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Effects of photoperiod on growth performances in female African Giant Rat (*Cricetomys gambianus*)

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Abstract

The present work aimed to investigate the effects of photoperiod on growth performances in captive African giant rat (AGR). It was carried out at the Teaching and Research Farm of the University of Dschang. Thus, twenty-eight animals with comparable weights were randomly assigned to four treatments T24 (24 hrs light/0 hr dark), T18 (18 hrs light/06 hrs dark), T12 (12 hrs light/12 hrs dark) and T0 (0 hr light/24 hrs dark). These animals were housed individually and fed *ad libitum* during four weeks. Food intake, body weight and daily weight gain were recorded weekly. At the end of the experiment, blood was collected and serum obtained was used to essay oxidative stress parameters such as malondialdehyde (MDA), superoxide dismutase (SOD), and catalase (CAT). Results showed that increased photoperiod didn't affect significantly ($p>0.05$) the growth performances. Nevertheless, higher food intake, live weight and daily weight gain were recorded in AGR enlighten compared to animals kept in dark conditions. It also appeared that, the lengthening of the photoperiod has induced a significant ($p<0.05$) enhancement of MDA, SOD and CAT concentrations. The findings of this study indicate that the lengthening of the photoperiod didn't has effect on growth performances in AGR.

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Introduction

In subtropical regions, malnutrition due to low meat consumption constitutes a main cause of infantile mortality and health problems in many adults. 1.3 billion of people are concerned by breeding which provide 80% of the meat consumed in the world (Gbaguidi *et al.*, 2011). Thus, breeding appears as a potential option to solve food imbalance in Africa (Steinfeld *et al.* 2008). In most countries, rodent production is an alternative for conventional meat production and constitutes an important income source for thousands of farmers (Fori,1998). African giant rat (AGR) is one of the most hunted rodents in tropical regions where they are still present. Its meat is much appreciated. Indeed, in Nigeria, 71.4% of the population use this animal as food (Ajayi and Olawoye, 1974). In many regions of Africa, bushmeat has always been an important cultural item and the main source of meat (Abernethy *et al.*, 2013). The development of husbandries for those rodent species would be one of the easiest ways to increase animal production and help protect them against over-hunting and extinction.

AGR is nocturnal in the wild but, in captivity, they are mostly subjected to photoperiod that is completely different from what is observed naturally. It has been noticed that photoperiod can affect growth performances and induces oxidative stress in some animals. Indeed, Tavolaro *et al.* (2015) and Erdem *et al.* (2015) have reported that, long photoperiod (superior to 12 hr/day) induces an increase in feed intake, weight gain and abdominal fat in rats and ducks. Moreover, Schanbacher *et al.* (1982) showed a better feed efficiency in ewe lamb exposed to along daily light. In addition, in poultry and fish it has been shown that increased photoperiod enhances growth performances (Olanrewaju *et al.*, 2012, Veras *et al.*, 2013). Dalal (2016) showed that dependent to species (short or long-day breeds) photoperiod constitutes a source of stress and stress is well-known to cause growth performances loss. Indeed, Yuan *et al.* (2007) showed that oxidative stress depresses growth performances in weaning pigs. Furthermore, it alters physiological functions and behaviour leading to low growth.

Therefore, considering AGR environment in captivity, photoperiod could be one of the major factors necessitating a particular study to improve its breeding. It is the reason why the main objective of this study is to show whether photoperiod affects growth performances of captive AGR.

Materials and methods

Study site

This study was carried out at the Teaching and Research Farm of the University of Dschang (latitude 5-7°N, longitude 8-12°E). Dschang, is situated in the western highlands of Cameroon which is in the sudano-guinean ecological zone. The mean annual temperature and relative humidity are 16-17°C and 49-97% respectively. The mean annual rainfall is about 2000mm and photoperiod is 12 hours dark and 12 hours light.

Experimental animals and housing

For this study, twenty-eight sexually matured females AGR weighting 850 ± 63 g were randomly assigned to four treatments (0hr, 12hrs, 18hrs and 24hrs of light per day) with seven repetitions each. The animals were individually housed in light-controlled rooms.

Feeding

Animals were fed with foodstuffs that are known to be consumed in the wild such as sweet potatoes, maize, ripe bananas and with provender (table 1). They had free access to food and water.

Table 1. Resumes the composition of the provender and bromatological characteristics of diets. kg : kilogram, Kcal : Kilocalorie, DM : dry matter

Ingredients	Proportions (%)
Maize	45
Wheat brand	15
Palm kernel meal	13
Groundnut meal	8
Fish meal	15
Oyster shell	1.5
Iodine salt	2.5
Total	100

Bromatological characteristics of diet

	Provender	Sweet Potatoes	Banana
Crude proteins (% DM)	21	5.11	5.61
Energy (kcal/kg DM)	2700	4040	4362
Lipids (% DM)	3.5	1.16	6.66
Crude Cellulose (% DM)	6	2.50	2.10
Calcium (% DM)	0.8	0.19	0.37
Phosphorus (% DM)	0.8	0.11	0.22

Data collection

Food intake

During the experimental period (four weeks), food intake (FI) was measured. The quantity of feed consumed by the animals was determined by calculating the difference between the quantities of distributed and the refusals.

Live weight

Animals were weekly weighted using an electronic balance (precision 1g). Thus, from the body weight evolution, weight gain (WG) and daily weight gain (DWG) were calculated using the following formulas:

$$WG = \frac{\sum(W_f - W_i)}{N}; DWG = \frac{WG}{T}$$

With,

WG = weight gain

W_f = weight of the week considered

W_i = weight of the previous week

N = numbers of animals per treatment

T = time (week)

Abdominal fat

After four weeks of treatment, the animals were sacrificed and abdominal fat was removed and weighed.

Oxidative stress markers

Blood collected during the sacrifice of the animals was centrifuged at 3000 rounds per minute for 15 min and the serum obtained was used to evaluate oxidative stress parameters. Serum samples were assayed in duplicate. Membrane peroxidase damage was determined by the evaluation of malondialdehyde (MDA) according to Kodjio *et al.* (2016). The activity of superoxide dismutase (SOD) and Catalase (CAT) was analysed according to Dimo *et al.* (2006).

Statistical analysis

Data obtained were submitted to one-way ANOVA to test the effects of photoperiod on studied parameters. Results were expressed as means ± standard deviation. Duncan's test was used to separate means when a significant difference existed.

Results and discussion

Food intake

From the beginning of the study until the coupling of experimental female with male, animals submitted to 12 h/24 seem to eat less than those others treatments (fig 1). However, at the end of the period, no significant ($P>0.05$) difference was noticed among daily food intake of different lighting time (Fig. 2).

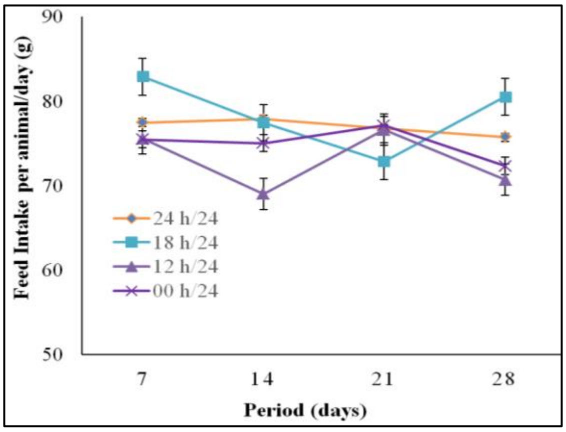

Fig. 1. Evolution of food intake in females AGR exposed to different photoperiods.

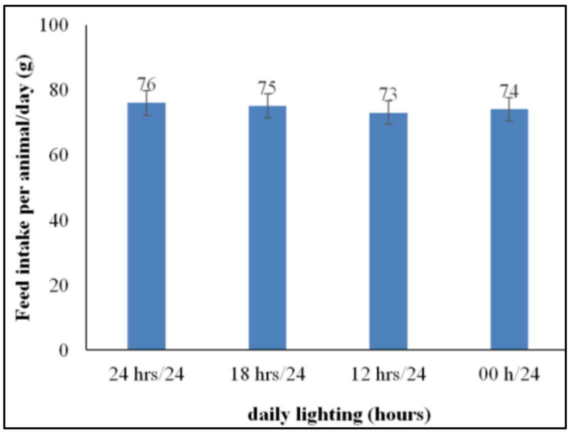

Fig. 2. Effect of photoperiod on food intake in female AGR.

Live weight

In a female AGR, the evolution curve of the live weight presented the same pace whatever the duration of lighting (Fig. 3). Body weight increased during the first week of the study and then remained constant until the end of the third week before increasing again. Thus, the final live weight before mating was not significantly ($P>0.05$) different among studied photoperiods (Fig. 4).

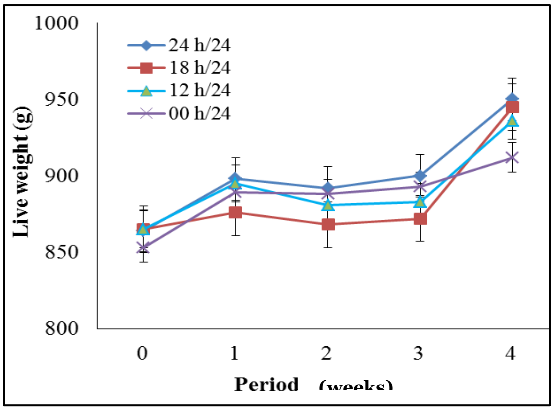

Fig. 3. Evolution of live weight of female African Giant Rat with the photoperiod.

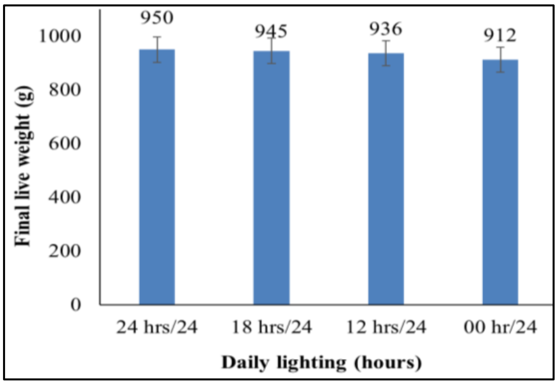

Fig. 4. Effect of photoperiod on live weight of female African giant rat.

Daily weight gain

The evolution of the daily weight gain showed that at the second week of the experiment, females AGR of all treatments lost weight before continuing growing from the third week (Fig. 5). The daily weight gain for the whole study period decreased in parallel direction to the duration of exposure to light (Fig. 6), although not significantly (P>0.05).

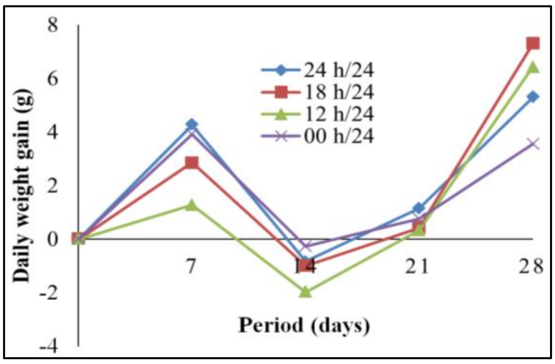

Fig. 5. Evolution of daily weight gain in female African Giant Rat with photoperiod.

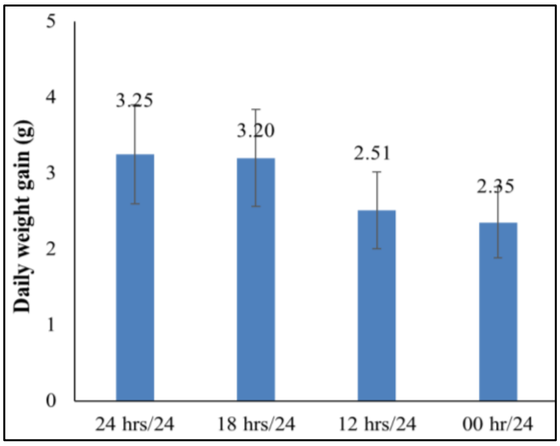

Fig. 6. Effect of photoperiod on daily weight gain in female African Giant Rat.

Abdominal fat

It appears from the Fig. 7 illustrating the effects of photoperiod that the amount of abdominal fat has varied independently of lighting duration. Indeed, it has been significantly (p<0.05) higher in females enlightened 24 hours over 24 compared to those in others treatments, but less important in females reared under 18h/24 photoperiod compared to those bred with12 h/24 and 0 h/24.

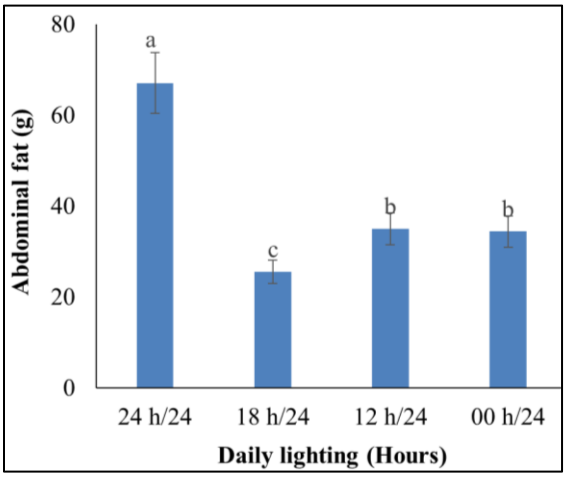

Fig. 7. Effect of photoperiod on abdominal fat in female African Giant Rat [a,b,c]: bar affected with the same letter do not differ significantly (p>0.05).

Oxidative stress

Table 2 shows the effects of photoperiod on oxidative stress markers in female AGR. It appears from this table that increase illumination time induced a significant enhancement (p<0.05) in the serum MDA, CAT and SOD levels in AGR.

Table 2. Effect of photoperiod on oxidative stress markers in female AGR [a,b,c]: means affected with the same letter do not differ significantly (p>0.05). p: probability.

Oxidatives stress markers	Daily lighting				
	24 h/24	18 h/24	12 h/24	00 h/24	p
MDA	3.75 ± 0.13[a]	2.66 ±0.09[b]	2.19 ± 0.50[b]	1.25 ± 0.11[c]	0.00
CAT	12,03 ± 0,86[c]	24.75 ±4.18[a]	17.56 ± 1.82[b]	10.80 ± 1.37[c]	0.00
SOD	0.04 ± 0.00[c]	0.31 ± 0.07[a]	0.17 ± 0.09[b]	0.16 ± 0.11[b]	0.00

Discussion

In domestic animals, there are many growth indicators including, live weight, weight gain and abdominal fat deposit among many others. Both growth and growth indicators are under the influence of food intake.

In the present study, food consumption did not change with the photoperiod, which is contrary to the results of Tavolaro *et al.* (2015) and of Erdem *et al.* (2015) respectively in laboratory rats and in Pekin ducks. These results are also contrary the expectations since African giant rat is a nocturnal animal (Ali *et al.*, 2017), which supposes that it should consume more at night than during the day.

The fact that the consumption of food be comparable between the studied photoperiods leads the reader to expect that growth performances are not significantly different, growth being linked to the presence of raw materials from digestion (McDonald *et al.*, 2010). The comparability of the body weight at the end of the present study was therefore predictable since the quantity of food ingested by the females of the different treatments being similar.

Beside the almost similar food consumption among lighting times, the closed growth performances between treatments could be linked to the age/weight of rats at the beginning of the experiment. African giant rats used in this study were almost adult and therefore at the stage at which growth is very low. More-over, at that stage, changes of the body weight are weak. Instead, changes can be noticed on the development of certain tissues such as reserve white adipose tissue depending on farming conditions, what seems to be the case in the present study. Indeed, the abdominal fat accumulated during the experiment is a form of energy storage (Lawrence and Fowler, 2002). In other words, adipose tissue, specifically reserve white adipose tissue develops when the availability of substrates, be it energetic or not, is above needs (Lawrence and Fowler, 2002). It was therefore not surprising that the accumulation of abdominal fat be positively correlated to food consumption under each photoperiod, and then significantly most important with the longest lighting time. Animals are sometime submitted to various types of stressors present in the external and internal environment (Siegel and Gross, 2000). Oxidative stress markers such as malondialdehyde (MDA), superoxide dismutase (SOD), and catalase (CAT) represent physiological signs of stress in animals. Findings obtained in this experiment showed a significant (p<0.05) increase of MDA, CAT and SOD concentrations in enlighted animals. This result attests that the presence of light induces stress in AGR. Meanwhile, enlighted animals seem to growth more rapidly than animals kept in dark conditions.

This finding be explained by the fact that, rapid growth is linked to an increase of cellular respiration which is a principal source of reactive oxygen species Furthermore, in mammals, there are several studies linking increased growth rate to increase metabolic rate (Criscuolo *et al.* 2008, Careau *et al.*, 2013, Shona *et al.*, 2016). Growth performances in the African Giant Rat are not affected by the photoperiod.

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