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RESEARCH ARTICLE

TESTICULAR MEASUREMENTS OF ISA BROWN COCK BREEDERS RANDOMLY SELECTED FROM TWO CLIMATIC ZONES IN NIGERIA

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ABSTRACT

Objective: This work was designed to compare testicular parameters of Isa- brown cockerel from two climates in Nigeria. A total of twelve Isa-brown cockerels of 18-24 months weighing between 3-4 kg were used. Six cockerels were randomly selected from three breeder farms inJos (group A)while six were from Gwagwalada (group B) during the dry season. **Methods:** The twelve cockerels were assembled at the University of Abuja Permanent site for the study. The cockerels were acclimatized for two weeks after which they were weighed and sacrificed by method of cervical dislocation and the testes and pituitary glands were dissected out. The weight of the organs were measured with a sensitive scale. Testicular length and width were measured with a measuring tape. **Results:** Results showed that values of the testicular parameters were higher in the left testes compared to the right testes. Testicular width and weight of the cockerels were higher in Jos. The group A showed left testicular length, width and weight of 3.98±0.24cm,1.83±0.17cm, 8.38±2.21g while B showed values of 3.15±0.33cm, 1.42±0.22cm, 8.00±1.60g respectively ($p>0.05$). The right testicular parameters were 3.52±0.30 cm, 1.75±0.14cm,7.28±1.90g for group A, while group B showed values of 3.87±0.48cm, 1.37±0.23cm, 6.77±1.46g respectively ($P>0.05$). The mean body weight for groups A and B were 3.50± 1.21 kg and 3.47± 0.15kg respectively. ($P>0.05$), Weight of pituitary gland for both groups were3.90±0.21g and 4.64±0.80g respectively ($p>0.05$). **Conclusion:** It was concluded that group B may have been exposed to heat stress resulting in lower testicular width and weight.It was recommended that caution be exercised in establishing commercial breeder farms in Gwagwalada area of Abuja. Further studies should be done to unravel more comfortable zones in Abuja for breeder farm operations.

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INTRODUCTION

Poultry farming, which is the raising of domesticated birds such as chickens, turkeys, ducks, and geese, for the purpose of producing meat or eggs for food; whether intensively or on free range system (Worldwatch, 2006), is said to have started in Asia, and there is evidence of domesticated chickens in China that dates back to 6000 BC (West and Zhou, 1988). Poultry were kept by farmers in China, India and East Asia long before they were known to the Europeans and Americans (Van Wulfeten Palthe, 1992). Poultry, or domestic birds, are raised for their meat and eggs and are important sources of edible animal protein. Poultry meat accounts for 30% of global meat consumption.

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The worldwide average per capita consumption of poultry meat has nearly quadrupled since the 1960s (11 kg in 2003 compared with 3 kg in 1963). Poultry meat and eggs are highly nutritious. The meat is rich in proteins and is a good source of phosphorus and other minerals, and of B-complex vitamins. Poultry meat contains less fat than most cuts of beef and pork. Poultry liver is especially rich in vitamin A. It has a higher proportion of unsaturated fatty acids than saturated fatty acids. This fatty acid ratio suggests that poultry may be a healthier alternative to red meat. The following five factors are believed to have contributed to the increasing popularity of chicken meat: Value (price) compared with other foods; Good nutritional profile (low in fat); Convenience (ease) of preparation; Versatility; and well suited for quick-service and casual dining menus. The genetic diversity within Nigerian indigenous chicken breeds is decreasing due to their replacement by high producing exotic commercial hybrids indigenous breeds of chickens have been a product of their environment and have survived under harsh condition for many generations (Umesiobi, 2000; Fourie *et al.,* 2004). The limited production of indigenous chicken breeds in large numbers, however, may be attributed to their slow growth rates, poor egg production (Sonaiya and Odubote, 1979; Umesiobi, 2000; Okereke *et al.,* 2008), high rearing mortalities and susceptibility to diseases (Adenokun and Sonaiya, 2001). Reproductive efficiency of commercial breeders continue to pose a challenge to the industry in Nigeria. Several tests to evaluate semen quality have been described (Wisharf *et al.,* 2001; Umesiobi, 2006a & 2006b) but rarely been applied in on farm settings. The industry previously rather relied on the evaluation of semen using colour and volume parameters, which gave estimates of sperm quality (Okereke *et al.,* 2008). Avian males have testes that are located internally, anterior to the kidneys and attached to the dorsal body cavity. Because of the location of the testes, spermatogenesis occurs at body temperature in avian species. The left testis is often larger than the right (Lake, 1957; Lofts and Murton, 1973), and total testicular weight is approximately 1% of the total body weight, depending on the breed of bird (Sturkie and Opel, 1976). The testes contain interstitial tissue and seminiferous tubules. The interstitial tissue and surrounding connective tissue contain blood vessels, lymphatic vessels, nerves and Leydig cells while the seminiferous tubules contain the seminiferous epithelium, consisting of Sertoli cells (Osman *et al.,* 1980; Bergmann and Schindelmeiser, 1987) and various stages of developing germ cells (Lin and Jones, 1990). The epididymis is a series of ducts attached to the testes that empty into the deferent duct. Starting at the testis, the epididymis consists of the rete testis, efferent ducts, connecting ducts and epididymal duct. The deferent duct is a coiled continuation of the epididymal duct that is larger in diameter by 3-fold between the cranial epididymal duct and distal deferent duct (Tingari, 1971).

The distal deferent duct straightens and widens at the cloacal juncture and terminates in the urodeum. Spermatogenesis occurs in the seminiferous epithelium and is the process where stem cells produce diploid spermatogonia that undergo mitosis and then meiosis to divide into haploid spermatocytes. The spermatocytes then undergo meiosis to form spermatids. Spermatogenesis is ultimately controlled by neurons (Sharpe *et al.,* 1994), and depends on testosterone, follicle stimulating hormone (FSH), and the activity of Sertoli cells (Sharp and Gow, 1983). The transformation of spermatids into sperm cells is referred to as spermiogenesis and takes place during 8-10 morphological steps (Gunawardana and Scott, 1977; Tiba *et al.,* 1993) in the seminiferous epithelium. Spermiogenesis includes the formation of an acrosome and axoneme, loss of cytoplasm and nuclear condensation of the cell (Nagano *et al.,* 1962; Tingari, 1973; Gunawardana and Scott, 1977; Oliva and Mezquita, 1986; Sprando and Russell, 1988). The release of fully formed sperm cells from the seminiferous epithelium into the lumen of the seminiferous tubules is known as spermiation. Cells are suspended in fluid secreted by the Sertoli cells. Passage through the seminiferous tubules depends on hydrostatic pressure of the fluid and contraction of myoepithelial cells (Rothwell and Tingari, 1973). Sperm cell transport through recurrent ducts is estimated to take several days (Munro, 1938; De Reviers, 1975) and it is presumed that passage through the deferent duct is dependent upon peristalsis (De Reviers, 1975). The extragonadal sperm reserve is located in the deferent duct (De Reviers, 1975), where the concentration of sperm cells is highest (Clulow and Jones, 1988). Sperm cells are immotile at spermiation (Ashizawa and Sano, 1990). Sperm acquire the potential for motility as they pass through the recurrent ducts (Munro, 1938; De Reviers, 1975; Clulow and Jones, 1988; Ashizawa and Sano, 1990). 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. High ambient temperatures can have a major impact on performance of commercial poultry. When they are coupled with high humidity, the combination can become critical. Therefore, there is a need to re-evaluate the management of poultry and equipment used in hot weather so that heat stress is minimized. Heat Stress not only causes suffering and death in the birds, but also results in reduced or lost production that adversely affects the profit from the enterprise

Birds are ‘heat stressed’ if they have difficulty achieving a balance between body heat production and body heat loss. This can occur at all ages and in all types of poultry. In the ‘thermo neutral zone’, birds can lose heat at a controlled rate using normal behavior. There is no heat stress and body temperature is held constant. When conditions i.e the ‘upper critical temperature’ is exceeded, birds must lose heat actively by panting. Panting is a normal response to heat and is not initially considered a welfare problem. But as temperatures increase, the rate of panting increases. If heat production becomes greater than ‘maximum heat loss’ either in intensity (acute heat stress) or over long periods (chronic heat stress), birds may die. It is important to note that a welfare problem is likely to occur somewhere between the ‘upper critical temperature’ and ‘maximum heat loss’, i.e., before bird losses occur. The stock keeper should be aware of bird behavior and looking for signs of distress. Heat is produced by metabolism within the body, which includes maintenance, growth and egg production. Heat production is affected by body weight, species and breed, level of production, level of feed intake, feed quality and, to a lesser extent, by the amount of activity and exercise. Excluding temperature of the air ventilating the house, heat is also added from the roof and walls. Much of the heat from working litter is used to evaporate moisture and dry the litter. However, 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%). The body weight of the cockerel is important when selecting for breeding flock performance. A significant negative correlation has been established between the growth rate or body weight and the reproductive performance in males (Harris *et al.,* 1980; Lukaszewicz and Kruszynski, 2003). It is crucial for the males to reach a minimum body weight typical for a given breed, strain or type, before being used for breeding (Lisowski and Bednarczyk, 2005). The number of sperm per ejaculate and body weight has been positively correlated and it may be concluded that body weight and length of the shank, comb and wattle are good predictors of semen attributes in cockerels. This is contrary to the reported negative effect of body weight on semen production (Wilson *et al.,* 1979; Galal *et al.,* 2007); Harris *et al.,* 1980 however recorded a positive correlation between body weight and semen volume when cockerels were 48 weeks of age. However, this relationship was not observed when the males were 30 or 40 weeks of age. As would be expected, the body weight of the cockerels increased with an increase in age and the male body weight noticeably influenced the percentage of reproducing males with age. The overall mean age of peak percentage of males regarding semen production, was 44 weeks of age. 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 body, 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 gonadotropins (Bah *et al.,* 2001; Ayo and Sinkalu, 2007; Obidi *et al.,* 2008; Oguntunji *et al.,* 2008). 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 (Karaca *et al.,* 2002). Froman and Feltmann 2005 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 (Ayo and Sinkalu, 2007). The testes in the cockerels are located in the centre of the body cavity, and spermatogenesis occurs at body temperature (41°C), as opposed to the mammalian scrotal temperature of 24 to 26°C (Tuncer *et al.,* 2006). In view of the role of the testes in the production of the male germ cells, measurement of testicular parameters could be used as good indicators of reproductive performance in the cocks. It has been reported that there exists a positive correlation between testis weight and sperm production (Cameron *et al.,* 1990). An accurate method of determining the quantity of sperm that a bird can produce is generally by measuring the circumference of the testes, e.g. the larger the size of the testes, the greater the sperm production (Senger, 2003). This work was designed to compare testicular parameters (length, width and weight) of Isa-brown cockerel breeders from two different climatic zones in Nigeria via Jos which is predominantly cold and Gwagwalada which is predominantly hot.

MATERIALS AND METHODS

The Study Area: The study was carried out at the Pathology laboratory of the Faculty of Veterinary Medicine University of Abuja during the dry season. 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 (Mundi and Chup, 2000). 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 (FCDA, 1979).

Georaphy and climate of study zones: Jos: 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 (National Population Commission, 2006).

Gwagwalada: 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). 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 (Climatologic Information of Abuja).

Experimental cockerels: The animal experiments followed the principles of the Laboratory animal care (Canadian Council on Animal Care Guide). For this study, a total number of twelve breeders Isa-brown cockerels of (18-24 months) weighing between (3-4 kg) were used. These cockerels were randomly selected from two different climatic zones, the first group were selected from Jos Plateau, Nigeria (predominantly temperate region) and the second group were selected from Gwagwalada (predominantly tropical region). All cockerels were maintained in enclosed houses and were fed with standard breeder ration for the period of study.

Experimental Design: Twelve breeder Isa- brown cockerels were randomly selected. Six were selected from three breeder farms in Jos, Plateau state (group A) while six were selected from Gwagwalada, Abuja (group B) during the dry season. 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 zones were measured and recorded after selecting the cockerels. Parameters that were measured were mean daily temperatures (T^o C) and mean relative humidity (%).

Collection of testes and pituitary gland: The cockerels were sacrificed by method of cervical dislocation. After sacrifice the testes and pituitary glands were dissected out and immersed in 10% formalin. The weight of the organs were measured with a sensitive scale and recorded.

Gross examination: The testes were physically examined for colour and size, testicular length and width were measured with a measuring tape and values were recorded.

Statistical Method: 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.

RESULTS

The mean ± SEM of testicular parameters, body weight and the weight of pituitary glands from Isa-brown Cocks selected from Gwagwalada and Jos is presented (Table 1). There were no statistically significant differences between the two groups ($p >0.05$).Weather parameters in the study zones at the time of study were mean daily temperature (°C) 37.5^{o}C and 20^{o}C, Mean relative humidity (%) 54% and 60% for Gwagwalada and Jos respectively.

DISCUSSION

Thetesticular parameters recorded in this study showed that the left testes of both groups have higher values than the right testes. This is in agreement with the report of (Lake, 1957; Lofts and Murton, 1973), the left testis is often larger than the right. The total testicular weight and mean body weight of Gwagwalada cocks were 14.77g and 3.47kg respectively, while the values for Jos cocks were15.66g and 3.50kg respectively. This means that the total testicular weight for Gwagwalada cocks and Jos cocks were 0.43% and 0.45% of total body weight respectively. This finding is in contrast to the report that total testicular weight is approximately 1% of the total body weight, depending on the breed of bird (Sturkie and Opel, 1976). If we are to put the breed into consideration, we can say that the total testicular weight of Isa- brown cocks is approximately 0.5% of total body weight. Again our finding agrees with the report of Etches, 1996 (Etches, 1996), according to the report the size of the two testes may differ, the left testis usually being 0.5-3g heavier than the right testis. However the weight of the paired testes in our study were far from the report of Etches, 1996 who reported that the gross weight of the paired testes is on average 25g, and the sperm produced per gram of testicular parenchyma is approximately 100×10^6, with a daily sperm production of 2.5×10^9sperm/ml. The gross weight of the paired testes in our studies were 14.77g and 15.66g for Gwagwalada and Jos respectively. This means that the values recorded may be peculiar to Isa-brown cocks.The breeder cockerels from Jos Plateau state showed predominantly higher testicular weight and width compared to the cockerels from Gwagwalada, although the differences were not statistically significant. The higher testicular values from Jos corresponds to the lower mean temperature of 20^{o}C and mean relative humidity of 60% recorded. These climatic conditions in Jos are likely not to affect normal physiology of the cockerels, testicular function and development. In contrast, Gwagwalada recorded a mean daily temperature of 37.5^{O}C and relative humidity of 54% during the same period. The birds from Gwagwalada may have been subjected to a chronic heat stress and to some extent dehydration. 37.5^{O}C is well outside the thermo neutral zone for birds. Under this climate, the birds will constantly adjust to loose body heat by evaporative heat loss (panting). Rapid panting may predispose the birds to metabolic alkalosis. Heat stress in this kind of climate may be a chronic type.

Stress emanating from heat may impair the immune system of poultry and increase susceptibility to disease. High ambient temperatures can have a major impact on performance of commercial poultry. When they are coupled with high humidity, the combination can become critical. Therefore, there is a need to re-evaluate the management of poultry and equipment used in hot weather so that heat stress is minimized. Heat Stress not only causes suffering and death in the birds, but also results in reduced or loss of production that adversely affects the profit from the enterprise. Birds are ‘heat stressed’ if they have difficulty achieving a balance between body heat production and body heat loss. This can occur at all ages and in all types of poultry.

In the ‘thermo neutral zone’, birds can lose heat at a controlled rate using normal behavior. There is no heat stress and body temperature is held constant. When conditions i.e the ‘upper critical temperature’ is exceeded, birds must lose heat actively by panting. The non-significant difference observed from the testicular parameters of the cocks from the two study zones may be attributed to the relative humidity of 54% observed in Gwagwalada. This means that heat stress experienced in Gwagwalada may not be as severe as would be experienced in hot damp zones or it may be seasonal. Adult birds take about five days to acclimatize to high temperatures. In line with the testicular parameters the body weight of cocks from Jos were higher than those from Gwagwalada although the difference was not statistically significant. The body weight of the cockerel is important when selecting for breeding flock performance. A significant negative correlation has been established between the growth rate or body weight and the reproductive performance in males (Harris *et al.,* 1980; Lukaszewicz and Kruszynski, 2003). 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. 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. Body temperature increases in heat stressed cockerels, sperm metabolism, sperm motility and sperm quality are generally lower in heat-stressed cockerels. Heat stress may be evaluated by measuring the rectal temperature which is the true reflection of the internal body temperature (Ayo and Sinkalu, 2007). Heat stress has been reported to reduce egg size, shell quality and egg production in the hens. Heat stress has been reported to impair normal hormone function in birds. 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 gonadotropins (Bah *et al.,* 2001; Ayo and Sinkalu, 2007; Obidi *et al.,* 2008; Oguntunji *et al.,* 2008). The role of the reproductive hormones in the male reproduction is pivotal. The testis is a hormone dependent organ. The testes and the accessory male reproductive organs of the cock are androgen dependent. Any disruption of the testosterone function will adversely affect the testicular function and development. Higher weight of the pituitary gland from the cockerels from Gwagwalada may be as a result of compensatory hypertrophy. This is possible because the heat stress which arises when upper critical temperature is attained takes place daily and comes back to thermo neutral zone in the cool evening. The constant fluctuation of temperature and stress induction may lead to constant release of cortisol i.e. that is stress hormone. Cortisol is a steroid and may mimic similar signal of steroid hormones to the pituitary and hypothalamus. This regular signal may have resulted in compensatory hypertrophy of the pituitary glands.

The increase of plasma androgens in the circulatory system has a negative feedback effect by acting upon both the anterior pituitary gland and the hypothalamus to suppress the release of both GnRH and LH (Braunstein *et al.,* 1997). Both LH and FSH are essential for spermatogenesis (Brown and Follett, 1977). Testicular function is dependent upon the combined actions of FSH and testosterone (Sharpe, 1994). In this study the weight of the pituitary from the cockerels from Gwagwalada is inversely related to the values of the testicular parameters. Testicular size has been positively correlated to testicular function. Testicular size is known to be higher in animals that are sexually very active. The cock may not be an exception. Heat stress supresses libido and sexual activity. The lower size of testicular parameters observed from Gwagwalada may be as a result of disuse due to heat stress. Lack of use of the male reproductive organ may have initiated disuse atrophy. Age related effects of the neuroendocrine system on male reproduction include depressed aromatase and vasotocin systems, which are important for sexual behaviour (Panzica *et al.,* 1996; Ottinger, 1997) and indicate that the aging rooster may demonstrate decreased libido. Age factor may not have impacted the result of the present study because the experimental animals were randomly selected within the same age bracket of 18 to 24 months.

Conclusion

It was concluded that the climatic condition in Gwagwalada has mean daily temperature that exceeded the thermoneutral zone for birds,the relative humidity in Gwagwalada may not lead to a damp hot climate depending on the season. The cockerels in Gwagwalada showed lower values of testicular parameters and body weight. The differences were not statistically significant. Heat stress in Isa- brown cockerels is imminent in Gwagwalada although, it may not be as severe as seen in humid hot zones all year round. It was therefore recommended that caution be exercised in establishing commercial breeder farms within the Gwagwalada metropolis. Further studies should be done in other parts of the Federal Capital Territory to unveil more favourable areas for poultry breeder farms and hatchery operations.

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