arbor Acres[25] .High values of sperm motility percent with high testicular and body weight were reported in Beijing-You chicken [41].

The motile sperm percentage was positively correlated with intact acrosomes and plasma membrane integrity in Indian Red Jungle Fowl [42]. Similarly, an increase in sperm motility with

advanced age was indicated [13]. In old age Merawang rooster breed a percent of (81.83±8.10) motile sperms were reported [38]. However, the low values of IM reported in the last collections beyond 35 weeks of age in ,the current study, could be related to the decline in fertility. A natural reduction in fertility of Arbor Acres cocks occurs beyond the 35 weeks of age [25]. Also this reduction of IM could be due to the use of energy source by aged sperms. The forward progressive motility of sperm is linked to energy production [42,36] where both endogenous and exogenous lipids play a substantial role in the supply of energy for the motility and viability of spermatozoa and the effect of ageing is a change in the use of endogenous and exogenous lipid sources, by spermatozoa [43] However, no significant effects of age on sperm motility percent were reported in Thai native cocks [40] and naked neck and dwarf chicken under tropical conditions [12].

The lowest value of SC was obtained in 26th week of age (2.02±1.13x10^{7}/ml). This could be related to handling of semen, however, the numerical insignificant value was obtained at 30th weeks of age (3.21±1.62x10^{7}/ml) is associated with the growth of testes with increased production of sperms. This maximum values of SC obtained and the following decline agree with what was reported about the fertility performance of arbor acres cocks which increases during the period of age between 25th and 30th week of age and declines beyond 35weeks of age [25]. Similar low value of sperm production was reported in roosters [13] and aged normal feather and naked neck Nigerian local chicken [14]. In Nigerian local cocks, SC was higher at 36 weeks of age [14]. Authors [44] reported a maximum number of sperm in broiler breeders at 36 weeks of age which declined progressively until 55 weeks of age. This was attributed to decreased testis weight and testosterone level with advancing age and increase in spermatozoal and seminal lipid concentration. Reduced SC in naked neck broiler fowl was attributed to the large increase in lipid concentration in spermatozoal and seminal plasma which is associated with antioxidant enzymes protection and reduction of fertility [39]. In Thai native cocks, no significant effects of age on SC were reported [40] However, there was no effects of age observed on SC in White Leghorn reared under Sudan conditions [5] and naked neck and dwarf chicken under tropical conditions [12].

The gradual increase in LSP with the significant level reported in the 30th week of age (87.70±4.15) compared to other values could be related to the increase in age and testicular development[25]. This high value of LSP is in the same line with values reported in this study for IM,SC in 30 th week of age. In Arbor Acres the 30 weeks of age represent the peak of semen production and fertility [25]. In the following two month LSP decreased with advanced age of cocks. A natural reduction in fertility of Arbor Acres cocks beyond the 35th weeks of age was reported [25]. Similarly, a reduction in live sperm percent in older naked neck broiler fowl compared to younger ones was reported and this was related to the reduction of the metabolic activity of the sperms and reduction in the activity of glutathione peroxidase of spermatozoa[39]. Minor changes in LSP between younger and older Thai native cocks [40] However, no change in LSP was reported with aged normal feather and naked neck Nigerian local chicken [14].

The significantly ($p \leq 0.05$) higher value (9.63 ± 4.26) of ASP reported in the first collection at 22^{end} weeks of age could related to the first sample characteristics produced in early age. Also this high value could be related to low values reported in this study for motility and LSP. It was reported that hat most morphological defects reported in Korean native chicken breeds are at the head and tail and defective tail were associated with poor motility [45]. In this study, with advanced age ASP showed fluctuations with general patterns of low values compared to the first values. Authors indicated that increased sperm abnormalities are indicators of disturbances of spermatogenesis with advanced age [46]. In white Leghorn cock, reared under Sudan conditions , the ASP reported in older ones was (5.62±0.16) [5]. It was reported that, the adverse changes in the quality of spermatozoa with age were associated with a similar increase in the lipid content of the semen [39]. In this study the values of ASP obtained for arbor acres are within the normal limits. It was indicated that, semen with percentage of abnormality less than 10% is generally considered to be of good quality [47,45].

5. CONCLUSIONS

It can be concluded that the reproductive performance of Arbor Acres cocks under Sudan conditions was remarkable. Obtained semen

samples physical characteristics were good and within the range of other foreign poultry breeds reared in Sudan and other tropical countries. Semen physical characteristics are adversely affected by advanced age of cocks. Further studies in female Arbor Acres fertility and hatchability are needed.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

SIGNIFICANT STATEMENT

This study discovered that Arbor Acres as a foreign breed can withstand Sudan conditions. Also, it will help in improving and upgrading local poultry breed production by applying artificial insemination.

ETHICAL APPROVAL

This experiment was conducted according to the ethical approval of the Research Board, College of Veterinary Medicine, University of Bahri,Sudan.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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