

Semen Quality of Cockerel Breeders *Gallus domesticus* in Two Climates in Nigeria

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Abstracts: The present study was designed to access the reproductive status of Isa-brown cockerel breeders raised in Gwagwalada by comparing the semen quality of the cockerels raised in Gwagwalada and those raised in Jos. Twelve Isa-brown cockerels of (18-24 months) weighing between (3-4 kg) were used. Six cockerel breeders were randomly selected from three different breeder farms in Jos and six from Gwagwalada during the dry season. Environmental parameters that were measured were mean daily temperatures (T°C) and mean relative humidity (%) of study zones. After acclimatization semen samples were collected from the cockerels by cloaca massage into a graduated tube and analysed. The parameters that were analysed for semen quality included: motility, mass activity, percentage live, morphological defects, semen volume, pH and colour. Results showed that the cockerels from the two zones, had similar semen characteristics. The mean values for all the parameters measured werenot significantly different between the two zones ($p>0.05$). The average ambient temperature and relative humidity at the time of study were 37.5°C and 54% for Gwagwalada versus 20°C and 60% for Jos. It was concluded that the variations in the climatic conditions of the two zones had real effects on cockerel semen quality comparing the volume of semen obtained from the cockerels. High environmental temperature recorded in Gwagwalada was not combined with high humidity. Recommendation was that conscious effort must be made in terms of poultry house design and provision of facilities in other to shield the effect of heat stress on breeder farms in Gwagwalada.

Keywords: Semen, Cockerels, Breeders, Isa-brown, Climate, Nigeria

1. Introduction

The poultry industry has in recent years occupied a leading role among agricultural industries in many parts of the world. There has been a remarkable growth in poultry meat and eggs during the last 35 years [1]. The potential for further growth is obvious in view of the value of eggs and poultry meat as basic protective foods in the human diet. Africa, Asia and South America have the greatest increases in egg production [1]. During the past 35 years, the production of eggs has continued to increase rapidly in the developing regions, which include most of the hot regions of the world [1]. These regions are also aware of the contribution that the poultry industry can make towards improving the quality of human diets in their countries. There is therefore, a very rapid

expansion of the industry in many countries in these regions. This is very evident, for example, in Brazil in South America, Morocco and Nigeria in Africa and Saudi Arabia in the Middle East. Poultry meat and eggs are among the highest-quality human foods; they can serve as important sources of animal protein in those areas of the world that have protein insufficiency. Most countries in the hot regions of the world have daily per capita animal protein consumption below that recommended by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). In the Middle East and North Africa, the average daily per capita intake of animal protein does not exceed 25 g, compared with over 45 g in most of the developed countries. The poultry industry is highly developed in South Africa and has seen a great deal of

development in other African countries during the past two decades. Eggs and poultry meat are beginning to make a substantial contribution to relieving the protein insufficiency in many African countries. [1] and [2] however, reported that almost 80% of poultry production in Africa is found in the rural and peri-urban areas, where birds are raised in small numbers by the traditional extensive or semi-intensive, low-input-low-output systems. According to a study by [3], chickens are the most commonly kept livestock species in Zimbabwe. Chicken production is divided into large-scale and small-holder chicken production. The smallholder production is mainly free-range systems. Women are the care takers and decision makers of most chicken flocks, and chicken meat is eaten more than any other meat. [4] reported that only 44 eggs were produced in the African continent per person per year. Per capita consumption of eggs and chicken meat has increased significantly in certain African countries, particularly where production has been rising, as one would expect. For example, per capita egg consumption in South Africa went up from 89 eggs in 1990 to 107 eggs in 2005, and chicken meat consumption from 15.5 kg in 1990 to 24.7 kg in 2005 [5];[6]. Chicken meat production in Africa as a whole went up from 1790 thousand tonnes in 1990 to 3189 thousand tonnes in 2005. The leading countries in chicken meat production in Africa are Algeria, Egypt, Morocco, Nigeria and South Africa [7]. There is very little statistical information on the industry from other African countries, with few exceptions. "In spite of the expansion that Nigeria has seen in its poultry meat industry, per capita consumption is still below 2.0 kg [6]", as was reported by [8]. The Moroccan industry had undergone tremendous growth since the early 1980s, when per capita consumption was estimated at 50 eggs and 7.6 kg of poultry meat [9]. Today, per capita consumption in Morocco is 102 eggs and 8.6 kg of poultry meat [6]. The top egg-producing countries of Africa (Nigeria, South Africa, Egypt and Algeria) have increased their production from 957,000 t in 1990 to 1,220,000 t in 2005 [7]. The World's Poultry Congresses have helped, since their inception in 1921, to spread knowledge about poultry production. The International Association of Poultry Instructors and Investigators was founded in 1912. This organization was later transformed to become the World's Poultry Science Association, and the first congress was held in The Hague in 1921. Out of twenty two congresses held between 1921 and 2004, only five were held in the warm regions of the world (Barcelona, 1924; Madrid, 1970; Rio de Janeiro, 1978; India, 1996; and Turkey, 2004). This may be one of the reasons why knowledge of modern poultry husbandry has not reached the warm regions of the world as rapidly as it has in temperate areas [10].

Heat, especially in the tropics, can have negative effects on poultry performance. Number of eggs produced can reduce, weight gain can be impaired and feed conversion efficiency can be affected during the dry season if measures are not put in place to mitigate the effect of heat. Stress emanating from heat may impair the immune system of poultry and increase susceptibility to disease. When a bird begins to pant,

physiological changes have already started within its body to dissipate excess heat. Even before the bird reaches this point, anything that can be done to help birds remain comfortable and healthy will help maintain optimum growth rates, hatchability, egg size, egg shell quality and egg production. To avoid total reliance on natural air movement, most producers have added circulation to increase air movement and promote the loss of body heat from the birds.

Photo-schedules in poultry production are currently being practiced, and designed to maximize the yield of semen for a prolonged period, by delaying the onset of photo refractoriness. In addition, the generation interval can be reduced when photo stimulation is practiced at an earlier age [11]. Time of the day for the collection of semen also affects the quality and quantity of cockerel semen. Generally semen production is higher in the morning and in the afternoon, when it is cooler [12]. The breed of poultry also contributes to a difference in semen production capability. The production of semen also differs within seasons, being regulated primarily by daylight length or photoperiod. The chicken breeding season generally starts in spring when the daylight length is long and terminates when the daylight length is even longer, due to the effect of the refractoriness (delayed response to long day length), of the pituitary gland [13]. According to Hafez and Hafez 2000[14] the onset of reproduction occurs when light, acting through photoreceptors in the brain, provides neural signals which the bird's reproductive endocrine system perceives as a change in daylight length, sufficient to initiate reproduction. The neural signals with time fail to maintain gonadotrophin secretion, despite continued light stimulation. Refractoriness is characterized by a gradual decline in LH, which causes a gradual decline in the egg production until the pituitary can no longer secrete sufficient LH. The mechanism of this ovarian regression appears to reside in the hypothalamus where luteinizing hormone releasing hormone is secreted. Most domestic birds are seasonal breeders and in most birds, photoperiod stimulates spermatogenesis, especially semen production in e.g. the White Leghorn. The duration and intensity of photoperiod may have an effect on the conditioning of the chickens for reproduction [15].

Reproduction performance in the male comprises the production of semen containing normal sperm (quality) in adequate number (quantities), together with the desire (libido) and mating ability (servicing capacity). It is genetically accepted that, although hens and cocks are generally considered to be equal partners in the outcome to a mating, cock reproductive performance has a major impact on the reproductive efficiency of poultry operations [16]; [17]. By definition semen from high performing male with a relatively quick reaction time [18] and ejaculation rate [16] can be used to inseminate a greater number of females per unit time, compared to semen from low performing males [19]; [20] if these hypotheses are true then the quality of semen after sexual massage, may serve as indicators of the reproductive status of cocks. To test such a premise requires the use of sexually stimulated cocks which would also permit

the assessment of the effects of level of reproductive performance on semen viability subsequent fertilising capacity of cocks. There are no commercial hatcheries in Gwagwalada which is a sub unit of the Federal Capital Territory of Nigeria (FCT) (Abuja). Basically, because Gwagwalada and Abuja in general is regarded as a non-favourable zone for poultry production due to heat stress. Considering the strategic location of the FCT in the country and the number of day old chicks that come in to Abuja from other parts of the country like Ibadan, Jos, Owerri etc. It becomes imperative for researches to be conducted to see the possibilities of establishing breeder farms and hatcheries within the FCT so as to reduce the risk of transporting day old chicks from far places to the Federal Capital Territory. The period of transportation of day old chicks poses a great risk in terms of stress and high mortality when the end farmers stock them. The present study was designed to access the reproductive status of Isa-brown cockerels raised in Gwagwalada by comparing the semen quality of Isa-brown cocks raised in Gwagwalada FCT (hot zone) and those raised in Jos Plateau state (cold zone) of Nigeria.

2. Materials and Methods

2.1. Study Location

The study was carried out at the Pathology laboratory of the Faculty of Veterinary Medicine University of Abuja. Although Abuja, under the Köppen climate classification system features a tropical wet and dry climate, the FCT experiences three weather conditions annually; these include a warm, humid rainy season and a blistering dry season. In between the two, there is a brief interlude of Harmattan occasioned by the northeast trade wind, with the main feature of dust haze, intensified coldness and dryness [21]. Gwagwalada geographical coordinates are 8° 56' 29" North, 7° 5' 31" East. The territory covers a land area of 923, 768 km², it shares boundaries with Kuje Area Council to East, Abuja municipal Area Council to the North, Kwali Area Council to the South and Suleja (Niger state) to the West [22].

2.2. Geography and Climate of Study Zones

2.2.1. Jos Climate

Jos is situated almost at the geographical centre of Nigeria and about 179 kilometres (111 miles) from Abuja, the nation's capital, Jos is linked by road, rail and air to the rest of the country. With an altitude of 1,217 m (4,062 feet) above sea level, Jos enjoys a more temperate climate than much of the rest of Nigeria. Average monthly temperatures range from 21° to 25°C (70° to 77°F), and from mid-November to late January, night-time temperatures drop as low as 11°C (52°F), resulting in chilly nights. Hail sometimes falls during the rainy season, owing to the cool high-altitude weather. These cooler temperatures have meant that, from colonial times until the present day, Jos is a favourite holiday location for both tourists and expatriates based in Nigeria. Jos receives

about 1,400 millimetres (55 inches) of rainfall annually, the precipitation arising from both conventional and geographic sources, owing to the location of the city on the Jos Plateau. Jos 9°56'N 8°53'E is a city in the Middle Belt of Nigeria. The city has a population of about 900,000 residents based on the 2006 census. Popularly called "J-town" or "Jesus Our Saviour" by the residents, it is the administrative capital of Plateau State. [23]

2.2.2. Gwagwalada Climate

Gwagwalada has a highly dynamic population with an influx of people into the Federal Capital Territory, leading to a rapid population growth. This rapid population growth is aided by the expansion of the satellite towns in the peri-urban areas. The rainy season begins in April and ends in October, while daytime temperatures reach 28°C to 30°C and night time low temperatures hover around 22°C and 23°C. In the dry season, daytime temperatures can soar to as high as 40°C and night time temperatures can dip to 12°C (Climatologic Information of Abuja, 2006). Even the chilliest nights can be followed by daytime temperatures well above 30°C. The high altitudes and undulating terrain of the FCT have a moderating influence on the weather of the territory [24].

2.3. Experimental Cockerels

The animal experiments followed the principles of the Laboratory animal care [25]. For this study, a total number of twelve Isa-brown cockerel breeders of (18-24 months) weighing between (3-4 kg) were used. These cockerels were from two different climatic zones, the first group were from Jos Plateau, Nigeria (temperate) and the second group were from Gwagwalada (tropical). All cockerels were maintained in enclosed houses and were fed with standard breeder ration for the period of the study.

2.4. Experimental Design

Twelve Isa-brown cockerels were randomly selected. Six were selected from three different breeder farms in Jos, Plateau state while six were selected from Gwagwalada, Abuja. They were properly identified with a marker and housed in a poultry basket, the twelve cockerels were assembled at the University of Abuja Permanent site for the study. Physical examination was done to ascertain their health. The cockerels were acclimatized for two weeks. Weather parameters of the study areas were measured and recorded after selecting the cockerels. Parameters that were measured were mean daily temperatures (T°C) and mean relative humidity (%),

2.5. Semen Collection

After acclimatization semen samples were collected from the cockerels by cloacal massage into a graduated tube and analysed. Semen was collected by the abdominal massage method [26]. Glass test tubes were used for semen collection. Volume of semen was measured when aspirated from the cloacal vent by using insulin syringes, while their needles

were removed. After exciting of cocks with abdominal massage, the male organ swelled and protruded outwards and downwards and white to creamy semen was seen in the central furrow of the organ. The semen was milked down by firm finger pressure at either side of the vent in to the collecting tube. If the semen, which should be white, was discoloured due to contamination by faecal material or blood, it would be eliminated. At the end of the collection period, Weather parameters of the study areas were measured and recorded. Parameters that were measured were mean daily temperatures ($T^{\circ}\text{C}$) and mean humidity (%)

2.6. Semen Analysis

Immediately after collection colour and volume of semen were recorded and a drop of raw semen was made on a prewarmed microscopic slide, covered with a cover slip and placed under the light microscope for assessment of mass activity at $\times 4$. Mas activity was scored with +, ++ and +++ from the least to the highest wave motions and figures of 1, 2 and 3 were assigned respectively.

Semen smears were made with eosin-nigrosin for percentage live and sperm morphological studies. The parameters that were analysed for semen quality included: motility, mass activity, percentage live, morphological defects, semen volume, pH and colour. Values of 0 were given to cockerels that did not yield semen across the board. For semen colour values of 4, 3 and 2 were given for creamy, milky, and watery semen respectively. The semen pH was estimated with a pH strip. For evaluation of motility, one drop of the diluted semen was placed on the prewarmed slide and covered with cover slip. The sperm motility was estimated by microscopic observation ($\times 40$ magnifications). Motility was expressed as the percentage of motile spermatozoa with moderate to rapid progressive movement. At least 10 microscopic fields were examined for each sample. Sperm morphology was examined in smears stained with eosin and nigrosin. At each preparation, 150 cells were counted and the percentage of various defects calculated. The proportions of live (eosin-impermeable) and dead (eosin-permeable) spermatozoa in a sample were assessed on the basis of 150 spermatozoa.

2.7. Statistical Methods

The statistical tests used for analysis was the student T-test. Data were expressed as means and standard error of means (SEM) data was analysed using the student T-test with SPSS/PC computer programme, version 16.0. Differences with confidence values of $p < 0.05$ were considered statistically significant.

3. Results

The mean (\pm SEM) Semen parameters of Isa-brown cockerels from Gwagwalada and Jos is presented (Table 1.). There was no statistically significant difference in all the parameters between the two groups ($P > 0.05$). There was

high percentage of live sperm cells but lower density of sperm cells of cockerels from Gwagwalada (Figure 1). There was high percentage of live sperm cells and high density of sperm cells of cockerels from Jos (Figure 2). Semen volume was appreciably higher in Jos (Table 1.). Average weather parameters at the time of study were recorded as follows: Daily temperature 37.5°C and 20°C and Relative humidity 54% and 60% for Gwagwalada and Jos respectively.

Table 1. Mean (\pm SEM) Semen parameters of Isa-brown cockerels from Gwagwalada and Jos.

Parameters	Gwagwalada	Jos
Colour	4.00 \pm 0.00	4.00 \pm 0.00
Semen volume (ml)	0.57 \pm 0.10	1.57 \pm 0.07
Mass activity	3.00 \pm 0.00	2.67 \pm 0.21
Motility (%)	90.33 \pm 4.17	86.33 \pm 4.22
Abnormal morphology (%)	1.50 \pm 0.22	1.00 \pm 0.00
Semen pH	7.55 \pm 0.39	7.69 \pm 0.04
Viability (%)	96.00 \pm 0.73	95.66 \pm 0.99

There was no statistically significant difference in all the parameters between the two groups ($P > 0.05$)

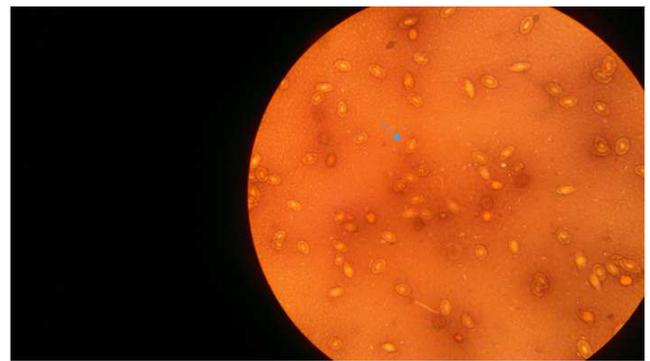


Figure 1. Photomicrograph showing high percentage of live sperm cells but lower density of cells of cockerels from gwagwalada ($\times 40$) (Eosin and Nigrosin) stain.



Figure 2. Photomicrograph showing high percentage of live sperm cells and high density of cells of cockerels from Jos ($\times 40$) (eosin and nigrosin) stain.

4. Discussion

Assessing the reproductive status of the breeder cockerels from the two study zones, it seems that semen parameters are the same. The results showed no significant differences in the semen parameters between the two study zones. The period

of the study might be contributing to the non-significant differences. The study was carried out in dry season when heat stress might not be as severe as in hot humid period in Gwagwalada. Looking at the temperature of Gwagwalada and its humidity during the study period 37.5°C and 54% respectively, heat stress was not at its peak. Heat stress is very severe in hot humid environments. This is in agreement with the report of [27]; [28]; [29]; [30]. In hot weather, damp litter will make heat stressed birds feel much more uncomfortable than dry litter. In dry litter, birds will attempt to dust bathe more readily to aid cooling. The heat of electric lights and motors is a very small fraction of that produced by the body metabolism (normally less than 1%). Direct climatic factors acting on the birds include high ambient temperature and relative humidity, resulting in severe heat stress. Heat stress can be one of the main limitations in poultry production and reproduction, more especially in hot areas. Elevated environmental temperatures pose a threat to the general well-being of the cockerels. The increase in the body temperature without a rapid compensation of heat loss, resulting from a prolonged exposure to environmental temperature, may cause a change in the body temperature of the cockerel, leading to a significant impairment of semen production and reproduction. The intensity and duration of heat stress combined with relative humidity may also affect the behavioural, hormonal and physiology of the cockerel. Such detrimental effects limit reproduction characteristics of the males thus inhibiting spermatogenesis and a decrease in the secretion of gonadotrophins [27]; [28]; [29]; [30]. Body temperature increases in heat stress, sperm metabolism, sperm motility and sperm quality are generally lower in heat-stressed cockerels. Although research concerning hyperthermia on semen characteristics is lacking, several researchers have found that sperm can function at normal body temperature [31]. Froman and Feltmann 2005 [32] found sperm to be motile at a body temperature of 41°C, and decline with time after ejaculation. Heat stress may be evaluated by measuring the rectal temperature which is the true reflection of the internal body temperature [28]. Intensity and duration of heat may be high, but if it is not combined with a high relative humidity, the heat stress may not be so severe as to reflect a significant difference in the semen quality between the hot study zone and the cold zone.

The heat in Gwagwalada during the study period was not combined with high humidity. Considering the figure 54% relative humidity as presented in the result. The cockerels can undergo normal testicular degeneration which is influenced by season. This degeneration is reversible in seasonally breeding cocks. When conditions become favourable the testes can reverse and continue with normal spermatogenesis. The study period may have masked the effect of heat stress on the Gwagwalada group of cocks. Looking at the natural prevailing weather conditions in Gwagwalada and Jos, the cockerels in Jos would have been expected to yield a significantly higher semen quality compared to the Gwagwalada cockerels. The effect of heat on spermatogenesis have been well documented.

If we look at the result critically the impact of high environmental temperature on the Gwagwalada cocks can be x-rayed from the appreciable difference in semen volume between the two study zones. Although the difference was not statistically significant ($p > 0.05$). Semen volume is usually more under cooler environmental conditions and this was exactly a reflection of the ambient temperatures of Gwagwalada and Jos during the study period. The average ambient temperature values were 37.5°C and 20°C for Gwagwalada and Jos respectively. This is in agreement with the report of Peters *et al.*, 2008 [12] which states that time of the day for the collection of semen also affects the quality and quantity of cockerel semen. Generally semen production is higher in the morning and in the afternoon, when it is cooler [12]. The breed of poultry also contributes to a difference in semen production capability. The production of semen also differs within seasons, being regulated primarily by daylight length or photoperiod. The overall reported average ejaculate volume of cockerel has been quoted as 0.7 ml for different poultry breeds [33]. Generally, poultry breeds with heavier body weights have been found to have larger testes and produce more sperm cells during spermatogenesis and thus ultimately resulting in a higher semen concentration [34]. The mean semen volume obtained from cockerels in Jos was higher than the mean semen volume obtained from the cockerels in Gwagwalada which depends on the testicular size and weight that corresponds to body size of cockerels. The reproductive status of the Gwagwalada group of cockerels are likely to be compromised even in this study period that heat stress is not deemed as severe as the hot humid period. The heat stress here is likely going to affect normal mating behaviour, hormonal function, reaction time, semen volume, sperm output etc. The mean pH of the cockerel semen from the 2 groups studied was slightly alkaline and ranged from 7.55 ± 0.39 to 7.69 ± 0.04 . These results are all within the range generally reported for poultry semen. The pH of cockerel semen recorded by other researchers is 7.02 ± 0.01 , 7.4 ± 0.2 and 7.68 ± 0.01 . A factor that could play a role is the technique of semen collection and stimulation of the accessory sex glands. The accessory sex gland fluid is generally alkaline [27]; [12]; [33].

The colour of the cockerel ejaculates did not differ significantly between the 2 groups studied, being creamy-white and showing that the massage technique used was adequate for the study to obtain good quality semen. These observations were consistent with Peters *et al.*, 2008 [12]. It was also observed that variations in semen color may arise in part due to the presence of contaminants or as a result of low sperm concentrations [35]. High relative humidity also causes a temporary decrease in sperm production, hence low ejaculate volumes and sperm concentration that could affect sperm motility and fertility [29].

In semen evaluation methods, the human factor is very important and cannot be ignored with differences in results often being related to individual bias and experience [36]. Semen quality of cockerels from the two study zones did not

differ much from those reported in other breeds of chickens. It is however important to select males with a higher semen volume, higher sperm concentration and larger number of viable sperm, with few abnormalities, especially for breeding purposes to obtain higher fertilization rates. Sperm concentration was not evaluated in this study, but density of sperm cells in the smears suggest that Gwagwalada cocks may have lower sperm concentration. Considering the lower semen volume it means that sperm output in Gwagwalada cocks was appreciably lower. It is important to also consider the morphology of the sperm for the different breeds as they also differ significantly. The quality of sperm is to a large extent also determined by the sperm abnormalities. As could be expected, the higher the sperm abnormalities of individual cockerels or breeds, the lower the quality of semen and fertilizing ability of the sperm and hence fertilization rate following AI or natural mating.

5. Conclusion

From the results obtained in this study, it was concluded that the variation in the climatic conditions of the two different geographical zones had real effects on cockerel semen quality comparing the volume of semen obtained from the cockerels, the birds from Jos produced higher ejaculate volume than the group of birds from Gwagwalada although, the difference was not statistically significant. This would translate to lower sperm output. Other semen parameters measured were similar between the two groups. High environmental temperature recorded in Gwagwalada was not combined with high humidity, therefore the heat stress experienced during the study period was not as severe as usually experienced in hot damp environments. This non severe heat stress may be responsible for the non-significant difference in semen parameters recorded between the two groups. Reproductive status of Isa-brown cocks from Gwagwalada was lower than those from Jos and it has the tendency to be worse than the present observation during severe heat stress. It was recommended that conscious effort must be made in terms of poultry house design, provision of air circulators, forgers etc. in other to mitigate the effect of heat stress on poultry in Gwagwalada if a breeder operations must be established there.

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